# Geochemical and Microbiological Characterization of the Historic Waste Rock Piles at the Detour Lake Gold Mine

by

Brayden McNeill

A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirements for the degree of

Master of Science

in

Earth Sciences

Waterloo, Ontario, Canada, 2016

©Brayden McNeill 2016

## *Author's Declaration*

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## *Abstract*

Four of the historic waste rock stockpiles (WRS #1-#4) at the Detour Lake mine site were studied to determine the potential for generation of acid rock drainage (ARD). The stockpiles were constructed during the original mine operations (1983 - 1999) and were covered with 1 - 1.5 m of local overburden in 2000 to provide a reclamation cover. Waste rock was composed primarily of plagioclase, horneblende, quartz and clinochlore, with small amounts of biotite. The principal sulfide minerals identified were pyrite and pyrrhotite, with small amounts of chalcopyrite and covellite. Measurements of sulfur content ranged from 0 - 2.2 wt. %, whereas the carbon content ranged from 0 - 2.5 wt. %. The neutralization potential ratios (NPR) of WRS#1 and WRS#2 ranged from 0 - 61.1 with an average of 1.6 and 0.7 in profile excavation samples. Over 50 % of samples from WRS#1 and WRS#2 were potential acid generating (PAG). WRS#3 and WRS#4 were slightly less sulfidic resulting in average NPR of 43 and 10, respectively. None of the samples from WRS#3 were PAG, and 45 % of WRS#4 samples were PAG.

The hydrology of the piles is typical of waste rock piles, with a large unsaturated zone. The water tables at WRS#3 and WRS#4 are approximately 16 and 22 mBGS, respectively. The waste rock is usually near residual saturation (5 vol. %), but the passage of wetting fronts commonly increased moisture content to near matrix saturation (~25 vol. %). The cover material retains more moisture than the waste rock, and usually 10 - 20 vol. %. Thermal profiles indicate that both stockpiles remain > 0 ˚C throughout the year, except within the cover. Seasonal fluctuations in temperature are dampened and delayed with greater depth in the stockpile, except near the edge of WRS#4 where the cover was damaged suggesting the cover plays a role in regulating the temperature of the stockpiles. Air-permability testing of the cover material and waste rock

indicates that the cover material impedes advective gas and heat flow. Waste rock at WRS#3 and WRS#4 had air-permeability coefficients of $10^{-9}$ - $10^{-10}$ $m^2$, whereas the cover material had air-permeability coefficients of approximately $10^{-11}$ $m^2$ indicating that air flow through the cover is primarily by diffusion. This observation is in agreement with pore-gas trends at WRS#3 which show $O_2$ depletion and $CO_2$ enrichment with depth. Pore gas at WRS#4 is at atmospheric concentrations throughout, since the destruction of the cover material has removed the barrier to advective gas flow. The results of pore-gas monitoring indicate that the installation of a simple, unengineered cover made from local material may be a cost-effective tool in the management of sulfide oxidation and potential ARD generation at this site.

Pore-water quality at WRS#3 and WRS#4 is characterized as neutral mine drainage, and compares favourably to other neutral mine drainage sites. The pore-wate throughout WRS#3 and WRS#4 is neutral pH. Concentrations of $SO_4^{2-}$ between 200 and 1500 mg/L are caused by sulfide oxidation. Circumneutral pH and depletion of alkalinity in the unsaturated zone indicate that acidity released through sulfide oxidation is neutralized through carbonate dissolution. Pore-water at both piles was saturated with respect to calcite and dolomite. Metal concentrations (i.e. Al, Cu, Fe, Mn, Ni, Zn) in the unsaturated zone were usually < 100 µg/L. Pore-water at WRS#3 and WRS#4 are oversaturated with respect to several secondary Fe and Al minerals including $Fe(OH)_{3(a)}$, goethite, gibbsite and diaspore, which provide controls on the concentrations of dissolved Fe and Al. Secondary covellite (CuS) was observed throughout the stockpiles, suggesting that covellite formation may constrain Cu concentrations. Pore-water samples were undersaturated with respect to secondary Cu, Ni and Zn minerals, indicating that these metals are likely removed from the aqueous phase through adsorption or complexation to Fe-hydroxides. Elevated concentrations of Fe (> 1000 µg/L) and Mn (> 500 µg/L) below the water table at

WRS#4 indicate that these metals are released by reductive dissolution of Fe and Mn oxides. Overall the concentration of dissolved metals in the pore-water of WRS#3 and WRS#4 is much lower than concentrations measured at other sites characterized by neutral mine drainage.

Several genera of fungi were identified in the waste rock of WRS#1 using 18S rRNA analysis, including *Pycnopeziza*, *Leptosphaeria*, *Tetracladium* and *Cucurbitaria*. None of the encountered fungi were ubiquitous or have been shown to impact pore-water geochemistry through sulfide oxidation. Bacterial enumerations were performed on samples from WRS#1 to evaluate the presence of iron and sulfur oxidizing organisms. The enumerated species are common waste rock bacteria including acidophilic sulfur oxidizers (*Thiobacillus thiooxidans* and related species; SOBa), neutrophilic sulfur oxidizers (*Thiobacillus thiparus* and related species; SOBn) and acidophilic iron oxidizers (*Acidithiobacillus ferrooxidans* and related species; FeO) oxidizers. The most numerous were FeO with an average abundance of $9.0x10^5$ bacteria/g. The average abundance of SOBn was $5.5x10^5$ bacteria/g. The SOBa were much less numerous with an average abundance of $1.2x10^3$ bacteria/g. A 16S rRNA analysis confirmed the presence of *Thiobacillus* and *Acidithiobacillus* species. Bacterial diversity was greatest in samples of the cover material. Unoxidized waste rock samples were usually characterized by a dominant iron or sulfur oxidizing genera even at neutral pH (*i.e. Thiobacillus*), whereas oxidized and acidic waste rock samples saw a shift to a dominant acidophilic genera (*i.e. Acidithiobacillus*).

## *Acknowledgements*

I would like to acknowledge the help I received from many people in writing this thesis. First and foremost I should thank my supervisor Dr. David Blowes, who guided all the research and helped me with my writing. I owe a lot to the other architects of this project including Dr. Richard Amos from Carleton University and Dr. Ward Wilson from the University of Alberta. Without the vision and planning of these three professors, there simply would not have been a project for me to work on. The whole project also relied heavily on Jeff Bain, whose dedication and practical experience were invaluable to the organizing of instrument installations and sampling. Thank you to Dr. Dogan Paktunc and Dr. Doug Gould from the Canmet-MMSL laboratories for their guidance in the mineralogical and microbiological research presented in this thesis.

I would like to thank Aileen Cash from the University of Alberta for laying out the groundwork for much of my research with her thesis on the waste rock at Detour Gold. I also received support from several graduate students from the University of Waterloo in the field including Adam Lentz, Mark Steinepreis and Lianna Smith. Several co-op students from the University of Waterloo also helped in field and laboratory research; my thanks to Jackie Chan, Adrienne Trac, Prianca Patel, Seyi Adaghe, Katherine Raymond, Margareta Stoeckl. Several members of the GGR research group helped with the laboratory analysis used in this thesis; thank you to Joy Hu, Julia Jamison-Hanes, Laura Groza and Steven Holland. Also Shuhuan Li who helped out with the XRD and electron microscope work.

Finally, I received a lot of help from employees of the Detour Gold Corporation. Thank you to the members of the Detour Gold Environment Department, who helped provide logistical support and technical advice througout the project. These people include Marie-Helen Turgeon, Ryan Johnson, Maxime Morin, Travis Desormeaux, Mike Bingham, Clarence Trapper, Alex Archibald, Linda St-Germain and Jim Robertson.

If I’ve ommitted anybody who belongs in these acknowledgements I sincerely thank you too.

## *Dedication*

I dedicate this work to the people reading it. You'll have made it worth the effort!

# Table of Contents

*List of Tables* ..... *x*

*List of Figures* ..... *xi*

*Chapter 1 – Introduction* ..... *1*

*1.1 Detour Lake Research Program* ..... *3*

*1.1.1 Research Objectives* ..... *3*

*1.2 Thesis Organization* ..... *4*

*1.3 Detour Lake Mine Site* ..... *4*

*1.3.1 Local Climate* ..... *5*

*1.3.2 Local Geology* ..... *6*

*1.3.3 Site History* ..... *7*

*1.3.4 Historic and Future Waste* ..... *8*

*1.3.5 Waste Rock Physical Characterization* ..... *9*

*Figures* ..... *12*

*Chapter 2 – Detour Gold Waste Rock Characterization Project: Mineralogical and Geochemical Characterization of Two Deconstructed Historic Sulfide-Bearing Waste-Rock Stockpiles* ..... *16*

*2.1 Overview* ..... *16*

*2.2 Introduction* ..... *17*

*2.3 ARD and Mineral Weathering* ..... *18*

*2.3.1 Acid Base Accounting* ..... *21*

*2.4 Site Description* ..... *23*

*2.5 Materials and Methods* ..... *24*

*2.6 Results and Discussion* ..... *27*

*2.6.1 Acid-Base Accounting* ..... *27*

*2.6.2 Mineralogy and Whole Rock Analysis* ..... *29*

*2.6.3 Grain Size Trends* ..... *32*

*2.7 Summary and Conclusions* ..... *34*

*Tables* ..... *35*

*Figures* ..... *38*

*Chapter 3 – Detour Gold Waste Rock Characterization Project: Microbiological Characterization of a Historic Sulfide-Bearing Waste-Rock Stockpile* ..... *68*

*3.1 Overview* ..... *68*

*3.2 Introduction* ..... *69*

*3.3 Microbiology of Acid Rock Drainage* ..... *71*

*3.4 Materials and Methods* ..... *73*
*3.5 Results and Discussion* ..... *75*
*3.6 Summary and Conclusions* ..... *87*
*Tables* ..... *90*
*Figures* ..... *99*
*Chapter 4 – Detour Gold Waste Rock Characterization Project: Sulfide Oxidation and Gas Transport in Two Historic Sulfide-Bearing Waste-Rock Stockpiles* ..... *108*
*4.1 Overview* ..... *108*
*4.2 Introduction* ..... *110*
*4.3 Gas and Water Transport in Waste-Rock Stockpiles* ..... *110*
*4.3.1 Internal Structure of Waste Dumps* ..... *110*
*4.3.2 Gas Transport* ..... *111*
*4.3.3 Heat Transfer* ..... *114*
*4.3.4 Waste Rock Hydrology* ..... *115*
*4.4 Site Description* ..... *118*
*4.5 Materials and Methods* ..... *120*
*4.6 Results and Discussion* ..... *126*
*4.6.1 Waste Rock Characterization* ..... *126*
*4.6.2 Hydrology and Temperature* ..... *128*
*4.6.3 Gas Transport and Pore-Gas Composition* ..... *131*
*4.6.4 The Hydrogeochemistry of WRS#3 and WRS#4* ..... *134*
*4.7 Summary and Conclusions* ..... *141*
*Tables* ..... *146*
*Figures* ..... *153*
*Chapter 5 – Summary and Conclusions* ..... *194*
*References* ..... *198*
*Appendix A – Whole Rock Analysis Data* ..... *208*
*Appendix B – In Situ Waste Rock Monitoring Data* ..... *307*
*Appendix C – Waste Rock Microbiology Data* ..... *381*

## List of Tables

*Table 2.1: C/S and ABA Results (Minimum-Maximum [Average])* ..... *35*
*Table 2.2: X-Ray Fluorescence Results – Minimum-Maximum (Average)* ..... *35*
*Table 2.3: Mineral Composition of WRS#1 and WRS#2 Waste Rock – XRD Results* ..... *36*
*Table 2.4: Optical and SEM-EDS Sample Properties* ..... *37*
*Table 3.1: Qualitative Depth Designation of WRS#1 Microbiology Samples* ..... *90*
*Table 3.2: Detailed Results of Carbon, Sulfur, paste pH and Most Probable Number (bacteria/g) of Thiobacillus thioparus (SOBn), Acidithiobacillus thiooxidans (SOBa) and Acidithiobacillus ferrooxidans (FeO)* ..... *90*
*Table 3.3: Average SOBn, SOBa and FeO Count at Different pH Levels* ..... *91*
*Table 3.4: Bacterial Ecology of Waste Rock Samples from WRS#1 for Sample Sites 1-6 Including all Genera Accounting for > 5 % of DNA in at Least One Sample* ..... *92*
*Table 3.5: Bacterial Ecology of Waste Rock Samples from WRS#1 for Sample Sites 7-12 Including all Genera Accounting for > 5 % of DNA in at Least One Sample* ..... *93*
*Table 3.6: List of Significant (> 10 % in one sample or > 1 % overall) Fungal Genera at WRS#1* ..... *94*
*Table 4.1: Mineral Composition of WRS#4 Waste Rock – XRD Results* ..... *146*
*Table 4.2: C/S and ABA Results (Minimum-Maximum [Average])* ..... *146*
*Table 4.3: X-Ray Fluorescence Results – Minimum-Maximum (Average)* ..... *147*
*Table 4.4: Depth to Ground Water (mBGS) at WRS#3 and WRS#4, 2012-2014* ..... *148*
*Table 4.5: Results of Air Permeability Testing at WRS#3* ..... *148*
*Table 4.6: Results of Air Permeability Testing at WRS#4* ..... *149*
*Table 4.7: Average Saturation Index Calculated for Secondary Carbonate and Sulfate Minerals at WRS#3 and WRS#4* ..... *150*
*Table 4.8: Average Saturation Index Calculated for Secondary Iron and Aluminum Minerals at WRS#3 and WRS#4* ..... *151*
*Table 4.9: Average Saturation Index Calculated for Secondary Zinc, Copper and Nickel Minerals at WRS#3 and WRS#4* ..... *152*

## List of Figures

*Figure 1.1: Detour Lake Historic Waste Rock Stockpiles 1-4 and Pit Lake* ..... *12*

*Figure 1.2: Detour Lake Property – Location Map (from DGC, 2012b)* ..... *13*

*Figure 1.3: Simple Site Diagram of the Detour Gold Mine Site Showing the Location of Future and Historic Waste Rock Stockpiles, the Extent of Planned Excavations, Production Facilities and Tailings Ponds* ..... *14*

*Figure 1.4: Average Daily Temperature (red symbol), Average Atmospheric Temperature (0.9˚C; dashed line) and Cumulative Monthly Precipitation at the Detour Lake Mine Site, 2011-2014* ..... *15*

*Figure 2.1: Location Map of WRS#1, WRS#2 and WRS#3 (WRS#4 nearby) with the Distribution of Test Pits at WRS#1 and WRS#2. (modified from Cash, 2014)* ..... *38*

*Figure 2.2: Results of Acid Base Accounting – WRS#1, WRS#2, WRS#3 and WRS#4 Profile Excavation (PE), Test Pit (TP) and Drill Cutting (DC) Samples* ..... *39*

*Figure 2.3: Results of ABA – WRS#1 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)* ..... *40*

*Figure 2.4: Results of ABA – WRS#1 Test Pit Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) ('*' indicates cover samples)* ..... *41*

*Figure 2.5: Results of ABA – WRS#2 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)* ..... *42*

*Figure 2.6: Results of ABA – WRS#2 Test Pit Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) ('*' indicates cover samples)* ..... *43*

*Figure 2.7: X-Ray Fluorescence Results – Average of WRS#1 and WRS#2 Samples* ..... *44*

*Figure 2.8: X-Ray Fluorescence Results – Waste Rock (Black) and Cover (Red) Samples from WRS#1 and WRS#2 Test Pits* ..... *44*

*Figure 2.9: Quartz (Qtz) and Muscovite (Ms) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *45*

*Figure 2.10: Quartz (Qtz) Grain in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *46*

*Figure 2.11: Quartz (Qtz), Albite (Ab) and Anorthite (An) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *47*

*Figure 2.12: Anorthite (An) Grain in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *48*

*Figure 2.13: Albite (An), Clinochlore (Clc) and Biotite (Bt) Grains in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *49*

*Figure 2.14: Horneblende (Hbl) and Clinochlore (Clc) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *50*

*Figure 2.15: Horneblende (Hbl) and Mixed Horneblende/Albite (Hbl/Ab) Grains in Sample WRS-2-5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *51*

*Figure 2.16: Horneblende (Hbl) and Pyrrhotite (Po) Grains in Sample P1-P2-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification* ..... *52*

*Figure 2.17: Weathered and Unweathered Pyrrhotite (Po) Grains and a Weathered Chalocopyrite grain (Ccp) in Sample P1-P2-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *53*

*Figure 2.18: Weathered and Unweathered Pyrrhotite (Po) Grains and an Unweathered Pyrite grain (Ccp) in Sample P1-P2-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *54*

*Figure 2.19: Unweathered Pyrite (Py) Grain Adjacent to Pyrrhotite (Po) Grain Displaying Weathering Along Fractures in Sample WRS-2-5; Reflected Light Optical Microscopy and SEM-EDS Element*

*Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *55*

*Figure 2.20: Weathered Pyrite (Py) Grain and a Fractured but Marginally Weathered Pyrrhotite (Po) Grain in Sample WRS-2-5; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *56*

*Figure 2.21: Weathered and Unweathered Pyrite (Py) Grains in Sample P4-P7-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *57*

*Figure 2.22: Fractured and Partially Weathered Pyrrhotite (Po) Grains in Sample P4-P7-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *58*

*Figure 2.23: Weathered Pyrite (Py) Grains in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *59*

*Figure 2.24: Weathered Pyrrhotite (Po) Grains in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *60*

*Figure 2.25: Pyrrhotite (Po) Grain Embedded in a Covellite (Cv) Grain in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification* ..... *61*

*Figure 2.26: Grain Size Trends in Carbon/Sulfur – a) WRS#1 Profile Excavation Samples and b) WRS#1 Test Pit Samples* ..... *62*

*Figure 2.27: Grain Size Trends in Carbon/Sulfur – a)WRS#2 Profile Excavation Samples and b) WRS#3 Test Pit Samples* ..... *63*

*Figure 2.28: X-Ray Fluorescence Results – Grain Size Distribution of a) $SiO_2$, b) MgO, c) $Fe_2O_3$ and d) $Al_2O_3$ in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples* ..... *64*

*Figure 2.29: X-Ray Fluorescence Results – Grain Size Distribution of a) CaO, b) $Na_2O$, c) $K_2O$ and d) MnO in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples* ..... *65*

*Figure 2.30: X-Ray Fluorescence Results – Grain Size Distribution of a) Sulfur, b) Copper, c) Nickel and d) Zinc in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples* ..... *66*

*Figure 2.31: X-Ray Fluorescence Results – Grain Size Distribution of a) Chromium and b) Lead in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples* ..... *67*

*Figure 3.1: Approximate Location of WRS#1 Microbiology Samples – Photo Taken July, 2013 (inset modified from Google Maps, 2015)* ..... *99*
*Figure 3.2: Results Paste pH and Carbon Sulfur Analysis for Microbiology Samples* ..... *99*
*Figure 3.3: Results Paste pH and Bacterial Enumerations using the Most Probable Number (MPN) Technique for Thiobacillus thioparus (SOBn), Acidithiobacillus thiooxidans (SOBa) and Acidithiobacillys ferrooxidans (FeO). Cover samples shown in yellow.* ..... *100*
*Figure 3.4: Cumulative Contribution of Bacterial Genera Accounting for > 1 % of Total DNA Across All Samples* ..... *104*
*Figure 3.5: Bacterial Ecology of Cover Samples* ..... *104*
*Figure 3.6: Bacterial Ecology of pH 2-3 Samples* ..... *105*
*Figure 3.7: Bacterial Ecology of pH 3-5 Samples* ..... *105*
*Figure 3.8: Bacterial Ecology of pH 5-6 Samples* ..... *106*
*Figure 3.9: Bacterial Ecology of pH > 6 Samples* ..... *106*
*Figure 3.10: Cumulative Contribution of Fungal Genera Accounting for > 1 % of Total DNA Across All Samples* ..... *107*
*Figure 4.1: Extent of Excavation at WRS#4 and Location of Remaining Instrumented Boreholes* ..... *153*
*Figure 4.2: Approximate Location of Instrumented Boreholes (BH3-1 and BH3-2) and Test Pits (TP3-3, TP3-4, TP3-5, TP3-6 and TP3-7) at WRS#3 (modified from Google Maps, 2015)* ..... *154*
*Figure 4.3: Results of ABA – WRS#4 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)* ..... *155*
*Figure 4.4: Results of ABA – WRS#3 Cover Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)* ..... *156*
*Figure 4.5: Results of ABA – WRS#3 and WRS#4 Drill Cutting Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)* ..... *157*
*Figure 4.6: X-Ray Fluorescence Results – WRS#4 Waste Rock (Black) from Profile Excavation (PE), WRS#3 Cover (Red) and Drill Cutting (DC) Samples* ..... *158*
*Figure 4.7: Thermal Profile of WRS#3 Cover at Locations a) TP3-3, b) TP3-4 and c) TP3-5* ..... *159*
*Figure 4.8: Hydrological Profile of WRS#3 Cover at Locations a) TP3-3, b) TP3-4 and c) TP3-5* ..... *160*
*Figure 4.9: Hydrological Profile of WRS#4 at Locations a) WRS4-2, b) WRS4-3, c) WRS4-4 and d) WRS4-5* ..... *161*

*Figure 4.10: Thermal Profile of WRS#4 at Locations a) WRS4-2, b) WRS4-3, c) WRS4-4 and d) WRS4-5 ..... 162*
*Figure 4.11: Thermal Profile of WRS#3 at Locations a) BH3-1 and b) BH3-2 ..... 163*
*Figure 4.12: Hydrological Profile of WRS#3 at Locations a) BH3-1 and b) BH3-2 ..... 164*
*Figure 4.13: Average Air Permeability Coefficients at WRS#3 and WRS#4 ..... 165*
*Figure 4.14: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#3 at Locations a) BH3-1 and b) BH3-2, 2012-2014 ..... 166*
*Figure 4.15: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#4 at a) BH4-2 and b) BH4-3, 2012-2014 . 167*
*Figure 4.16: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#4 at a) BH4-4 and b) BH4-5, 2012-2014 . 168*
*Figure 4.17: Pore-Gas $O_2$ and $CO_2$ Concentration through WRS#3 Cover Material at Locations a) TP3-3, b) TP3-4, c) TP3-5, d) TP3-6 and e) TP3-7, 2014-2015 ..... 169*
*Figure 4.18a: Pore-Water Geochemical Conditions at BH4-2, 2012-2014 ..... 170*
*Figure 4.18b: Pore-Water Geochemical Conditions at BH4-2, 2012-2014 ..... 171*
*Figure 4.18c: Pore-Water Geochemical Conditions at BH4-2, 2012-2014 ..... 172*
*Figure 4.19a: Pore-Water Geochemical Conditions at BH4-3, 2012-2014 ..... 173*
*Figure 4.19b: Pore-Water Geochemical Conditions at BH4-3, 2012-2014 ..... 174*
*Figure 4.19c: Pore-Water Geochemical Conditions at BH4-3, 2012-2014 ..... 175*
*Figure 4.20a: Pore-Water Geochemical Conditions at BH4-4, 2012-2014 ..... 176*
*Figure 4.20b: Pore-Water Geochemical Conditions at BH4-4, 2012-2014 ..... 177*
*Figure 4.20c: Pore-Water Geochemical Conditions at BH4-4, 2012-2014 ..... 178*
*Figure 4.21a: Pore-Water Geochemical Conditions at BH4-5, 2012-2014 ..... 179*
*Figure 4.21b: Pore-Water Geochemical Conditions at BH4-5, 2012-2014 ..... 180*
*Figure 4.21c: Pore-Water Geochemical Conditions at BH4-5, 2012-2014 ..... 181*
*Figure 4.22a: Pore-Water Geochemical Conditions at BH3-1, 2012-2014 ..... 182*
*Figure 4.22b: Pore-Water Geochemical Conditions at BH3-1, 2012-2014 ..... 183*
*Figure 4.22c: Pore-Water Geochemical Conditions at BH3-1, 2012-2014 ..... 184*
*Figure 4.23a: Pore-Water Geochemical Conditions at BH3-2, 2012-2014 ..... 185*
*Figure 4.23b: Pore-Water Geochemical Conditions at BH3-2, 2012-2014 ..... 186*
*Figure 4.23c: Pore-Water Geochemical Conditions at BH3-2, 2012-2014 ..... 187*
*Figure 4.24: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-2 with Standard Deviation ..... 188*
*Figure 4.25: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-3 with Standard Deviation ..... 189*

*Figure 4.26: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-4 with Standard Deviation* ..... *190*
*Figure 4.27: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-5 with Standard Deviation* ..... *191*
*Figure 4.28: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH3-1 with Standard Deviation* ..... *192*
*Figure 4.29: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH3-2 with Standard Deviation* ..... *193*

# Chapter 1 – Introduction

The environmental challenges associated with extractive mining processes are well understood. The production and storage of tailings material can result in seepage of contaminants to groundwater systems. In some unfortunate cases the failure of storage facilities has resulted in massive releases of contaminants to vulnerable ecosystems. Catastrophic failure of tailings facilities such as the recent incident at Mount Polley Mine – which saw 25 million $m^3$ of effluent released into the neighbouring Polley and Quesnel Lakes (B.C. Ministry of Environment, 2014) – are shocking and captivate public attention, but an equally pernicious and persistent environmental threat exists in the acid rock drainage of waste rock material associated with metal ore mining.

Waste rock makes up the primary waste stream at most open-pit mining operations and consists of host rock or overburden material which is uneconomical to process. Waste rock is retained on site in waste rock stockpiles which frequently contain hundreds of millions of tonnes of material. Once exposed to the atmosphere sulfide minerals contained in waste rock can oxidize and generate acidity resulting in the liberation of trace metals and other elements. Liberated acidity may be neutralized by the dissolution of carbonate minerals if they are present. Acid rock drainage (ARD) derived from many sulfide-bearing waste-rock stockpiles is characterized by low pH, elevated $SO_4^{2-}$, Fe, Al and Mn concentrations, and high concentrations of toxic heavy metals (Akcil and Koldas, 2006). The large volumes of waste rock and the potential for acid rock drainage (ARD) make waste rock management and ARD prevention a key aspect of environmental stewardship for any mining project. The environmental liability and economic cost associated with ARD and waste rock storage is significant. Data published by the government-industry Mine Environment Neutral Drainage (MEND, 2001) research program

shows that there are 6.3 billion tonnes of waste rock in Canada of which 750 million tonnes is acid generating. The cost estimates for managing waste rock and tailings at Canadian mines range from $1.9 to $5.3 billion (MEND, 2001). Considerable research into ARD has been completed with several integrated studies in the recent past investigating the hydrogeological, geochemical, mineralogical, microbiological and physical controls on sulfide oxidation and metal leaching (*e.g.* waste rock research programs at the Diavik Diamond mine (Smith et al., 2013); the Antamina Cu-Zn-Mo mine (Beckie et al., 2011); the Grasberg gold mine (Andrina et al., 2006)). These studies are integral in advancing the predictive and preventative capabilities which will allow mining entities to fulfil their responsibilities as environmental stewards.

The renewal of mining activities at the Detour Lake gold mine provided the opportunity for a comprehensive study on the geochemistry of several historic waste rock stockpiles and the potential for acid rock drainage. The original mine operations, from 1983 to 1999, generated several million tons of waste rock which were placed in five stockpiles each covering several hectares at a depth of 15-20m. In 2000 1-1.5m covers of local overburden material were placed on each stockpile to meet mine closure requirements. In 2006 the Detour Lake mine was purchased by the Detour Gold Corporation (DGC) with plans to expand the existing open pit. DGC estimates over 15 million ounces of gold will be recovered over the 21.5 year mine life, generating over 1,400,000 Mt of waste rock (DGC, 2012a). A study of the historic waste-rock stockpiles on the site was initiated in 2012 to better predict and prevent ARD in future waste dumps.

This thesis presents the results of the waste rock research performed at Detour Lake Mine. Monitoring equipment has been installed in boreholes in two of the historic stockpiles to provide *in situ* measurement of geochemical parameters. The ongoing weathering of these waste dumps

will be monitored throughout the life of mine to measure the extent of sulfide oxidation and acid neutralizing processes, and assess the potential for ARD generation. Two of the historic waste-rock stockpiles, located in the footprint of the expanded pit, have been relocated into new waste rock stockpiles. The relocation provided a rare opportunity to sample the interior of weathered waste-rock stockpiles, providing direct observations of the physical structure and geochemical characteristics, including the extent of sulfide oxidation and secondary mineralization. The study of these four stockpiles will provide insight into the hydrology, gas and water transport, geochemical, and microbiological processes which controlling ARD generation at this site.

## 1.1 Detour Lake Research Program

The study presented here represents only a portion of the waste rock research being conducted at the Detour Lake mine. The overall objective of the research program is to improve waste rock management practices by providing a better understanding of the physical and chemical processes governing pore water geochemistry in sulfide bearing waste rock.

### 1.1.1 Research Objectives

Several long term goals have been identified to achieve the overall objective of improved waste rock management practices at the Detour Lake gold mine:

1. Characterize and understand the hydrology of existing waste-rock stockpiles.
2. Determine the distribution and reactivity of acid-generating sulfide minerals, acid-consuming components, including carbonate minerals, and secondary minerals within the existing waste rock stockpiles and determine the mechanisms controlling the release, transport and attenuation of acidity and dissolved trace elements.
3. Estimate the rates of gas transport, sulfide mineral oxidation, water transport and evolution of water chemistry within waste rock stockpiles at the Detour Lake site.

4. Assess the activity and contribution of sulfide oxidizing bacteria to acid rock drainage at the Detour Lake site.

Monitoring of *in situ* moisture content and weather data along with the physical characterization by Cash (2014) will provide the basis for understanding the hydrology of the waste dumps (goal 1). The geochemical and mineralogical analysis presented in this thesis focuses on determining the potential mineral sources of ARD and potential neutralizing minerals, and geochemical speciation modeling to infer potential secondary mineral controls on pore water geochemistry. Both of these efforts will help accomplish goal 2. Analysis of pore gas and pore water composition, air permeability, *in situ* temperature and moisture content data collected for this study will help realize goal 3. The microbiological analysis presented in this thesis will determine the presence of iron and sulfur oxidizing bacteria (goal 4).

## 1.2 Thesis Organization

This thesis contains five chapters. The first chapter introduces the Detour Lake waste rock research program and outlines the research objectives of this thesis. The first chapter also contains a detailed site introduction and history. Chapter 2 presents the results of geochemical and mineralogical analysis of solid samples recovered during the excavation of waste rock stockpile (WRS) #1 and WRS#2. Chapter 3 presents the results of microbiological testing of waste rock samples recovered from WRS#1. Chapter 4 presents the results of long-term *in situ* monitoring of geochemical conditions at WRS#3 and WRS#4. Chapter 5 presents the conclusions of this study and provides recommendations for future research.

## 1.3 Detour Lake Mine Site

The Detour Lake mine site is located approximately 185 kilometers by road northeast of Cochrane, ON (Figure 1.2). The site has an area of approximately 572 $km^2$ with the production

facilities and open pit located near the center of the property (Figure 1.3). Production facilities include a primary crusher, a dual circuit semi-autogenous grinding mill, a cyanide leached carbon-in-pulp (CIP) processing system and typical ancillary systems (mechanical shops, storage facilities, accommodations, power supply, etc.).

The property encompasses several dozen lakes and waterways, the largest being Sunday Lake (2.8 $km^2$) at the eastern edge of the property. An environmental assessment for the project determined that most catchments on the property drain into the Detour River and identified elevated concentrations of copper, cadmium, cobalt, phosphorus, lead, and iron downstream of the historical tailings pond relative to the provincial and federal water quality criteria (CEAA, 2011). Water quality issues are problematic due to the high species diversity in the local waterways which are home to northern pike, brook trout, whitefish and many more. Several at-risk species also frequent the site including lake sturgeon, woodland caribou, bald eagles, rusty blackbirds, common nighthawks, olive-sided flycatchers, and monarch butterflies (CEAA, 2011).

The land is also the subject of traditional land claims by several First Nations. Ancestors of the present day Ojibwa, Northern Algonquin and Cree people occupied the land as long ago as 8000 years. Several contemporary First Nation and Metis stakeholders including the Moose Cree First Nation, Taykwa Tagamou Nation and Wahgoshig First Nation have identified traditional lands overlapping with the project site.

### 1.3.1 Local Climate

DGC (2012) has reported average historical climate conditions from two Environment Canada weather stations (Kapuskasing, ON and Matagami, QU) in their mine production plans. Average daily temperatures at the site range from -18.8 ˚C in January to 16.6 ˚C in July, with an average yearly temperature of 0.3 ˚C. Average total precipitation is 851 mm with the majority occurring

as rain from June-October. Mean annual wind speed was 12.6 km/h. The prevalent wind direction was from the west and northwest in the winter and spring, and from the west and southwest during the summer and fall.

A weather station was installed on site and has been active since October, 2010. Average yearly wind speed in 2011, 2012 and 2013 was 7.9, 8.6 and 9.6 km/h respectively with prevalent winds from the west-southwest each year. Average yearly temperature from 2011-2013 ranged from -0.4 ˚C to 2.1 ˚C, with an average of 0.9 ˚C. Average yearly cumulative rainfall was 499mm from 2011-2013, but from January to October, 2014 over 730mm of precipitation fell. Figure 1.4 shows the average daily temperature and monthly cumulative precipitation over the study period.

### 1.3.2 Local Geology

Several geological studies of the regional gold belt have been performed over the decades. Oliver et al. (2012) provide the most recent review of the local geology at the Detour Lake deposit. Three primary lithological units have been identified on the property including the Upper Detour Lake Formation (UDLF), Lower Detour Lake Formation (LDLF) and Caopatina assemblage.

The UDLF accounts for approximately 55 % of the waste rock in the historic waste rock stockpiles on site (Robertson et al., 2012) and is dominated by two mafic rock types. The most significant rock type is the massive mafic flow, characterized by magnesium enrichment. The massive flows typically contain 12-15 % plagioclase and 85 % mafic minerals (actinolite-hornblende), and are host to quartz veins and small amounts (< 5 %) of carbonates and sulfides, mainly pyrrhotite and pyrite. The second major rock type of the UDLF are the potassically altered mafic pillow flows, commonly containing secondary biotite, albite and pyrrhotite-pyrite-chalcopyrite (DGC, 2012a; Oliver et al., 2012).

The LDLF is composed of several rock types including the “chert marker horizon”, a chloritic schist contact unit, and ultramafic flows and sills. Other secondary rock types in the LDLF include mafic volcanic, felsic volcaniclastics, mafic sills and dykes, and a megacryptic dioritic sill. The chert marker horizon is a 0.5 - 2.0 m thick unit at the contact between LDLF and UDLF. This horizon is one of the primary host rocks associated with targeted mining during the historical mining operation, and is calc-alkaline in composition. The chloritic schist unit is 5 – 20 m in thickness and also follows the contact between LDLF and UDLF. It lacks matrix feldspar and has chloritic and local potassic alteration. The largest unit of the LDLF are the ultramafic flows and with coarse grained pyroxenites and fine-grained ultramafic sills which are commonly altered in a talc-chlorite schist (DGC, 2012a; Oliver et al., 2012).

The Caopatina assemblage, which together with the LDLF accounts for approximately 44 % of the waste in the historic waste-rock stockpiles (Robertson et al., 2012), is a sedimentary rock unit characterized “by a well-laminated sequence of argillaceous siltites, quartz wackes, banded amphibolites and volcaniclastics and lesser mafic tuffaceous rocks” (DGC, 2012a).

### 1.3.3 Site History

In 1974 an anomalous geological deposit was located on the current mine property, and the first exploration borehole was sunk in October of that year (DGC, 2010). The property owner, Amoco, initiated exploration in earnest in 1975 with over 55,000 meters of drilled surface wells between 1974 and 1979. Amoco began a joint venture agreement with Campbell and Dome Mines Ltd. in 1978 and five years later open pit mining began. From 1983 to 1987 over 3 Mt of ore with a grading of 3.25 g/t Au was retrieved from the open pit. Open pit production was reduced from 1987 to 1999, during which time only 1.6 Mt with a grade of 1.4 g/t Au was retrieved from the open pit. Reduced output from the open pit was offset by underground mining

which began in 1987. In the same year Campbell, Dome and Placer development merged to form Placer Dome Inc., which purchased the remaining shares of Amoco. Underground mining continued under the full ownership of Placer Dome Inc. until 1998, during which time approximately 9 Mt of ore with a grading of 4.98 g/t Au was retrieved. In July, 1999, due to low gold prices and the depletion of high grade deposits, mining was stopped indefinitely at the Detour Lake mine site.

After Placer Dome Inc. stopped mining on the site the property passed through several ownership agreements. In 2005 the mine operator (Pelangio-Larder Mines Limited) released mineral resource estimates. Further explorative drilling was carried out by Detour Gold Corporation (DGC) over the next few years. In 2006 DGC began purchasing the mine property through several agreements and gained majority ownership on October 31, 2008. Redevelopment of the property and construction of new processing facilities took place from 2010 - 2012 and mine production resumed in early 2013. The mine should be operational for 23 years and is expected to yield 16.4 million ounces of gold. Upon completion the pit will be 3.3 km long, 1.2 km wide and 600 meters deep. In total, the mine will remove approximately 2.2 billion tonnes of rock, most of which will be stored in vast stockpiles.

### 1.3.4 Historic and Future Waste

Previous operations at the Detour mine site produced several million tonnes of waste rock which were placed in four stockpiles around the open pit starting in 1983. Today the historic waste rock stockpiles at Detour Gold are between 16 and 32 years old (mine production from 1983-1999). Historical operations also generated approximately 10 Mt of tailings which were contained in a pond approximately two kilometers east-northeast of the former open pit (Figure 1.3).

Two of the initial waste stockpiles (WRS#1 & WRS#2) were excavated and relocated into a permanent stockpile, which will contain waste rock from the expanded mine. The remaining historical stockpiles, WRS#3 and WRS#4 have areas of approximately 3.5 and 11.5 hectares respectively (Ryan Johnson, personal communication, 2014). All of the historical stockpiles are smaller than the planned waste rock stockpiles. Although the compositions of the historical and planned stockpiles at the Detour Lake mine differ, the instrumentation and analysis of geochemical data from the historical stockpiles will provide DGC insight on the future behavior of their waste rock stockpiles.

The 10 Mt of historical tailings are located within the expanded tailings management area (TMA) which is currently under construction. When completed the TMA will have a capacity of approximately 482 Mt and will completely overlie the historic tailings facility.

Waste rock produced over the coming decades will be confined to two large waste rock stockpiles, the North Pile with a capacity of 185 $Mm^3$ and the South Pile with a capacity of 450 $Mm^3$ (Figure 1.3). Low grade ore will be stockpiled over the mine life and potentially beyond in Low Grade Piles 1-3, with capacities of 37, 72 and 28 $Mm^3$. A final stockpile of overburden (52 $Mm^3$) will also be stored on site. Potentially acid generating waste rock, which accounts for as much as 20 % of the generated waste rock, will be segregated to a specific area on the southern edge of the North Pile (DGC, 2012a).

### 1.3.5 Waste Rock Physical Characterization

The initial characterization of solid waste-rock samples from Detour Gold (Cash, 2014) had two main components. First, the collection of *in situ* waste rock samples and the measurement of physical conditions such as matric suction and moisture content. The second task was to perform a laboratory analysis including grain size distribution using traditional sieves and digital imaging

techniques, paste pH analysis, saturated hydraulic conductivity estimates using a constant head permeameter, and the measurement of soil water characteristic curves (SWCC) to predict unsaturated flow behavior.

Cash made several key conclusions following the physical characterization of WRS#1, WRS#2 and WRS#4. The first is that the stockpiles were likely constructed using a push or paddock style dump which resulted in significant particle size segregation during deposition. The piles were built in 10 - 15 m lifts, and coarse grained boulders and cobbles have accumulated at the bottom of the lifts. Cash also noted that the piles displayed evidence of oxidation and weathering (rust colour), both on the surface of clasts but especially in the fine-grained material. After digital image processing the waste rock was classified as being rock-like, with < 40 % of the particles passing the 4.75 mm sieve. On average the < 4.75 mm fraction – which is where water flow occurs – consisted of 17 % of the waste rock mass. *In situ* measurements of matric suction and moisture content taken during the sampling campaign ranged from 1 kPa to 53 kPa and 0.3 wt. % to 12.5 wt. % respectively. The results of the paste pH analysis were mostly in the neutral range of 6 to 8 pH, with notably reddish, oxidized samples typically having a more acidic paste pH. Approximately 20% of the samples had a paste pH less than 4. Saturated hydraulic conductivity for the waste rock fines ranged from $10^{-5}$ m/s to $10^{-6}$ m/s. The waste rock SWCCs measured by Cash show “large transition zones and low air entry values”, meaning the samples drained quickly under very low applied suction. Cash also noted that the storage capacity of the cover material was far greater than that of the waste rock. Finally, Cash provided an estimate of the residence time of a 20 m waste-rock stockpile with the average characteristics of those measured from WRS#1 and WRS#2. Assuming 100 % infiltration, Cash estimated that the average pore

water residence time in the stockpiles would be approximately 1.1 years, or assuming 50 % infiltration approximately 2.2 years (Cash, 2014).

## Figures

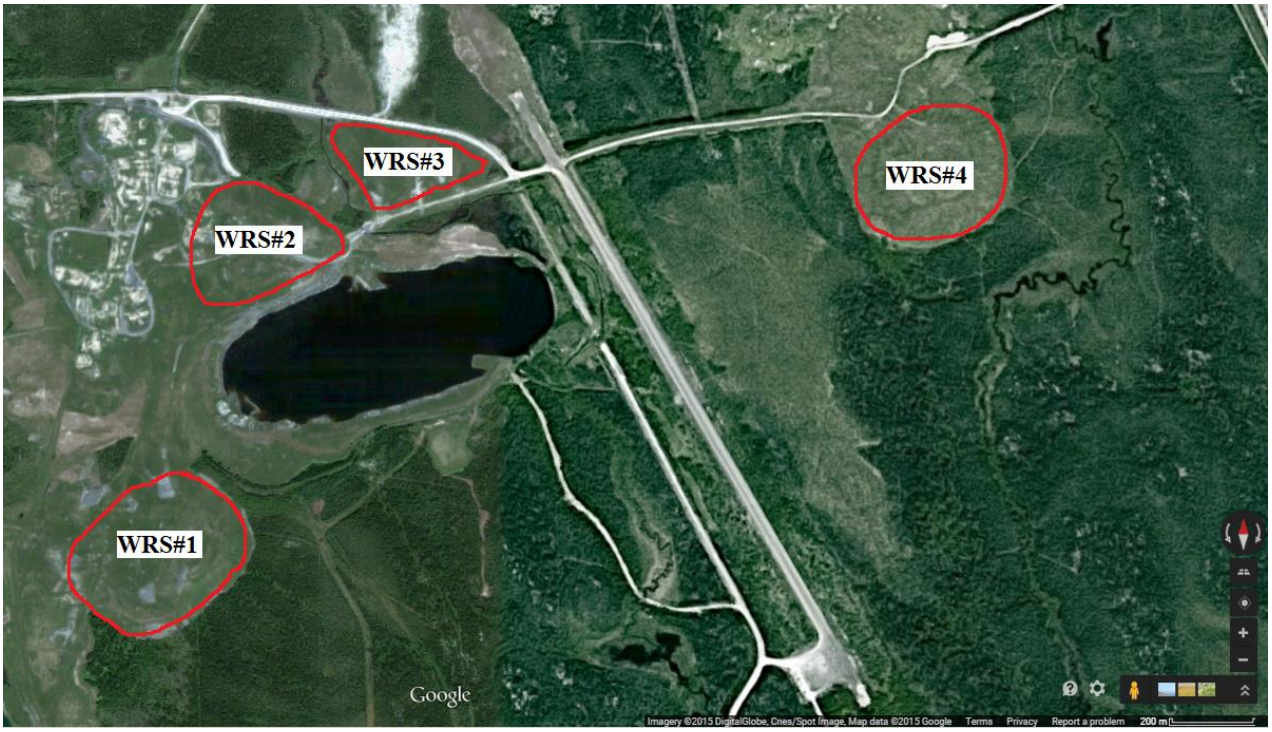



***Figure 1.1: Detour Lake Historic Waste Rock Stockpiles 1-4 and Pit Lake (modified from Google Maps, 2015)***




***Figure 1.2: Detour Lake Property – Location Map (from DGC, 2012b)***

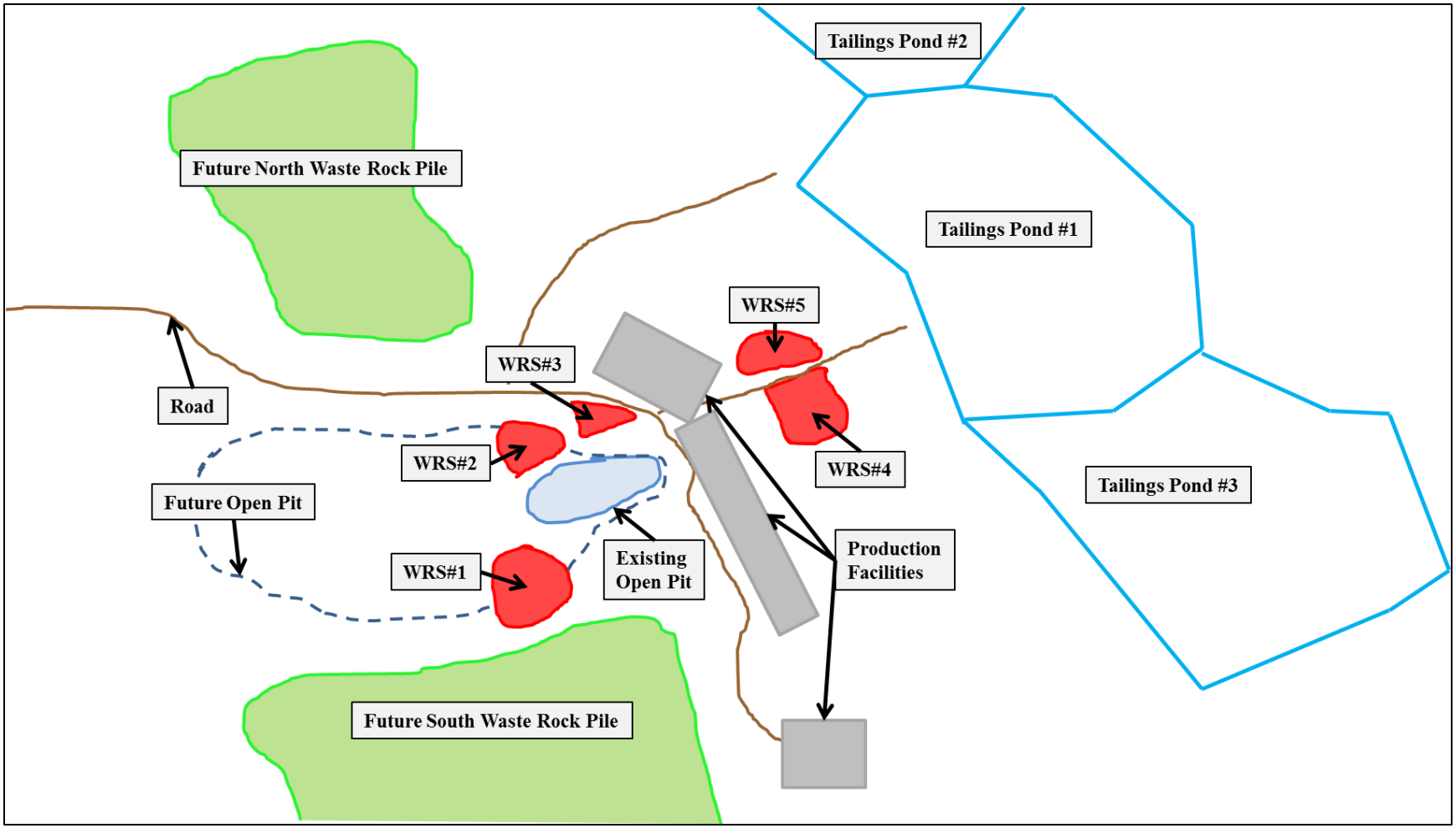



***Figure 1.3: Simple Site Diagram of the Detour Gold Mine Site Showing the Location of Future and Historic Waste Rock Stockpiles, the Extent of Planned Excavations, Production Facilities and Tailings Ponds***

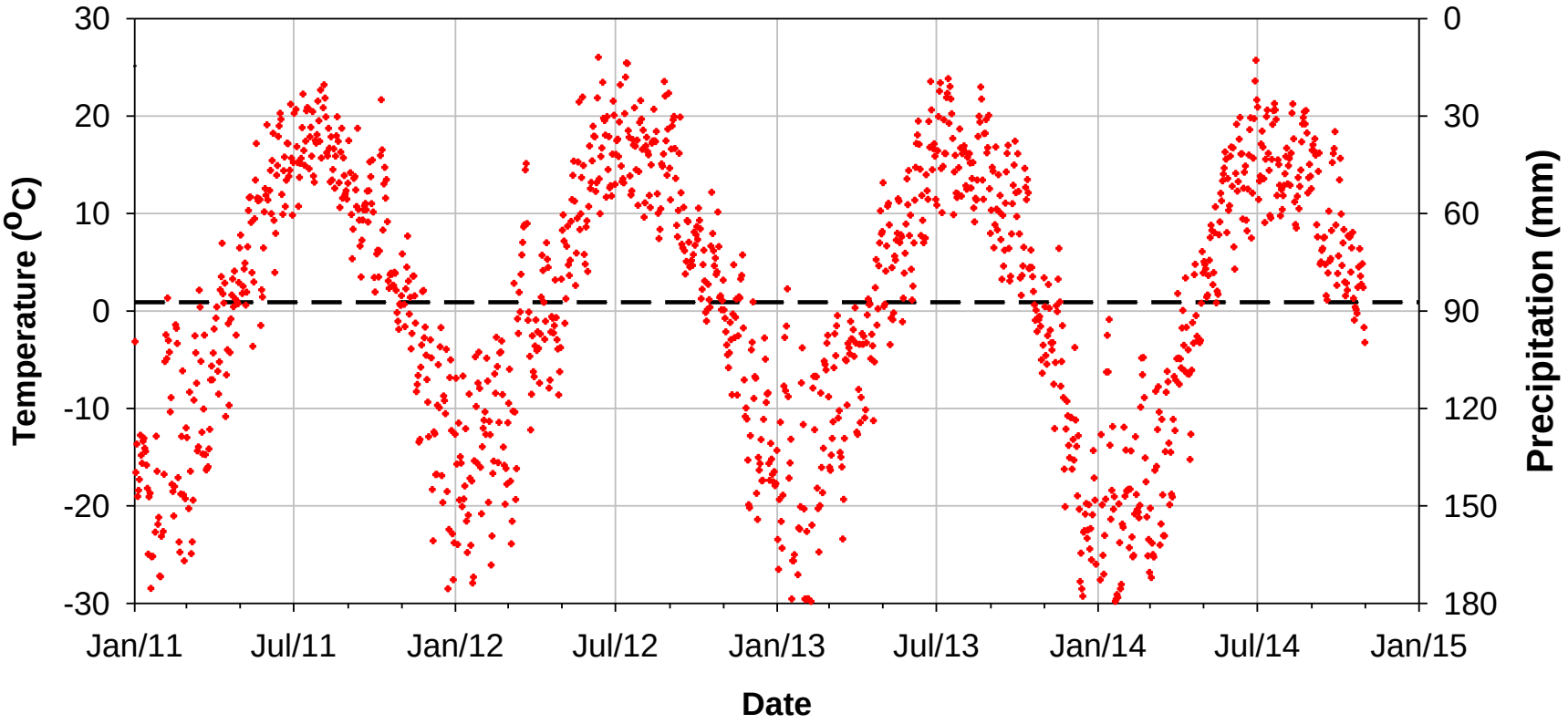



***Figure 1.4: Average Daily Temperature (red symbol), Average Atmospheric Temperature (0.9˚C; dashed line) and Cumulative Monthly Precipitation (black line) at the Detour Lake Mine Site, 2011-2014***

# Chapter 2 – Detour Gold Waste Rock Characterization Project: Mineralogical and Geochemical Characterization of Two Deconstructed Historic Sulfide-Bearing Waste-Rock Stockpiles

## 2.1 Overview

Two historic waste rock stockpiles (WRS) at the Detour Lake mine northeast of Cochrane, ON were deconstructed and extensively sampled as part of a project to characterize the 20 - 30 year old historic waste and to develop plans for future waste management. This chapter presents the results of mineralogical and whole rock analyses performed on samples recovered from stockpiles WRS#1 and WRS#2. The mineralogy results show the geochemical alteration of the waste rock, specifically the depletion of carbon and relative concentration of sulfur and trace metals at small grain sizes (< 0.2 mm).

Samples were recovered from test pits on the surface as well as the excavated profiles of both stockpiles. The mineralogy of the waste rock is dominated by plagioclase and horneblende with lesser amounts of clinochlore, vermiculite, biotite and quartz. Variable quantities of sulfides (*i.e.* pyrite, pyrrhotite) and carbonates (*i.e.* calcite, dolomite) are present throughout the piles. Characterization of the stockpile material indicates that the minimum and maximum sulfur content of WRS#1 and WRS#2 ranged from 0.05 - 2.2 wt. % (*i.e.* acid production potential (APP) of 1.4 - 69.3 kg$CaCO_3$/tonne) with an average of approximately 0.9 wt. % (*i.e.* APP = 30.4 kg$CaCO_3$/tonne) at both stockpiles, with very little difference between test pit and profile samples. Total carbon content, assumed to be present as carbonate, ranged from 0.03 - 1.8 wt. % and averaged approximately 0.4 wt. % at WRS#1 and 0.2 wt. % at WRS#2. Neutralization potential (NP), assuming all carbon is present as carbonate, ranged from 0.3 - 150.6 kg$CaCO_3$/tonne and averaged 39.1 kg$CaCO_3$/tonne at WRS#1, and 20.4 kg$CaCO_3$/tonne at WRS#2. The neutralization potential ratio (NPR) of samples from WRS#1 and WRS#2 ranged

from 0.04 - 61.1. Lower NPR values were measured in the profile excavation samples as compared to test pit samples. Average test pit NPR values for WRS#1 and WRS#2 were 8.1 and 6.9 respectively, while the average of the WRS#1 and WRS#2 profile excavation samples were only 1.6 and 0.7. The NPR values of these stockpiles indicate that approximately 62 % of WRS#1 samples and 72 % of WRS#2 samples are considered potentially acid generating (PAG) based on the NPR cutoff value of 1.5 at the Detour Gold mine. The acid-base analysis is consistent with the results of a paste pH analysis carried out on the samples. The paste pH of the samples was mostly in the neutral range of 6 to 8 pH, with notably reddish, oxidized samples typically having a more acidic paste pH.

Grain size trends in waste rock composition at WRS#1 and WRS#2 show enrichment of sulfur, Fe, Cu, Ni and Zn in the finer grain size fractions. Carbon was mostly depleted in intermediate grain sizes (0.105-0.149 mm), but enriched in the smallest size fractions (< 0.105 mm). The observed trends in sample compositon can be attributed to the dissolution of secondary minerals and precipitation of secondary minerals commonly encountered in mine waste systems.

## 2.2 Introduction

Waste rock makes up the primary waste stream at most open-pit mining sites. Typically waste rock is stockpiled at the mine site in large structures known as a waste-rock stockpiles which frequently contain hundreds of millions of tonnes of material. Once exposed to the atmosphere sulfide minerals contained within the waste rock can oxidize, potentially generating acidity and resulting in the liberation of sulfate, dissolved metals and other dissolved constituents. Acid consuming reactions in may delay the onset of acidic conditions. The volume of waste rock and the potential for generation of acid rock drainage (ARD) make waste rock management a key component of environmental stewardship for any mining project.

The renewal of mining activities at the Detour Lake is expected to generate over 1,400,000 MT of waste rock over its forecasted 21.5 year life (DGC, 2012a). The original mine operations from 1983 to 1999 generated several million tons of waste rock which were separated into five stockpiles covering several hectares each at a depth of 15 - 20 m (Figure 1.1; *n.b.* only the four stockpiles studied in this thesis are shown). The stockpiles were covered in 1999 as part of mine closure activities. The relocation of waste-rock stockpiles derived from previous mining at the Detour Lake mine site provided the opportunity for a comprehensive study on sulfide mineral oxidation and acid neutralization on several waste-rock stockpiles that have been in place for up to 32 years. A study of the historic waste rock stockpiles on the site was initiated in 2012 to better predict and prevent ARD in future waste dumps.

Two of the older waste-rock stockpiles (WRS#1 and WRS#2) were located in the footprint of the expanded pit-mine, making a complete deconstruction necessary. This chapter describes the mineralogical characterization of waste-rock samples recovered from the deconstructed stockpiles and effects of weathering on the primary minerals within the waste.

## 2.3 ARD and Mineral Weathering

Acid rock drainage (ARD) is derived from iron-sulfide bearing waste rock. Oxidation of iron-sulfide minerals results in drainage water characterized by acidic pH, abundant $SO_4^{2-}$ and dissolved metals (Akcil and Koldas, 2006). Carbonate or silicate minerals present in the waste rock provide acid neutralization capacity to offset the acid generated by sulfide oxidation, but in cases where acid producing minerals are abundant or where acid neutralizing minerals are scarce the neutralization capacity of the waste rock may be depleted as sulfide hydroxide oxidation continues.

Sulfide oxidation may proceed biotically or abiotically with a variety of oxidants (Nordstrom et al., 2015), most commonly $O_2$ and Fe(III). The overall reaction for pyrite oxidation, hydrolysis of Fe(III) and precipitation of ferric (oxy) [$Fe(OH)_3$] releases four moles of $H^+$ and two moles of $SO_4^{2-}$ for every mole of pyrite oxidized. The reaction begins with the surface oxidation of the iron-sulfide (*e.g.* pyrite) by dissolved $O_2$ (equation 2.1):

(2.1) $$FeS_{2_s} + \frac{7}{2}O_{2_{aq}} + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$$

The liberated Fe(II) is oxidized to Fe(III) under acidic conditions (equation 2.2):

(2.2) $$Fe^{2+} + \frac{1}{4}O_{2_{aq}} + H^+ \rightarrow Fe^{3+} + \frac{1}{2}H_2O$$

Fe(III) contributes to further oxidation of the sulfide (equation 3.3) and, under low pH conditions, likely overtakes dissolved $O_2$ as the primary oxidant (Moses et al., 1987):

(2.3) $$FeS_{2_s} + 14Fe^{3+} + 8H_2O \rightarrow 15Fe^{2+} + 2SO_4^{2-} + 16H^+$$

Fe(III) may also precipitate as iron oxides and hydroxides (equation 3.4) such as Fe(III) hydroxide ($Fe(OH)_3$), ferrihydrite ($Fe_2O_3.0.5H_2O$), magnetite ($Fe_3O_4$), hematite ($\alpha$-$Fe_2O_3$) and goethite ($\alpha$-FeOOH), due to the low solubility of Fe(III) hydroxide minerals at near neutral pH (Schwertmann, 1991):

(2.4) $$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_{3_s} + 3H^+$$

Combining equations 2.1, 2.2 and 2.4 yields the overall iron-sulfide oxidation reaction in the presence of excess $O_2$ (equation 2.5):

(2.5) $$FeS_{2_s} + \frac{7}{2}H_2O + \frac{15}{4}O_{2_{aq}} \rightarrow Fe(OH)_{3_s} + 2SO_4^{2-} + 4H^+$$

The mobility of $H^+$ in waste-rock stockpiles is a function of acid neutralization processes in addition to sulfide oxidation. Acid neutralization takes place through the dissolution of a sequence of minerals including carbonates, Al- and Fe(III)-hydroxide phases, and aluminosilicate minerals. The consumption of $H^+$ through these reactions, acid neutralization can result in a decline in dissolved contaminant concentrations through the precipitation, co-precipitation, adsorption and complexation of secondary minerals and metals.

Carbonate dissolution is the primary acid neutralization mechanism at most mine waste sites through reactions of the form (Al et al., 2000; Jurjovec et al., 2002; Sherlock et al., 1995; Gunsinger et al., 2006b):

$$CaCO_3 + H^+ = Ca^{2+} + HCO_3^- \quad (2.6)$$

Calcite [$CaCO_3$] dissolution proceeds more rapidly than dissolution of dolomite [$CaMg(CO_3)_2$], ankerite [$Ca(Fe,Mg)(CO_3)_2$] and siderite [$FeCO_3$] (Al et al., 2000). Dissolution rates depend on several variables including mineral type, temperature, flow rate, grain size, and pH.

Silicate minerals also provide a nominal neutralization capacity to most waste rock stockpiles. Jambor et al. (2002) suggest that most silicates do not dissolve rapidly enough to provide sufficient acid consuming capacity to offset acid generation. The low neutralization capacities of the silicates may be attributed to the rate of silicate dissolution, which are orders of magnitude lower than the rate of sulfide oxidation and carbonate (especially calcite) dissolution. Sherlock et al. (1995) and others (Strömberg and Banwart, 1999) argue that silicates can contribute significantly to the acid neutralization regime of a waste rock stockpile by virtue of their abundance, especially in the long-term – after the depletion of easily dissolved carbonate minerals.

As with carbonate minerals, the dissolution rate of silicate minerals is dependent on several variables. Impurities in the silicon lattice (*i.e.* Al substitutions) will increase dissolution rates, as will increases in temperature and smaller grain sizes (Jambor et al., 2002), but several studies reviewed by Sherlock et al. (1995) indicate that the dissolution rate is dependent primarily on pH.

As carbonate dissolution neutralizes acidic pore-water conditions, mobilized metals will precipitate as a variety of secondary Fe(III) and Al- oxide, hydroxide and sulfate minerals. Several of these minerals are important sources of acidity as they precipitate, and may provide acid neutralizing capacity if future pore-water conditions (*i.e.* after carbonate depletion) become more acidic. Notable secondary minerals in waste rock stockpiles include the Fe(III) (oxy)hydroxide phases of goethite [α-FeOOH] and ferrihydrite [$Fe(OH)_{3(a)}$], amorphous aluminum oxide [$Al(OH)_3(a)$], and gibbsite [$Al(OH)_3$]. Secondary sulfate minerals are also common, notably gypsum [$CaSO_4 \cdot 2H_2O$] and jarosite [$KFe_3(SO_4)_2(OH)_6$] (Hammarstrom et al., 2005).

### 2.3.1 Acid Base Accounting

Acid-base accounting (ABA) provides a forecasting tool to estimate the potential for generation of ARD. The ABA method relies on static measurements of the sample composition in order to compare the distribution of acid-generating versus acid-neutralizing minerals. The relative contribution of these minerals should determine the quality of waste rock effluent, and the comparison allows a prediction of ARD severity to be obtained (Skousen et al., 2002; Brady and Cravotta, 1992).

The ABA method presented in this thesis (Brady and Cravotta, 1992) relies on several simplifications and assumptions to generalize the method and extend observations between sites.

Acidic drainage can be caused by the oxidation of several different types of minerals; however, in this thesis it is assumed that the oxidation of each mole of sulfur will generate two moles of $H^+$. It is also assumed that all sulfur and carbon in the sample are available for consumption and that 100% of the material would contribute to acid consuming and acid generating reactions.

The carbon and sulfur content are then multiplied by constant values to determine their equivalence as kg of $CaCO_3$ based on an idealized system of acid production by pyrite oxidation and complete acid neutralization through calcite dissolution – presented in equation 2.7 (Skousen et al., 2002):

(2.7) $$FeS_2 + 2CaCO_3 + 3.75O_2 + 1.5H_2O \rightarrow Fe(OH)_3 + 2SO_4^{-2} + 2Ca^{+2} + 2CO_2$$

In equation 2.7 one mole of pyrite (64 grams) is neutralized by two moles of calcite (200 grams). Therefore 3.125 grams of calcite are required to neutralize every gram of pyrite present in the rock – or, for every 1 wt. % of sulfur in a tonne of waste rock enough acid is produced to neutralize 31.25 kg of $CaCO_3$. The total acid production potential (APP) is calculated using equation 2.8. Carbon content is multiplied by 83 to obtain the neutralization potential (NP) as kg $CaCO_3$ per tonne of waste rock (equation 2.9). The net neutralization potential (NNP) of a sample is determined by the difference between the NP and APP (equation 2.10), while the neutralization potential ratio (NPR) is obtained by taking the ratio of NP to APP (equation 2.11).

(2.8) $$\text{APP}\left[\frac{kg\ CaCO_3}{tonne}\right] = Total\ Sulfur\ [wt.\%] \times 31.25\left[\frac{eq.\ kg\ CaCO3}{wt.\%\ S}\right]$$

(2.9) $$\text{NP}\left[\frac{kg\ CaCO_3}{tonne}\right] = Total\ Carbon\ [wt.\%] \times 83\left[\frac{eq.\ kg\ CaCO3}{wt.\%\ S}\right]$$

(2.10) $$\text{NNP} = \text{NP} - \text{APP}$$

(2.11) $$\text{NPR} = \frac{NP}{APP}$$

Typically waste rock is considered acid generating (PAG) if NPR < 1, not acid generating (NAG) if NPR > 2, and potentially acid generating (PAG) if 1 < NPR < 2. DGC policy is to classify any waste material with NPR < 1.5 as PAG material, a conservative approach.

## 2.4 Site Description

The Detour Lake mine site is located approximately 185 kilometers by road northeast of Cochrane, ON (Figure 1.2). Climate conditions estimated from historic measurements made at two nearby Environment Canada weather stations indicated an average yearly temperature of 0.3 ˚C (DGC, 2012a). Average total precipitation was 851 mm with the majority occurring as rain from June-October. Mean annual wind speed was 12.6 km/h and the prevalent wind direction was from the west. A weather station was installed at the Detour Lake site in October, 2010, and has been monitored since installation. Average annual wind speeds in 2011, 2012 and 2013 were 7.9, 8.6 and 9.6 km/h respectively with prevalent winds from the west-southwest. Average yearly temperature from 2011-2013 ranged from -0.4 ˚C to 2.1 ˚C, with an average of 0.9 ˚C. Average yearly cumulative rainfall was 499 mm from 2011-2013, but from January to October, 2014 over 730 mm of precipitation fell. Figure 1.4 shows the average daily temperature and monthly cumulative precipitation over the study period.

Waste rock at the Detour Lake mine is derived primarily from three geological formations found on site (Oliver et al., 2012). The majority (55 %) of waste rock is derived from the Upper Detour Lake Formation (UDLF), a formation of massive and pillowed mafic flows. The composition of the UDLF is dominated by mafic minerals (actinolite-horneblende) and plagioclase. The UDLF also contains quartz veins and small quantities (< 5%) of carbonates and sulfides. The Lower Detour Lake Formation and Caopatina assemblage are geological formations which account for

the remaining waste rock (44 %). The LDLF contains several distinct geological units including the “chert marker horizon”, a chloritic schist contact unit, ultramafic flows and sills, mafic volcanic, felsic volcaniclastics, mafic sills and dykes, and a megacryptic dioritic sill (Oliver et al., 2012). The primary sulfide minerals on site are pyrite and lesser pyrrhotite, with minor chalcopyrite, pentlandite and arsenopyrite. Calcite is the primary carbonate mineral, with limited dolomite (Robertson et al., 2012).

Little is known about the depositional history of the Detour Gold initial waste-rock stockpiles, but it can be deduced from the site history that they were initially deposited between 1983 - 1999. A 1.0 - 1.5 m cover composed of local overburden material was installed on the stockpiles in 2000 to meet mine closure requirements. Visual observations during the excavation of WRS#1 and WRS#2 indicate that a significant quantity of overburden material was deposited in the stockpiles along with the waste rock.

## 2.5 Materials and Methods

### *2.5.1 Solid Sampling and Waste Rock Characterization Methods*

Waste rock samples were recovered from test pits on the surface of WRS#1 and WRS#2 in August, 2011 (Cash, 2014). Thirteen test pits were dug on the surface of WRS#1 and an additional 15 test pits were dug on WRS#2. The test pits were distributed evenly across the stockpiles with a 100 m by 100 m grid at WRS#1 and a 75 m by 75 m grid at WRS#2. Test pits were dug using a backhoe and were approximately 4 m in depth. The footprint of the test pits were approximately 10 m by 10 m and were benched to recover samples at multiple depths at each location. The freshly exposed surfaces of the test pits were evaluated during sampling to determine a variety of parameters including rock type, level of oxidation, colouring, moisture content, and matric suction (Cash, 2014). Samples were recovered from three depths at each test

pit location using a hand shovel and used to evaluate the characteristics of cover and shallow waste-rock material. Samples were stored in a refrigerator to minimize moisture loss during the sampling period. In total 39 samples were taken from test pits on WRS#1 and 30 samples were recovered from test pits on WRS#2. Figure 2.1 shows the locations of the test pits excavated before the relocation of WRS#1 and WRS#2.

Profile samples were also collected from the excavated face of WRS#1, WRS#2 and WRS#4 during their relocation (Cash, 2014). A backhoe or front end loader was used to expose and recover fresh waste rock material from the vertical face or profile of the stockpile. Characteristics were recorded at each location (*i.e.* rock type, degree of oxidation, colouring, moisture content, and matric suction). Effort was also made to gather samples from multiple depths at each location wherever possible. Samples were refrigerated during the sampling period to minimize moisture loss. Vertical profile sampling of WRS#1 took place in June, 2011. Twenty-one samples from 11 locations were recovered during the profile sampling of WRS#1. Vertical profile sampling of WRS#2 took place in October, 2011. Thirteen samples were recovered from separate locations on WRS#2 (no vertical integration of samples). Waste rock samples recovered from WRS#1 and WRS#2 were segregated into nine size fractions (*i.e.* pan, 0.074, 0.105, 0.149, 0.25, 0.42, 0.841, 2.0, and 4.76 mm) and characterized separately. All solid samples recovered from the Detour Gold stockpiles were analyzed for total carbon and total sulfur content using an ELTRA CS-2000 carbon/sulfur analyzer. An initial multi-point calibration was performed using 0.0054/0.0021 % C/S, 0.468/0.011 % C/S, 1.89/1.19 % C/S standards, and recalibration using a 0.034/0.031 % C/S standard was performed daily during the analysis period. Each standard was run multiple times at the beginning of the day to ensure the proper working order of the furnace. A check against these standards was also performed once

during the course of the day to ensure the results were accurate. Duplicate analysis were performed for every 10-12 samples run during the course of the day (variability in this rate of duplicate analysis is due to the low volume of sample material for some samples). In total, 847 distinct samples were analyzed (not counting WRS#3 cover material, which was analyzed several times and the results averaged). Of the 847 samples analyzed for carbon and sulfur, 69 (8 %) of the analyses were duplicated. Of the duplicated analyses, 20% had a discrepancy of >10 %. However, only 10% of the duplicated analyses had a discrepancy >15 %.

The elemental composition of the samples was determined by energy dispersive x-ray fluorescence (ED-XRF) using a Panalytical Minipal 4 desktop ED-XRF analyzer. Several certified reference materials were used including several rock types (*e.g.* basalt, andesite, gabbro, diabase, anorthosite, orthoclase), gold-ore and gold-tailings reference materials. Sample preparation consisted of pulverization to a uniform particle size (< 100 μm) using a Fritsch planetary ball mill. Cellulose acetate binder was added to the sample at a weight ratio of 16.7 % (1.75 g binder, 7.0 g sample) and pressed at 22.5 tonnes using a Carver Model 3853 25 tonne press. Of the 713 distinct samples analyzed, 114 analysis (16 %) were duplicated. Using the MgO content as an indicator, 17 % of the duplicated analysis had a discrepancy of >10 %. If the drill cuttings samples recovered from WRS#3 and WRS#4 are excluded from this reckoning only 15 duplicated analysis (or 10 %) had a discrepancy of >10 %.

Mineral composition was studied using x-ray diffraction (XRD), optical microscopy and scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS). XRD was conducted using a PANanalytical Model Empyrean II diffractometer using a copper anode ($\lambda$ = 1.543 Å). Samples were set in a 10 mm diameter sample holder and diffractograms were taken at the 2$\Theta$ range from 10˚-70˚. Sample grain size was verified to be < 63 μm by sieving before

scanning. Optical microscopy was conducted using a Nikon Eclipse LV100N-POL polarizing microscope with epi-illumination attachment. Samples of the 0.149 mm grain-size fraction mounted on purified quartz glass slides (30 um thickness). The sample material was elutriated before being cast into slides in order to remove lighter material (*e.g.* overburden/cover material) and concentrate the primary minerals making up the waste rock. A Hitachi TM3000 table-top scanning electron microscope (SEM) coupled with a Bruker QUANTAX 70 energy dispersive spectroscope (EDS) was used to examine the physical characteristics and elemental composition of selected samples.

## 2.6 Results and Discussion

### 2.6.1 Acid-Base Accounting

Twenty-five test pit samples from WRS#1 and 19 test pit samples from WRS#2 were analyzed along with 17 samples from the WRS#1 excavation and 10 samples from the WRS#2 excavation. The samples were derived from the grain-size fractions separated by Cash (2014). The carbon (C) and sulfur (S) of each size fraction was determined separately. The C and S of the various size fractions were then used in conjunction with the results of the grain size distribution measured by (Cash, 2014) to calculate a composite C and S content for each sample. These values were used in ABA calculations and are the figures referred to throughout this discussion, unless otherwise stated. Table 2.1 summarizes the ABA for test pitting and profile excavation samples from WRS#1 and WRS#2. Detailed C and S results are available in Appendix A.

Waste-rock samples from WRS#1 and WRS#2 had variable C and S content resulting in NPR values ranging from 0.01 (potentially acid generating; PAG) to 61.1 (not acid generating; NAG). Certain sample subsets were much more likely to generate ARD. For example, test-pit samples usually contained very little S, because these samples are largely composed of the cover material,

with less waste rock. At WRS#1 the test-pit samples had average C and S contents of 0.4 wt. % and 0.8 wt. %, respectively, resulting in an average NPR of 8.1. This NPR is high compared to the excavation samples at WRS#1 which had average C and S contents of 0.4 wt. % and 1.0 wt. %, respectively, and average NPR of only 1.6. A similar pattern was observed at WRS#2 where test-pit samples have average C and S contents of 0.7 wt. % and 0.9 wt %, respectively, with an average NPR of 6.9, whereas the excavation samples have average C and S contents of 0.2 wt. % and 1.0 wt %, respectively, and an average NPR of 0.7.

Most samples sets have a similar distribution with NP and APP values of < 50 kg $CaCO_3$/tonne (Figure 2.2). Many of the WRS#1 and WRS#2 test pit samples have a much higher C than S content (Figure 2.2). Using a site specific value developed by DGC for the ABA cut-off value for segregating acid generating waste (NPR <= 1.5) 59 % of WRS#1 and 70 % of WRS#2 profile excavation samples are PAG, while 52 % of WRS#1 and 40 % of WRS#2 test pit samples are PAG. With both test pit and profile excavation samples taken into account approximately 62% of WRS#1 samples and 72% of WRS#2 samples are considered PAG.

The C and S and ABA results plotted in order of increasing paste pH (from Cash, 2014) for each sample subset show that most waste-rock samples from the profile excavations and test pits on WRS#1 and WRS#2 (Figure 2.3-2.6) have a higher S than C content, and therefore lower NPR. This trend is particularly strong for the samples taken from the deeper benches in the test pits (*i.e.* sample numbers ending in –S2 or –S3). Conversely, samples with a higher NPR tend to be from the shallower sampling locations (*i.e.* sample numbers ending in –S1). The elevated NPR values associated with the shallow samples are due primarily to much lower S content (*i.e.* no waste rock in the cover samples), rather than an elevated C content.

### 2.6.2 Mineralogy and Whole Rock Analysis

The samples analyzed using XRF were derived from the grain-size fractions separated by Cash (2014). The composition of each size fraction was determined separately. The XRF results of the various size fractions were then used in conjunction with the results of the grain size distribution measured by (Cash, 2014) to calculate an overall composition for each sample. These are the values reported in this section.Table 2.2 summarizes the results obtained from the XRF analysis. The complete XRF data set is included in Appendix A. The whole rock composition determined by XRF is consistent with the local host rock composition. Silica is the single largest component in the waste rock (average mass fraction = 54 %), with $SiO_2$ and various metal oxides (*i.e.*, $Al_2O_3$, CaO, $Fe_2O_3$, $K_2O$, MgO, MnO, $Na_2O$) accounting for > 99 wt. % of the samples. Trace metals (*e.g.*, Cr, Cu, Ni, Zn, Pb) cumulatively account for < 1 wt. % of the sample in most cases. The $90^{th}$ and $10^{th}$ percentile values for samples recovered during the borehole drilling and profile excavation and test-pit sampling of WRS#1 and WRS#2 (Figure 2.7) illustrate that the samples are most varied in the relative concentrations of $K_2O$, MgO, $Na_2O$, S, and trace metals (*i.e.*, Cr, Cu and Ni). The cover material is characterized by deficiencies in Fe, S and the trace metals (*i.e.*, Cu, Cr, Mn, Ni, Zn; Figure 2.8). The deficiencies are compensated by elevated concentrations of K and Na and slightly higher concentrations of $SiO_2$ (*i.e.*, average $SiO_2$ of 53 wt. % and 62 wt. % in waste rock and cover samples respectively).

A total of 19 samples from the WRS#1 and WRS#2 test pit and profile excavations were analyzed using XRD to determine the mineral composition of the samples (Table 2.3). In most cases the primary mineral components of the waste rock samples are anorthite and horneblende with average concentrations of 26 wt. % and 20 wt. % respectively. Clinochlore was a third major component with an average contribution of 15 wt. %. Albite, quartz and vermiculite are

also significant contributors, with average mineral contents of 12 wt. %, 13 wt. % and 11 wt. % respectively.

Optical and SEM-EDS microscopy were also utilized to confirm the primary mineral assemblage of the waste rock samples. Varying quantities of quartz (Figure 2.9-2.11), plagioclase (Figures 2.11-2.13), horneblende (Figure 2.14-2.16), biotite (Figure 2.13) and clinochlore (Figure 2.13-2.14) were seen in each of the samples.

The results of these mineralogical analyses are consistent with the rock types mined at Detour Lake. Approximately 55 % of the historic waste rock originates from the massive mafic flows of the Upper Detour Lake Formation (Oliver et al., 2012) which consist mainly of plagioclase (anorthite) and mafic minerals (*e.g.* actinolite-horneblende), and are also host to quartz veins. This formation also hosts potasically altered mafic flows which contain secondary albite, biotite and sulfides. The remaining historic waste rock (~45 %) originates from the Lower Detour Lake Formation which consists of more ultramafic rock types as well as a chloritic schist contact unit which is the likely source of the observed chlinochlore. The small amounts of vermiculite present in the sample likely originate through the weathering of biotite. These results along with the C and S data indicate that the samples are composed overwhelmingly (> 90 %) of silicate minerals, with very minor contributions by carbonates and sulfides.

The remaining mineral composition was contributed by biotite with an average content of 5 wt. %, while small amounts of pyrrhotite (< 5 wt. %) were detected in some samples. Anorthite content does not vary widely, generally remaining between 20-30 %, but anorthite was conspicuously absent in two samples (TP-P1-S9-S3 and P1-P7-S1). The other minerals were variable in content, with coefficients of variation ranging from 30-50 %.

Optical microscopy coupled with SEM-EDS analysis was used to investigate sulfide mineral content and weathering patterns. One sample was selected from each sample locale, including one sample from nearby WRS#4 (*i.e.* P1-P2-S2, WRS-2-5, TP-P1-S9-S3, TP-P2-S5 and P4-P7-S2) for the analysis. The selected samples each contained more S (> 1.3 wt. %) than C (< 0.6 wt. %), although they represented a range of paste pH values (Table 2.4) due to variability in the C content.

Optical microscopy images and SEM-EDS elemental maps for these samples show that sulfide minerals, primarily pyrrhotite with lesser amounts of pyrite and chalcopyrite, were observed in each sample with varying levels of weathering (Figure 2.17-2.25). A heavily weathered pyrrhotite grain, with alteration along fractures within the grain, adjacent to two unweathered grains and a partially weathered grain of chalcopyrite in sample P1-P2-S2 shows the variability of weathering within a sample (Figure 2.17). Also from sample P1-P2-S2, Figure 2.18 shows unweathered pyrite and pyrrhotite grains alongside a pyrrhotite grain which displays weathering along mineral fractures. Sulfide minerals at WRS#2 (*e.g.* Sample WRS-2-5) were similar to WRS#1 in composition and weathering, including coexistence of an unweathered grain of pyrite with a grain of pyrrhotite which exhibits weathering along fractures within the grain (Figure 2.19) and a fully weathered pyrite grain alongside a highly fractured but only marginally weathered pyrrhotite grain (Figure 2.20). Sample P4-P7-S2 also contained weathered and unweathered grains of pyrite and pyrrhotite (Figures 2.21 and 2.22).

Samples recovered during the test pitting campaign at WRS#1 and WRS#2 (*i.e.* samples TP-P1-S9-S3 and TP-P2-S5) displayed more complete sulfide oxidation with fewer unweathered grains compared to samples recovered from deeper within the stockpiles. Figures 2.23 and 2.24 illustrate highly weathered pyrite and pyrrhotite grains from sample TP-P1-S9-S3. A single

covellite grain with an embedded grain of pyrrhotite was observed in sample TP-P1-S9-S3 (Figure 2.25). Covellite has not been identified as an accessory sulfide mineral within the local geology (Oliver et al., 2005; Robertson et al., 2012; Detour, 2012a) indicating that this grain probably formed due to the oxidation and alteration of the pyrrhotite and that covellite may be providing a sink for dissolved Cu released through sulfide oxidation (Pekala et al., 2011).

### 2.6.3 Grain Size Trends

The results of C and S analysis also indicate that there is some correlation between C and S content and grain size. Figure 2.26 and 2.27 illustrate the C and S grain size distribution for WRS#1 and WRS#2 profile excavation samples, respectively (*n.b.*, these figures only show results for waste rock samples; *i.e.*, cover samples have been removed). The overall trends in C content of the samples *versus* grain size appeared to follow two general patterns. Some samples with relatively low overall C content (< 1.0 wt. %), showed no trend in C distribution *versus* grain size, whereas many more samples were slightly enriched with C in the finer grain-size fractions. This trend is illustrated by several samples in each subset (*e.g.*, sample P1-P1-S3 and TP-P1-S15-S1 in Figure 2.26, sample WRS-2-7 and TP-P2-S11-S2 in Figure 2.27), and is best illustrated by samples from the WRS#2 profile excavation (Figure 2.27). Samples with relatively high overall C content (> 1.0 wt. %) often had a similar C distribution, however a higher overall C content was correlated with a second grain size trend. Best illustrated by profile excavation samples in Figures 2.26 and 2.27, several samples were characterized by a depletion of C in the grain size range from 0.1 - 0.3 mm, with C enrichment of the larger and smaller grain sizes.

The relationship between S content and grain size in the samples also follow two general patterns (Figure 2.26 - 2.28). Samples with a low overall S content (< 1.0 wt. %) tend to have uniform S content across all grain sizes. This trend is illustrated by samples from each sample location

including sample P1-P4-S1 from the WRS#1 profile excavations (Figure 2.26), sample WRS-2-9 from the WRS#2 profile excavations (Figure 2.27), sample TP-P1-S17-S1 from the WRS#1 test pits (Figure 2.26) and sample TP-P2-S17-S1 from the WRS#2 test pits (Figure 2.27). However, the more common trend – especially among samples with relatively high overall S content (> 1.0 wt. %) – was significant S enrichment at decreasing grain sizes. This trend is evident for both test pit and profile excavation samples from WRS#1 and WRS#2.

Trends in C and S content *versus* grain size potentially are a result of both the preferential partitioning of sulfide and carbonate minerals into the finer fractions during blasting and deposition and preferential dissolution of carbonate and sulfide minerals during weathering. Although dissolution of sulfide and carbonate grains will proceed at all grain sizes, smaller grains will react preferentially due to a higher surface area to mass ratio. This preference can explain the depletion of C at moderately small grain sizes (*e.g.*, 0.105mm, 0.149mm), but is fails to explain the enrichment of C at sizes < 0.105 mm, suggesting that this enrichment is due to the initial particle sizes of carbonate and sulfide grains in the rock. Grain size trends in sample composition were also evaluated using the XRF data. Figures 2.28 - 2.31 show the grain size distribution of several analytes. Most of the waste rock components including CaO, Cr, $K_2O$, MgO and MnO, lacked discernable correlation with grain size.

The concentrations of Cu, Fe, Ni and Zn (Figures 2.30, 2.28, 2.30 and 2.30 respectively) all increase in the finer grain-size fractions. These trends indicate these trace metals occur preferentially at the finest grain sizes.

Some waste rock components were positively correlated with grain size, best illustrated by $Al_2O_3$ concentrations (Figure 2.28). Lead was also positively correlated with grain size, being depleted

at the smallest sizes (Figure 2.31), as were $SiO_2$ concentrations (Figure 2.28), and $Na_2O$ concentrations (Figure 2.29).

## 2.7 Summary and Conclusions

The geochemical characterization of samples recovered from the 20-30 year old waste-rock stockpiles located at the Detour Lake mine site has highlighted the results of ongoing sulfide oxidation within WRS#1 and WRS#2 and will assist in the prediction of the potential for ARD generation. Mineralogical study indicates that the samples are composed primarily of horneblende and plagioclase (*e.g.* anorthite and albite) with significant quantities of quartz, biotite and clinochlore. The primary sulfide minerals observed in the samples were pyrrhotite and pyrite, with slightly lesser amounts of pyrite. Chalcopyrite and covellite grains were also observed although at much lower concentrations. Weathered sulfide grains were ubiquitous in all samples, although unweathered grains were also detected throughout. The greatest variation in S and metals associated with sulfide minerals (*e.g.*, Cu, Fe, Ni, Zn) was encountered at smaller grain size fractions.

Acid-base accounting of the samples from WRS#1 and WRS#2 test pit and profile excavation campaigns suggest that the stockpiles have significant potential to develop ARD in the future, since 62% and 72% of WRS#1 and WRS#2 samples exceed the DGC cut-off value for PAG material segregation. The presence of cover material in the test pit samples resulted in relatively low S concentrations and very high NPR values in many cases, resulting in an average NPR of 8.1 and 6.9 for the WRS#1 and WRS#2 test pit samples respectively. WRS#1 and WRS#2 profile excavation samples, which are more representative of the waste rock contained at depth within the piles compared to test pit samples, had lower average NPR values of 1.6 and 0.7 respectively.

## Tables

***Table 2.1: C/S and ABA Results (Minimum-Maximum [Average])***

| | ***Carbon (wt. %)*** | ***Sulfur (wt. %)*** | ***Neutralization Potential, NP (kg $CaCO_3$/tonne)*** | ***Acid Production Potential, APP (kg $CaCO_3$/tonne)*** | ***Net Neutralization Potential, NNP (NNP = NP-APP)*** | ***Neutralization Potential Ratio NPR (NPR=NP/APP)*** |
|---|---|---|---|---|---|---|
| ***WRS#1 test pits*** | 0.03 - 1.3 (0.4) | 0.05 - 2.2 (0.8) | 2.4 - 108.4 (34) | 1.4 - 69.3 (26.6) | -49.9 - 104.8 (7.3) | 0.04 - 41.9 (8.1) |
| ***WRS#1 excavation*** | 0.005 - 1.3 (0.4) | 0.5 - 1.6 (1) | 0.3 - 110.5 (39.1) | 16.1 - 50.7 (31.5) | -37.5 - 94.3 (7.5) | 0 - 6.8 (1.6) |
| ***WRS#2 test pits*** | 0.05 - 1.8 (0.7) | 0.05 - 2.1 (0.9) | 3.9 - 150.6 (59.9) | 1.7 - 68.5 (30.4) | -41.8 - 145 (29.5) | 0.1 - 61.1 (6.9) |
| ***WRS#2 excavation*** | 0.06 - 0.3 (0.2) | 0.7 - 1.5 (1) | 5.3 - 31.5 (20.4) | 23 - 49.7 (32.8) | -42.2 - 7.2 (-12.3) | 0.1 - 1.3 (0.7) |

***Table 2.2: X-Ray Fluorescence Results – Minimum-Maximum (Average)***
***WRS#1 and WRS#2 Profile Excavation (PE) and Test Pit (TP) Samples***

| ***Analyte (Unit)*** | ***WRS#1 PE [Min-max Avg.]*** | ***WRS#1 TP [Min-max Avg.]*** | ***WRS#2 PE [Min-max Avg.]*** | ***WRS#2 TP [Min-max Avg.]*** |
|---|---|---|---|---|
| $SiO_2$ (wt. %) | 49 – 60 (55) | 33 – 65 (56) | 53 – 57 (55) | 26 – 58 (52) |
| MgO (wt. %) | 7 – 25 (17) | 2 – 25 (9) | 6 – 21 (10) | 3 – 31 (13) |
| $Fe_2O_3$ (wt. %) | 9 – 13 (11) | 2 – 16 (10) | 10 – 14 (12) | 2 – 14 (10) |
| $Al_2O_3$ (wt. %) | 7 – 11 (9) | 2 – 11 (9) | 8 – 12 (11) | 2 – 11 (8) |
| CaO (wt. %) | 4 – 8 (6) | 3 – 11 (6) | 4 – 8 (6) | 0 – 11 (6) |
| $Na_2O$ (wt. %) | 0 - 2.1 (1) | 0 - 3.1 (1.5) | 0.5 - 1.7 (1.2) | 0 – 2 (0.9) |
| S (wt. %) | 0.49 – 1.90 (1.12) | 0.04 – 2.55 (0.97) | 0.88 – 2.27 (1.22) | 0.09 – 2.36 (1.04) |
| $K_2O$ (wt. %) | 0.2 - 1.1 (0.7) | 0.3 - 2.1 (1.1) | 0.5 - 1.2 (0.9) | 0.1 - 2.1 (0.8) |
| MnO (wt. %) | 0.1 - 0.1 (0.1) | 0 - 0.2 (0.1) | 0.1 - 0.1 (0.1) | 0 - 0.1 (0.1) |
| Cr (ppm) | 280 – 1977 (1143) | 112 – 1780 (592) | 203 – 1681 (538) | 88 – 2561 (829) |
| Cu (ppm) | 141 – 782 (391) | 52 – 1642 (480) | 210 – 663 (450) | 43 – 1169 (392) |
| Ni (ppm) | 104 – 688 (372) | 23 – 504 (144) | 46 – 294 (131) | 23 – 760 (243) |
| Zn (ppm) | 54 – 99 (80) | 21 – 125 (71) | 68 – 91 (74) | 21 – 173 (82) |
| Pb (ppm) | 7 – 10 (9) | 1 – 13 (9) | 6 – 10 (8) | 6 – 14 (9) |

## *Table 2.3: Mineral Composition of WRS#1 and WRS#2 Waste Rock – XRD Results*

| ***Sample ID*** | ***Depth*** | ***Oxidation Level*** | ***Paste pH*** | ***Quartz*** $SiO2$ ***(wt. %)*** | ***Vermiculite*** $(Mg^{2+},Fe^{2+},Fe^{3+})_3[(AlSi)_4O_{10}](OH)_2*4H_2O$ ***(wt. %)*** | ***Biotite, manganoan*** $K(Mg,Fe)_3(AlSi_3O_{10})(F,OH)_2$ ***(wt. %)*** | ***Anorthite*** $CaAl_2Si_2O_8$ ***(wt. %)*** | ***Clinochlore*** $(Mg_5Al)(AlSi_3O_{10}(OH)_8$ ***(wt. %)*** | ***Albite low, calcian*** $NaAlSi_3O_8$ ***(wt. %)*** | ***Horneblend, magnesian*** $Ca_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$ ***(wt. %)*** | ***Pyrrhotite*** $Fe_{1-x}S$ ***(wt. %)*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***WRS#1 – Test Pitting Samples*** | | | | | | | | | | | |
| ***TP-P1-S9-S3*** | ~3m | Very High | 2.3 | 6 | 17 | 5 | - | 33 | 7 | 30 | 2 |
| ***TP-P1-S14-S3*** | ~3m | High | 4 | 14.1 | 5.1 | 3 | 27.3 | 15.2 | 12.1 | 21.2 | 2 |
| ***TP-P1-S15-S2*** | ~2m | Moderate | 4.9 | 16 | 7 | 3 | 29 | 11 | 12 | 21 | 1 |
| ***TP-P1-S4-S2*** | ~2m | Low, Trace | 7.1 | 13 | 14 | 3 | 24 | 8 | 11 | 25 | 2 |
| ***TP-P1-S17-S1*** | Cover (< 1m) | Low | 7.2 | 17 | 15 | 6 | 30 | 4 | 17 | 9 | 2 |
| ***WRS#1 – Profile Excavation Samples*** | | | | | | | | | | | |
| ***P1-P1-S1*** | > 5 m | Very High | 2.8 | 17 | 8 | 4 | 26 | 13 | 12 | 20 | - |
| ***P1-P7-S1*** | > 5 m | Very High | 3.2 | 5.9 | 18.8 | 6.9 | - | 27.7 | 5.9 | 34.7 | - |
| ***P1-P4-S2*** | > 5 m | Moderate | 4.4 | 11 | 11 | 5 | 21 | 18 | 10 | 23 | 1 |
| ***P1-P5-S2*** | > 5 m | Very High | 4.8 | 13 | 8 | 4 | 27 | 16 | 13 | 19 | |
| ***P1-P11-S1*** | > 5 m | Low | 6.5 | 6.9 | 10.9 | 6.9 | 33.7 | 18.8 | 7.9 | 13.9 | 1 |
| ***WRS#2 – Test Pitting Samples*** | | | | | | | | | | | |
| ***TP-P2-S14-S2*** | ~2m | High | 3 | 16.8 | 9.9 | 3 | 19.8 | 8.9 | 11.9 | 29.7 | - |
| ***TP-P2-S15-S2*** | ~2m | High | 3.6 | 11 | 7 | 6 | 27 | 14 | 12 | 23 | - |
| ***TP-P2-S16-S1*** | Cover (< 1m) | Low | 5.2 | 14.1 | 9.1 | 5.1 | 27.3 | 16.2 | 11.1 | 16.2 | 1 |
| ***TP-P2-S13-S2*** | ~2m | Moderate to Low | 5.6 | 14.9 | 14.9 | 10.9 | 17.8 | 6.9 | 13.9 | 18.8 | 2 |
| ***TP-P2-S17-S3*** | ~3m | Low | 6.7 | 9.1 | 11.1 | 4 | 29.3 | 18.2 | 10.1 | 17.2 | 1 |
| ***TP-P2-S5*** | - | Low | 7.2 | 21.2 | 16.2 | 3 | 34.3 | | 17.2 | 7.1 | 1 |
| ***WRS#2 – Profile Excavation Samples*** | | | | | | | | | | | |
| ***WRS-2-7*** | > 5 m | Moderate | 4.3 | 15 | 7 | 4 | 20 | 14 | 12 | 26 | 2 |
| ***WRS-2-8*** | > 5 m | Low | 6.6 | 10.9 | 9.9 | 2 | 24.8 | 19.8 | 11.9 | 19.8 | 1 |
| ***WRS-2-13*** | > 5 m | Low | 6.6 | 8 | 16 | 4 | 19 | 24 | 6 | 19 | 4 |

***Table 2.4: Optical and SEM-EDS Sample Properties***

| *Sample I.D.* | *Rock Type* | *Level of Oxidation** | *Depth of Recovery* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Paste pH* |
|---|---|---|---|---|---|---|
| ***P1-P2-S2*** | TC, II | Low | > 5 m | 0.28 | 1.32 | 6.0 |
| ***TP-P1-S9-S3*** | MF, TC, trace II | Very High | ~3 m | 0.03 | 1.68 | 2.3 |
| ***WRS-2-5*** | MF | Low | > 5 m | 0.21 | 1.59 | 6.4 |
| ***TP-P2-S5*** | MF, TC | Moderate | ~3 m | 0.59 | 1.84 | 6.4 |
| ***P4-P7-S2*** | - | Very High | > 5 m | 0.11 | 1.65 | 4.9 |

*Visual observation made at time of sample collection (Cash, 2014)

## Figures

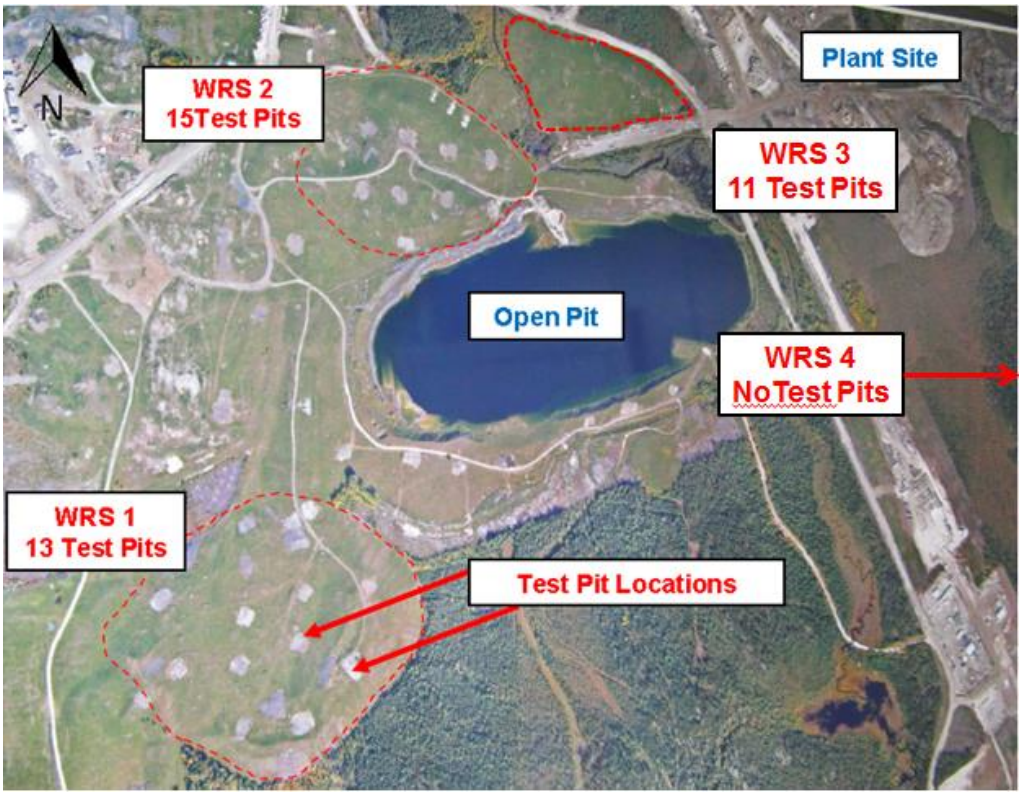



***Figure 2.1: Location Map of WRS#1, WRS#2 and WRS#3 (WRS#4 nearby) with the Distribution of Test Pits at WRS#1 and WRS#2. (modified from Cash, 2014)***

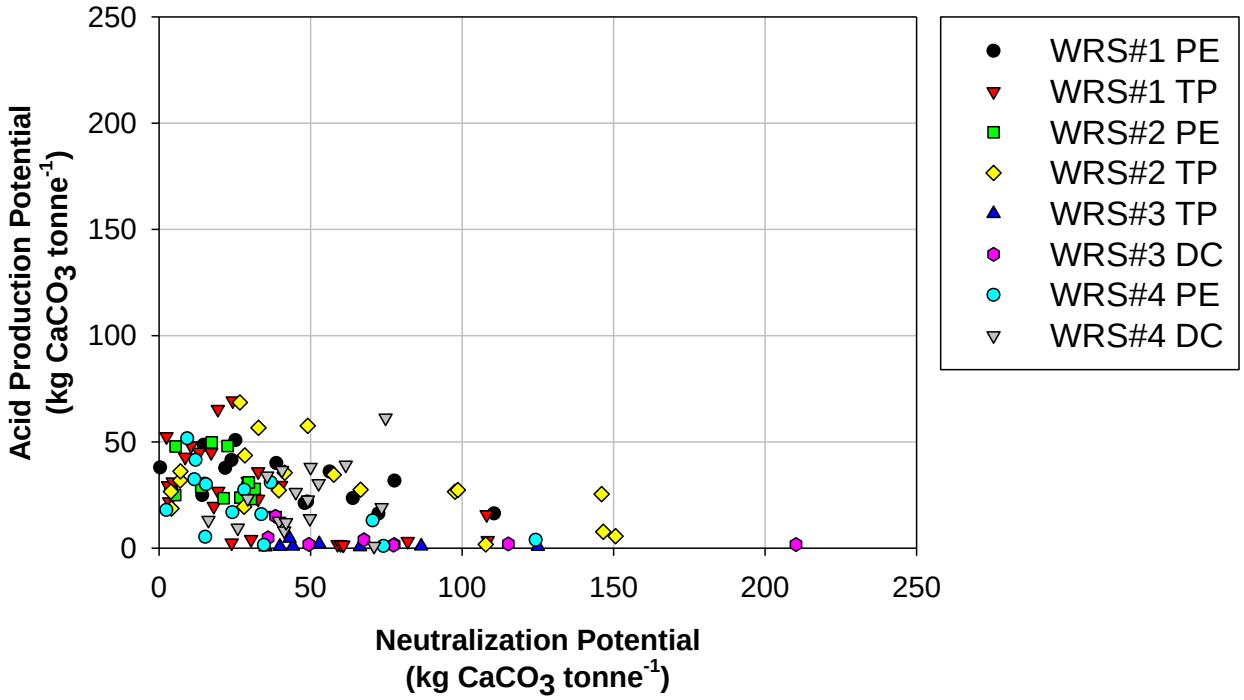



***Figure 2.2: Results of Acid Base Accounting – WRS#1, WRS#2, WRS#3 and WRS#4 Profile Excavation (PE), Test Pit (TP) and Drill Cutting (DC) Samples***

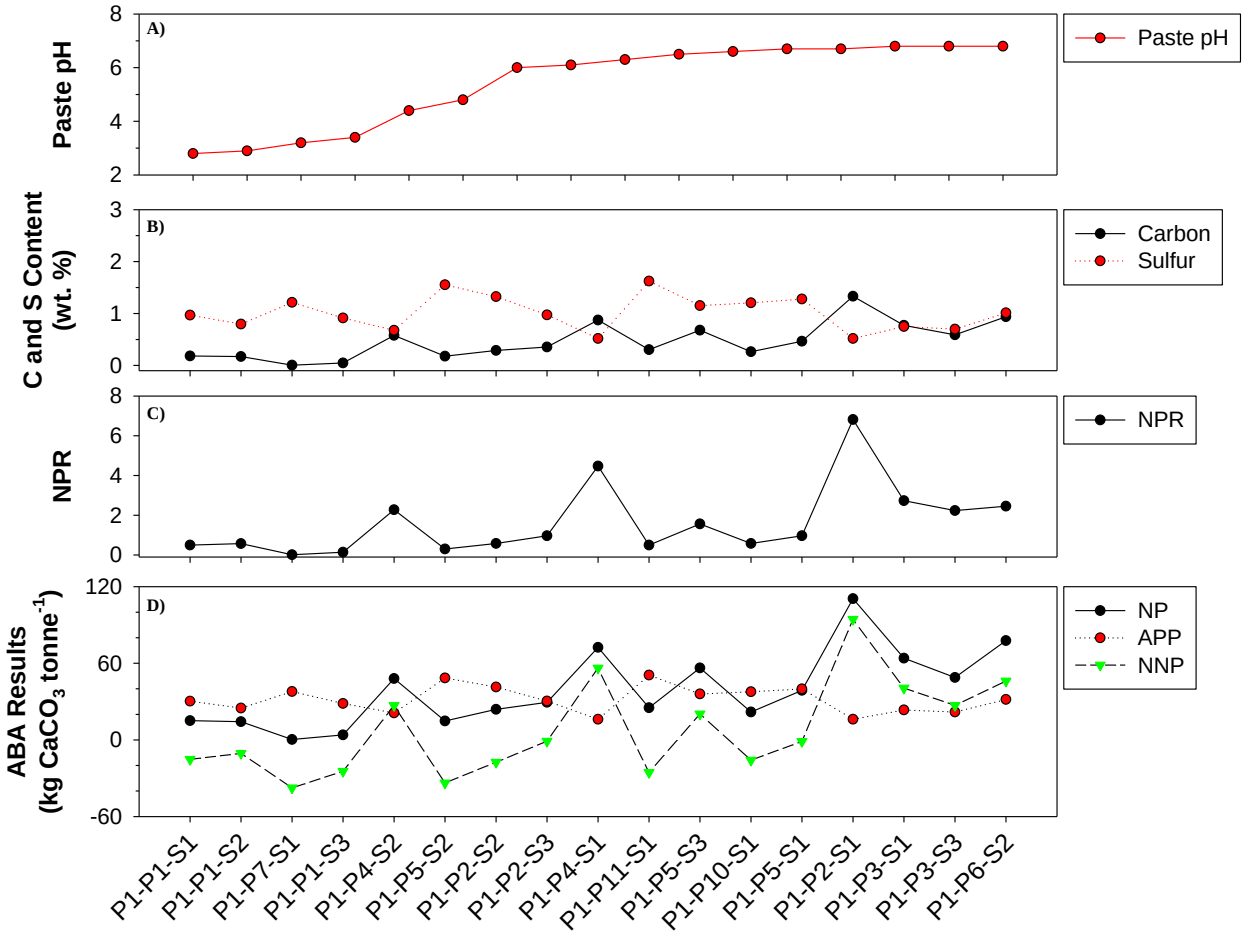



***Figure 2.3: Results of ABA – WRS#1 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)***

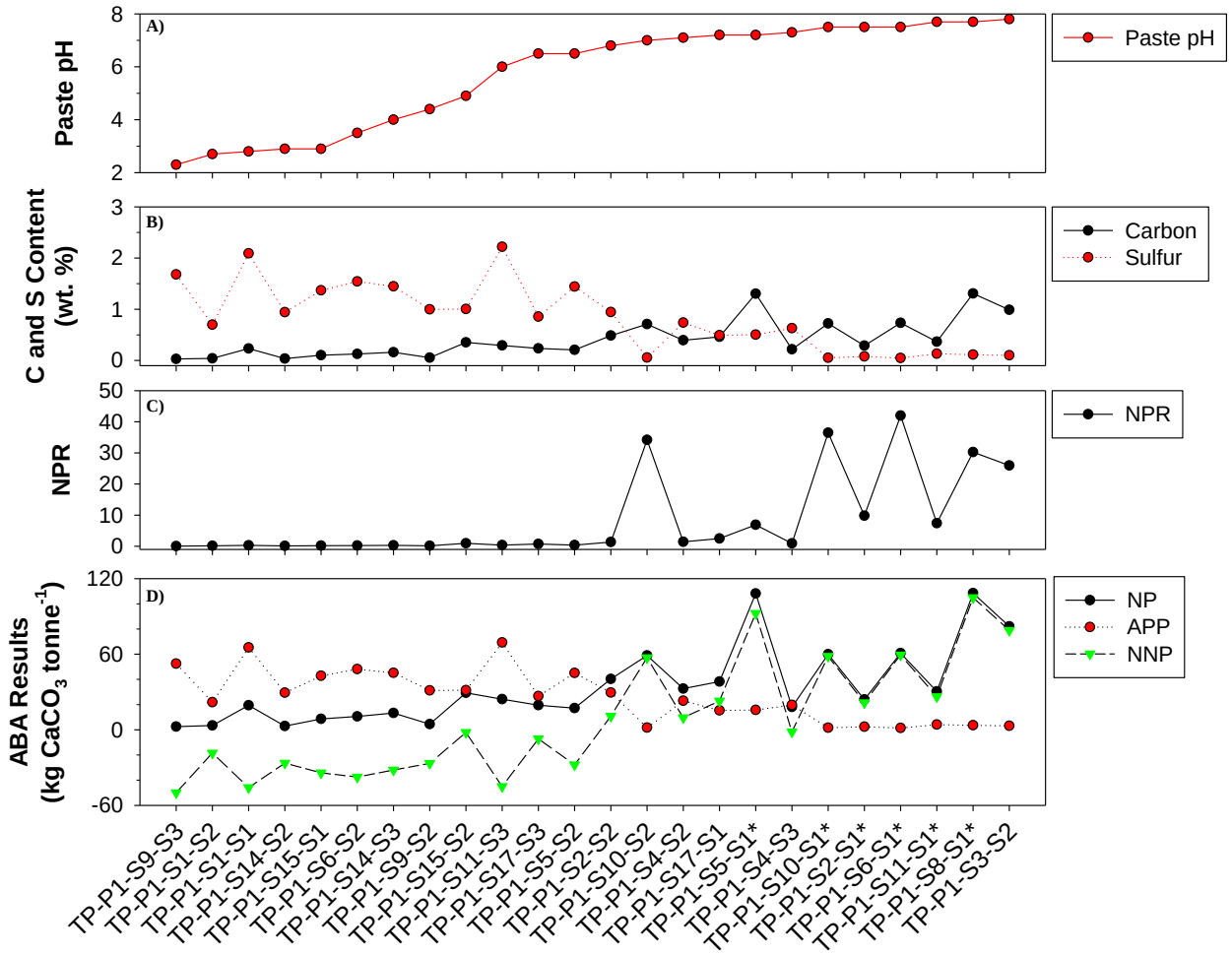



***Figure 2.4: Results of ABA – WRS#1 Test Pit Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) ('*' indicates cover samples)***

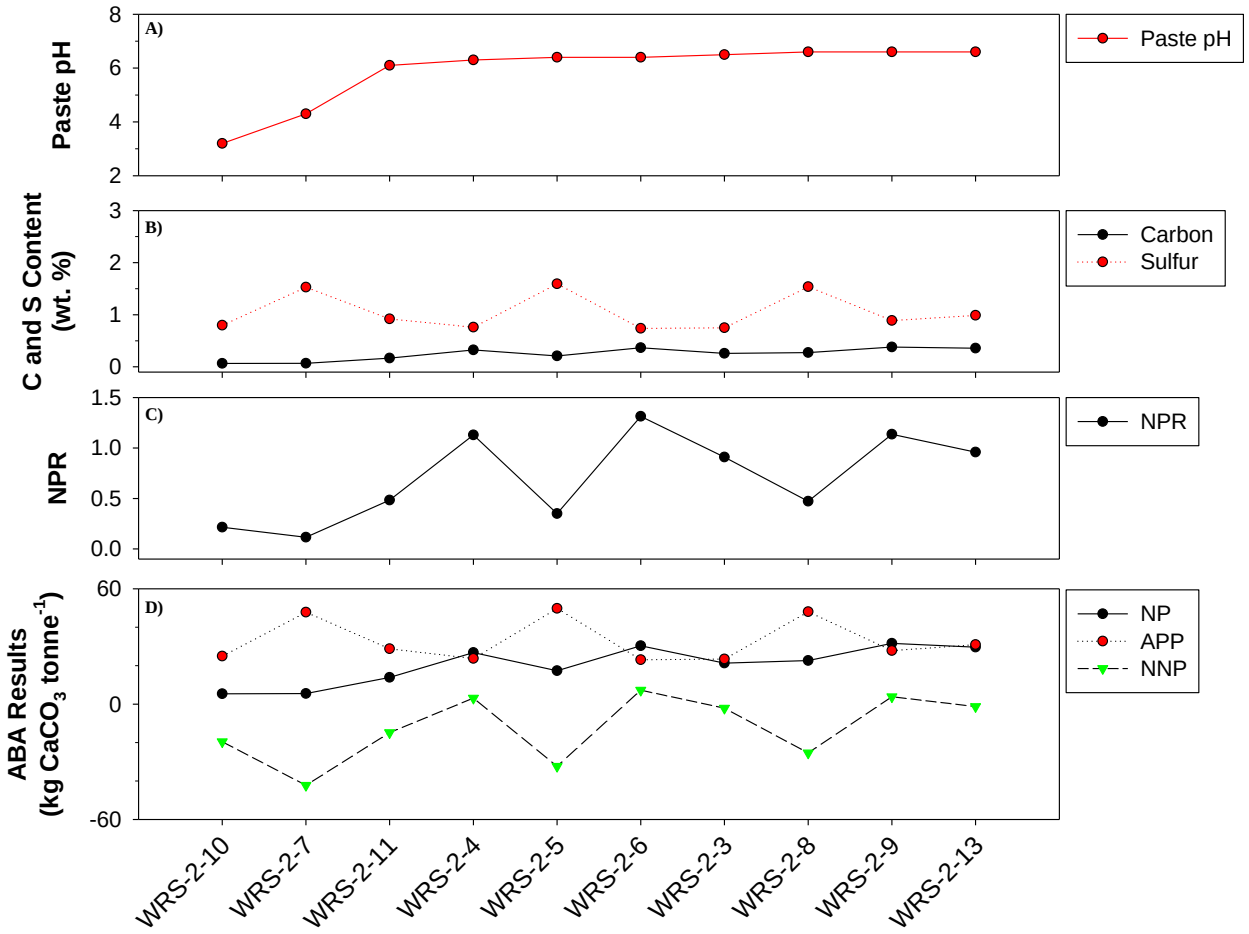



***Figure 2.5: Results of ABA – WRS#2 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP)***

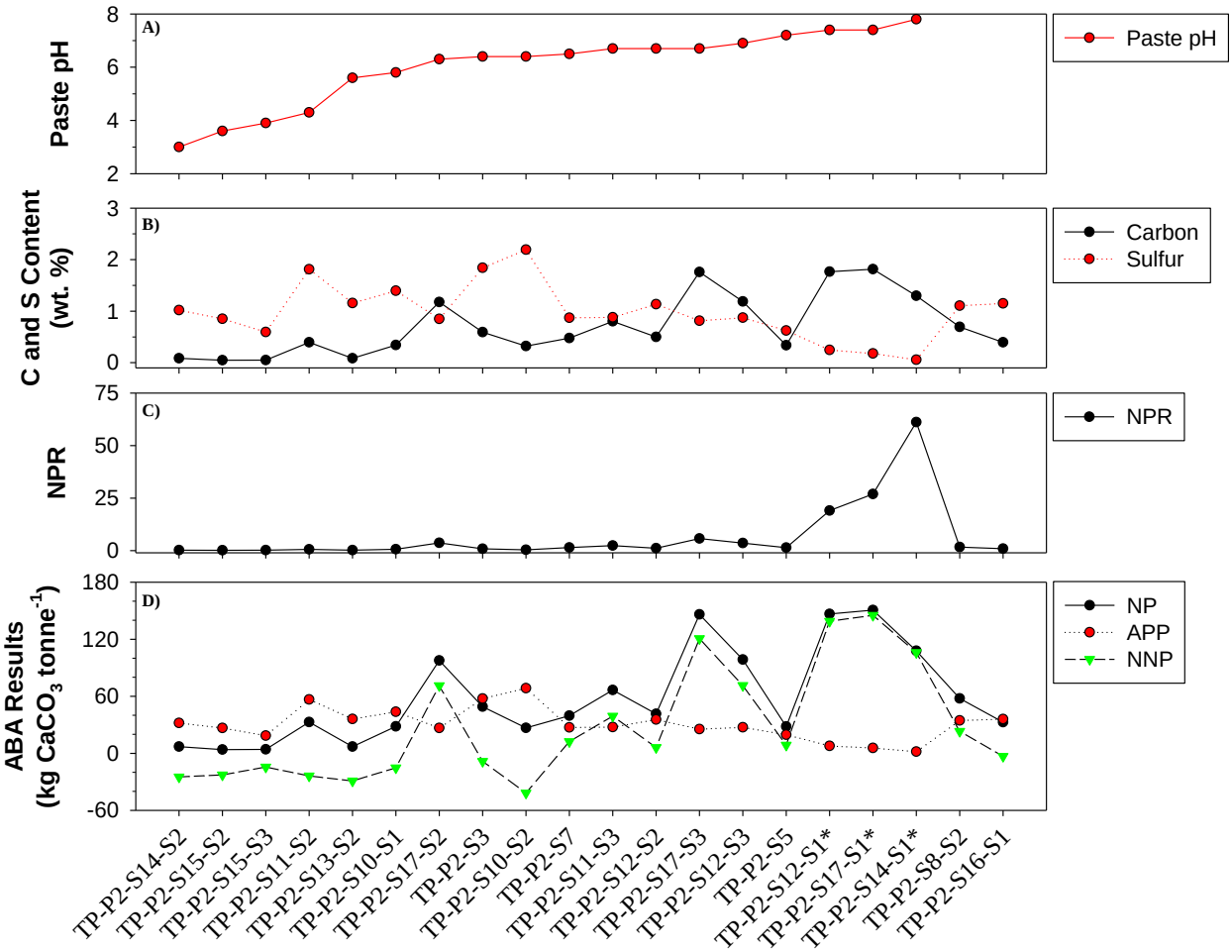



***Figure 2.6: Results of ABA – WRS#2 Test Pit Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) ('*' indicates cover samples)***

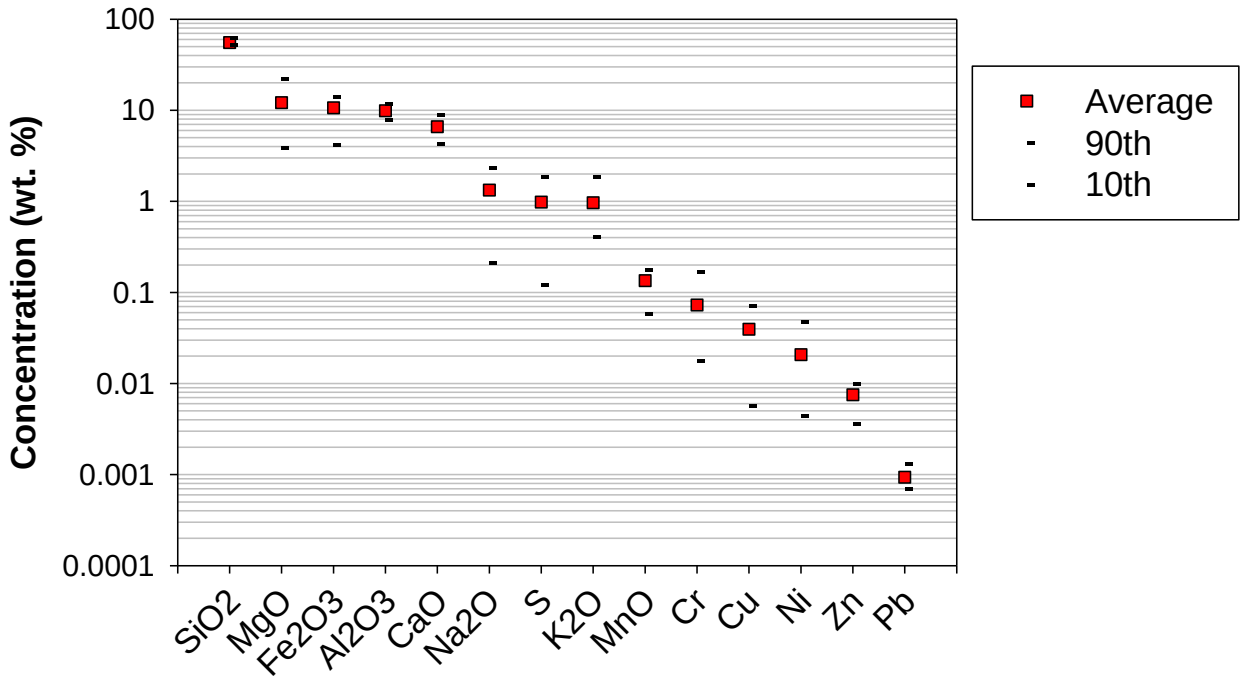



***Figure 2.7: X-Ray Fluorescence Results – Average of WRS#1 and WRS#2 Samples***

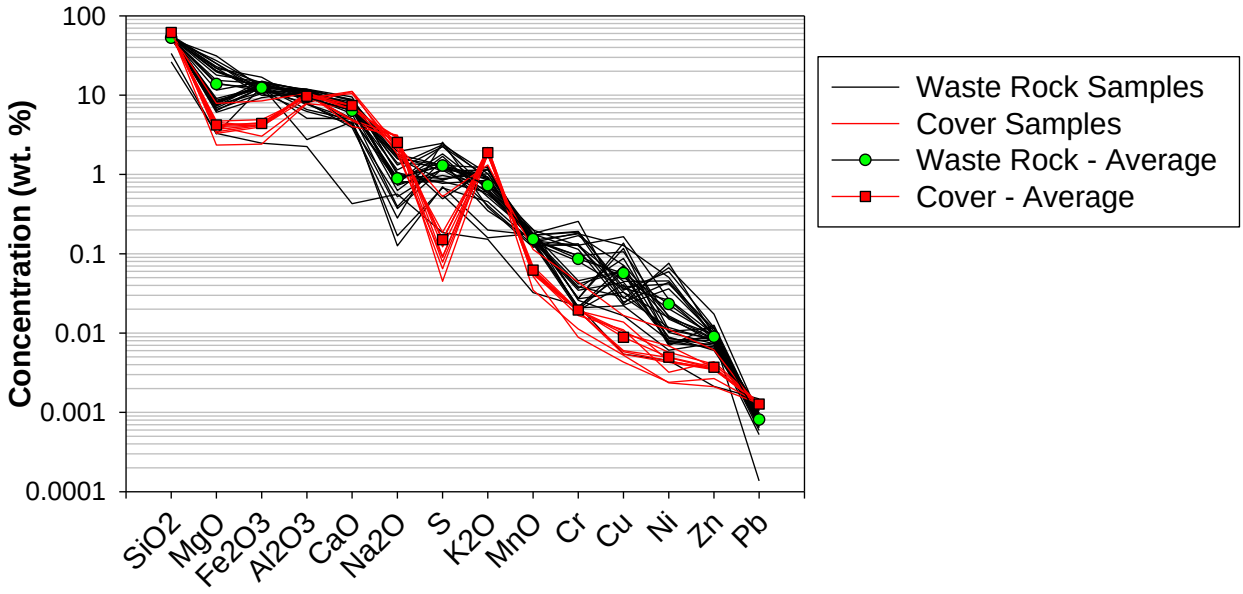



***Figure 2.8: X-Ray Fluorescence Results – Waste Rock (Black) and Cover (Red) Samples from WRS#1 and WRS#2 Test Pits***

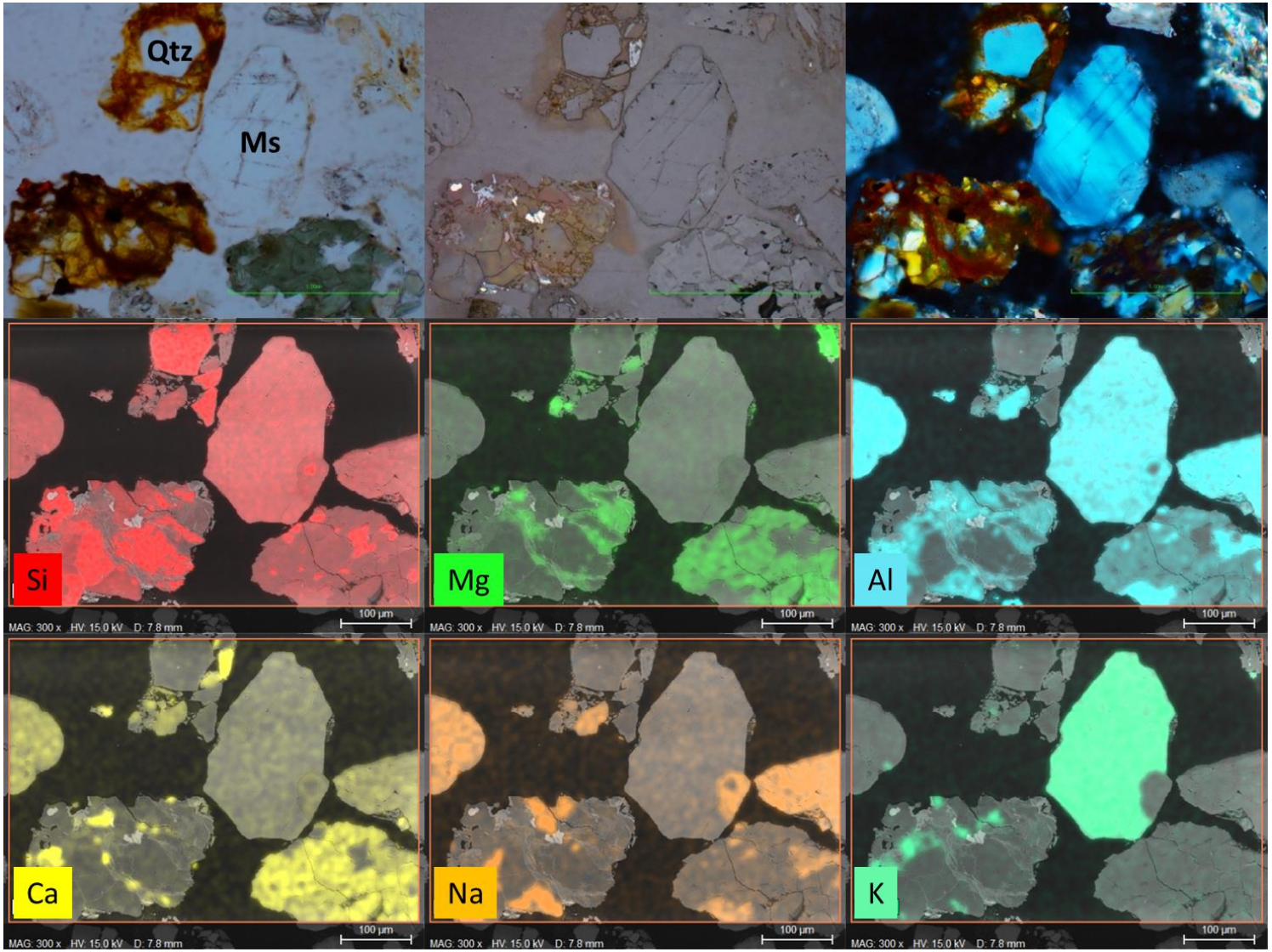



***Figure 2.9: Quartz (Qtz) and Muscovite (Ms) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

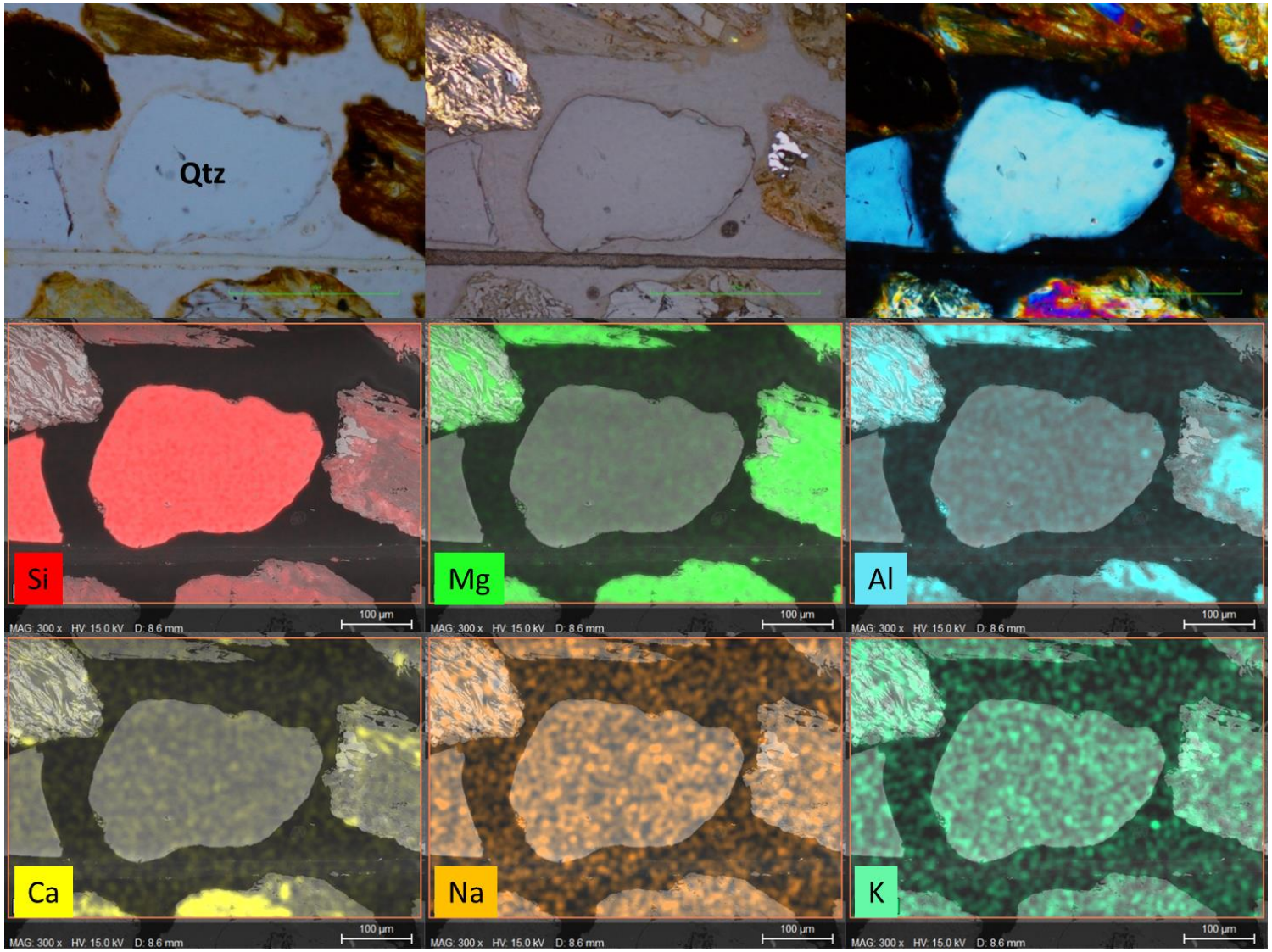



***Figure 2.10: Quartz (Qtz) Grain in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

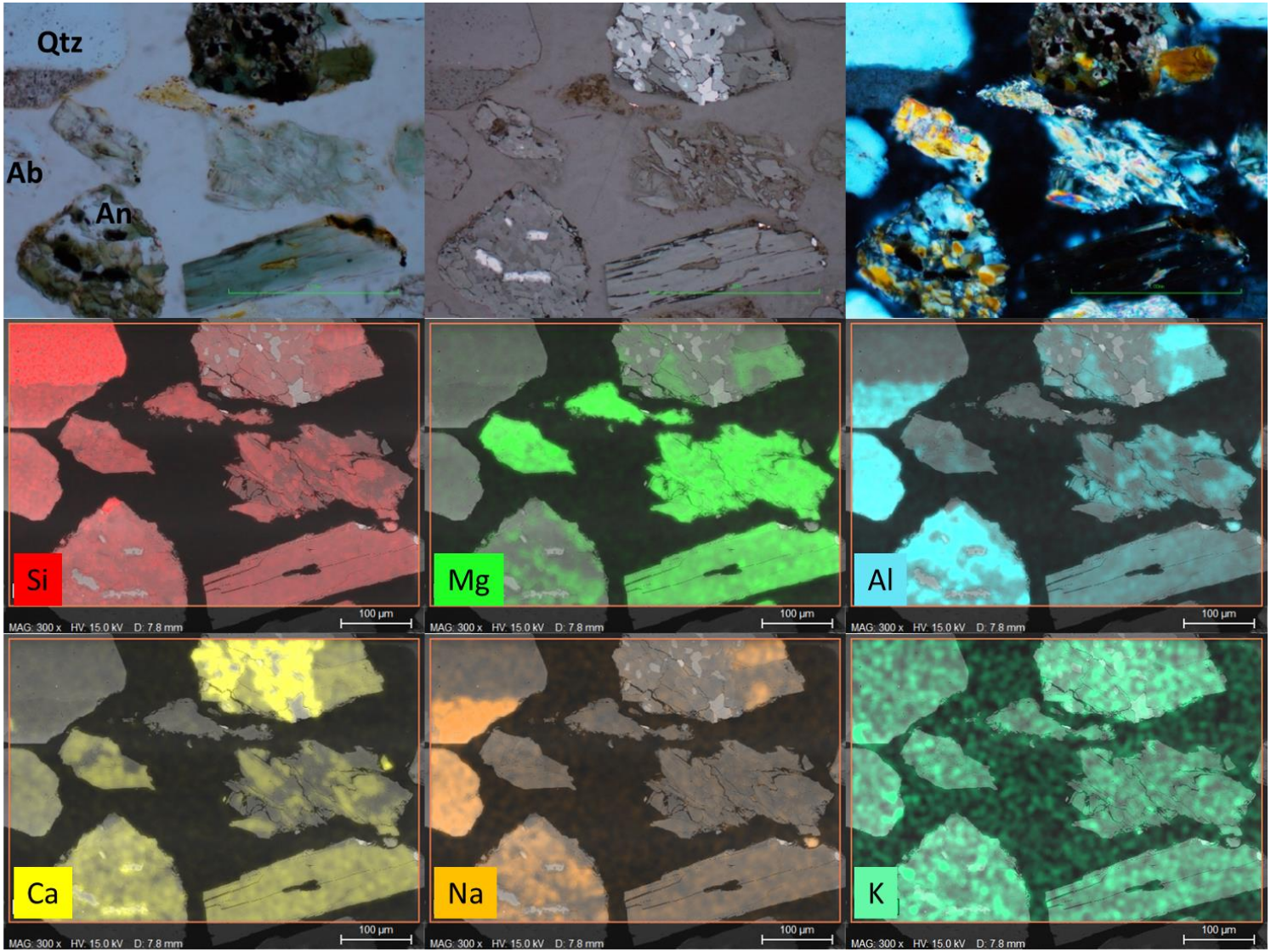



***Figure 2.11: Quartz (Qtz), Albite (Ab) and Anorthite (An) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

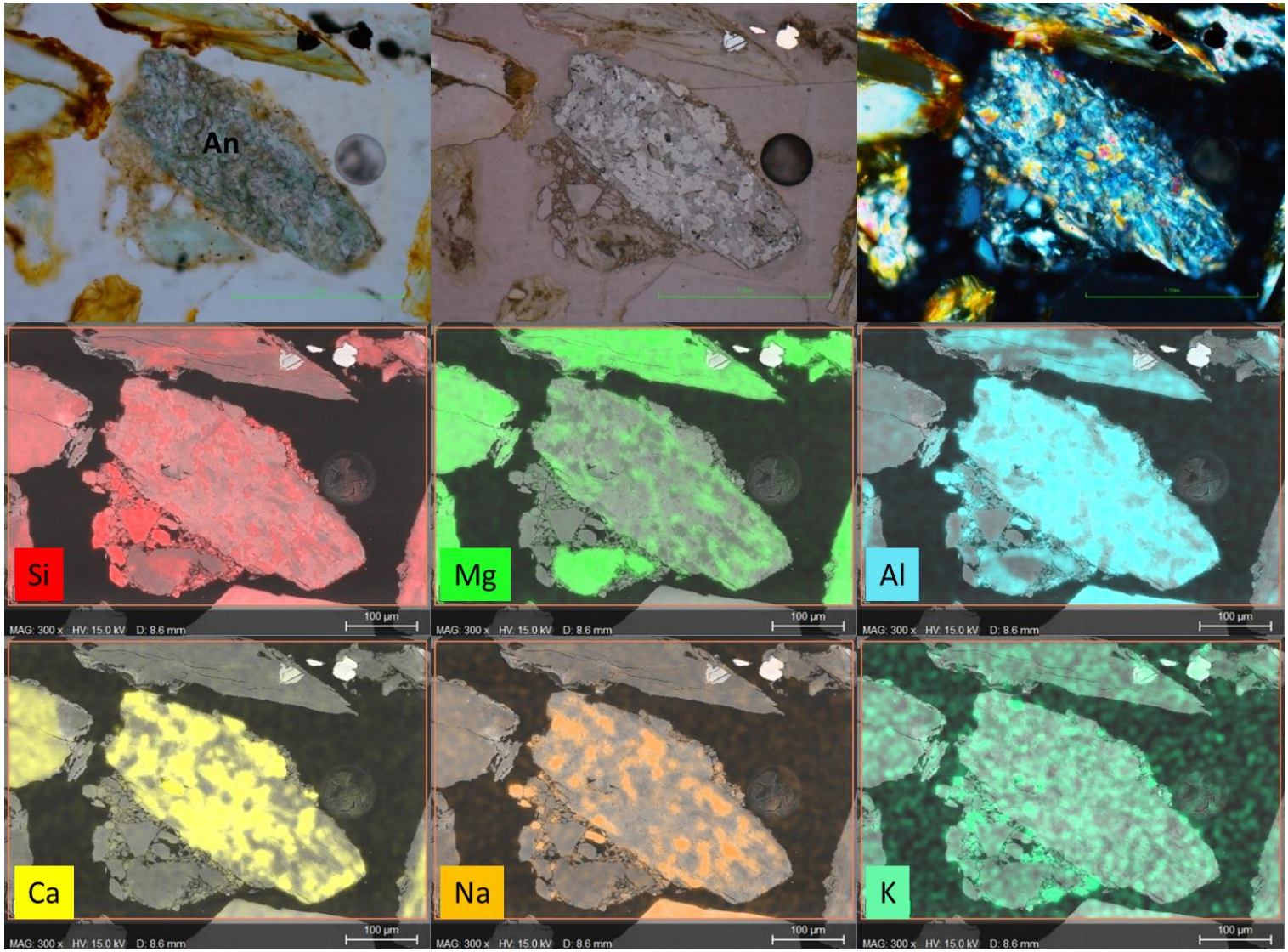



***Figure 2.12: Anorthite (An) Grain in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

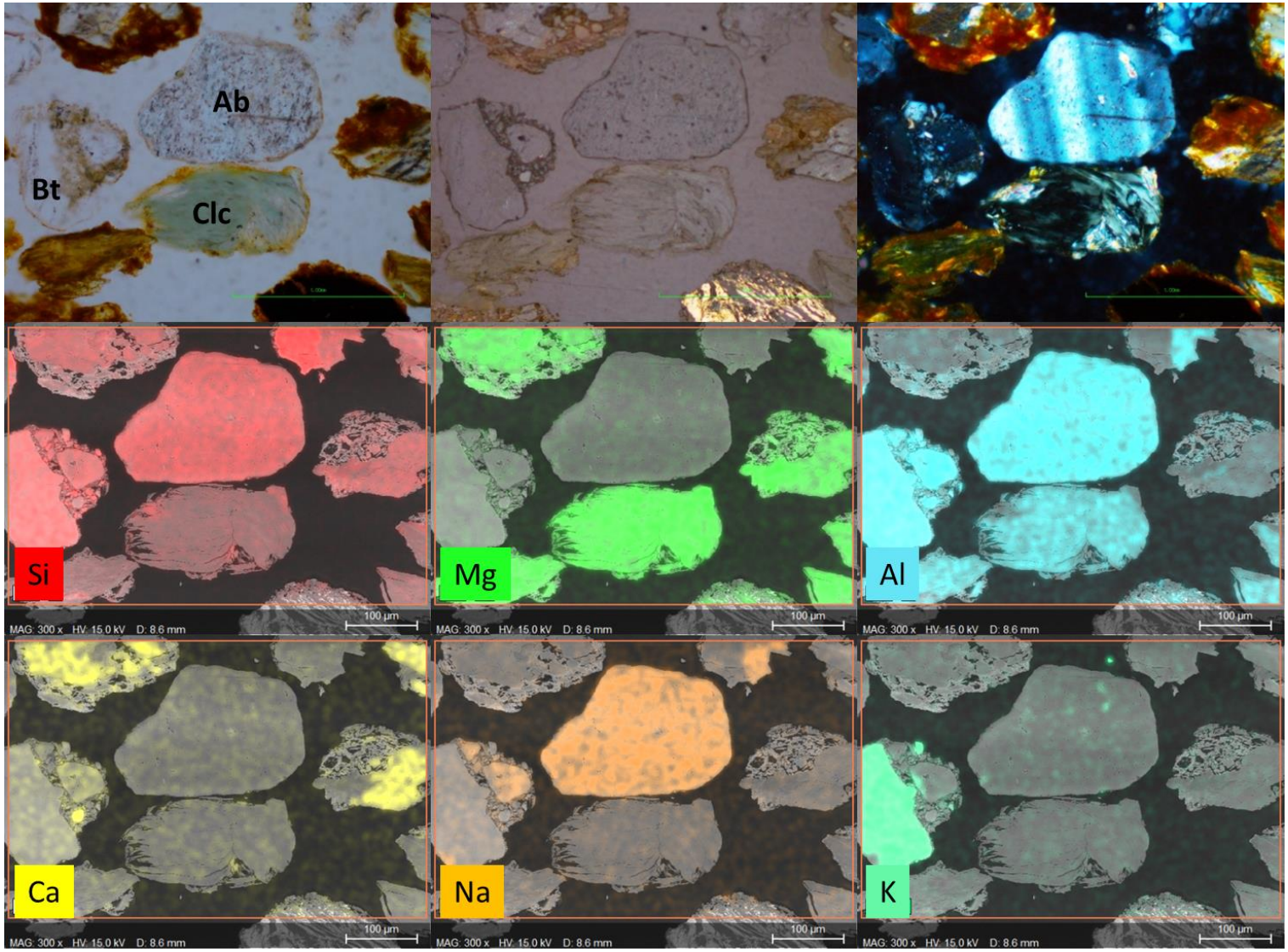



***Figure 2.13: Albite (An), Clinochlore (Clc) and Biotite (Bt) Grains in Sample P4-P7-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

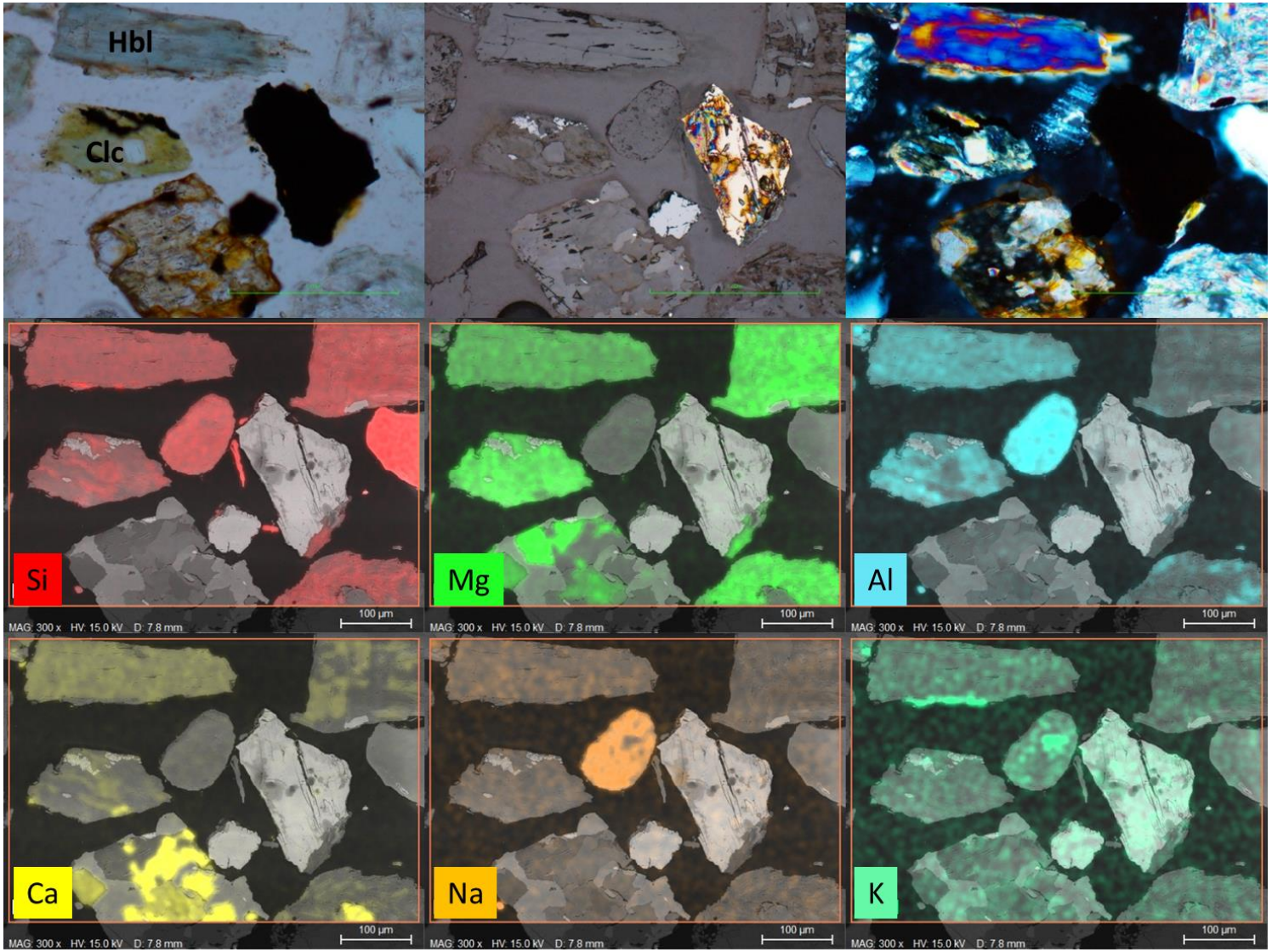



***Figure 2.14: Horneblende (Hbl) and Clinochlore (Clc) Grains in Sample TP-P2-S5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

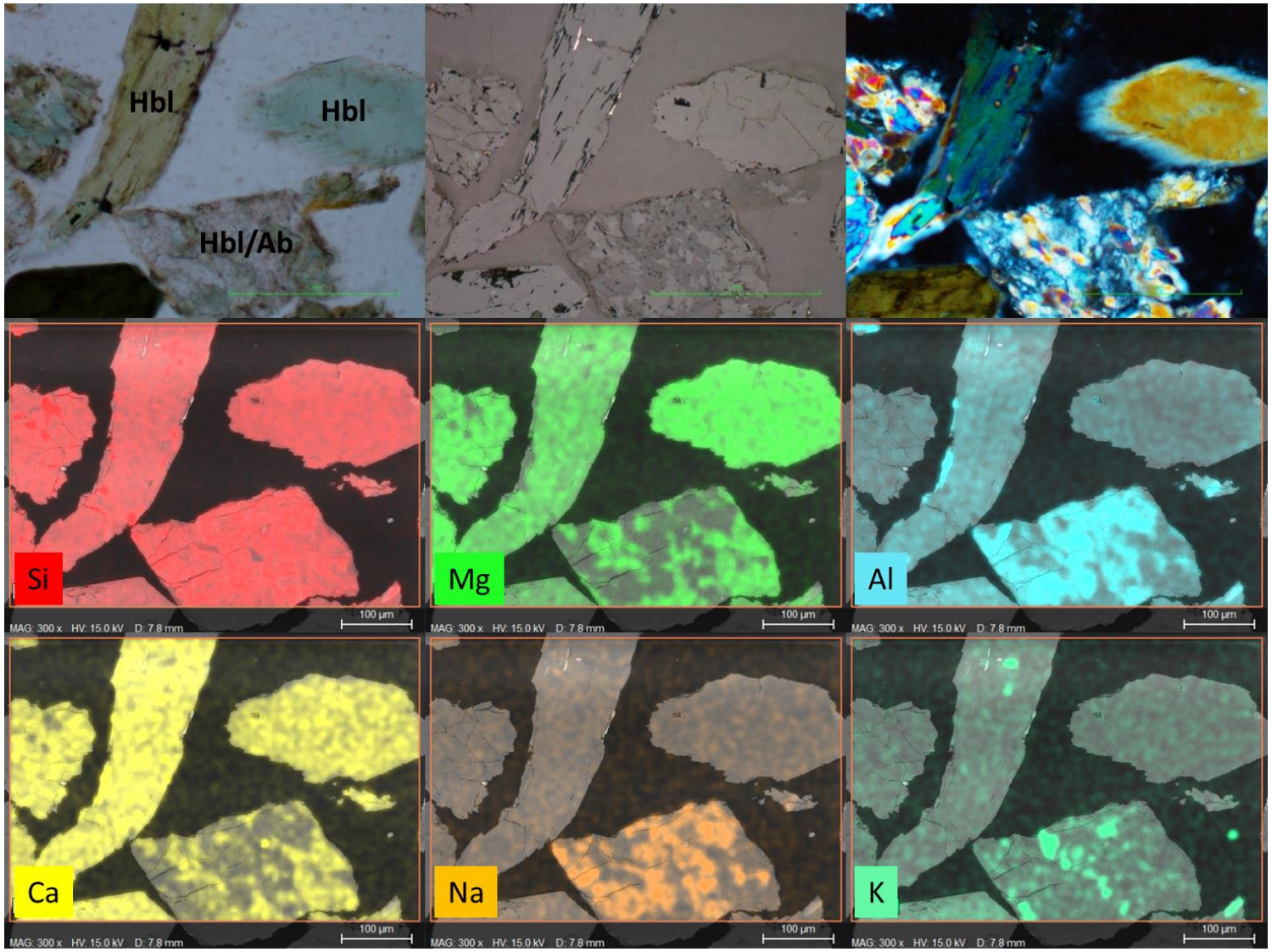



***Figure 2.15: Horneblende (Hbl) and Mixed Horneblende/Albite (Hbl/Ab) Grains in Sample WRS-2-5; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

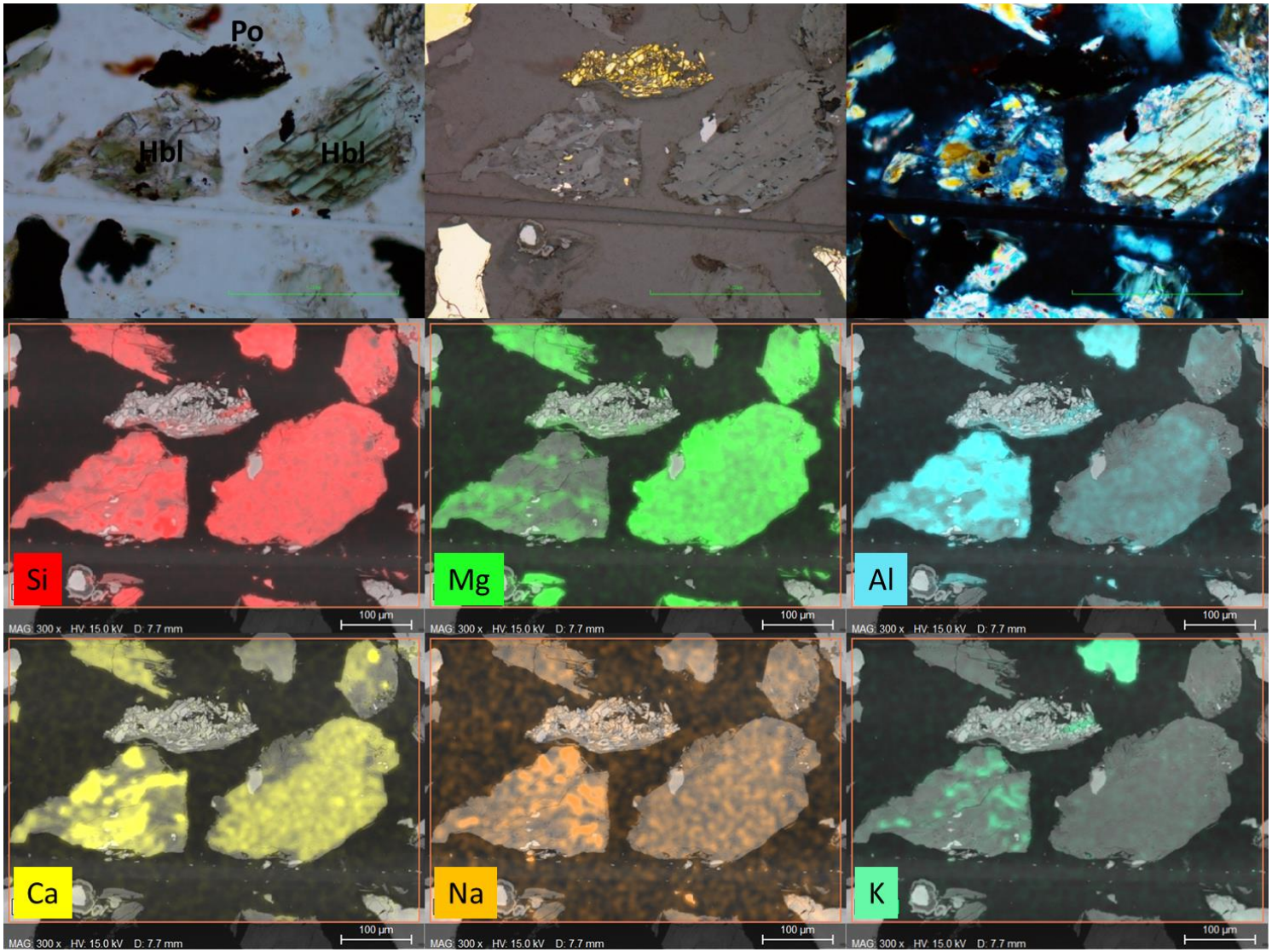



***Figure 2.16: Horneblende (Hbl) and Pyrrhotite (Po) Grains in Sample P1-P2-S2; Transmitted, Reflected and Polarized Light Optical Microscopy and SEM-EDS Element Maps of Silicon (red), Magnesium (green), Aluminum (light blue), Calcium (yellow), Sodium (orange) and Potassium (teal) at 300X Magnification***

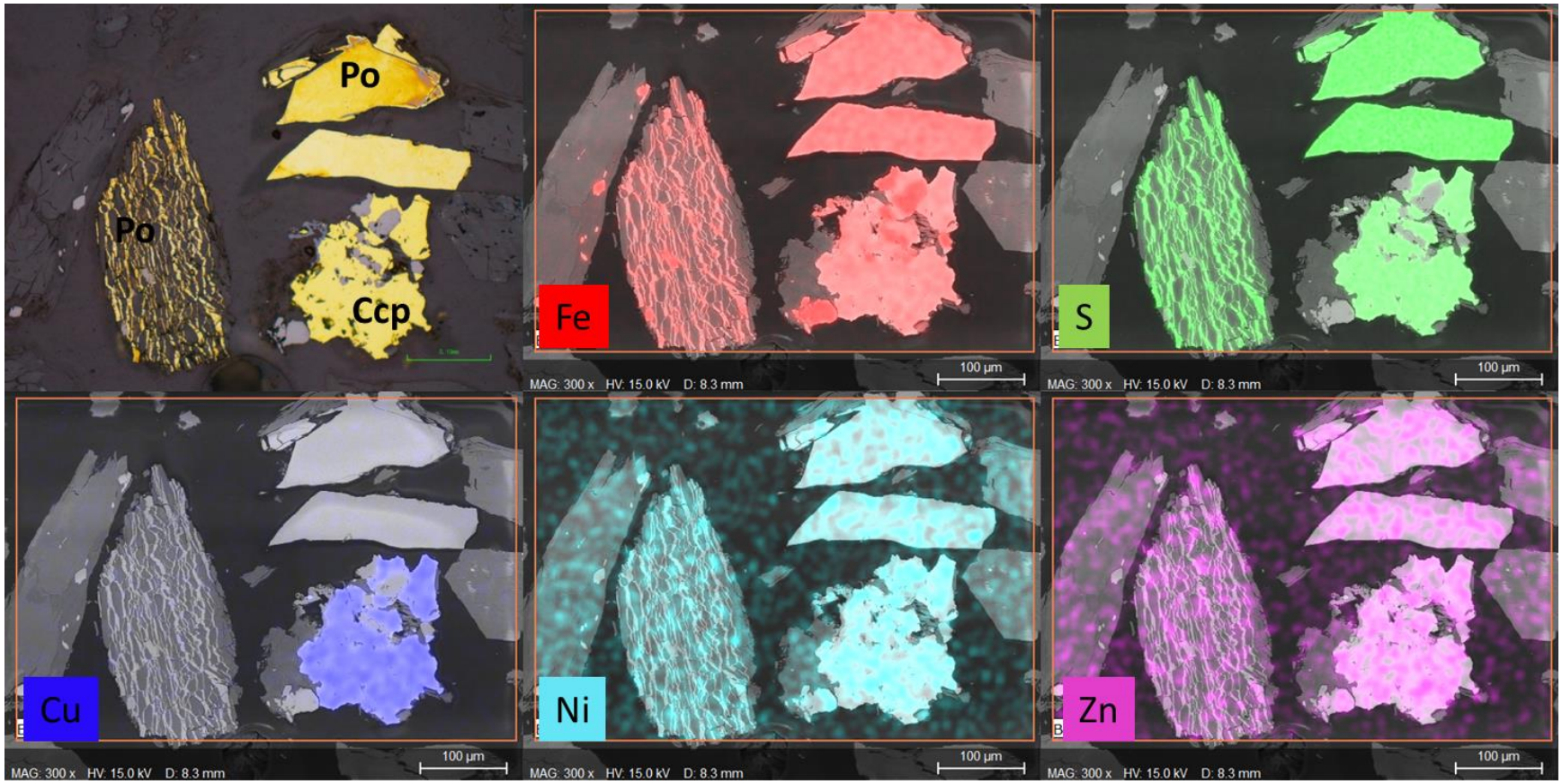



***Figure 2.17: Weathered and Unweathered Pyrrhotite (Po) Grains and a Weathered Chalocopyrite grain (Ccp) in Sample P1-P2-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

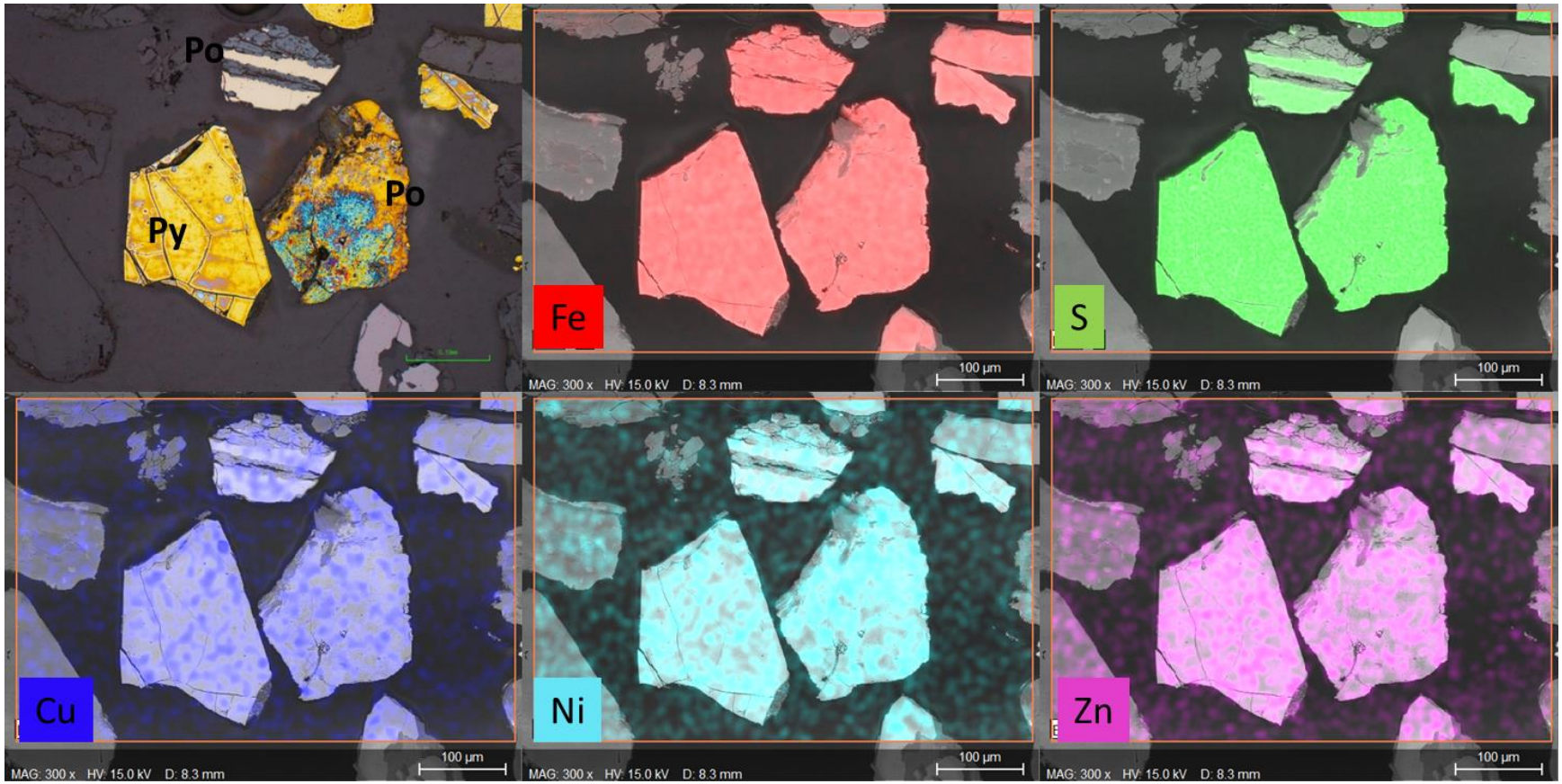



***Figure 2.18: Weathered and Unweathered Pyrrhotite (Po) Grains and an Unweathered Pyrite grain (Ccp) in Sample P1-P2-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

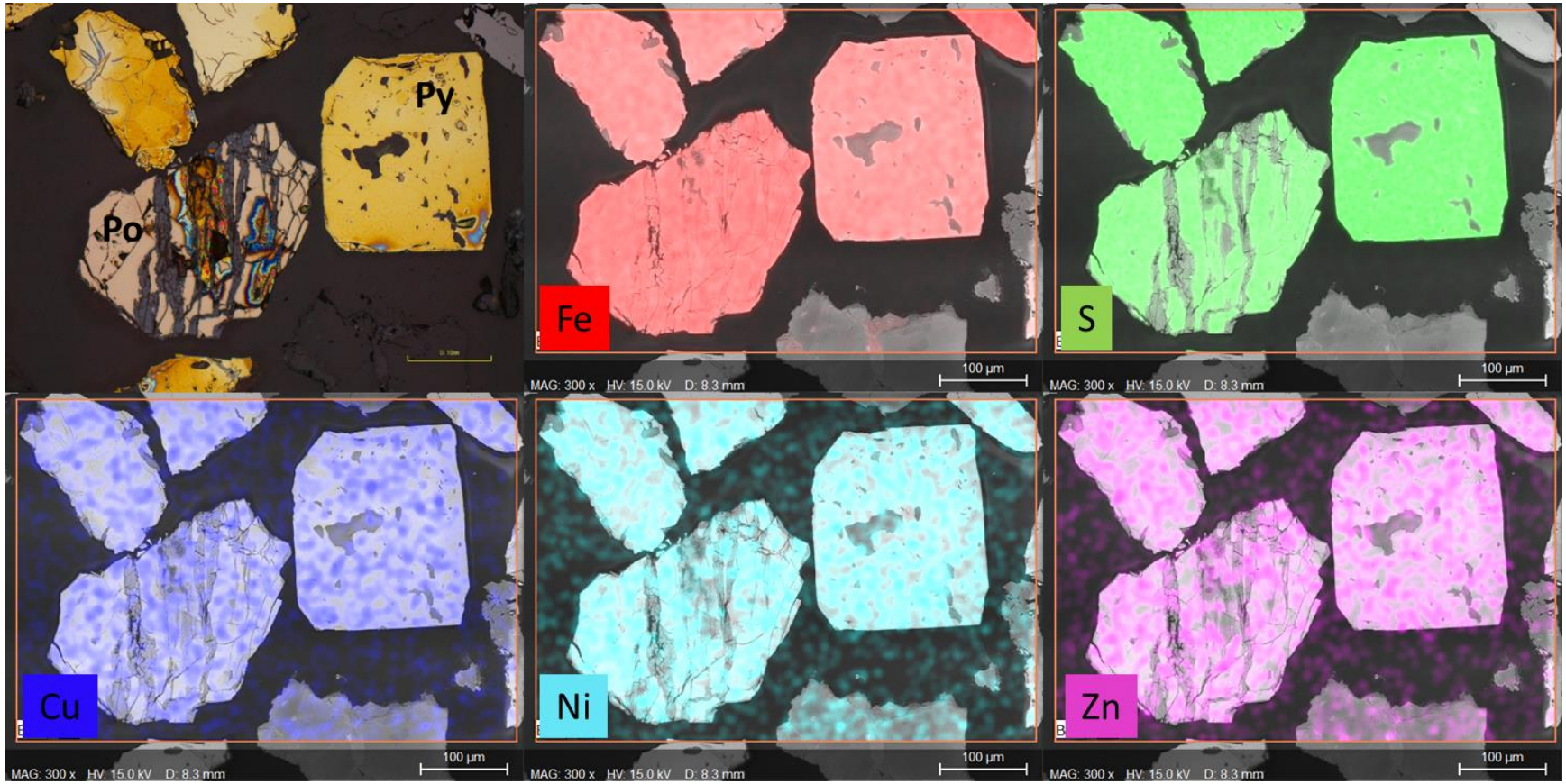



***Figure 2.19: Unweathered Pyrite (Py) Grain Adjacent to Pyrrhotite (Po) Grain Displaying Weathering Along Fractures in Sample WRS-2-5; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

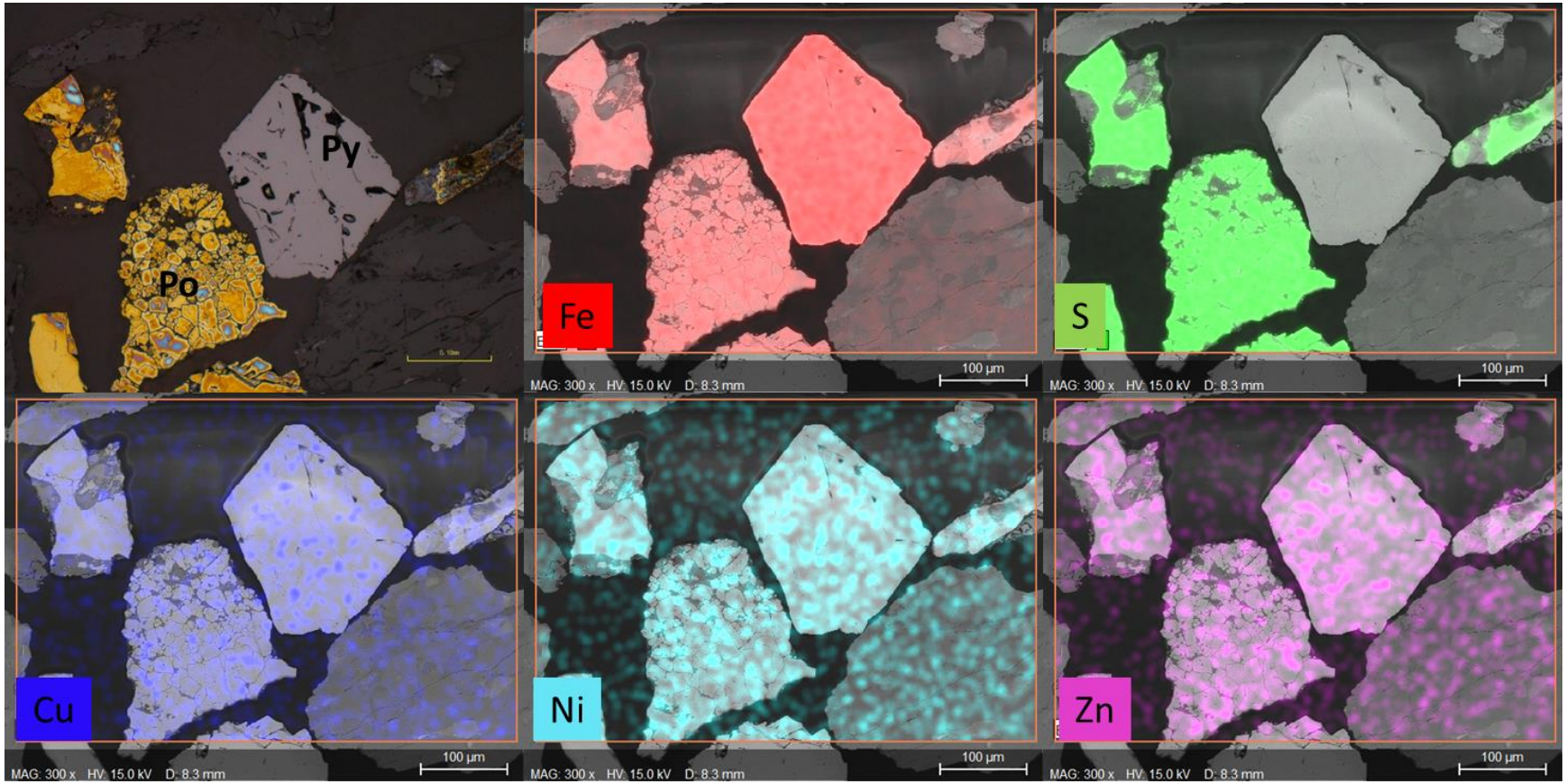



***Figure 2.20: Weathered Pyrite (Py) Grain and a Fractured but Marginally Weathered Pyrrhotite (Po) Grain in Sample WRS-2-5; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

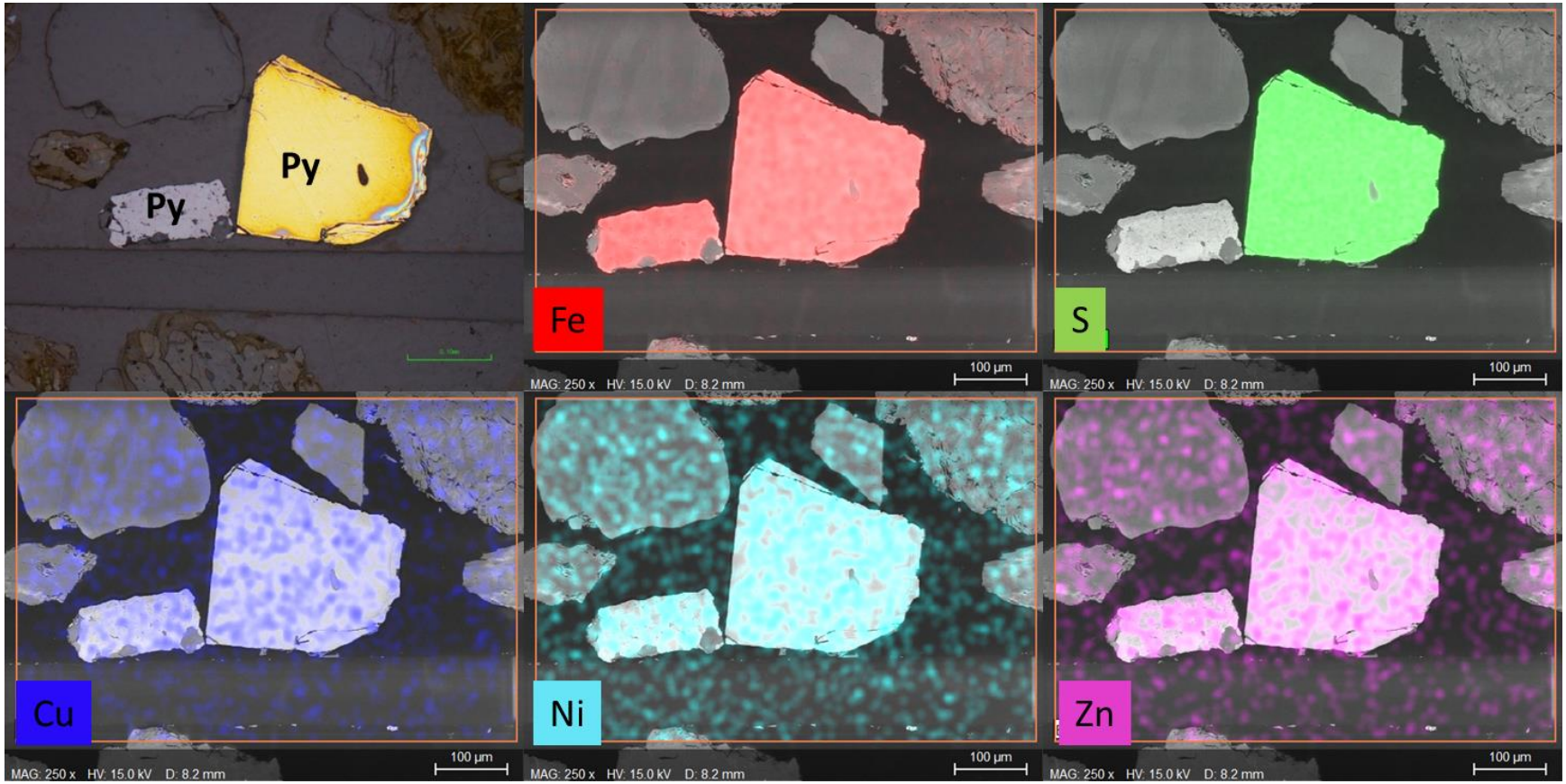



***Figure 2.21: Weathered and Unweathered Pyrite (Py) Grains in Sample P4-P7-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

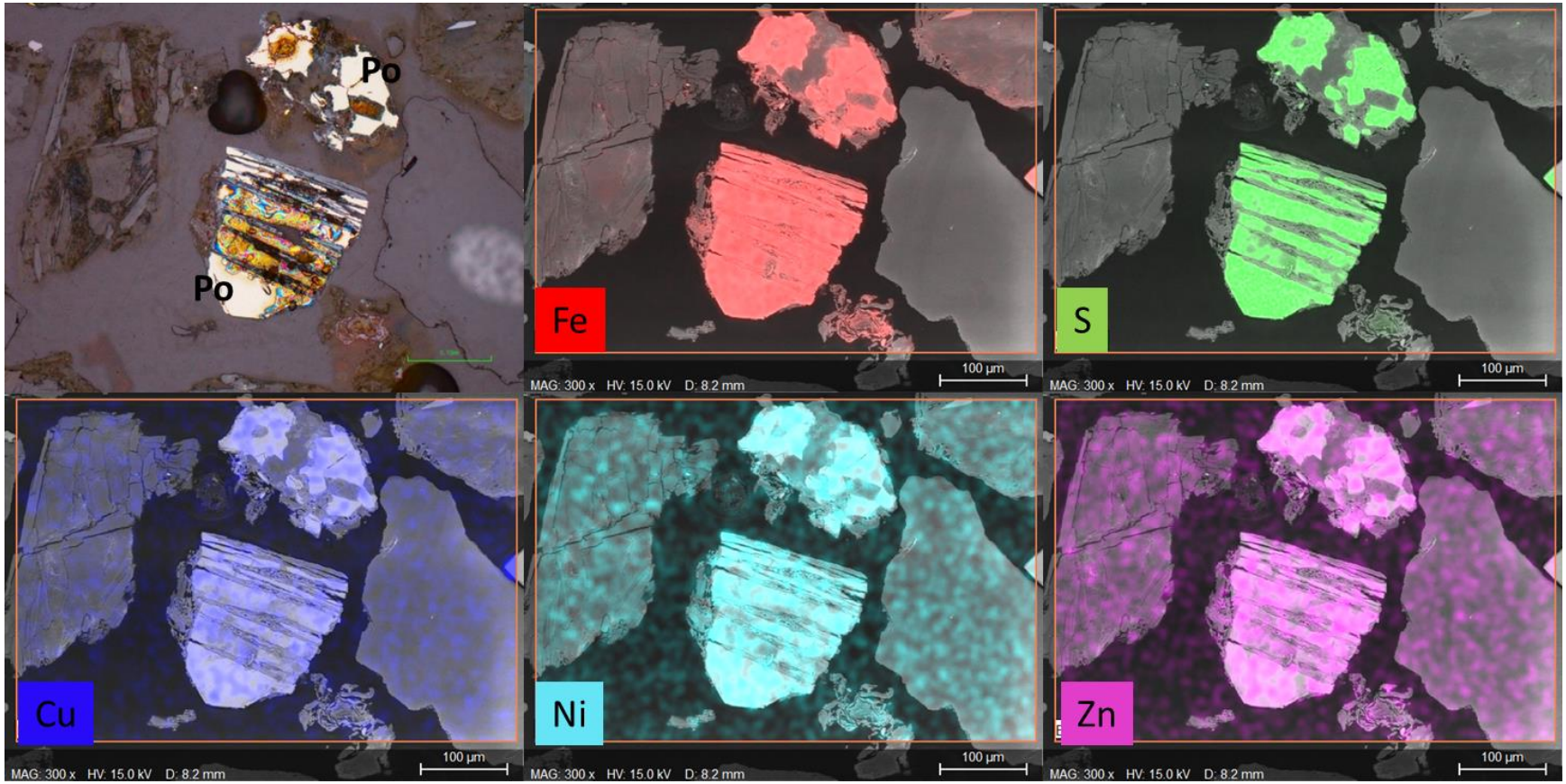



***Figure 2.22: Fractured and Partially Weathered Pyrrhotite (Po) Grains in Sample P4-P7-S2; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

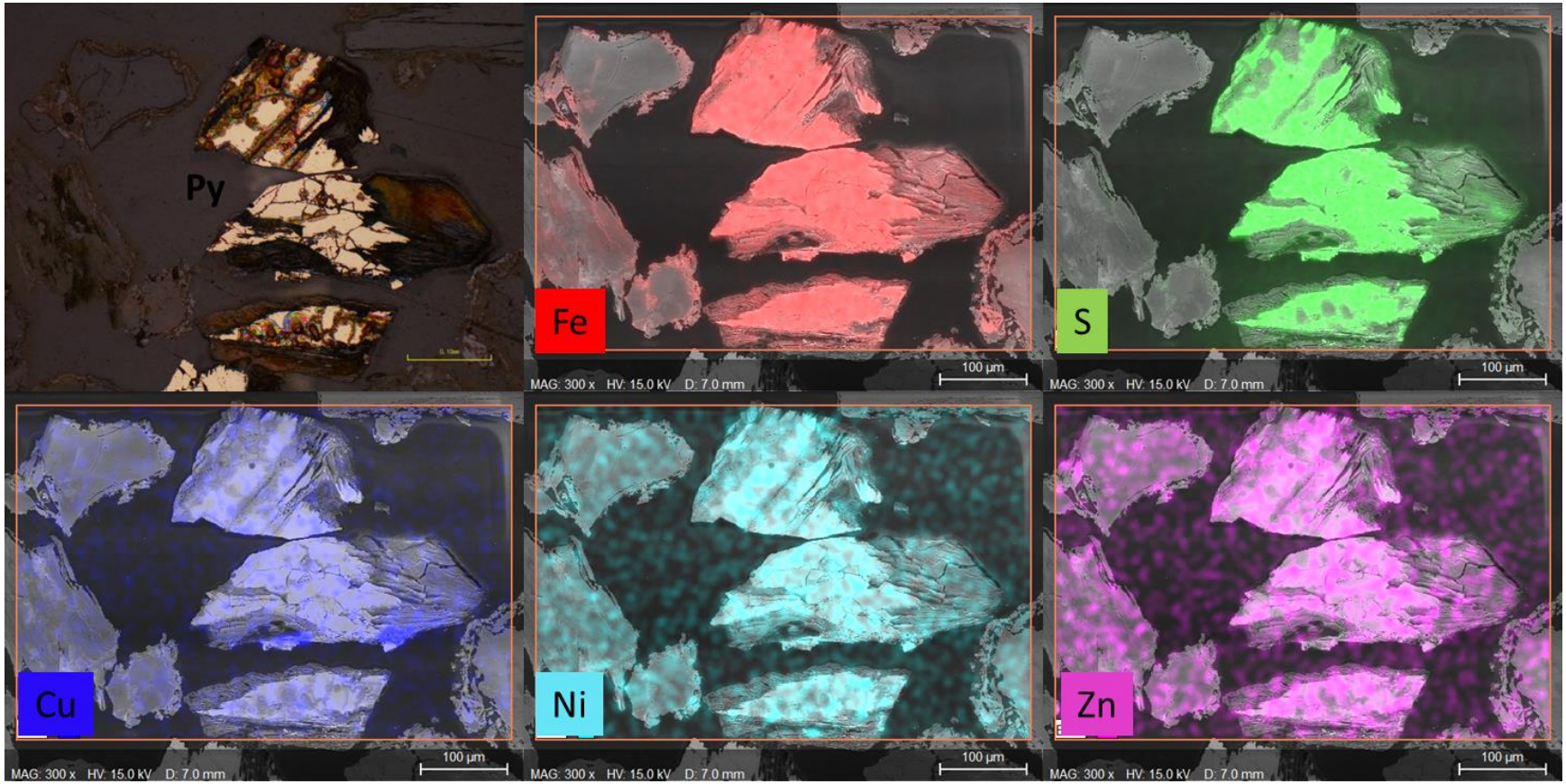



***Figure 2.23: Weathered Pyrite (Py) Grains in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

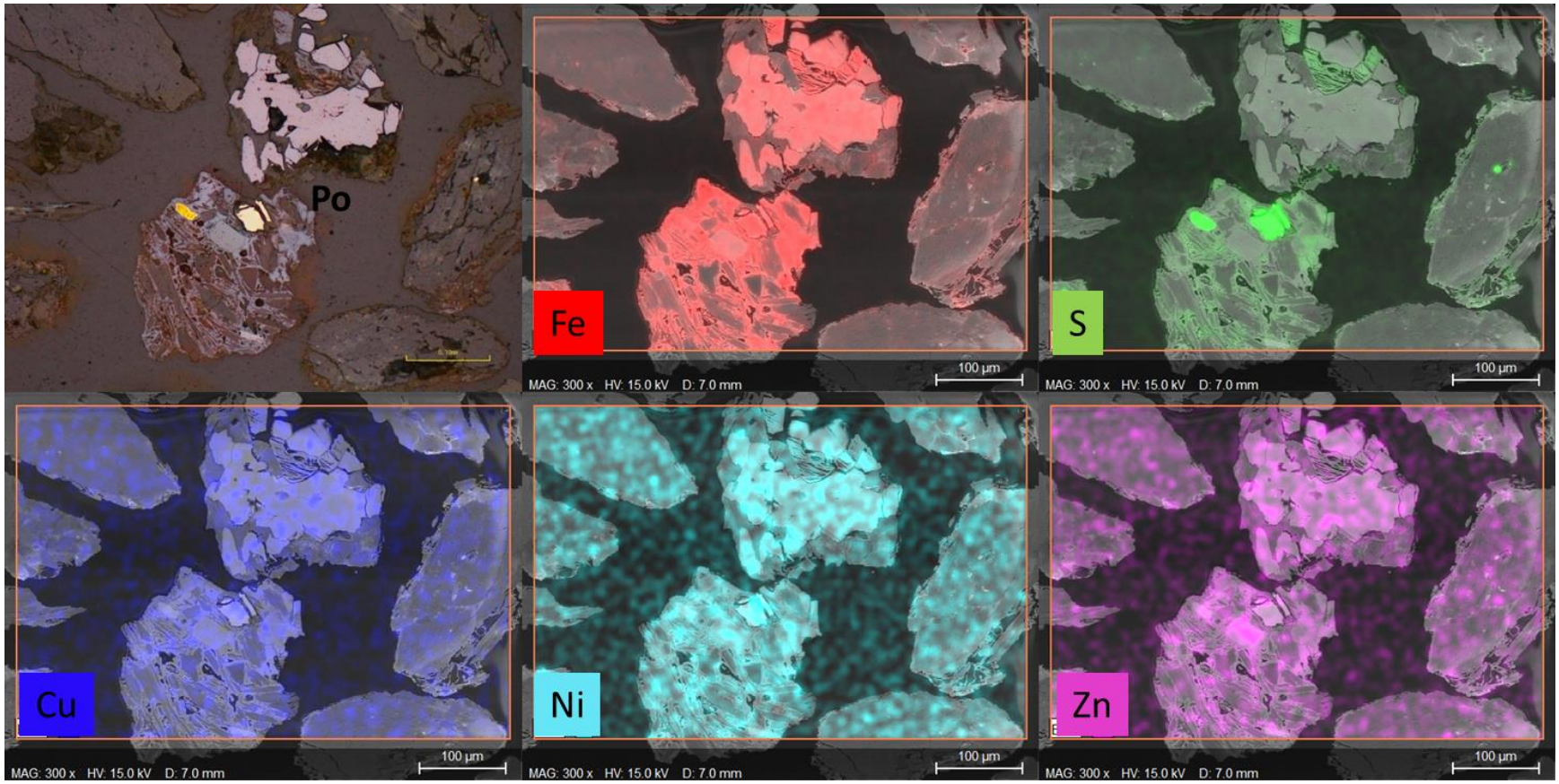



***Figure 2.24: Weathered Pyrrhotite (Po) Grains in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

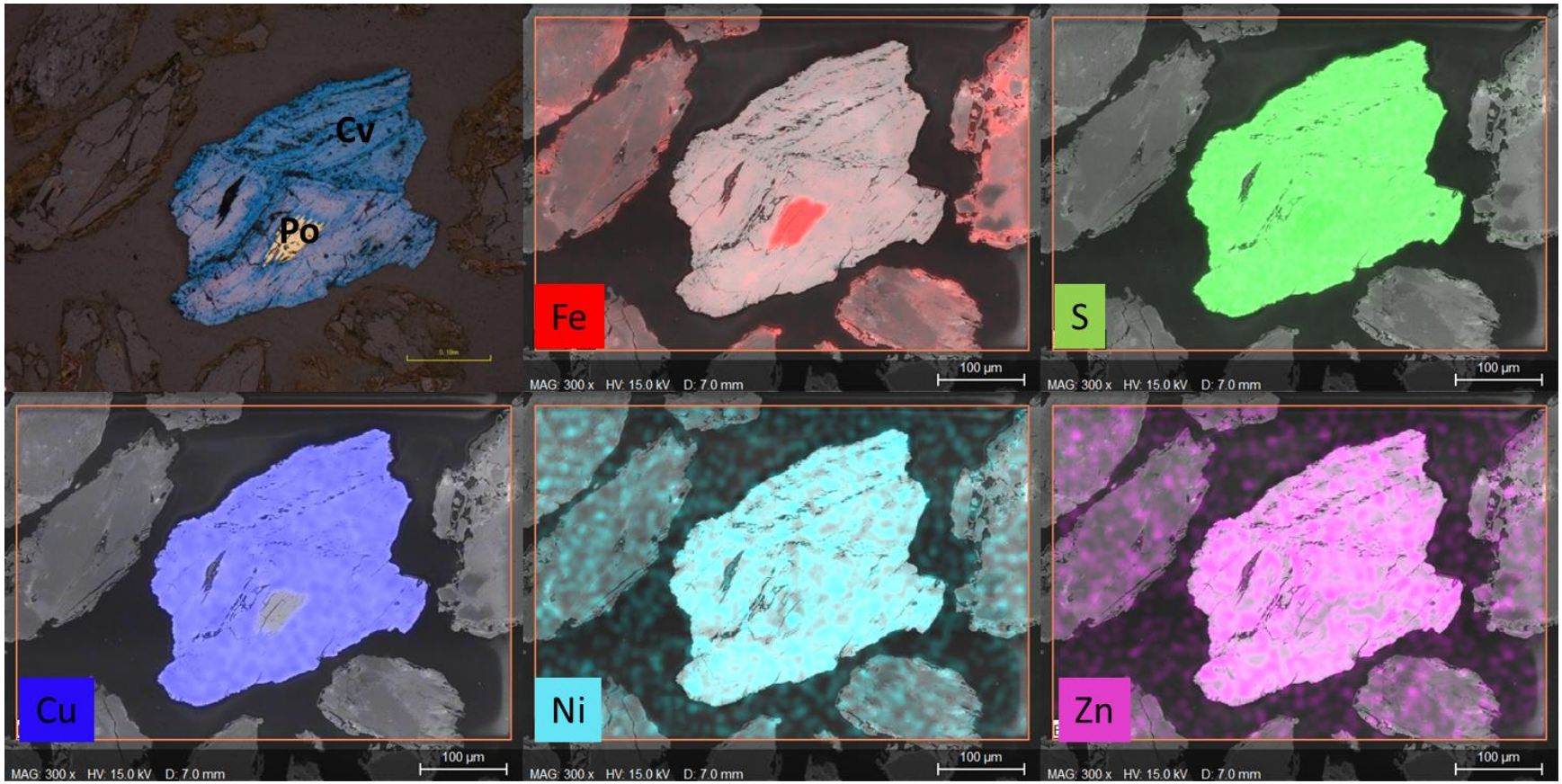



***Figure 2.25: Pyrrhotite (Po) Grain Embedded in a Covellite (Cv) Grain in Sample TP-P1-S9-S3; Reflected Light Optical Microscopy and SEM-EDS Element Maps of Iron (red), Sulfur (green), Copper (dark blue), Nickel (light blue) and Zinc (pink) at 300X Magnification***

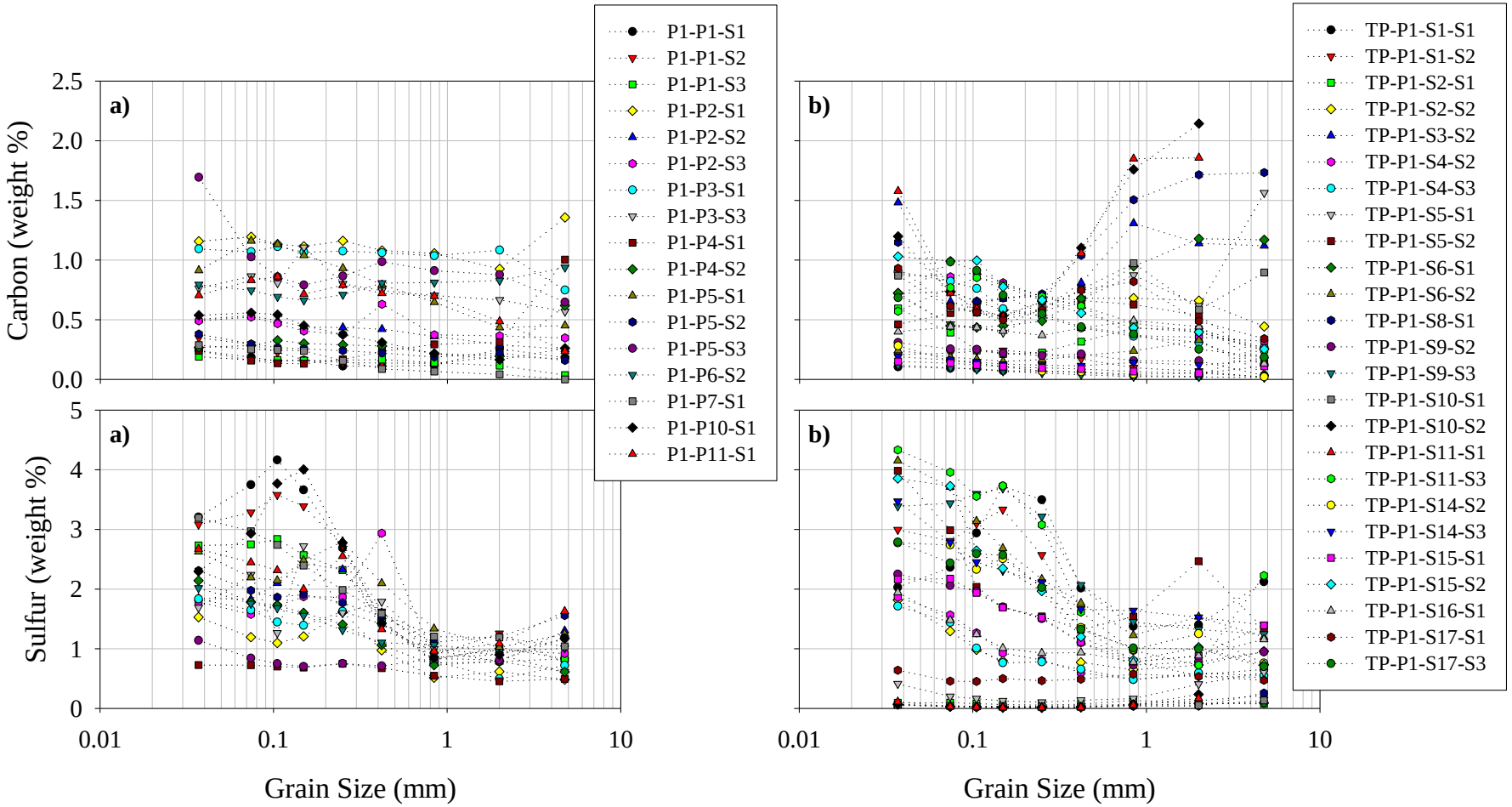



***Figure 2.26: Grain Size Trends in Carbon/Sulfur – a) WRS#1 Profile Excavation Samples and b) WRS#1 Test Pit Samples***

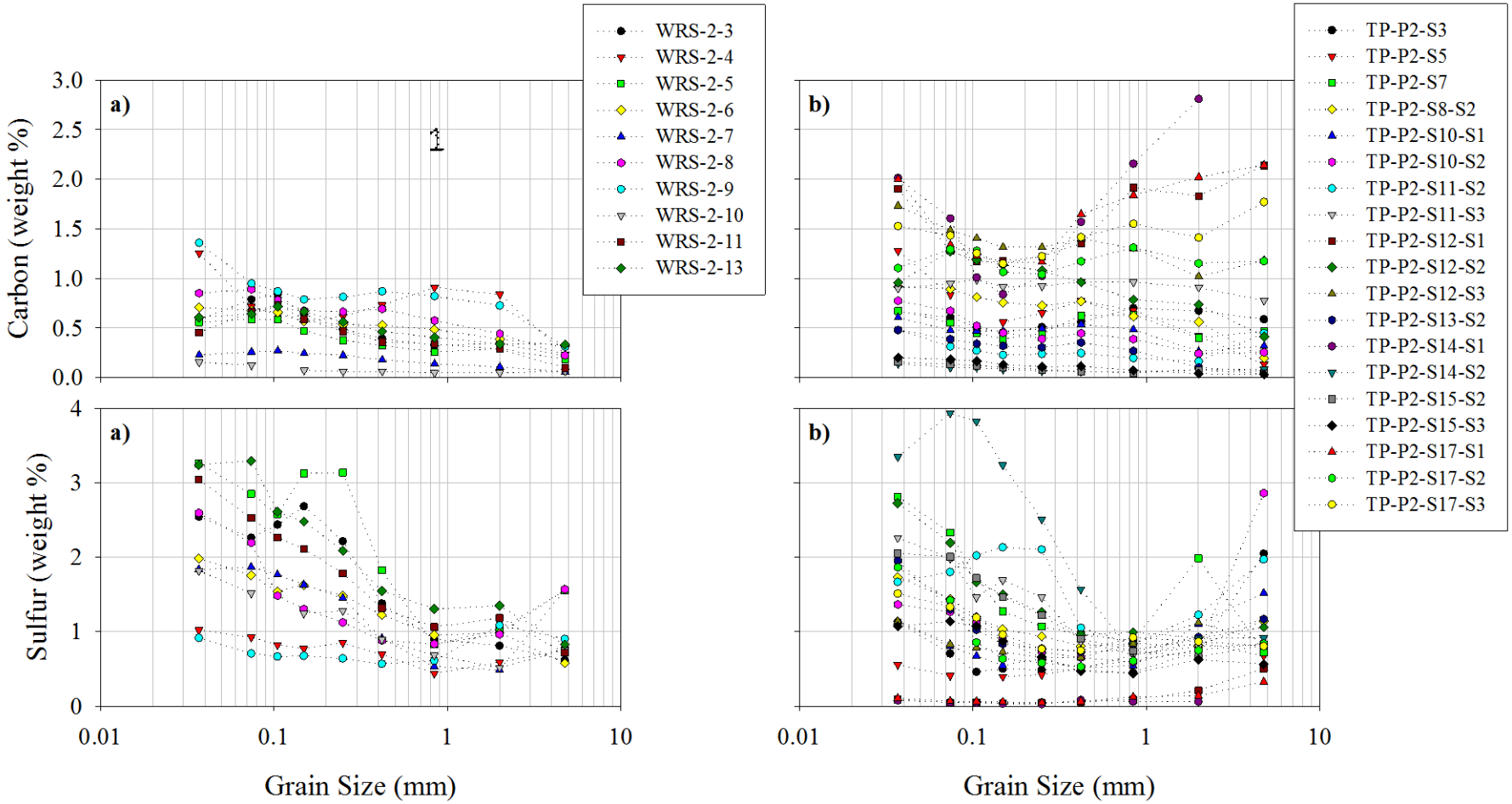



***Figure 2.27: Grain Size Trends in Carbon/Sulfur – a)WRS#2 Profile Excavation Samples and b) WRS#2 Test Pit Samples***

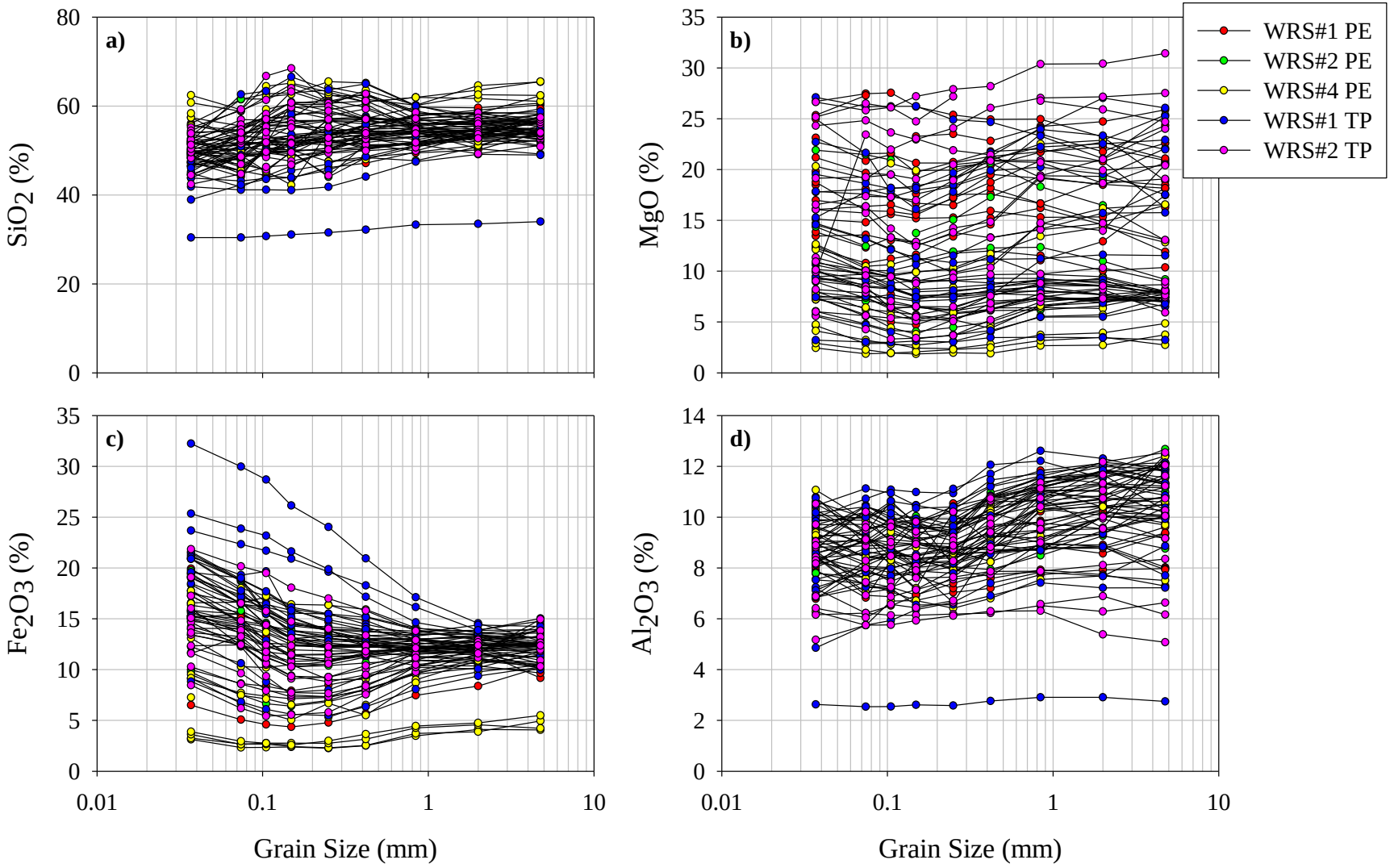



***Figure 2.28: X-Ray Fluorescence Results – Grain Size Distribution of a) $SiO_2$, b) MgO, c) $Fe_2O_3$ and d) $Al_2O_3$ in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples***

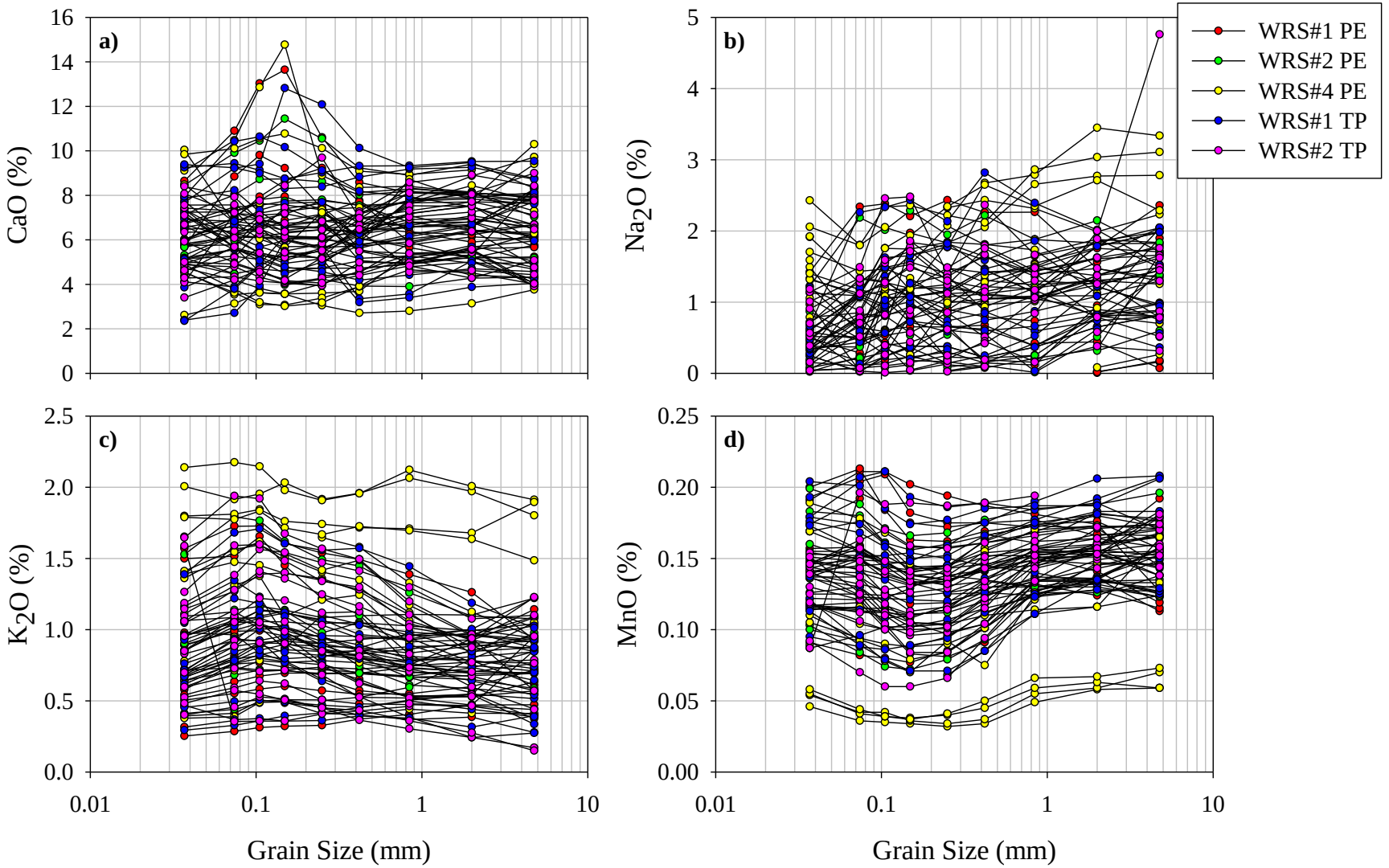



***Figure 2.29: X-Ray Fluorescence Results – Grain Size Distribution of a) CaO, b) $Na_2O$, c) $K_2O$ and d) MnO in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples***

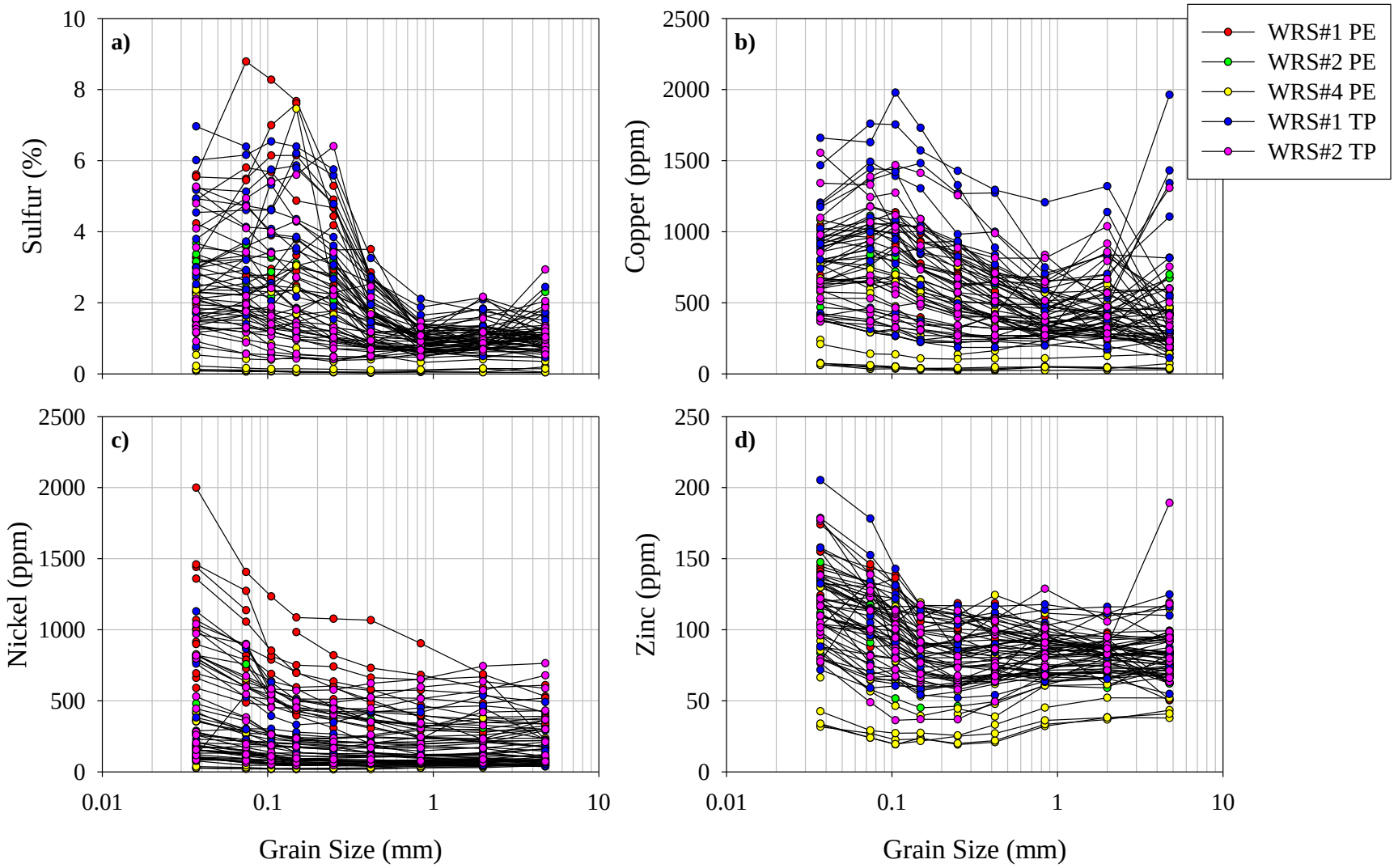



***Figure 2.30: X-Ray Fluorescence Results – Grain Size Distribution of a) Sulfur, b) Copper, c) Nickel and d) Zinc in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples***

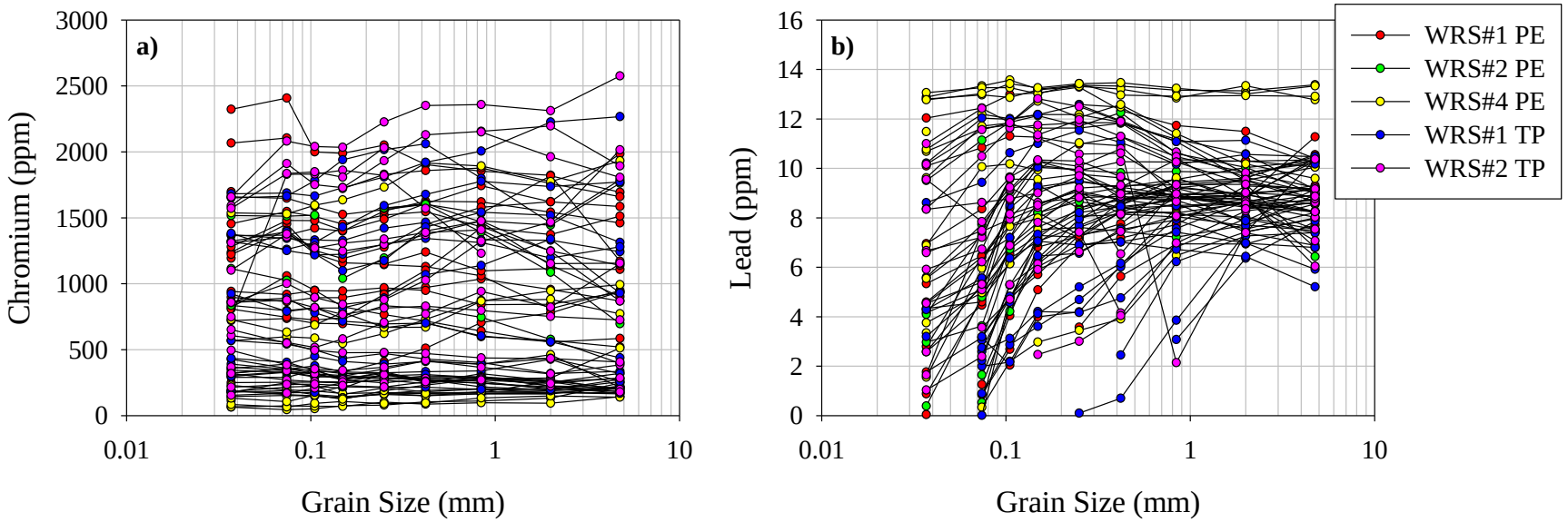



***Figure 2.31: X-Ray Fluorescence Results – Grain Size Distribution of a) Chromium and b) Lead in WRS#1, WRS#2 and WRS#4 Profile Excavation (PE) and Test Pit (TP) Samples***

# Chapter 3 – Detour Gold Waste Rock Characterization Project: Microbiological Characterization of a Historic Sulfide-Bearing Waste-Rock Stockpile

## 3.1 Overview

Sulfide oxidation has resulted in neutral mine drainage conditions in two of the historic waste rock stockpiles (WRS) at the Detour Lake mine northeast of Cochrane, ON (Figure 1.1). WRS#1 and WRS#2 were deconstructed and extensively sampled as part of a project to characterize the 20 - 30 year old historic waste and to develop plans for future waste management. This chapter presents the results of microbiological analyses performed on waste rock and overburden samples recovered from the flanks and cover of WRS#1 in July, 2013. The analysis indicates that extensive populations of chemolithotrophic bacteria have colonized the stockpile and are contributing actively to sulfide oxidation.

Enumerations of three common waste rock bacteria indicate that the neutrophilic sulfur oxidizing bacteria (*Thibacillus thioparus* and related species) were the most ubiquitous species with an average density of $5.5x10^5$ bacteria/g. Acidophilic iron oxidizing bacteria (*Acidithiobacillus ferrooxidans* and related species) were less widespread but were abundant in oxidized samples, with a maximum recorded density of $1.6x10^7$ bacteria/g and a mean density of $9.0x10^5$ bacteria/g. Acidophilic sulfur oxidizing bacteria (*Acidithiobacillus thiooxidans* and related species) were detectable throughout the stockpile but at a much lower mean density of $1.2x10^3$ bacteria/g. The results of the 16S rRNA analysis are consistent with bacterial enumerations. Populations of sulfur and iron oxidizing bacteria dominated in most samples, particularly species of the *Thiobacillus* and *Acidithiobacillus* genera. The bacterial composition of samples fell into three categories. Samples of the overburden material covering WRS#1 were characterized by great diversity in bacterial composition compared to samples collected from interior of the

stockpile. Unoxidized waste rock samples were similar but typically had a dominant sulfur oxidizing genera (*i.e. Thiobacillus*). Oxidized waste rock samples were characterized by a shift to acidiphillic genera (*i.e. Acidithiobacillus*). The 18S rRNA analysis also indicated several genera of fungi including *Pycnopeziza*, *Leptosphaeria*, *Tetracladium* and *Cucurbitaria* were present in WRS#1. None of the fungi detected at WRS#1 are believed to play an important role in generation of acid rock drainage.

## 3.2 Introduction

Sulfide oxidation and acid rock drainage (ARD) have long been understood to be processes greatly enhanced by the biological oxidation of inorganic compounds present in mine wastes. A range of lithoautotrophic organisms impact the rate of sulfide and Fe(II) oxidation. *Acidithiobacillus ferrooxidans* (formerly *Thiobacillus ferrooxidans*) catalyzes the oxidation of Fe(II) to Fe(III), which is the rate limiting step in sulfide oxidation (Williamson and Rimstidt, 1994). Several species of sulfur oxidizing bacteria may directly oxidize sulfide minerals (Nordstrom and Southam, 1997) but more commonly biotic sulfide oxidation utilizes the intermediary reaction products of abiotic sulfide oxidation such as $H_2S$, $S^o$, $S_2O_3^{2-}$, $S_3O_6^{2-}$ and $S_4O_6^{2-}$ (Baker and Banfield, 2003). In addition to catalyzing sulfide oxidation, the biomineralization of aqueous contaminants by bacteria through the precipitation of ferric hydroxysulfates affects contaminant mobility. Whereas iron and sulfur oxidizing bacteria are typically associated with acidic mine drainage, common acidophilic sulfur and iron oxidizing bacteria have been cultured in low numbers from waste rock environments characterized by neutral mine drainage (NMD) (Southam and Beveridge, 1992; Blowes et al., 1998; Lindsay et al., 2009).

The renewal of mining activities at the Detour Lake gold mine provided the opportunity to study the microbiology of a historic sulfide-bearing waste-rock stockpile characterized by neutral mine drainage. The original mine operations from 1983 to 1999 generated several million tons of waste rock which were placed into four stockpiles covering several hectares each at a depth of 15 - 20 m (Figure 1.1). A thin soil reclamation cover was placed on the stockpiles during mine closure in 1999. WRS#1 was located within the footprint of the proposed open pit and was deconstructed starting in 2011. The majority of waste rock in this stockpile originated from the massive mafic flows of the Upper Detour Lake Formation (Oliver et al., 2012) which consist mainly of plagioclase (anorthite) and mafic minerals (*e.g.* actinolite-horneblende), and are also host to quartz veins. This formation also hosts potasically altered mafic flows which contain secondary albite, biotite and sulfides. The remaining historic waste rock (~45 %) originates from the Lower Detour Lake Formation which consists of more ultramafic rock types as well as a chloritic schist contact unit. Visual observations during the deconstruction of the pile indicate that local overburden material was also mixed into the stockpile during deposition. Carbon and sulfur content of waste rock at WRS#1 range from 0.0 - 1.3 wt. % and 0.0 - 2.3 wt. % respectively; with average carbon and sulfur contents of approximately 0.4 and 1.0 wt. %, respectively (Chapter 2).

The objective of this chapter is to describe the microbiological characterization of samples recovered from WRS#1 in the summer of 2013. Samples of waste rock and cover material were gathered from a range of depths and levels of oxidation. Enumerations of three common waste rock bacteria and bacterial 16S rRNA and fungal 18S rRNA determinations were conducted in conjunction with carbon, sulfur and paste pH data to understand the distribution and activity of microorganisms within the stockpile and at different levels of oxidation.

## 3.3 Microbiology of Acid Rock Drainage

Microorganisms including bacteria, archaea and fungi are ubiquitous in terrestrial environments, including waste rock stockpiles. The processes of bacterial and fungal growth are closely intertwined with sulfide oxidation and gangue mineral weathering. The biological oxidation rate of pyrite by bacteria is up to two orders of magnitude greater than the chemical oxidation rate (Schippers et al., 2010) and the biological weathering of rocks is said to be more significant than physical weathering (Burford et al., 2003). Nordstrom (2000) reviewed the history of research on pyrite oxidation by bacteria. As early as 1919 the catalysis of pyrite oxidation by bacteria was proposed, and by the 1960s hydrometallurgical applications for enhanced metal extraction had been established. Colmer and Hinkle (1947) isolated the most commonly studied iron and sulfur oxidizing autotroph *Thiobaccilus ferrooxidans* (later reclassified as *Acidithiobacillus ferrooxidans*) from acidic drainage retrieved from a coal mine in West Virginia. Since that time several other species native to ARD environments have been identified. *Acidithiobacillus thiooxidans* and *Leptospirillum ferrooxidans*, species of sulfur and iron oxidizing autotrophs respectively, are now generally accepted as important species at mine drainage sites (Nordstrom, 2000; Shrenk et al., 1998). Environmental conditions ultimately determine the distribution of species. Low pH values and high temperatures brought about by sulfide oxidation favour species suited to these extreme conditions. Heterotrophic bacteria can also be found living in association with their chemoautotrophic counter parts. Kuenen and Beudeker (1982) further demonstrated that several species of *Thiobacillus* can grow mixotrophically.

Baker and Banfield (2003) provide a review of the bacterial, archael and eukaryiotic species commonly found in ARD environments. Bacteria common to waste rock fall into four phyla; proteobacteria, nitrospira, firmicutes, and acidobacteria. Amongst the proteobacteria are species

from the *Thiomonas* genus, the *Acidiphilum* genus, and the *Acidithiobacillus* genus (including *T. ferrooxidans, T. thiooxidans,* and other *Thiobacillus/Acidithiobacillus* species). The nitrospira phylum includes the *Leptospirillum* genus and the attendant species (*e.g. L. ferroxidans, L. ferriphilum*). The firmicutes phylum contains the *Actinobacter* group which includes the *Acidimicrobium* genus (*e.g. A. ferrooxidans*) and *Ferromicrobium acidophilus*, as well as the *Sulfobacillus* group (*e.g. S. thermosulfidooxidans*, *S. disulfidooxidans*). Baker and Banfield (2003) report that the archael orders of *Thermoplasmatales* and *Sulfolobales* are commonly found at ARD site. Another review of the microbiology of sulfidic mine waste by Schippers et al. (2010) provides a genus level inventory of bacteria encountered at mine waste site and noted 43 genera of bacteria including 10 iron and/or sulfur oxidizers. Schippers et al. also noted the following iron and/or sulfur oxidizing achaeal genera; *Acidianus*, *Ferroplasma*, *Metallosphaera*, *Sulfolobus* and *Sulfurisphaera*.

Although the role of bacterial catalysis in sulfide oxidation and ARD generation is well established there is a relative scarcity of studies on the fungal ecology of mine wastes. Fungi are ubiquitous in terrestrial environments and play an important role in the subsurface ecology (Webster and Weber, 2007). Burford et al. (2003) reviewed the contribution of fungi to mineral weathering and contaminant sequestration through secondary mineral precipitation or bioaccumulation. Dozens of common fungal species were identified which are capable of colonizing various rocks including sandstone, granite, quartzite, andesite and basalt. Rock weathering generally occurs as a result of acidification. Acidification occurs through the excretion of protons or organic acids, via proton exchange for nutrients or through respiration of $CO_{2(g)}$. The release of metals from solubilized minerals can also be mitigated by the growth of fungi. Bioaccumulation of metals into fungal structures, intracellular sequestration and

precipitation of metal compounds through chelating effects on the filamentous fungal network all provide sinks for liberated metals (Burford et al., 2003). Fungi are capable of silicate mineral dissolution and are instrumental in the formation and alteration of clay minerals. A number of fungal genera have been noted for their ability to solubilize silicates and liberate several contaminants, notably iron (Burford et al., 2003).

Baker and Banfield (2003) reviewed the eukaryotic organisms reported in ARD and found that most belonged to the *Cinetochilium* (ciliate) genus, or were related to *Vahlkampfia* (amoeba) or *Eutreptial* (flagellate) species. In a more recent review Schippers et al. (2010) reported the following eukaryotic genera in mine waste environments; *Amoeba*, *Cladosporium* (molds), *Euglena* (flagellate protists), *Eutrepia*, *Hormidium* (algae), *Penicillium* (ascomycetous fungi), *Rhodotorula* (yeasts), *Trichosporon* (anamorphic fungi) and *Ulothrix* (algae). However, none of the Eukaryotic genera reportedly isolated from mine wastes have any significant iron/sulfur oxidizing functions.

The goal of this study is to identify mine waste bacteria and fungi at WRS#1 and to determine their abundance. Iron and sulfur oxidizing bacteria are important catalysts for the generation of ARD at many mine-waste sites, and the enumeration of these bacteria will indicate their activity and contribution to ARD at the Detour Gold mine.

## 3.4 Materials and Methods

Twenty four samples of fine-grained waste rock material were collected during the excavation of WRS#1 in July, 2013 for microbiological analysis. Samples were taken at two depths at 12 separate sample sites (Figure 3.1). An excavator was used to dig approximately 1.0 m into the exposed flank of the stockpile to access waste material which was not exposed to direct sunlight. A trowel sterilized using methanol was used to scoop fine grained waste rock and soil into

dedicated 250 mL glass containers. The samples were kept refrigerated for enumeration of sulfur and iron oxidizing bacteria. Separate 250 mL samples were taken and kept frozen for 16S rRNA and 18S rRNA analysis.

At sites 1-6 the excavator was used to retrieve one large scoop of fresh waste rock material from the upper flank of the 25 m tall stockpile, approximately 10 m below the crest of the stockpile. A second sample was gathered from the base of the stockpile at each of these six locations. Sites 7 and 8 were collected from the edge of the stockpile in an area approximately 10 m in height and were composed of more fine-grained material. At each of these sites a sample was gathered from adjacent patches of clearly oxidized (orange) and unoxidized (light grey) soil. Sites 9 - 12 were located near the top of a separate section of WRS#1 with an intact till cover. At these four locations a sample was taken from the cover material (< 1 m depth) and another from the shallow waste rock material underneath the till cover (1 - 2 m depth).

Samples from WRS#1 were subjected to two methods of microbiological analysis. Enumerations of several common iron and sulfur oxidizing bacteria were performed at the University of Waterloo. A genomic analysis was performed by MR DNA in Shallowater, Texas. Carbon and sulfur contents were determined on splits of the samples using an ELTRA CS-2000 carbon/sulfur analyzer, and paste pH determinations were conducted according to ASTM standard D4972 (2007).

The method of Blowes et al. (1995) was used to enumerate populations of neutrophilic sulfur oxidizing (*Thiobacillus thioparus* and related species), acidophilic sulfur oxidizing (*Acidithiobacillus thiooxidans* and related species) and acidophilic iron oxidizing (*Acidithiobacillus ferrooxidans* and related species) bacteria using the modifications described in

Hulshof et al. (2006). Growth media was prepared using ultrapure water (Millipore Canada Limited, Nepean, ON) and handled using sterilized instruments. The growth media was not sterilized before dispensation.

The frozen split samples were thawed for DNA extraction and isolation in May, 2014 using a PowerSoil® DNA Isolation Kit (Mo Bio Laboratories, Carlsbad, CA). DNA yield determined by Nano drop at the University of Waterloo ranged from 2.2 – > 15 ng/µL. Extracts were refrozen before being sent to MR DNA (Shallowater, TX) for a bacterial and fungal diversity analysis. MR DNA uses a proprietary barcoded amplicon sequencing process under the trademark bTEFAP®, a technique first described by Dowd et al. (2008). This process has been used to characterize microbial populations in a wide range of environmental microbiomes. PCR amplification was performed using assay 515-806 with the SSU 18s primer. PCR cycling was performed using a single-step 30 cycle PCR HotStarTaq Plus Master Mix Kit (Qiagen, Valencia, CA). The PCR cycling took place under the following conditions; 94$^{o}$C for 3 minutes, followed by 28 cycles of 94$^{o}$C for 30 seconds; 53$^{o}$C for 40 seconds and 72$^{o}$C for 1 minute; after which a final elongation step at 72$^{o}$C for 5 minutes was performed. Following PCR, all amplicon products from different samples were mixed in equal concentrations and purified using Agencourt Ampure beads (Agencourt Bioscience Corporation, MA, USA). Samples were sequenced utilizing Roche 454 FLX titanium instruments and reagents and following the manufacturer's guidelines.

## 3.5 Results and Discussion

Microbiology samples were organized into four qualitative groupings based on the depth of collection from the 20 - 25 m deep WRS#1. At locations 1 - 6 samples were recovered from two depths; approximately mid (M) depth (*e.g.* sample 1M) and deep (D) in the stockpile near the

base (*e.g.* sample 1D). Highly oxidized and unoxidized zones of waste rock were present at both locations 7 and 8. At each location two samples were taken at mid depth, with the oxidized samples denoted by a star (*e.g.* samples 7M-1 and 7M-2*). At locations 9 - 12 samples were taken from the cover (C) material and also the shallow (S) waste rock (*e.g.* samples 9C and 9S*). Table 3.1 summarizes the depth designation of the microbiology samples. Several additional samples were collected from visibly oxidized zones in the waste rock as indicated in Table 3.1. Large zones of oxidation are visible at multiple depths and spread heterogeneously across the area of the remaining waste rock and were identifiable by a distinct reddish rusty colour.

The carbon and sulfur contents of the samples selected for microbiological analysis recovered from WRS#1 (Figure 3.2, Table 3.2) were in the same range as those collected during the comprehensive sampling campaign (Chapter 2). The carbon and sulfur contents of the test pit and profile samples ranged from 0.0 - 1.3 wt. % and 0.0 - 2.2 wt. % respectively, whereas the carbon and sulfur contents of the microbiology samples ranged from 0.1 - 1.3 wt. % and 0.1 - 2.4 wt. % respectively. Average carbon and sulfur content of the test pit and profile samples were approximately 0.4 wt. % and 1.0 wt. % respectively, while the average carbon and sulfur content of the microbiology samples were 0.6 wt. % and 1.0 wt. % respectively. On the basis of carbon and sulfur contents, the microbiology samples are representative of the larger sample set and of the waste rock stockpile.

The paste pH results for the microbiology samples ranged from 2.48 - 7.52, with an average of 5.57 for the entire sample set. The paste pH values for a majority of samples, particularly from the deep and intermediate depths, ranged from pH of 5.0 – 7.0. The paste pH values for the cover samples were consistently pH > 7, reflecting the very low sulfur contents. All the waste-rock samples from the shallow zone had paste pH < 4, along with two intermediate depth samples. All

of the samples with a low paste pH (< 5.5) were significantly oxidized. The range of paste pH measurements are in agreement with those reported by Cash (2014), who found paste pH distribution for WRS#1 waste rock ranging from 2.5 - 7.5. However, Cash reported a bimodal distribution with the majority of waste rock samples having a paste pH of 6 - 8. The slight discrepancy in the distribution of paste pH values reported here is attributed to the targeted selection of oxidized samples for the microbiological study.

### *3.5.1 Sulfur and Iron Oxidizing Bacteria*

The results of bacterial enumeration (Table 3.2) indicate that there are viable populations of neutrophilic sulfur oxidizing (*Thiobacillus thioparus* and related species; SOBn), acidophilic sulfur oxidizing (*Acidithiobacillus thiooxidans* and related species*;* SOBa) and acidophilic iron oxidizing (*Acidithiobacillus ferroxidans* and related species*;* FeO) bacteria throughout WRS#1. The largest population on average was the neutrophilic sulfur oxidizing bacteria which exhibited a large abundance in most samples (Figure 3.4). The maximum recorded abundance of SOBn was $4.0x10^6$ [bacteria/gram of waste rock] in sample 11S* (paste pH = 2.48). The lowest recorded abundance of SOBn was $3.9x10^2$ bacteria/g in sample 1M (paste pH = 5.72). Excluding the results from cover samples, the mean and median density of SOBn in the waste rock samples were $5.5x10^5$ bacteria/g and $8.4x10^4$ bacteria/g, respectively (Figure 3.4).

Acidophilic iron oxidizing bacteria had moderate to small bacterial abundances (< $1.0x10^4$ bacteria/g) at most locations, but had extremely high bacterial density in many of the samples recovered from highly oxidized zones (Figure 3.6). The maximum recorded abundance of FeO was in sample 2M* ($1.6x10^7$ bacteria/g; paste pH = 3.65), whereas multiple samples had the minimum recorded abundance of FeO of $1.6x10^1$ bacteria/g (samples 1M, 4M, 4D, 7M-1, 10C and 12C; paste pH 5.67 – 7.52). The average and median waste rock FeO density were $9.0x10^5$

bacteria/g and $5.3x10^2$ bacteria/g, respectively; if oxidized samples are excluded from the calculation the mean and median waste rock FeO density are only $2.7x10^3$ bacteria/g and $1.0x10^2$ bacteria/g, respectively (Figure 3.6)

The acidophilic sulfur oxidizing bacteria had the lowest population density of cultivated species across the sample set (Figure 3.5). The maximum recorded abundance of SOBa were in sample 11S* which had $4.0x10^3$ bacteria/g and was the most acidic sample (paste pH = 2.48). The lowest recorded abundance of SOBa was also recorded in one of the most acidic samples; sample 8M-2* had SOBa abundance of $6.6x10^1$ bacteria/g and a paste pH of 2.89. The average and median waste rock SOBa density at WRS#1 are $6.6x10^2$ bacteria/g and $1.6x10^2$ bacteria/g, respectively. Slightly higher SOBa densities were measured in the oxidized samples, with mean and median abundance of $1.2x10^3$ bacteria/g and $6.6x10^2$ bacteria/g, respectively. These results are consistent with the expected microbiological profile based on the pore-water conditions at site. Near neutral pore-water pH has been established at neighbouring WRS#3 and WRS#4 and paste pH measurements at WRS#1 are also mostly neutral. Near neutral pH would promote the growth of neutrophilic organisms in the waste rock, with pockets of acidophilic iron oxidizers where sulfide oxidation is actively occurring (Figure 3.5)

The overall abundance of iron and sulfur oxidizing organisms at WRS#1 is within the range reported at similar sites. Schippers et al. (2010) reviewed microbiological studies of mine waste from eight different countries and reported maximum SOBn density ranging from $< 10^2$ to $1.2x10^7$ bacteria/g, maximum FeO density ranging from $2.8x10^2$ to $3.1x10^8$ bacteria/g, and maximum SOBa densities reported by Schippers et al. (2010) ranging from $5.2x10^3$ to $1.2x10^7$ bacteria/g. The maximum recorded abundance of both SOBn and FeO at WRS#1 fall within the range reported by Shippers et al. (2010), whereas the maximum recorded abundance of SOBa at

WRS#1 ($4.0x10^3$ bacteria/g) is slightly lower than the range reported for other sites. The relative abundance of SOBn, SOBa and FeO at WRS#1 is similar to the distribution of these species at other neutral pH waste rock sites. Dockrey (2010) evaluated the distribution of iron and sulfur oxidizing bacteria within waste rock test piles at the Antamina mine and reported that *T. thioparus* (SOBn) were the dominant organism with an abundance > $10^6$ bacteria/g throughout those stockpiles. The low overall abundance of *T. thiooxidans* (SOBa; usually undetected, one sample > $10^7$ bacteria/g) and *A. ferrooxidans* (FeO; usually undetected, one sample > $10^6$ bacteria/g) at the Antamina mine is possibly due to the recent deposition of those stockpiles (< 5 years), which has not allowed the extensive development of acidic microenvironments in which SOBa and FeO may thrive (Dockrey, 2010). The microbiology of WRS#1 is also very similar to several neutral pH tailings ponds in North America. For example, the relative abundance of SOBn over SOBa seen in WRS#1 is similar to the distribution and range of abundance for species in tailings at the Agnico Eagle Joutel gold mine (Blowes et al., 1998) and the Greens Creek mine (Lindsay et al., 2009), where SOBn abundances were six and two orders of magnitude larger than SOBa, respectively. FeO are more abundant at WRS#1 overall than at most neutral pH sites, although several studies have shown that acidophilic FeO are capable of living in neutral pH conditions. FeO populations are generally larger in acidic samples at WRS#1 as with other sites (Southam and Beveridge, 1992; Dockrey, 2010; Blowes et al., 1998).

Figures 3.3-3.6 and Table 3.3 illustrate the results of the bacterial enumerations arranged in order or increasing paste pH. The results indicate that there is a negative correlation between the density of the three enumerated bacteria and paste pH. All of the enumerated species had higher population densities in oxidized samples with a low paste pH (< 5.5). Large variations in FeO (2 - 5 orders of magnitude), SOBn and SOBa (1 - 2 orders of magnitude) density between samples

from similarly acidic soil indicate that although the soil pH is not an absolute indicator for the abundance of these species, the pH is weakly correlated to bacterial density. The Pearson's product-moment correlation coefficient (r) between paste pH and SOBn, SOBa and FeO are -0.65, -0.58 and -0.33, respectively (Table 3.3).

### *3.5.2 Bacterial Biodiversity*

Most of the samples collected from WRS#1 share a similar bacterial metagenome. The aggregate result of bacterial DNA analysis is presented in Figure 3.7 which illustrates the cumulative contribution of the prevalent genera over the 24 samples. The microbiology samples from WRS#1 are characterized by a great diversity in species. The 27 genera shown in Figure 3.7 accounted for a significant (> 1 %) contribution of genetic material in at least one sample. Only two genera, both sulfur oxidizers, account for > 5 % of genetic material cumulatively across the data set. *Thiobacillus* is the most significant genus, providing 12 % of the genetic material among all samples. *Acidithiobacillus* is also a significant genus, contributing to 7 % of the total bacterial DNA. The *Arthrobacter* genus is a common soil microbe regularly found in waste rock stockpiles (Eschbach et al., 2003; Schippers et al., 2010) which accounted for ~3.3 % of the total bacterial DNA. *Candidatus chloroacidobacterium* is a novel genus of aerobic phototrophic bacteria (Bryant et al., 2007) which accounted for ~3.0 % of total DNA. Several of the genera represented in Figure 3.7 are sulfur and iron oxidizing bacteria encountered in other waste rock environments including *Leptospirillum*, *Dokdonella*, *Pseudomonas*, and *Sphingomonas* (Schippers et al., 2010). The remaining genera shown in Figure 3.7 are assorted soil microorganisms and which account for a small (< 3 %) amount of the total DNA. Despite the low overall contribution of many genera, variability from sample to sample can be high. For example, the genera *Roseiflexus*, *Coprothermobacter*, *Leptospirillum* and *Flexibacter* each account for < 3 % of the total bacterial DNA, but each of these genera is the single largest

contributor of DNA in one sample. The results must be analyzed closely to understand the variability and importance of the bacteria present in the samples.

The bacterial taxonomy of the samples fall into three general categories correlated to the spatial origin and paste pH of the samples. The first category is comprised of the soil samples recovered from the cover material (9C, 10C, 11C and 12C). The bacterial taxonomy of these cover samples is typical of most soils, consisting of a large diversity of non-dominant (comprising < 10 % of genetic material) organisms. The second category is comprised of waste-rock samples collected from non-oxidized zones in the stockpile (1M, 1D, 2D, 3M, 3D, 4M, 4D, 5M, 5D, 6M, 6D, 7M-1 and 8M-1). These samples also have a wide diversity of organisms, but can be distinguised from samples recovered from the cover horizon by a higher contribution of genetic material by the *Thiobacillus* and *Acidithiobacillus* genera. The third category is comprised of waste-rock samples collected from oxidized zones in the stockpile (2M*, 7M-2*, 8M-2*, 9S*, 10S*, 11S* and 12S*). These samples also be distinguished from the cover samples by a higher contribution of *Thiobacillus* and *Acidithiobacillus,* and can further be distinguished from non-oxidized waste rock samples by a dominant contribution of *Acidithiobacillus* compared to *Thiobacillus*. Figures 3.8 - 3.12 illustrate this trend by showing the bacterial taxonomy of the samples recovered from WRS#1 based on the pH levels in Table 3.3. Cover samples had very little contribution of genetic material by sulfur or iron oxidizing bacteria (Figure 3.8). The waste rock samples had a significant contribution by iron and sulfur oxidizing bacteria. At low pH the acidophilic genera were dominant (*i.e. Acidithiobacillus*; Figures 3.9, 3.10), whearas the waste rock samples with circumneutral pH had a greater contribution of neutrophilic genera (*i.e. Thiobacillus*; Figures 3.11, 3.12).

Genera in these figures are placed into groups based on their metabolic function (Schippers et al., 2010). Genera of acidophilic waste rock bacteria capable of oxidizing iron and sulfur compounds are plotted in red (*i.e. Acidithobacillus, Alicyclobacillus, Sulfobacillus, Leptospirillum, Acidimicrobium* and *Gallionella*). Genera of neutrophilic waste rock bacteria capable of oxidizing sulfur are plotted in blue (*i.e. Thiobacillus, Acidiphilium, Pseudomonas* and *Thiomonas*). Sulfur and iron reducing bacteria are plotted in pink (*i.e. Bacillus, Desulfobacterium, Desulfobulbus, Desulfococcus, Desulfosporosinus, Desulfotomaculum* and *Desulfovibrio).* Nitrogen oxidizing organisms are plotted in orange (*i.e. Steroidobacter, Flexibacter, Azospira, Nitrospira, Nitrosomonas, Nitrospina, Nitrospira, Nitrosococcus* and *Nitrosovibrio*), while common soil bacteria are plotted in brown (*i.e. Arthrobacter, Achromobacter, Pirellula, Rhodopirellula, Sphingomonas* and *Arenimonas*). Finally, the hundreds of genera which do not belong in the previous categories have been grouped together and are plotted in green. Genera accounting for > 5 % of the total DNA in a group of samples (*i.e. Acidithiobacillus, Thiobacillus, Leptospirillum* and *Dokdonella*) are highlighted.

The bacteria in the four cover samples collected at WRS#1 were characterized by diversity in species and the absence of iron or sulfur oxidizing bacteria (Figure 3.8). The trends in bacterial taxonomy versus pH show that the neutrophilic sulfur oxidizing bacteria, composed primarily of the genera *Thiobacillus,* were present in both acidic and circumneutral pH conditions (Figures 3.9 - 3.12). Acidphillic sulfur and iron oxidizers, especially *Acidithiobacillus*, were also present in both acidic and circumneutral pH conditions, but outnumbered the sulfur oxidizers from pH 3 - 5. Iron oxidizers such as *Leptospirillum* and *Dokdonella* were only present in greater numbers under acidic conditions.

Tables 3.4 and 3.5 summarize the bacterial taxonomy of the individual samples. In all samples 30-70 % of the genetic material was contributed by species accounting for < 1 % individually. However, many samples have a dominant genus which accounts for a larger portion of the DNA. Only five genera accounted for > 10 % of the DNA recovered from any sample; *Thiobacillus*, *Acidithiobacillus*, *Pseudomonas*, *Leptospirillum* and *Dokdonella.* The most pervasive genus was *Thiobacillus* which includes the species *T. thioparus* (SOBn). *Thiobacillus* was a dominant genus in the majority of waste rock samples recovered from locations 1 - 6 at both depths (*i.e.* locations 1M, 1D, 2M, 2D, 3M, 3D, 4M, 4D, 5D and 6M; Table 3.4) and at location 8M-1* (Table 3.5), often accounting for > 25 % of the DNA. The second most significant genus was *Acidithiobacillus* which was dominant at six of the sampling locations including the majority of the oxidized samples (*e.g.* 2M*, 9S*, 10S*, 11S* and 12S*; Tables 3.4 and 3.5) and the unoxidized locations 7M-1 and 8M-1 (Table 3.5).

*Pseudomonas* is a genus of facultative organisms capable of oxidizing sulfur which previously have been observed in waste rock (Schippers et al., 2010). At WRS#1 only sample 6M was found to contain a significant portion of *Pseudomonas* DNA (11.4 %; Table 3.4). The iron oxidizing genera of *Leptospirillum* and *Dokdonella* were also found in several of the oxidized waste rock samples; *Dokdonella* was the second most significant bacteria in samples 9S* and 10S* (Table 3.5), whereas *Leptospirillum* surpassed even *Acidithiobacillus* in sample 11S* (Table 3.5) and was a significant iron oxidizer in sample 10S* (Table 3.5).

Generally the DNA contribution by individual species falling into the “Common Soil” or “Nitrogen Oxidizing” groups is small (< 5 %), but several samples also have dominant genera for these groups. The overall most dominant nitrogen oxidizing organisms were those from the *Azospira* genus which contributed 2.9 % of the aggregate DNA across the entire sample set and

also contributed > 5 % of DNA at locations 1M, 9C, 10C and 11C (Tables 3.4 and 3.5). *Flexibacter* is another significant nitrogen oxidizing genus which also contributed 2.9 % of the aggregate DNA across the entire sample set and contributed > 5 % at locations 4M and 10C (Tables 3.4 and 3.5). Finally, *Steroidobacter* contributed only < 0.5 % of the aggregate DNA across the entire sample set but was the most dominant nitrogen oxidizing genera at location 8M-2* (Table 3.5).

At several locations organisms belonging to the genus *Arthrobacter* contributed significantly to the microbiome (*i.e.* locations 1D, 2D, 4M, 5D, 6D, 7M-2*; Tables 3.4 and 3.5). The *Arthrobacter* genus is widely distributed in subsurface environments. It is the third most abundant genus in the sample set and can be found at low levels (1-5 %) in most samples. *Arenimonas* is another genus of soil organism that has been isolated from agricultural soil, lake sediment, seashore sand and from various industrial sites. Overall the contribution of *Arenimonas* is small with most samples having < 1 % *Arenimonas* DNA and an overall aggregate DNA contribution of only 1.1 % across the whole sample set. However, at location 6M *Arenimonas* is one of the dominant genus with a contribution > 10 %. Finally, *Ktedonobacter* is a common soil organism which is mostly insignificant at this site, providing total aggregate DNA contribution across the sample set of ~0.3 %. However, *Ktedonobacter* was a dominant genus at location 7M-2* (Table 3.5)

Several of the genera contained within the “Other” category were also numerous in one or more samples. Location 7M-2* had an unusual DNA composition considering it was collected from a highly oxidized zone. Despite the high level of oxidation, the contributions of *Thiobacillus*, *Acidithiobacillus* and other organisms common to waste rock were very small compared to other samples (< 5 % of DNA). Instead, the genera *Coprothermobacter, Arthrobacter* and

*Ktedonobacter* were present at > 5 % of DNA. *Coprothermobacter* was also a dominant genus at 10S* (~7 % of DNA). *Coprothermobacter* is a novel genus of bacteria first isolated from a high-protein waste water stream used for treating cattle waste. Overall contribution of *Coprothermobacter* is ~1.4 % and it is unclear why it has thrived at location 7M-2* and 10S*. Finally, *Candidatus chloracidobacterium* is a novel genus of aerobic phototroph which provided > 1 % of DNA in most samples, with an average contribution of 3.0 % and significant (> 5 % of DNA) contribution at locations 7M-1, 11C and 12C (Table 3.5). Since *Candidatus Chloracidobacterium* is a phototrophic organism its presence may be an indication that samples were contaminated with soil from the outermost, sun-exposed layer of waste rock.

### *3.5.3 Fungal Biodiversity*

The aggregate results of the fungal DNA analysis are presented in Figure 3.13, which includes fungal genera which accounted for > 1 % of the total DNA accrued across the entire sample set. Similarly to the results of the bacterial DNA analysis the majority of fungal genetic material in each sample was contributed by genera which accounted for very little DNA individually (< 1 %, 'Other' in Figure 3.13). The second largest contributor of DNA was from fungal species which have yet to be classified into appropriate genera (10 % of total DNA, 'Fungi' in Figure 3.13). *Pycnopeziza* (9.2 %), *Leptosphaeria* (6.1 %), *Tetracladium* (5.8 %), *Cucurbitaria* (5.3 %), *Sclerotinia* (4.7 %), *Chaetomium* (4.4 %), *Chytridiomycota* (3.6 %) and *Anguillospora* (3.2 %) are the most dominant genera at WRS#1, although the samples are heterogeneous in their composition and all of these genera are more dominant and account for significant quantities of genetic material (> 10 % of DNA) in several samples. Other fungal genera which accounted for > 10 % of DNA in at least one sample include *Chaetothyriales*, *Ascomycota*, *Malassezia*, *Kionochaeta*, *Teratosphaeria*, *Calvatia*, *Phialophora*, *Mycosphaerella* and *Psoroglaena*. A summary of the significant fungal genera at WRS#1 is presented in Table 3.6.

The significant fungal genera represented at WRS#1 are mostly saprotrophic (consume dead organic matter), endophytes (consume living organic matter without harm to the host) or pathogens (consume living organic matter to the detriment of the host, disease causing). All the encountered genera consume living or dead plant matter, with the exception of the genus *Malassezia* whose species are naturally found on the skin surface of many animals including humans.

The detailed fungal ecology of each sample is summarized in detail in Tables 3.7, 3.8 and 3.9 for samples from sites 1 - 4, 5 - 8 and 9 - 12, respectively. The DNA analysis reveals several common genera, although none is ubiquitous. Most samples have a few semi-dominant genera in common such as *Leptosphaeria* (samples 1M, 1D, 2D, 3M, 3D, 4D, 6D, 8M-1, 9C, 10C, 11C, 12S*; Tables 3.7-3.9), *Tetracladium* (samples 1M, 1D, 2D, 3M, 3D, 11C, 12C, 12S*; Tables 3.7 and 3.9), *Pycnopeziza* (samples 1M, 3D, 6D, 7M-2*, 8M-1, 8M-2*, 9S*, 12S*; Tables 3.7-3.9), *Cucurbitaria* (samples 1M, 1D, 2D, 3M, 3D, 4M, 4D, 5D, 6D, 12S*; Tables 3.7-3.9) or *Chaetomium* (samples 7M-1, 9C, 10C, 10S*, 11C, 12C; Tables 3.8 and 3.9).

Several samples are characterized by a single dominant genus such as *Pycnopeziza* in samples 2M* and 11S* (Tables 3.7 and 3.9), *Anguillospora* in sample 7M-2* (Table 3.8), *Chaetothyriales* in sample 8M-2* (Table 3.8) or *Chytridiomycota* in sample 10S* (Table 3.9). Sample 6M was uniquely characterized by a dominance of the *Malassezia* and *Kionochaeta* genera, a strong indication of sample contamination. However, besides these cases the samples recovered from WRS#1 are characterized by a wide diversity of fungal DNA. The results indicate that micro-niche environments probably exist within the waste-rock stockpiles which provide suitable habitat for various species of fungi; the physical and chemical heterogeneity of the stockpile is reflected in the heterogeneity of fungal DNA.

It should be noted that none of the eukaryotic or fungal genera reportedly isolated from mine waste by Schippers et al. (2010), Baker and Banfield (2003) or Burford et al. (2003) – see section 2.3 – were detected at WRS#1 at significant concentrations. *Aspergillus* and *Penicillium* were at a maximum density in sample 6D with a contribution of 2.3 % and 0.39 % of DNA respectively, while *Trichoderma* was at a maximum density of 0.19 % of DNA in sample 7M-1. Of the fungi encountered at WRS#1 only *Chaetomium* sp. and *Humicola* sp. are capable of inhabiting and weathering rock; *Chaetomium* sp. have been isolated from sandstone and limestone from temperate climates, *Humicola* sp. have been isolated from sandstone, quartzite and andesite in various climates (Burford et al., 2003).

Overall the results of the DNA analysis indicate that the fungal composition of WRS#1 is characterized by a diversity of saprotrophic soil fungi with several recurring but no ubiquitous genera. Heterogeneity in the pile structure and composition ostensibly provide micro-niches within WRS#1 that provide a suitable habitat for a few organisms (*i.e. Pycnopeziza*, *Anguillospora*, *Chaetothyriales* and *Chytridiomycota*) to flourish, although fungal cultures have not been performed to demonstrate the activity of these fungal populations. Visual observations of the subsurface at WRS#1, WRS#2 and WRS#4 have not provided any indication that extensive fungal growth (*i.e.* mycelium, mushrooms, etc.) is occurring in these stockpiles.

## 3.6 Summary and Conclusions

Microbial study of the soil samples recovered from WRS#1 indicates that populations of iron and sulfur oxidizing bacteria are present and active within the stockpile. Samples are characterized by a heterogeneous distribution of bacterial and fungal genera, although some genera are more common. Enumerations of *Thiobacillus thioparus* and related species, *Acidithiobacillus thiooxidans* and related species and *Acidithiobacillus ferrooxidans* and related species, were

completed to estimate the activity of neutrophilic sulfur oxidizers (SOBn), acidophilic sulfur oxidizers (SOBa) and acidophilic iron oxidizers (FeO) respectively. Maximum bacterial density measurements were within the range of those measured at other waste-rock sites (Schippers et al., 2010). Overall the SOBn were the most common species with a mean bacterial density of $5.5x10^5$ bacteria/g. The FeO were less common but very abundant in oxidized samples, with a mean bacterial density and $9.0x10^5$ bacteria/g. The SOBa were less abundant with an average density of $1.2x10^3$ bacteria/g. Bacterial density of all three populations was negatively correlated with the paste pH of samples; the strongest correlation was between FeO and paste pH. Samples recovered from oxidized zones had lower paste pH values and correspondingly higher populations of FeO and SOBn.

The results of the 16S rRNA analysis are consistent with the observations of bacterial enumerations. Populations of sulfur and iron oxidizing bacteria dominated in most samples, particularly species of the *Thiobacillus* and *Acidithiobacillus* genera. Cover samples were characterized by high diversity of species. Unoxidized waste rock samples were also diverse but usually had a dominant sulfur or iron oxidizing genera (*i.e. Thiobacillus*). Oxidized waste rock samples were characterized by a shift to more acidiphillic genera (*i.e. Acidithiobacillus*).

Several genera of fungi were also encountered in WRS#1 including *Pycnopeziza*, *Leptosphaeria*, *Tetracladium* and *Cucurbitaria*, although none of the species was ubiquitous. While fungi were common in WRS#1 waste rock samples, none of the observed genera have been shown to affect sulfide oxidation or the the generation of ARD.

The bacterial enumerations of common waste rock organisms demonstrate that WRS#1 shares populations of bacteria common to waste rock with similarities to stockpiles from around the

world. The detection of species of the *Thiobacillus* and *Acidithiobacillus* genera through barcoded amplicon sequencing indicates their presence in WRS#1. Due to the similarities in composition, time of placement and climatic effects between WRS#1 and the remaining stockpiles at the Detour Gold mine, WRS#1 provides an appropriate analogue for the micro-ecology of WRS#3 and WRS#4. The results suggest that bacteria play a significant role in sulfide oxidation at the Detour Lake mine site. Neutrophilic sulfur oxidizing bacteria are seemingly ubiquitous while acidophilic iron oxidizing bacteria are more prevalent in oxidized zones within the stockpiles.

## Tables

***Table 3.1: Qualitative Depth Designation of WRS#1 Microbiology Samples***

| *Group* | *Depth (mBGS)* | *Sample I.D.* |
|---|---|---|
| Cover | < 1 | 9C, 10C, 11C, 12C |
| Shallow | 1-2 | 9S*, 10S*, 11S*, 12S* |
| Mid | ~10 | 1M, 2M*, 3M, 4M, 5M, 6M, 7M-1, 7M-2*, 8M-1, 8M-2* |
| Deep | ~20-25 | 1D, 2D, 3D, 4D, 5D, 6D |

*indicates sample recovered from highly oxidized zone (based on colour)

***Table 3.2: Detailed Results of Carbon, Sulfur, paste pH and Most Probable Number (bacteria/g) of Thiobacillus thioparus (SOBn), Acidithiobacillus thiooxidans (SOBa) and Acidithiobacillus ferrooxidans (FeO)***

| *Sample I.D.* | *Depth Group* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Paste pH* | *SOBn* | *SOBa* | *FeO* |
|---|---|---|---|---|---|---|---|
| 1M | Mid | 0.41 | 0.98 | 5.72 | $3.9x10^{2}$ | $1.0x10^{2}$ | $1.6x10^{1}$ |
| 2M* | Mid | 0.17 | 1.40 | 3.65 | $1.6x10^{4}$ | $1.0x10^{2}$ | $1.6x10^{7}$ |
| 3M | Mid | 0.44 | 2.17 | 5.86 | $2.4x10^{4}$ | $4.0x10^{2}$ | $2.4x10^{4}$ |
| 4M | Mid | 0.78 | 1.25 | 5.67 | $1.5x10^{4}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 5M | Mid | 1.30 | 0.60 | 6.2 | $4.0x10^{5}$ | $1.6x10^{3}$ | $4.0x10^{3}$ |
| 6M | Mid | 0.81 | 1.14 | 6.66 | $1.6x10^{4}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 7M-1 | Mid | 1.21 | 0.48 | 6.49 | $2.6x10^{4}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 7M-2* | Mid | 0.48 | 0.49 | 5.16 | $6.2x10^{5}$ | $4.0x10^{2}$ | $1.6x10^{2}$ |
| 8M-1 | Mid | 0.43 | 0.51 | 5.81 | $1.0x10^{5}$ | $1.0x10^{3}$ | $1.0x10^{2}$ |
| 8M-2* | Mid | 0.08 | 2.24 | 2.89 | $6.5x10^{4}$ | $6.6x10^{1}$ | $6.6x10^{2}$ |
| 1D | Deep | 0.44 | 1.26 | 5.74 | $1.0x10^{4}$ | $1.6x10^{2}$ | $4.0x10^{3}$ |
| 2D | Deep | 0.88 | 0.90 | 6.38 | $2.4x10^{4}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 3D | Deep | 0.54 | 1.53 | 5.93 | $6.6x10^{4}$ | $1.6x10^{2}$ | $4.0x10^{2}$ |
| 4D | Deep | 0.82 | 1.03 | 6.27 | $1.6x10^{5}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 5D | Deep | 1.03 | 1.24 | 6.44 | $2.6x10^{5}$ | $1.6x10^{2}$ | $2.4x10^{2}$ |
| 6D | Deep | 0.75 | 1.00 | 6.52 | $4.0x10^{5}$ | $4.0x10^{2}$ | $1.6x10^{3}$ |
| 9C | Cover | 0.80 | 0.06 | 7.26 | $1.5x10^{3}$ | $4.0x10^{1}$ | $1.6x10^{1}$ |
| 10C | Cover | 0.79 | 0.05 | 7.52 | $6.6x10^{4}$ | $1.0x10^{2}$ | $1.6x10^{1}$ |
| 11C | Cover | 0.82 | 0.17 | 6.74 | $6.5x10^{5}$ | $4.0x10^{2}$ | $6.6x10^{1}$ |
| 12C | Cover | 0.74 | 0.13 | 7.37 | $1.1x10^{5}$ | $1.6x10^{2}$ | $1.6x10^{1}$ |
| 9S* | Shallow | 0.23 | 0.93 | 4.27 | $1.0x10^{6}$ | $6.6x10^{2}$ | $1.0x10^{6}$ |
| 10S* | Shallow | 0.22 | 0.62 | 3.75 | $1.0x10^{6}$ | $1.6x10^{3}$ | $6.6x10^{4}$ |
| 11S* | Shallow | 0.14 | 2.39 | 2.48 | $4.0x10^{6}$ | $4.0x10^{3}$ | $1.0x10^{6}$ |
| 12S* | Shallow | 0.15 | 1.28 | 2.96 | $2.6x10^{6}$ | $1.6x10^{3}$ | $2.4x10^{5}$ |

***Table 3.3: Average SOBn, SOBa and FeO Count at Different pH Levels***

| ***Paste pH*** | ***Samples*** | ***SOBn T. thioparus*** | ***SOBa A. thiooxidans*** | ***FeO A. ferroxidans*** |
|---|---|---|---|---|
| | | ***Correlation Coefficient (r) with Paste pH*** | | |
| | | ***-0.65*** | ***-0.58*** | ***-0.33*** |
| | | ***MPN (bacteria/g)*** | | |
| ***2-3*** | *8-2, 11-2, 12-2* | $2.3x10^6$ | $1.9x10^3$ | $4.2x10^5$ |
| ***3-5*** | *2-1, 9-2, 10-2* | $6.9x10^5$ | $7.7x10^2$ | $5.5x10^6$ |
| ***5-6*** | *1-1, 1-2, 3-1, 3-2, 4-1, 7-2, 8-1* | $1.2x10^5$ | $3.4x10^2$ | $4.2x10^3$ |
| ***> 6*** | *2-2, 4-2, 5-1, 5-2, 6-1, 6-2, 7-1* | $1.8x10^5$ | $3.9x10^2$ | $8.4x10^2$ |
| ***Cover*** | *9-1, 10-1, 11-1, 12-1* | $2.0x10^5$ | $1.8x10^2$ | $2.8x10^1$ |

***Table 3.4: Bacterial Ecology of Waste Rock Samples from WRS#1 for Sample Sites 1-6 Including all Genera Accounting for > 5 % of DNA in at Least One Sample***

| ***Metabolic Group*** *(significant genera)* | ***Contribution of Total Bacterial DNA (%)*** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***1M*** | ***1D*** | ***2M**** | ***2D*** | ***3M*** | ***3D*** | ***4M*** | ***4D*** | ***5M*** | ***5D*** | ***6M*** | ***6D*** |
| ***S/Fe Oxidizers*** | *8.84* | *5.98* | *12.09* | *4.78* | *2.53* | *9.71* | *3.98* | *3.01* | *0.91* | *4.31* | *3.67* | *4.99* |
| *Acidithiobacillus* | *8.84* | *5.98* | ***11.69*** | *4.78* | *2.53* | *9.71* | *3.98* | *3.01* | *0.91* | *4.27* | *3.67* | *4.97* |
| ***S Oxidizers*** | *12.91* | *14.97* | *13.45* | *11.93* | *23.25* | *18.82* | *27.95* | *18.12* | *4.33* | *14.18* | *44.12* | *30.85* |
| *Thiobacillus* | ***12.65*** | ***14.62*** | ***10.44*** | ***11.32*** | ***22.77*** | ***18.07*** | ***27.45*** | ***17.36*** | *3.27* | ***13.63*** | ***32.74*** | ***30.29*** |
| *Pseudomonas* | *0.26* | *0.34* | *0.21* | *0.61* | *0.44* | *0.66* | *0.46* | *0.76* | *1* | *0.31* | ***11.38*** | *0.51* |
| ***Fe Oxidizers*** | *0.93* | *0.75* | *3.29* | *1.31* | *1.4* | *0.71* | *1.38* | *0.86* | *2.52* | *1.31* | *1.3* | *1.05* |
| *Dokdonella* | *0.03* | *0.09* | *1.46* | *0.44* | *0.53* | *0.14* | *0.03* | *0.14* | *1.38* | *0.45* | - | *0.35* |
| *Leptospirillum* | *0.15* | *0.21* | *0.87* | *0.12* | *0.33* | *0.27* | *0.78* | *0.04* | *0.55* | *0.54* | *1.3* | *0.07* |
| ***S/Fe Reducers*** | *0.64* | *0.15* | *2.22* | *0.85* | *0.62* | *0.87* | *4.58* | *0.28* | *0.11* | *0.27* | - | *0.14* |
| ***Fe reducers*** | *0.57* | *0.13* | *2.14* | *0.7* | *0.58* | *0.84* | *4.58* | *0.19* | *0.11* | *0.27* | - | *0.14* |
| ***S reducers*** | *0.15* | *0.01* | *0.4* | *0.23* | *0.19* | *0.35* | *0.03* | *0.09* | *0.01* | - | - | - |
| ***N Oxidizers*** | *12.74* | *10.31* | *9.53* | *11.13* | *7.39* | *10.2* | *9.92* | *8.46* | *11.12* | *7.09* | *4.62* | *4.99* |
| *Azospira* | *5.04* | *3.44* | *2.14* | *2.46* | *1.84* | *2.02* | *1.38* | *3.53* | *3.44* | *2.04* | *0.23* | *0.81* |
| *Flexibacter* | *1.92* | *3.19* | *3.14* | *3.66* | *2.32* | *3.69* | *5.97* | *1.86* | *3.06* | *2.81* | *4.03* | *2.2* |
| *Steroidobacter* | - | *0.01* | *0.02* | *0.06* | *0.1* | - | - | - | *0.13* | *0.31* | - | *0.01* |
| ***Common Soil Bacteria*** | *8.75* | *11.93* | *7.32* | *12.23* | *9.54* | *9.15* | *13.01* | *12.72* | *11.58* | *15* | *13.28* | *11.59* |
| *Arthrobacter* | *1.95* | *5.06* | *2.84* | *5.38* | *2.78* | *3.7* | *7.85* | *4.39* | *2.28* | *6.13* | - | *6.36* |
| *Ktedonobacter* | - | - | - | - | *0.01* | *0.01* | - | - | - | - | - | - |
| ***Others*** | *54.43* | *55.72* | *49.52* | *56.79* | *54.46* | *49.31* | *34.53* | *56.24* | *69.26* | *57.54* | *32.97* | *46.2* |
| *Candidatus chloracidobacterium* | *5.61* | *3.79* | *3.92* | *3.68* | *1.41* | *1.32* | *0.24* | *1.72* | *4.14* | *0.77* | - | *0.24* |
| *Coprothermobacter* | *0.55* | *0.23* | *0.16* | *0.21* | *0.4* | *0.3* | *0.03* | *0.47* | *0.53* | *0.27* | - | *0.05* |

***Table 3.5: Bacterial Ecology of Waste Rock Samples from WRS#1 for Sample Sites 7-12 Including all Genera Accounting for > 5 % of DNA in at Least One Sample***

| ***Metabolic Group*** *(significant genera)* | ***Contribution of Total DNA (%)*** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***7M-1*** | ***7M-2**** | ***8M-1*** | ***8M-2**** | ***9C*** | ***9S**** | ***10C*** | ***10S**** | ***11C*** | ***11S**** | ***12C*** | ***12S**** |
| ***S/Fe Oxidizers*** | *8.08* | *3.07* | *6.47* | *1.59* | *1.67* | *19.13* | *1.72* | *31.14* | *0.23* | *20.86* | *0.28* | *8.61* |
| *Acidithiobacillus* | *8.08* | *3.07* | *6.47* | *1.39* | *1.67* | ***18.8*** | *1.72* | ***31.14*** | *0.23* | ***17.57*** | *0.28* | *8.55* |
| ***S Oxidizers*** | *6.48* | *2.9* | *5.48* | *50.49* | *1.5* | *2.86* | *1.32* | *2.95* | *0.91* | *3.6* | *0.63* | *4.48* |
| *Thiobacillus* | *5.98* | *2.47* | *5* | ***47.93*** | *0.61* | *1.82* | *0.42* | *1.07* | *0.35* | *2.75* | *0.17* | *2.83* |
| *Pseudomonas* | *0.48* | *0.28* | *0.4* | *0.93* | *0.88* | *0.33* | *0.9* | *0.08* | *0.55* | *0.19* | *0.46* | *1.2* |
| ***Fe Oxidizers*** | *0.69* | *2.54* | *2.22* | *2.55* | *1.52* | *15.05* | *1.87* | *13.97* | *1.86* | *21.25* | *1.17* | *8.48* |
| *Dokdonella* | *0.17* | *1.05* | *1.07* | *0.59* | *0.59* | ***11.19*** | *0.42* | *7.75* | *0.83* | *1.72* | *0.76* | *4.79* |
| *Leptospirillum* | *0.06* | *0.71* | *0.37* | *0.76* | *0.29* | *3.58* | *0.72* | *5.72* | *0.33* | ***18.82*** | *0.13* | *3.22* |
| ***S/Fe Reducers*** | *0.74* | *0.56* | *0.45* | *0* | *0.86* | *0.11* | *2.71* | *0.05* | *0.73* | *0.23* | *0.36* | *0.37* |
| ***Fe reducers*** | *0.73* | *0.48* | *0.45* | *0* | *0.86* | *0.11* | *2.62* | *0.05* | *0.61* | *0.23* | *0.24* | *0.35* |
| ***S reducers*** | *0.19* | *0.17* | *0.08* | *0* | *0.19* | *0* | *0.48* | *0.05* | *0.47* | *0.03* | *0.3* | *0.19* |
| ***N Oxidizers*** | *12.54* | *7.2* | *11.77* | *10.47* | *14.77* | *7.28* | *15.17* | *5.8* | *14.24* | *8.17* | *12.52* | *9.62* |
| *Azospira* | *3.8* | *1.85* | *3.81* | *0.16* | *5.07* | *2.48* | *5.1* | *1.46* | *6.12* | *3.32* | *4.12* | *3.4* |
| *Flexibacter* | *3.68* | *1.98* | *3.41* | *0.53* | *3.84* | *1.93* | *5.25* | *0.93* | *3.36* | *1.68* | *3.66* | *2.1* |
| *Steroidobacter* | *0.02* | *0.05* | *0.1* | *9.07* | *0.27* | *0* | *0.09* | *0.05* | *0.13* | *0.05* | *0.01* | *0.3* |
| ***Common Soil Bacteria*** | *8.85* | *16.46* | *11.06* | *5.98* | *11.29* | *5.95* | *7.31* | *3.6* | *12.05* | *4.65* | *11.01* | *6.14* |
| *Arthrobacter* | *1.8* | *5.84* | *4.13* | *4.22* | *3.49* | *2.42* | *1.48* | *0.39* | *2.76* | *1.42* | *3.26* | *0.98* |
| *Ktedonobacter* | *0* | *5.61* | *0.01* | *0.26* | *0* | *0.05* | *0* | *0.08* | *0* | *0.17* | *0* | *0* |
| ***Others*** | *61.66* | *66.57* | *61.96* | *28.88* | *67.3* | *49.47* | *66.75* | *42.33* | *68.84* | *40.93* | *73.44* | *61.7* |
| *Candidatus chloracidobacterium* | *8.39* | *3.64* | *3.6* | *0* | *3.27* | *2.31* | *4.5* | *2.19* | *5.13* | *1.6* | *6.83* | *3.7* |
| *Coprothermobacter* | *1.15* | *6.3* | *0.9* | *1.46* | *1.37* | *3.75* | *1.2* | *6.93* | *0.91* | *3* | *1.78* | *2.66* |

***Table 3.6: List of Significant (> 10 % in one sample or > 1 % overall) Fungal Genera at WRS#1***

| ***Genus (% of Total DNA†)*** | ***Samples > 10 %††*** | ***Family / Order*** | ***Comments*** |
|---|---|---|---|
| *Fungi* (9.99) | 2D, 3D, 4M, 4D, 5M, 5D, 6D, 7M-1, 10C, 11C, 12C | - | Unclassified organisms of the Fungi kingdom. |
| *Pycnopeziza* (9.23) | 2M, 9S*, 11S*, 12S* | *Sclerotiniaceae* / *Heliotales* | Members of the *Sclerotiniaceae* family are typically saprotrophic, or plant pathogens.[a] This genus has three species, the type species (*P. sympodalis*) grows on plant material deposited the previous season and over-wintered in a moist area.[b] |
| *Leptosphaeria* (6.06) | 1M, 1D, 2D, 6D, 8M-1, 11C | *Leptosphaeriaceae* / *Pleosporales* | There are approximately 100 species in this genus of saprotrophic organisms.[a] Some species are the cause of serious disease in the host plant. |
| *Tetracladium* (5.75) | 1M, 1D, 3M, 3D, 9C, 12S* | - / *Heliotales* | Genus with eight species of aquatic saprotrophic hyphomycetes commonly found in rivers and waterways.[c] Some species are root endophytes.[d] |
| *Cucurbitaria* (5.33) | 3M, 3D, 4M, 4D, 5D | *Cucurbitariaceae* / *Pleosporales* | Genus of six saprotrophic species typified by *C. berberidis* which grows in decorticated (barkless) wood.[e] |
| *Sclerotinia* (4.67) | 5D, 9C | *Sclerotiniaceae* / *Heliotales* | Members of the *Sclerotiniaceae* family are typically saprotrophic, or plant pathogens. This genus contains over twenty species; the type species *S. curreyana* is a pathogen of the rush *Juncus effusus*.[a] |
| *Chaetomium* (4.38) | 7M-1, 10C, 11C | *Chaetomiaceae* / *Sordariales* | Genus comprised of over 80 species of saprotrophic organisms which fruit on "cellulose-rich substrata such as seeds, textiles in contact with soil, sacking and dung."[a] Several species cause soft-rot in wood. |
| *Chytridiomycota* (3.6) | 4M, 10S* | - | Unclassified organisms of the *Chytridiomycota* phylum, which contains over 900 species in five orders. Most species are saprotrophic, while others are plant pathogens and others are biotrophic endophytes.[a] |
| *Anguillospora* (3.23) | 7M-2*, 8M-2* | - / *Pleosporales* | Species of aquatic mycoparasites or saprotrophs.[a] |
| *Juncigena* (3.02) | - | *Magnaporthaceae* / *Magnaporthales* | The *Magnaporthacaea* family contains 9 genera and 26 species.[a] The *Juncigena* type species (*J. adarca*) is an endophyte isolated from salt-marsh plants in the USA.[f] |
| *Chaetothyriales* (2.76) | 8M-2* | - / *Chaetothyriales* | Members of this group include the common black yeast fungi and several animal pathogens.[g] |
| *Oidiodendron* (2.31) | - | *Myxotrichaceae* / *Onygenales* | Genus with 18 species that have been isolated worldwide from soils and decaying plant matter.[h] |
| *Ascomycota* (2.31) | 12C | - | Unclassified organisms in the *Ascomycota* phyllum. |

| | | | |
|---|---|---|---|
| *Malassezia* (2.3) | 6M | *Malasseziaceae* / *Malasseziales* | Genus of seven species which can be isolated from human and animal skin.[a] |
| *Kionochaeta* (1.88) | 6M | - | Genus of the *Ascomycota* phyllum containing 10 species. Aquatic hyphomyctes, grow on submerged decaying plant matter.[i] |
| *Spizellomyces* (1.52) | - | *Spizellomycetaceae* / *Spizellomycetales* | Genus comprised of eight species of very common soil organisms which are known to parasitize other fungi and microorganisms.[j] |
| *Humicola* (1.51) | - | *Chaetomiaceae* / *Sordariales* | Genus of five confirmed species of soil saprotrophs commonly found in peat and humus. Also isolated from agricultural soil/manure.[k] |
| *Didymella* (1.29) | - | *Didymellaceae* / *Pleosporales* | Genus of over thirty species known as plant/legume pathogens.[a] |
| *Powellomyces* (1.25) | - | *Spizellomycetaceae* / *Spizellomycetales* | Genus of two species (*P. hirtus*, *P. variabilis*) of chytrids commonly found in soil.[l] |
| *Podosphaera* (1.09) | - | *Erysiphaceae* / *Erysiphales* | Genus of over twenty species of plant pathogens causing powdery mildew.[a] |
| *Berkleasmium* (1.00) | - | *Sporormiaceae* / *Pleosporales* | Hyphomycete genus of 26 species isolated from both living but more often dead plant matter.[m] |
| *Teratosphaeria* (0.70) | 9S* | *Teratosphaeriaceae* / *Capnodiales* | This genus contains over 70 species, many of which are noted eucalyptus pathogens. They have been isolated worldwide.[n] |
| *Calvatia* (0.66) | 10C | *Agaricaceae* / *Agaricales* | A genus containing several hundred species, including giant puffball mushrooms (gasterocarp).[a] |
| *Phialophora* (0.63) | 5M | *Herpotrichiellaceae* / *Chaetothyriales* | Genus with over 120 species, most of which are grass pathogens or endophytes.[a] |
| *Mycosphaerella* (0.51) | 9S* | *Mycosphaerellaceae* / *Capnodiales* | A large genus with over 2000 species of plant pathogens and endophytes, many of which cause economical plant diseases.[a] |
| *Psoroglaena* (0.50) | 9S* | *Verrucariaceae* / *Verrucariales* | Small genus of three species of lichenised fungus.[a] |

† % of total DNA contribution from all 24 samples across WRS#1

†† Samples in which the indicated genus contributed > 10 % of the DNA extracted

[a] Webster and Weber, 2007 [b] White and Whetzel, 1938 [c] Roldan et al., 1989 [d] Sati et al., 2009 [e] Doilom et al., 2013
[f] Kohlmeyer et al., 1997 [g] Geiser et al., 2006 [h] Rice and Currah, 2005 [I] Goh and Hyde, 1997
[j] Lozupone and Klein, 2002 [k] Salar and Aneja, 2007 [l] Longcore et al., 1995 [m] Bussaban et al., 2001
[n] Andjic et al., 2010

***Table 3.7: Fungal Ecology of Waste Rock Samples from WRS#1 for Sample Sites 1-4 Including all Genera Accounting for > 5 % of DNA in at Least One Sample***

| *Fungal Genera* | *Contribution of Total Fungal DNA (%)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***1M*** | ***1D*** | ***2M**** | ***2D*** | ***3M*** | ***3D*** | ***4M*** | ***4D*** |
| ***Fungi*** | *6.13* | *5.63* | *1.64* | ***11.4*** | *8.27* | ***11.53*** | ***34.71*** | ***18.72*** |
| ***Pycnopeziza*** | *7.97* | *2.1* | ***59.77*** | *1.7* | *3.92* | *8.62* | *0.94* | *0.87* |
| ***Leptosphaeria*** | ***24.7*** | ***16.85*** | *1.92* | ***12.15*** | *7.3* | *9.44* | *0.43* | *3.16* |
| ***Tetracladium*** | ***19.82*** | ***13.45*** | *0.71* | *6.39* | ***12.16*** | ***10.71*** | *0.47* | *5.51* |
| ***Cucurbitaria*** | *6.47* | *7.24* | *0.59* | *8.37* | ***10.21*** | ***13.13*** | ***10.26*** | ***14.23*** |
| ***Sclerotinia*** | *0.69* | *8.09* | *0.24* | *1.74* | *0.12* | *2.74* | *0.02* | *6.79* |
| ***Chaetomium*** | *0.4* | *2.16* | *0.18* | *0.95* | *0.24* | *0.41* | *1.37* | *2.6* |
| ***Chytridiomycota*** | *1.07* | *2.3* | *-* | *7.66* | *5* | *0.33* | ***17.83*** | *1.2* |
| ***Anguillospora*** | *0.4* | *0.54* | *1.73* | *0.26* | *0.58* | *0.25* | *0.04* | *0.85* |
| ***Juncigena*** | *4.24* | *3.74* | *0.11* | *6.87* | *7.29* | *1.21* | *2.68* | *5.68* |
| ***Chaetothyriales*** | *0.25* | *0.92* | *-* | *0.17* | *0.28* | *0.37* | *0.14* | *0.85* |
| ***Oidiodendron*** | *1.32* | *1.09* | *7.5* | *1.09* | *3.29* | *2.41* | *1.16* | *0.31* |
| ***Ascomycota*** | *0.56* | *0.63* | *0.63* | *0.36* | *0.49* | *0.49* | *0.12* | *1.68* |
| ***Malassezia*** | *0.02* | *-* | *-* | *-* | *0.1* | *0.05* | *1.06* | *0.02* |
| ***Kionochaeta*** | *0.38* | *1.64* | *0.01* | *0.22* | *0.38* | *0.87* | *0.01* | *0.01* |
| ***Spizellomyces*** | *0.02* | *1.2* | *0* | *2.43* | *0.95* | *0.21* | *1.29* | *0.12* |
| ***Humicola*** | *0.15* | *1.26* | *0.24* | *0.27* | *0.05* | *0.39* | *0.11* | *1.41* |
| ***Didymella*** | *1.22* | *1.7* | *0.14* | *4.64* | *0.44* | *0.67* | *6.17* | *3.19* |
| ***Powellomyces*** | *0.76* | *4.77* | *-* | *3.01* | *8.98* | *0.07* | *0.77* | *1.41* |
| ***Podosphaera*** | *0.89* | *0.27* | *4.93* | *0.34* | *0.93* | *1.15* | *0.22* | *0.1* |
| ***Berkleasmium*** | *0.46* | *0.27* | *9.28* | *0.87* | *1.26* | *2.41* | *0.11* | *0.47* |
| ***Byssoascus*** | *0.46* | *0.26* | *0.18* | *0.4* | *1.88* | *0.53* | *1.09* | *0.07* |
| ***Cladosporium*** | *0.86* | *0.13* | *0.91* | *0.4* | *0.59* | *7.39* | *0.63* | *0.17* |
| ***Hygrocybe*** | *-* | *-* | *-* | *-* | *-* | *0.03* | *2.48* | *0.32* |
| ***Phoma*** | *0.89* | *1.17* | *0.08* | *2.31* | *1.35* | *1.77* | *1.05* | *1.99* |
| ***Pyrenochaeta*** | *0.33* | *0.96* | *0.03* | *1.6* | *1.7* | *2.64* | *0.18* | *5.81* |
| ***Teratosphaeria*** | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *-* |
| ***Calvatia*** | *-* | *-* | *-* | *0.03* | *0.1* | *-* | *-* | *0.02* |
| ***Phialophora*** | *0.2* | *0.27* | *0* | *0.08* | *0.28* | *-* | *-* | *0.49* |
| ***Catenomyces*** | *-* | *0.84* | *0.02* | *9.54* | *0.4* | *-* | *0.36* | *0.17* |
| ***Valdensinia*** | *-* | *0.02* | *0.05* | *-* | *-* | *0.03* | *0.26* | *-* |
| ***Mycosphaerella*** | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *0.03* |
| ***Psoroglaena*** | *-* | *-* | *-* | *-* | *-* | *-* | *-* | *1.7* |
| ***Glomeromycota*** | *-* | *0.14* | *-* | *-* | *-* | *-* | *-* | *0.03* |

***Table 3.8: Fungal Ecology of Waste Rock Samples from WRS#1 for Sample Sites 5-8 Including all Genera Accounting for > 5 % of DNA in at Least One Sample***

| *Fungal Genera* | *Contribution of Total Fungal DNA (%)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***5M*** | ***5D*** | ***6M*** | ***6D*** | ***7M-1*** | ***7M-2**** | ***8M-1*** | ***8M-2**** |
| ***Fungi*** | ***14.4*** | ***10.53*** | - | ***10.8*** | ***16.07*** | 3.62 | 8.57 | 1.97 |
| ***Pycnopeziza*** | 4.5 | 0.23 | - | 5.94 | 1.61 | 6.27 | 5.12 | 9.22 |
| ***Leptosphaeria*** | 2.14 | 2.39 | 0.1 | ***12.07*** | 1.25 | 3.44 | ***13.94*** | 0.2 |
| ***Tetracladium*** | 3.87 | 2.28 | - | 2.8 | 1.82 | 2.44 | 2.95 | 1.93 |
| ***Cucurbitaria*** | 4.04 | ***18.96*** | - | 7.7 | 0.51 | 1.12 | 3.53 | 0.96 |
| ***Sclerotinia*** | 3.85 | ***22.54*** | - | 0.03 | 6.62 | 1.67 | 8.75 | 0.4 |
| ***Chaetomium*** | 4.16 | 4.54 | - | 2.18 | ***31.66*** | 0.07 | 1.48 | - |
| ***Chytridiomycota*** | 0.19 | 4.24 | - | 0.13 | 0.51 | 0.79 | 1.11 | 0.59 |
| ***Anguillospora*** | 0.45 | 0.8 | - | 1.14 | 0.32 | ***47.53*** | 2.26 | ***11.93*** |
| ***Juncigena*** | 5.01 | 1.86 | - | 8.48 | 5.54 | 1.06 | 2.41 | 0.39 |
| ***Chaetothyriales*** | 2.67 | 0.03 | - | 0.09 | 0.01 | 1.53 | 0.76 | ***53.48*** |
| ***Oidiodendron*** | 0.7 | 0.28 | 0.1 | 8.39 | 0.92 | 2.91 | 2.23 | 1.93 |
| ***Ascomycota*** | 3.24 | 1.91 | - | 0.71 | 2.07 | 1.65 | 0.66 | 1.48 |
| ***Malassezia*** | - | 0.01 | ***53.23*** | 0.58 | - | 0.03 | - | - |
| ***Kionochaeta*** | 0.03 | 0.03 | ***41.11*** | - | 0.19 | - | 0.11 | - |
| ***Spizellomyces*** | 0.17 | 0.79 | - | 0.19 | 3.42 | 9.51 | 9.3 | 0.05 |
| ***Humicola*** | 1.06 | 1.12 | - | 0.88 | 5.52 | 0.13 | 1.18 | - |
| ***Didymella*** | 1.78 | 3.48 | - | 0.97 | 0.36 | 0.3 | 1.75 | 0.14 |
| ***Powellomyces*** | 0.47 | 4.97 | - | 0.03 | 0.11 | 0.91 | 1.11 | 0.62 |
| ***Podosphaera*** | 0.21 | 0.04 | - | 2.08 | 0.32 | 1.19 | 0.71 | 1.13 |
| ***Berkleasmium*** | 0.31 | 0.12 | 0.1 | 0.22 | 0.59 | 1.13 | 0.35 | 0.26 |
| ***Byssoascus*** | 0.07 | 0.06 | - | 7.99 | 0.42 | 1.19 | 1.33 | 0.33 |
| ***Cladosporium*** | 0.47 | 0.68 | - | 1.3 | 0.25 | 1.15 | 0.51 | 1.16 |
| ***Hygrocybe*** | 8.74 | - | - | 0.09 | 0.73 | - | 7.27 | - |
| ***Phoma*** | 0.82 | 1.39 | - | 0.91 | 0.4 | 0.31 | 0.53 | 0.14 |
| ***Pyrenochaeta*** | 0.19 | 1.14 | - | 0.32 | 0.17 | 0.08 | 0.36 | 0.04 |
| ***Teratosphaeria*** | - | - | - | - | - | - | 0.01 | - |
| ***Calvatia*** | 0.01 | - | - | 0.09 | - | 0.02 | 0.06 | 0.01 |
| ***Phialophora*** | ***12.22*** | 0.88 | - | 0 | 0.11 | - | 0.2 | 0.11 |
| ***Catenomyces*** | 0.13 | 0.45 | - | 0.09 | 0.21 | 0.14 | 0.9 | - |
| ***Valdensinia*** | 0.03 | - | - | 0.52 | 0.13 | 0.46 | - | 0.77 |
| ***Mycosphaerella*** | 0.05 | - | - | - | 0.01 | 0.04 | - | - |
| ***Psoroglaena*** | - | - | - | - | - | 0.01 | - | - |
| ***Glomeromycota*** | 0.01 | - | - | - | 0.19 | 0.03 | - | - |

***Table 3.9: Fungal Ecology of Waste Rock Samples from WRS#1 for Sample Sites 9-12 Including all Genera Accounting for > 5 % of DNA in at Least One Sample***

| *Fungal Genera* | *Contribution of Total Fungal DNA (%)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** |
| ***Fungi*** | *4.57* | *3.33* | ***16.35*** | *5.24* | ***18.29*** | *5* | ***15.56*** | *7.42* |
| ***Pycnopeziza*** | *4.73* | ***16.8*** | *0.33* | *2.83* | *0.59* | ***60.53*** | *4.56* | ***12.3*** |
| ***Leptosphaeria*** | *3.87* | *1.06* | *5.94* | *0.08* | ***13.12*** | *1.4* | *2.3* | *6.31* |
| ***Tetracladium*** | ***14.75*** | *1.43* | *4.24* | *0.72* | *8.98* | *0.34* | *7.57* | ***12.64*** |
| ***Cucurbitaria*** | *0.34* | *1.3* | *3.95* | *0.45* | *4.23* | *0.29* | *1.15* | *8.95* |
| ***Sclerotinia*** | ***28.34*** | *1.67* | *2.2* | *3.4* | *5.59* | *0.81* | *3.97* | *1.73* |
| ***Chaetomium*** | *8.42* | *0.89* | ***10.28*** | *7.97* | ***14.34*** | *0.27* | *6.29* | *4.23* |
| ***Chytridiomycota*** | *0.1* | *0.44* | *0.02* | ***42.49*** | *0.05* | *-* | *0.2* | *0.05* |
| ***Anguillospora*** | *3.25* | *1.13* | *0.16* | *0.88* | *0.18* | *1.25* | *0.35* | *1.2* |
| ***Juncigena*** | *0.67* | *1.09* | *2.47* | *1.11* | *5.22* | *0.46* | *3.49* | *1.46* |
| ***Chaetothyriales*** | *-* | *1.25* | *0.02* | *2.59* | *0.05* | *0.04* | *0.16* | *0.49* |
| ***Oidiodendron*** | *3.98* | *2.25* | *1.06* | *0.83* | *0.82* | *2.97* | *1.12* | *6.87* |
| ***Ascomycota*** | *0.34* | *1.23* | *9.02* | *7.74* | *1.08* | *0.71* | ***13.87*** | *4.71* |
| ***Malassezia*** | *0.02* | *0.02* | *-* | *-* | *-* | *-* | *0.06* | *0.01* |
| ***Kionochaeta*** | *-* | *0.07* | *-* | *-* | *0.01* | *-* | *-* | *0.1* |
| ***Spizellomyces*** | *1.13* | *0.15* | *0.24* | *0.28* | *2.26* | *0.02* | *1.9* | *0.86* |
| ***Humicola*** | *3.36* | *0.42* | *5.58* | *3.58* | *4.55* | *0.17* | *2.63* | *2.26* |
| ***Didymella*** | *0.1* | *0.37* | *0.43* | *0.31* | *1.06* | *0.1* | *0.98* | *0.56* |
| ***Powellomyces*** | *-* | *0.12* | *-* | *0.77* | *0.01* | *-* | *1.15* | *-* |
| ***Podosphaera*** | *1.07* | *2.02* | *0.19* | *0.45* | *0.09* | *5.94* | *0.35* | *1.51* |
| ***Berkleasmium*** | *1.53* | *1.05* | *0.02* | *0.03* | *0.05* | *1.94* | *0.12* | *1* |
| ***Byssoascus*** | *1.88* | *0.57* | *0.89* | *0.16* | *0.39* | *0.5* | *0.48* | *2.24* |
| ***Cladosporium*** | *0.1* | *0.15* | *0.31* | *0.44* | *0.69* | *0.44* | *0.58* | *1.94* |
| ***Hygrocybe*** | *-* | *0.05* | *-* | *0.69* | *-* | *-* | *0.16* | *0.13* |
| ***Phoma*** | *0.1* | *0.23* | *0.43* | *0.12* | *0.86* | *0.09* | *0.23* | *1.29* |
| ***Pyrenochaeta*** | *0.08* | *0.03* | *0.09* | *0.04* | *0.93* | *0.07* | *0.18* | *1.03* |
| ***Teratosphaeria*** | *-* | ***16.85*** | *-* | *-* | *-* | *-* | *-* | *-* |
| ***Calvatia*** | *0.16* | *0.05* | ***11.04*** | *0.32* | *0.39* | *-* | *3.59* | *0.05* |
| ***Phialophora*** | *-* | *0.17* | *-* | *0.01* | *0.01* | *-* | *0.02* | *0.03* |
| ***Catenomyces*** | *0.02* | *0.01* | *0.21* | *0.94* | *0.31* | *0.01* | *0.14* | *0.05* |
| ***Valdensinia*** | *2.55* | *1.5* | *-* | *0.05* | *0.03* | *7.99* | *0.06* | *0.2* |
| ***Mycosphaerella*** | *-* | ***12.24*** | *-* | *0.01* | *-* | *-* | *-* | *0.01* |
| ***Psoroglaena*** | *-* | ***10.2*** | *0.04* | *-* | *-* | *-* | *-* | *0.05* |
| ***Glomeromycota*** | *0.18* | *0.1* | *0.21* | *0.05* | *-* | *0.03* | *6.48* | *0.27* |

## Figures

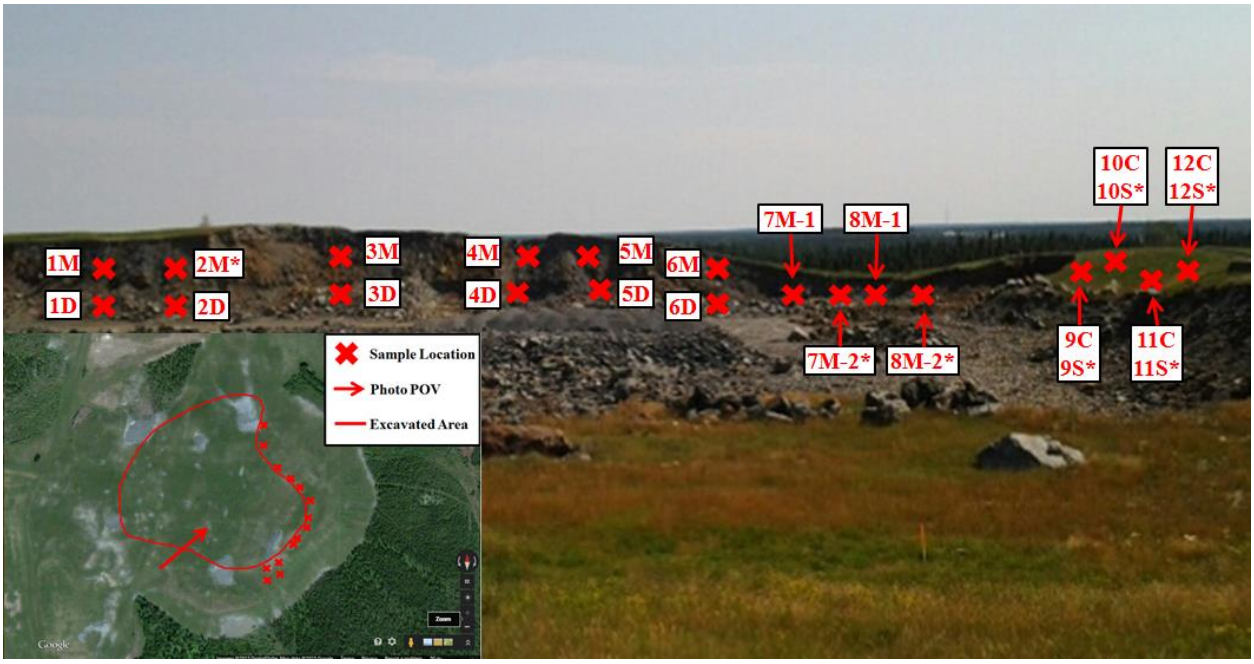



***Figure 3.1: Approximate Location of WRS#1 Microbiology Samples – Photo Taken July, 2013 (inset modified from Google Maps, 2015)***

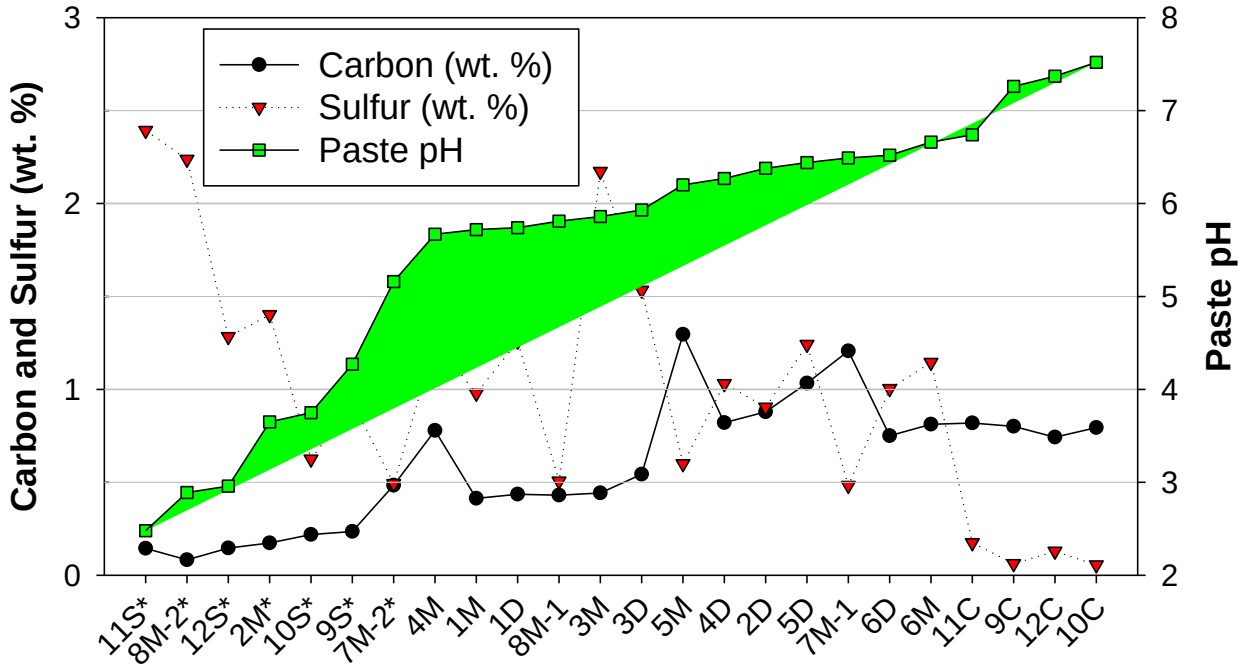



***Figure 3.2: Results Paste pH and Carbon Sulfur Analysis for Microbiology Samples***

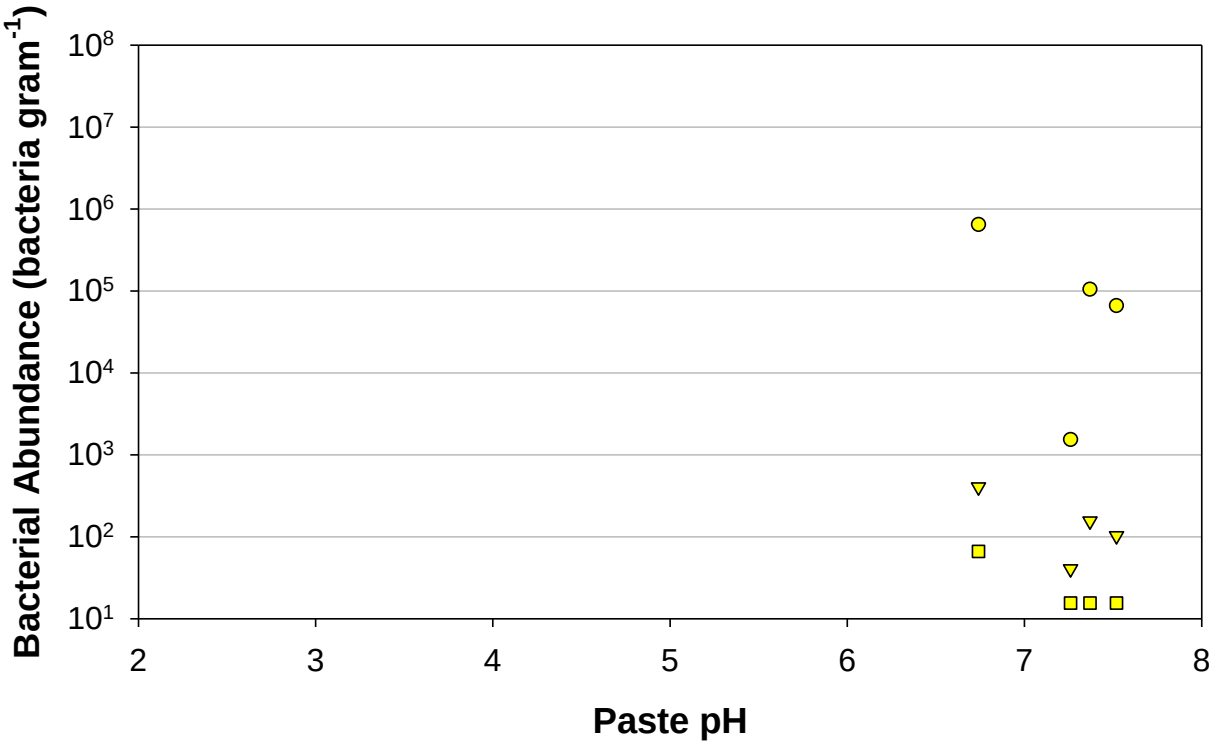



***Figure 3.3: Results of Paste pH and Bacterial Enumerations using the Most Probable Number (MPN) Technique for Thiobacillus thioparus (SOBn), Acidithiobacillus thiooxidans (SOBa) and Acidithiobacillus ferrooxidans (FeO) in the WRS#1 Cover***

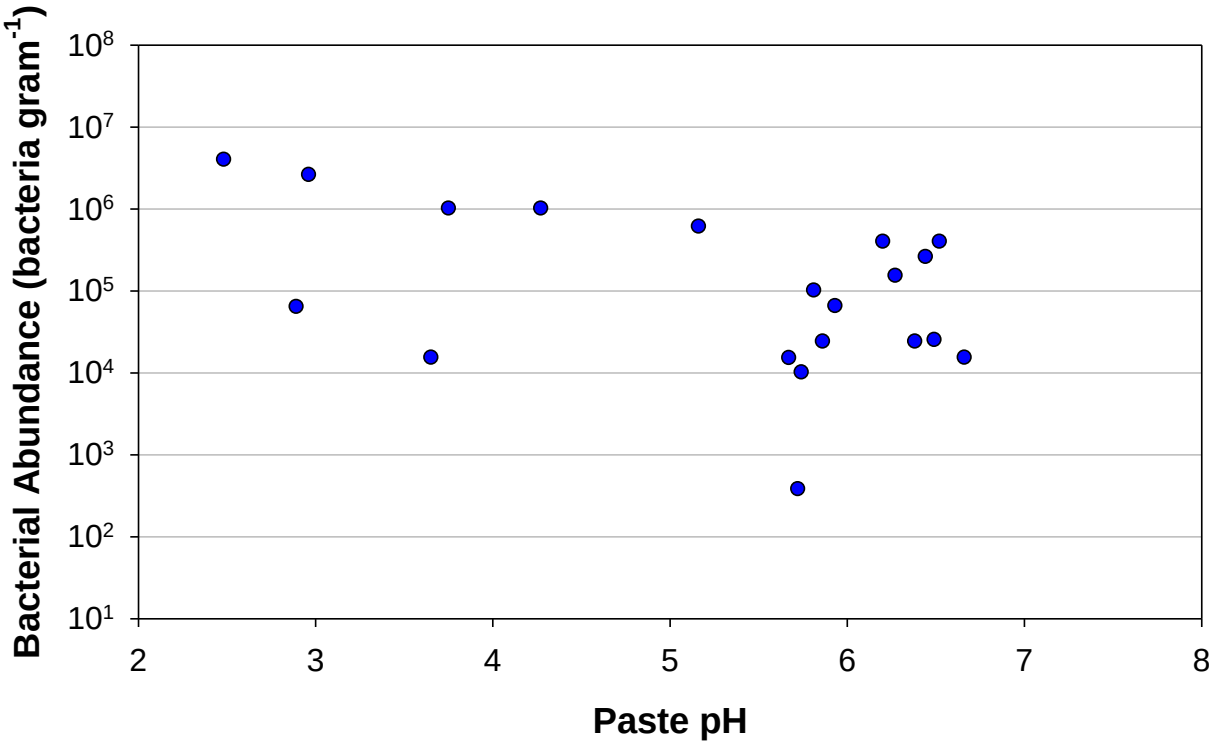



***Figure 3.4: Results of Paste pH and Bacterial Enumerations using the Most Probable Number (MPN) Technique for Thiobacillus thioparus (SOBn) in WRS#1 Waste Rock***

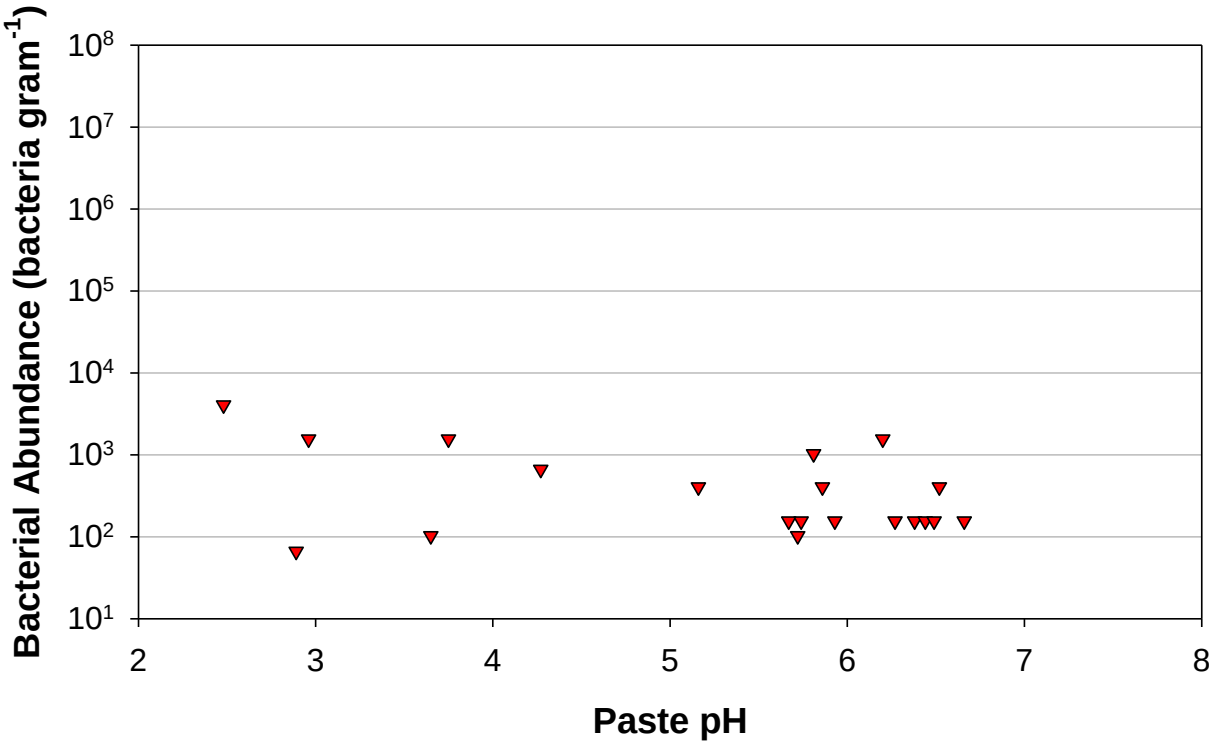



***Figure 3.5: Results of Paste pH and Bacterial Enumerations using the Most Probable Number (MPN) Technique for Thiobacillus thiooxidans (SOBa) in WRS#1 Waste Rock***

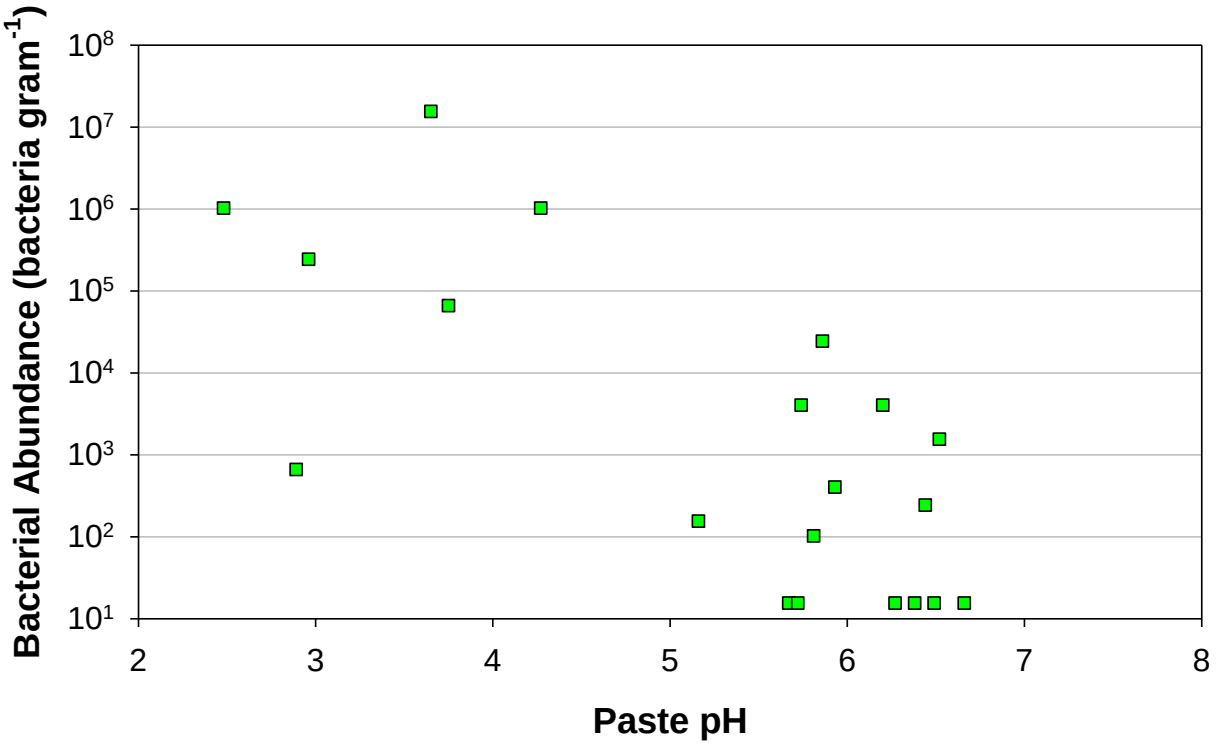



***Figure 3.6: Results of Paste pH and Bacterial Enumerations using the Most Probable Number (MPN) Technique for Acidithiobacillus ferrooxidans (FeO) in WRS#1 Waste Rock***

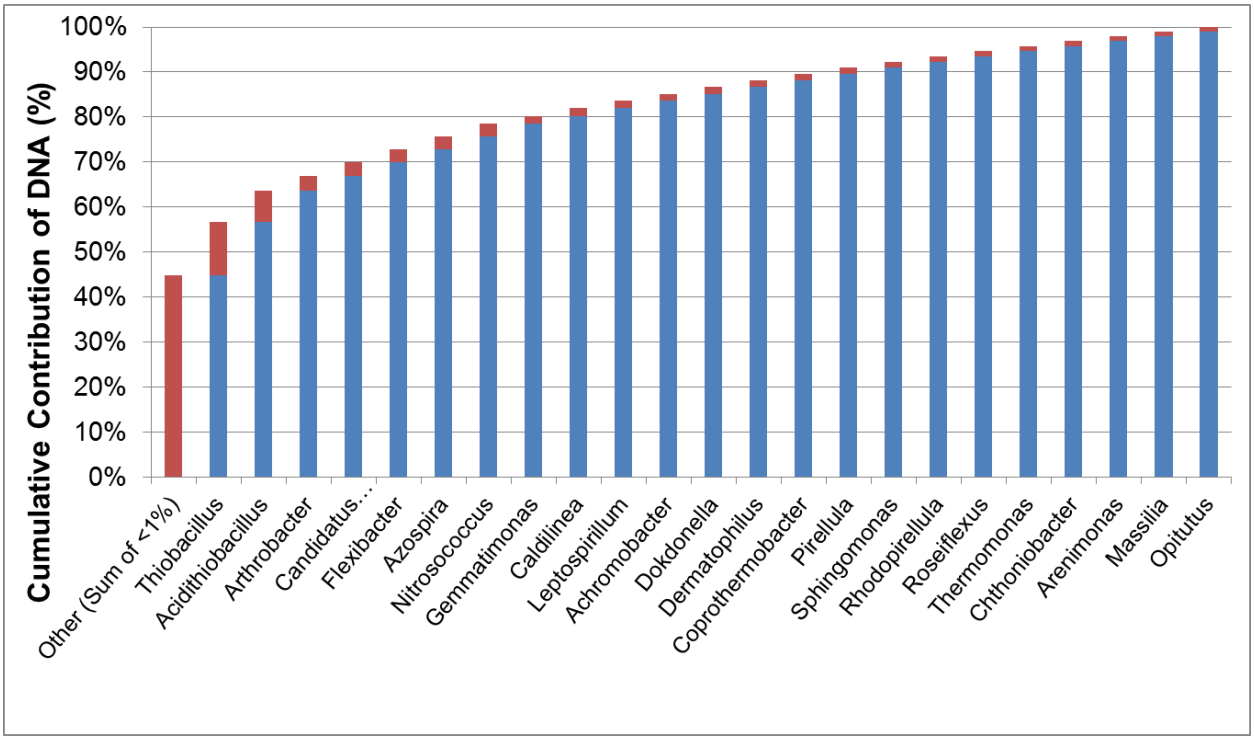



***Figure 3.7: Cumulative Contribution of Bacterial Genera Accounting for > 1 % of Total DNA Across All Samples***

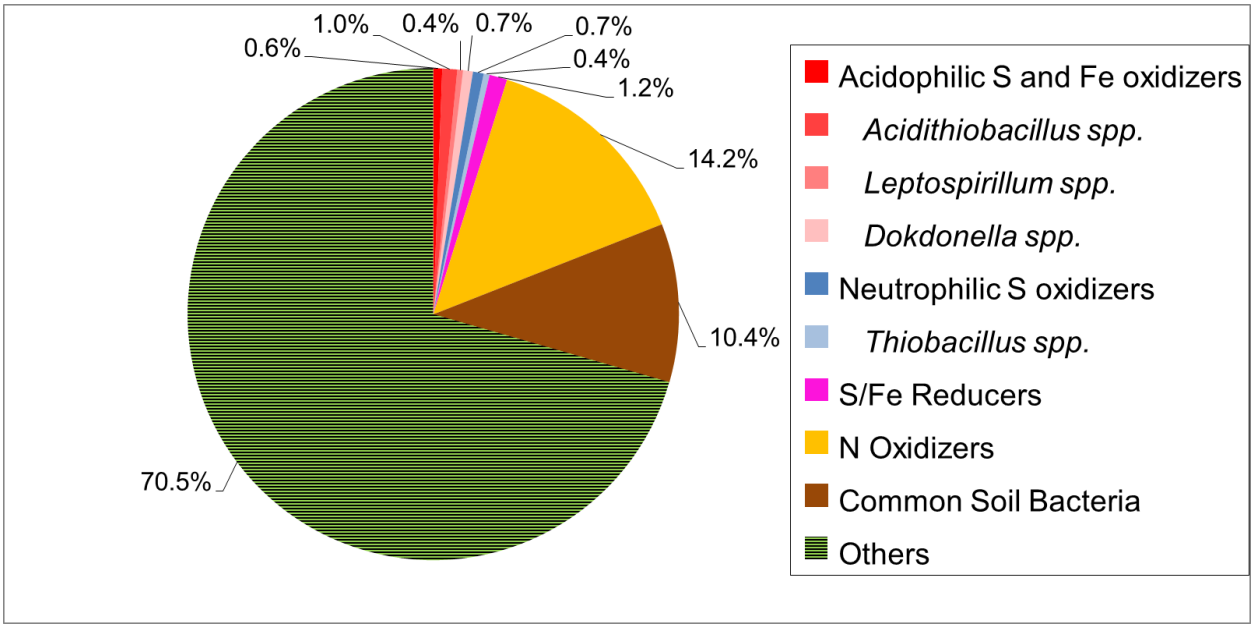



***Figure 3.8: Bacterial Ecology of Cover Samples***

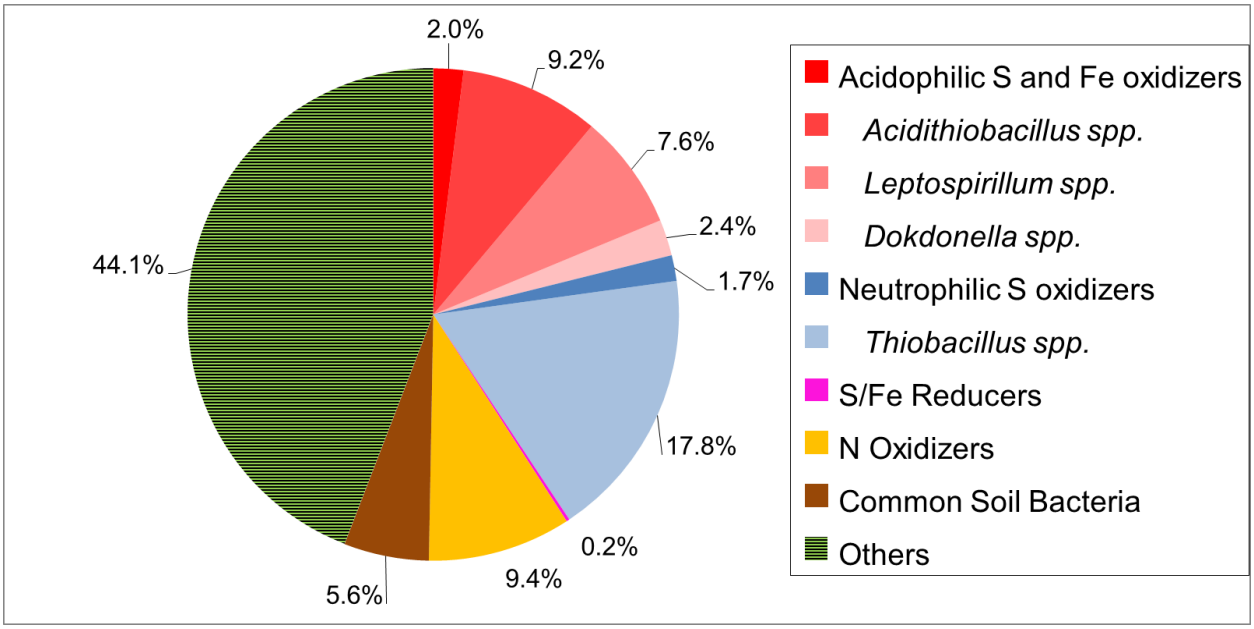



***Figure 3.9: Bacterial Ecology of pH 2-3 Samples***

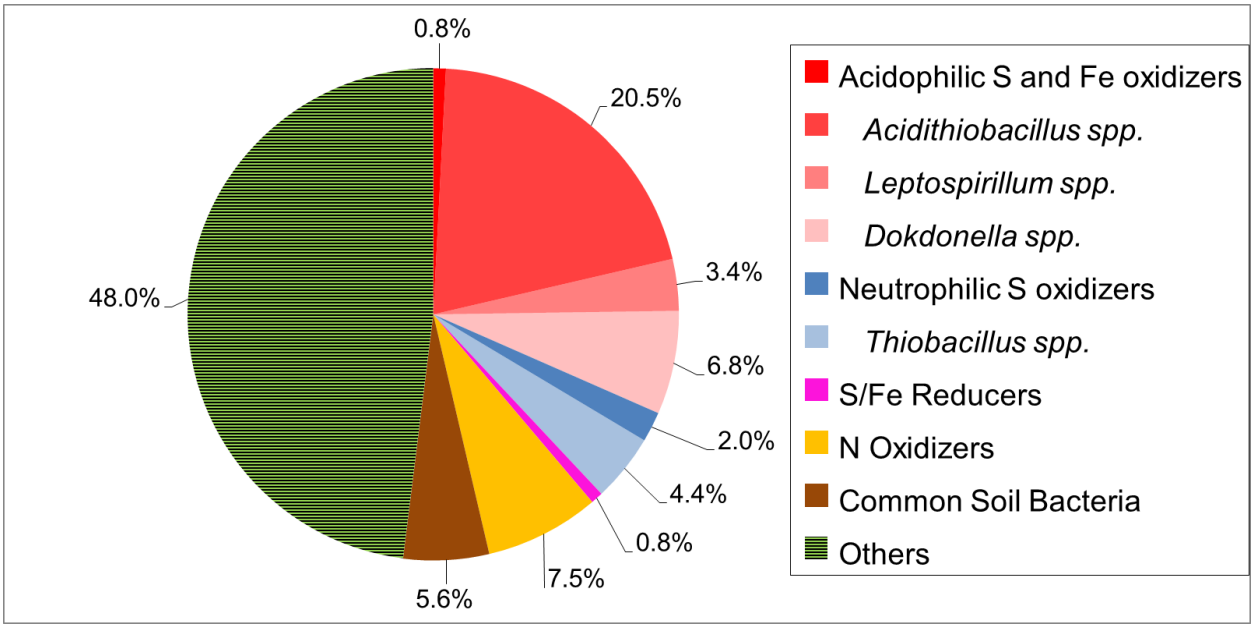



***Figure 3.10: Bacterial Ecology of pH 3-5 Samples***

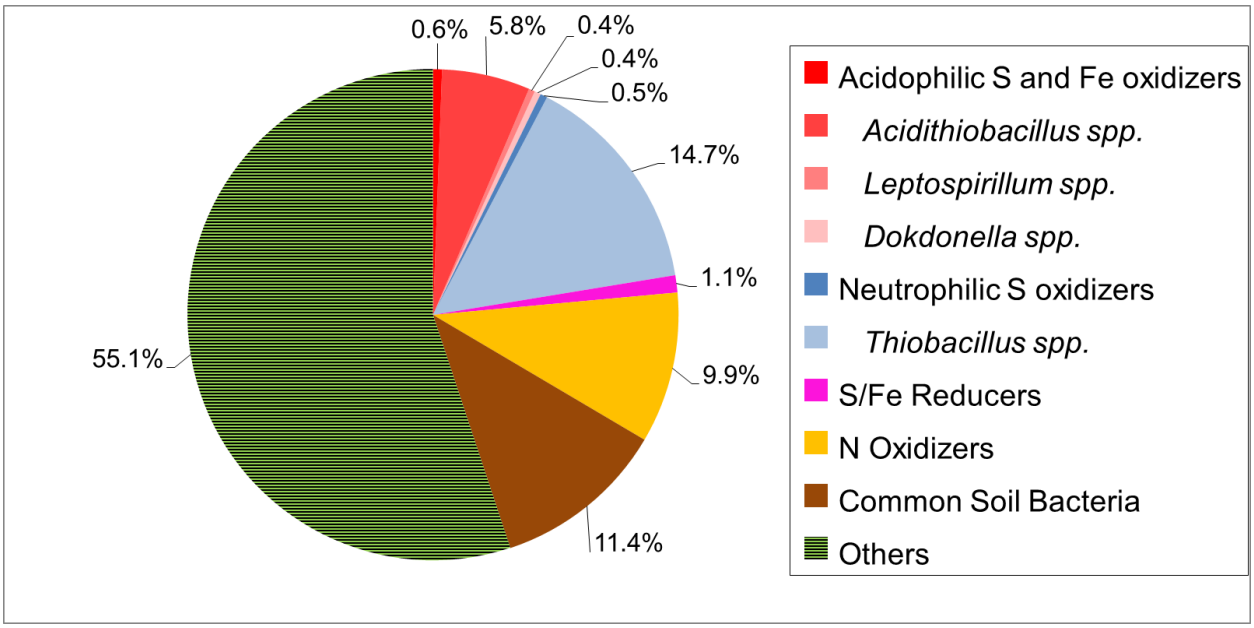



***Figure 3.11: Bacterial Ecology of pH 5-6 Samples***

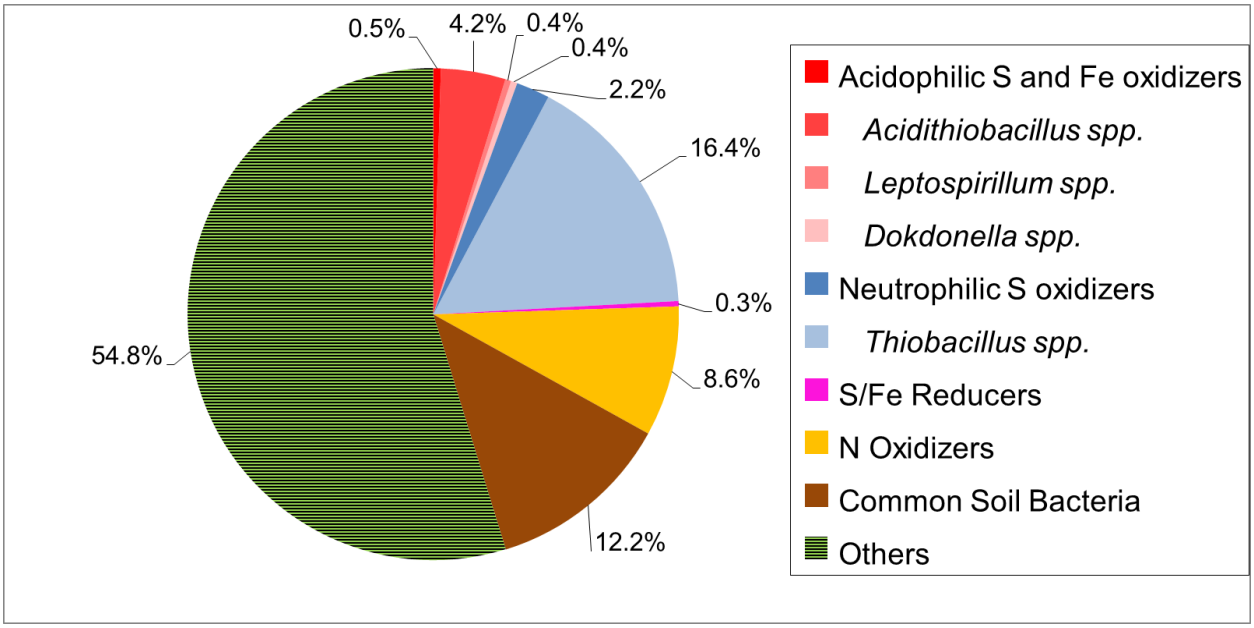



***Figure 3.12: Bacterial Ecology of pH > 6 Samples***

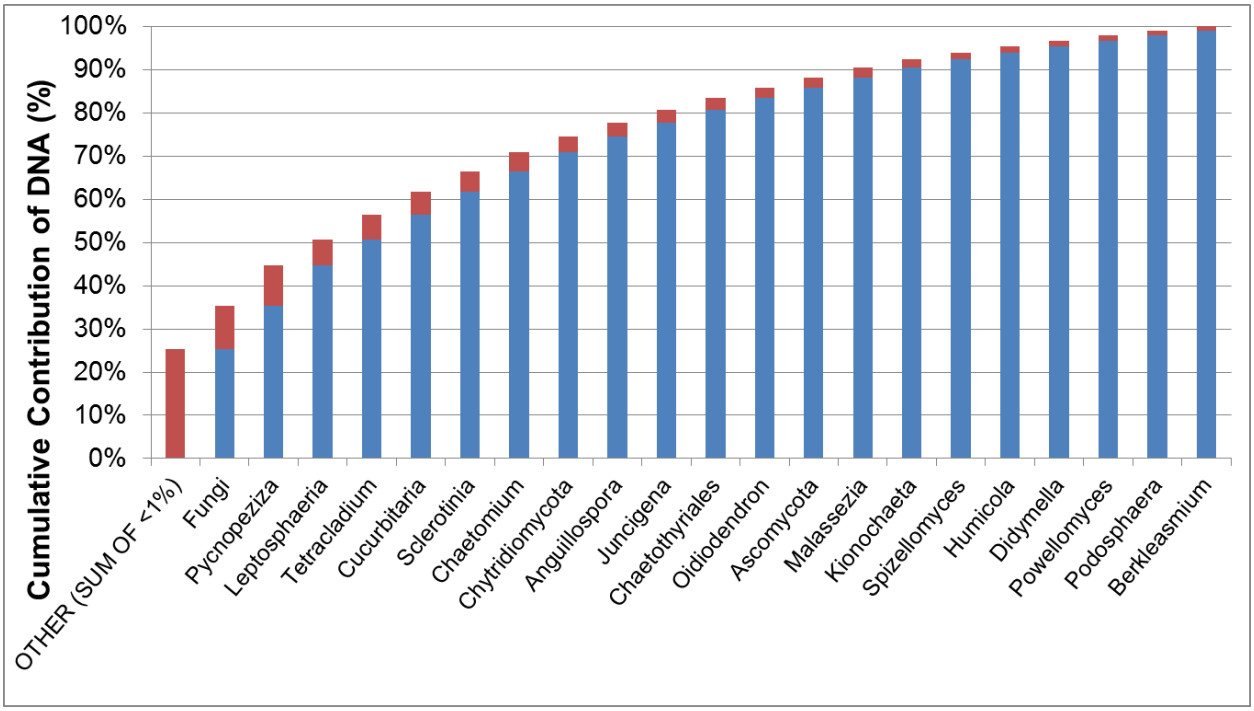



***Figure 3.13: Cumulative Contribution of Fungal Genera Accounting for > 1 % of Total DNA Across All Samples***

# Chapter 4 – Detour Gold Waste Rock Characterization Project: Sulfide Oxidation and Gas Transport in Two Historic Sulfide-Bearing Waste-Rock Stockpiles

## 4.1 Overview

Two waste-rock stockpiles (WRS) at the Detour Lake mine northeast of Cochrane, ON have been the subject of geochemical study since the summer of 2012 as part of a project to characterize the 20 - 30 year old waste and to develop plans for future waste management. This chapter presents the results of *in situ* monitoring conducted from 2012-2014 at two stockpiles and provides an initial evaluation of the physical and chemical mechanisms controlling sulfide oxidation and acid neutralization. The first stockpile has a simple 1.0 - 1.5 m cover (WRS#3), whereas the second stockpile had much of the cover material removed (WRS#4) shortly before the study. Instrumented boreholes at both stockpiles facilitated regular pore-gas and pore-water sampling, air-permeability measurements and provided continuous records of subsurface temperature and moisture content. The geochemical speciation software PHREEQCi was used to evaluate secondary mineral controls on dissolved trace-metal concentrations. Overall both stockpiles are characterized by neutral mine drainage. The results also indicate that sulfide oxidation rates are limited at WRS#3 compared to WRS#4 due to the presence of a low-permeability cover which restricts advective air flow into the pile.

Characterization of the stockpile material indicates that average sulfur contents at WRS#3 and WRS#4 are 0.1 wt. % and 0.6 wt. %, respectively, and average carbon contents are 0.4 wt. % and 0.5 wt. % respectively. None of the samples recovered from WRS#3 are considered potentially acid generating (PAG), whereas 45 % of the samples recovered from WRS#4 are PAG. The overall neutralization potential ratio (NPR) of each stockpile indicates that neither pile is likely to generate acidic drainage (WRS#3 NPR = 42.9; WRS#4 NPR = 8.4).

This prediction is consistent with the results of pore-water monitoring. Both stockpiles have near-neutral pore-water pH. Concentrations of $SO_4^{2-}$ are usually greater than 1000 mg/L at WRS#4 and greater than 100 mg/L at WRS#3 in the unsaturated zone, mirrored by the release of alkalinity due to acid neutralization reactions. Trace metal concentrations were < 100 µg/L in the unsaturated zone, although Fe and Mn concentrations frequently exceeded 500 µg/L in the saturated zone. Speciation modeling has indicates that the pore-waters are oversaturated with respect to calcite and dolomite, which suggests that these minerals may play a key role in acid-neutralization. Saturation with respect to several other secondary minerals, especially Fe- and Al-hydroxides (*i.e.* gypsum, goethite, gibbsite), throughout WRS#3 and WRS#4 indicate possible solubility controls on several important dissolved constituents (*i.e.* $SO_4^{2-}$, Fe, Al). Pore-water was mostly undersaturated with respect to secondary Cu, Ni and Zn minerals, indicating that these trace metals are possibly controlled through Fe- and Al-hydroxide precipitation, although precipitation of secondary Cu, Ni and Zn minerals may provide a sink for these dissolved metals at some disparate locations.

The limiting factor for sulfide oxidation at WRS#3 is gas transport. The average air permeability of the cover material at WRS#3 was approximately $3.2 \times 10^{-11}$ $m^2$, while the average air permeability of waste rock at WRS#3 and WRS#4 ranged from $1.3 \times 10^{-10}$ to $9.2 \times 10^{-9}$ $m^2$. In soils with permeability < $10^{-10}$ $m^2$ gas transport is diffusion dominated (Pantelis and Ritchie, 1992). This observation suggests that where the cover material is still intact on WRS#3, diffusion should be the dominant gas-transport mechanism, whereas gas transport at WRS#4 should be dominated by advection. These results are consistent with pore-gas measurements; at WRS#3 pore-gas $O_2$ declines with increased depth below the cover material, whereas pore-gas concentrations at WRS#4 are at atmospheric concentrations throughout. The abundance of $O_2$ at

WRS#4 is reflected in the higher concentrations of dissolved constituents compared to WRS#3. These results indicate the importance of a complete cover in restricting air-flow into waste rock stockpiles.

## 4.2 Introduction

Waste-rock stockpiles are structures found at open-pit mining sites which contain large volumes of rock which are uneconomical to process. Sulfide minerals found in waste rock, which are often associated with formations of high-grade ore, can oxidize when exposed to atmospheric conditions and generate acid rock drainage (ARD). ARD is characterized by low pH and elevated levels of dissolved contaminants including $SO_4^{2-}$, Fe, Al, Mn and other toxic heavy metals (Akcil and Koldas, 2006). Potential for ARD generation is an essential aspect of mine-waste management strategies.

## 4.3 Gas and Water Transport in Waste-Rock Stockpiles

The highly heterogeneous structure and composition of waste rock stockpiles make the scaling of laboratory findings to the field difficult. The pursuit of high-grade ore can generate many millions of tonnes of waste rock frequently originating from several separate and geochemically distinct rock and overburden units composed of rock particles ranging from the size of boulders to silt and clay (Persson, 1997). The internal structure of the waste pile plays an important role in regulating the rate of sulfide oxidation. Oxygen and water transport are necessary for the reaction to occur and heat transfer rates also affect the rate of oxidation (Belzile et al., 2004; Lefebvre et al., 2001a). Water transport also governs the mobility of contaminants and $O_2$ transport can be the rate limiting step for sulfide oxidation in the pile (Pantelis and Ritchie, 1992).

### 4.3.1 Internal Structure of Waste Dumps

Waste-rock stockpiles are highly heterogeneous and anisotropic. The difficulty in characterizing the transport of reactants and contaminants in these stockpiles lies in the wide variability of

hydraulic and thermal conductivity, air permeability and $O_2$ diffusion coefficient of the waste rock material. The method of deposition of waste rock (*e.g.* end dumping, push dumping, free dumping) will have an effect on the progression of ARD generation because it determines the physical characteristics governing air, water and heat transport (MEND, 1991). The most commonly used disposal method, end dumping and push dumping, typically result in particle-size segregation, with the larger, coarser fraction of waste rock material falling to the bottom of the stockpile, whereas fine grained material is retained near the surface (Fala et al., 2005). Layering of the waste-rock stockpile from coarse to fine grained material is more pronounced in larger stockpiles (Fala et al., 2003; MEND, 1991). Traffic surfaces are often compacted during the construction of the waste-rock stockpile creating distinct layers of finer grain-size material. Grading of waste rock within the stockpile may promote $O_2$ flow through the coarse material at the base of the stockpile (Fala et al., 2005; Herasymuik, 1996). Layering of fine-grained material also plays a large role in water transport through the waste-rock stockpile.

### 4.3.2 Gas Transport

Gas transport through waste rock occurs via three mechanisms: infiltration of water carrying dissolved gases, diffusive transport, and advection. Infiltration of dissolved gases usually accounts for a small part of total gas transport due to the relative insolubility of atmospheric gases (Amos et al., 2014). MEND (1991) provides the hypothetical estimate that several hundred meters of precipitation would be required every year to provide the same dissolved $O_2$ flux as diffusive $O_{2(g)}$ transport under nominal conditions. However, diffusion of atmospheric gases into waste rock is a slow process compared to advection, but diffusion can be the dominant gas transport mechanism in low permeability waste rock (Lefebvre et al., 2001a, Binning et al., 2007). Oxygen consumption in the stockpile generates a gradient in $O_2$ concentration between the interior and exterior of the dump. Diffusion becomes a dominant transport mechanism when

this gradient increases. The flux of $O_2$ due to diffusion is a function of Fick's first law (MEND, 1991):

$$4.1 \qquad F = -D_{air}\frac{dC}{dx}$$

Where F is the flux of $O_2$ (moles/$m^2$/s), $D_{air}$ is the diffusion coefficient of air ($m^2$/s), and dC/dx is the $O_2$ gradient across the waste-rock stockpile. Lefebvre et al. (2001a) provide the following equation for determining the diffusion coefficient under different pressure (p) and temperature (T) conditions:

$$4.2 \qquad D_{air} = D_o\frac{p_o}{p}\left(\frac{T+273.15}{273.15}\right)^{\theta}$$

where $D_o$ is a reference value at 0˚C and near atmospheric pressure ($p_o$) and θ is usually 1.8. The effective diffusivity ($D_e$) of air through a porous media is related to the porosity (n), gas saturation ($\theta_a$) and tortuosity (τ) of the media as described by the Millington and Quirk (1961) model, equation 4.3 (Lefebvre et al., 2001a):

$$4.3 \qquad D_e = n\theta_a\tau D_{air}$$

Tortuosity (τ) can be calculated using equation 4.4 (Aachib et al., 2002):

$$4.4 \qquad \tau = {\theta_a}^{7/3}n^{-2}$$

Where $\theta_a$ and n are the air content and porosity, respectively. The effective diffusivity of a material can also be calculated according to the Aachib model, equation 4.5 (Molson et al., 2005):

$$4.5 \qquad D_e = \frac{1}{n^2}\left[D_a\theta_a^{p_a} + \frac{D_w}{H}\theta_w^{p_w}\right]$$

Where $D_a$ and $D_w$ are the diffusion coefficients in air and water, respectively, $\theta_a$ and $\theta_w$ are the air and water filled porosity, respectively, H is the Henry'law partitioning coefficient between water and air (H = 33.2), and $p_a$ and $p_w$ are fitting coefficients ($p_a = p_w = 3.3$).

Lefebvre et al. (2001a) estimated the effective diffusivity of two waste-rock stockpiles, one composed of relatively coarse material (Doyon, Quebec; $d_{10}$,$d_{50}$ and $d_{90}$ of 2 mm, 40 mm and 150 mm respectively) and one composed of relatively fine material (Nordhalde, Germany; $d_{10}$,$d_{50}$ and $d_{90}$ of 0.02 mm, 5.5 mm and 60 mm respectively). The effective diffusivity of the coarse material was $2.85 \times 10^{-6}$ $m^2/s$ and the finer material was $5.70 \times 10^{-6}$ $m^2/s$.

Advective gas transport takes place due to pressure differences between two locations. Three significant advective gas transport mechanisms deliver $O_2$ to the interior of waste dumps. The first mechanism is $O_2$ transport due to wind around the waste dump. Research at the heavily instrumented test piles at Diavik Diamond Mine determined that the contribution of wind driven $O_2$ transport was "of similar magnitude to diffusive $O_2$ fluxes and temperature induced convective fluxes observed at other waste rock piles" (Amos et al., 2009). The second mechanism for advective flow into waste dumps is the development of thermal convection cells. Heat generated by sulfide oxidation causes gases in the waste dump to decrease in density and rise to the top of the dump. Cold air at the base of the stockpile can be drawn into the pile through the pore spaces between large cobbles that have accumulated at the base due to depositional effects (Lefebvre et al., 2001b; Andrina et al., 2006). Significant advective flow has also been caused by pressure gradients caused by the consumption of gas phase reactants (Binning et al., 2007). The third mechanism for advective flow is called "barometric pumping" and is caused by pressure gradients between the interior and exterior of the pile induced by a

change in local barometric pressures. This mechanism is considered a minor contributor due to the reliance on the compressibility of the gases involved (MEND, 1991).

Each mechanism of advective gas transport is equally impacted by the air permeability of the waste rock material. Amos et al. (2014) reviewed data from seven waste-rock stockpiles and found air permeability values from $3.9x10^{-13}$ $m^2$ to $4.7x10^{-9}$ $m^2$. Lower permeability (*i.e.* fine grained) material is often used to cover waste dumps in order to reduce air permeability and $O_2$ fluxes into the waste dumps (Yanful et al., 1993; Swanson et al., 2003).

### 4.3.3 Heat Transfer

There are two primary mechanisms of heat transport within waste-rock stockpiles: convective or advective transfer in which the heat is transported through the stockpile via air flow, and conductive heat transfer through the waste rock. The overall contribution of each mechanism to the thermal regime is dependent on the characteristics of the waste rock, the amount of heat generated within the pile through geochemical reactions (*i.e.*, sulfide oxidation) and environmental conditions. Conductive heat transfer is driven by thermal gradients in the bulk of the waste-rock material, and is most influential in stockpiles with low air-permeability, whereas advective/convective heat transport is more dominant in stockpiles with higher air-permeability. Advective heat transport occurs as a result of pressure gradients within and through the boundaries of a stockpile. Pressure gradients are caused by heating during the process of exothermic sulfide oxidation, $O_2$ depletion from sulfide oxidation and atmospheric perturbations. There is a strong connection between advective/convective heat transfer, gas transport and sulfide oxidation in waste-rock stockpiles. For example the $O_2$ depletion and heat released during sulfide oxidation can form pressure gradients which draw more $O_2$ into the pile, resulting in further sulfide oxidation and positive feedback between these processes. The thermal regimes of

waste-rock piles with low sulfide content, and therefore little heat generated through sulfide oxidation, may be primarily driven by the ambient atmospheric temperature which may be the primary source of variability in thermal gradients driving advective/convective heat transfer (Amos et al., 2015; Lefebvre et al., 2001a,b; Kuo and Ritchie, 1999).

Lefebvre et al. (2001a) summarize several waste rock properties related to heat transfer using equation 4.6:

$$\rho c = n\rho_w S_w c_w + (1-n)\rho_s c_s \quad (4.6)$$

where $\rho c$ is the global volumetric heat capacity (J/m$^3$) of the waste rock, n is the waste rock porosity, $c_w$ and $c_s$ are the water and solids specific heat capacities (J/kg ˚C) respectively, $\rho_w$ and $\rho_s$ are the densities of water and solids and $S_w$ is the level of saturation. The volumetric heat capacity is a measure of the energy required to heat the waste rock by 1˚C. Heat diffusivity, $\alpha_{th}$ (m$^2$/s) is defined as:

$$\alpha_{th} = \frac{K_{th}}{\rho c} \quad (4.7)$$

where $K_{th}$ is the thermal conductivity (W/m ˚K) of the waste rock material. Amos et al. (2014) provide a review of thermal conductivity estimates from seven waste-rock stockpiles ranging from 0.7 to 3.3 W/m ˚K. The average of several measurements taken at the Diavik Diamond Mine waste-rock stockpiles s was 3.0 W/m ˚K for the granitic waste-rock material.

### 4.3.4 Waste Rock Hydrology

The progress of sulfide oxidation and the mobility of liberated contaminants both rely on the movement of water through the pore spaces in the waste-rock stockpile. Waste dumps act just

like any other landscape feature in their relation to surface hydrology. The flux of water through a waste dump can be summarized by equation 4.8 (MEND, 1991):

$$D = P - R - E - T - dS \quad (4.8)$$

where D is the discharge of waste water from the base of the dump, P is precipitation, E and T are evaporation and transpiration respectively, and dS is the change in water storage within the dump. The infiltration rate at any particular waste-rock stockpile is dependent on several factors, including the severity of the precipitation event, local topography and surface vegetation. Another key factor in determining the overall magnitude of infiltration into the waste dump is the presence of a low-permeability cover. A study by Adu-Wusu and Yanful (2006) found that approximately 56 % of precipitation onto uncovered waste rock will infiltrate the waste dump. A geosynthetic clay liner used in the same study reduced infiltration to 7 %. Another study by Swanson et al. (2003) predicted a reduction of infiltration to 2 % using a compacted soil cover system. Cash (2014) estimates that the infiltration rate of the stockpiles at the Detour Lake mine is approximately 25 %.

Because waste-rock stockpiles are composed of particles ranging from > 1 m to clay and silt sizes the interior structure is highly heterogeneous with many large pore spaces. This structure and the ample pore space allow waste rock to drain relatively freely and usually results in unsaturated waste-rock stockpiles. Large spatial variations in hydraulic conductivity and preferential flow paths through macropores result in a very complex hydrogeological regime. Distribution of flow through macropores or through fine grained media is a function of the distribution of fine grained material and the magnitude and frequency of precipitation events.

Under regular low flow conditions pore water transport through unsaturated waste rock takes place primarily in material associated with capillarity (*i.e.* material with a grain size < 5 mm or < 4.75 mm) (Neuner et al., 2013; Tokunaga et al., 2002). Amos et al. (2014) reviewed studies from three separate waste rock research programs and in each case matrix flow was the dominant flow path for infiltrated water. In saturated condition water flow through this fine grained material is governed by Darcy's law:

$$q = -K\frac{dh}{dx} \tag{4.9}$$

where q is Darcy's flux (m/s), K is the hydraulic conductivity of the waste rock (m/s) and dh/dx is the hydraulic gradient. Unsaturated conditions complicate matters as fluctuations in water saturation entrap air bubbles which obstruct fluid flow. Entrapped air reduces hydraulic conductivity as the cross sectional area of water-saturated porous media decreases. The van Genuchten model (1980) can be used to estimate the change in hydraulic conductivity under unsaturated conditions using an estimate of saturated hydraulic conductivity ($k_s$) and several sample specific values derived from a soil water retention curve or a measurement of soil suction ($\psi$), equations 4.10 and 4.11:

$$\theta_e = \frac{\theta-\theta_r}{\theta_s-\theta_r} = \left[\frac{1}{(1+\alpha_v\psi)^{n_v}}\right]^{m_v} \tag{4.10}$$

$$k(\theta_e) = k_s\theta_e{}^{\lambda}\left[1-\left(1-\theta_e{}^{1/m_v}\right)^{m_v}\right]^2 \tag{4.11}$$

where $k_s$ is the saturated hydraulic conductivity, $k(\theta_e)$ is the effective hydraulic conductivity, $\theta$ is the symbol for saturation, the subscripts 'e', 'r' and 's' stand for effective, residual and saturation respectively, $\psi$ is matric suction pressure, $n_v$, $m_v$ and $\alpha_v$ are van Genuchten parameters, and $\lambda$ is a parameter representing the degree of pore connection.

## 4.4 Site Description

The Detour Gold mine site is located approximately 185 km Northeast of Cochrane, ON (Figure 1.2). Average yearly wind speeds range from 8-10 km/h from the west-southwest. Average annual temperature from 2011-2014 was 0.9 ˚C with daily temperatures ranging from -19 ˚C in the winter to 17 ˚C in the summer. Average annual precipitation over the study period was 500 mm per year, although over 730 mm of precipitation fell in 2014.

WRS#3 and WRS#4 are 3.5 and 11.5 hectares, respectively, and are approximately 25 and 20 m in depth. Each was covered in 2000 with approximately 1.0-1.5 m of local overburden material to provide a simple cover. At the time of the study the cover on both piles was vegetated with long grass, shrubs and several small trees. A large portion of WRS#4 was excavated during the study period, providing the opportunity for solid samples to be recovered. However, the western flank of WRS#4 is now uncovered (Figure 4.1).

Most of the waste rock contained in WRS#3 and WRS#4 is derived primarily from the Upper Detour Lake Formation (UDLF), a local geological unit composed of mafic minerals (actinolite-horneblende; approximately 85 %) and plagioclase (approximately 15 %), with quartz veins and small amounts (< 5 %) of carbonates and sulfides. The remaining waste rock is derived from the Lower Detour Lake Formation (LDLF) and Caopatina assemblage, geological formations containing several rock types including a chloritic schist contact unit, ultramafic flows and sills, mafic volcanic, felsic volcaniclastics, mafic sills and dykes, and a megacryptic dioritic sill (Oliver et al., 2012). The primary sulfide minerals encountered on site were pyrite and pyrrhotite, with minor chalcopyrite, pentlandite and arsenopyrite (Robertson et al., 2012).

Mine operations at the Detour Lake gold mine from 1983-1999 resulted in the placement of four covered waste-rock stockpiles covering several hectares at a depth of 15-20 m (Figure 1.1). A

comprehensive study of sulfide oxidation and ARD on these historic stockpiles was initiated to assist the mine operator in predicting and preventing ARD in future waste-rock stockpiles.

A physical characterization (Cash, 2014) of waste rock samples from stockpiles WRS#1, WRS#2 and WRS#4 indicates that the piles were likely constructed using a push or paddock style dump. Several structural features were identified during the excavation of these piles, including traffic surface and rubble zones spread throughout the stockpiles. Zones of highly weathered waste rock were also observed throughout the piles, indicating that sulfide oxidation had occurred. The distribution of waste rock paste pH was bimodal, with the majority of samples having a paste pH of 6-8, while notably weathered samples had lower paste pH values. The majority of waste rock samples contained 20 - 29 wt. % fine grained material (*i.e.*, passing the 4.75 mm sieve), meaning the waste rock is considered "rock-like". In rock-like material there is not "adequate fine grained material to fill all interparticle void spaces. The coarse particles become dominant and as a result, lare open void spaces can be found between particles" (Herasymuic, 1996). On average 17 wt. % of the waste rock is composed of fine grained material in which unsaturated flow typically occurs. The saturated hydraulic conductivity of the fine-grained material ranged from 10-5 m/s to 10-6 m/s. Assuming 50 % infiltration, the residence time of a 20 m stockpile with the average characteristics measured in WRS#1, WRS#2 and WRS#3 is estimated to be approximately 2.2 years (Cash, 2014).

This chapter describes the *in situ* geochemical conditions governing sulfide oxidation and acid neutralization within two historic stockpiles, WRS#3 and WRS#4. Three years of *in situ* data has been collected from two instrumented boreholes at WRS#3 and four instrumented boreholes at WRS#4. Waste rock samples recovered from the interior of WRS#4 and eight geochemically distinct solid samples recovered from the cover material at WRS#3 were characterized. The

partial excavation of WRS#4 left the western flank of the stockpile uncovered, which affected gas-transport mechanisms in this stockpile.

## 4.5 Materials and Methods

### *4.5.1 Solid Sampling and Waste Rock Characterization Methods*

Waste rock samples were recovered from the profile along the western flank of WRS#4 in June, 2011. A front end loader provided by DGC was used to expose and recover fresh waste rock material from the vertical face. The material was evaluated at the time of sampling for a variety of parameters including rock type, level of oxidation, colouring and moisture content. 20 L bucket samples were recovered in each case and kept refrigerated during the sampling period to minimize moisture loss. In total 14 samples were recovered from the profile of WRS#4. They were sent to the University of Alberta for physical characterization (Cash, 2014) and forwarded to the University of Waterloo for geochemical characterization. The partial excavation of WRS#4 in 2012 resulted in the removal of cover material from the western flank of WRS#4 leaving it exposed to the atmosphere (Figure 4.1). The excavation also resulted in the loss of one instrumented borehole (BH4-1).

A backhoe provided by DGC was used to conduct an investigation of the intact cover at WRS#3 in October, 2013. Eleven test pits were excavated into the cover material through to waste rock material (Figure 4.2). The depth of cover material, thickness of the root zone, soil colour and composition were all recorded. At four locations samples were recovered from the shallow cover material (*i.e.* 0-50 cm depth) and from the deeper cover material (*i.e.* 50-150 cm depth) and returned to the University of Waterloo for geochemical characterization.

The drill cuttings generated during the borehole installations at WRS#3 and WRS#4 were also recovered and shipped to the University of Waterloo for characterization. A 6 5/8” dual-rotary,

air-recirculating down hole hammer drill was used in combination with a Foremost DR12 drill rig. The drill cuttings were collected in approximately 6 m intervals, and the boreholes were drilled to a depth of approximately 20-25 m. The inconsistent return of drill cuttings resulted in significant gaps in the recovery of samples, and data from the boreholes has been averaged.

The S and C contents of the samples were determined by infrared absorption spectroscopy following combustion using an Eltra CS-2000 carbon/sulfur analyzer. The elemental composition of the samples was determined by energy dispersive x-ray fluorescence (ED-XRF) using a Panalytical Minipal 4 desktop ED-XRF analyzer. A small subset of samples was selected for further quantitative mineralogical characterization using x-ray diffraction (XRD) analysis. A single sample was examined by transmitted and reflected light microscopy and by scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS) using a Hitachi TM3000 table-top scanning electron microscope (SEM) coupled with a Bruker QUANTAX 70 energy dispersive spectroscope (EDS) to qualitatively determine the primary mineral assemblage.

Profile samples recovered from WRS#4 were segregated into nine size fractions (*i.e.* pan, 0.074, 0.105, 0.149, 0.25, 0.42, 0.841, 2.0, and 4.76 mm) and C, S contents and XRF composition were characterized separately. The results reported here are presented as weighted averages based on the grain size analysis completed by Cash (2012). Drill cuttings and cover samples were sieved to remove pebbles (< 4.76 mm) and analyzed as a whole. XRD samples were sieved to < 63 µm prior to analysis. The sample for optical microscopy and SEM-EDS examination was washed to concentrate heavy minerals (*i.e.* sulfides). The sample was cast in a 30 µm high purity fused quartz glass slide mounted using super glue and a 0.5 µm diamond microprobe polish.

### *4.5.2* In Situ *Data Collection*

Instrumentation was installed in each of six borehole drilled at WRS#3 (BH3-1 and BH3-2; Figure 4.2) and WRS#4 (BH4-2, BH4-3, BH4-4 and BH4-5; Figure 4.1). Each borehole contains $ECH_2O$ probes and thermistors which record sub-surface temperature, moisture content and electrical conductivity at 6 hour intervals and store measurements on data loggers. Data was downloaded approximately monthly throughout the summer months of the study. Dedicated pore-gas sampling tubes, pore-water suction lysimeters and air-permeability probes were installed at 5.0 m intervals in each of the boreholes. Pore-gas $O_2$ and $CO_2$ concentrations were measured using a high precision (0.1%) Quantek $O_2/CO_2$ detector.

The air-permeability probes consist of 8 inch (20.3 cm) lengths of 1 ½ inch (3.8 cm) diameter schedule 40 PVC well screen with 0.125 inch (0.32 cm) slots at 3/16 inch (0.48 cm) slot spacing. The probes are connected to the surface via two polyethylene tubes. The air-permeability of the wasterock stockpiles is determined using an instrument designed and built at the University of Waterloo. The instrument is automated and consists or a flow regulating device, a pressure transducer and a data logging device. The instrument determines the air-permeability by calculation based on the subsurface pressure response to a regulated influx of nitrogen gas. The pressure data is converted to air-permeability estimates based on the following equation by Hvorslev (1951):

$$q = \frac{2*\pi*L*k*H}{\ln(\frac{2*L}{D})} \rightarrow k = \frac{q*\ln(\frac{2*L}{D})}{2*\pi*L*H} \tag{4.12}$$

where k = coefficient of permeability, q = rate of flow, H = pressure response, L = length of the nitrogen intake tube, and D = diameter of the nitrogen intake tube. The equation was developed to estimate the permeability of water in the subsurface. To reflect changes in the viscosity of

nitrogen under variable temperature and pressure equation (1) was slightly modified. Viscosity is calculated automatically by the air-permeability machine while it is used. The final equation used to calculate air-permeability is shown below:

$$q = \frac{2*\pi*L*k*H}{\ln(\frac{2*L}{D})*\mu} \rightarrow k = \frac{q*\ln(\frac{2*L}{D})*\mu}{2*\pi*L*H} \quad (4.13)$$

where μ = the viscosity of nitrogen gas. The flow rate, pressure response and an air-permeability estimate are recorded every second during a measurement. The flow rate is specified and increases incrementally every 30 seconds over a five minute period. The reported results are the average of the air-permeability estimates recorded over the measurement period. Nitrogen flow and pressure were monitored during each measurement to confirm the expected response, and erroneous data expunged from the results. Pore-gas measurement tubing, air-permeability probes and ECH2O probes were also installed in the cover material at WRS#3 at multiple locations (TP3-3, TP3-4, TP3-5, TP3-6 and TP3-7; Figure 4.2)

### *4.5.3 Pore-Water Geochemistry and Speciation Modeling*

Pore-water samples were analyzed on site to determine the pH, redox potential (Eh), alkalinity, electrical conductivity (EC), and temperature. The samples were collected for the following parameter groupings: dissolved cations, dissolved anions, nutrients, ammonia, and total organic carbon. All samples were filtered (0.45μm, nylon) with the exception of total organic carbon. The pH of the cation samples was adjusted to 2.0 using trace-metal grade concentrated $HNO_3$. The pH of the ammonia and total organic carbon samples were adjusted to 2.0 using $H_2SO_4$. Samples were refrigerated during transport to the University of Waterloo and prior to analysis. Cation concentrations (*i.e.* Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, Sn, Sr, Ti, Tl, U, V, Zn,) were determined using inductively coupled

plasma-optical emission spectrometry (EPA Method 6010C, 2000; this method includes one calibration blank and five calibration standards, every ten samples a lab blank, QC standard and sample duplicate are analyzed) and inductively coupled plasma-mass spectrometry (EPA Method 6020A, 1998; this method includes one calibration blank and nine calibration standards, every ten samples a lab blank, QC standard and sample duplicate are analyzed). Anion and nutrient (*i.e.* $SO_4^{2-}$, $NO_3^-$, $NO_2^-$, $PO_4^{3-}$, $Cl^-$, $F^-$ and $Br^-$) concentrations were determined via ion chromatography (EPA Method 300.0, 1993; this method includes one calibration blank and five calibration standards, every ten samples a lab blank, QC standard and sample duplicate are analyzed). Ammonia concentrations were determined using a Hach DR 2800 spectrophotometer (AmVer™ Salicylate Test 'N Tube™ Method 10023). Phosphate concentrations were also determined using a Hach DR 2800 spectrophotometer (Phosphate Ascorbic, Method 8048). Total organic carbon concentrations were determined by SGS Canada Inc. in Lakefield, Ontario using the Persulfate-Ultraviolet or Heated-Persulfate Oxidation Method.

Limited sample volumes made it very difficult to regularly collect a full suite of samples and duplicate samples from a variety of the sampling locations. Duplicate samples were collected as separate, independent samples during the same sampling event, rather than as split samples from a larger volume. Using this approach 2.5% of the pore-water samples had a full duplicate analysis over the course of the study (36% had partial duplication such as a duplicate pH or alkalinity measurement). Of the samples with a full duplicate analysis, all analyses showed discrepancies < 20%; 50% had an average analyte discrepancy < 5%, 33% had an average analyte discrepancy of 5-10%, and 17% had an average analyte discrepancy 10-20%. Of the duplicated analytes, 70% had < 10% discrepancy (including pH, Eh, EC, alkalinity, Ca, Mg, Na, K, Fe, S, Si, Li, B, V, Cr, Mn, As, Sr, Mo, Sb, Ba, U, $Cl^-$, $NO_3^-$ and $SO_4^{2-}$), 15% had

discrepancies from 10-20% (Fe, Co, Sn, Pb, $F^-$ and $PO_4^{3-}$) and the remaining 15% had discrepancies from 30-40% (Al, Ti, Cu, Ni, Zn and Tl). Analysis of field blanks indicated detectable concentrations of Cr, Mn, Ni, As, Ca, K, Mg, Na and Si on one occasion (Ca, K, Mg, Na and Si method detection limits of 0.006 µg/L, 0.01 µg/L, 0.01 µg/L, 0.008 µg/L, 0.2 mg/L, 0.1 mg/L, 0.2 mg/L, 0.2 mg/L and 0.07 mg/L respectively; Cr, Mn, Ni, As, Ca, K, Mg, Na and Si detected at 0.3 µg/L, 0.3 µg/L, 0.3 µg/L, 0.2 µg/L, 54.8 mg/L, 1.7 mg/L, 25.1 mg/L, 30.1 mg/L and 10.2 mg/L, respectively), detectable concentrations of Al, Fe, on two occasions (Al and Fe method detection limit of 0.04 µg/L and 0.06 µg/L, respectively; Al detected at 2.7 µg/L and 0.3 µg/L, Fe detected at 1.6 µg/L and 0.6 µg/L), and detectable concentrations of Cu on three occasions (Cu method detection limit of 0.02 µg/L; Cu detected at 20.6 µg/L, 2.6 µg/L and 2.7 µg/L on separate occasions).

The USGS modelling software PHREECQ Interactive (February 1st, 2013) was used to evaluate pore-water speciation and identify potential solid-phase controls on the concentations of dissolved constituents. Calculations were conducted using the WATEQ4F database. The following geochemical parameters were used in the speciation calculations; pH, Eh, alkalinity, $SO_4^{2-}$, $NO_3^-$, $F^-$, $Cl^-$, Al, As, Ba, Be, Ca, Cd, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Pb, Si, Sr, Zn and U. Results are reported as saturation indices (S.I.) for the available secondary minerals, defined in equation 4.14:

$$\text{S.I.} = \log_{10}\left(\frac{IAP}{K_{sp}}\right) = \log_{10}\left(\frac{\{A\}_{act}^{a}\{B\}_{act}^{b}}{\{A\}_{eq}^{a}\{B\}_{eq}^{b}}\right) \quad (4.14)$$

Where IAP is the ionic activity product, Ksp is the thermodynamic solubility product, and $\{A\}^a_{eq}$ and $\{A\}^a_{act}$ are the actual and equilibrium condition ionic activities of ion A, respectively.

## 4.6 Results and Discussion

### 4.6.1 Waste Rock Characterization

#### *4.6.1.1 Mineralogy*

Three representative samples (*e.g.* P4-P5-S1, P4-P5-S2 and P4-P7-S2) were selected for XRD analysis. The primary mineral components of the waste rock are plagioclase minerals with anorthite and albite together accounting for as much as 47 % of the mineral composition (Table 4.1). Horneblende and quartz were also important mineral components in the waste rock with average concentrations of 18 % and 14.3 % respectively. Clinochlore concentration was the most variable, accounting for 5-20 % of the waste rock mineralogy. Small amounts of vermiculite and biotite were observed, with average contents of just 8.7 % and 5 % respectively. Sulfide and carbonate concentrations were mostly too low to quantify (< 5 %) via XRD, but small amounts of pyrrhotite were detected in two samples. The composition of samples from WRS#4 is very similar to the composition of waste rock at WRS#1 and WRS#2, which were also composed primarily of plagioclase and horneblende, with lesser quartz, clinochlore and biotite and vermiculite (section 2.6.2).

Most of the primary minerals identified through XRD were observed microscopically, in sample P4-P7-S2 including plagioclase (Figures 2.12-2.13), quartz (Figure 2.10), clinchlore and biotite (Figure 2.13). Variably weathered pyrite and pyrrhotite grains were also observed in sample P4-P7-S2 (Figures 2.21-2.22).

These results are consistent with the rock types mined at Detour Lake. Approximately 55% of the historic waste rock originates from the massive mafic flows of the Upper Detour Lake Formation (Oliver et al., 2012) which consist mainly of plagioclase (anorthite) and mafic minerals (*e.g.* actinolite-horneblende), and are also host to quartz veins. This formation also

hosts potasically altered mafic flows which contain secondary albite, biotite and sulfides. The remaining historic waste rock (~ 45 %) originates from the Lower Detour Lake Formation which consists of more ultramafic rock types as well as a chloritic schist contact unit which is the likely source of the observed chlinochlore. The small amounts of vermiculite present in the sample likely originate through the weathering of biotite. These results along with the carbon and sulfur data indicate that the samples are composed overwhelmingly (> 90 %) of silicate minerals, with very minor (but geochemically significant) contributions by carbonates and sulfides.

#### *4.6.1.2 Carbon and Sulfur Content and Acid-Base Analysis*

The results of C and S analysis and the accompanying acid-base analysis (ABA) are summarized in Table 4.2 and presented fully in Figures 4.3-4.5. The cover material recovered from WRS#3 had < 0.4 wt. % S and C content ranged from 0.4-1.5 wt. %. WRS#3 drill cuttings, which are more representative of waste rock material at WRS#3 also had relatively low S concentrations (average 0.1 wt. %) and an average of 1 wt. % C resulting in a very high average NPR. None of the samples recovered from WRS#3 are considered potentially acid generating (NPR > 1.5). In contrast, samples from WRS#4 contained an average of approximately 0.6 wt. % S and 0.4 wt. % C. As a result several of the samples collected at WRS#4 (45 % of the total) are considered potentially acid generating. Nevertheless non-acid generating samples typically had very high NPR values, resulting in an average NPR for WRS#4 drill cutting and profile excavation samples of 6.7 and 10.4 respectively. Both WRS#3 and WRS#4 are characterized by high NPR values suggesting neither stockpile is likely to generate acidic drainage. However, S concentrations nearing 2 wt. % in several samples indicate that sulfide rich zones may generate locally acidic conditions within WRS#4. In total 5 of the samples (16 %) recovered from WRS#4 had net neutralization potential values < 0.

#### *4.6.1.3 Whole Rock Analysis*

The whole rock composition of samples from WRS#3 and WRS#4 were similar to the composition of samples from WRS#1 and WRS#2 (section 2.6.2) and is consistent with the bulk composition of the local host rock. Silicon is the single largest component in the waste rock (average mass fraction of 65 wt. % at WRS#3 and ~ 60 wt. % at WRS#4 ), with $SiO_2$ and various metal oxides (*i.e.* CaO, $Al_2O_3$, MgO, $Fe_2O_3$, $K_2O$, $Na_2O$, MnO) accounting for > 99 % of the samples. Trace metals (*i.e.* Cr, Cu, Ni, Zn, Pb, etc.) cumulatively account for < 1 %. A summary of XRF results are presented in Table 4.3, with more detailed results provided in Figure 4.6 and Appendix A.

High S concentrations at WRS#4 are associated with elevated concentrations of Mg, Fe, Cr, Cu, Ni and Zn two to five times greater than those measured in WRS#3 samples. Relative deficiencies in these metals at WRS#3 are offset by increased Si and K content. These differences are mostly attributed to the increased content of overburden (*i.e.* cover) material in WRS#3, which is clearly distinguishable from waste rock samples (Figure 4.6).

### 4.6.2 Hydrology and Temperature

#### *4.6.2.1 Cover Material*

Thermal measurements were made using $ECH_2O$ probes installed in the cover material on WRS#3 (< 0.5 mBGS). These probes closely followed the outdoor air temperature (Figure 4.7). Temperature in the cover material reached a maximum of approximately 15 ˚C in the summer months (June-September). Air temperature declined slowly from late September and the cover began to freeze at the shallowest depths (~ 0.5 mBGS) in December-January. The shallowest measuring point dropped to a minimum temperature of ~ -5 ˚C, but the deeper locations (< 0.75 mBGS) had minimum temperatures of ~ 0 ˚C. Freezing was delayed in deeper cover material; at location TP3-5 at a depth of ~ 0.5 mBGS freezing occurred in January, but at a depth of

approximately 0.8 mBGS freezing occurred in February and at a depth of 1.2 mBGS freezing was delayed until March. Thawing of the cover occurred in May-June, starting at the shallowest measuring location with a slight delay with increasing depth (Figure 4.7).

Hydrological profiles for the cover material were also constructed using the $ECH_2O$ measurements (Figure 4.8). The moisture content of the cover material ranged from a maximum of ~ 25-35 vol. % to a minimum of ~ 8 vol. %. Using the average porosity of the cover material (n = 0.54) these water contents correspond to a maximum and minimum saturation of 65 % and 15 %, respectively. The maximum measured moisture content at each location coincided with precipitation events and represent near saturation of the cover material. The deeper cover material was unresponsive to precipitation events early in the year as overlying material wetted up; at TP3-5 the deepest location (~ 1.2 mBGS) began to respond to precipitation events as approximately one month (May-June) after the shallowest depth (~ 0.5 mBGS). In the summer months (May-September) the cover material has a resting moisture content of ~ 15 vol. %. As temperatures decline in the fall and the cover begins to freeze the measured moisture content of the cover declines sharply as liquid water turns to ice, which is not measurable by $ECH_2O$ probes. The decline in moisture content coincides very well with the onset of freezing conditions at each measured depth (compare Figures 4.7 and 4.8).

#### *4.6.2.2 Waste Rock*

The moisture-content and water-level data collected at Detour Gold show the migration of frequent wetting fronts, which impacts the moisture content at shallow depths. The water table at WRS#3 was 16.0-16.5 mBGS which corresponds to a 6.0-6.5 m thickness of saturated waste rock at the base of this ~ 22.0 m waste-rock stockpile. The water table at measuring stations

within the much larger WRS#4 was 21.5-23.5 mBGS which corresponds to only 2.0-4.0 m of saturated waste rock at the base of the ~ 25 m deep stockpile (Table 4.4).

Hydrologic profiles constructed using the results of $ECH_2O$ probes at each borehole location show a zone of high saturation below the cover (to a depth of 10-15 mBGS) which is strongly influenced by passing wetting fronts (Figures 4.9 and 4.12). Measurements from this zone show rapid fluctuations in moisture content from values approaching residual moisture content (5 vol. %) to values approaching matrix saturation (~ 25 vol. %). The porosity of matric fines in waste rock from Detour Gold ranged from 0.3 – 0.5 (Cash, 2014). Calculations based on an average matric fines porosity of 0.4 indicates that the saturation of waste-rock fines range from 12.5 – 62.5 %. A zone of more uniform moisture content extends upward from the water table to a depth of 10-15 mBGS. The moisture content in this partially saturated zone does not reach saturation suggesting that the macropores are not water-filled (best illustrated by BH4-2 at 15.5 mBGS; Figure 4.9). The base of the pile is water saturated, as indicated by the moisture content measurements and water levels recorded in the piezometers.

Thermal profiles were also constructed for each borehole location using the $ECH_2O$ probe and thermistor measurements (Figures 4.10 and 4.11). The seasonal trend in the thermal profiles, with high temperatures in the summer and lower temperatures in the winter, shows an increasing lag time with increasing depth to the thermal profile, such that the deepest areas in the stockpile are significantly delayed in reaching their seasonal minima/maxima. The temperature measurements at the shallowest thermistors within the waste rock show the most extreme temperature fluctuations. The magnitude of the temperature fluctuations decreases deeper in the profile, with no temperature fluctuations at depths > 15.0 mBGS. The entire depth of waste rock except at the shallowest depths remains above 0 ˚C throughout the year. Sulfide oxidation rates

are temperature dependent, following the Arrhenius model (Williamson and Rimstidt, 1994; Nicholson and Scharer, 1994; Belzile et al., 2004; Ahonen and Tuovinen, 1992) with an approximate doubling of the sulfide oxidation rate for every 10 ˚C increase in temperature. The gradual temperature fluctuations and positive temperatures throughout WRS#3 and WRS#4 indicate that sulfide oxidation rates are mostly unimpacted by winter temperatures. The cover material on WRS#3 and WRS#4 is a factor in the gradual temperature changes seen at most measuring locations. Borehole measuring locations at WRS#4 near the exposed flank (e.g. BH4-4 and BH4-5) both experienced more rapid temperature fluctuations throughout the entire depth of the stockpile (Figures 4.10 c) and d)). This indicates that the cover material impedes advective heat flow throughout the pile. Overall, the temperature at most points throughout both piles is above the average air temperature at the mine site. Soil temperature typically fluctuates about the mean annual air temperature (Mann and Schmidt, 2003). The mean annual air temperature at Detour Gold is approximately 0.9 ˚C, while the average temperatures at depth range from 2.5-7.5 ˚C. However, the long-term trend in temperatures within the pile is negative and temperatures deeper in the pile are returning asymptotically to the mean annual air temperature, indicating that the slightly elevated temperature within WRS#3 and WRS#4 may be an effect of the instrument installations. The elevated temperature is probably a result of warm air introduced during drilling or an enhancement to exothermic sulfide oxidation due to oxygen introduced during drilling.

### 4.6.3 Gas Transport and Pore-Gas Composition

The results of air-permeability and pore-gas composition measurements indicate that WRS#3 and WRS#4 have different primary gas transport mechanisms due to the decimation of the cover at WRS#4. Air permeability measurements for WRS#3 and WRS#4 are summarized in Tables 4.5 and 4.6. The lowest permeability was measured in the WRS#3 cover material with an

average of $4.9x10^{-11}$ $m^2$. Waste rock material at WRS#3 had permeability ranging from $8.5x10^{-11}$ to $1.9x10^{-09}$ $m^2$, while the permeability of waste rock at WRS#4 ranged from $9.7x10^{-10}$ to $9.2x10^{-09}$ $m^2$. There is a slightly positive correlation between depth of measurement and air permeability (Figure 4.13). The correlation is most prominent in permeability measurements taken from WRS#3. This trend is likely a result of the depositional effects which promote size segregation in the waste dumps. Cash (2014) noted that the bases of WRS#1 and WRS#2 contained coarse grained material such as boulders and cobbles with more fine-grained material retained near the surface of the stockpiles. Increasing air-permeability at greater depth is consistent with these observations, because greater grain size is anticipated to equate to more open pore space.

The air-permeability coefficients recorded in waste stockpiles at the Detour Lake mine lie within the range of reported permeability values for waste-rock stockpiles. Amos et al. (2014) reviewed studies which reported air-permeability coefficients from $3.9x10^{-13}$ $m^2$ to $4.7x10^{-9}$ $m^2$, while the average permeability of Detour Gold waste rock ranges from $10^{-11}$ $m^2$ to $10^{-9}$ $m^2$. The lower permeability coefficients measured in the cover material of WRS#3 ($10^{-11}$ $m^2$) suggest that the dominant gas transport mechanism at that stockpile is diffusion. It has been proposed that below a permeability of $10^{-10}$ $m^2$ the contribution of advection to gas transport is secondary to diffusion (Pantelis and Ritchie, 1992). The waste rock itself at Detour Lake has a higher permeability coefficient, usually between $10^{-9}$ and $10^{-10}$ $m^2$. Heterogeneity in stockpile structure, moisture content and cover thickness result in a complex and dynamic combination of gas transport mechanisms. WRS#4 in particular, which lost large portions of its cover during the partial excavation of June, 2012, is likely dominated by advective gas transport.

At WRS#3 there is a trend of $O_2$ depletion and $CO_2$ enrichment with increasing distance from the pile surface (Figure 4.14), in contrast to WRS#4 where pore-gas concentrations are atmospheric

throughout (Figure 4.15 and 4.16). The depletion of $O_2$ at WRS#3 is an indication of $O_2$ consumption by sulfide oxidation, and the rate of $O_2$ replenishment is less than the rate of $O_2$ consumption. In contrast, the high $O_2$ concentrations observed in WRS#4 indicate that $O_2$ is replenished as rapidly as it is consumed through sulfide oxidation. Combined, these observations suggest that the cover on WRS#3 limits gas transport into the stockpile and thereby limits the overall rate of sulfide oxidation. The enrichment in $CO_2$ observed in WRS#3 probably reflects the carbonate dissolution which neutralizes the acidity from sulfide oxidation through equation 4.15:

$$2H^+ + CaCO_{3(s)} = Ca^{2+} + CO_{2(g)} + H_2O_{(l)} \quad (4.15)$$

Pore-gas trends through the cover at WRS#3 are also indicative of a diffusion dominated pore gas transport mechanism (Figure 4.17). Oxygen concentrations usually decreased with increasing depth through the cover, reaching a minimum of < 10 % $O_2$ at several locations (i.e. TP3-4, TP3-5 and TP3-7), whereas $CO_2$ concentrations slightly increased through the cover, reaching a maximum of 5-10 % $CO_2$ at several locations (*i.e.* TP3-3, TP3-4 and TP3-7).

Variability in the pore-gas composition over time (*e.g.* TP3-7; Figure 4.17) may be influenced by variability in the effective diffusivity of the cover material due to fluctuations in water content. Saturated soils with fewer open pore space restrict gaseous diffusion through porous media (Aachib et al., 2002). The effective diffusivity of the cover material at WRS#3 was estimated at various moisture content using two methods; the Millington and Quirk (1961) approach (equation 4.3) and the Aachib et al. (2002) approach (equation 4.5) have both been applied to waste rock research (Molson et al., 2005, Lefebvre et al., 2001a). The estimated effective diffusivity of the cover material near saturation (moisture content = 30 vol. % ) is approximately

$3.8x10^{-7}$ $m^2/s$ according to the Aachib et al. (2001a) model and $5.6x10^{-7}$ $m^2/s$ according to the Millington and Quirk (1961) model. Effective diffusivity increases to $2.6x10^{-6}$ $m^2/s$ (Aachib et al., 2001a) or $4.1x10^{-6}$ $m^2/s$ (Millington and Quirk, 1961) near residual saturation (moisture content = 10 vol. %), although this level of moisture content is rare (low moisture content measurements throughout the winter are due to the freezing of pore water, not drainage). The cover material typically retains moisture at approximately 20 vol. % throughout the summer months, which corresponds to an effective diffusivity of $1.1x10^{-6}$ $m^2/s$ (Aachib et al., 2001a) or $1.8x10^{-6}$ $m^2/s$ (Millington and Quirk, 1961). An effective diffusivity of $5x10^{-7}$ – $1.0x10^{-6}$ $m^2/s$ is 5 – 10 times smaller than the effective diffusivity of waste rock reported by Lefebvre et al. (2001a), which suggests that the cover at WRS#3 is a barrier to diffusive $O_2$ flux into the pile, especially when the cover material is near saturation. Overall the cover material at WRS#3 and WRS#4 provides a barrier to both advective and diffusive air flow into the pile, which is a benefit for the placement of the simple, unengineered revegetation cover composed of local overburden material.

### 4.6.4 The Hydrogeochemistry of WRS#3 and WRS#4

Overall the pore-water geochemistry at WRS#3 and WRS#4 is consistent with sulfide oxidation, and subsequent acid neutralization by dissolution of carbonate minerals. Pore-water pH within both stockpiles was near-neutral throughout 2012-2014, ranging from 7.0 - 8.6. The Eh values at WRS#3 and WRS#4 usually ranged from 300 - 350 mV, with some values in the 0 – 200 mV range. Eh are corrected to the standard hydrogen electrode (SHE). At WRS#4 alkalinity and $SO_4$ concentrations were inversely correlated, with higher alkalinity (300-1000 mg/L as $CaCO_3$) and lower $SO_4$ (200-500 mg/L) measured below the water table (Figures 4.18a-4.21a). Above the water table, alkalinity and $SO_4$ concentrations were usually < 200 mg/L as $CaCO_3$ and > 1500 mg/L, respectively. At WRS#3 pore-water samples were only recovered from the unsaturated

zone where alkalinity ranged from 160-1550 mg/L as $CaCO_3$ and dissolved $SO_4$ concentrations ranged from 80 - 670 mg/L (Figures 4.22a-4.23a). Elevated levels of $SO_4$ in the pore-water of WRS#3 and WRS#4 are the direct result the oxidation of sulfide minerals, primarily pyrite (equation 4.16) and pyrrhotite.

(4.16) $$FeS_{2_s} + 7O_{2_{aq}} + H_2O \rightarrow Fe^{2+} + SO_4^{2-} + 2H^+$$

Alkalinity is derived from the dissolution of carbonate minerals (*e.g.* calcite; equation 3.12). The decrease in alkalinity associated with elevated sulfate concentrations and elevated concentrations of pore gas $CO_2$ can be attributed to the neutralization of $H^+$ generated during sulfide oxidation reactions through carbonate mineral dissolution, stepwise formation of $HCO_3^-$ and $H_2CO_3$ and degassing of $CO_2$ (simplified in equations 4.17-4.20).

(4.17) $$CaCO_{3(s)} = Ca^{2+}{}_{(aq)} + CO_3{}^{2-}{}_{(aq)}$$

(4.18) $$H^+{}_{(aq)} + CO_3{}^{2-}{}_{(aq)} = HCO_3{}^-{}_{(aq)}$$

(4.19) $$H^+{}_{(aq)} + HCO_3{}^-{}_{(aq)} = H_2CO_3{}^0{}_{(aq)}$$

(4.20) $$H_2CO_3{}^0{}_{(aq)} = CO_{2(g)} + H_2O$$

Pore-water in both stockpiles was oversaturated with respect to several carbonate minerals including calcite, dolomite and rhodochrosite, especially at WRS#3 which had higher alkalinity concentrations (Table 4.7). At WRS#3 average calcite and dolomite saturation indices (S.I.) range from 1.23-1.62 and 2.11-3.86 respectively, indicating saturation with respect to these minerals (Figures 4.28a, 4.29a). The pore water in WRS#4 is near equilibrium or oversaturated with respect to calcite and dolomite, with average S.I. values ranging from 0.51-1.18 and 0.65-

2.25 respectively (Figures 4.24a- 4.27a). Oversaturation with respect to calcite and dolomite is a product of the elevated concentrations of carbonate, calcium and magnesium in the pore-water. These observations suggest that mineral sources of calcite and dolomite are still available for dissolution.

Geochemical speciation results show that the pore-water of WRS#3 and WRS#4 is also near saturation with respect to gypsum and jarosite. The favourable conditions for secondary sulfate precipitation could provide a sink for dissolved $SO_4$ and dissolved metals through co-precipitation and adsorption. Additionally, jarosite precipitation may be providing a sink for dissolved Fe.

Major cation (*i.e.* $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $K^{+}$) concentrations at WRS#4 were very stable throughout the study (Figures 4.18a-4.21a). The $Ca^{2+}$concentrations at most locations were low near the cover and increased at intermediate depths, declining below the water table. The $Ca^{2+}$ concentrations at intermediate depths were usually 400-600 mg/L, but were in the 100-250 mg/L range at shallow and deeper depths. The concentration of $Mg^{2+}$displayed a similar depth trend, reaching concentrations of 150-250 mg/L in the intermediate depths and lower concentrations of 50-100 mg/L in the deep and shallow zones. $Na^{+}$ concentrations were highest in the shallow waste rock, usually in the 40-50 mg/L range, but > 100 mg/L at BH4-4. $Na^{+}$ concentrations declined with depth and were usually < 20 mg/L throughout the depth of the stockpile. $K^{+}$ concentrations at WRS#4 ranged from 5-40 mg/L.

Major cation concentrations at WRS#3 were less stable than at WRS#4. The concentrations of $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$ and $K^{+}$ in the unsaturated zone of WRS#3 ranged from 20-380 mg/L, 30-150 mg/L, 7-50 mg/L and 3-13 mg/L, respectively (Figures 4.22a, 4.23a).

The concentrations of $Ca^{2+}$ and $Mg^{2+}$ in the pore water are attributable to the dissolution of carbonate minerals (*i.e.* calcite, dolomite; equation 3.12). Concentrations of dissolved $Na^{+}$ and $K^{+}$ are probably due to dissolution of gangue minerals (*e.g.* albite [$NaAlSi_3O_8$], biotite [$K(Mg,Fe)_3(AlSi_3O_{10})(F,OH)_2$]).

Elevated concentrations of Fe, Cu, Ni, Zn and other metals in the pore water of WRS#3 and WRS#4 are due to the oxidation of sulfide minerals present in the waste rock, including pyrite, pyrrhotite, chalcopyrite and covellite (*e.g.* pyrite; equation 3.11). The fate of dissolved metals released during sulfide oxidation is strongly determined by their mobility under the prevailing geochemical conditions. The precipitation of sulfate minerals (*e.g.* gypsum, jarosite) and metal (oxy)-hydroxides (*e.g.* $Fe(OH)_3$, goethite) are very commonly observed constraints on concentrations of dissolved $SO_4$, Fe and heavy metals at mine sites (Blowes and Jambor, 1990). Co-precipitation and adsorption of heavy metals also contributes to their immobilization (McGregor et al., 1998).

Metal concentrations at WRS#4 were generally < 100 µg/L. Fe and Mn concentrations were typically < 100 µg/L in the unsaturated zone but elevated below the water table (Figures 4.18b-4.21b). Fe concentrations commonly exceeded 1000 µg/L and Mn concentrations > 500 µg/L were common at this depth (*e.g.* BH4-2; Figure 4.18b). Cu, Ni and Zn concentrations were less uniform than other parameters, but concentrations were usually < 50 µg/L (with several exceptions). Arsenic concentrations were usually < 5 µg/L, but occasionally exceeded 10 µg/L (*e.g.* BH4-3; Figure 4.19b). Concentrations of Al at WRS#4 were < 40 µg/L.

Metal concentrations at WRS#3 were more varied than at WRS#4 (Figures 4.22b, 4.23b). Dissolved Fe concentrations at WRS#3 were lower than WRS#4, ranging from < 10-120 µg/L.

Dissolved Mn concentrations at WRS#3 varied widely, with concentrations falling between 7-1054 µg/L. Dissolved Cu concentrations were usually < 10 µg/L with some notable exceptions (*e.g.* 149.9 ug/L at BH3-1 in August, 2012; Figure 4.22b). Dissolved Ni concentrations were also usually < 10 µg/L, reaching a maximum of 14 µg/L in June, 2014. The highest dissolved Zn concentration was 1163 µg/L, observed at BH3-1 in June, 2012, although Zn concentrations were usually < 100 µg/L. The dissolved As concentrations were slightly higher in WRS#3 than at WRS#4, exceeding 20 µg/L at BH3-1 but were < 10 µg/L at BH3-2. Concentrations of Al at WRS#3 were usually < 50 µg/L, but sometimes reached 100 µg/L.

Throughout the entire depth of both WRS#3 and WRS#4 the pore waters are oversaturated with respect to several secondary iron minerals (Figures 4.24c-4.29c). S.I. for these iron minerals in order of increasing saturation are $Fe(OH)_{3(a)}$ (average S.I. = 0.82), maghemite (average S.I. = 5.03), goethite (average S.I. = 8.3), magnetite (average S.I. = 12.79) and hematite (average S.I. = 15.43). The result of oversaturation with respect to these iron oxides and iron hydroxides is a strong indication that conditions favour the precipitation of these minerals throughout the stockpiles, especially $Fe(OH)_{3(a)}$ which has the highest reported solubility product (Schwertmann, 1991).

In addition, the pore water in WRS#3 and WRS#4 were consistently near saturation with respect to some secondary aluminum hydroxides, notably gibbsite (average S.I. = -0.62), and the aluminum (oxy)hydroxides boehmite (average S.I. = -1.10) and diaspore (average S.I. = 0.60) throughout the entire depth of the stockpiles (Table 4.8; Figures 4.24d-4.29d). Pore-water conditions favouring the precipitation of secondary aluminum minerals is a likely control on the low concentrations of Al seen throughout the pore-water of WRS#3 and WRS#4.

The pore-water of WRS#3 and WRS#4 is mostly undersaturated with respect to secondary Zn, Cu and Ni minerals, including $Zn(OH)_2$, zincite, smithsonite, azurite, brochantite, malachite, $Ni(OH)_2$ and bunsenite, with some exceptions (Tables 4.9, Figures 4.24-4.29e,f,g). BH3-1 at a depth of 14.2 mBGS had the highest recorded concentrations of dissolved Zn (> 1000 µg/L) within the stockpiles and as a result the pore-water at this location is at or near saturation with respect to $Zn(OH)_2$ (S.I. = -0.72) and zincite (S.I. = 0.59). Undersaturation of pore-water at WRS#3 and WRS#4 with respect to these secondary Zn, Cu and Ni minerals indicates that direct removal of these metals from the aqueous phase through precipitation is not favoured throughout most of the stockpiles. Localized saturation of pore-water with respect to the minerals above may provide some control on dissolved metals, but Cu, Ni, Zn and other heavy metal concentrations are likely controlled primarily through co-precipitation and adsorption to iron oxides.

Neutral and oxidized pore-water conditions in the waste rock are conducive to iron hydroxide precipitation (equation 4.19), which helps to stabilize pore-water concentrations of various metals (*e.g.* Fe, Cu, Ni, Zn) through adsorption and co-precipitation.

(4.21) $$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_{3_s} + 3H^+$$

However elevated levels of Fe and Mn are observed at the base of the stockpile. These observations suggest that these metals are released by reductive dissolution of Fe and Mn oxides, probably associated with dissolved organic carbon derived from the peat layers underlying the waste-rock stockpiles. Iron and Mn concentrations are elevated in the saturated waste rock as Fe(III) and Mn(VI) reduce to the more soluble species Fe(II) and Mn(III) at neutral pore water pH under low dissolved $O_2$ concentrations. Dissolved $O_2$ concentrations have not been measured in this study, but the deepest measuring locations at WRS#4 are 2-3 m below the water table and

embedded in a mixture of waste rock and underlying peaty material which is disposed to $O_2$ consumption via aqueous sulfide oxidation as well as decomposition of organic carbon, making depletion of dissolved $O_2$ in the saturated zone probable. The general stability of the pore-water geochemistry in the unsaturated zone of WRS#4 may be attributed of the damaged cover, which ensures a stable, atmospheric pore-gas composition is available via advective gas transport. In turn the stable $O_2$ rich pore-gas ensures the ongoing, stable progression of sulfide oxidation.

The results of water chemistry analysis and speciation modeling indicate that WRS#3 and WRS#4 can be characterized as neutral mine drainage sites with low concentrations of dissolved metals. For example, Fe and Mn concentrations at WRS#3 and WRS#4 sometimes reach approximately 1.0 mg/L and 0.5 mg/L, respectively, in the saturated zoned underlying WRS#4. However, much higher concentrations of Fe and Mn are regularly encountered at neutral mine drainage sites. The Hitura tailings impoundement in Finland experiences seepage with Fe concentrations of approximately 3.4 - 163.0 mg/L and Mn concentrations of approximately 2.8 - 11.1 mg/L (Heikkinen et al., 2009). Effluent from a tailings pond at the Chambishi site in the Copperbelt of Zambia had Fe and Mn concentrations of 3 - 4 mg/L (Sracek et al., 2011). Fe concentrations in the tailings impoundement at the Agnico-Eagle gold mine in Joutel, Quebec were in excess of 20 mg/L (Blowes et al., 1998). Several other trace metals are often encountered at very high concentrations (compared to WRS#3 and WRS#4) in neutral drainage mine waste sites; Ni (Heikkinen et al., 2009; Lindsay et al., 2009; Blowes et al., 1998) and Zn (Lindsay et al., 2009; Blowes et al., 1998; Dockrey et al., 2014; Bay, 2004) have been measured at concentrations several orders of magnitude greater than those measured at WRS#3 and WRS#4.

The pore-water composition at WRS#3 and WRS#4 may be attributed to several factors: limited $O_2$ availability in the stockpiles due to the placement of the cover material, the stage of sulfide

weathering within the stockpiles, and the abundance of acid neutralizing minerals (*i.e.* carbonates) relative to acid generating minerals (*i.e.* sulfides). Limited availability of $O_2$ within the stockpiles (section 4.6.3) limits the release of dissolved metals as $O_2$ is the primary driver of sulfide oxidation at neutral pH. It is possible that both WRS#3 and WRS#4 were $O_2$ deficient before the initiation of this study. The atmospheric pore-gas concentrations at WRS#4 are likely a recent development as a result of the decimation of cover material, and it is probable that modest amounts of atmospheric air were introduced into both piles during instrument installations. Long-term monitoring of WRS#3 may reveal further $O_2$ depletion and $CO_2$ enrichment, conditions which would be indicative of the historic norm within these stockpiles. Another factor likely contributing to the overall high quality of drainage at WRS#3 and WRS#4 is the age of the stockpiles. Sulfide oxidation rates and acid generation are typically highest early in the life cycle of mine wastes due to the availability of unaltered sulfide grain surfaces within the waste rock (Langman et al., 2014). Finally, the relative abundance of acid neutralizing components compared to acid generating components within the Detour Lake waste rock (sections 2.6.1 and 4.6.1) has so far resulted in neutral pore-waters conducive to contaminant immobilization.

## 4.7 Summary and Conclusions

*In situ* monitoring of the Detour Gold historic waste-rock stockpiles has provided a broad understanding of the geochemical conditions controlling ARD in these decades-old stockpiles. The hydrology, thermal regime, gas transport and pore-water geochemical profiles of WRS#3 and WRS#4 have all been investigated. Overall the results strongly indicate that sulfide oxidation is occurring, however it seems that acidic mine drainage conditions have not set in after more than two decades of environmental exposure.

The hydrology of WRS#3 and WRS#4 are both similar, and typical of covered waste-rock stockpiles. Both stockpiles are mostly unsaturated; at WRS#3 the water table is found approximately 14.5 mBGS, at WRS#4 the water table is found approximately 22.0-23.0 mBGS. The relatively fine-grained cover material overlying the stockpiles has a residual moisture content of approximately 10 vol. %, while residual moisture content in the matrix waste rock is closer to 5 vol. %. The shallower waste rock material is frequently saturated (20-25 vol. %) by the passage of wetting fronts in response to precipitation events but quickly returns to residual moisture content. Mid-depth (~10.0 mBGS to water table) waste rock is influenced by capillary forces which maintain the moisture content above residual levels, while the wetting front response at mid-depth is more subdued.

The temperature profiles generated for WRS#3 and WRS#4 have provided several insights to the thermal regime of these stockpiles. The waste rock stockpiles remain > 0 ˚C throughout the year, with only the outer cover freezing over seasonally. Sulfide oxidation may be suspended under frozen conditions but this does not occur throughout the depth of WRS#3 and WRS#4. Subsurface temperatures fluctuate seasonally with increasing time lag at greater depth. Measurements near the exposed flanks of WRS#4 equilibrate more rapidly to atmospheric temperature with less time lag, indicating that the cover material insulates the stockpiles. However below ~15.0 mBGS temperatures are steady throughout the year at 2-5 ˚C. In addition, the average subsurface temperature is several degrees warmer than the mean annual air temperature of ~0.9 ˚C throughout both WRS#3 and WRS#4, likely due to heat introduced during the borehole installations.

The results of air-permeability testing indicate that the gas transport regimes of the Detour Gold waste-rock stockpiles are dynamic with significant diffusive and advective components. At

WRS#3 the average air-permeability coefficient of the cover material was approximately $3.2x10^{-11}$ $m^2$. This result indicates that gas transport through the cover material is primarily diffusive, as advective flow becomes secondary to diffusion in materials with air-permeability coefficients below $10^{-10}$ $m^2$ (Amos et al., 2014; Pantelis and Ritchie, 1992). Average air-permeability coefficients measured in the waste rock of WRS#3 and WRS#4 ranged from $8.5 \times 10^{-11}$ $m^2$ to $9.2 \times 10^{-09}$ $m^2$, well in the range of observed permeability coefficients in comparable waste rock stockpiles (Amos et al., 2014). A slightly positive correlation between air-permeability coefficients and depth was also observed, due to the effects of particle size segregation and the accumulation of large boulders near the base of the piles. The relative contribution of diffusion and advection to gas transport and the importance of the cover material in restricting air flow is well illustrated by the pore-gas compositions measured in the stockpiles.

At WRS#3 pore gas $O_2$ is depleted with increasing distance from the stockpiles covered surface. This gradient demonstrates the predicted behaviour for diffusive gas transport in low-permeability waste rock (Pantelis and Ritchie, 1992). In contrast $CO_2$ concentrations in WRS#3 are increasingly enriched with distance from the surface. $O_2$ depletion and $CO_2$ enrichment are significant evidence of ongoing sulfide oxidation and acid neutralization at WRS#3.

At WRS#4 decimation of the soil cover across much of the pile has exposed the flanks to wind induced pressure gradients leading to direct advective air flow. The result is atmospheric $O_2$ and $CO_2$ pore gas concentrations throughout WRS#4 which are in contrast to the generally $O_2$ depleted and $CO_2$ enriched environment of WRS#3. The absence of $O_2$ depletion and $CO_2$ enrichment at WRS#4 does not suggest that sulfide oxidation is not occurring there, but rather indicates that advective $O_2$ transport into the stockpile and $O_2$ depletion due to sulfide oxidation

within the stockpile are at equilibrium. The pore water composition at WRS#3 and WRS#4 provide further evidence that sulfide oxidation is ongoing in both stockpiles.

Elevated concentrations of sulfate have been measured consistently throughout the unsaturated zones of WRS#3 and WRS#4, providing evidence of sulfide oxidation. Major cation concentrations are also elevated indicating that dissolution of gangue minerals has taken place. Depletion of alkalinity in the unsaturated zone and neutral pore water pH throughout point to the neutralization of the acidity generated through sulfide oxidation. Dissolved metal (Cu, Ni, Zn, As, Pb, etc.) concentrations remain low (< 100 µg/L) which suggests there is a solid phase control for these metals. Iron and manganese also have low aqueous concentration throughout the unsaturated zone, but are slightly elevated (frequently > 200 µg/L) in the saturated zone. Elevated Fe and Mn are attributed to the slightly more reducing conditions in the saturated zone, likely due to a depletion of dissolved $O_2$. The absence of dissolved $O_2$ would result in increased concentrations of the more soluble Fe(II) and Mn(III) species. Although the oxidation of sulfide minerals is observed in WRS#3 and WRS#4, the neutral pH pore-water contains lower concentrations of dissolved metals when compared to other neutral mine drainage sites. The presence of the thin soil cover and the abundance of carbonate minerals may have contributed to the low concentrations of dissolved metals.

Removal of metals from the dissolved phase throughout the stockpiles is achieved through the precipitation of various secondary minerals. The pore-waters throughout WRS#3 and WRS#4 were supersaturated with respect to several iron and aluminum oxides, notably $Fe(OH)_{3(a)}$, goethite, gibbsite and diaspore. Supersaturation of these secondary minerals common to ARD environments (Shum and Lavkulich, 1999) suggests they are precipitating and providing a solid phase control on Fe and Mn solubility. Undersaturation with respect to several other secondary

copper, nickel and zinc minerals throughout most of WRS#3 and WRS#4 is an indication that these minerals are not forming. Solubility control of aqueous copper, nickel and zinc concentrations is likely achieved through adsorption or complexation to secondary iron minerals. The pore-water of WRS#3 and WRS#4 were also found to be saturated throughout with respect to several carbonate minerals, notably calcite and dolomite. Saturation with respect to these minerals is an indication of their earlier dissolution to counteract acid generation through sulfide oxidation. Several sulfate minerals were also found to be near saturation (*e.g.* gypsum) which provide solid phase controls on sulfate concentrations in the vadose zone.

Overall the remaining historic waste-rock stockpiles at the Detour Lake mine site are characterized by neutral mine drainage. Both piles are characterized by elevated sulfate and slightly elevated trace metal concentrations typical of acid rock drainage, however pH buffering through dissolution of carbonate minerals has hitherto delayed the onset of acidic conditions. Trace metal mobility is limited within the unsaturated waste rock due to the precipitation of secondary minerals – especially iron (oxy)hydroxides. The depletion of $O_2$ in WRS#3 provides an additional indication of sulfide oxidation. At WRS#4 the damaged cover has resulted in atmospheric gas concentrations, which has likely enhanced sulfide oxidation in this stockpile as indicated by higher concentrations of contaminants at WRS#4 – especially sulfate.

## Tables

***Table 4.1: Mineral Composition of WRS#4 Waste Rock – XRD Results***

| ***Sample I.D.*** | ***P4-P5-S1*** | ***P4-P5-S2*** | ***P4-P7-S2*** | ***WRS#4 Average*** |
|---|---|---|---|---|
| ***Depth*** | < 5 m | < 5 m | < 5 m | - |
| ***Oxidation Level*** | Very High | Low | Low | - |
| ***Paste pH*** | 4.9 | 6.7 | 7.7 | - |
| ***Quartz*** <br> ***SiO2*** | 16 | 18 | 9 | 14.3 |
| ***Vermiculite*** <br> $(Mg^{2+},Fe^{2+},Fe^{3+})_3(AlSi)_4O_{10}](OH)_2*4H_2O$ | 5 | 8 | 13 | 8.7 |
| ***Biotite, manganoan*** <br> $K(Mg,Fe)_3(AlSi_3O_{10})(F,OH)_2$ | 6 | 5 | 4 | 5 |
| ***Anorthite*** <br> $CaAl_2Si_2O_8$ | 30 | 27 | 25 | 27.3 |
| ***Clinochlore*** <br> $(Mg_5Al)(AlSi_3O_{10}(OH)_8$ | 7 | 5 | 20 | 10.7 |
| ***Albite low, calcian*** <br> $NaAlSi_3O_8$ | 14 | 20 | 10 | 14.7 |
| ***Horneblend, magnesian*** <br> $Ca_2(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH)_2$ | 21 | 16 | 17 | 18 |
| ***Pyrrhotite*** <br> $Fe_{1-x}S$ | 1 | 0 | 2 | 1 |

***Table 4.2: Carbon, Sulfur and ABA Results (Minimum-Maximum [Average])***

| | ***Carbon (wt. %)*** | ***Sulfur (wt. %)*** | ***Neutralization Potential, NP (kg $CaCO_3$/tonne)*** | ***Acid Production Potential, APP (kg $CaCO_3$/tonne)*** | ***Net Neutralization Potential, NNP*** | ***Neutralization Potential Ratio, NPR*** |
|---|---|---|---|---|---|---|
| ***WRS#3 Drill Cuttings*** | 0.4 - 2.5 (1) | 0.05 - 0.4 (0.1) | 35.9 - 210.2 (83.9) | 1.4 - 14.9 (4) | 2.8 - 29.9 (79.9) | 23.4 - 208.5 (42.8) |
| ***WRS#3 Cover*** | 0.4 - 1.5 (0.7) | 0.02 - 0.1 (0.05) | 35.1 - 125 (61.6) | 0.5 - 4.6 (1.4) | 34.5 - 124.1 (60.2) | 9.2 - 149.7 (68.8) |
| ***WRS#4 Drill Cuttings*** | 0.1 - 0.9 (0.5) | 0 - 1.9 (0.7) | 16.3 - 74.7 (46.9) | 0.9 - 61.2 (23.5) | 1.8 - 122.5 (23.3) | 1.7 - 70 (6.7) |
| ***WRS#4 Profile Excavation*** | 0.03 - 1.4 (0.4) | 0 - 1.6 (0.6) | 2.4 - 124.3 (35.2) | 0.9 - 51.5 (20.6) | -42.2 - 120.5 (14.5) | 0.1 - 74.4 (10.4) |

***Table 4.3: X-Ray Fluorescence Results – Minimum-Maximum (Average) of WRS#3 and WRS#4 Cover, Drill Cutting (DC) and Profile Excavation (PE) Sample***

| *Analyte (Unit)* | *WRS#3 Cover* | *WRS#3 DC* | *WRS#4 DC* | *WRS#4 PE* |
|---|---|---|---|---|
| SiO2 (%) | 62 – 64 (63) | 55 – 70 (65) | 53 – 67 (60) | 52 – 65 (57) |
| MgO (%) | 2 – 3 (3) | 2 – 7 (3) | 2 – 23 (9) | 2 – 25 (8) |
| Fe2O3 (%) | 2.9 – 4 (3.4) | 3 – 12 (5) | 3 – 14 (9) | 3 – 13 (9) |
| Al2O3 (%) | 8.9 – 10 (10) | 9 – 12 (10) | 7 – 12 (11) | 7 – 12 (10) |
| CaO (%) | 4 – 5 (5) | 4 – 13 (7) | 3 – 10 (6) | 3 – 9 (7) |
| Na2O (%) | 2 – 3 (2) | 1.7 - 3.8 (3) | 0.6 - 3.2 (2.1) | 0.2 - 3.1 (1.7) |
| S (%) | 0 – 0.1 (0) | 0.03 – 0.47 (0.17) | 0.04 – 2.06 (0.71) | 0.04 – 1.63 (0.66) |
| K2O (%) | 1.8 – 2.1 (1.9) | 1 - 2.2 (1.8) | 0.4 - 1.8 (1.1) | 0.4 - 1.9 (1.1) |
| MnO (%) | 0 – 0 (0) | 0 - 0.1 (0) | 0 - 0.1 (0.1) | 0 - 0.1 (0.1) |
| Cr (ppm) | 111 – 158 (131) | 126 – 291 (182) | 141 – 1881 (567) | 109 – 1922 (421) |
| Cu (ppm) | 25 – 162 (46) | 27 – 185 (70) | 38 – 742 (245) | 28 – 599 (232) |
| Ni (ppm) | 27 – 51 (32) | 23 – 79 (42) | 41 – 552 (169) | 31 – 369 (108) |
| Zn (ppm) | 23 – 36 (30) | 21 – 87 (41) | 33 – 95 (65) | 34 – 114 (67) |
| Pb (ppm) | 13 - 14 (13) | 7 – 13 (12) | 6 – 13 (10) | 7 – 13 (10) |

***Table 4.4: Depth to Ground Water (mBGS) at WRS#3 and WRS#4, 2012-2014***

| *Date* | *BH3-1* | *BH3-2* | *BH4-2* | *BH4-3* | *BH4-4* | *BH4-5* |
|---|---|---|---|---|---|---|
| ***July, 2012*** | 15.2 | 15.2 | 21.9 | 23.5 | dry | 22.7 |
| ***August, 2012*** | 15.7 | - | 21.8 | 23.5 | dry | 22.7 |
| ***September, 2012*** | - | - | 21.9 | 23.5 | dry | 22.7 |
| ***October, 2012*** | 16.1 | 15.6 | 21.8 | 23.7 | dry | 22.5 |
| ***May, 2013*** | 16.5 | 16.2 | 21.6 | 23.8 | dry | 22.7 |
| ***June, 2013*** | 16.5 | 16.2 | 21.7 | 23.5 | dry | 22.7 |
| ***July, 2013*** | 16.4 | 16.2 | 21.8 | 23.5 | dry | 22.7 |
| ***September, 2013*** | 16.4 | 16.2 | 21.8 | 23.8 | dry | 22.7 |
| ***October, 2013*** | 16.4 | 16.1 | 21.8 | 23.5 | dry | 22.7 |
| ***May, 2014*** | 16.7 | 16.4 | 21.8 | 23.4 | dry | 22.7 |
| ***June, 2014*** | 16.7 | 16.5 | 21.8 | 23.3 | dry | 22.7 |
| ***July, 2014*** | 16.6 | 16.4 | 21.9 | 23.4 | dry | 22.7 |
| ***August, 2014*** | 14.9 | 14.5 | 21.9 | 23.5 | dry | 22.8 |
| ***September, 2014*** | 15.1 | 14.6 | 22.9 | 23.3 | dry | 22.7 |
| ***Maximum*** | 16.7 | 16.5 | 22.9 | 23.8 | - | 22.8 |
| ***Minimum*** | 14.9 | 14.5 | 21.6 | 23.3 | - | 22.5 |
| ***Total Change*** | 1.7 | 2.0 | 1.3 | 0.6 | - | 0.2 |

***Table 4.5: Results of Air Permeability Testing at WRS#3***

| *Location* | *Depth (m)* | *Number of readings* | *Average Coefficient of Air Permeability [$m^2$]* | *Standard Deviation of Air Permeability Coefficient [$m^2$]* |
|---|---|---|---|---|
| BH3-1 | 6.7 | 16 | $8.5 \times 10^{-11}$ | $2.3 \times 10^{-11}$ |
| | 11.7 | 19 | $9.8 \times 10^{-10}$ | $1.6 \times 10^{-09}$ |
| | 16.7 | 3 | $1.9 \times 10^{-09}$ | $2.2 \times 10^{-09}$ |
| BH3-2 | 7.5 | 17 | $1.3 \times 10^{-10}$ | $1.7 \times 10^{-10}$ |
| | 12.5 | 11 | $2.9 \times 10^{-10}$ | $7.7 \times 10^{-11}$ |
| | 17.5 | 2 | $5.5 \times 10^{-10}$ | $4.8 \times 10^{-10}$ |
| TP3-3 | 0.75 | 5 | $4.9 \times 10^{-11}$ | $7.3 \times 10^{-11}$ |
| TP3-4 | 0.65 | 6 | $2.0 \times 10^{-11}$ | $1.3 \times 10^{-11}$ |
| TP3-5 | 0.57 | 5 | $2.6 \times 10^{-11}$ | $1.1 \times 10^{-11}$ |

***Table 4.6: Results of Air Permeability Testing at WRS#4***

| ***Location*** | ***Depth (m)*** | ***Number of readings*** | ***Average Coefficient of Air Permeability [$m^2$]*** | ***Standard Deviation of Air Permeability Coefficient [$m^2$]*** |
|---|---|---|---|---|
| BH4-2 | 8.0 | 5 | $1.3 \times 10^{-09}$ | $6.6 \times 10^{-10}$ |
| | 13.0 | 4 | $4.0 \times 10^{-09}$ | $4.4 \times 10^{-09}$ |
| | 18.0 | 5 | $4.1 \times 10^{-09}$ | $6.5 \times 10^{-10}$ |
| BH4-3 | 7.5 | 3 | $7.9 \times 10^{-09}$ | $5.9 \times 10^{-09}$ |
| | 12.5 | 1 | $5.9 \times 10^{-09}$ | $2.4 \times 10^{-09}$ |
| | 17.5 | 2 | $2.4 \times 10^{-09}$ | $2.3 \times 10^{-09}$ |
| | 22.5 | 4 | $6.7 \times 10^{-09}$ | $2.3 \times 10^{-09}$ |
| BH4-4 | 4.3 | 6 | $3.7 \times 10^{-09}$ | $2.1 \times 10^{-09}$ |
| | 9.3 | 3 | $1.4 \times 10^{-09}$ | $5.1 \times 10^{-10}$ |
| | 14.3 | 3 | $6.8 \times 10^{-09}$ | $5.5 \times 10^{-09}$ |
| | 19.3 | 1 | $3.3 \times 10^{-09}$ | 0 |
| BH4-5 | 7.5 | 4 | $4.1 \times 10^{-09}$ | $3.1 \times 10^{-09}$ |
| | 12.5 | 3 | $9.2 \times 10^{-09}$ | $4.7 \times 10^{-09}$ |
| | 17.5 | 1 | $9.7 \times 10^{-10}$ | 0 |
| | 22.5 | - | - | - |

***Table 4.7: Average Saturation Index Calculated for Secondary Carbonate and Sulfate Minerals at WRS#3 and WRS#4***

| *Location* | *Depth (mBGS)* | *Calcite* | *Dolomite* | *Rhodochrosite* | *Gypsum* | *Jarosite* | *Barite* |
|---|---|---|---|---|---|---|---|
| | | $CaCO_3$ | $CaMgCO_3$ | $MnCO_3$ | $CaSO_4{:}2H_2O$ | $KFe_3(SO_4)_2(OH)_6$ | $BaSO_4$ |
| ***BH3-1*** | 4.2 | 1.52 | 3.20 | -3.13 | 0.27 | -0.94 | -7.62 |
| | 9.2 | 1.62 | 3.86 | -5.61 | -0.21 | -1.48 | -7.93 |
| | 14.2 | - | - | - | - | -1.62 | -9.78 |
| ***BH3-2*** | 5.0 | 1.25 | 2.11 | -3.57 | -0.30 | -0.98 | -7.30 |
| | 10.0 | 1.23 | 2.31 | -5.67 | -0.08 | -1.17 | -5.25 |
| | 15.0 | 1.26 | 2.22 | -3.53 | 0.18 | -0.82 | -5.95 |
| ***BH4-2*** | 5.5 | 0.54 | 0.65 | -5.55 | -1.48 | -0.54 | -4.86 |
| | 10.5 | 0.64 | 1.06 | -5.81 | -1.44 | -0.09 | -4.93 |
| | 15.5 | 0.54 | 0.88 | -6.11 | -2.05 | -0.10 | -6.34 |
| | 20.5 | 0.75 | 1.30 | -5.45 | -1.21 | -0.22 | -5.02 |
| | 25.5 | 0.87 | 1.58 | -0.89 | 0.09 | -1.01 | -2.41 |
| ***BH4-3*** | 5.0 | 0.57 | 1.15 | -4.32 | -1.45 | -0.09 | -6.60 |
| | 15.0 | 1.18 | 2.25 | -4.68 | -0.99 | -0.28 | -5.31 |
| | 20.0 | 0.78 | 1.17 | -6.26 | -1.15 | -0.92 | -4.48 |
| | 25.0 | 0.95 | 1.73 | -2.70 | 0.52 | -1.57 | -6.50 |
| ***BH4-4*** | 1.8 | 0.59 | 0.88 | -5.86 | -1.86 | -1.19 | -9.17 |
| | 6.8 | 0.45 | 0.58 | -4.89 | -2.00 | -0.17 | -4.37 |
| | 11.8 | 0.53 | 0.93 | -6.05 | -1.55 | -0.14 | -4.74 |
| | 16.8 | 0.51 | 0.91 | -5.89 | -0.62 | -0.11 | -5.69 |
| | 21.8 | 0.62 | 1.11 | -6.04 | -0.14 | -0.15 | -5.78 |
| ***BH4-5*** | 5.0 | 0.63 | 0.80 | -5.08 | -2.14 | -0.26 | -5.44 |
| | 10.0 | 0.80 | 1.28 | -7.54 | -1.27 | -0.13 | -6.90 |
| | 15.0 | 0.65 | 1.27 | -5.60 | -1.44 | -0.11 | -6.56 |
| | 20.0 | 1.00 | 2.03 | -4.29 | -0.52 | -0.21 | -7.15 |
| | 25.0 | 0.86 | 1.58 | -3.57 | -0.24 | -1.03 | -6.68 |

***Table 4.8: Average Saturation Index Calculated for Secondary Iron and Aluminum Minerals at WRS#3 and WRS#4***

| *Location* | *Depth (mBGS)* | *Fe(III) Hydroxide* | *Goethite* | *Hematite* | *Gibbsite* | *Boehmite* | *Diaspore* |
|---|---|---|---|---|---|---|---|
| | | $Fe(OH)_3$ | $\alpha FeOOH$ | $\alpha$-$Fe_2O_3$ | $Al(OH)_3$ | $\gamma$-$AlO(OH)$ | $\alpha$-$AlO(OH)$ |
| ***BH3-1*** | 4.2 | 0.48 | 6.37 | 14.75 | -2.50 | -2.97 | -1.27 |
| | 9.2 | 0.81 | 6.70 | 15.41 | 0.22 | -0.26 | 1.45 |
| | 14.2 | 1.03 | 6.92 | 15.84 | 0.49 | 0.02 | 1.72 |
| ***BH3-2*** | 5.0 | 0.33 | 6.22 | 14.45 | 0.03 | -0.44 | 1.26 |
| | 10.0 | 0.61 | 6.50 | 15.02 | -0.18 | -0.65 | 1.05 |
| | 15.0 | 0.92 | 6.82 | 15.64 | 0.49 | 0.01 | 1.72 |
| ***BH4-2*** | 5.5 | 1.16 | 7.05 | 16.11 | -0.27 | -0.74 | 0.96 |
| | 10.5 | 0.82 | 6.71 | 15.43 | -0.70 | -1.17 | 0.53 |
| | 15.5 | 0.50 | 6.39 | 14.80 | -0.64 | -1.11 | 0.59 |
| | 20.5 | 0.95 | 6.84 | 15.69 | -0.61 | -1.08 | 0.63 |
| | 25.5 | 1.89 | 7.78 | 17.56 | -0.59 | -1.07 | 0.64 |
| ***BH4-3*** | 5.0 | 0.19 | 6.08 | 14.17 | -1.42 | -1.89 | -0.19 |
| | 15.0 | 1.10 | 6.99 | 15.98 | -0.67 | -1.14 | 0.56 |
| | 20.0 | 1.79 | 7.68 | 17.38 | 0.29 | -0.18 | 1.52 |
| | 25.0 | 1.32 | 7.21 | 16.42 | -0.63 | -1.11 | 0.60 |
| ***BH4-4*** | 1.8 | 0.51 | 6.40 | 14.80 | -1.47 | -1.95 | -0.24 |
| | 6.8 | 0.41 | 6.30 | 14.60 | -0.74 | -1.22 | 0.49 |
| | 11.8 | 0.89 | 6.78 | 15.57 | -1.07 | -1.55 | 0.16 |
| | 16.8 | 0.49 | 6.38 | 14.77 | 0.11 | -0.36 | 1.34 |
| | 21.8 | 0.50 | 6.39 | 14.80 | -0.78 | -1.25 | 0.46 |
| ***BH4-5*** | 5.0 | 0.81 | 6.71 | 15.42 | -0.76 | -1.23 | 0.48 |
| | 10.0 | 0.35 | 6.24 | 14.50 | -2.57 | -3.04 | -1.34 |
| | 15.0 | 0.44 | 6.33 | 14.67 | -1.78 | -2.26 | -0.55 |
| | 20.0 | 0.59 | 6.48 | 14.98 | -1.02 | -1.49 | 0.21 |
| | 25.0 | 0.92 | 6.82 | 15.64 | -1.23 | -1.71 | 0.00 |

***Table 4.9: Average Saturation Index Calculated for Secondary Zinc, Copper and Nickel Minerals at WRS#3 and WRS#4***

| Location | Depth (mBGS) | Zincite | $Zn(OH)_2$ | Azurite | Brochantite | Malachite | $Ni(OH)_2$ |
|---|---|---|---|---|---|---|---|
| | | $ZnO$ | - | $Cu_3(OH)_2(CO_3)_2$ | $Cu_4(OH)_6SO_4$ | $Cu_2(OH)_2CO_3$ | - |
| BH3-1 | 4.2 | -5.15 | -6.46 | -4.90 | -9.58 | -2.68 | -4.47 |
| | 9.2 | -2.26 | -3.57 | -6.18 | -11.67 | -3.49 | -3.71 |
| | 14.2 | 0.59 | -0.72 | - | -10.38 | - | -1.27 |
| BH3-2 | 5.0 | -3.08 | -4.39 | -5.53 | -9.94 | -1.41 | -4.01 |
| | 10.0 | -2.84 | -4.15 | -6.51 | -12.08 | -2.14 | -4.61 |
| | 15.0 | -3.75 | -5.06 | -5.47 | -10.08 | -1.43 | -4.83 |
| BH4-2 | 5.5 | -2.79 | -4.10 | -6.52 | -8.92 | -3.47 | -3.15 |
| | 10.5 | -2.60 | -3.91 | -7.65 | -9.57 | -4.12 | -3.11 |
| | 15.5 | -3.04 | -4.36 | -7.68 | -9.34 | -4.08 | -4.11 |
| | 20.5 | -3.24 | -4.55 | -6.20 | -8.46 | -3.26 | -4.36 |
| | 25.5 | -4.80 | -6.11 | -9.02 | -15.04 | -5.57 | -6.32 |
| BH4-3 | 5.0 | -3.07 | -4.38 | -7.12 | -9.16 | -3.85 | -2.85 |
| | 15.0 | -1.67 | -2.98 | -8.55 | -13.80 | -4.76 | -3.51 |
| | 20.0 | -0.62 | -1.93 | -4.09 | -5.54 | -1.70 | -1.42 |
| | 25.0 | -4.61 | -5.92 | -6.55 | -12.37 | -3.80 | -6.42 |
| BH4-4 | 1.8 | -2.96 | -4.27 | -6.08 | -8.19 | -3.03 | -3.68 |
| | 6.8 | -3.04 | -4.35 | -7.00 | -8.88 | -3.76 | -3.97 |
| | 11.8 | -2.39 | -3.70 | -7.89 | -9.87 | -4.30 | -2.61 |
| | 16.8 | -3.09 | -4.40 | -7.22 | -9.27 | -3.86 | -2.40 |
| | 21.8 | -2.87 | -4.18 | -7.28 | -10.13 | -3.94 | -3.30 |
| BH4-5 | 5.0 | -4.22 | -5.53 | -5.49 | -7.05 | -2.73 | -3.80 |
| | 10.0 | -2.24 | -3.55 | -7.90 | -10.30 | -4.33 | -3.86 |
| | 15.0 | -2.51 | -3.82 | -9.21 | -11.43 | -5.10 | -3.33 |
| | 20.0 | -1.94 | -3.25 | -6.95 | -9.58 | -3.65 | -3.29 |
| | 25.0 | -3.85 | -5.16 | -7.47 | -12.00 | -4.31 | -5.90 |

## Figures

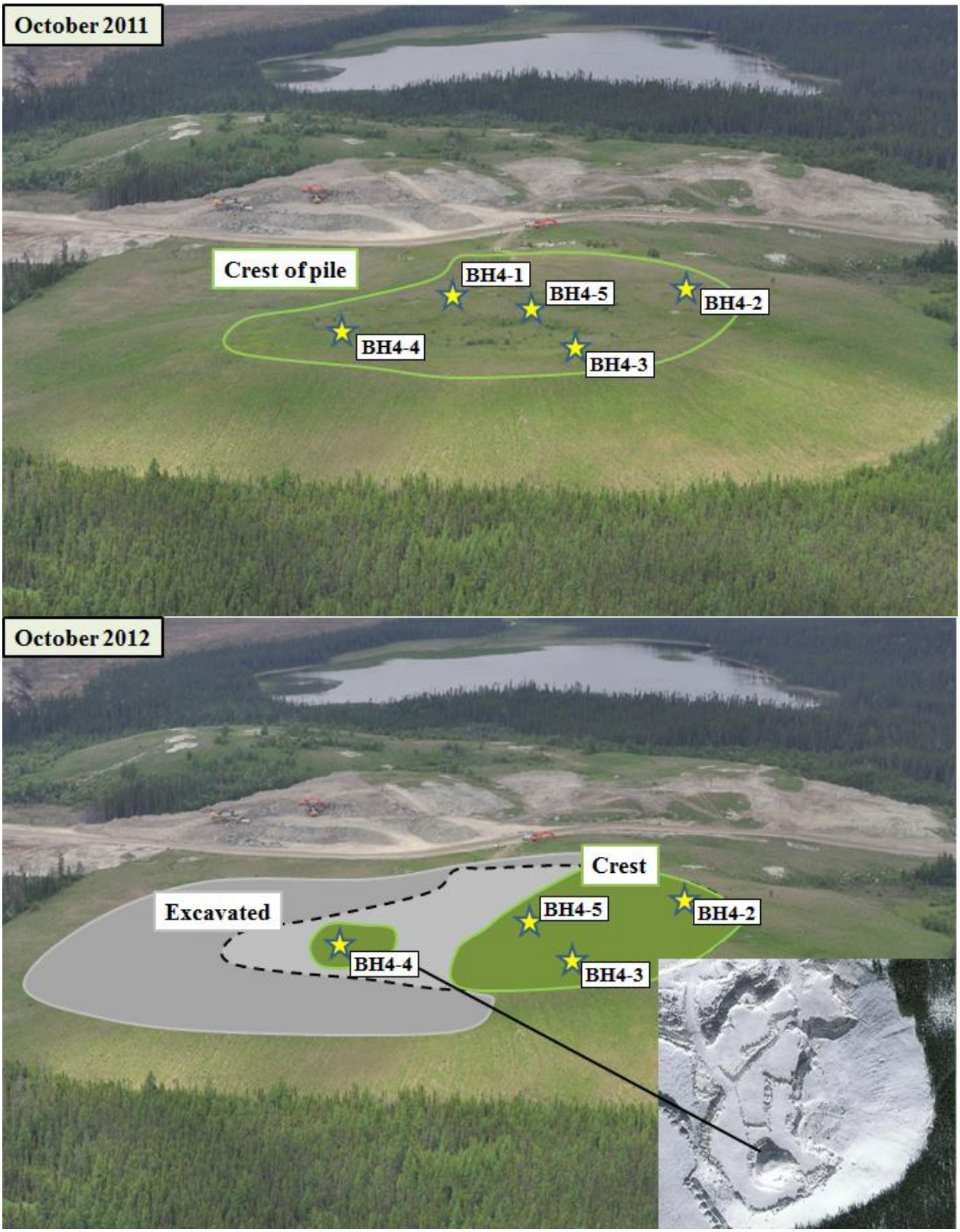



***Figure 4.1: Extent of Excavation at WRS#4 and Location of Remaining Instrumented Boreholes***

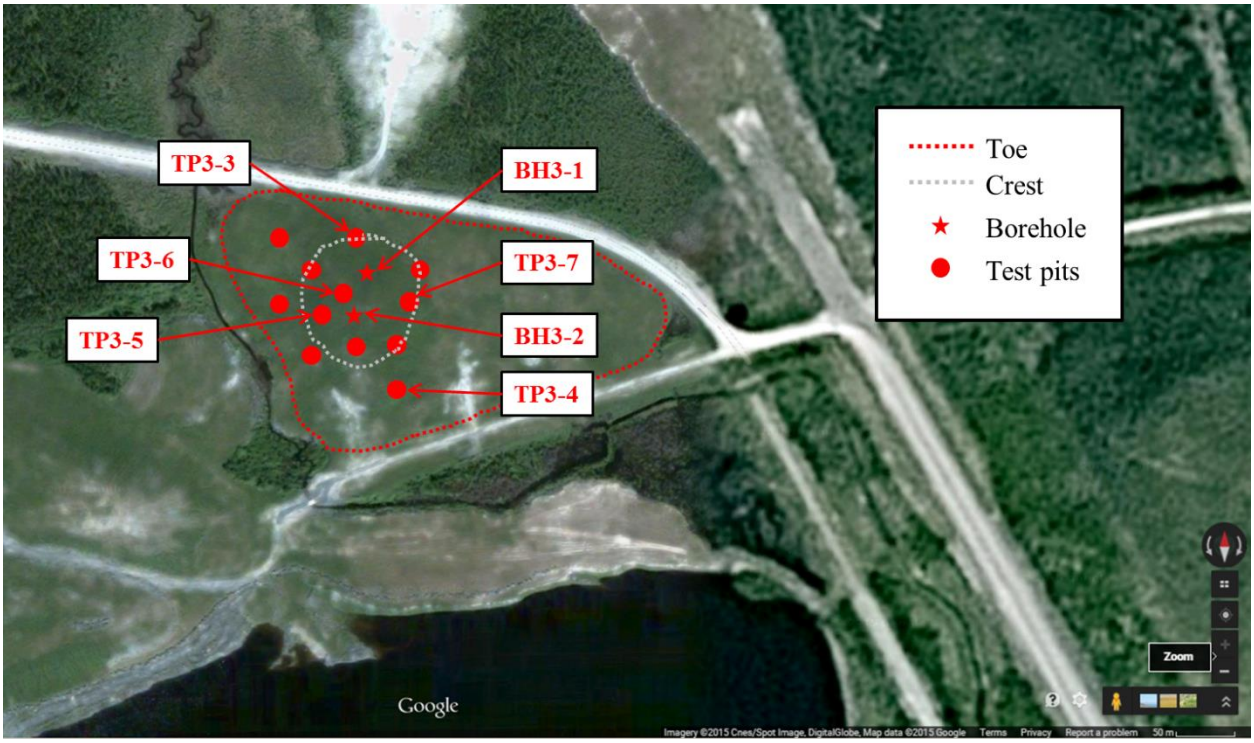



***Figure 4.2: Approximate Location of Instrumented Boreholes (BH3-1 and BH3-2) and Test Pits (TP3-3, TP3-4, TP3-5, TP3-6 and TP3-7) at WRS#3 (modified from Google Maps, 2015)***

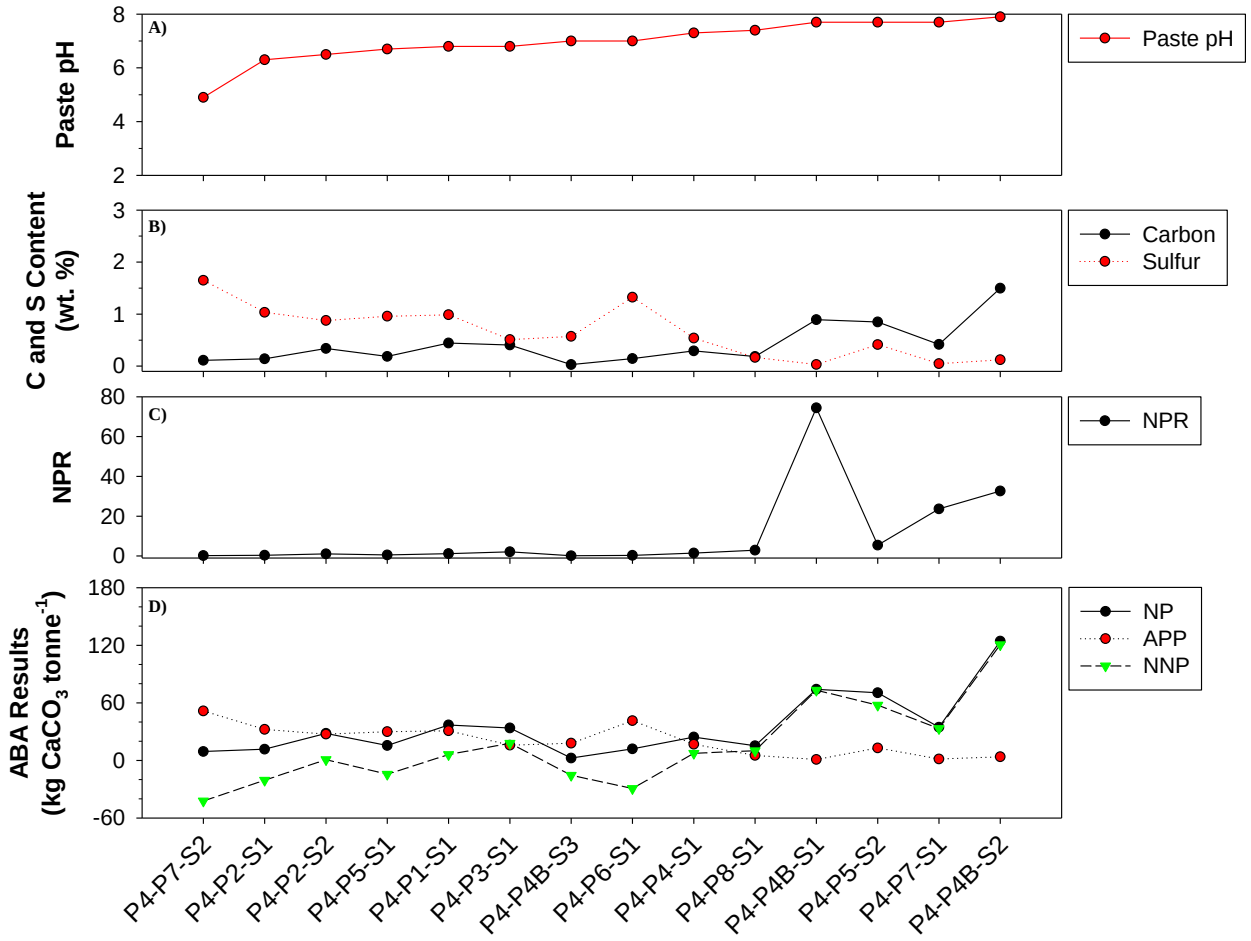



***Figure 4.3: Results of ABA – WRS#4 Excavation Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) Plotted in Order of Increasing pH***

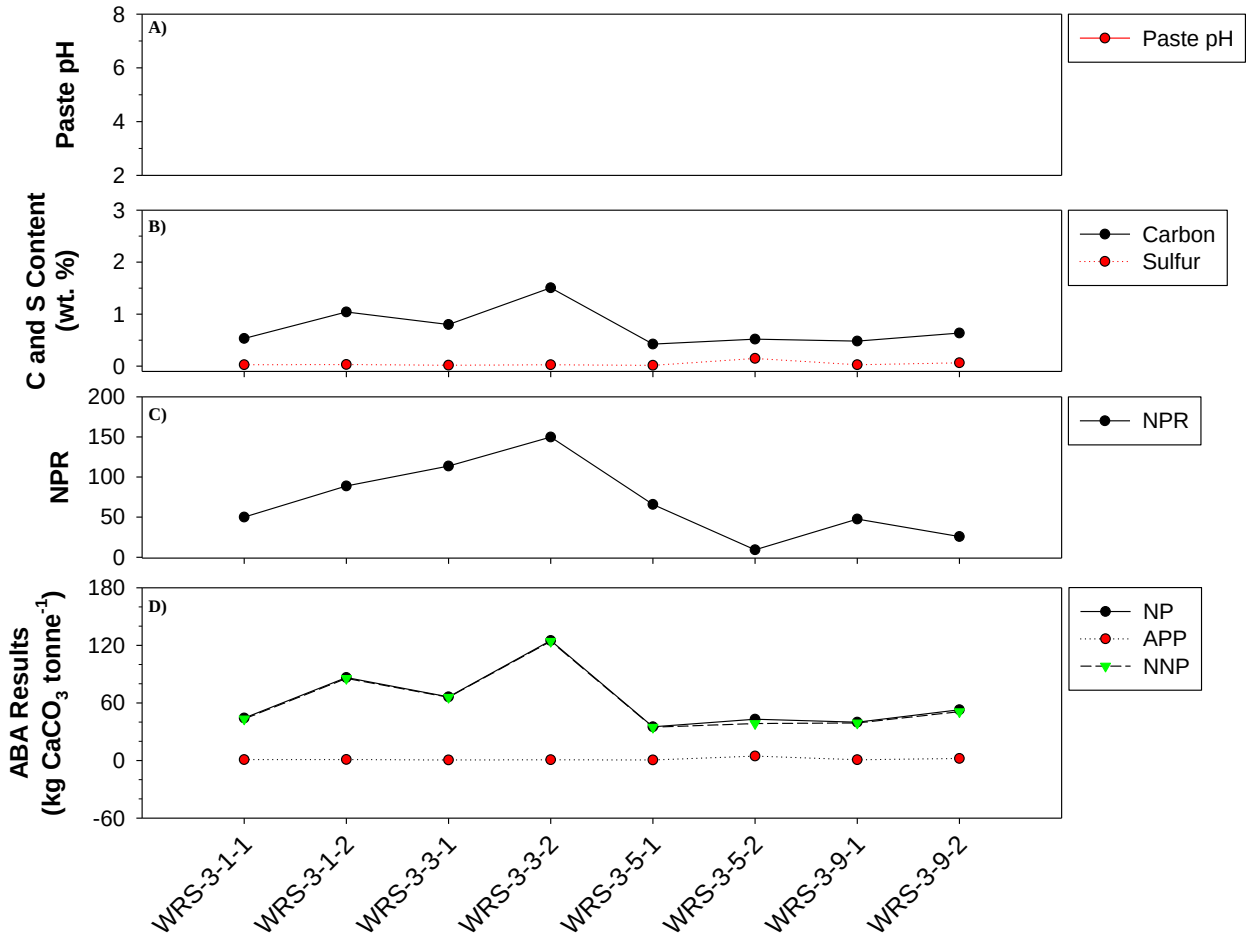



***Figure 4.4: Results of ABA – WRS#3 Cover Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) Plotted in Order of Increasing pH***

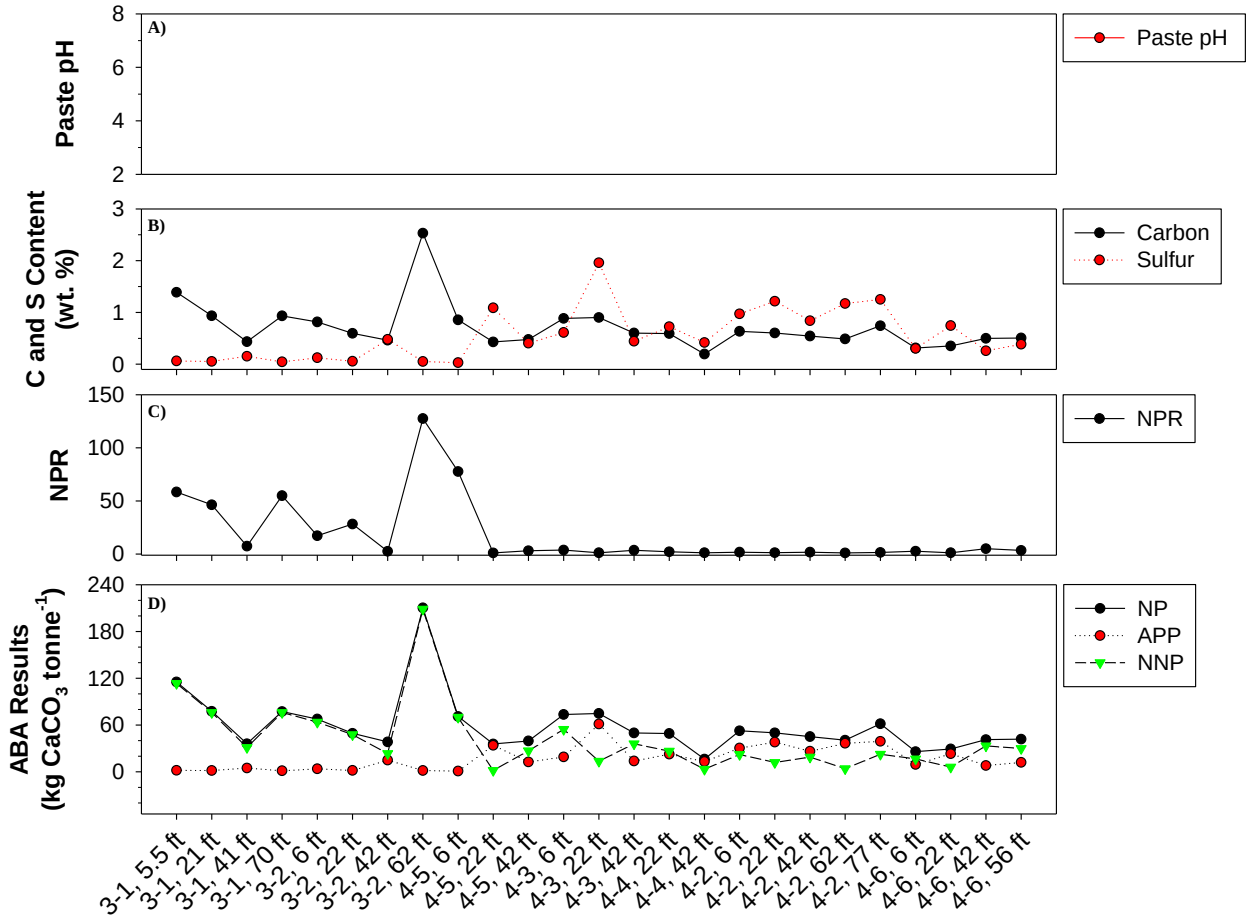



***Figure 4.5: Results of ABA – WRS#3 and WRS#4 Drill Cutting Samples: A) Paste pH, B) Carbon/Sulfur Content, C) Neutralization Potential Ratio (NPR), D) Neutralization, Acid Production, and Net Neutralization Potentials (NP, APP, NNP) Plotted in Order of Increasing pH***

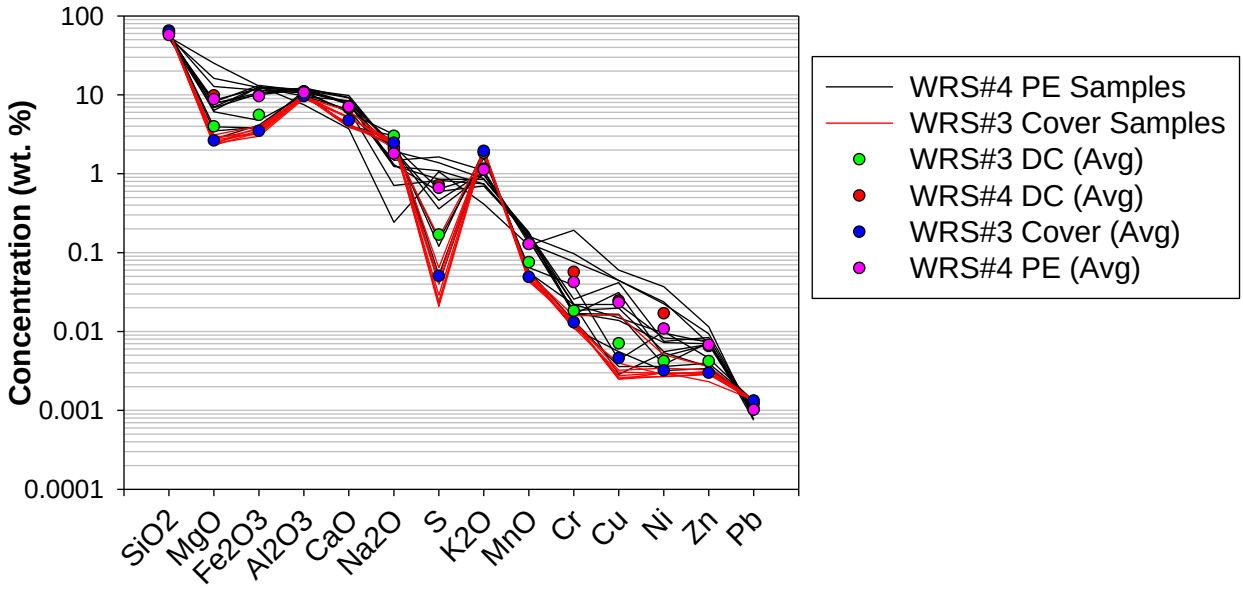



***Figure 4.6: X-Ray Fluorescence Results – WRS#4 Waste Rock (Black) from Profile Excavation (PE), WRS#3 Cover (Red) and Drill Cutting (DC) Samples***

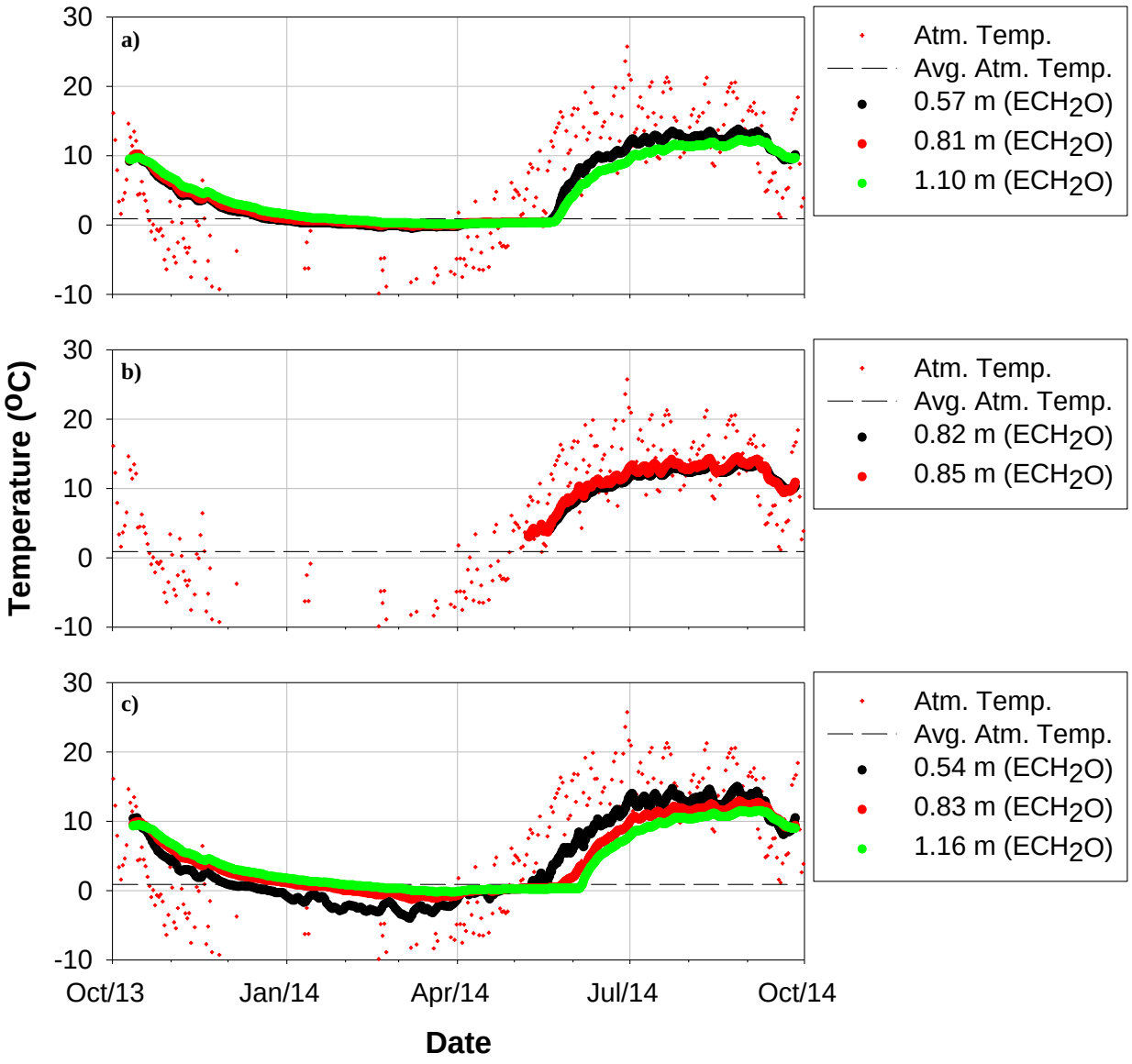



***Figure 4.7: Thermal Profile of WRS#3 Cover at Locations a) TP3-3, b) TP3-4 and c) TP3-5***

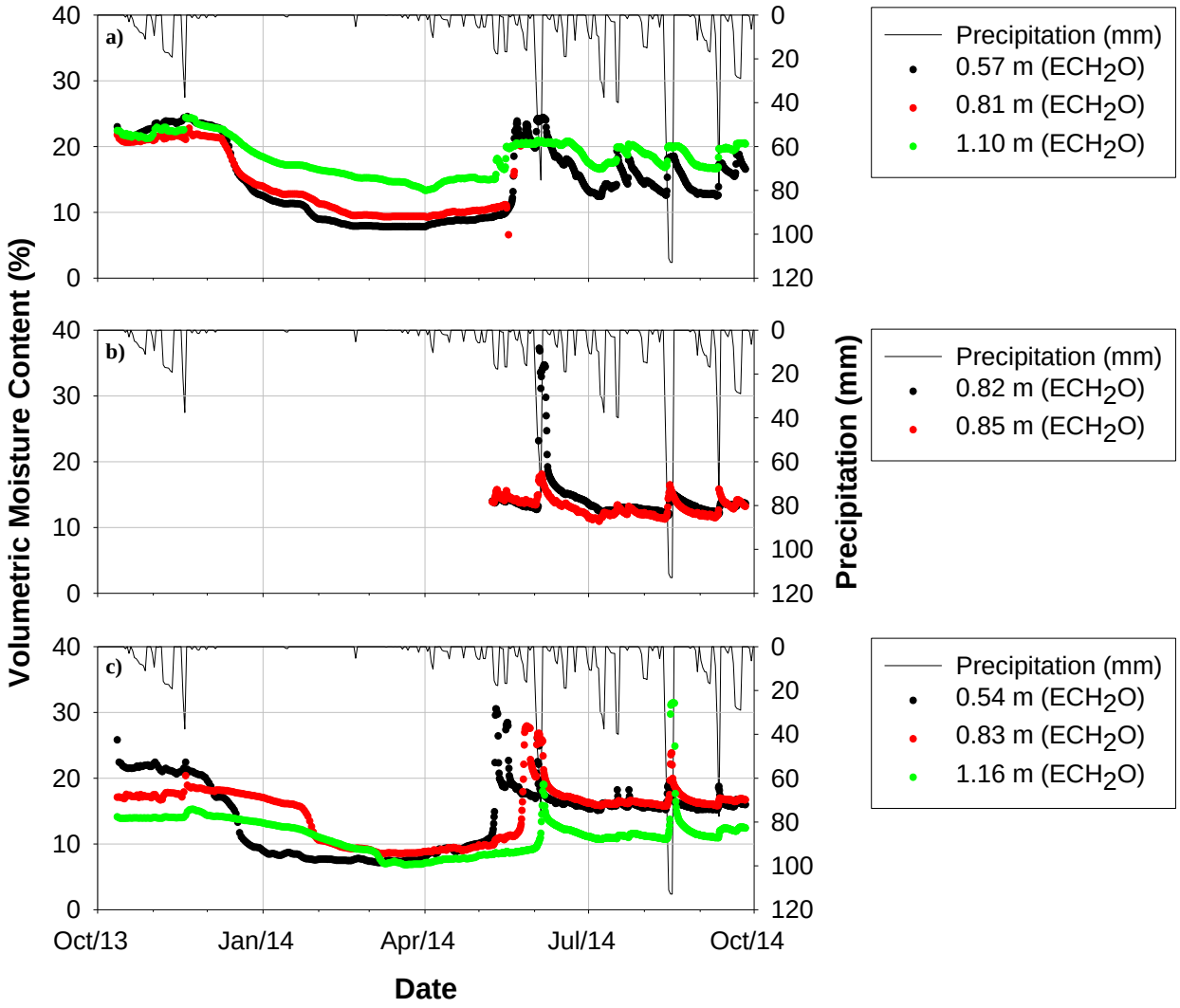



***Figure 4.8: Hydrological Profile of WRS#3 Cover at Locations a) TP3-3, b) TP3-4 and c) TP3-5***

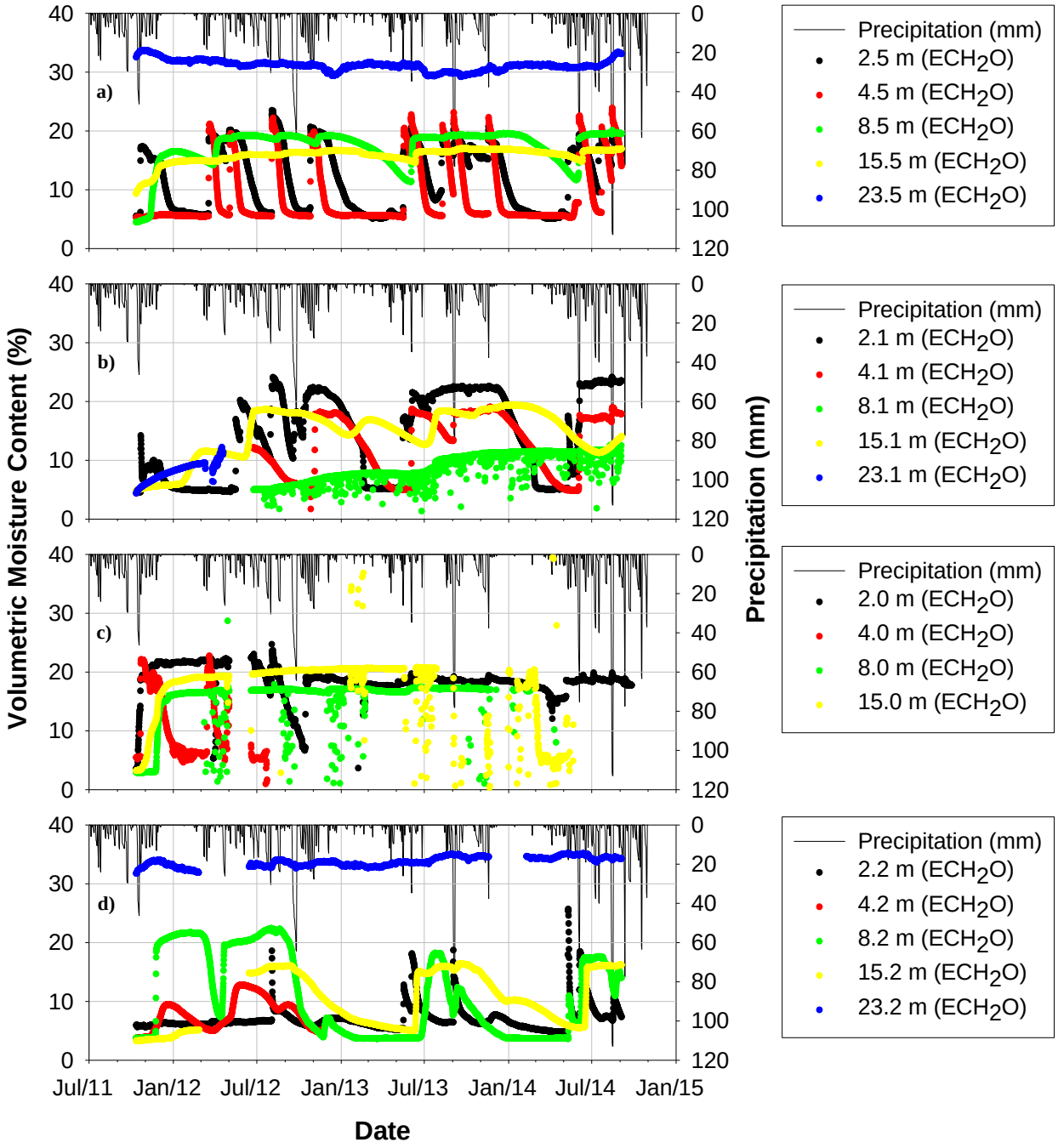



***Figure 4.9: Hydrological Profile of WRS#4 at Locations a) WRS4-2, b) WRS4-3, c) WRS4-4 and d) WRS4-5***

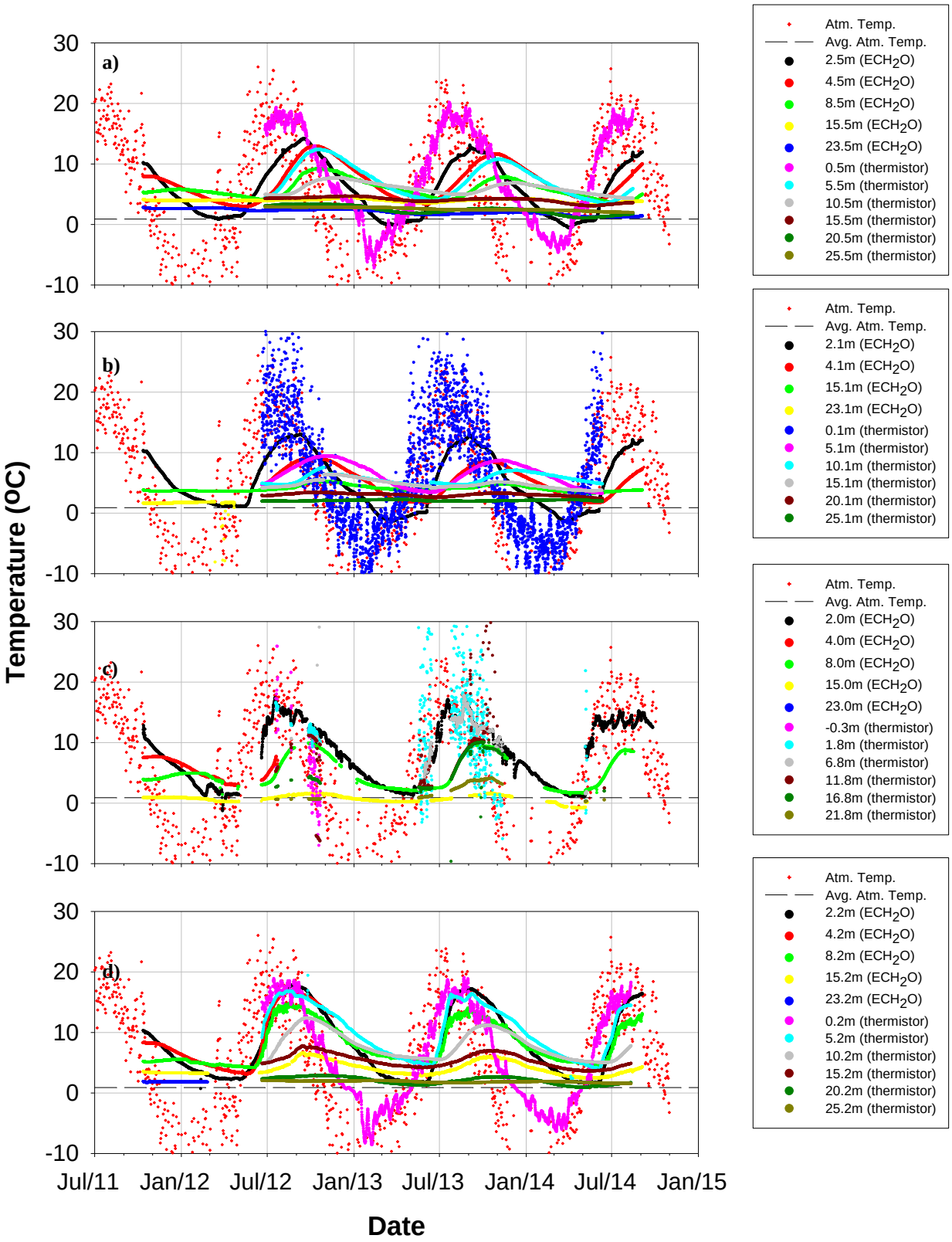



***Figure 4.10: Thermal Profile of WRS#4 at Locations a) WRS4-2, b) WRS4-3, c) WRS4-4 and d) WRS4-5***

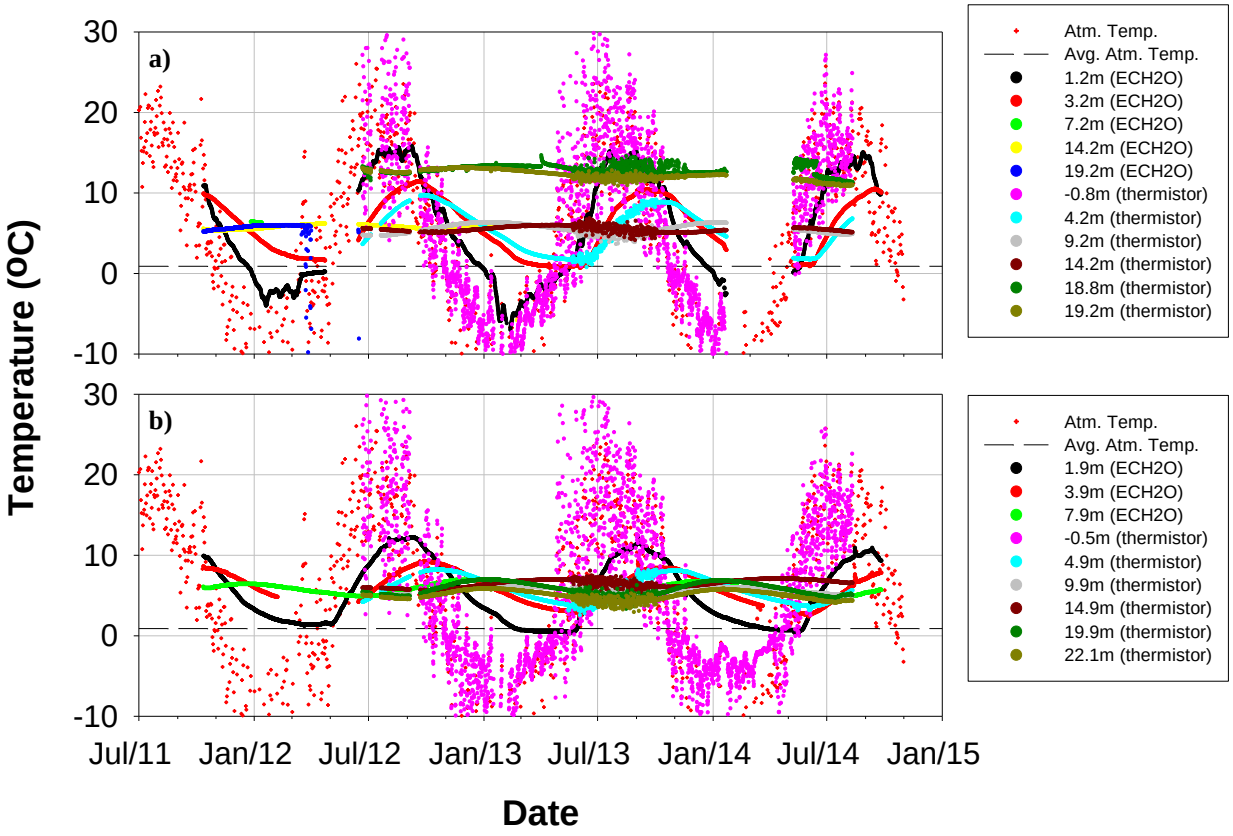



***Figure 4.11: Thermal Profile of WRS#3 at Locations a) BH3-1 and b) BH3-2***

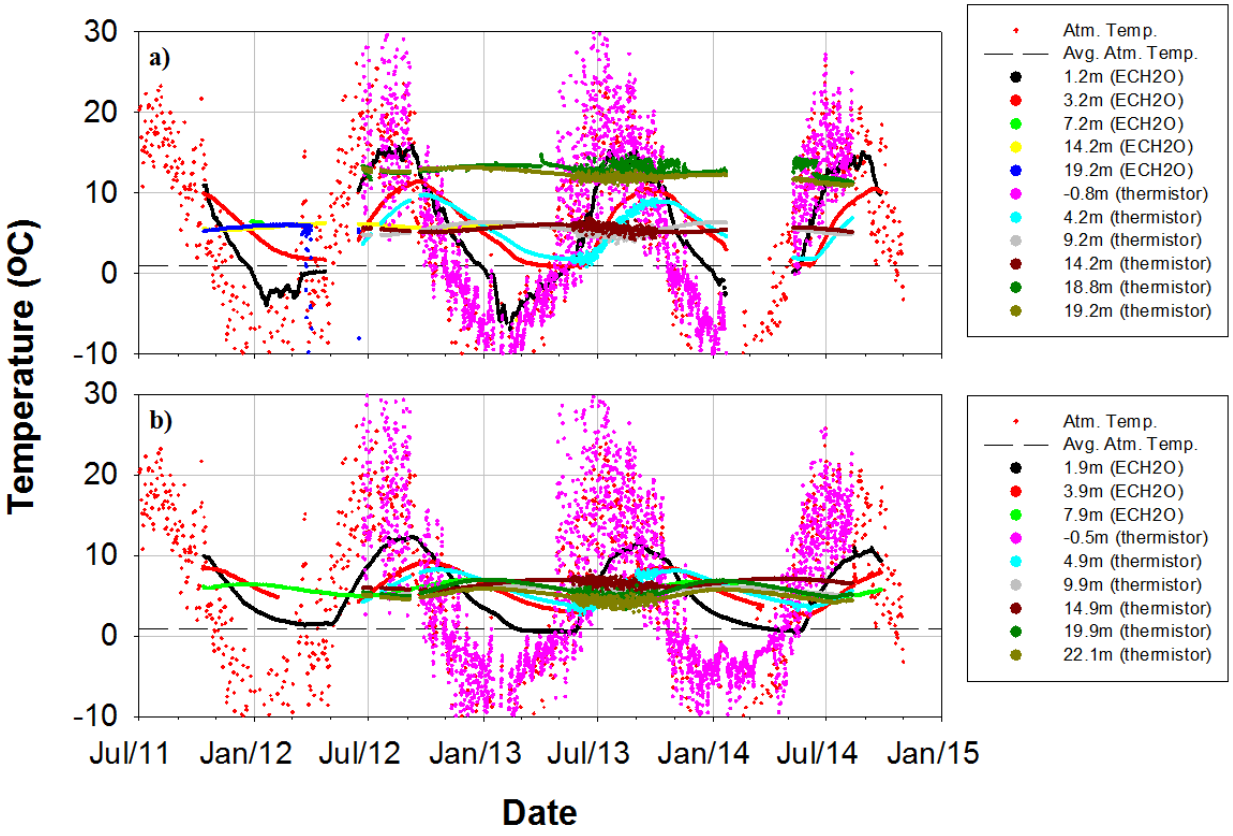



***Figure 4.12: Hydrological Profile of WRS#3 at Locations a) BH3-1 and b) BH3-2***

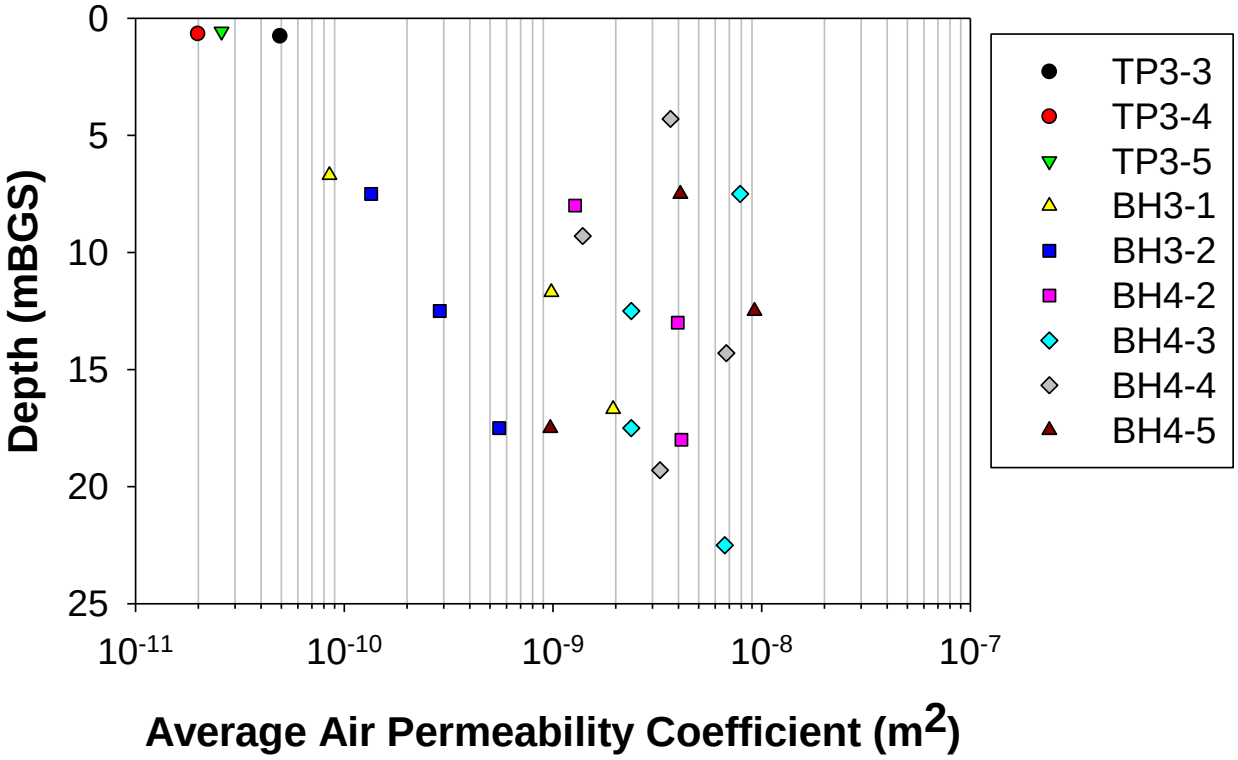



***Figure 4.13: Average Air Permeability Coefficients at WRS#3 and WRS#4***

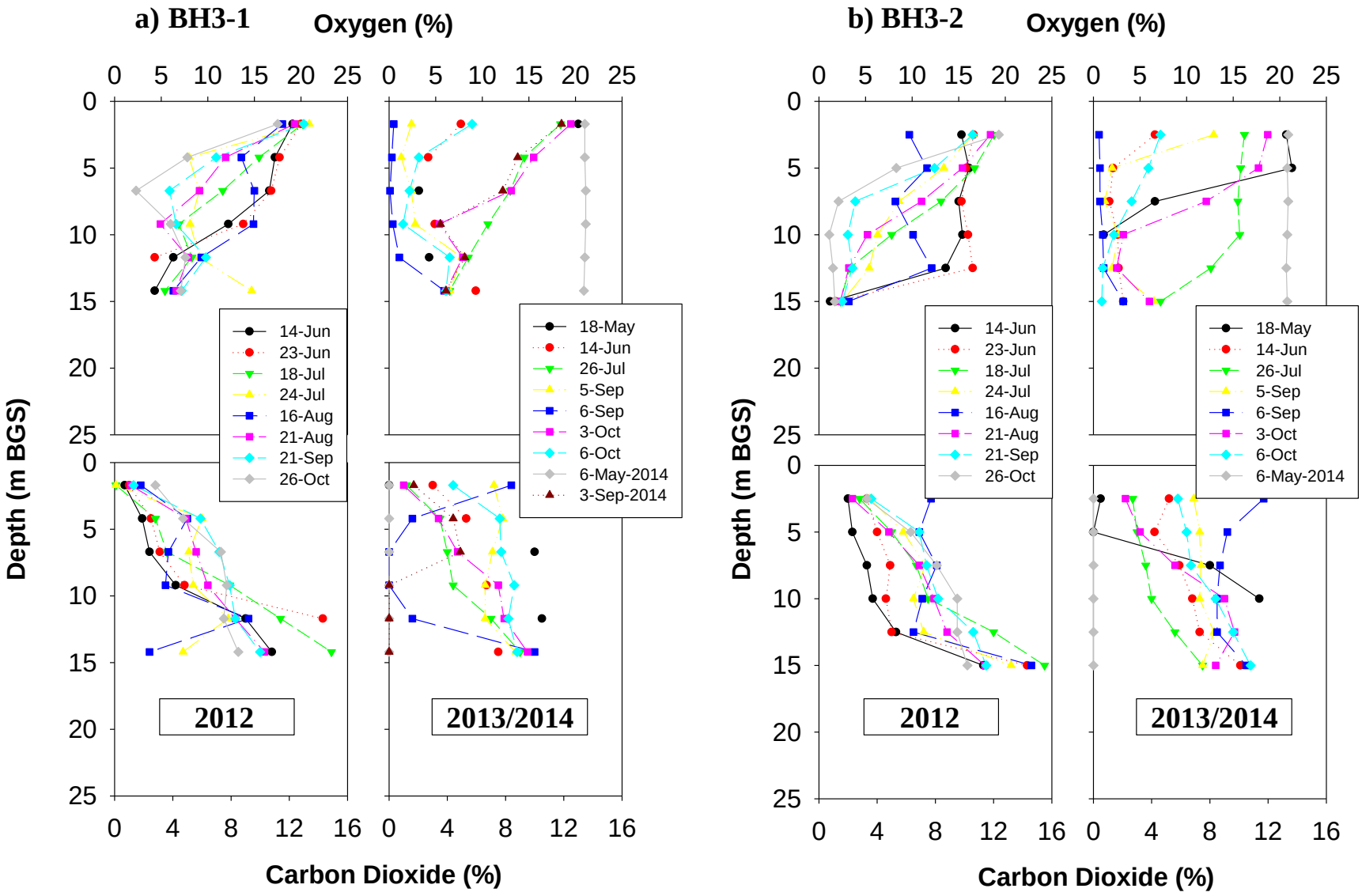



*Figure 4.14: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#3 at Locations a) BH3-1 and b) BH3-2, 2012-2014*

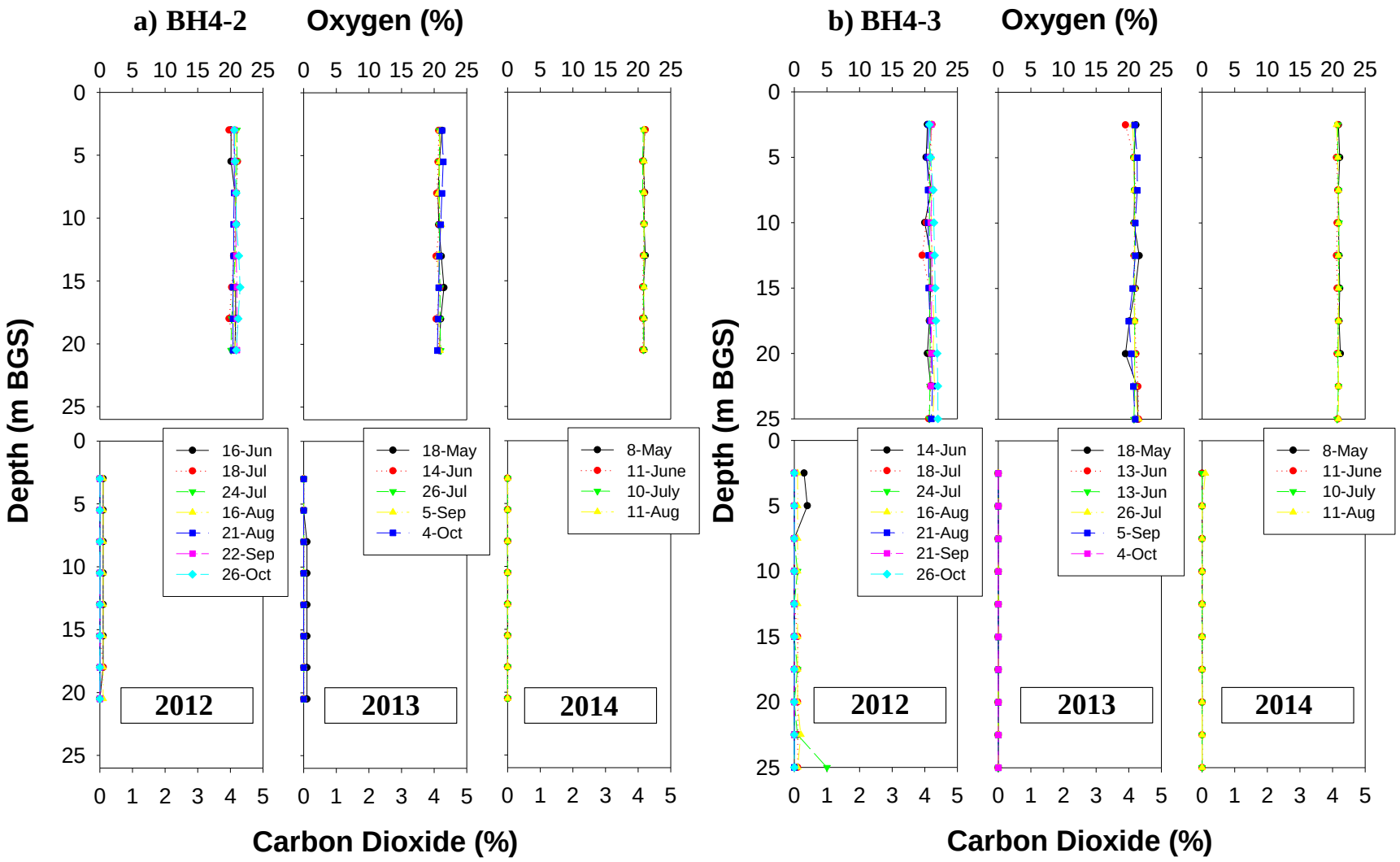



*Figure 4.15: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#4 at a) BH4-2 and b) BH4-3, 2012-2014*

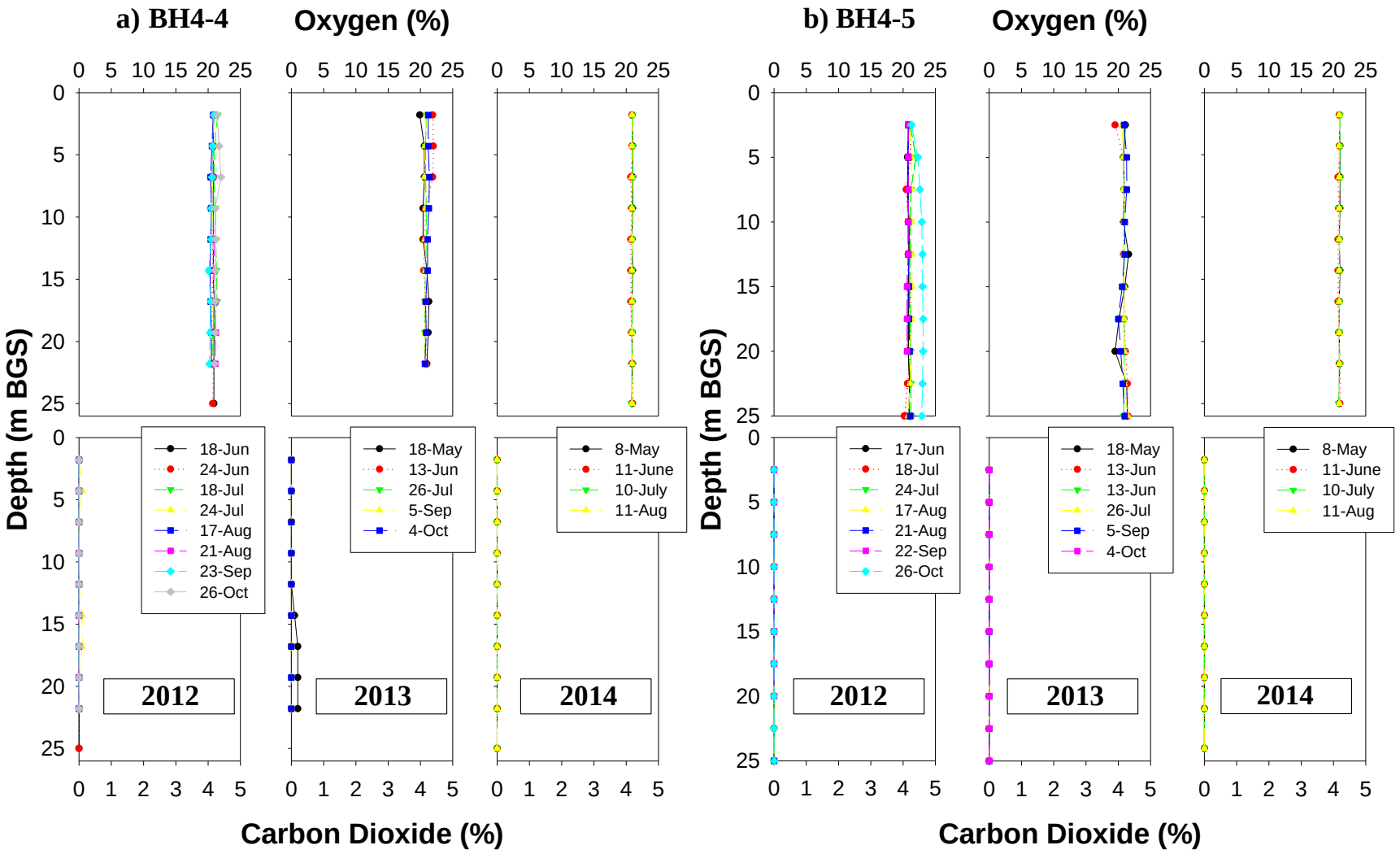



*Figure 4.16: Pore-Gas $O_2$ and $CO_2$ Concentrations in WRS#4 at a) BH4-4 and b) BH4-5, 2012-2014*

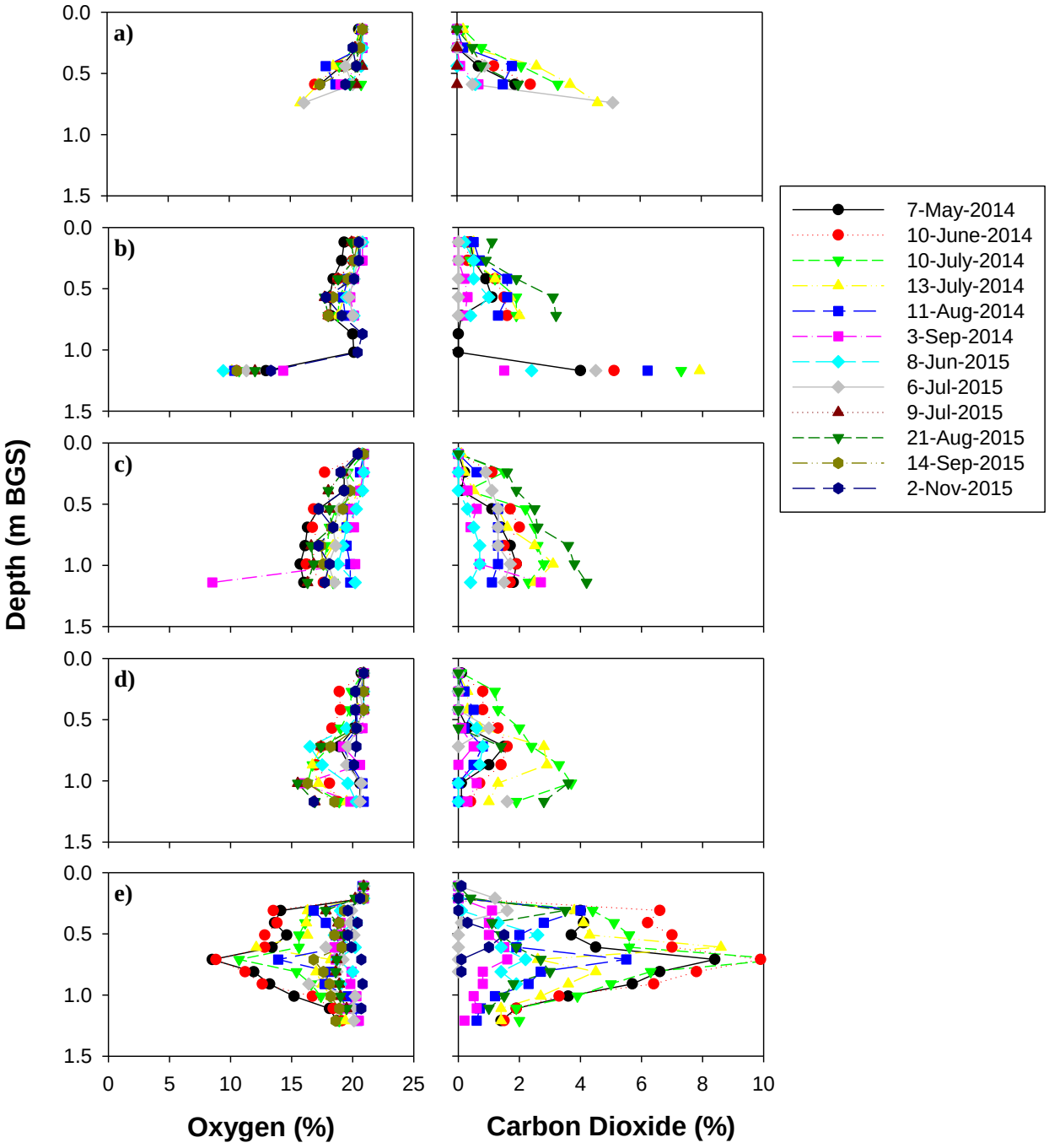



***Figure 4.17: Pore-Gas $O_2$ and $CO_2$ Concentration through WRS#3 Cover Material at Locations a) TP3-3, b) TP3-4, c) TP3-5, d) TP3-6 and e) TP3-7, 2014-2015***

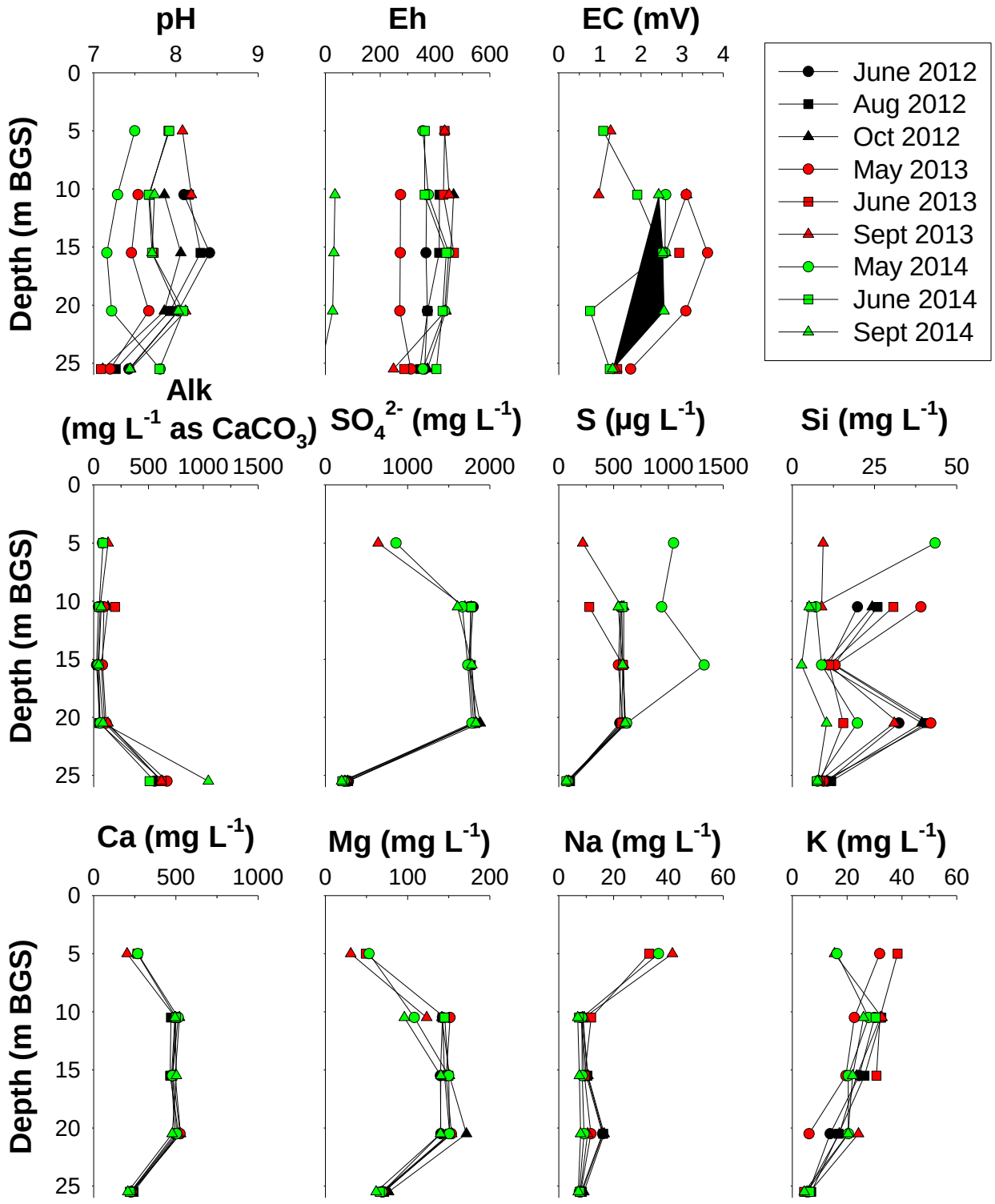



*Figure 4.18a: Pore-Water Geochemical Conditions at BH4-2, 2012-2014*

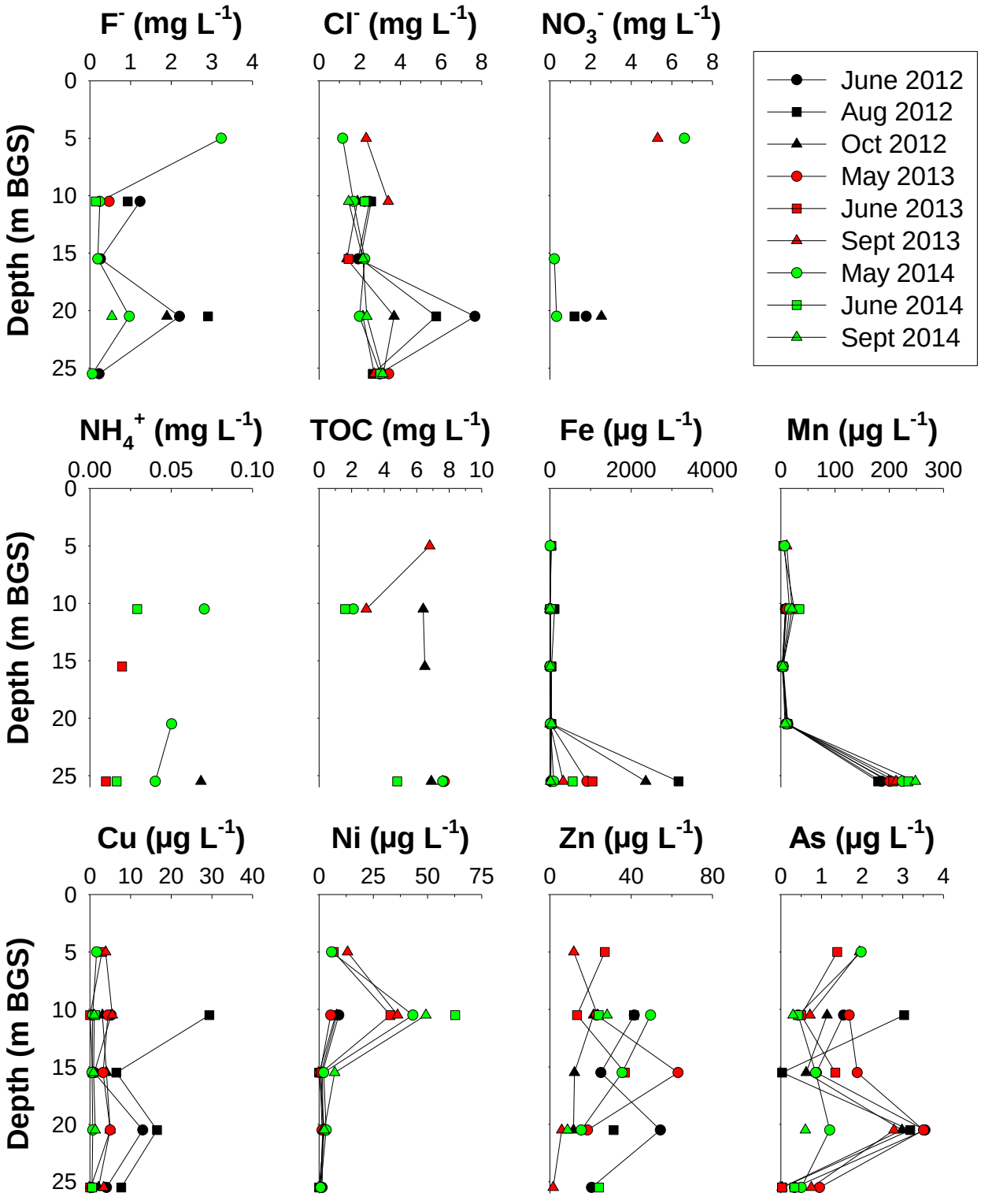



*Figure 4.19b: Pore-Water Geochemical Conditions at BH4-2, 2012-2014*

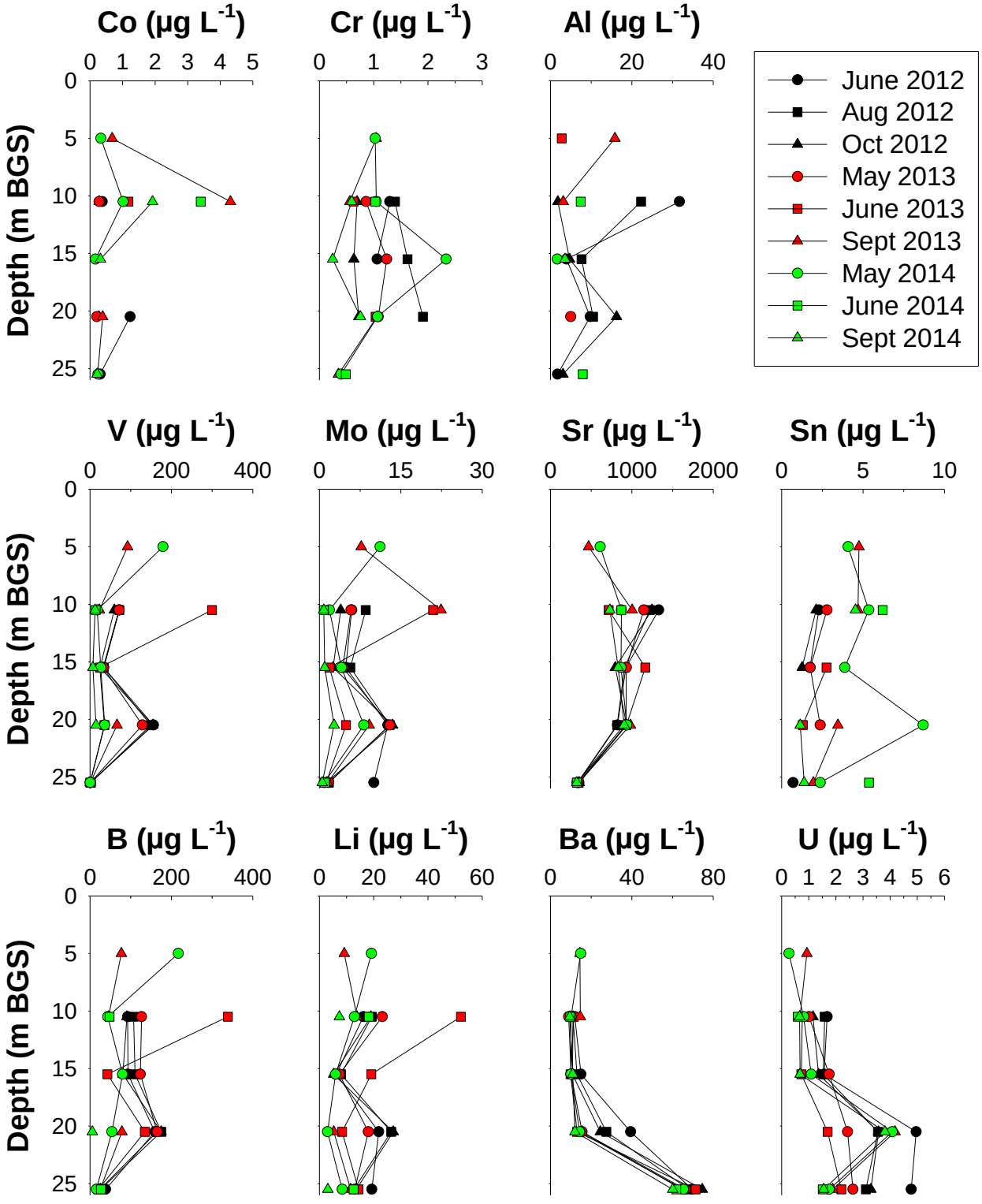



*Figure 4.20c: Pore-Water Geochemical Conditions at BH4-2, 2012-2014*

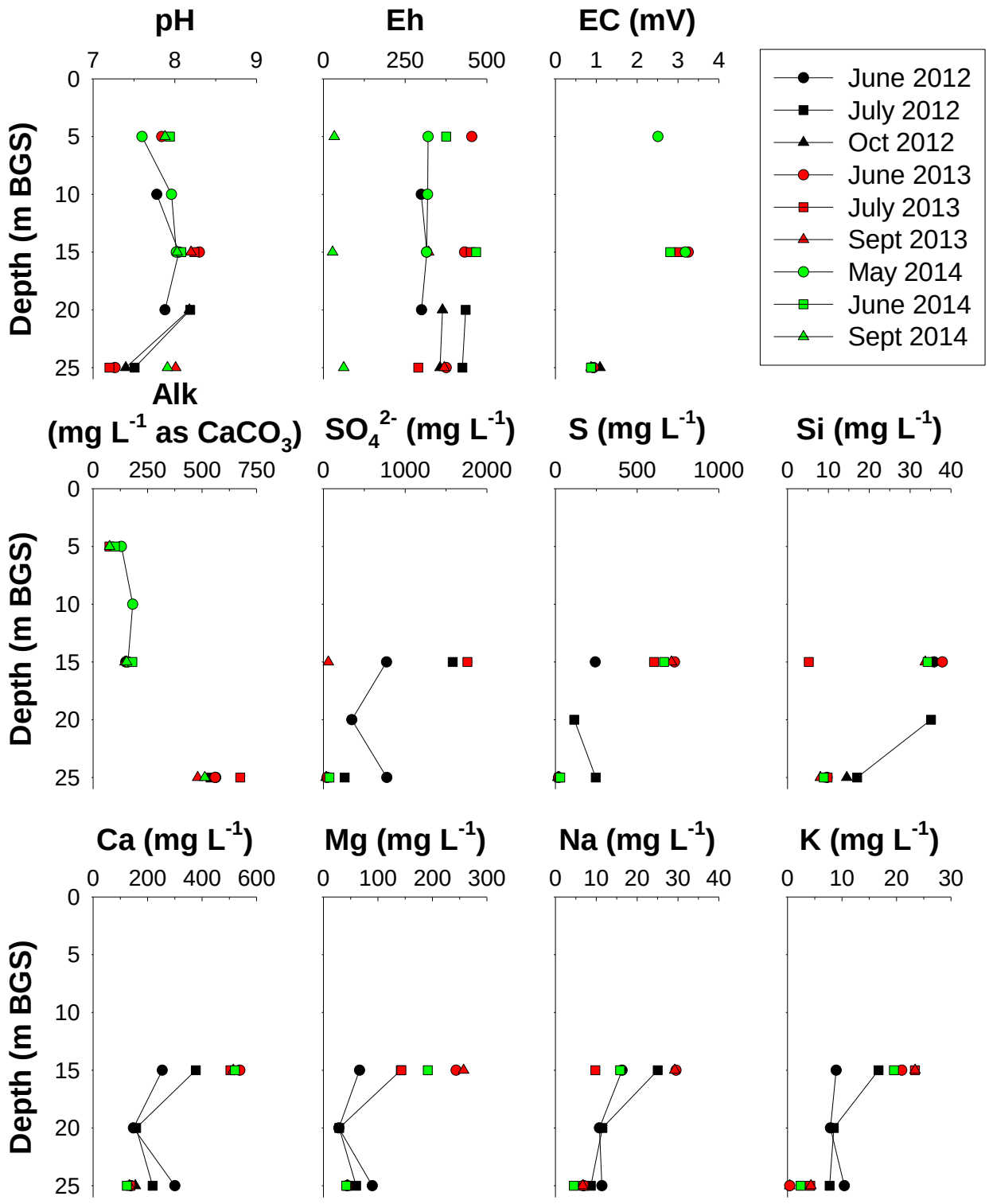



*Figure 4.21a: Pore-Water Geochemical Conditions at BH4-3, 2012-2014*

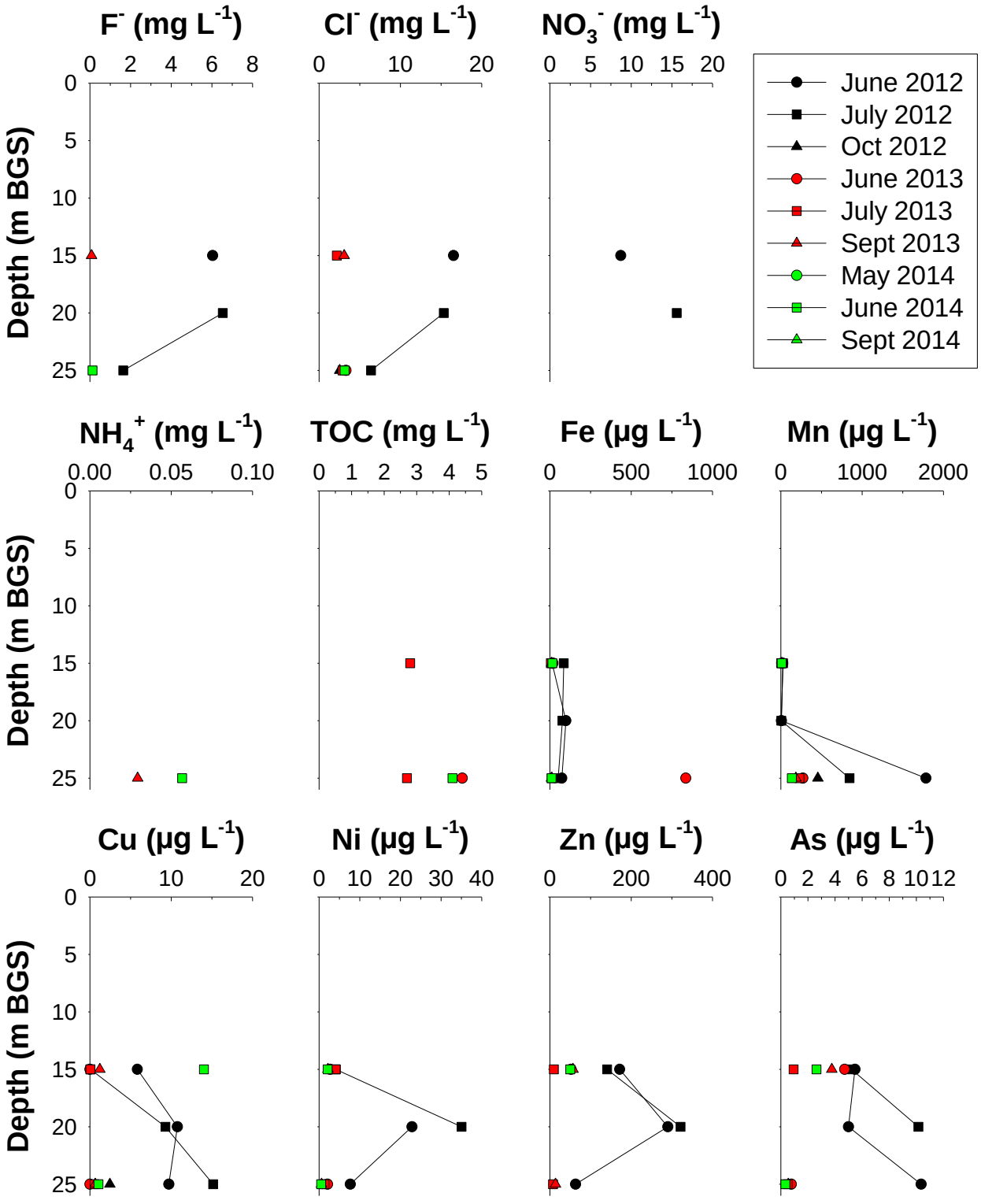



*Figure 4.22b: Pore-Water Geochemical Conditions at BH4-3, 2012-2014*

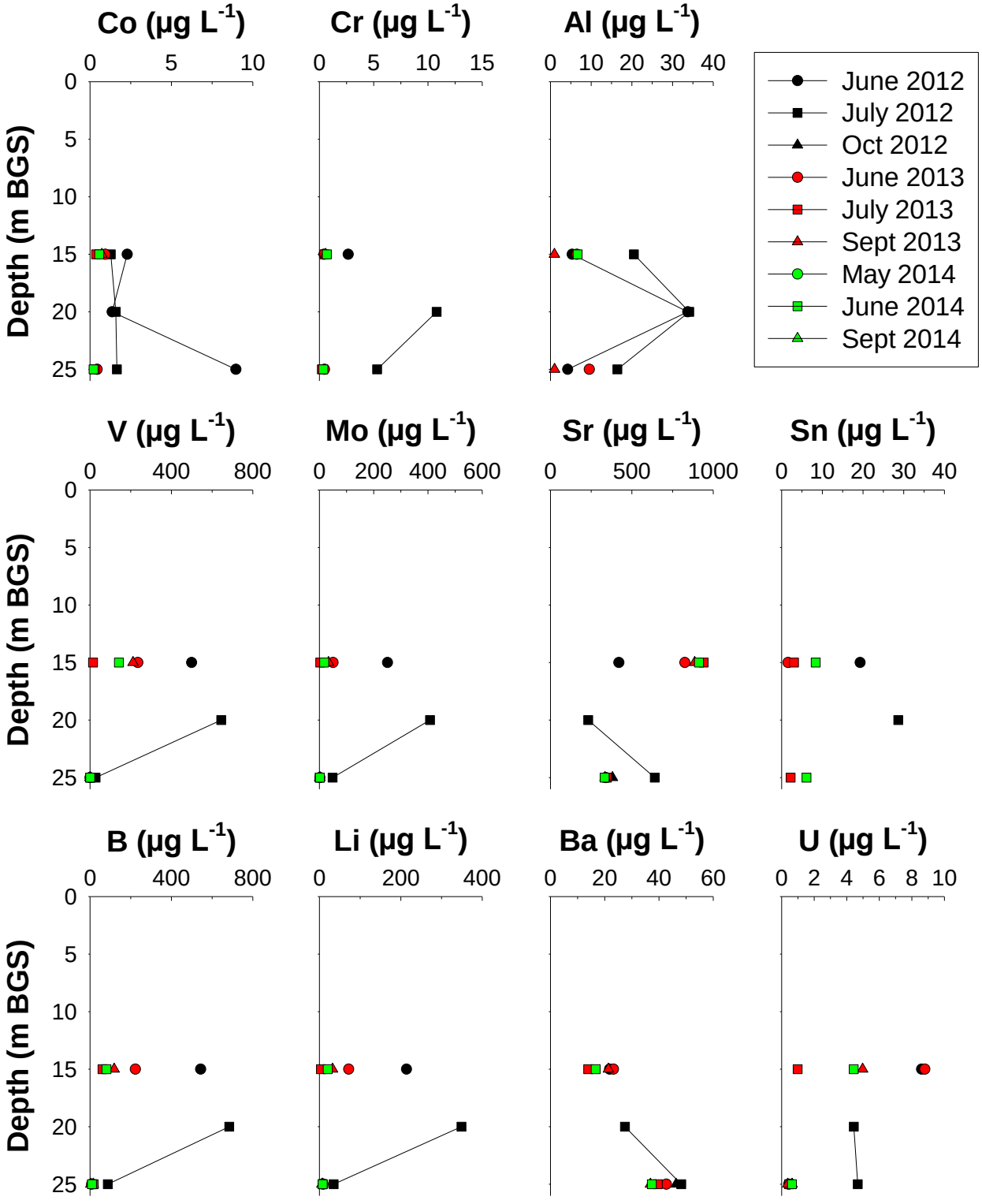



*Figure 4.23c: Pore-Water Geochemical Conditions at BH4-3, 2012-2014*

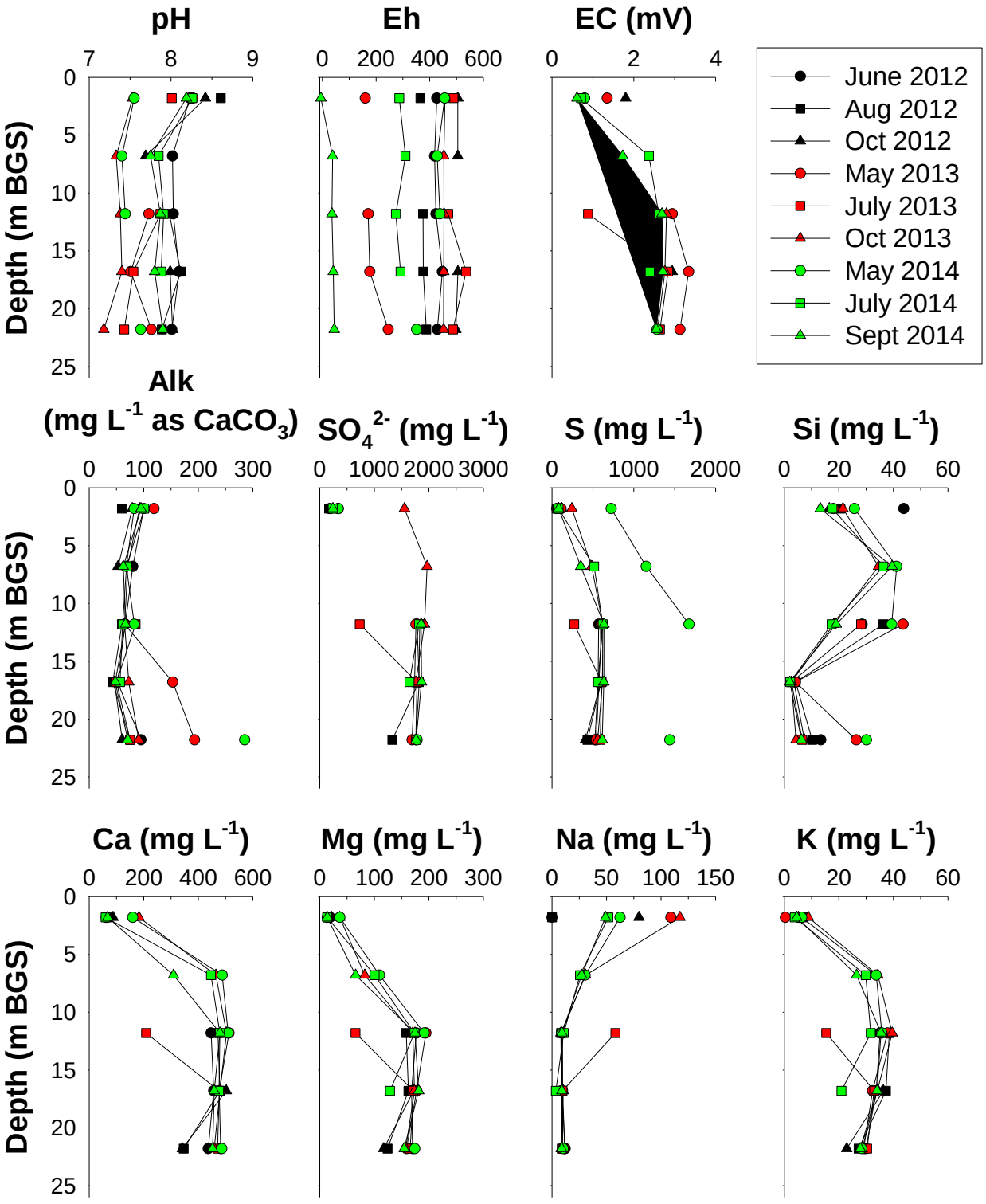



*Figure 4.24a: Pore-Water Geochemical Conditions at BH4-4, 2012-2014*

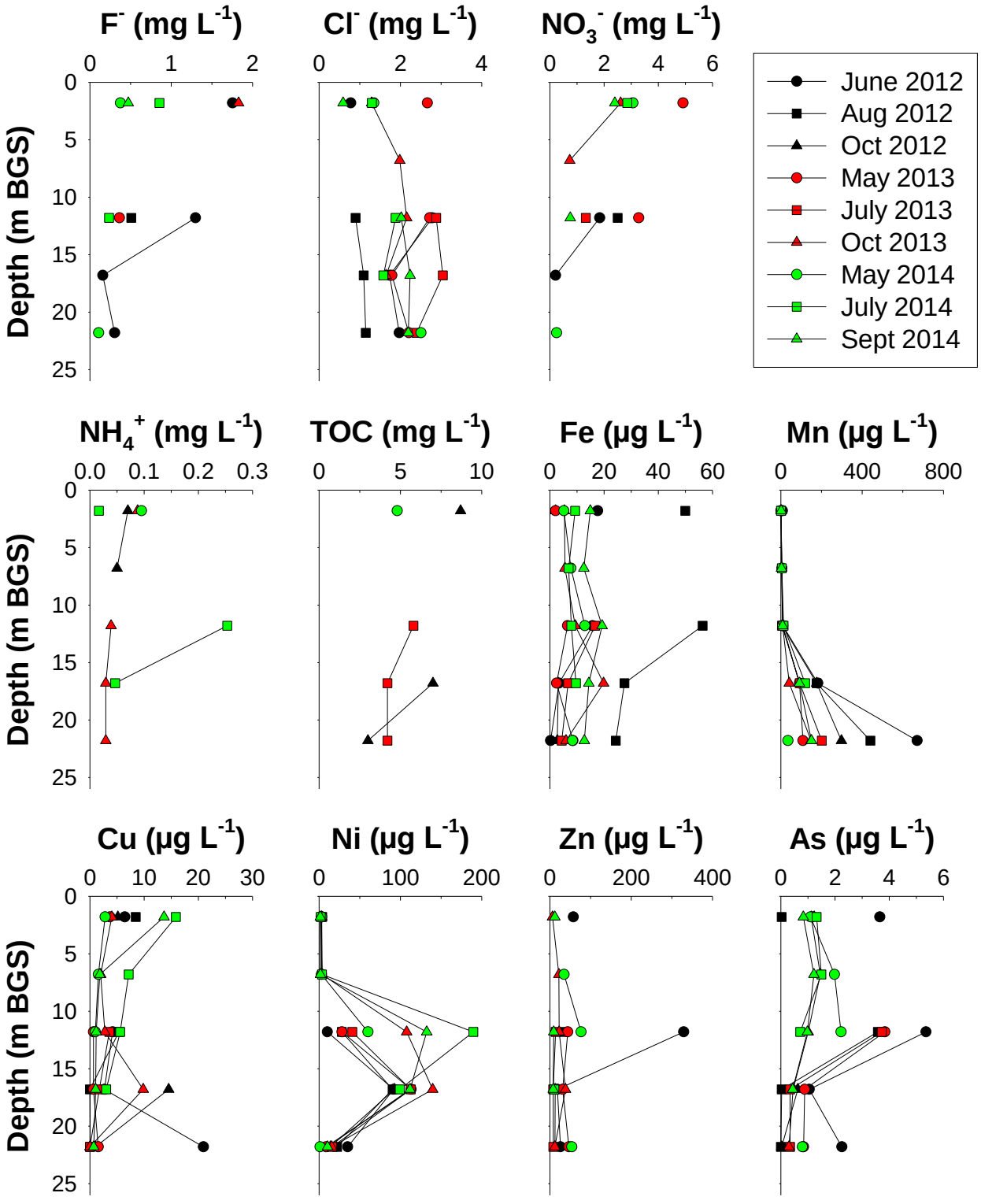



*Figure 4.25b: Pore-Water Geochemical Conditions at BH4-4, 2012-2014*

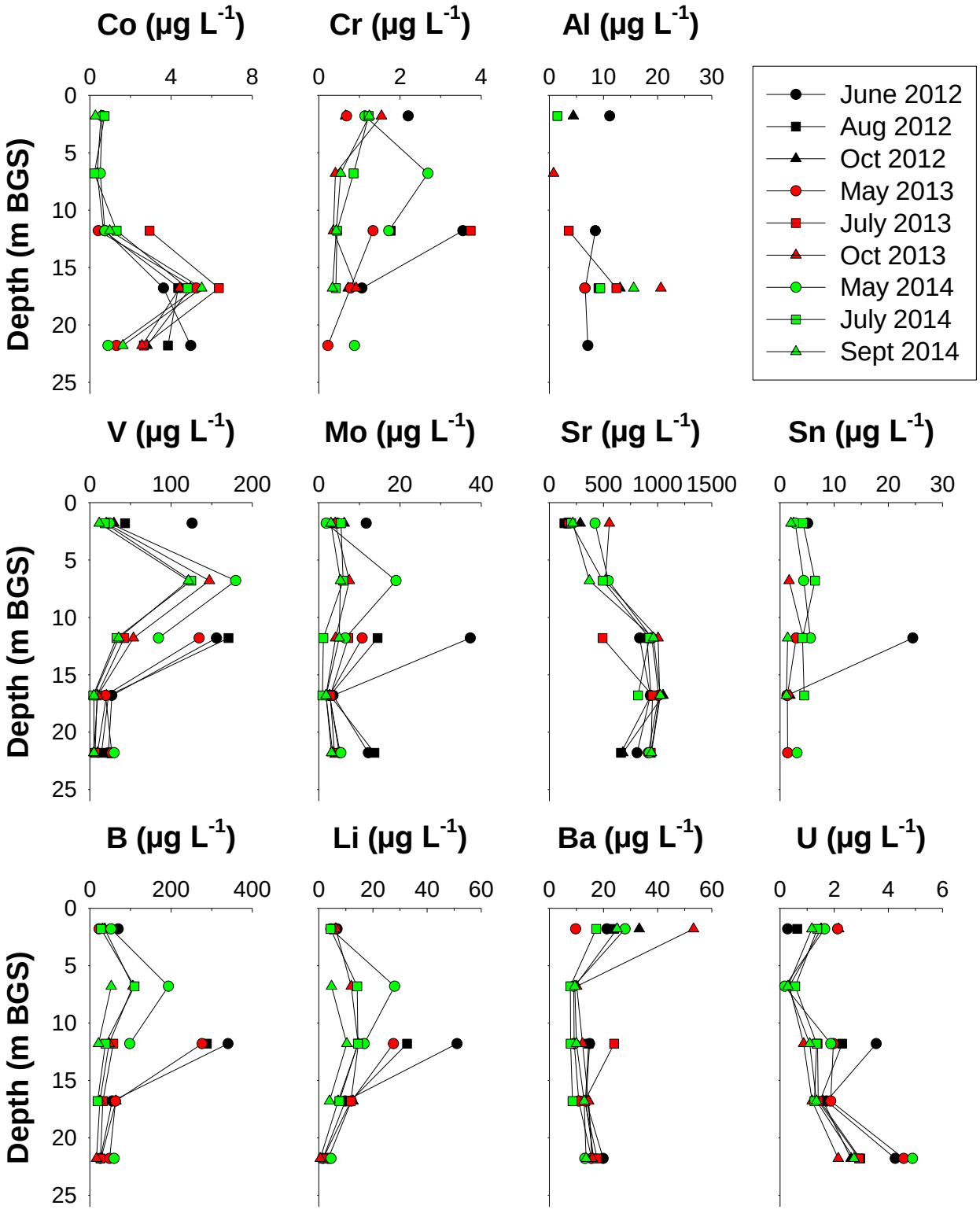



*Figure 4.26c: Pore-Water Geochemical Conditions at BH4-4, 2012-2014*

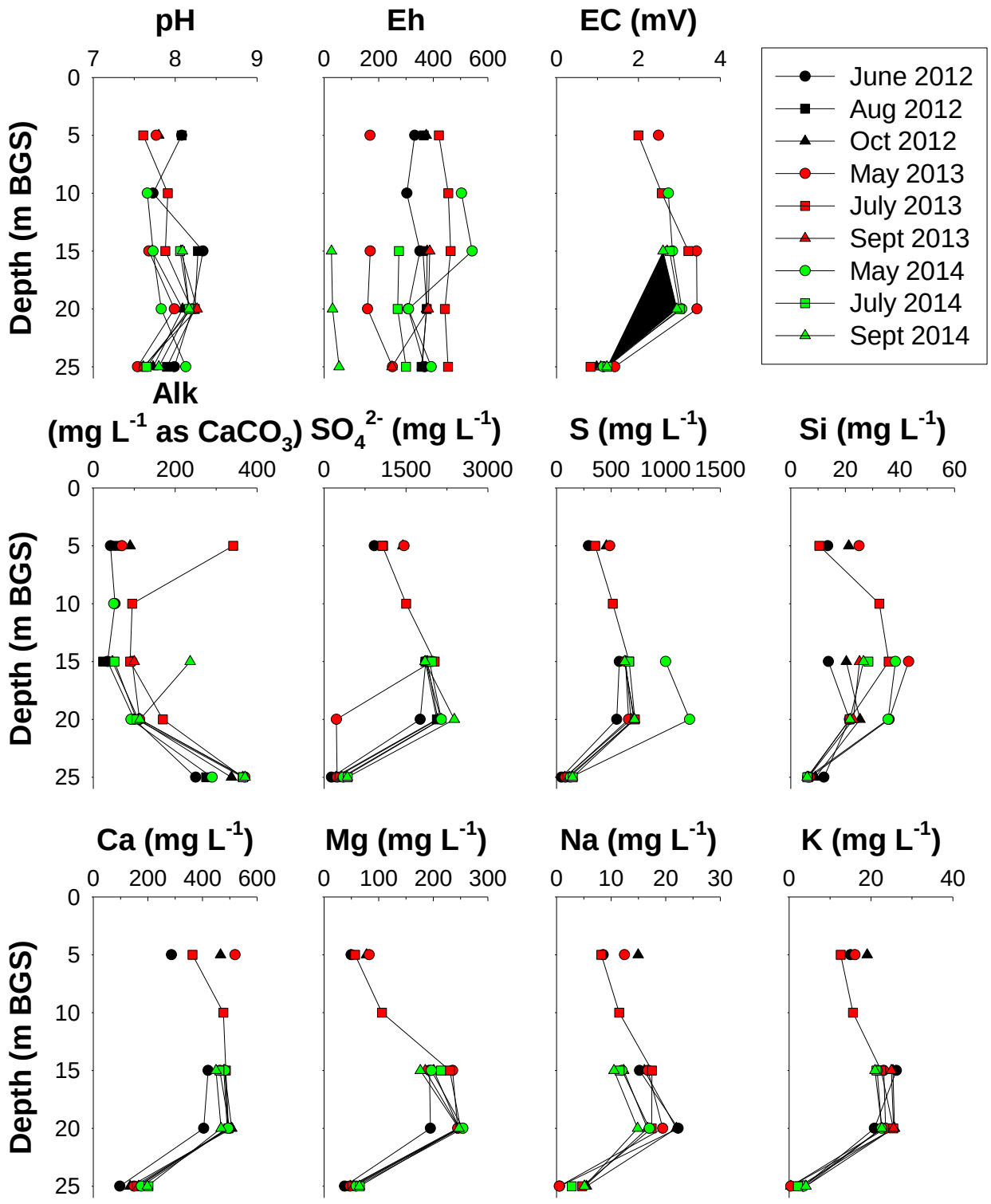



*Figure 4.27a: Pore-Water Geochemical Conditions at BH4-5, 2012-2014*

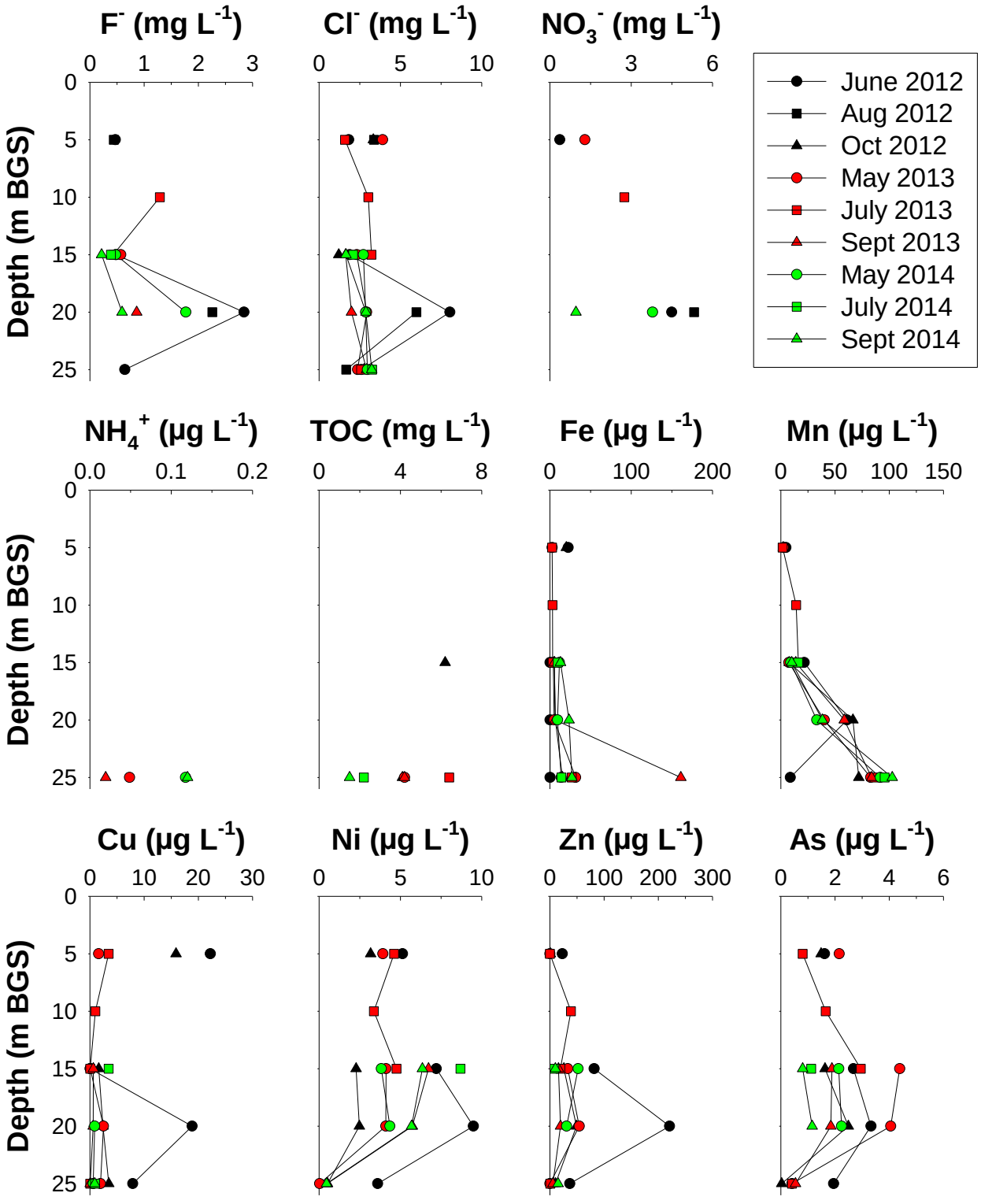



*Figure 4.28b: Pore-Water Geochemical Conditions at BH4-5, 2012-2014*

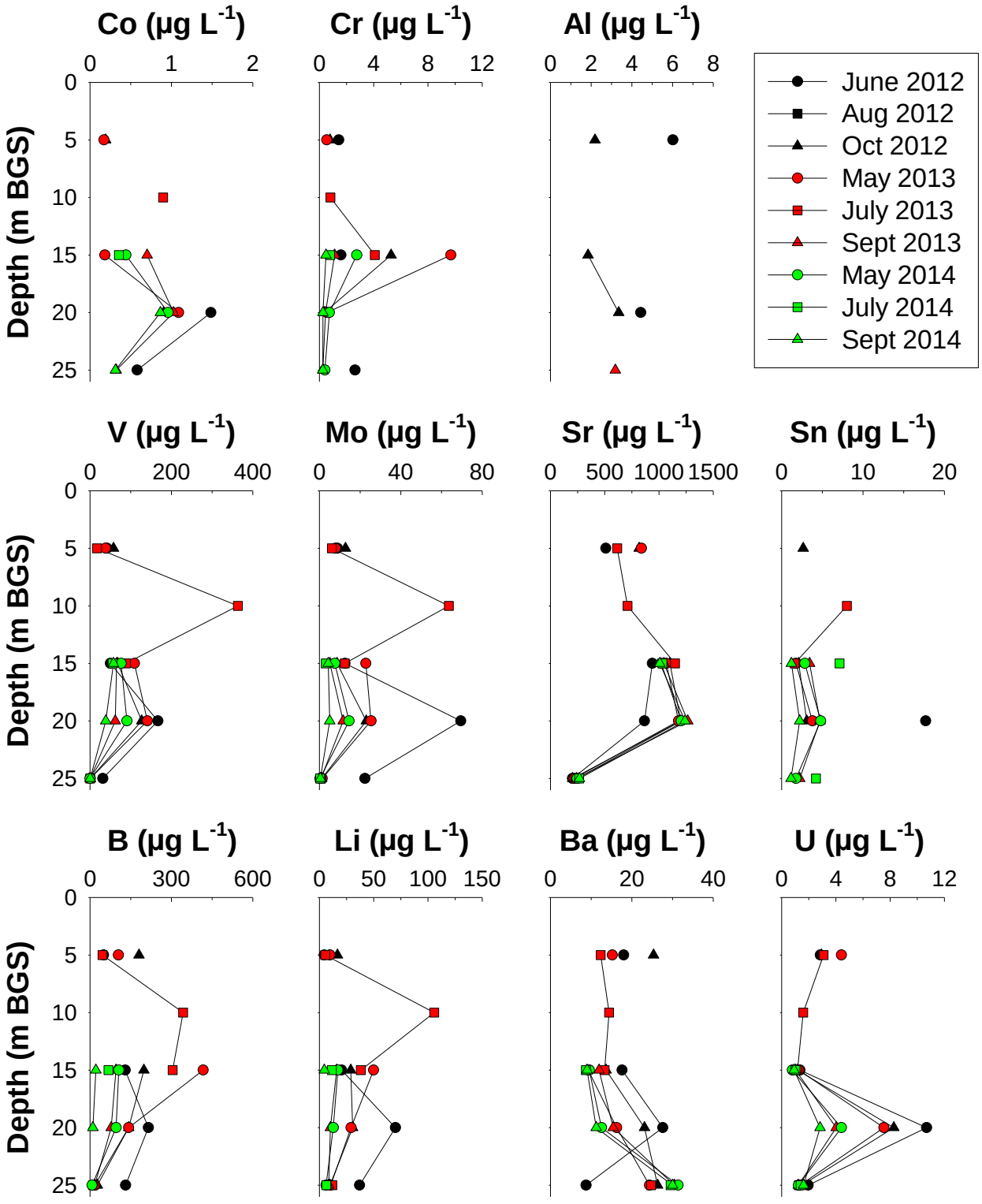



*Figure 4.291c: Pore-Water Geochemical Conditions at BH4-5, 2012-2014*

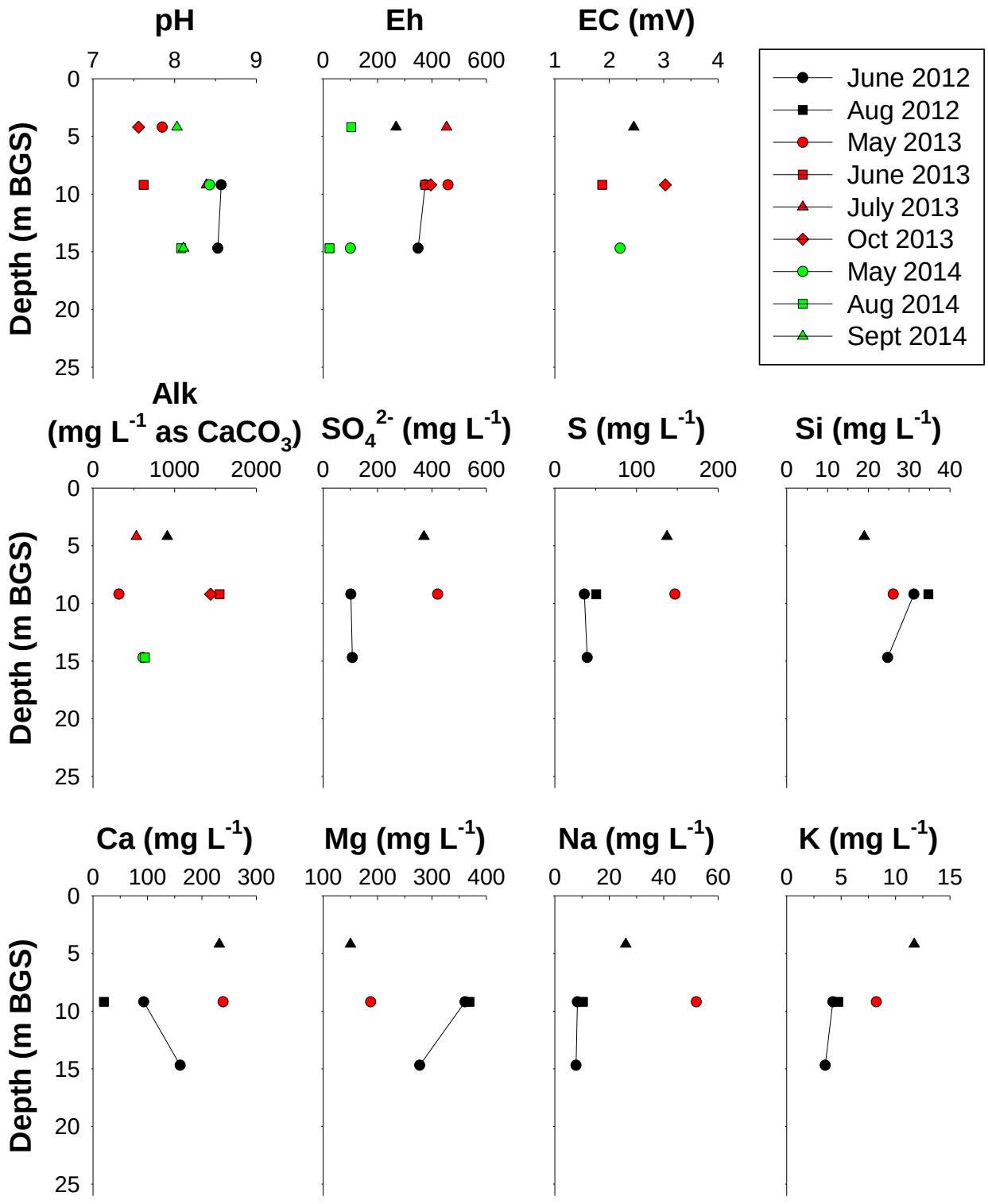



*Figure 4.30a: Pore-Water Geochemical Conditions at BH3-1, 2012-2014*

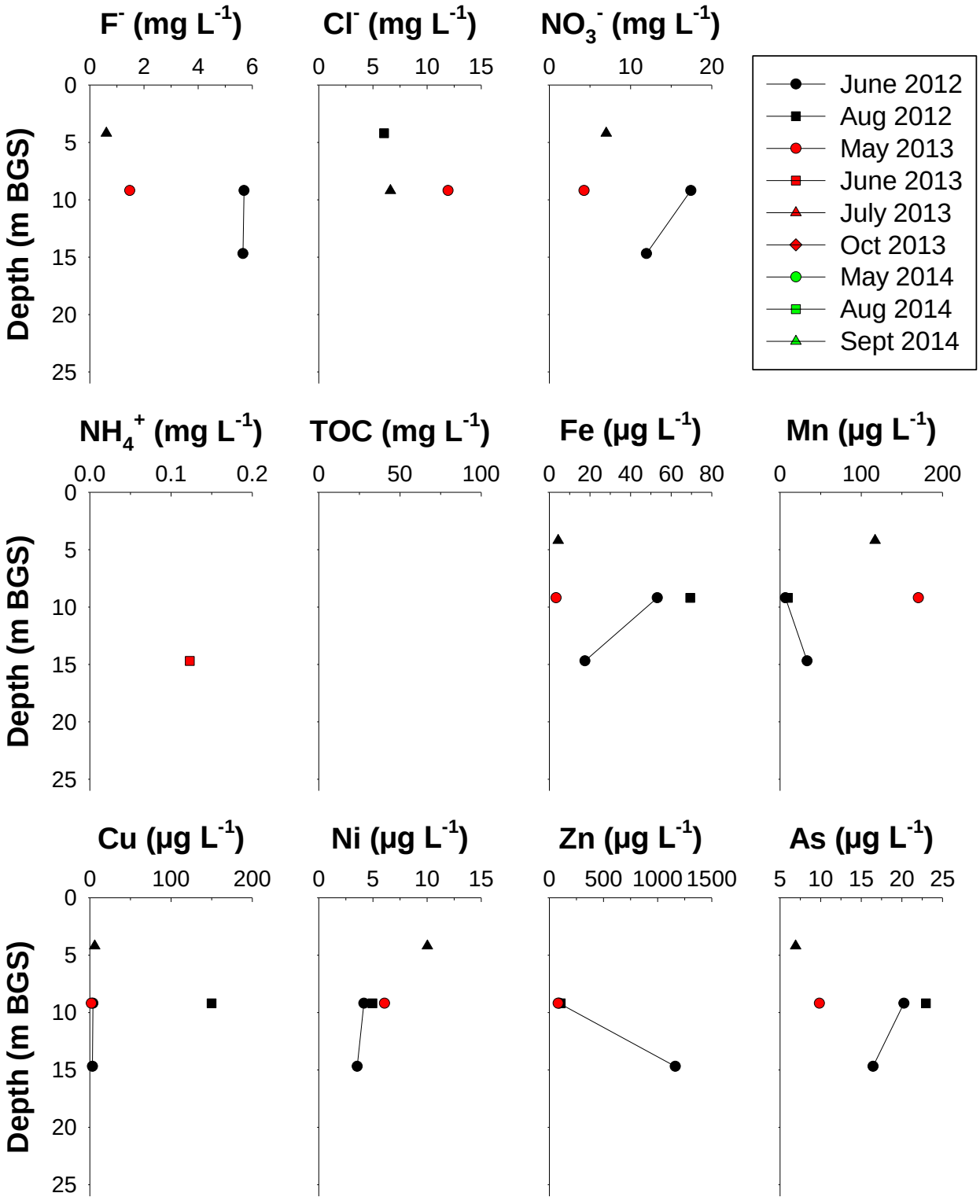



*Figure 4.31b: Pore-Water Geochemical Conditions at BH3-1, 2012-2014*

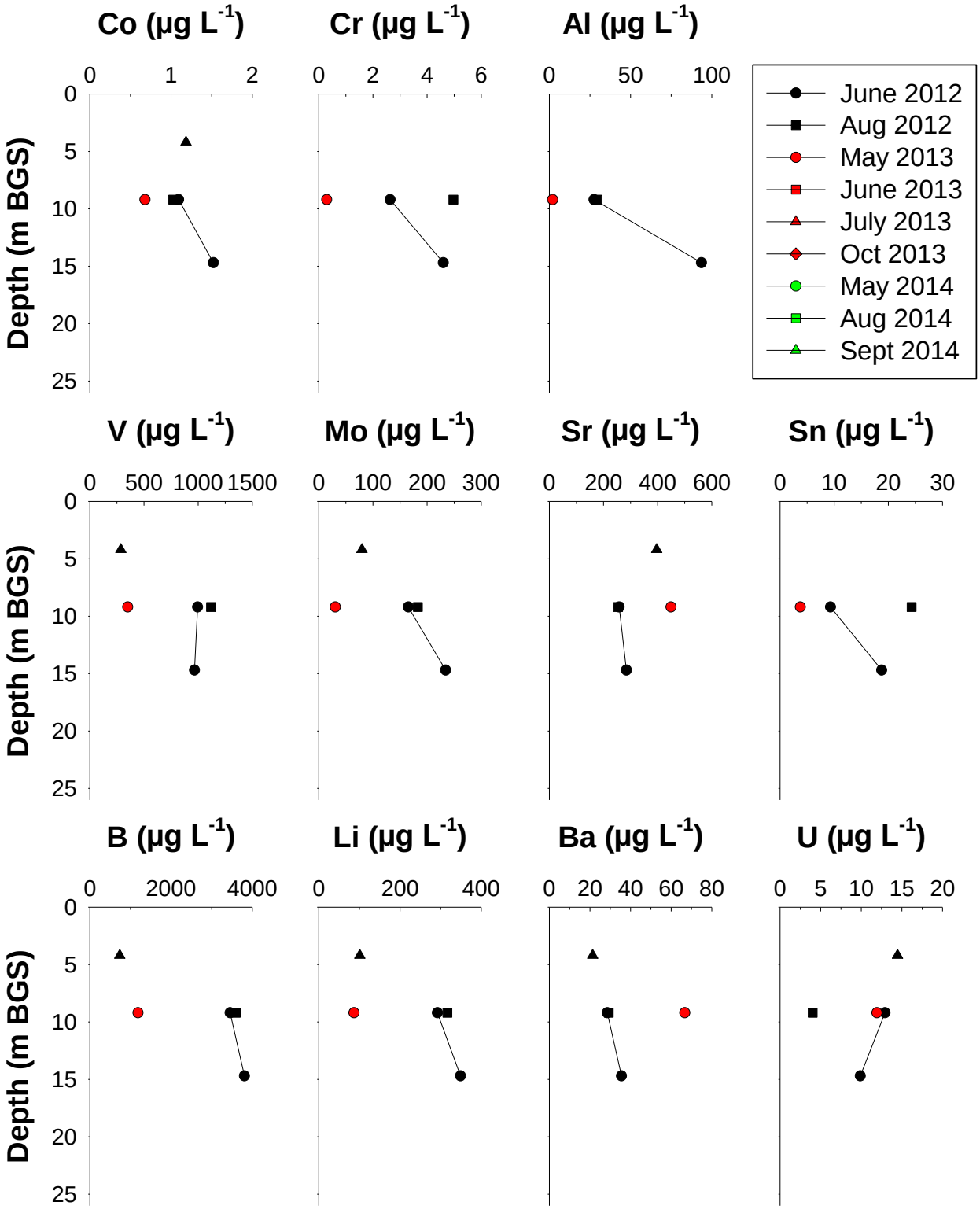



*Figure 4.32c: Pore-Water Geochemical Conditions at BH3-1, 2012-2014*

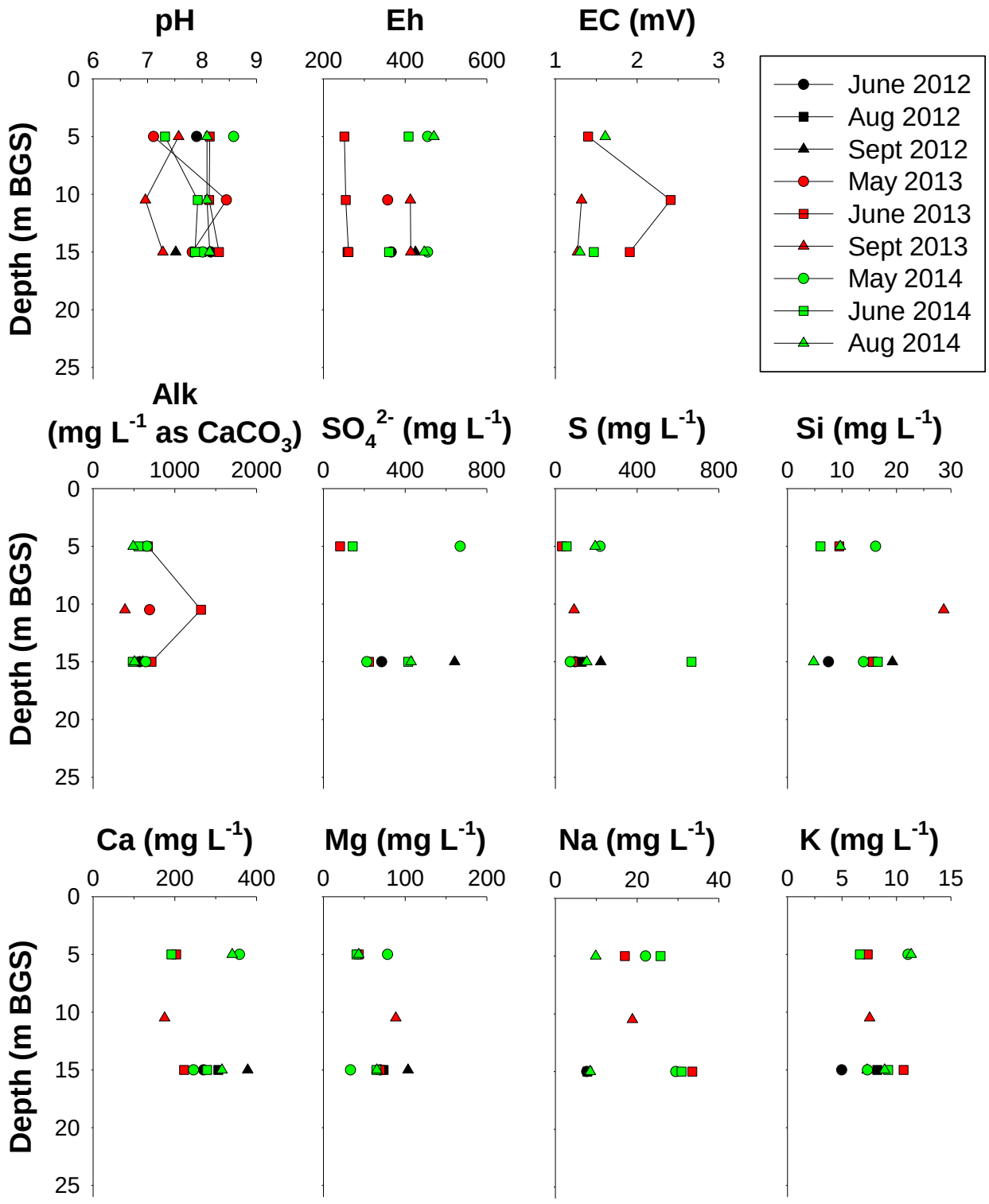



*Figure 4.33a: Pore-Water Geochemical Conditions at BH3-2, 2012-2014*

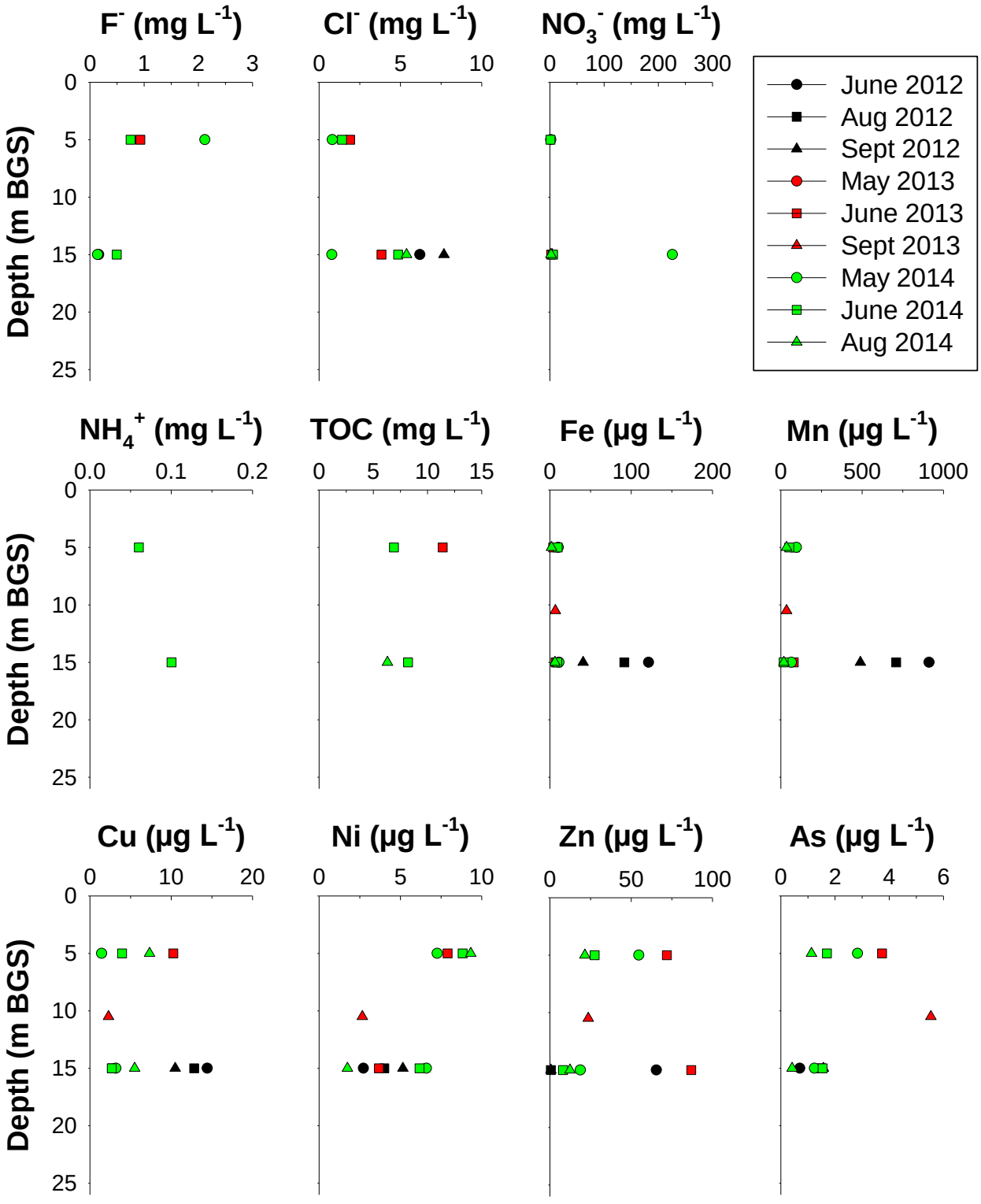



*Figure 4.34b: Pore-Water Geochemical Conditions at BH3-2, 2012-2014*

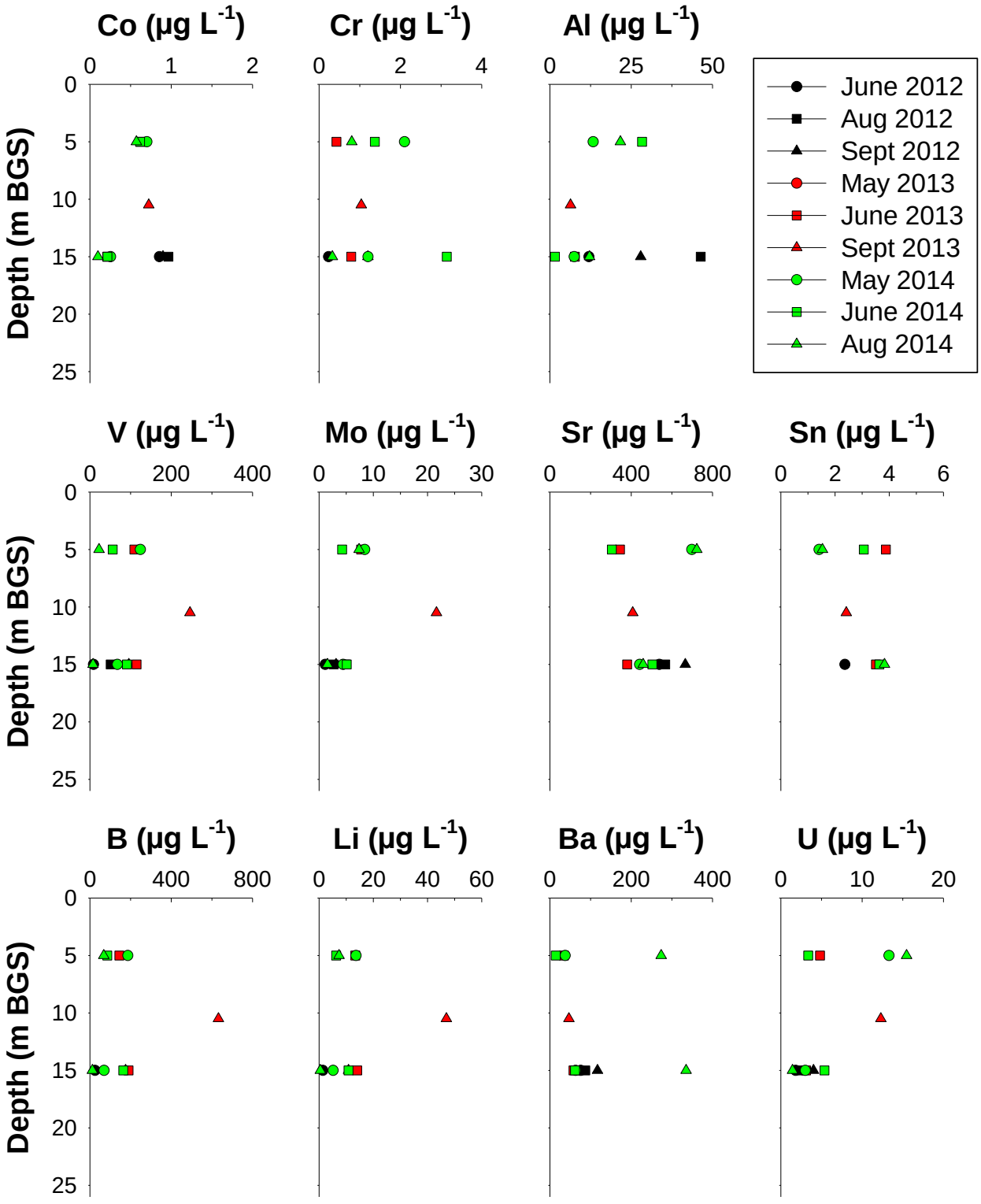



*Figure 4.35c: Pore-Water Geochemical Conditions at BH3-2, 2012-2014*

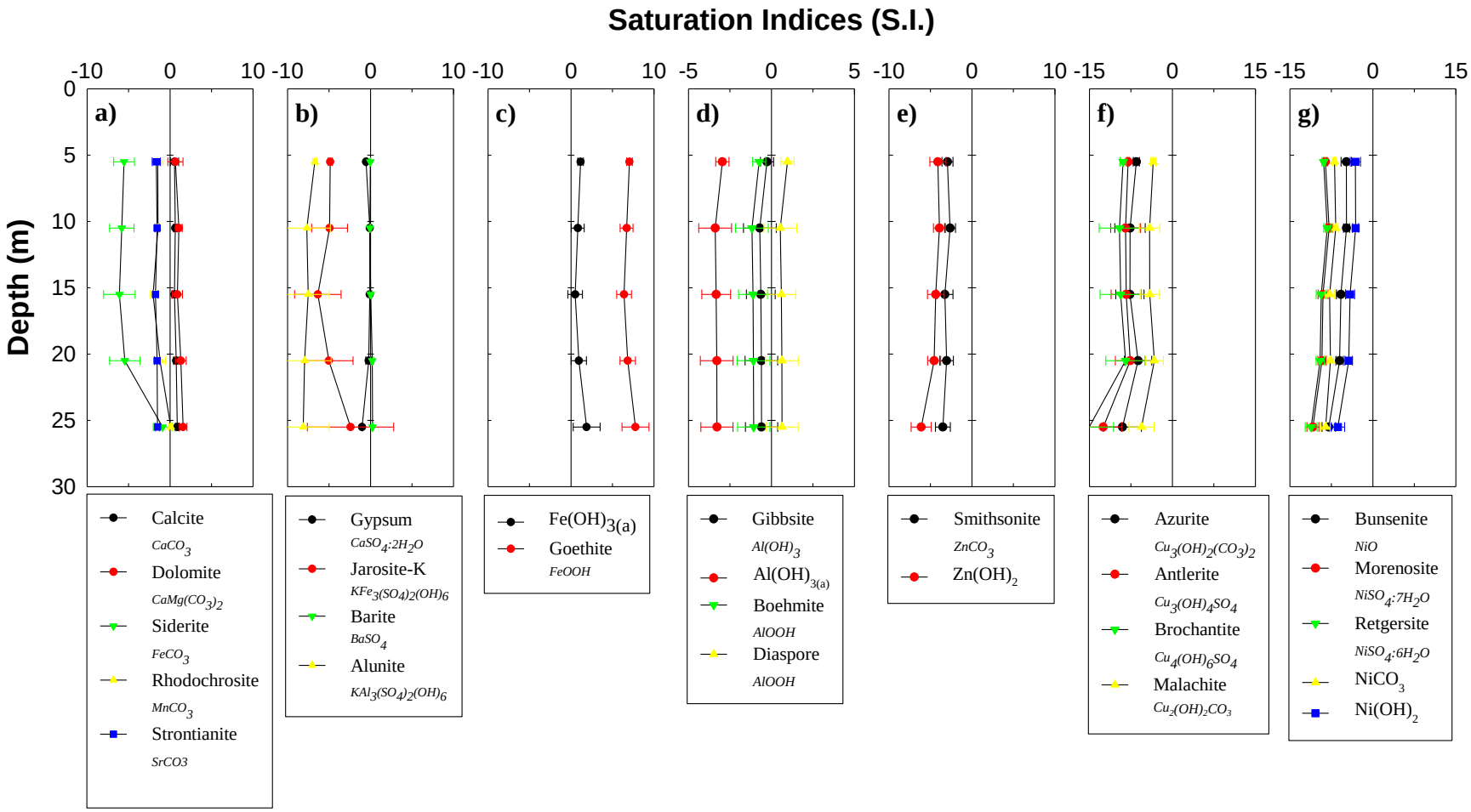



***Figure 4.36: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-2 with Standard Deviation***

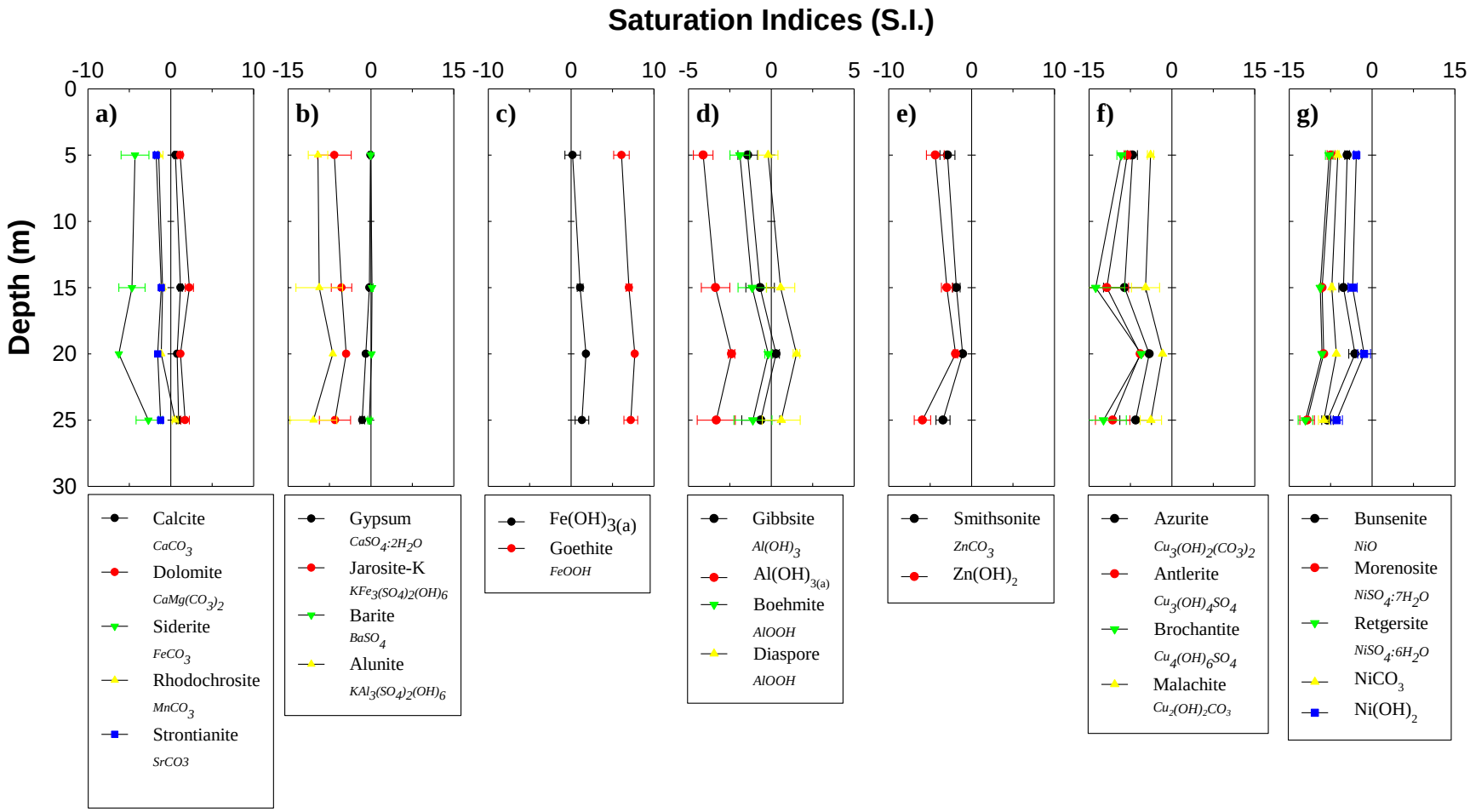



***Figure 4.37: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-3 with Standard Deviation***

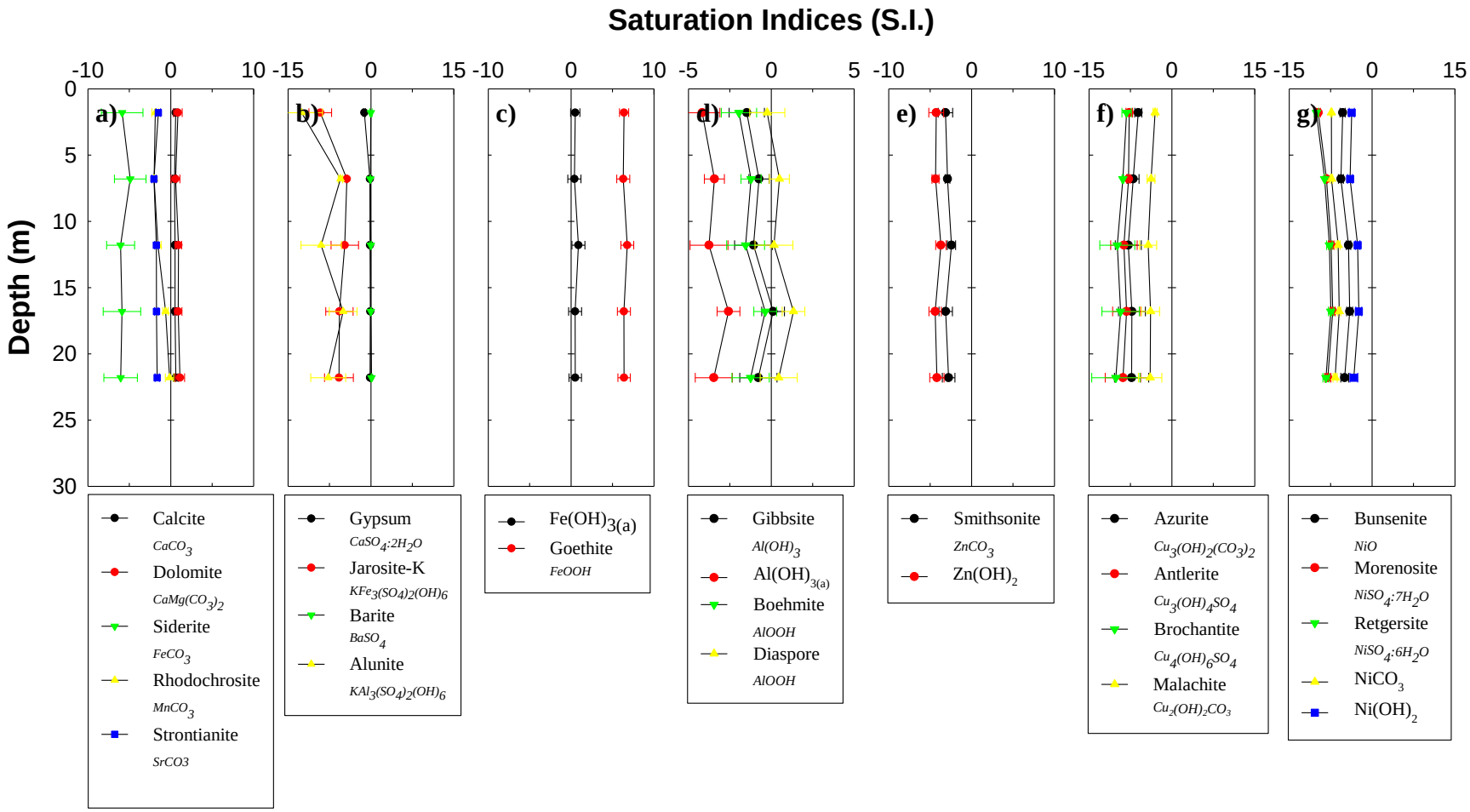



***Figure 4.38: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-4 with Standard Deviation***

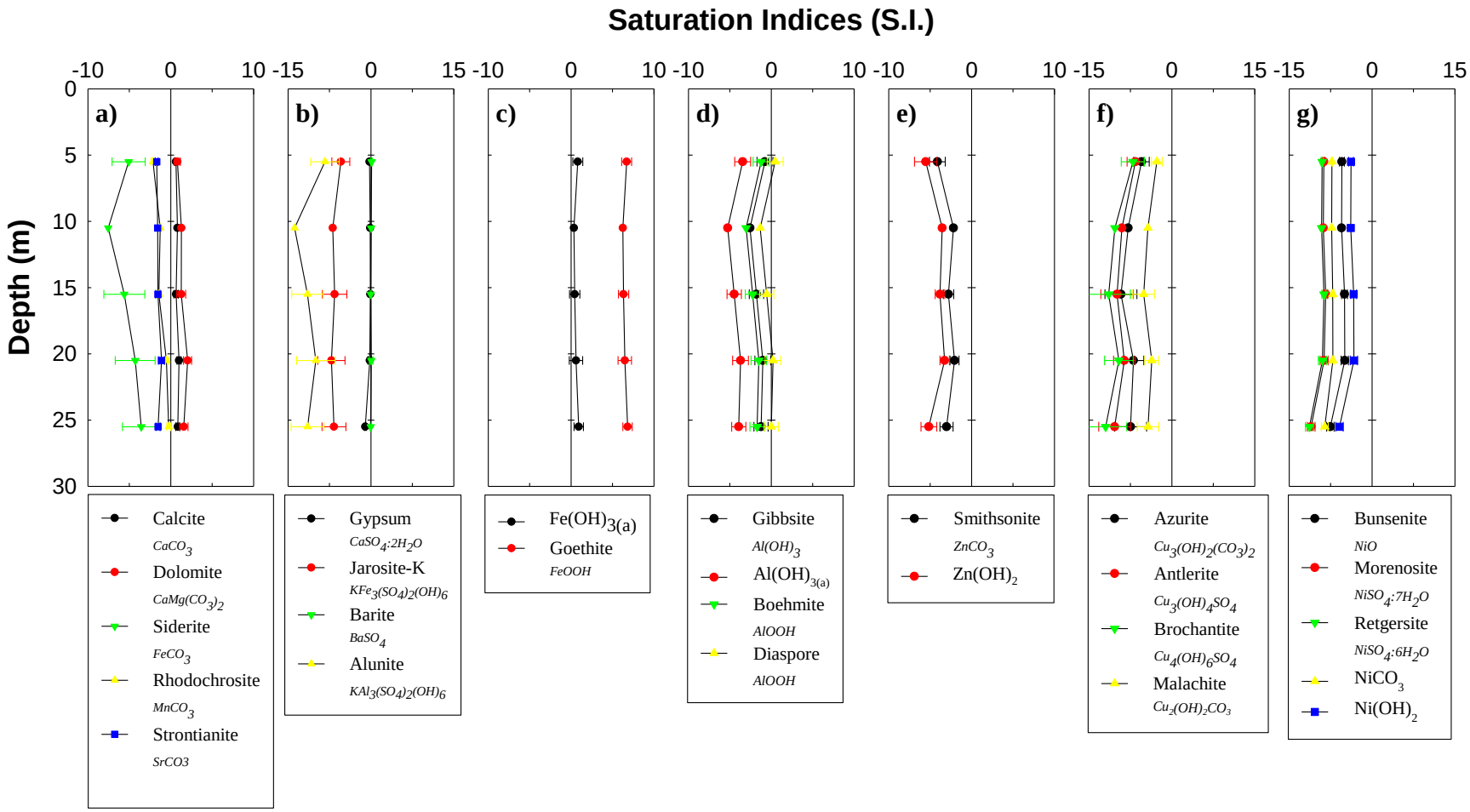



***Figure 4.39: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH4-5 with Standard Deviation***

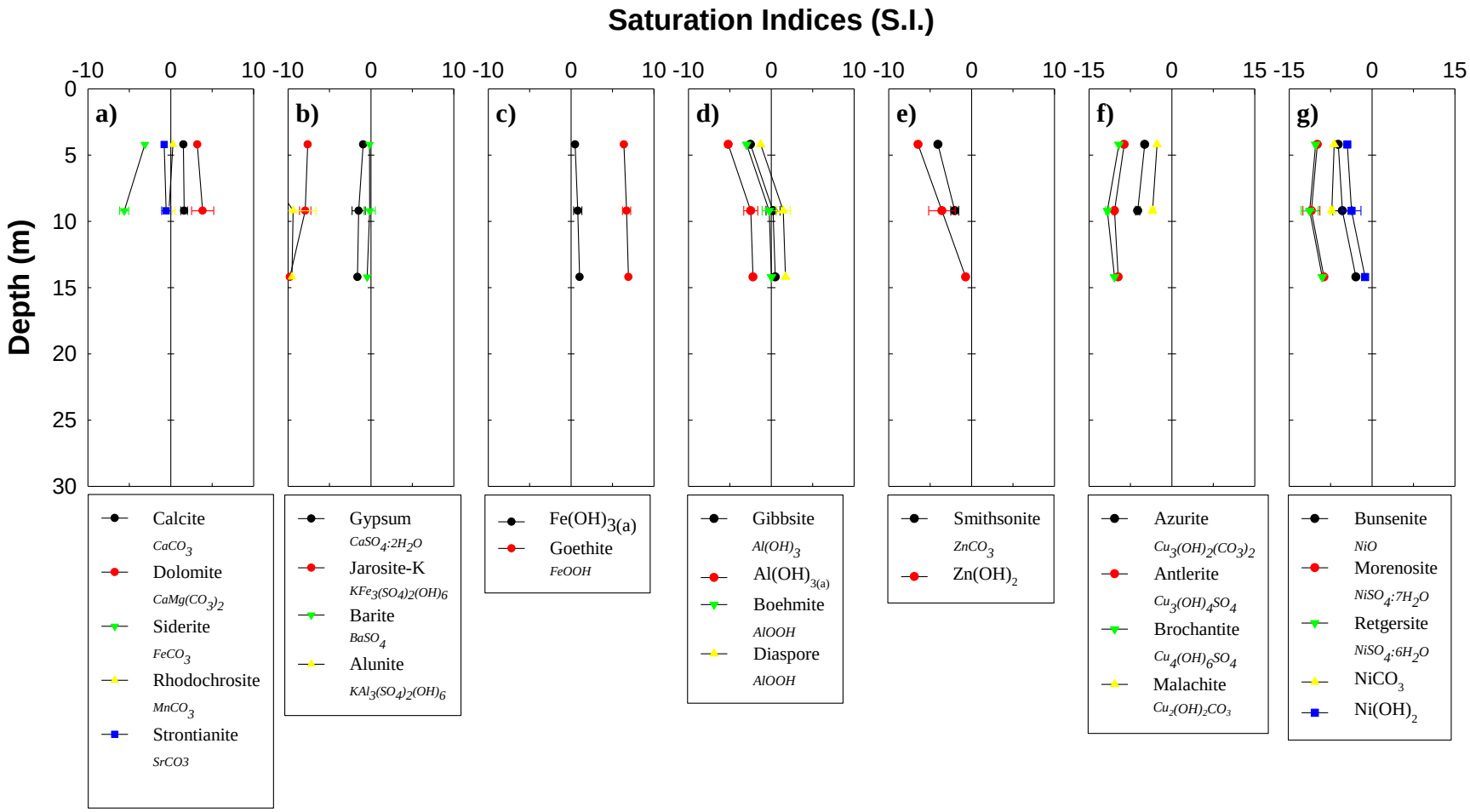



***Figure 4.40: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH3-1 with Standard Deviation***

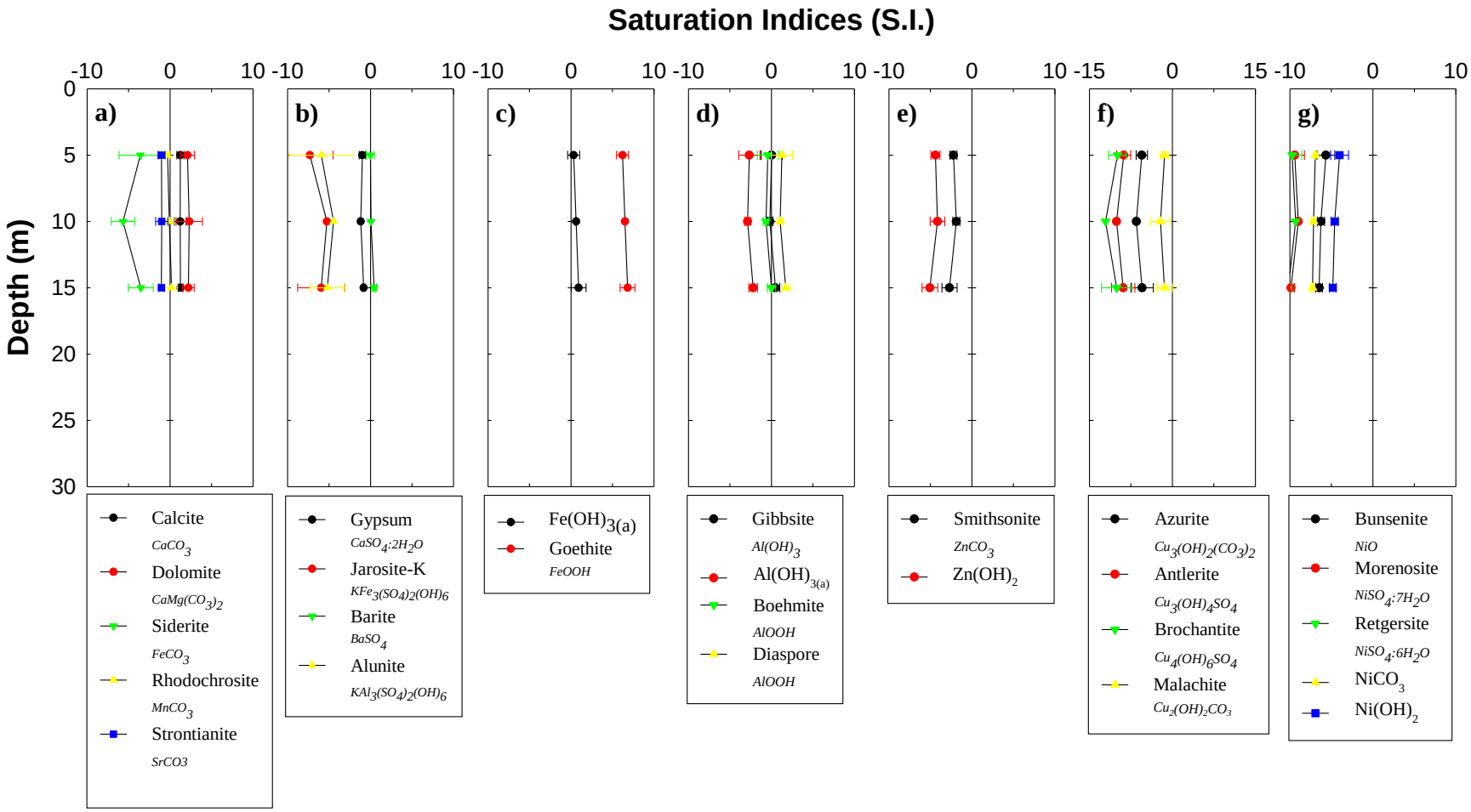



***Figure 4.41: Average Saturation Indices of Secondary a) Carbonate, b) Sulfate, c) Iron, d) Aluminum, e) Zinc, f) Copper and g) Nickel Minerals at BH3-2 with Standard Deviation***

# Chapter 5 – Summary and Conclusions

The waste rock in WRS#1, WRS#2 and WRS#4 is composed primarily of horneblende and plagioclase minerals with lesser quantities of quartz, biotite and chlinochlore. Variably weathered sulfide minerals were observed in all samples, primarily pyrite and pyrrhotite with some chalcopyrite and covellite. Sulfur content in the stockpiles ranged from 0 – 2.2 wt. %, and C ranged from 0 – 2.5 wt. %. Samples of the overburden material used to cover the piles were distinguishable from the waste rock by lower S and trace metal content. Mixing of overburden into the piles and variability in the waste resulted in different potential for acid rock drainage. WRS#1 and WRS#2 had the lowest overall neutralization potential ratios (NPR) of 1.6 and 0.7 and > 50 % of samples from these piles are considered potentially acid generating (PAG). In contrast, WRS#3 and WRS#4 had NPRs of > 50 and 10, respectively. 45 % of samples from WRS#4 are PAG, and none of the samples from WRS#3 are considered PAG.

*In situ* monitoring at WRS#3 and WRS#4 indicate that sulfide oxidation is generating neutral mine drainage (NMD) and the prevailing geochemical conditions in these stockpiles differ due to the removal of the cover material at WRS#4. The hydrology of both piles is similar, although WRS#4 is deeper and has a thicker unsaturated zone. The cover material retains moisture well with moisture content remaining > 10 vol. % (approximately 15 % saturated), whereas the waste rock has a residual moisture content of approximately 5 vol. % (approximately 12.5 % saturation). The passage of wetting fronts through the cover and shallow waste rock has been observed. The thermal regimes of the stockpiles are also similar, remaining > 0 ˚C throughout the year. Temperature fluctuations are more extreme in the shallow waste rock, with a considerable time lag in temperature fluctuations at greater depths. This lag time is moderated by the cover material, as measurments near the exposed flanks of WRS#4 indicate that these regions

equilibrate with atmospheric temperature more rapidly. The cover material at WRS#3 also moderated the advective transport of $O_2$ into the stockpile. The average air-permeability coefficient of waste rock at WRS#3 and WRS#4 was $6.6x10^{-10}$ $m^2$ and $4.3x10^{-9}$ $m^2$, respectively. The cover material has a much lower air-permeability coefficient, ranging from $2.0x10^{-11}$ – $4.9x10^{-11}$ $m^2$, indicating that $O_2$ transport through the cover material is diffusion dominated. The effective diffusion coefficient of the cover material is estimated to be on the order of $1x10^{-6}$ $m^2/s$ under unsaturated conditions and on the order of $1x10^{-7}$ $m^2/s$ when saturated. A diffusion dominant gas-transport mechanism is consistent with the observed pore-gas composition in WRS#3. Oxygen depletion and $CO_2$ enrichment were observed throughout WRS#3, especially at greater depths. These trends are in contrast to the pore-gas composition observed at WRS#4. The removal of the cover at WRS#4 removed the barrier to advective air flow into the stockpile, resulting in atmospheric pore-gas composition throughout. These results illustrate the potential benefit of a simple, unengineered cover in limiting $O_2$ transport into a waste-rock stockpile, suggesting that this may be a cost-effective tool in ARD management at this site.

Despite the difference in gas-transport mechanisms, pore-water concentrations indicate that sulfide oxidation is ongoing at both stockpiles, although acid neutralizing reactions have kept the pH circumneutral to this day. Sulfate and alkalinity concentrations are inversely correlated; sulfate concentrations were lower (200-500 mg/L) and alkalinity concentrations were higher (300-1000 mg/L as $CaCO_3$) in the unsaturated zone, whereas the saturated zone had higher concentrations of sulfate (> 1500 mg/L) and lower concentrations of alkalinity (< 200 mg/L as $CaCO_3$). Dissolved metal concentrations (Cu, Ni, Zn, As, Pb, etc.) were low (< 100 µg/L), although Fe and Mn concentrations were elevated (frequently > 200 µg/L) in the saturated zone. The composition of pore-water at WRS#3 was more variable but the presence of $SO_4$ and

dissolved metals at low concentrations indicate that sulfide oxidation is occurring, but to a lesser extent than WRS#4. Overall the pore-water quality compares very favourably to other waste-rock sites, with neutral pH and relatively low concentrations of dissolved metals.

Speciation modeling identified several secondary minerals potentially providing solid phase controls on dissolved metal concentrations. Pore-water at WRS#3 and WRS#4 was supersaturated with respect to several Fe and Al oxides including $Fe(OH)_{3(a)}$, goethite, gibbsite and diaspore, potentially providing a solid phase control on dissolved metal concentrations. Most of the pore-water samples were undersaturated with respect to secondary minerals containing Cu, Ni, Zn and other trace metals, suggesting that the primary control on the aqueous concentrations of these metals is through complexation or adsorption to Fe-hydroxides.

A study of the microbiology at WRS#1 provided insight into the dominant bacteria mediating sulfide oxidation within this stockpile. Enumerations of common neutrophilic sulfur oxidizing bacteria (*i.e. Thiobacillus thioparus* and related species; SOBn), acidophilic sulfur oxidizing bacteria (*i.e. Acidithiobacillus thooxidans* and related species; SOBa) and acidophilic iron oxidizing bacteria (*i.e. Acidithiobacillus ferrooxidans* and related species; FeO) indicate that these bacteria are present at WRS#1 within the range of reported population densities for other waste rock stockpiles. SOBn and FeO were more abundant, with average densities of $5.5x10^5$ and $9.0x10^5$ bacteria/gram of waste rock, respectively, whereas SOBa had an average population density of $1.2x10^3$ bacteria/gram of waste rock. SOBn, SOBa and FeO were all negatively correlated to the paste pH of the sample, with correlation coefficients (r) of -0.65, -0.58 and -0.33, respectively. The 16S rRNA analysis agreed with the results of bacterial enumerations. The bacterial ecology of the waste rock samples were mostly dominated by neutrophilic sulfur oxidizing genera (*e.g. Thiobacillus spp.*), however acidic samples had more dominant acidiphilic

genera (*e.g. Acidithiobacillus spp.*). Cover samples were characterized by a great abundance of diversity in bacteria, without a dominant sulfur oxidizing genera. Several genera of fungi were well established in samples from WRS#1 (*i.e. Pycnopeziza, Leptosphaeria, Tetracladium and Cucurbitaria*) although none have been previously identified as contributors to ARD generation.

This study provides a better understanding of the geochemical conditions in the historical waste-rock stockpiles at the Detour Gold mine site. Many of the physical, chemical and biological processes impacting sulfide oxidation and the mass transport of reactants and oxidation products have been studied. A better understanding of sulfide oxidation and the processes generating ARD at this site can be used to improve the prediction and management of low-quality drainage in future waste stockpiles.

## References


Aachib, M., Aubertin, M., Mbonimpa, M., 2002. Laboratory measurements and predictive equations for gas diffusion coefficient of unsaturated soils. Proceedings of the 55th Canadian Geotechnical and Joint IAH-CNC and CGS Groundwater Speciality Conference Niagara Falls, Ontario, Canadian Geotechnical Society, Ottawa, 163-171.

Adu-Wusu, C., Yanful, E.K., 2006. Performance of engineered test covers on acid generating waste rock at Whistle mine, Ontario. Canadian Geotechnical Journal 43, 1-18.

Ahonen, L., Tuovinen, O.H., 1992. Bacterial Oxidation of Sulfide Minerals in Column Leaching Experiments at Suboptimal Temperatures. Applied and Environmental Microbiology 58(2), 600-606.

Akcil, A., Koldas, S., 2006. Acid Mine Drainage (AMD): causes, treatment and case studies. Journal of Cleaner Production 14, 1139-1145.

Al, T.A., Martin, C.J., Blowes, D.W., 2000. Carbonate-mineral/water interactions in sulfide-rich mine tailings. Geochimica et Cosmochimica Acta 64(23), 3933-3948.

Andjic, V., Whyte, G., Hardy, G., & Burgess, T., 2010. New *Teratosphaeria* species occurring on eucalypts in Australia. Fungal Diversity, 43(1), 27-38.

Amos, R.T., Blowes, D.W., Smith, L.S., Sego, D.C., 2009. Measurement of wind-induced pressure gradients in a waste-rock pile. Vadose Zone Journal 8(4), 953-962.

Amos, R.T., Blowes, D.W., Bailey, B.L., Sego, D.C., Smith, L., Ritchie, A.I.M., 2015. Waste-rock hydrogeology and geochemistry. Applied Geochemistry 57, 140-156.

Andrina, J., Wilson, G.W., Miller, S., Neale, A., 2006. Performance of the acid rock drainage mitigation waste rock trial dump at Grasberg mine. Paper presented at the 7th International Conference on Acid Rock Drainage (ICARD), March 26-30, 2006. St. Louis, MO.

ASTM Standard D4972, 2013. Standard Test Methods for pH of Soils. West Conshohocken, PA: ASTM International.

Baker, B.J., Banfield, J.F., 2003. Microbial communities in acid mine drainage. FEMS Microbiology Ecology 44, 139-152.

Bay, D.S., 2004. Hydrological and hydrogeochemical characteristics of neutral drainage from a waste rock test pile. (Master's thesis, University of British Columbia). Retrieved from <https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0052724>.

B.C. Ministry of Environment, November, 2014. Mount Polley Mine Tailings Breach: Environmental Mitigation and Remediation Progress Report. Retrieved from <http://www.env.gov.bc.ca/eemp/incidents/2014/mount-polley/>

Becker, U., Munz, A.W., Lennie, A.R., Thornton, G., Vaughan, D., 1997. The atomic and electronic structure of the (001) surface of monoclinic pyrrhotite ($Fe_7S_8$) as studied using STM, LEED and quantum mechanical calculations. Surface Science 389, 66-87.

Beckie, R.D., Aranda, C., Blackmore, S.R., Peterson, H.E., Hirsche, D.T., Javadi, M., Blaskovich, R., Haupt, C., Dockrey, J., Conlan, M., Bay, D., Harrison, B., Brienne, S., Smith, L., Klein, B., Mayer, K.U., 2011. A Study of the Mineralogical, Hydrological and Biogeochemical Controls on Drainage from Waste Rock at the Antamina Mine, Peru: an Overview. In Tailings and Mine Waste 2011: Proceedings of the 15th International Conference on Tailings and Mine Waste, Vancouver, BC.

Belzile, N., Chen, Y.-W., Cai, M.-F., Li, Y., 2004. A review on pyrrhotite oxidation. Journal of Geochemical Exploration 84, 65-76.

Binning, P.J., Postma, D., Russell, T.F., Wesselingh, J.A., Boulin, P.F., 2007. Advective and diffusive contributions to reactive gas transport during pyrite oxidation in the unsaturated zone. Water Resources Research 43, 1-12.

Blowes, D.W., Jambor, J.L., 1990. The pore-water geochemistry of the vadose zone of sulfide tailings, Waite Amulet, Quebec, Canada. Applied Geochemistry 5, 327-346.

Blowes, D.W., Al T., Lortie, L, Gould, W.D., Jambor, J.L, 1995. Microbiological, chemical, and mineralogical characterization of the Kidd Creek mine tailings impoundment, Timmins Area, Ontario. Geomicrobiology Journal 13(1), 13-31.

Blowes, D.W., Jamor, J.L., Hanton-Fong, C.J., Lortie, L., Gould, W.D., 1998. Geochemical, mineralogical and microbiological characterization of a sulphide-bearing carbonate-rich gold-mine tailings impoundment, Joutel, Quebec. Applied Geochemistry 113(6), 687-705.

Borek, S.L., 1994. Effect of Humidity on Pyrite Oxidation. In Environmental Geochemistry of Sulfide Oxidation (Eds. C.N Alpers, D.W. Blowes). ACS Symposium Series 550, 31-44.

Brady, K.B.C, and Cravotta, C.A., 1992. Acid base accounting: An improved method of interpreting overburden chemistry to predict quality of coal mine drainage. In 13th Annual West Virginia Surface Mine Drainage Task Force Symp., 13-21.

Brookfield, A.E., Blowes, D.W., Mayer, K.U., 2006. Integration of field measurements and reactive transport modelling to evaluate contaminant transport at a sulfide mine tailings impoundment. Journal of Contaminant Hydrology 88, 1-22.

Bryant, D.A., Garcia Costas, A.M., Maresca, J.A., Maqueo-Chew, A.G., Klatt, C.G., Bateson, M.M., Tallon, L.J., Hostetler, J., Nelson, W.C., Heidelberg, J.F., Ward, D.W., 2007. *Candidatus Chloracidobacterium thermophilum*: An Aerobic Phototrophic Acidobacterium. Science 317(5837), 523-526.

Burford, E.P, Fomina, N., Gadd, G.M., 2003. Fungal involvement in bioweathering and biotransformation of rocks and minerals. Mineralogical Magazine 67(6), 1127-1155.

Bussaban, B., Lumyong, S., Lumyong, P., McKenzie, E. H. C., Hyde, K. D., 2001. A synopsis of the genus *Berkleasmium* with two new species and new records of *Canalisporium caribense* from Zingiberaceae in Thailand. Fungal Diversity 8, 73-85.

Canadian Environmental Assessment Agency, 2011. Comprehensive Study Report; Detour Lake Gold Mine. Retrieved from <http://publications.gc.ca/collections/collection_2012/acee-ceaa/En106-105-2011-eng.pdf>

Cash, A., 2014. Structural and Hydrologic Characterization of Two Historic Waste Rock Piles (Master's thesis, University of Alberta). Unpublished.

Cochrane, W.G., 1950. Estimation of Bacterial Densities by Means of the "Most Probable Number". Biometrics 6(2), 105-116.

Colmer, A. R., Hinkle, M. E., 1947. The role of microorganisms in acid mine drainage: Preliminary report. Science 106, 253-256.

Detour Gold Corporation (DGC), 2010. Technical Report: Feasibility Study of the Detour Lake Project, Ontario for Detour Gold Corporation. Retrieved from <http://www.detourgold.com/files/doc_downloads/Detour_Gold_Corporation_Technical_Report_2010.pdf>

Detour Gold Corporation (DGC), 2012a. Detour Lake Updated Mine Production Plan (NI 43-101 Technical Report). Retrieved from <http://www.detourgold.com/files/doc_downloads/Detour%20Lake%20Gold%20Project%20NI%2043-101.pdf>

Detour Gold Corporation (DGC), 2012b. Projects – At a Glance. Retrieved April 30, 2015, from Detour Gold: http://www.detourgold.com/projects/at-a-glance/default.aspx

Detour Gold Corporation (DGC), 2012c. Projects – Detour Lake Mine. Retrieved April 30, 2015, from Detour Gold: http://www.detourgold.com/projects/at-a-glance/default.aspx

Dockrey, J.W., Lindsay, M.B.J., Ulrich Mayer, K., Beckie, R.D., Norlund, K.L.I., Warren, L.A., Southam, G., 2014. Acidic Microenvironments in Waste Rock Characterized by Neutral Drainage: Bacteria-Mineral Interactions at Sulfide Surfaces. Minerals 4, 170-190.

Doilom, M., Liu, J. K., Jaklitsch, W. M., Ariyawansa, H., Wijayawardene, N. N., Chukeatirote, E., Zhang, M., McKenzie, E.H.C., Geml, J., Voglmayr, H., Hyde, K. D., 2013. An outline of the family *Cucurbitariaceae*. Sydowia, 65(1), 167-192.

Dubrovsky, N.M., Cherry, J.A., Reardon, E.J., Vivyurka, A.J., 1985. Geochemical evolution of inactive pyrite tailings in the Elliot Lake uranium district. Canadian Geotechnical Journal 22, 110-128.

Edwards, K.J., Bond, P.L., Banfield, J.F., 2000. Characteristics of attachment and growth of Thiobacillus caldus on sulphide minerals: a chemotactic response to sulphur minerals? Environmental Microbiology 2(3), 324-332.

Environmental Protection Agency, 1993. Method 300.0 – Determination of Inorganic Anions by Ion Chromatography. Retreived from <https://www.epa.gov/sites/production/files/2015-08/documents/method_300-0_rev_2-1_1993.pdf>

Environmental Protection Agency, 1998. Method 6020A – Inductively Coupled Plasma – Mass Spectrometry. Retrieved from < https://www.epa.gov/sites/production/files/2015-07/documents/epa-6020a.pdf>

Environmental Protection Agency, 2000. Method 6010C – Inductively Coupled Plasma – Atmomic Emission Spectrometry. Retrieved from <https://www.epa.gov/sites/production/files/2015-07/documents/epa-6010c.pdf>

Environment Canada, 2014. Facility greenhouse gas emissions reporting: Overview of reported emissions 2012. Retrieved from < http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=8044859A-1>

Eschbach, M., Mobitz, H., Rompf, A., Jahn, D., 2003. Members of the genus *Arthrobacter* grow anaerobically using nitrate ammonification and fermentative processes: anaerobic adaptation or aerobic bacteria abundant in soil. FEMS Microbiology Letters 223, 227-230.

Fala, O., Aubertin, M., Molson, J., Bussiere, B., Wilson, G.W., Chapuis, R., Martin, V., 2003. Numerical Modelling of Unsaturated Flow in Uniform and Heterogeneous Waste Rock Piles. Paper presented at 6th International Conference on Acid Rock Drainage (ICARD), Ottawa, Ontario, 11-18 July. Cairns, North Queensland, Australia.

Fala, O., Molson, J., Aubertin, M., Bussiere, B., 2005. Numerical modelling of flow and capillary barrier effects in unsaturated waste rock piles. Mine Water and Environment 24, 172-185.

Fisher, R.A., Yates, F., 1963. Statistical Tables for Biological, Agricultural and Medical Research, 6th Edition. London, England: Oliver and Boyd.

Geiser, D. M., Gueidan, C., Miadlikowska, J., Lutzoni, F., Kauff, F., Hofstetter, V., Fraker, E., Schoch, C.L., Tibell, L., Untereiner, W.A., Aptroot, A., 2006. Eurotiomycetes: eurotiomycetidae and Chaetothyriomycetidae. Mycologia, 98(6), 1053-1064.

Goh, T. K., & Hyde, K. D., 1997. The generic distinction between *Chaetopsina* and *Kionochaeta*, with descriptions of two new species. Mycological Research 101(12), 1517-1523.

Gunsinger, M.R., Ptacek, C.J., Blowes, D.W., Jambor, J.L., 2006a. Evaluation of long-term sulfide oxidation processes within pyrrhotite-rich tailings, Lynn Lake, Manitoba. Journal of Contaminant Hydrology 83, 149-170.

Gunsinger, M.R., Ptacek, C.J., Blowes, D.W., Jambor, J.L., Moncur, M.C., 2006b. Mechanisms controlling acid neutralization and metal mobility within a Ni-rich tailings impoundment. Applied Geochemistry 21, 1301-1321.

Hammarstrom, J.M., Seal II., R.R., Meier, A.L., Kornfeld, J.M., 2005. Secondary sulfate minerals associated with acid drainage in the eastern US: recycling of metals and acidity in surficial environments. Chemical Geology 215, 407-431.

Heikkinen, P.M., Raisanen, M.L., Johnson, R.H., 2009. Geochemical characterization of seepage and drainage water quality from two sulphide mine tailings impoundments: acid mine drainage versus neutral mine drainage. Mine Water and the Environment 28, 30-49.

Herasymuik, G.M., 1996. Hydrogeology of a sulfide waste rock dump (Master's thesis, University of Saskatchewan). Retrieved from <http://ecommons.usask.ca/handle/10388/etd-11132012-133516>

Hulshof, A.H.M, Blowes, D.W., Gould, W.D., 2006. Evaluation of in situ layers for treatment of acid mine drainage: A field comparison. Water Research 40, 1816-1826.

Hvorslev, M.J., 1951. Time lag and soil permeability in groundwater observations. Bulletin No. 36 Waterways Experiment Station, Corps of Engineers, Vicksburg, MS.

Jambor, J.L., Dutrizac, J.E., Groat, L.A., Raudsepp, M., 2002. Static tests of neutralization potentials of silicate and aluminosilicate minerals. Environmental Geology 43, 1-17.

Janzen, M.P., Nicholson, R.V., Scharer, J.M., 2000. Pyrrhotite reaction kinetics: Reaction rates for oxidation by oxygen, ferric iron, and for nonoxidative dissolution. Geochimica et Cosmochimica Acta 64(9), 1511-1522.

Jerz, J.K., Rimstidt, D.J., 2004. Pyrite oxidation in moist air. Geochimica et Cosmochimica Acta 68(4), 701-714.

Johnson, R.H., Blowes, D.W., Robertson, W.D., Jambor, J.L., 2000. The hydrogeochemistry of the Nickel Rim mine tailings impoundment, Sudbury, Ontario. Journal of Contaminant Hydrology 41, 49-80.

Jurjovec, J., Ptacek, C.J., Blowes, D.W., 2002. Acid neutralization mechanisms and metal release in mine tailings: A laboratory column experiment. Geochimica et Cosmochimica Acta 66(9), 1511-1523.

Kamei, G., Ohmoto, H., 2000. The kinetics of reactions between pyrite and $O_2$-bearing water revealed from in situ monitoring of DO, Eh and pH in a closed system. Geochimica et Cosmochimica Acta 64(15), 2585-2601.

Kelly, D.P., Shergill, J.K., Lu, W.-P., Wood, A.P., 1997. Oxidative metabolism of inorganic sulfur compounds by bacteria. Antonie van Leeuwenhoek Journal of Microbiology 71, 95-107.

Kohlmeyer, J., Volkmann-Kohlmeyer, B., Eriksson, O.E., 1997. Fungi on *Juncus roemerianus* 9. New Obligate and Facultative Marine *Ascomycotina*. Botanica Marina 40, 291-300.

Kuenen, J.G., Beudeker, R.F., 1982. Microbiology of thiobacilli and other sulphur-oxidizing autotrophs, mixotrophs and heterotrophs. Philosophical Transactions of the Royal Society of London: Series B, Biological Sciences 298(10), 473-497.

Kuo, E.Y., Ritchie, A.I.M., 1999. The impact of convection on the overall oxidation rate in sulfidic waste rock dumps. In Proceedings of Sudbury '99, Mining and the Environment II. (Eds. D. Goldsack, N. Belzile, P. Yearwood, G. Hall), 211-220. Retrieved from <http://pdf.library.laurentian.ca/medb/conf/Sudbury99/AcidicDrainage/AD23.PDF>

Langman, J.B., Moore, M.L., Ptacek, C.J., Smith, L., Sego, D., Blowes, D.W., 2014. Diavik waste rock project: Evolution of mineral weathering, element release, and acid generation and neutralization during a five-year humidity cell experiment. Minerals 4, 257-278.

Lefebvre, R., Hockley, D., Smolensky, J., Gelinas, P., 2001a. Multiphase transfer processes in waste rock piles producing acid mine drainage 1: Conceptual model and system characterization. Journal of Contaminant Hydrology 52, 137-164.

Lefebvre, R., Hockley, D., Smolensky, J., Lamontagne, A., 2001b. Multiphase transfer processes in waste rock piles producing acid mine drainage 1: Application of numerical simulation. Journal of Contaminant Hydrology 52, 165-186.

Lindsay, M.B.J., Condon, P.D., Jambor, J.L., Lear, K.G., Blowes, D.W., Ptacek, C.J., 2009. Mineralogical, geochemical, and microbial investigation of a sulfide-rich tailings deposit characterized by neutral drainage. Applied Geochemistry 24(12), 2212-2221.

Longcore, J. E., Barr, D. J., & Desaulniers, N. (1995). *Powellomyces*, a new genus in the *Spizellomycetales*. Canadian Journal of Botany 73(9), 1385-1390.

Lowson, R.T., 1982. Aqueous oxidation of pyrite by molecular oxygen. Chemical Reviews 82(5), 481-497.

Lozupone, C. A., & Klein, D. A., 2002. Molecular and cultural assessment of chytrid and *Spizellomyces* populations in grassland soils. Mycologia 94(3), 411-420.

Mann, M.E., Schmidt, G.A., 2003. Ground vs. Surface Air Temperature Trends: Implications for Borehole Surface Temperature Reconstructions. Geophysical Research Letters 30(12), 1607-1617.

McGregor, R.G., Blowes, D.W., Jambor, J.L., Robertson, W.D., 1998. The solid-phase controls on the mobility of metals at the Copper Cliff tailings area, Sudbury, Ontario, Canada. Journal of Contaminant Hydrology 33, 247-271.

Mine Environment Neutral Drainage (MEND), 1991. Morin, K.A., Gerencher, E., Jones, C.E., Konasewich D.E. (Eds.) Critital Literature Review of Acid Drainage from Waste Rock: MEND Project 1.11.1. Retrieved from <http://mend-nedem.org/wp-content/uploads/2013/01/1.11.1.pdf>

Mine Environment Neutral Drainage (MEND), 2001. Tremblay, G.A., Hogan, C.M. (Eds.) Mend Manual: Volume 1 – Summary (MEND Report 5.4.2a). Retrieved from <http://mend-nedem.org/wp-content/uploads/2013/01/5.4.2a.pdf>

Mickibben, A.M., Barnes, H.L., 1986. Oxidation of pyrite in low temperature acidic solutions: Rate laws and surface textures. Geochimica et Cosmochimica Acta 50, 1509-1520.

Millington, R.J., Quirk, J.P., 1960. Permeability of porous solids. Transactions of the Faraday Society 57, 1200-1207.

Molson, J.W., Fala, O., Aubertin, M., Bussiere, B., 2005. Numerical similations of pyrite oxidation and acid mine drainage in unsaturated waste rock piles. Journal of Contaminant Hydrology 78, 343-371.

Moses, C.O., Nordstrom, D.K., Herman, J.S., & Mills, A.L., 1987. Aqueous pyrite oxidation by dissolved oxygen and ferric iron. Geochimica et Cosmochimica Acta 51, 1561-1571.

Moses, C.O., Herman, J.S., 1991. Pyrite oxidation at neutral pH. Geochimica et Cosmochimica Acta 55, 471-482.

Neuner, M., Smith, L., Blowes, D.W., Sego, D.C., Smith, L.J.D., Fretz, N.,Gupton, M., 2013. The Diavik waste rock project: Water flow through mine waste rock in a permafrost terrain. Applied Geochemistry 36, 222-233.

Nicholson, R.V, Scharer, J.M, 1994. Laboratory studies of pyrrhotite oxidation kinetics. In Environmental Geochemistry of Sulfide Oxidation (Eds. C.N Alpers, D.W. Blowes). ACS Symposium Series 550, 14-30.

Nordstrom, D.K., 1982. Aqueous pyrite oxidation and the consequent formation of secondary iron minerals. In Acid Sulfate Weathering (Eds. L. R. Hossner, J. A. Kittrick, D. F. Fanning). Soil Science Society of American Press.

Nordstrom, D.K., 2000. Advances in the hydrogeochemistry and microbiology of acid mine waters. International Geology Review 42, 499-515.

Nordstrom, D.K., 2011. Hydrogeochemical processes governing the origin, transport and fate of major and trace elements from mine wastes and mineralized rocks to surface waters. Applied Geochemistry 26, 1777-1791.

Nordstrom, D.K., Blowes, D.W., Ptacek, C.J., 2015. Hydrogeochemistry and microbiology of mine drainage: An update. Applied Geochemistry 57, 3-16.

Nordstrom, D.K., Southam, G., 1997. Geomicrobiology of sulfide mineral oxidation. Reviews in Mineralogy 35, 361-390.

Oliver, J., Ayer, J., Dube, B., Aubertin, R., Burson, M., Panneton, G., Friedman, R., Hamilton, M., 2012. Structure, stratigraphy, U-Pb geochronology and alteration characteristics of gold mineralization at the Detour Lake gold deposit, Ontario, Canada. Exploration and Mining Geology 20, 1-30.

Pantelis, G., Ritchie, A.I.M., 1992. Rate-limiting factors in dump leaching of pyritic ores. Applied Mathematical Modeling 16, 553-560.

Pantelis, G., Ritchie, A.I.M., Stepanyants, Y.A., 2002. A conceptual model for the description of oxidation and transport processes in sulphidic waste rock dumps. Applied Mathematical Modeling 26, 751-770.

Pekala, M., Asael, D., Butler, I.B., Matthews, A., Richard, D., 2011. Experimental study of Cu isotope fractionation during the reaction of aqueous Cu(II) with Fe(II) sulphides at temperatures between 40 and 200 ˚C. Chemical Geology 289, 31-38.

Persson, P.-A., 1997. The relationship between strain energy, rock damage, fragmentation, and throw in rock blasting. International Journal of Blasting and Fragmentation 1, 99-110.

Pu, X.,Vazquez, O., Monnell, J.D., Neufeld, R.D., 2010. Speciation of aluminum precipitates from acid rock discharges in Central Pennsylvania. Environmental Engineering Science 27(2), 169-180.

Rice, A. V., Currah, R. S., 2005. *Oidiodendron*: A survey of the named species and related anamorphs of *Myxotrichum*. Studies in Mycology, 53, 83-120.

Robertson, J., Barazzuol, L., Day, S., 2012. Extraction of ARD/ML Information from a Brownfield Site for Development for an ARD/ML Plan at the Detour Gold Mine, Ontario, Canada. Paper presented at 9th International Conference on Acid Rock Drainage (ICARD), Ottawa, Ontario, 20-26 May. Ottawa, Ontario: Mine Environment Neutral Drainage (MEND)

Roldan, A., Descals, E., Honrubia, M., 1989. Pure culture studies on *Tetracladium*. Mycological Research 93(4), 452-465.

Salar, R. K., & Aneja, K. R., 2007. Thermophilic fungi: taxonomy and biogeography. Journal of Agricultural Technology 3(1), 77-107.

Sati, S.C., Arya, P., Belwal, M., 2009. *Tetracladium nainitalense* sp. nov., a root endophyte from Kumaun Himalaya, India. Mycologia 101(5), 692-695.

Schippers, A., Jorgensen, B.B., 2001. Oxidation of pyrite and iron sulfide by manganese dioxide in marine sediments. Geochimica et Cosmochimica Acta 66, 915-922.

Schippers, A., Breuker, A., Blazejak, A., Bosecker, K., Kock, D., Wright, T.L., 2010. The biogeochemistry and microbiology of sulfidic mine waste and bioleaching dumps and heaps, and novel Fe(II)-oxidizing bacteria. Hydrometallurgy 104, 342-350.

Shrenk, M.O., Edwards, K.J., Goodman, R.M., Hamers, R.J., Banfield, J.F., 1998. Distribution of Thiobacillus ferrooxidans and Leptospirrilum ferrooxidans: Implications for generation of acid mine drainage. Science 279, 1519-1522. Retrieved from <http://www.sciencemag.org.proxy.lib.uwaterloo.ca/content/279/5356/1519.full>

Schwertmann, U., 1991. Solubility and dissolution of iron oxides. Plant and Soil 130, 1-25.

Sherlock, E.J., Lawrence, R.W., Poulin, R., 1995. On the neutralization of acid rock drainage by carbonate and silicate minerals. Environmental Geology 25, 43-54.

Shum, M., Lavkulich, L., 1999. Speciation and solubility relationships of Al, Cu and Fe in solutions associated with sulfuric acid leached mine waste rock. Environmental Geology 38 (1), 59-68.

Skousen, J., Simmons, J., McDonald, L.M., Ziemkiewicz, P., 2002. Acid–Base Accounting to Predict Post-Mining Drainage Quality on Surface Mines. Journal of Environmental Quality 31, 2034-2044.

Smith, L.J.D., Moncur, M.C., Neuner, M., Gupton, M., Blowes, D.W., Smith, L., Sego, D.C., 2013. The Diavik Waste Rock Project: Design, construction, and instrumentation of field-scale experimental waste-rock piles. Applied Geochemistry 36, 187-199.

Southam, G., Beveridge, T.J., 1992. Enumeration of Thiobacilli within pH-Neutral and Acidic Mine Tailings and Their Role in the Development of Secondary Mineral Soil. Applied and Environmental Microbiology 58(6), 1904-1912.

Sracek, O., Filip, J., Mihaljevic, M., Kribek, B., Majer, V., Veselovsky, F., 2011. Attenuation of dissolved metals in neutral mine drainage in the Zambian Copperbelt. Environmental Monitoring and Assessment 172, 287-299.

Strömberg, B., Banwart, S.A., 1999. Experimental study of acidity-consuming processes in mining waste rock: some influences of mineralogy and particle size. Applied Geochemistry 14, 1-16.

Suzuki, I., Chan, C.W., Takeuchi, T.L., 1994. Oxidation of inorganic sulfur compounds by Thiobacilli. In Environmental Geochemistry of Sulfide Oxidation (Eds. C.N Alpers, D.W. Blowes). ACS Symposium Series 550, 60-67.

Swanson, D.A., Barbour, S.L., Wilson, G.W., O'Kane, M., Soil–atmosphere modelling of an engineered soil cover for acid generating mine waste in a humid, alpine climate. Canadian Geotechnical Journal 40, 276-292.

Tokunaga, T.K., Wan, J., Olson, K.R., 2002. Saturation-matric potential relations in gravel. Water Resources Research 38 (10), 1214.

van Genuchten, M.T., 1980. A closed-form equation for predicting hydraulic conductivity of unsaturated soils. Soil Science Society of America Journal 44(5), 892-898.

Webster, J., Weber, R.W.S., 2007. Introduction to the Fungi – 3rd Edition. Cambridge University Press.

Weirsma, C.L., Rimstidt, J.D., 1984. Rates of reaction of pyrite and marcasite with ferric iron at pH 2. Geochimica et Cosmochimica Acta 48, 85-92.

White, W.L., Whetzel, H.H., 1938. Pleomorphic life cycles in a new genus of the *Helotiaceae*. Mycologia 30(2), 187-203.

Williamson, M.A., Rimstidt, J.D. 1994. The kinetics and electrochemical rate-determining step of aqueous pyrite oxidation. Geochimica et Cosmochimica Acta 58, 5443-5454.

Yanful, E.K., Riley, M.D., Woyshner, M.K., Duncan, J., 1993. Construction and monitoring of a composite soil cover on an experimental waste-rock pile near Newcastle, New Brunswick, Canada. Canadian Geotechnical Journal 30, 588-59.

# Appendix A – Whole Rock Analysis Data

Appendix A contains a detailed summary of whole rock analysis results for waste rock and cover samples recovered from WRS#1, WRS#2, WRS#3 and WRS#4. The detailed results include the following data:

- Table A.1: Carbon, Sulfur and Acid-Base Accounting Data for WRS#3 and WRS#4 Drill Cutting Samples
- Table A.2: Carbon, Sulfur and Acid-Base Accounting Data for WRS#3 Cover Samples
- Table A.3: Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples
- Table A.4: Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples
- Table A.5: Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Profile Excavation Samples
- Table A.6: Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples
- Table A.7: Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples
- Table A.8: X-Ray Fluorescence Data for WRS#3 and WRS#4 Drill Cutting Samples
- Table A.9: X-Ray Fluorescence Data for WRS#3 Cover Samples
- Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples
- Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples
- Table A.12: X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples
- Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples
- Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples

*Table A.1: Carbon, Sulfur and Acid-Base Accounting Data for WRS#3 and WRS#4 Drill Cutting Samples*

| *Sample ID** | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| BH3-1_5.5ft | - | 1.38 | 0.06 | 115.26 | 1.97 | 113.28 | 58.42 |
| BH3-1_21ft | - | 0.93 | 0.05 | 77.63 | 1.67 | 75.95 | 46.44 |
| BH3-1_41ft | - | 0.43 | 0.15 | 35.99 | 4.82 | 31.17 | 7.46 |
| BH3-1_72ft | - | 0.93 | 0.04 | 77.38 | 1.4 | 75.97 | 54.91 |
| BH3-2_6ft | - | 0.81 | 0.12 | 67.62 | 3.91 | 63.7 | 17.26 |
| BH3-2_22ft | - | 0.59 | 0.05 | 49.43 | 1.74 | 47.68 | 28.3 |
| BH3-2_42ft | - | 0.46 | 0.47 | 38.42 | 14.96 | 23.45 | 2.56 |
| BH3-2_62ft | - | 2.53 | 0.05 | 210.21 | 1.64 | 208.56 | 127.48 |
| BH4-2_6ft | - | 0.63 | 0.97 | 52.68 | 30.4 | 22.27 | 1.73 |
| BH4-2_22ft | - | 0.6 | 1.21 | 50.03 | 38.03 | 11.99 | 1.31 |
| BH4-2_42ft | - | 0.54 | 0.84 | 45.11 | 26.26 | 18.85 | 1.71 |
| BH4-2_62ft | - | 0.48 | 1.17 | 40.56 | 36.62 | 3.94 | 1.1 |
| BH4-2_77ft | - | 0.74 | 1.25 | 61.63 | 39.13 | 22.49 | 1.57 |
| BH4-3_6ft | - | 0.88 | 0.61 | 73.46 | 19.11 | 54.35 | 3.84 |
| BH4-3_22ft | - | 0.9 | 1.96 | 74.77 | 61.25 | 13.52 | 1.22 |
| BH4-3_42ft | - | 0.59 | 0.44 | 49.79 | 13.89 | 35.9 | 3.58 |
| BH4-4_22ft | - | 0.59 | 0.72 | 49.12 | 22.66 | 26.46 | 2.16 |
| BH4-4_42ft | - | 0.19 | 0.42 | 16.31 | 13.13 | 3.18 | 1.24 |
| BH4-5_6ft | - | 0.85 | 0.02 | 70.95 | 0.91 | 70.04 | 77.67 |
| BH4-5_22ft | - | 0.43 | 1.08 | 35.69 | 33.96 | 1.72 | 1.05 |
| BH4-5_42ft | - | 0.47 | 0.4 | 39.63 | 12.68 | 26.95 | 3.12 |
| BH4-6_6ft | - | 0.31 | 0.3 | 25.95 | 9.47 | 16.48 | 2.74 |
| BH4-6_22ft | - | 0.35 | 0.74 | 29.25 | 23.26 | 5.98 | 1.25 |
| BH4-6_42ft | - | 0.49 | 0.25 | 41.33 | 8.08 | 33.24 | 5.1 |
| BH4-6_56ft | - | 0.5 | 0.38 | 41.91 | 12.05 | 29.85 | 3.47 |

*indicates the sample location and mid-point of the sampling depth interval (location BH4-6 actually corresponds to BH4-1 in Figure 4.1

*Table A.2: Carbon, Sulfur and Acid-Base Accounting Data for WRS#3 Cover Samples*

| *Sample ID** | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| WRS3-1-1 | - | 0.53 | 0.02 | 44.16 | 0.88 | 43.28 | 50.05 |
| WRS3-1-2 | - | 1.04 | 0.03 | 86.51 | 0.97 | 85.54 | 88.77 |
| WRS3-3-1 | - | 0.79 | 0.01 | 66.34 | 0.58 | 65.76 | 113.69 |
| WRS3-3-2 | - | 1.5 | 0.02 | 125.01 | 0.83 | 124.17 | 149.76 |
| WRS3-5-1 | - | 0.42 | 0.01 | 35.11 | 0.53 | 34.57 | 65.9 |
| WRS3-5-2 | - | 0.51 | 0.14 | 43.06 | 4.64 | 38.42 | 9.27 |
| WRS3-9-1 | - | 0.48 | 0.02 | 39.86 | 0.83 | 39.02 | 47.63 |
| WRS3-9-2 | - | 0.63 | 0.06 | 52.89 | 2.04 | 50.84 | 25.81 |

*indicates the sample location (see Figure 4.2) and depth. Samples ending in -1 were collected approximately 0.5m above samples ending in -2 (see Section 3.2.2)

*Table A.3: Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P1-S1-pan | 0.037 | 0.23 | 3.2 | 19.91 | 100.17 | -80.25 | 0.19 |
| P1-P1-S1-No200 | 0.074 | 0.18 | 3.74 | 15.39 | 117.15 | -101.76 | 0.13 |
| P1-P1-S1-No140 | 0.105 | 0.15 | 4.16 | 12.73 | 130.11 | -117.38 | 0.09 |
| P1-P1-S1-No100 | 0.149 | 0.15 | 3.66 | 13.26 | 114.39 | -101.13 | 0.11 |
| P1-P1-S1-No60 | 0.25 | 0.11 | 2.68 | 9.14 | 84.03 | -74.88 | 0.1 |
| P1-P1-S1-No40 | 0.42 | 0.11 | 1.48 | 9.22 | 46.37 | -37.15 | 0.19 |
| P1-P1-S1-No20 | 0.841 | 0.11 | 0.76 | 9.71 | 23.75 | -14.03 | 0.4 |
| P1-P1-S1-No10 | 2 | 0.25 | 0.78 | 21.31 | 24.39 | -3.07 | 0.87 |
| P1-P1-S1-No4 | 4.76 | 0.18 | 0.83 | 15 | 26.02 | -11.01 | 0.57 |
| P1-P1-S1 Avg* | - | 0.18 | 0.96 | 15.06 | 30.28 | -15.22 | 0.49 |
| P1-P1-S2-pan | 0.037 | 0.34 | 3.08 | 28.84 | 96.3 | -67.45 | 0.29 |
| P1-P1-S2-No200 | 0.074 | 0.29 | 3.28 | 24.35 | 102.59 | -78.23 | 0.23 |
| P1-P1-S2-No140 | 0.105 | 0.22 | 3.57 | 18.7 | 111.82 | -93.11 | 0.16 |
| P1-P1-S2-No100 | 0.149 | 0.16 | 3.38 | 13.67 | 105.87 | -92.19 | 0.12 |
| P1-P1-S2-No60 | 0.25 | 0.14 | 2.72 | 11.62 | 85.29 | -73.67 | 0.13 |
| P1-P1-S2-No40 | 0.42 | 0.13 | 1.62 | 11.33 | 50.74 | -39.41 | 0.22 |
| P1-P1-S2-No20 | 0.841 | 0.13 | 0.89 | 11.12 | 27.85 | -16.72 | 0.39 |
| P1-P1-S2-No10 | 2 | 0.19 | 1.25 | 15.95 | 39.25 | -23.29 | 0.4 |
| P1-P1-S2-No4 | 4.76 | 0.17 | 0.75 | 14.22 | 23.64 | -9.41 | 0.6 |
| P1-P1-S2 Avg* | - | 0.17 | 0.79 | 14.29 | 24.88 | -10.58 | 0.57 |
| P1-P1-S3-pan | 0.037 | 0.18 | 2.73 | 15.75 | 85.32 | -69.56 | 0.18 |
| P1-P1-S3-No200 | 0.074 | 0.16 | 2.74 | 13.48 | 85.86 | -72.37 | 0.15 |
| P1-P1-S3-No140 | 0.105 | 0.16 | 2.83 | 13.48 | 88.67 | -75.19 | 0.15 |
| P1-P1-S3-No100 | 0.149 | 0.15 | 2.56 | 12.98 | 80.3 | -67.31 | 0.16 |
| P1-P1-S3-No60 | 0.25 | 0.16 | 2.31 | 13.32 | 72.45 | -59.12 | 0.18 |
| P1-P1-S3-No40 | 0.42 | 0.16 | 1.45 | 13.76 | 45.54 | -31.77 | 0.3 |
| P1-P1-S3-No20 | 0.841 | 0.13 | 0.81 | 11.51 | 25.43 | -13.91 | 0.45 |
| P1-P1-S3-No10 | 2 | 0.11 | 1.02 | 9.49 | 31.92 | -22.42 | 0.29 |
| P1-P1-S3-No4 | 4.76 | 0.03 | 0.82 | 2.98 | 25.85 | -22.87 | 0.11 |
| P1-P1-S3 Avg* | - | 0.04 | 0.91 | 3.98 | 28.54 | -24.56 | 0.13 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.3(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P2-S1-pan | 0.037 | 1.15 | 1.52 | 96.07 | 47.78 | 48.28 | 2.01 |
| P1-P2-S1-No200 | 0.074 | 1.19 | 1.19 | 99.08 | 37.28 | 61.8 | 2.65 |
| P1-P2-S1-No140 | 0.105 | 1.13 | 1.09 | 93.95 | 34.21 | 59.73 | 2.74 |
| P1-P2-S1-No100 | 0.149 | 1.11 | 1.2 | 92.51 | 37.7 | 54.81 | 2.45 |
| P1-P2-S1-No60 | 0.25 | 1.16 | 1.61 | 96.35 | 50.36 | 45.99 | 1.91 |
| P1-P2-S1-No40 | 0.42 | 1.07 | 0.97 | 89.55 | 30.41 | 59.13 | 2.94 |
| P1-P2-S1-No20 | 0.841 | 1.05 | 0.51 | 87.58 | 16.05 | 71.52 | 5.45 |
| P1-P2-S1-No10 | 2 | 0.92 | 0.61 | 76.83 | 19.26 | 57.56 | 3.98 |
| P1-P2-S1-No4 | 4.76 | 1.35 | 0.48 | 112.59 | 15.03 | 97.55 | 7.48 |
| P1-P2-S1 Avg* | - | 1.33 | 0.51 | 110.59 | 16.22 | 94.37 | 6.81 |
| P1-P2-S2-pan | 0.037 | 0.5 | 1.84 | 41.74 | 57.7 | -15.96 | 0.72 |
| P1-P2-S2-No200 | 0.074 | 0.53 | 1.82 | 44.32 | 57.14 | -12.81 | 0.77 |
| P1-P2-S2-No140 | 0.105 | 0.49 | 2.09 | 40.69 | 65.57 | -24.88 | 0.62 |
| P1-P2-S2-No100 | 0.149 | 0.44 | 2.42 | 36.6 | 75.83 | -39.22 | 0.48 |
| P1-P2-S2-No60 | 0.25 | 0.43 | 2.32 | 36.06 | 72.71 | -36.65 | 0.49 |
| P1-P2-S2-No40 | 0.42 | 0.42 | 1.6 | 34.92 | 50.01 | -15.09 | 0.69 |
| P1-P2-S2-No20 | 0.841 | 0.36 | 0.97 | 29.92 | 30.43 | -0.5 | 0.98 |
| P1-P2-S2-No10 | 2 | 0.29 | 0.78 | 24.11 | 24.41 | -0.3 | 0.98 |
| P1-P2-S2-No4 | 4.76 | 0.25 | 1.3 | 20.92 | 40.62 | -19.69 | 0.51 |
| P1-P2-S2 Avg* | - | 0.28 | 1.32 | 23.9 | 41.4 | -17.49 | 0.57 |
| P1-P2-S3-pan | 0.037 | 0.49 | 1.78 | 40.76 | 55.8 | -15.04 | 0.73 |
| P1-P2-S3-No200 | 0.074 | 0.52 | 1.57 | 43.35 | 49.26 | -5.91 | 0.88 |
| P1-P2-S3-No140 | 0.105 | 0.46 | 1.72 | 38.79 | 53.9 | -15.1 | 0.71 |
| P1-P2-S3-No100 | 0.149 | 0.4 | 1.87 | 33.54 | 58.5 | -24.96 | 0.57 |
| P1-P2-S3-No60 | 0.25 | 0.37 | 1.86 | 31.32 | 58.31 | -26.98 | 0.53 |
| P1-P2-S3-No40 | 0.42 | 0.62 | 2.93 | 52.22 | 91.76 | -39.54 | 0.56 |
| P1-P2-S3-No20 | 0.841 | 0.37 | 0.84 | 30.92 | 26.39 | 4.52 | 1.17 |
| P1-P2-S3-No10 | 2 | 0.36 | 0.98 | 30.21 | 30.75 | -0.54 | 0.98 |
| P1-P2-S3-No4 | 4.76 | 0.34 | 0.91 | 28.75 | 28.68 | 0.06 | 1 |
| P1-P2-S3 Avg* | - | 0.35 | 0.97 | 29.42 | 30.38 | -0.96 | 0.96 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.3(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P3-S1-pan | 0.037 | 1.09 | 1.83 | 90.76 | 57.29 | 33.46 | 1.58 |
| P1-P3-S1-No200 | 0.074 | 1.06 | 1.64 | 88.72 | 51.5 | 37.22 | 1.72 |
| P1-P3-S1-No140 | 0.105 | 1.11 | 1.44 | 92.33 | 45.2 | 47.12 | 2.04 |
| P1-P3-S1-No100 | 0.149 | 1.06 | 1.39 | 88.39 | 43.48 | 44.91 | 2.03 |
| P1-P3-S1-No60 | 0.25 | 1.07 | 1.62 | 89.18 | 50.81 | 38.37 | 1.75 |
| P1-P3-S1-No40 | 0.42 | 1.06 | 1.41 | 88.03 | 44.15 | 43.88 | 1.99 |
| P1-P3-S1-No20 | 0.841 | 1.03 | 0.79 | 85.98 | 24.9 | 61.07 | 3.45 |
| P1-P3-S1-No10 | 2 | 1.08 | 0.49 | 89.92 | 15.46 | 74.46 | 5.81 |
| P1-P3-S1-No4 | 4.76 | 0.74 | 0.72 | 62.08 | 22.54 | 39.54 | 2.75 |
| P1-P3-S1 Avg* | - | 0.77 | 0.74 | 63.98 | 23.43 | 40.54 | 2.72 |
| P1-P3-S3-pan | 0.037 | 0.76 | 1.68 | 63.37 | 52.78 | 10.58 | 1.2 |
| P1-P3-S3-No200 | 0.074 | 0.86 | 2.23 | 71.76 | 69.96 | 1.8 | 1.02 |
| P1-P3-S3-No140 | 0.105 | 0.8 | 1.26 | 67.09 | 39.49 | 27.6 | 1.69 |
| P1-P3-S3-No100 | 0.149 | 1.1 | 2.71 | 91.76 | 84.94 | 6.82 | 1.08 |
| P1-P3-S3-No60 | 0.25 | 0.8 | 1.59 | 66.45 | 49.98 | 16.46 | 1.32 |
| P1-P3-S3-No40 | 0.42 | 0.74 | 1.78 | 61.82 | 55.86 | 5.95 | 1.1 |
| P1-P3-S3-No20 | 0.841 | 0.7 | 0.99 | 58.34 | 31.13 | 27.21 | 1.87 |
| P1-P3-S3-No10 | 2 | 0.66 | 0.89 | 55.19 | 27.99 | 27.2 | 1.97 |
| P1-P3-S3-No4 | 4.76 | 0.56 | 0.61 | 47.17 | 19.12 | 28.05 | 2.46 |
| P1-P3-S3 Avg* | - | 0.58 | 0.69 | 48.86 | 21.84 | 27.01 | 2.23 |
| P1-P4-S1-pan | 0.037 | 0.23 | 0.72 | 19.83 | 22.71 | -2.88 | 0.87 |
| P1-P4-S1-No200 | 0.074 | 0.15 | 0.72 | 13.04 | 22.64 | -9.59 | 0.57 |
| P1-P4-S1-No140 | 0.105 | 0.13 | 0.7 | 11.14 | 21.89 | -10.75 | 0.5 |
| P1-P4-S1-No100 | 0.149 | 0.13 | 0.68 | 10.79 | 21.34 | -10.55 | 0.5 |
| P1-P4-S1-No60 | 0.25 | 0.16 | 0.74 | 13.87 | 23.4 | -9.52 | 0.59 |
| P1-P4-S1-No40 | 0.42 | 0.23 | 0.67 | 19.44 | 21.02 | -1.58 | 0.92 |
| P1-P4-S1-No20 | 0.841 | 0.29 | 0.54 | 24.27 | 17.05 | 7.22 | 1.42 |
| P1-P4-S1-No10 | 2 | 0.31 | 0.45 | 25.88 | 14.19 | 11.68 | 1.82 |
| P1-P4-S1-No4 | 4.76 | 1 | 0.49 | 83.28 | 15.43 | 67.84 | 5.39 |
| P1-P4-S1 Avg* | - | 0.87 | 0.51 | 72.4 | 16.18 | 56.21 | 4.47 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.3(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P4-S2-pan | 0.037 | 0.26 | 2.14 | 22.13 | 66.91 | -44.78 | 0.33 |
| P1-P4-S2-No200 | 0.074 | 0.28 | 1.78 | 23.59 | 55.64 | -32.05 | 0.42 |
| P1-P4-S2-No140 | 0.105 | 0.32 | 1.72 | 27.1 | 53.9 | -26.8 | 0.5 |
| P1-P4-S2-No100 | 0.149 | 0.3 | 1.6 | 25 | 50.05 | -25.05 | 0.49 |
| P1-P4-S2-No60 | 0.25 | 0.28 | 1.4 | 24.06 | 43.97 | -19.9 | 0.54 |
| P1-P4-S2-No40 | 0.42 | 0.27 | 1.06 | 23.22 | 33.13 | -9.91 | 0.7 |
| P1-P4-S2-No20 | 0.841 | 0.21 | 0.72 | 17.98 | 22.65 | -4.66 | 0.79 |
| P1-P4-S2-No10 | 2 | 0.19 | 0.78 | 16.05 | 24.68 | -8.62 | 0.65 |
| P1-P4-S2-No4 | 4.76 | 0.61 | 0.61 | 51.26 | 19.1 | 32.15 | 2.68 |
| P1-P4-S2 Avg* | - | 0.57 | 0.67 | 48.06 | 21.12 | 26.93 | 2.27 |
| P1-P5-S1-pan | 0.037 | 0.91 | 2.62 | 75.75 | 82.08 | -6.32 | 0.92 |
| P1-P5-S1-No200 | 0.074 | 1.16 | 2.19 | 96.34 | 68.57 | 27.76 | 1.4 |
| P1-P5-S1-No140 | 0.105 | 1.13 | 2.14 | 93.98 | 67 | 26.98 | 1.4 |
| P1-P5-S1-No100 | 0.149 | 1.03 | 2.48 | 86.22 | 77.55 | 8.67 | 1.11 |
| P1-P5-S1-No60 | 0.25 | 0.93 | 2.79 | 77.29 | 87.45 | -10.15 | 0.88 |
| P1-P5-S1-No40 | 0.42 | 0.79 | 2.09 | 65.86 | 65.47 | 0.38 | 1 |
| P1-P5-S1-No20 | 0.841 | 0.64 | 1.33 | 53.67 | 41.72 | 11.94 | 1.28 |
| P1-P5-S1-No10 | 2 | 0.43 | 1.02 | 36.02 | 31.89 | 4.13 | 1.12 |
| P1-P5-S1-No4 | 4.76 | 0.45 | 1.24 | 37.4 | 39.02 | -1.61 | 0.95 |
| P1-P5-S1 Avg* | - | 0.46 | 1.27 | 38.73 | 39.92 | -1.19 | 0.97 |
| P1-P5-S2-pan | 0.037 | 0.37 | 2.3 | 31.53 | 72.14 | -40.61 | 0.43 |
| P1-P5-S2-No200 | 0.074 | 0.29 | 1.97 | 24.6 | 61.79 | -37.19 | 0.39 |
| P1-P5-S2-No140 | 0.105 | 0.26 | 1.86 | 22.09 | 58.23 | -36.14 | 0.37 |
| P1-P5-S2-No100 | 0.149 | 0.25 | 1.9 | 21.2 | 59.66 | -38.46 | 0.35 |
| P1-P5-S2-No60 | 0.25 | 0.24 | 1.76 | 20 | 55.26 | -35.25 | 0.36 |
| P1-P5-S2-No40 | 0.42 | 0.22 | 1.53 | 18.32 | 48.1 | -29.77 | 0.38 |
| P1-P5-S2-No20 | 0.841 | 0.18 | 1.1 | 15.49 | 34.63 | -19.14 | 0.44 |
| P1-P5-S2-No10 | 2 | 0.22 | 1.2 | 18.33 | 37.58 | -19.24 | 0.48 |
| P1-P5-S2-No4 | 4.76 | 0.15 | 1.55 | 13.15 | 48.6 | -35.44 | 0.27 |
| P1-P2-S2 Avg* | - | 0.17 | 1.55 | 14.79 | 48.5 | -33.71 | 0.3 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.3(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P5-S3-pan | 0.037 | 1.69 | 1.13 | 140.48 | 35.58 | 104.9 | 3.94 |
| P1-P5-S3-No200 | 0.074 | 1.02 | 0.84 | 85.09 | 26.29 | 58.8 | 3.23 |
| P1-P5-S3-No140 | 0.105 | 0.85 | 0.74 | 71.23 | 23.41 | 47.82 | 3.04 |
| P1-P5-S3-No100 | 0.149 | 0.79 | 0.7 | 65.58 | 21.88 | 43.7 | 2.99 |
| P1-P5-S3-No60 | 0.25 | 0.86 | 0.75 | 71.82 | 23.44 | 48.38 | 3.06 |
| P1-P5-S3-No40 | 0.42 | 0.98 | 0.71 | 81.81 | 22.24 | 59.57 | 3.67 |
| P1-P5-S3-No20 | 0.841 | 0.91 | 0.83 | 75.61 | 26.12 | 49.48 | 2.89 |
| P1-P5-S3-No10 | 2 | 0.87 | 0.8 | 72.81 | 25.28 | 47.53 | 2.88 |
| P1-P5-S3-No4 | 4.76 | 0.64 | 1.17 | 53.64 | 36.77 | 16.86 | 1.45 |
| P1-P5-S3 Avg* | - | 0.67 | 1.15 | 56.31 | 35.97 | 20.33 | 1.56 |
| P1-P6-S2-pan | 0.037 | 0.79 | 2.01 | 65.88 | 63 | 2.88 | 1.04 |
| P1-P6-S2-No200 | 0.074 | 0.74 | 1.75 | 61.88 | 54.84 | 7.04 | 1.12 |
| P1-P6-S2-No140 | 0.105 | 0.69 | 1.68 | 57.46 | 52.57 | 4.88 | 1.09 |
| P1-P6-S2-No100 | 0.149 | 0.66 | 1.55 | 54.93 | 48.57 | 6.36 | 1.13 |
| P1-P6-S2-No60 | 0.25 | 0.7 | 1.31 | 58.89 | 41.04 | 17.84 | 1.43 |
| P1-P6-S2-No40 | 0.42 | 0.8 | 1.1 | 66.94 | 34.52 | 32.41 | 1.93 |
| P1-P6-S2-No20 | 0.841 | 0.81 | 1.06 | 67.36 | 33.15 | 34.2 | 2.03 |
| P1-P6-S2-No10 | 2 | 0.82 | 0.94 | 68.73 | 29.64 | 39.09 | 2.31 |
| P1-P6-S2-No4 | 4.76 | 0.93 | 1 | 77.9 | 31.54 | 46.36 | 2.46 |
| P1-P6-S2 Avg* | - | 0.93 | 1.01 | 77.71 | 31.66 | 46.04 | 2.45 |
| P1-P7-S1-pan | 0.037 | 0.28 | 3.19 | 23.83 | 99.76 | -75.93 | 0.23 |
| P1-P7-S1-No200 | 0.074 | 0.25 | 2.96 | 20.77 | 92.8 | -72.03 | 0.22 |
| P1-P7-S1-No140 | 0.105 | 0.24 | 2.74 | 20.52 | 85.63 | -65.1 | 0.23 |
| P1-P7-S1-No100 | 0.149 | 0.23 | 2.39 | 19.72 | 74.8 | -55.08 | 0.26 |
| P1-P7-S1-No60 | 0.25 | 0.15 | 1.98 | 12.89 | 61.97 | -49.07 | 0.2 |
| P1-P7-S1-No40 | 0.42 | 0.08 | 1.58 | 7.21 | 49.65 | -42.43 | 0.14 |
| P1-P7-S1-No20 | 0.841 | 0.06 | 1.2 | 5.46 | 37.6 | -32.13 | 0.14 |
| P1-P7-S1-No10 | 2 | 0.04 | 1.18 | 3.48 | 37.17 | -33.69 | 0.09 |
| P1-P7-S1 Avg* | - | 0.00 | 1.21 | 0.37 | 37.91 | -37.54 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.3(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P1-P10-S1-pan | 0.037 | 0.53 | 2.29 | 44.53 | 71.76 | -27.23 | 0.62 |
| P1-P10-S1-No200 | 0.074 | 0.55 | 2.93 | 46.28 | 91.61 | -45.33 | 0.5 |
| P1-P10-S1-No140 | 0.105 | 0.54 | 3.76 | 44.93 | 117.77 | -72.84 | 0.38 |
| P1-P10-S1-No100 | 0.149 | 0.45 | 4 | 37.41 | 125.09 | -87.68 | 0.29 |
| P1-P10-S1-No60 | 0.25 | 0.37 | 2.77 | 31.03 | 86.75 | -55.72 | 0.35 |
| P1-P10-S1-No40 | 0.42 | 0.3 | 1.42 | 25.68 | 44.53 | -18.84 | 0.57 |
| P1-P10-S1-No20 | 0.841 | 0.21 | 0.85 | 17.9 | 26.77 | -8.86 | 0.66 |
| P1-P10-S1-No10 | 2 | 0.16 | 0.89 | 13.64 | 28.11 | -14.46 | 0.48 |
| P1-P10-S1-No4 | 4.76 | 0.26 | 1.17 | 21.59 | 36.59 | -15 | 0.59 |
| P1-P10-S1 Avg* | - | 0.26 | 1.2 | 21.86 | 37.69 | -15.83 | 0.57 |
| P1-P11-S1-pan | 0.037 | 0.7 | 2.67 | 58.46 | 83.45 | -24.99 | 0.7 |
| P1-P11-S1-No200 | 0.074 | 0.83 | 2.44 | 68.93 | 76.41 | -7.47 | 0.9 |
| P1-P11-S1-No140 | 0.105 | 0.86 | 2.31 | 71.48 | 72.29 | -0.81 | 0.98 |
| P1-P11-S1-No100 | 0.149 | 0.71 | 1.99 | 59.28 | 62.37 | -3.08 | 0.95 |
| P1-P11-S1-No60 | 0.25 | 0.78 | 2.55 | 65.5 | 79.71 | -14.21 | 0.82 |
| P1-P11-S1-No40 | 0.42 | 0.72 | 1.32 | 59.93 | 41.45 | 18.48 | 1.44 |
| P1-P11-S1-No20 | 0.841 | 0.69 | 0.96 | 57.83 | 30.04 | 27.79 | 1.92 |
| P1-P11-S1-No10 | 2 | 0.48 | 1.08 | 40.29 | 33.92 | 6.36 | 1.18 |
| P1-P11-S1-No4 | 4.76 | 0.23 | 1.62 | 19.5 | 50.92 | -31.41 | 0.38 |
| P1-P11-S1 Avg* | - | 0.3 | 1.62 | 25.21 | 50.73 | -25.52 | 0.49 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4: Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S1-S1-pan | 0.037 | 0.1 | 2.02 | 8.7 | 63.42 | -54.72 | 0.13 |
| TP-P1-S1-S1-No200 | 0.074 | 0.09 | 2.36 | 7.7 | 73.86 | -66.16 | 0.1 |
| TP-P1-S1-S1-No140 | 0.105 | 0.09 | 2.93 | 7.52 | 91.8 | -84.27 | 0.08 |
| TP-P1-S1-S1-No100 | 0.149 | 0.07 | 3.72 | 5.96 | 116.39 | -110.43 | 0.05 |
| TP-P1-S1-S1-No60 | 0.25 | 0.07 | 3.49 | 5.86 | 109.28 | -103.41 | 0.05 |
| TP-P1-S1-S1-No40 | 0.42 | 0.05 | 2.01 | 4.78 | 63.01 | -58.23 | 0.07 |
| TP-P1-S1-S1-No20 | 0.841 | 0.03 | 1.37 | 2.59 | 42.94 | -40.35 | 0.06 |
| TP-P1-S1-S1-No10 | 2 | 0.02 | 1.39 | 2.09 | 43.74 | -41.64 | 0.04 |
| TP-P1-S1-S1-No4 | 4.76 | 0.26 | 2.12 | 21.97 | 66.31 | -44.34 | 0.33 |
| TP-P1-S1-S1 Avg* | - | 0.23 | 2.09 | 19.42 | 65.32 | -45.9 | 0.29 |
| TP-P1-S1-S2-pan | 0.037 | 0.2 | 2.99 | 17.09 | 93.52 | -76.42 | 0.18 |
| TP-P1-S1-S2-No200 | 0.074 | 0.22 | 2.8 | 18.31 | 87.72 | -69.41 | 0.2 |
| TP-P1-S1-S2-No140 | 0.105 | 0.23 | 3.09 | 19.69 | 96.78 | -77.09 | 0.2 |
| TP-P1-S1-S2-No100 | 0.149 | 0.24 | 3.33 | 20.12 | 104.2 | -84.07 | 0.19 |
| TP-P1-S1-S2-No60 | 0.25 | 0.21 | 2.57 | 18.24 | 80.37 | -62.12 | 0.22 |
| TP-P1-S1-S2-No40 | 0.42 | 0.17 | 1.35 | 14.17 | 42.47 | -28.3 | 0.33 |
| TP-P1-S1-S2-No20 | 0.841 | 0.09 | 0.79 | 8.05 | 24.79 | -16.74 | 0.32 |
| TP-P1-S1-S2-No10 | 2 | 0.06 | 0.54 | 5.67 | 16.94 | -11.27 | 0.33 |
| TP-P1-S1-S2-No4 | 4.76 | 0.01 | 0.51 | 1.39 | 16.18 | -14.79 | 0.08 |
| TP-P1-S1-S2 Avg* | - | 0.04 | 0.69 | 3.38 | 21.81 | -18.42 | 0.15 |
| TP-P1-S2-S1-pan | 0.037 | 0.59 | 0.09 | 49.3 | 2.91 | 46.38 | 16.89 |
| TP-P1-S2-S1-No200 | 0.074 | 0.39 | 0.09 | 32.51 | 3.01 | 29.49 | 10.77 |
| TP-P1-S2-S1-No140 | 0.105 | 0.24 | 0.08 | 20.02 | 2.53 | 17.48 | 7.89 |
| TP-P1-S2-S1-No100 | 0.149 | 0.21 | 0.06 | 17.54 | 1.96 | 15.58 | 8.94 |
| TP-P1-S2-S1-No60 | 0.25 | 0.22 | 0.05 | 18.57 | 1.77 | 16.79 | 10.44 |
| TP-P1-S2-S1-No40 | 0.42 | 0.31 | 0.07 | 26.22 | 2.24 | 23.98 | 11.7 |
| TP-P1-S2-S1-No20 | 0.841 | 0.42 | 0.13 | 35.52 | 4.28 | 31.24 | 8.28 |
| TP-P1-S2-S1-No10 | 2 | 0.41 | 0.08 | 34.81 | 2.58 | 32.23 | 13.47 |
| TP-P1-S2-S1-No4 | 4.76 | 0.26 | 0.07 | 21.81 | 2.37 | 19.43 | 9.16 |
| TP-P1-S2-S1 Avg* | - | 0.28 | 0.07 | 23.97 | 2.44 | 21.53 | 9.79 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S2-S2-pan | 0.037 | 0.72 | 1.81 | 59.82 | 56.73 | 3.08 | 1.05 |
| TP-P1-S2-S2-No200 | 0.074 | 0.73 | 1.29 | 61.02 | 40.43 | 20.59 | 1.5 |
| TP-P1-S2-S2-No140 | 0.105 | 0.65 | 0.98 | 54.06 | 30.69 | 23.37 | 1.76 |
| TP-P1-S2-S2-No100 | 0.149 | 0.57 | 0.79 | 47.93 | 24.9 | 23.03 | 1.92 |
| TP-P1-S2-S2-No40 | 0.42 | 0.67 | 0.77 | 56.39 | 24.08 | 32.3 | 2.34 |
| TP-P1-S2-S2-No20 | 0.841 | 0.68 | 0.64 | 56.53 | 20.23 | 36.29 | 2.79 |
| TP-P1-S2-S2-No10 | 2 | 0.65 | 0.72 | 54.75 | 22.67 | 32.08 | 2.41 |
| TP-P1-S2-S2-No4 | 4.76 | 0.44 | 0.95 | 36.74 | 29.89 | 6.84 | 1.22 |
| TP-P1-S2-S2 Avg* | - | 0.48 | 0.94 | 40.26 | 29.51 | 10.74 | 1.36 |
| TP-P1-S3-S2-pan | 0.037 | 1.48 | 0.05 | 122.98 | 1.69 | 121.29 | 72.74 |
| TP-P1-S3-S2-No200 | 0.074 | 0.65 | 0.04 | 54.13 | 1.26 | 52.86 | 42.69 |
| TP-P1-S3-S2-No140 | 0.105 | 0.58 | 0.03 | 48.23 | 1.13 | 47.09 | 42.46 |
| TP-P1-S3-S2-No100 | 0.149 | 0.45 | 0.03 | 37.99 | 1.13 | 36.86 | 33.55 |
| TP-P1-S3-S2-No60 | 0.25 | 0.58 | 0.03 | 48.78 | 1.06 | 47.71 | 45.66 |
| TP-P1-S3-S2-No40 | 0.42 | 0.8 | 0.05 | 67.18 | 1.7 | 65.48 | 39.38 |
| TP-P1-S3-S2-No20 | 0.841 | 1.3 | 0.06 | 108.54 | 2.16 | 106.37 | 50.08 |
| TP-P1-S3-S2-No10 | 2 | 1.13 | 0.12 | 94.6 | 4.04 | 90.56 | 23.41 |
| TP-P1-S3-S2-No4 | 4.76 | 1.11 | 0.21 | 92.88 | 6.78 | 86.1 | 13.69 |
| TP-P1-S3-S2 Avg* | - | 0.98 | 0.1 | 82.09 | 3.16 | 78.93 | 25.95 |
| TP-P1-S4-S2-pan | 0.037 | 0.87 | 1.86 | 72.99 | 58.17 | 14.82 | 1.25 |
| TP-P1-S4-S2-No200 | 0.074 | 0.85 | 1.56 | 71.34 | 48.91 | 22.43 | 1.45 |
| TP-P1-S4-S2-No140 | 0.105 | 0.89 | 1.26 | 74.48 | 39.56 | 34.92 | 1.88 |
| TP-P1-S4-S2-No100 | 0.149 | 0.8 | 0.92 | 67.15 | 28.91 | 38.24 | 2.32 |
| TP-P1-S4-S2-No60 | 0.25 | 0.69 | 0.81 | 57.48 | 25.33 | 32.15 | 2.26 |
| TP-P1-S4-S2-No40 | 0.42 | 0.61 | 0.59 | 50.96 | 18.59 | 32.36 | 2.74 |
| TP-P1-S4-S2-No20 | 0.841 | 0.36 | 0.48 | 30.35 | 15.1 | 15.25 | 2 |
| TP-P1-S4-S2-No10 | 2 | 0.35 | 0.56 | 29.32 | 17.66 | 11.66 | 1.66 |
| TP-P1-S4-S2-No4 | 4.76 | 0.31 | 0.65 | 26.55 | 20.44 | 6.11 | 1.29 |
| TP-P1-S4-S2 Avg* | - | 0.39 | 0.73 | 32.68 | 23.05 | 9.63 | 1.41 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S4-S3-pan | 0.037 | 0.9 | 1.71 | 74.83 | 53.57 | 21.25 | 1.39 |
| TP-P1-S4-S3-No200 | 0.074 | 0.82 | 1.44 | 68.25 | 45.01 | 23.24 | 1.51 |
| TP-P1-S4-S3-No140 | 0.105 | 0.76 | 1 | 63.23 | 31.55 | 31.68 | 2 |
| TP-P1-S4-S3-No100 | 0.149 | 0.59 | 0.76 | 49.07 | 23.83 | 25.23 | 2.05 |
| TP-P1-S4-S3-No60 | 0.25 | 0.52 | 0.77 | 43.86 | 24.31 | 19.55 | 1.8 |
| TP-P1-S4-S3-No40 | 0.42 | 0.43 | 0.65 | 35.74 | 20.51 | 15.22 | 1.74 |
| TP-P1-S4-S3-No20 | 0.841 | 0.36 | 0.48 | 29.91 | 15.09 | 14.81 | 1.98 |
| TP-P1-S4-S3-No10 | 2 | 0.3 | 0.59 | 25.71 | 18.58 | 7.12 | 1.38 |
| TP-P1-S4-S3-No4 | 4.76 | 0.12 | 0.54 | 10.1 | 17.16 | -7.05 | 0.58 |
| TP-P1-S4-S3 Avg* | - | 0.21 | 0.62 | 18.05 | 19.65 | -1.6 | 0.91 |
| TP-P1-S5-S1-pan | 0.037 | 0.7 | 0.41 | 58.47 | 12.83 | 45.63 | 4.55 |
| TP-P1-S5-S1-No200 | 0.074 | 0.46 | 0.19 | 38.29 | 6.23 | 32.06 | 6.14 |
| TP-P1-S5-S1-No140 | 0.105 | 0.43 | 0.16 | 35.94 | 5.11 | 30.82 | 7.03 |
| TP-P1-S5-S1-No100 | 0.149 | 0.39 | 0.12 | 32.51 | 3.92 | 28.59 | 8.28 |
| TP-P1-S5-S1-No60 | 0.25 | 0.56 | 0.1 | 47.01 | 3.21 | 43.79 | 14.61 |
| TP-P1-S5-S1-No40 | 0.42 | 0.67 | 0.13 | 55.81 | 4.32 | 51.48 | 12.9 |
| TP-P1-S5-S1-No20 | 0.841 | 0.87 | 0.16 | 72.48 | 5.11 | 67.37 | 14.18 |
| TP-P1-S5-S1-No10 | 2 | 0.61 | 0.4 | 51.11 | 12.66 | 38.44 | 4.03 |
| TP-P1-S5-S1-No4 | 4.76 | 1.56 | 0.6 | 129.71 | 18.95 | 110.76 | 6.84 |
| TP-P1-S5-S1 Avg* | - | 1.3 | 0.5 | 108.12 | 15.71 | 92.4 | 6.87 |
| TP-P1-S5-S2-pan | 0.037 | 0.46 | 3.98 | 38.27 | 124.38 | -86.1 | 0.3 |
| TP-P1-S5-S2-No200 | 0.074 | 0.55 | 2.98 | 46.11 | 93.29 | -47.17 | 0.49 |
| TP-P1-S5-S2-No140 | 0.105 | 0.62 | 2.03 | 51.78 | 63.6 | -11.82 | 0.81 |
| TP-P1-S5-S2-No100 | 0.149 | 0.68 | 1.69 | 56.54 | 52.94 | 3.6 | 1.06 |
| TP-P1-S5-S2-No60 | 0.25 | 0.69 | 1.54 | 57.85 | 48.19 | 9.66 | 1.2 |
| TP-P1-S5-S2-No40 | 0.42 | 0.66 | 1.31 | 54.94 | 41.2 | 13.74 | 1.33 |
| TP-P1-S5-S2-No20 | 0.841 | 0.62 | 1.53 | 52.05 | 48.12 | 3.93 | 1.08 |
| TP-P1-S5-S2-No10 | 2 | 0.53 | 2.46 | 44.3 | 77.06 | -32.76 | 0.57 |
| TP-P1-S5-S2-No4 | 4.76 | 0.15 | 1.33 | 13.12 | 41.58 | -28.46 | 0.31 |
| TP-P1-S5-S2 Avg* | - | 0.2 | 1.44 | 17.21 | 45.06 | -27.84 | 0.38 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S6-S1-pan | 0.037 | 0.72 | 0.06 | 60.13 | 2.02 | 58.11 | 29.73 |
| TP-P1-S6-S1-No200 | 0.074 | 0.44 | 0.02 | 37.2 | 0.87 | 36.32 | 42.48 |
| TP-P1-S6-S1-No140 | 0.105 | 0.43 | 0.02 | 36.14 | 0.75 | 35.38 | 47.77 |
| TP-P1-S6-S1-No100 | 0.149 | 0.44 | 0.02 | 37.29 | 0.77 | 36.51 | 47.88 |
| TP-P1-S6-S1-No60 | 0.25 | 0.48 | 0.02 | 40.63 | 0.73 | 39.89 | 55.46 |
| TP-P1-S6-S1-No40 | 0.42 | 0.67 | 0.02 | 56.22 | 0.8 | 55.42 | 70.13 |
| TP-P1-S6-S1-No20 | 0.841 | 0.94 | 0.05 | 78.73 | 1.56 | 77.16 | 50.29 |
| TP-P1-S6-S1-No10 | 2 | 1.17 | 0.08 | 97.74 | 2.62 | 95.12 | 37.3 |
| TP-P1-S6-S1-No4 | 4.76 | 1.16 | 0.09 | 97.06 | 2.81 | 94.24 | 34.47 |
| TP-P1-S6-S1 Avg* | - | 0.73 | 0.04 | 60.81 | 1.44 | 59.36 | 41.95 |
| TP-P1-S6-S2-pan | 0.037 | 0.24 | 4.15 | 20.05 | 129.74 | -109.68 | 0.15 |
| TP-P1-S6-S2-No200 | 0.074 | 0.18 | 3.71 | 15.4 | 116 | -100.59 | 0.13 |
| TP-P1-S6-S2-No140 | 0.105 | 0.16 | 3.13 | 14.07 | 98.12 | -84.04 | 0.14 |
| TP-P1-S6-S2-No100 | 0.149 | 0.15 | 2.68 | 12.53 | 83.8 | -71.26 | 0.14 |
| TP-P1-S6-S2-No60 | 0.25 | 0.16 | 2.16 | 13.76 | 67.64 | -53.87 | 0.2 |
| TP-P1-S6-S2-No40 | 0.42 | 0.19 | 1.76 | 16.55 | 55.1 | -38.54 | 0.3 |
| TP-P1-S6-S2-No20 | 0.841 | 0.23 | 1.22 | 19.76 | 38.31 | -18.55 | 0.51 |
| TP-P1-S6-S2-No10 | 2 | 0.32 | 1.53 | 27.25 | 48.02 | -20.77 | 0.56 |
| TP-P1-S6-S2-No4 | 4.76 | 0.04 | 1.19 | 4.02 | 37.28 | -33.25 | 0.1 |
| TP-P1-S6-S2 Avg* | - | 0.12 | 1.54 | 10.56 | 48.15 | -37.58 | 0.21 |
| TP-P1-S8-S1-pan | 0.037 | 1.14 | 0.06 | 95.25 | 2.06 | 93.18 | 46.05 |
| TP-P1-S8-S1-No200 | 0.074 | 0.73 | 0.02 | 61.1 | 0.91 | 60.18 | 66.53 |
| TP-P1-S8-S1-No140 | 0.105 | 0.65 | 0.02 | 54.28 | 0.68 | 53.6 | 79.7 |
| TP-P1-S8-S1-No100 | 0.149 | 0.68 | 0.02 | 56.59 | 0.7 | 55.89 | 80.4 |
| TP-P1-S8-S1-No60 | 0.25 | 0.71 | 0.02 | 59.35 | 0.68 | 58.67 | 87.15 |
| TP-P1-S8-S1-No40 | 0.42 | 1.03 | 0.02 | 86.3 | 0.73 | 85.56 | 116.65 |
| TP-P1-S8-S1-No20 | 0.841 | 1.5 | 0.03 | 124.84 | 1.14 | 123.7 | 109 |
| TP-P1-S8-S1-No10 | 2 | 1.71 | 0.03 | 142.24 | 1.23 | 141 | 114.79 |
| TP-P1-S8-S1-No4 | 4.76 | 1.73 | 0.25 | 143.82 | 7.99 | 135.82 | 17.98 |
| TP-P1-S8-S1 Avg* | - | 1.3 | 0.11 | 108.47 | 3.58 | 104.88 | 30.25 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S9-S2-pan | 0.037 | 0.3 | 2.24 | 25.57 | 70.29 | -44.72 | 0.36 |
| TP-P1-S9-S2-No200 | 0.074 | 0.25 | 2.05 | 21.13 | 64.36 | -43.23 | 0.32 |
| TP-P1-S9-S2-No140 | 0.105 | 0.25 | 1.96 | 20.83 | 61.33 | -40.49 | 0.33 |
| TP-P1-S9-S2-No100 | 0.149 | 0.21 | 1.69 | 18.17 | 53.07 | -34.9 | 0.34 |
| TP-P1-S9-S2-No60 | 0.25 | 0.19 | 1.5 | 16.4 | 47.01 | -30.6 | 0.34 |
| TP-P1-S9-S2-No40 | 0.42 | 0.21 | 1.1 | 17.57 | 34.39 | -16.81 | 0.51 |
| TP-P1-S9-S2-No20 | 0.841 | 0.15 | 0.72 | 12.93 | 22.65 | -9.72 | 0.57 |
| TP-P1-S9-S2-No10 | 2 | 0.15 | 0.77 | 12.81 | 24.32 | -11.5 | 0.52 |
| TP-P1-S9-S2-No4 | 4.76 | 0.03 | 0.94 | 2.68 | 29.57 | -26.88 | 0.09 |
| TP-P1-S9-S2 Avg* | - | 0.05 | 0.99 | 4.51 | 31.18 | -26.67 | 0.14 |
| TP-P1-S9-S3-pan | 0.037 | 0.11 | 3.38 | 9.81 | 105.83 | -96.02 | 0.09 |
| TP-P1-S9-S3-No200 | 0.074 | 0.09 | 3.43 | 8 | 107.47 | -99.47 | 0.07 |
| TP-P1-S9-S3-No140 | 0.105 | 0.08 | 3.59 | 6.9 | 112.37 | -105.46 | 0.06 |
| TP-P1-S9-S3-No100 | 0.149 | 0.06 | 3.68 | 5.61 | 115.26 | -109.65 | 0.04 |
| TP-P1-S9-S3-No60 | 0.25 | 0.05 | 3.21 | 4.38 | 100.5 | -96.12 | 0.04 |
| TP-P1-S9-S3-No40 | 0.42 | 0.03 | 2.06 | 3.27 | 64.66 | -61.38 | 0.05 |
| TP-P1-S9-S3-No20 | 0.841 | 0.02 | 1.44 | 1.96 | 45.24 | -43.28 | 0.04 |
| TP-P1-S9-S3-No10 | 2 | 0.02 | 1.32 | 1.71 | 41.26 | -39.54 | 0.04 |
| TP-P1-S9-S3-No4 | 4.76 | 0.01 | 1.24 | 1.32 | 38.97 | -37.65 | 0.03 |
| TP-P1-S9-S3 Avg* | - | 0.02 | 1.67 | 2.47 | 52.45 | -49.97 | 0.04 |
| TP-P1-S10-S1-pan | 0.037 | 0.86 | 0.05 | 72.15 | 1.86 | 70.28 | 38.6 |
| TP-P1-S10-S1-No200 | 0.074 | 0.59 | 0.04 | 49.52 | 1.28 | 48.23 | 38.4 |
| TP-P1-S10-S1-No140 | 0.105 | 0.55 | 0.03 | 46.45 | 1.07 | 45.38 | 43.04 |
| TP-P1-S10-S1-No100 | 0.149 | 0.52 | 0.02 | 43.66 | 0.89 | 42.76 | 48.53 |
| TP-P1-S10-S1-No60 | 0.25 | 0.59 | 0.02 | 49.25 | 0.86 | 48.38 | 57.15 |
| TP-P1-S10-S1-No40 | 0.42 | 0.75 | 0.02 | 62.53 | 0.82 | 61.71 | 76.16 |
| TP-P1-S10-S1-No20 | 0.841 | 0.97 | 0.06 | 80.71 | 1.91 | 78.8 | 42.2 |
| TP-P1-S10-S1-No10 | 2 | 0.58 | 0.05 | 48.46 | 1.64 | 46.82 | 29.43 |
| TP-P1-S10-S1-No4 | 4.76 | 0.89 | 0.13 | 74.33 | 4.14 | 70.18 | 17.93 |
| TP-P1-S10-S1 Avg* | - | 0.72 | 0.05 | 59.94 | 1.64 | 58.3 | 36.48 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S10-S2-pan | 0.037 | 1.19 | 0.07 | 99.44 | 2.24 | 97.2 | 44.32 |
| TP-P1-S10-S2-No200 | 0.074 | 0.73 | 0.02 | 60.88 | 0.9 | 59.98 | 67.47 |
| TP-P1-S10-S2-No140 | 0.105 | 0.57 | 0.02 | 47.8 | 0.63 | 47.16 | 75.4 |
| TP-P1-S10-S2-No100 | 0.149 | 0.53 | 0.01 | 44.28 | 0.36 | 43.92 | 122.27 |
| TP-P1-S10-S2-No60 | 0.25 | 0.65 | 0 | 54.35 | 0.3 | 54.04 | 178.69 |
| TP-P1-S10-S2-No40 | 0.42 | 1.1 | 0.01 | 91.42 | 0.47 | 90.95 | 191.66 |
| TP-P1-S10-S2-No20 | 0.841 | 1.75 | 0.06 | 145.98 | 2.03 | 143.95 | 71.74 |
| TP-P1-S10-S2-No10 | 2 | 2.14 | 0.23 | 177.92 | 7.31 | 170.6 | 24.32 |
| TP-P1-S10-S2 Avg* | - | 0.71 | 0.05 | 58.94 | 1.72 | 57.22 | 34.15 |
| TP-P1-S11-S1-pan | 0.037 | 1.57 | 0.11 | 130.98 | 3.44 | 127.54 | 38.07 |
| TP-P1-S11-S1-No200 | 0.074 | 0.72 | 0.03 | 60.11 | 0.97 | 59.14 | 61.41 |
| TP-P1-S11-S1-No140 | 0.105 | 0.59 | 0.02 | 49.34 | 0.65 | 48.68 | 74.86 |
| TP-P1-S11-S1-No100 | 0.149 | 0.52 | 0.01 | 43.65 | 0.43 | 43.21 | 99.31 |
| TP-P1-S11-S1-No60 | 0.25 | 0.65 | 0.01 | 53.95 | 0.35 | 53.59 | 153.13 |
| TP-P1-S11-S1-No40 | 0.42 | 1.05 | 0.01 | 87.72 | 0.53 | 87.18 | 163.3 |
| TP-P1-S11-S1-No20 | 0.841 | 1.84 | 0.05 | 153.5 | 1.76 | 151.74 | 87.2 |
| TP-P1-S11-S1-No10 | 2 | 1.85 | 0.16 | 154.15 | 5.26 | 148.89 | 29.3 |
| TP-P1-S11-S1 Avg* | - | 0.36 | 0.13 | 30.39 | 4.1 | 26.28 | 7.39 |
| TP-P1-S11-S3-pan | 0.037 | 0.57 | 4.33 | 47.38 | 135.34 | -87.96 | 0.35 |
| TP-P1-S11-S3-No200 | 0.074 | 0.76 | 3.95 | 63.84 | 123.65 | -59.8 | 0.51 |
| TP-P1-S11-S3-No140 | 0.105 | 0.85 | 3.55 | 70.86 | 111.06 | -40.2 | 0.63 |
| TP-P1-S11-S3-No100 | 0.149 | 0.79 | 3.73 | 65.63 | 116.57 | -50.94 | 0.56 |
| TP-P1-S11-S3-No60 | 0.25 | 0.69 | 3.07 | 57.67 | 96.14 | -38.47 | 0.59 |
| TP-P1-S11-S3-No40 | 0.42 | 0.61 | 1.61 | 50.95 | 50.45 | 0.49 | 1 |
| TP-P1-S11-S3-No20 | 0.841 | 0.47 | 0.96 | 39.16 | 30.26 | 8.89 | 1.29 |
| TP-P1-S11-S3-No10 | 2 | 0.39 | 0.72 | 32.86 | 22.59 | 10.27 | 1.45 |
| TP-P1-S11-S3-No4 | 4.76 | 0.24 | 2.22 | 19.93 | 69.59 | -49.65 | 0.28 |
| TP-P1-S11-S3 Avg* | - | 0.29 | 2.21 | 24.32 | 69.32 | -45 | 0.35 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S14-S2-pan | 0.037 | 0.28 | 2.77 | 23.34 | 86.64 | -63.3 | 0.26 |
| TP-P1-S14-S2-No200 | 0.074 | 0.15 | 2.73 | 12.85 | 85.58 | -72.72 | 0.15 |
| TP-P1-S14-S2-No140 | 0.105 | 0.13 | 2.32 | 11.23 | 72.77 | -61.53 | 0.15 |
| TP-P1-S14-S2-No100 | 0.149 | 0.1 | 2.5 | 8.76 | 78.36 | -69.59 | 0.11 |
| TP-P1-S14-S2-No60 | 0.25 | 0.06 | 2.02 | 5.7 | 63.41 | -57.71 | 0.08 |
| TP-P1-S14-S2-No40 | 0.42 | 0.06 | 1.35 | 5.28 | 42.32 | -37.03 | 0.12 |
| TP-P1-S14-S2-No20 | 0.841 | 0.04 | 0.98 | 3.59 | 30.78 | -27.18 | 0.11 |
| TP-P1-S14-S2-No10 | 2 | 0.05 | 1.25 | 4.43 | 39.07 | -34.64 | 0.11 |
| TP-P1-S14-S2-No4 | 4.76 | 0.02 | 0.75 | 1.7 | 23.68 | -21.98 | 0.07 |
| TP-P1-S14-S2 Avg* | - | 0.03 | 0.94 | 2.98 | 29.41 | -26.43 | 0.1 |
| TP-P1-S14-S3-pan | 0.037 | 0.18 | 3.47 | 15.68 | 108.49 | -92.8 | 0.14 |
| TP-P1-S14-S3-No200 | 0.074 | 0.16 | 2.78 | 13.31 | 86.91 | -73.6 | 0.15 |
| TP-P1-S14-S3-No140 | 0.105 | 0.14 | 2.45 | 12.09 | 76.58 | -64.48 | 0.15 |
| TP-P1-S14-S3-No100 | 0.149 | 0.12 | 2.3 | 10.54 | 72.14 | -61.59 | 0.14 |
| TP-P1-S14-S3-No60 | 0.25 | 0.11 | 2.11 | 9.82 | 66.03 | -56.21 | 0.14 |
| TP-P1-S14-S3-No40 | 0.42 | 0.11 | 1.66 | 9.42 | 51.98 | -42.55 | 0.18 |
| TP-P1-S14-S3-No20 | 0.841 | 0.14 | 1.63 | 11.76 | 51.24 | -39.48 | 0.22 |
| TP-P1-S14-S3-No10 | 2 | 0.11 | 1.52 | 9.87 | 47.66 | -37.79 | 0.2 |
| TP-P1-S14-S3-No4 | 4.76 | 0.16 | 1.39 | 13.42 | 43.71 | -30.28 | 0.3 |
| TP-P1-S14-S3 Avg* | - | 0.15 | 1.44 | 13.26 | 45.2 | -31.94 | 0.29 |
| TP-P1-S15-S1-pan | 0.037 | 0.14 | 2.16 | 12.35 | 67.57 | -55.22 | 0.18 |
| TP-P1-S15-S1-No200 | 0.074 | 0.13 | 2.17 | 11.27 | 67.9 | -56.63 | 0.16 |
| TP-P1-S15-S1-No140 | 0.105 | 0.11 | 1.93 | 9.91 | 60.52 | -50.6 | 0.16 |
| TP-P1-S15-S1-No100 | 0.149 | 0.1 | 1.69 | 8.86 | 52.86 | -44 | 0.16 |
| TP-P1-S15-S1-No60 | 0.25 | 0.09 | 1.51 | 7.92 | 47.45 | -39.52 | 0.16 |
| TP-P1-S15-S1-No40 | 0.42 | 0.08 | 1.11 | 7.18 | 34.73 | -27.54 | 0.2 |
| TP-P1-S15-S1-No20 | 0.841 | 0.06 | 0.78 | 5.4 | 24.58 | -19.18 | 0.21 |
| TP-P1-S15-S1-No10 | 2 | 0.05 | 0.88 | 4.29 | 27.53 | -23.23 | 0.15 |
| TP-P1-S15-S1-No4 | 4.76 | 0.1 | 1.39 | 9.07 | 43.47 | -34.4 | 0.2 |
| TP-P1-S15-S1 Avg* | - | 0.1 | 1.37 | 8.6 | 42.81 | -34.21 | 0.2 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S15-S2-pan | 0.037 | 1.02 | 3.85 | 85.4 | 120.41 | -35 | 0.7 |
| TP-P1-S15-S2-No200 | 0.074 | 0.98 | 3.72 | 82.16 | 116.48 | -34.31 | 0.7 |
| TP-P1-S15-S2-No140 | 0.105 | 0.99 | 2.64 | 82.66 | 82.58 | 0.07 | 1 |
| TP-P1-S15-S2-No100 | 0.149 | 0.77 | 2.34 | 64.38 | 73.34 | -8.96 | 0.87 |
| TP-P1-S15-S2-No60 | 0.25 | 0.66 | 1.96 | 55.13 | 61.42 | -6.28 | 0.89 |
| TP-P1-S15-S2-No40 | 0.42 | 0.55 | 1.19 | 46.11 | 37.43 | 8.68 | 1.23 |
| TP-P1-S15-S2-No20 | 0.841 | 0.43 | 0.8 | 35.79 | 25.28 | 10.51 | 1.41 |
| TP-P1-S15-S2-No10 | 2 | 0.39 | 1.02 | 32.98 | 32.01 | 0.96 | 1.03 |
| TP-P1-S15-S2-No4 | 4.76 | 0.25 | 0.73 | 20.99 | 22.84 | -1.85 | 0.91 |
| TP-P1-S15-S2 Avg* | - | 0.35 | 1 | 29.28 | 31.36 | -2.08 | 0.93 |
| TP-P1-S16-S1-pan | 0.037 | 0.39 | 1.94 | 33.19 | 60.77 | -27.57 | 0.54 |
| TP-P1-S16-S1-No200 | 0.074 | 0.44 | 1.47 | 36.54 | 46.18 | -9.63 | 0.79 |
| TP-P1-S16-S1-No140 | 0.105 | 0.43 | 1.24 | 36.05 | 38.8 | -2.75 | 0.92 |
| TP-P1-S16-S1-No100 | 0.149 | 0.4 | 1 | 33.68 | 31.52 | 2.15 | 1.06 |
| TP-P1-S16-S1-No60 | 0.25 | 0.36 | 0.92 | 30.68 | 28.95 | 1.72 | 1.05 |
| TP-P1-S16-S1-No40 | 0.42 | 0.43 | 0.93 | 35.77 | 29.22 | 6.55 | 1.22 |
| TP-P1-S16-S1-No20 | 0.841 | 0.49 | 0.77 | 40.84 | 24.26 | 16.58 | 1.68 |
| TP-P1-S16-S1-No10 | 2 | 0.44 | 0.88 | 36.66 | 27.58 | 9.08 | 1.32 |
| TP-P1-S16-S1-No4 | 4.76 | 0.13 | 1.15 | 10.91 | 36.09 | -25.17 | 0.3 |
| TP-P1-S16-S1 Avg* | - | 0.39 | 1.14 | 32.7 | 35.93 | -3.22 | 0.91 |
| TP-P1-S17-S1-pan | 0.037 | 0.93 | 0.63 | 77.24 | 19.92 | 57.31 | 3.87 |
| TP-P1-S17-S1-No200 | 0.074 | 0.61 | 0.45 | 50.96 | 14.24 | 36.72 | 3.57 |
| TP-P1-S17-S1-No140 | 0.105 | 0.56 | 0.45 | 46.58 | 14.09 | 32.49 | 3.3 |
| TP-P1-S17-S1-No100 | 0.149 | 0.49 | 0.49 | 41.47 | 15.56 | 25.91 | 2.66 |
| TP-P1-S17-S1-No60 | 0.25 | 0.58 | 0.46 | 48.2 | 14.47 | 33.73 | 3.33 |
| TP-P1-S17-S1-No40 | 0.42 | 0.74 | 0.48 | 62.06 | 15.26 | 46.79 | 4.06 |
| TP-P1-S17-S1-No20 | 0.841 | 0.81 | 0.57 | 68.01 | 17.9 | 50.1 | 3.79 |
| TP-P1-S17-S1-No10 | 2 | 0.48 | 0.53 | 40.54 | 16.71 | 23.82 | 2.42 |
| TP-P1-S17-S1-No4 | 4.76 | 0.34 | 0.47 | 28.3 | 14.7 | 13.6 | 1.92 |
| TP-P1-S17-S1 Avg* | - | 0.46 | 0.49 | 38.23 | 15.37 | 22.86 | 2.48 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.4(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P1-S17-S3-pan | 0.037 | 0.68 | 2.78 | 56.81 | 87.09 | -30.28 | 0.65 |
| TP-P1-S17-S3-No200 | 0.074 | 0.98 | 2.43 | 81.68 | 76.13 | 5.55 | 1.07 |
| TP-P1-S17-S3-No140 | 0.105 | 0.91 | 2.59 | 75.73 | 81.01 | -5.27 | 0.93 |
| TP-P1-S17-S3-No100 | 0.149 | 0.7 | 2.56 | 58.41 | 80.28 | -21.87 | 0.72 |
| TP-P1-S17-S3-No60 | 0.25 | 0.54 | 2.02 | 45.6 | 63.3 | -17.69 | 0.72 |
| TP-P1-S17-S3-No40 | 0.42 | 0.43 | 1.32 | 36.47 | 41.35 | -4.88 | 0.88 |
| TP-P1-S17-S3-No20 | 0.841 | 0.37 | 1.01 | 31.34 | 31.57 | -0.22 | 0.99 |
| TP-P1-S17-S3-No10 | 2 | 0.25 | 0.99 | 20.92 | 31.1 | -10.17 | 0.67 |
| TP-P1-S17-S3-No4 | 4.76 | 0.18 | 0.69 | 15.32 | 21.85 | -6.52 | 0.7 |
| TP-P1-S17-S3 Avg* | - | 0.23 | 0.85 | 19.51 | 26.74 | -7.22 | 0.72 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.5: Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| WRS-2-3-pan | 0.037 | 0.58 | 2.54 | 48.49 | 79.47 | -30.98 | 0.61 |
| WRS-2-3-No200 | 0.074 | 0.78 | 2.26 | 65.47 | 70.67 | -5.19 | 0.92 |
| WRS-2-3-No140 | 0.105 | 0.84 | 2.43 | 69.94 | 76.14 | -6.2 | 0.91 |
| WRS-2-3-No100 | 0.149 | 0.63 | 2.68 | 53.07 | 83.88 | -30.81 | 0.63 |
| WRS-2-3-No60 | 0.25 | 0.48 | 2.21 | 40.44 | 69.19 | -28.75 | 0.58 |
| WRS-2-3-No40 | 0.42 | 0.39 | 1.37 | 32.73 | 43.1 | -10.36 | 0.75 |
| WRS-2-3-No20 | 0.841 | 0.32 | 0.89 | 26.96 | 27.97 | -1 | 0.96 |
| WRS-2-3-No10 | 2 | 0.34 | 0.81 | 28.77 | 25.36 | 3.41 | 1.13 |
| WRS-2-3-No4 | 4.76 | 0.22 | 0.61 | 18.27 | 19.18 | -0.91 | 0.95 |
| WRS-2-3 Avg* | - | 0.25 | 0.75 | 21.31 | 23.44 | -2.12 | 0.9 |
| WRS-2-4-pan | 0.037 | 1.25 | 1.02 | 104.12 | 31.92 | 72.19 | 3.26 |
| WRS-2-4-No200 | 0.074 | 0.71 | 0.92 | 59.34 | 28.89 | 30.45 | 2.05 |
| WRS-2-4-No140 | 0.105 | 0.63 | 0.82 | 52.83 | 25.62 | 27.2 | 2.06 |
| WRS-2-4-No100 | 0.149 | 0.57 | 0.77 | 47.39 | 24.1 | 23.28 | 1.96 |
| WRS-2-4-No60 | 0.25 | 0.61 | 0.84 | 51.12 | 26.56 | 24.56 | 1.92 |
| WRS-2-4-No40 | 0.42 | 0.73 | 0.69 | 60.85 | 21.69 | 39.16 | 2.8 |
| WRS-2-4-No20 | 0.841 | 0.9 | 0.43 | 75.41 | 13.67 | 61.74 | 5.51 |
| WRS-2-4-No10 | 2 | 0.83 | 0.58 | 69.6 | 18.4 | 51.19 | 3.78 |
| WRS-2-4-No4 | 4.76 | 0.23 | 0.76 | 19.46 | 23.8 | -4.34 | 0.81 |
| WRS-2-4 Avg* | - | 0.32 | 0.76 | 26.81 | 23.75 | 3.06 | 1.12 |
| WRS-2-5-pan | 0.037 | 0.55 | 3.25 | 46.43 | 101.77 | -55.34 | 0.45 |
| WRS-2-5-No200 | 0.074 | 0.59 | 2.85 | 49.12 | 89.07 | -39.94 | 0.55 |
| WRS-2-5-No140 | 0.105 | 0.58 | 2.57 | 48.54 | 80.57 | -32.02 | 0.6 |
| WRS-2-5-No100 | 0.149 | 0.47 | 3.12 | 39.26 | 97.7 | -58.44 | 0.4 |
| WRS-2-5-No60 | 0.25 | 0.37 | 3.13 | 31.15 | 98.11 | -66.95 | 0.31 |
| WRS-2-5-No40 | 0.42 | 0.32 | 1.82 | 27.07 | 57.05 | -29.98 | 0.47 |
| WRS-2-5-No20 | 0.841 | 0.25 | 0.82 | 21.43 | 25.77 | -4.33 | 0.83 |
| WRS-2-5-No10 | 2 | 0.29 | 1.03 | 24.23 | 32.43 | -8.19 | 0.74 |
| WRS-2-5-No4 | 4.76 | 0.18 | 1.55 | 15.12 | 48.49 | -33.36 | 0.31 |
| WRS-2-5 Avg* | - | 0.2 | 1.59 | 17.39 | 49.76 | -32.36 | 0.34 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.5(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| WRS-2-6-pan | 0.037 | 0.7 | 1.98 | 58.81 | 61.9 | -3.09 | 0.95 |
| WRS-2-6-No200 | 0.074 | 0.68 | 1.75 | 56.47 | 54.96 | 1.51 | 1.02 |
| WRS-2-6-No140 | 0.105 | 0.66 | 1.54 | 54.84 | 48.13 | 6.71 | 1.13 |
| WRS-2-6-No100 | 0.149 | 0.56 | 1.62 | 47.22 | 50.82 | -3.59 | 0.92 |
| WRS-2-6-No60 | 0.25 | 0.53 | 1.48 | 44.69 | 46.43 | -1.73 | 0.96 |
| WRS-2-6-No40 | 0.42 | 0.52 | 1.22 | 43.91 | 38.26 | 5.65 | 1.14 |
| WRS-2-6-No20 | 0.841 | 0.48 | 0.95 | 40.3 | 29.77 | 10.52 | 1.35 |
| WRS-2-6-No10 | 2 | 0.38 | 0.98 | 32.2 | 30.64 | 1.56 | 1.05 |
| WRS-2-6-No4 | 4.76 | 0.32 | 0.57 | 26.56 | 18.04 | 8.52 | 1.47 |
| WRS-2-6 Avg* | - | 0.36 | 0.73 | 30.33 | 23.09 | 7.24 | 1.31 |
| WRS-2-7-pan | 0.037 | 0.22 | 1.83 | 18.98 | 57.33 | -38.35 | 0.33 |
| WRS-2-7-No200 | 0.074 | 0.26 | 1.86 | 21.59 | 58.37 | -36.77 | 0.37 |
| WRS-2-7-No140 | 0.105 | 0.27 | 1.76 | 22.65 | 55.16 | -32.51 | 0.41 |
| WRS-2-7-No100 | 0.149 | 0.24 | 1.63 | 20.3 | 50.96 | -30.66 | 0.39 |
| WRS-2-7-No60 | 0.25 | 0.22 | 1.45 | 18.7 | 45.35 | -26.64 | 0.41 |
| WRS-2-7-No40 | 0.42 | 0.17 | 0.9 | 14.82 | 28.39 | -13.56 | 0.52 |
| WRS-2-7-No20 | 0.841 | 0.14 | 0.52 | 11.66 | 16.51 | -4.84 | 0.7 |
| WRS-2-7-No10 | 2 | 0.1 | 0.48 | 9.04 | 15.18 | -6.13 | 0.59 |
| WRS-2-7-No4 | 4.76 | 0.05 | 1.56 | 4.79 | 48.9 | -44.11 | 0.09 |
| WRS-2-7 Avg* | - | 0.06 | 1.52 | 5.49 | 47.79 | -42.29 | 0.11 |
| WRS-2-8-pan | 0.037 | 0.85 | 2.59 | 70.8 | 81.14 | -10.33 | 0.87 |
| WRS-2-8-No200 | 0.074 | 0.89 | 2.19 | 73.95 | 68.61 | 5.34 | 1.07 |
| WRS-2-8-No140 | 0.105 | 0.78 | 1.48 | 65.05 | 46.31 | 18.73 | 1.4 |
| WRS-2-8-No100 | 0.149 | 0.67 | 1.3 | 56.02 | 40.77 | 15.25 | 1.37 |
| WRS-2-8-No60 | 0.25 | 0.66 | 1.12 | 55.15 | 35.18 | 19.97 | 1.56 |
| WRS-2-8-No40 | 0.42 | 0.69 | 0.88 | 57.59 | 27.51 | 30.07 | 2.09 |
| WRS-2-8-No20 | 0.841 | 0.57 | 0.83 | 47.82 | 26.1 | 21.72 | 1.83 |
| WRS-2-8-No10 | 2 | 0.44 | 0.96 | 36.8 | 30.06 | 6.73 | 1.22 |
| WRS-2-8-No4 | 4.76 | 0.22 | 1.56 | 18.75 | 49.04 | -30.29 | 0.38 |
| WRS-2-8 Avg* | - | 0.27 | 1.53 | 22.64 | 48.02 | -25.38 | 0.47 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.5(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| WRS-2-9-pan | 0.037 | 1.35 | 0.91 | 112.8 | 28.61 | 84.18 | 3.94 |
| WRS-2-9-No200 | 0.074 | 0.94 | 0.7 | 78.84 | 22.11 | 56.72 | 3.56 |
| WRS-2-9-No140 | 0.105 | 0.86 | 0.66 | 72.19 | 20.81 | 51.38 | 3.46 |
| WRS-2-9-No100 | 0.149 | 0.78 | 0.67 | 65.37 | 21.06 | 44.3 | 3.1 |
| WRS-2-9-No60 | 0.25 | 0.81 | 0.63 | 67.53 | 19.98 | 47.55 | 3.37 |
| WRS-2-9-No40 | 0.42 | 0.86 | 0.56 | 72.12 | 17.69 | 54.42 | 4.07 |
| WRS-2-9-No20 | 0.841 | 0.82 | 0.61 | 68.21 | 19.1 | 49.1 | 3.57 |
| WRS-2-9-No10 | 2 | 0.72 | 1.08 | 60.31 | 33.9 | 26.4 | 1.77 |
| WRS-2-9-No4 | 4.76 | 0.31 | 0.9 | 25.81 | 28.19 | -2.37 | 0.91 |
| WRS-2-9 Avg* | - | 0.38 | 0.88 | 31.57 | 27.78 | 3.78 | 1.13 |
| WRS-2-10-pan | 0.037 | 0.15 | 1.81 | 12.88 | 56.85 | -43.96 | 0.22 |
| WRS-2-10-No200 | 0.074 | 0.12 | 1.51 | 10.46 | 47.32 | -36.85 | 0.22 |
| WRS-2-10-No100 | 0.149 | 0.07 | 1.24 | 6.16 | 38.93 | -32.77 | 0.15 |
| WRS-2-10-No60 | 0.25 | 0.06 | 1.27 | 5.22 | 39.99 | -34.76 | 0.13 |
| WRS-2-10-No40 | 0.42 | 0.06 | 0.89 | 5.25 | 27.88 | -22.62 | 0.18 |
| WRS-2-10-No20 | 0.841 | 0.04 | 0.68 | 4.1 | 21.32 | -17.22 | 0.19 |
| WRS-2-10-No10 | 2 | 0.04 | 0.51 | 4.03 | 16.06 | -12.03 | 0.25 |
| WRS-2-10-No4 | 4.76 | 0.06 | 0.75 | 5.24 | 23.54 | -18.29 | 0.22 |
| WRS-2-10-pan | 0.037 | 0.15 | 1.81 | 12.88 | 56.85 | -43.96 | 0.22 |
| WRS-2-10 Avg* | - | 0.06 | 0.79 | 5.34 | 24.93 | -19.59 | 0.21 |
| WRS-2-11-pan | 0.037 | 0.45 | 3.04 | 37.96 | 95.04 | -57.07 | 0.39 |
| WRS-2-11-No200 | 0.074 | 0.66 | 2.52 | 55.37 | 78.98 | -23.61 | 0.7 |
| WRS-2-11-No140 | 0.105 | 0.73 | 2.26 | 60.95 | 70.72 | -9.76 | 0.86 |
| WRS-2-11-No100 | 0.149 | 0.59 | 2.11 | 49.05 | 66.03 | -16.97 | 0.74 |
| WRS-2-11-No60 | 0.25 | 0.46 | 1.78 | 38.84 | 55.69 | -16.84 | 0.69 |
| WRS-2-11-No40 | 0.42 | 0.36 | 1.31 | 29.93 | 41.16 | -11.22 | 0.72 |
| WRS-2-11-No20 | 0.841 | 0.33 | 1.06 | 28.07 | 33.24 | -5.17 | 0.84 |
| WRS-2-11-No10 | 2 | 0.29 | 1.18 | 24.1 | 37.01 | -12.91 | 0.65 |
| WRS-2-11-No4 | 4.76 | 0.09 | 0.71 | 8.07 | 22.38 | -14.31 | 0.36 |
| WRS-2-11 Avg* | - | 0.16 | 0.92 | 13.9 | 28.76 | -14.86 | 0.48 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.5(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| WRS-2-13-pan | 0.037 | 0.6 | 3.24 | 50.34 | 101.29 | -50.94 | 0.49 |
| WRS-2-13-No200 | 0.074 | 0.64 | 3.29 | 53.36 | 102.94 | -49.57 | 0.51 |
| WRS-2-13-No140 | 0.105 | 0.72 | 2.61 | 59.84 | 81.64 | -21.79 | 0.73 |
| WRS-2-13-No100 | 0.149 | 0.66 | 2.47 | 55.24 | 77.47 | -22.23 | 0.71 |
| WRS-2-13-No60 | 0.25 | 0.56 | 2.08 | 46.59 | 65.22 | -18.62 | 0.71 |
| WRS-2-13-No40 | 0.42 | 0.46 | 1.54 | 38.63 | 48.43 | -9.8 | 0.79 |
| WRS-2-13-No20 | 0.841 | 0.4 | 1.3 | 33.72 | 40.73 | -7.01 | 0.82 |
| WRS-2-13-No10 | 2 | 0.33 | 1.34 | 28.17 | 42.06 | -13.88 | 0.66 |
| WRS-2-13-No4 | 4.76 | 0.33 | 0.82 | 27.81 | 25.82 | 1.99 | 1.07 |
| WRS-2-13 Avg* | - | 0.35 | 0.98 | 29.61 | 30.9 | -1.28 | 0.95 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6: Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S3-pan | 0.037 | 0.66 | 1.12 | 55.51 | 35.29 | 20.21 | 1.57 |
| TP-P2-S3-No200 | 0.074 | 0.6 | 0.7 | 50.3 | 22.04 | 28.25 | 2.28 |
| TP-P2-S3-No140 | 0.105 | 0.5 | 0.45 | 42.19 | 14.36 | 27.83 | 2.93 |
| TP-P2-S3-No100 | 0.149 | 0.45 | 0.5 | 38.06 | 15.62 | 22.44 | 2.43 |
| TP-P2-S3-No60 | 0.25 | 0.5 | 0.48 | 42.25 | 15.24 | 27 | 2.77 |
| TP-P2-S3-No40 | 0.42 | 0.55 | 0.48 | 46.21 | 15.06 | 31.14 | 3.06 |
| TP-P2-S3-No20 | 0.841 | 0.69 | 0.45 | 58.06 | 14.06 | 43.99 | 4.12 |
| TP-P2-S3-No10 | 2 | 0.67 | 0.74 | 56.01 | 23.19 | 32.81 | 2.41 |
| TP-P2-S3-No4 | 4.76 | 0.58 | 2.04 | 48.86 | 64.05 | -15.19 | 0.76 |
| TP-P2-S3 Avg* | - | 0.59 | 1.84 | 49.05 | 57.53 | -8.47 | 0.85 |
| TP-P2-S5-pan | 0.037 | 1.27 | 0.55 | 106.01 | 17.36 | 88.65 | 6.1 |
| TP-P2-S5-No200 | 0.074 | 0.83 | 0.4 | 69.41 | 12.73 | 56.67 | 5.44 |
| TP-P2-S5-No100 | 0.149 | 0.55 | 0.39 | 46.39 | 12.32 | 34.06 | 3.76 |
| TP-P2-S5-No60 | 0.25 | 0.65 | 0.42 | 54.07 | 13.13 | 40.94 | 4.11 |
| TP-P2-S5-No40 | 0.42 | 0.77 | 0.49 | 64.18 | 15.57 | 48.6 | 4.11 |
| TP-P2-S5-No20 | 0.841 | 0.67 | 0.68 | 56.37 | 21.33 | 35.04 | 2.64 |
| TP-P2-S5-No10 | 2 | 0.41 | 0.85 | 34.82 | 26.65 | 8.16 | 1.3 |
| TP-P2-S5-No4 | 4.76 | 0.13 | 0.67 | 11.09 | 21.09 | -9.99 | 0.52 |
| TP-P2-S5 Avg* | - | 0.33 | 0.62 | 28.08 | 19.47 | 8.6 | 1.44 |
| TP-P2-S7-pan | 0.037 | 0.67 | 2.81 | 55.95 | 87.97 | -32.01 | 0.63 |
| TP-P2-S7-No200 | 0.074 | 0.55 | 2.32 | 46.05 | 72.78 | -26.73 | 0.63 |
| TP-P2-S7-No140 | 0.105 | 0.44 | 1.7 | 37.14 | 53.41 | -16.26 | 0.69 |
| TP-P2-S7-No100 | 0.149 | 0.38 | 1.27 | 32.34 | 39.78 | -7.43 | 0.81 |
| TP-P2-S7-No60 | 0.25 | 0.44 | 1.06 | 36.92 | 33.43 | 3.49 | 1.1 |
| TP-P2-S7-No40 | 0.42 | 0.62 | 0.95 | 51.71 | 29.87 | 21.84 | 1.73 |
| TP-P2-S7-No20 | 0.841 | 0.63 | 0.87 | 52.41 | 27.43 | 24.98 | 1.91 |
| TP-P2-S7-No10 | 2 | 0.4 | 1.98 | 33.25 | 62.09 | -28.84 | 0.53 |
| TP-P2-S7-No4 | 4.76 | 0.46 | 0.72 | 38.8 | 22.5 | 16.3 | 1.72 |
| TP-P2-S7 Avg* | - | 0.47 | 0.87 | 39.54 | 27.19 | 12.35 | 1.45 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S8-S2-pan | 0.037 | 0.91 | 1.73 | 76.17 | 54.12 | 22.04 | 1.4 |
| TP-P2-S8-S2-No200 | 0.074 | 0.89 | 1.44 | 74.04 | 45.03 | 29 | 1.64 |
| TP-P2-S8-S2-No140 | 0.105 | 0.81 | 1.2 | 67.37 | 37.53 | 29.84 | 1.79 |
| TP-P2-S8-S2-No100 | 0.149 | 0.75 | 1.03 | 62.84 | 32.19 | 30.64 | 1.95 |
| TP-P2-S8-S2-No60 | 0.25 | 0.72 | 0.93 | 60.37 | 29.3 | 31.06 | 2.05 |
| TP-P2-S8-S2-No40 | 0.42 | 0.76 | 0.8 | 63.8 | 25.17 | 38.63 | 2.53 |
| TP-P2-S8-S2-No20 | 0.841 | 0.61 | 0.83 | 51.36 | 26.19 | 25.17 | 1.96 |
| TP-P2-S8-S2-No10 | 2 | 0.56 | 0.81 | 46.66 | 25.43 | 21.22 | 1.83 |
| TP-P2-S8-S2-No4 | 4.76 | 0.19 | 1.14 | 16.31 | 35.68 | -19.36 | 0.45 |
| TP-P2-S8-S2 Avg* | - | 0.69 | 1.1 | 57.66 | 34.52 | 23.14 | 1.67 |
| TP-P2-S10-S1-pan | 0.037 | 0.6 | 1.13 | 50.36 | 35.41 | 14.95 | 1.42 |
| TP-P2-S10-S1-No200 | 0.074 | 0.47 | 0.8 | 39.49 | 25.02 | 14.47 | 1.57 |
| TP-P2-S10-S1-No140 | 0.105 | 0.47 | 0.67 | 39.3 | 21.04 | 18.26 | 1.86 |
| TP-P2-S10-S1-No100 | 0.149 | 0.46 | 0.54 | 38.84 | 17.07 | 21.76 | 2.27 |
| TP-P2-S10-S1-No60 | 0.25 | 0.49 | 0.63 | 40.88 | 19.73 | 21.14 | 2.07 |
| TP-P2-S10-S1-No40 | 0.42 | 0.53 | 0.51 | 44.65 | 16 | 28.64 | 2.78 |
| TP-P2-S10-S1-No20 | 0.841 | 0.48 | 0.54 | 40.26 | 16.98 | 23.27 | 2.36 |
| TP-P2-S10-S1-No10 | 2 | 0.26 | 1.1 | 21.91 | 34.55 | -12.63 | 0.63 |
| TP-P2-S10-S1-No4 | 4.76 | 0.31 | 1.51 | 26.48 | 47.44 | -20.95 | 0.55 |
| TP-P2-S10-S1 Avg* | - | 0.34 | 1.39 | 28.3 | 43.63 | -15.33 | 0.64 |
| TP-P2-S10-S2-pan | 0.037 | 0.77 | 1.36 | 64.36 | 42.64 | 21.71 | 1.5 |
| TP-P2-S10-S2-No200 | 0.074 | 0.67 | 1.26 | 56.01 | 39.56 | 16.44 | 1.41 |
| TP-P2-S10-S2-No140 | 0.105 | 0.52 | 1.11 | 43.52 | 34.83 | 8.69 | 1.24 |
| TP-P2-S10-S2-No100 | 0.149 | 0.45 | 0.89 | 37.51 | 28.11 | 9.39 | 1.33 |
| TP-P2-S10-S2-No60 | 0.25 | 0.39 | 0.72 | 32.6 | 22.75 | 9.85 | 1.43 |
| TP-P2-S10-S2-No40 | 0.42 | 0.44 | 0.65 | 37.1 | 20.37 | 16.73 | 1.82 |
| TP-P2-S10-S2-No20 | 0.841 | 0.38 | 0.59 | 32.29 | 18.48 | 13.81 | 1.74 |
| TP-P2-S10-S2-No10 | 2 | 0.24 | 0.75 | 20.18 | 23.7 | -3.51 | 0.85 |
| TP-P2-S10-S2-No4 | 4.76 | 0.25 | 2.86 | 21.26 | 89.41 | -68.14 | 0.23 |
| TP-P2-S10-S2 Avg* | - | 0.32 | 2.19 | 26.68 | 68.51 | -41.83 | 0.38 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S11-S2-pan | 0.037 | 0.48 | 1.66 | 39.95 | 52.17 | -12.21 | 0.76 |
| TP-P2-S11-S2-No200 | 0.074 | 0.31 | 1.8 | 26.04 | 56.29 | -30.25 | 0.46 |
| TP-P2-S11-S2-No140 | 0.105 | 0.27 | 2.02 | 22.66 | 63.22 | -40.56 | 0.35 |
| TP-P2-S11-S2-No100 | 0.149 | 0.22 | 2.13 | 18.96 | 66.63 | -47.67 | 0.28 |
| TP-P2-S11-S2-No60 | 0.25 | 0.23 | 2.1 | 19.84 | 65.69 | -45.84 | 0.3 |
| TP-P2-S11-S2-No40 | 0.42 | 0.24 | 1.05 | 20.48 | 32.87 | -12.38 | 0.62 |
| TP-P2-S11-S2-No20 | 0.841 | 0.19 | 0.83 | 16.34 | 25.98 | -9.64 | 0.62 |
| TP-P2-S11-S2-No10 | 2 | 0.16 | 1.22 | 13.7 | 38.25 | -24.54 | 0.35 |
| TP-P2-S11-S2-No4 | 4.76 | 0.45 | 1.97 | 37.37 | 61.59 | -24.21 | 0.6 |
| TP-P2-S11-S2 Avg* | - | 0.39 | 1.81 | 32.82 | 56.62 | -23.79 | 0.57 |
| TP-P2-S11-S3-pan | 0.037 | 0.89 | 2.25 | 74.66 | 70.6 | 4.05 | 1.05 |
| TP-P2-S11-S3-No200 | 0.074 | 0.94 | 1.98 | 78.78 | 62.06 | 16.72 | 1.26 |
| TP-P2-S11-S3-No140 | 0.105 | 0.98 | 1.46 | 81.95 | 45.64 | 36.3 | 1.79 |
| TP-P2-S11-S3-No100 | 0.149 | 0.91 | 1.69 | 75.94 | 52.93 | 23.01 | 1.43 |
| TP-P2-S11-S3-No60 | 0.25 | 0.92 | 1.46 | 76.65 | 45.73 | 30.92 | 1.67 |
| TP-P2-S11-S3-No40 | 0.42 | 0.96 | 0.86 | 80.34 | 27 | 53.34 | 2.97 |
| TP-P2-S11-S3-No20 | 0.841 | 0.96 | 0.69 | 79.88 | 21.61 | 58.27 | 3.69 |
| TP-P2-S11-S3-No10 | 2 | 0.9 | 0.79 | 75.5 | 24.94 | 50.56 | 3.02 |
| TP-P2-S11-S3-No4 | 4.76 | 0.77 | 0.82 | 64.52 | 25.75 | 38.77 | 2.5 |
| TP-P2-S11-S3 Avg* | - | 0.8 | 0.87 | 66.51 | 27.49 | 39.02 | 2.41 |
| TP-P2-S12-S1-pan | 0.037 | 1.9 | 0.08 | 157.79 | 2.78 | 155.01 | 56.74 |
| TP-P2-S12-S1-No200 | 0.074 | 1.28 | 0.04 | 106.31 | 1.36 | 104.94 | 78.09 |
| TP-P2-S12-S1-No140 | 0.105 | 1.17 | 0.04 | 97.13 | 1.46 | 95.67 | 66.37 |
| TP-P2-S12-S1-No100 | 0.149 | 1.17 | 0.04 | 97.6 | 1.3 | 96.3 | 74.78 |
| TP-P2-S12-S1-No60 | 0.25 | 1.21 | 0.04 | 101.24 | 1.36 | 99.88 | 74.28 |
| TP-P2-S12-S1-No40 | 0.42 | 1.35 | 0.05 | 112.42 | 1.7 | 110.72 | 66.02 |
| TP-P2-S12-S1-No20 | 0.841 | 1.91 | 0.08 | 158.9 | 2.73 | 156.17 | 58.16 |
| TP-P2-S12-S1-No10 | 2 | 1.83 | 0.2 | 152 | 6.53 | 145.46 | 23.24 |
| TP-P2-S12-S1-No4 | 4.76 | 2.13 | 0.5 | 177.38 | 15.71 | 161.66 | 11.28 |
| TP-P2-S12-S1 Avg* | - | 1.76 | 0.24 | 146.61 | 7.69 | 138.91 | 19.06 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S12-S2-pan | 0.037 | 0.95 | 2.72 | 79.46 | 85.13 | -5.66 | 0.93 |
| TP-P2-S12-S2-No200 | 0.074 | 1.27 | 2.19 | 105.72 | 68.6 | 37.12 | 1.54 |
| TP-P2-S12-S2-No140 | 0.105 | 1.18 | 1.66 | 98.52 | 51.91 | 46.6 | 1.89 |
| TP-P2-S12-S2-No100 | 0.149 | 1.13 | 1.49 | 94.22 | 46.79 | 47.43 | 2.01 |
| TP-P2-S12-S2-No60 | 0.25 | 1.07 | 1.25 | 89.58 | 39.31 | 50.26 | 2.27 |
| TP-P2-S12-S2-No40 | 0.42 | 0.96 | 0.95 | 79.8 | 29.82 | 49.97 | 2.67 |
| TP-P2-S12-S2-No20 | 0.841 | 0.78 | 0.99 | 65.28 | 31.04 | 34.24 | 2.1 |
| TP-P2-S12-S2-No10 | 2 | 0.73 | 0.91 | 61.15 | 28.61 | 32.54 | 2.13 |
| TP-P2-S12-S2-No4 | 4.76 | 0.41 | 1.05 | 34.42 | 33.06 | 1.36 | 1.04 |
| TP-P2-S12-S2 Avg* | - | 0.49 | 1.13 | 41.48 | 35.46 | 6.01 | 1.16 |
| TP-P2-S12-S3-pan | 0.037 | 1.73 | 1.14 | 143.71 | 35.64 | 108.07 | 4.03 |
| TP-P2-S12-S3-No200 | 0.074 | 1.48 | 0.82 | 123.22 | 25.92 | 97.29 | 4.75 |
| TP-P2-S12-S3-No140 | 0.105 | 1.4 | 0.78 | 116.7 | 24.43 | 92.26 | 4.77 |
| TP-P2-S12-S3-No100 | 0.149 | 1.31 | 0.72 | 109.19 | 22.62 | 86.57 | 4.82 |
| TP-P2-S12-S3-No60 | 0.25 | 1.31 | 0.64 | 109.16 | 20.19 | 88.97 | 5.4 |
| TP-P2-S12-S3-No40 | 0.42 | 1.4 | 0.65 | 116.21 | 20.49 | 95.71 | 5.67 |
| TP-P2-S12-S3-No20 | 0.841 | 1.3 | 0.84 | 108.14 | 26.25 | 81.88 | 4.11 |
| TP-P2-S12-S3-No10 | 2 | 1.01 | 1.11 | 84.64 | 34.94 | 49.7 | 2.42 |
| TP-P2-S12-S3-No4 | 4.76 | 1.18 | 0.87 | 98.13 | 27.3 | 70.82 | 3.59 |
| TP-P2-S12-S3 Avg* | - | 1.18 | 0.87 | 98.61 | 27.3 | 71.31 | 3.61 |
| TP-P2-S13-S2-pan | 0.037 | 0.48 | 1.95 | 39.91 | 61 | -21.08 | 0.65 |
| TP-P2-S13-S2-No200 | 0.074 | 0.38 | 1.29 | 32.26 | 40.57 | -8.31 | 0.79 |
| TP-P2-S13-S2-No140 | 0.105 | 0.34 | 1.02 | 28.6 | 32.05 | -3.44 | 0.89 |
| TP-P2-S13-S2-No100 | 0.149 | 0.32 | 0.83 | 26.59 | 26.07 | 0.51 | 1.01 |
| TP-P2-S13-S2-No60 | 0.25 | 0.3 | 0.77 | 25.44 | 24.13 | 1.31 | 1.05 |
| TP-P2-S13-S2-No40 | 0.42 | 0.35 | 0.72 | 29.44 | 22.79 | 6.64 | 1.29 |
| TP-P2-S13-S2-No20 | 0.841 | 0.27 | 0.74 | 22.47 | 23.39 | -0.91 | 0.96 |
| TP-P2-S13-S2-No10 | 2 | 0.1 | 0.92 | 8.48 | 28.99 | -20.5 | 0.29 |
| TP-P2-S13-S2-No4 | 4.76 | 0.05 | 1.16 | 4.87 | 36.52 | -31.65 | 0.13 |
| TP-P2-S13-S2 Avg* | - | 0.08 | 1.15 | 7.05 | 36.11 | -29.06 | 0.19 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S14-S1-pan | 0.037 | 2.01 | 0.07 | 166.94 | 2.34 | 164.59 | 71.18 |
| TP-P2-S14-S1-No200 | 0.074 | 1.6 | 0.04 | 133.16 | 1.54 | 131.61 | 86.01 |
| TP-P2-S14-S1-No140 | 0.105 | 1 | 0.04 | 83.67 | 1.49 | 82.17 | 55.94 |
| TP-P2-S14-S1-No100 | 0.149 | 0.83 | 0.03 | 69.71 | 1.03 | 68.67 | 67.25 |
| TP-P2-S14-S1-No60 | 0.25 | 1.02 | 0.02 | 85.13 | 0.86 | 84.26 | 98.18 |
| TP-P2-S14-S1-No40 | 0.42 | 1.56 | 0.07 | 130.23 | 2.45 | 127.78 | 53.12 |
| TP-P2-S14-S1-No20 | 0.841 | 2.15 | 0.06 | 178.94 | 1.92 | 177.02 | 93 |
| TP-P2-S14-S1-No10 | 2 | 2.81 | 0.05 | 233.28 | 1.86 | 231.42 | 125.3 |
| TP-P2-S14-S1 Avg* | - | 1.29 | 0.05 | 107.8 | 1.76 | 106.03 | 61.11 |
| TP-P2-S14-S2-pan | 0.037 | 0.14 | 3.34 | 11.71 | 104.58 | -92.86 | 0.11 |
| TP-P2-S14-S2-No200 | 0.074 | 0.1 | 3.93 | 8.47 | 123.01 | -114.54 | 0.06 |
| TP-P2-S14-S2-No140 | 0.105 | 0.1 | 3.82 | 8.55 | 119.48 | -110.93 | 0.07 |
| TP-P2-S14-S2-No100 | 0.149 | 0.08 | 3.23 | 7.03 | 101.15 | -94.11 | 0.06 |
| TP-P2-S14-S2-No60 | 0.25 | 0.06 | 2.5 | 5.72 | 78.42 | -72.69 | 0.07 |
| TP-P2-S14-S2-No40 | 0.42 | 0.06 | 1.56 | 5.15 | 49.01 | -43.85 | 0.1 |
| TP-P2-S14-S2-No20 | 0.841 | 0.05 | 0.73 | 4.57 | 23.04 | -18.47 | 0.19 |
| TP-P2-S14-S2-No10 | 2 | 0.08 | 0.9 | 6.97 | 28.25 | -21.28 | 0.24 |
| TP-P2-S14-S2-No4 | 4.76 | 0.08 | 0.91 | 7.03 | 28.63 | -21.59 | 0.24 |
| TP-P2-S14-S2 Avg* | - | 0.08 | 1.01 | 6.97 | 31.84 | -24.87 | 0.21 |
| TP-P2-S15-S2-pan | 0.037 | 0.15 | 2.05 | 13.13 | 64.11 | -50.98 | 0.2 |
| TP-P2-S15-S2-No200 | 0.074 | 0.13 | 2 | 11.16 | 62.66 | -51.49 | 0.17 |
| TP-P2-S15-S2-No140 | 0.105 | 0.12 | 1.72 | 10.19 | 53.81 | -43.62 | 0.18 |
| TP-P2-S15-S2-No100 | 0.149 | 0.1 | 1.46 | 8.73 | 45.82 | -37.08 | 0.19 |
| TP-P2-S15-S2-No60 | 0.25 | 0.08 | 1.22 | 6.68 | 38.16 | -31.48 | 0.17 |
| TP-P2-S15-S2-No40 | 0.42 | 0.06 | 0.9 | 5.05 | 28.3 | -23.24 | 0.17 |
| TP-P2-S15-S2-No20 | 0.841 | 0.04 | 0.74 | 4.08 | 23.18 | -19.1 | 0.17 |
| TP-P2-S15-S2-No10 | 2 | 0.07 | 0.65 | 6.41 | 20.61 | -14.2 | 0.31 |
| TP-P2-S15-S2-No4 | 4.76 | 0.04 | 0.82 | 3.44 | 25.66 | -22.21 | 0.13 |
| TP-P2-S15-S2 Avg* | - | 0.04 | 0.85 | 3.94 | 26.62 | -22.68 | 0.14 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S15-S3-pan | 0.037 | 0.2 | 1.07 | 16.77 | 33.49 | -16.72 | 0.5 |
| TP-P2-S15-S3-No200 | 0.074 | 0.18 | 1.13 | 15.22 | 35.54 | -20.32 | 0.42 |
| TP-P2-S15-S3-No140 | 0.105 | 0.16 | 1.07 | 13.9 | 33.59 | -19.68 | 0.41 |
| TP-P2-S15-S3-No100 | 0.149 | 0.13 | 0.87 | 10.83 | 27.27 | -16.44 | 0.39 |
| TP-P2-S15-S3-No60 | 0.25 | 0.1 | 0.65 | 9.11 | 20.49 | -11.38 | 0.44 |
| TP-P2-S15-S3-No40 | 0.42 | 0.11 | 0.46 | 9.62 | 14.63 | -5.01 | 0.65 |
| TP-P2-S15-S3-No20 | 0.841 | 0.07 | 0.43 | 6.21 | 13.73 | -7.52 | 0.45 |
| TP-P2-S15-S3-No10 | 2 | 0.04 | 0.62 | 3.37 | 19.5 | -16.12 | 0.17 |
| TP-P2-S15-S3-No4 | 4.76 | 0.03 | 0.56 | 2.65 | 17.58 | -14.93 | 0.15 |
| TP-P2-S15-S3 Avg* | - | 0.04 | 0.59 | 4.13 | 18.58 | -14.45 | 0.22 |
| TP-P2-S17-S1-pan | 0.037 | 1.99 | 0.1 | 165.91 | 3.31 | 162.6 | 49.99 |
| TP-P2-S17-S1-No200 | 0.074 | 1.33 | 0.06 | 111.09 | 2.06 | 109.03 | 53.88 |
| TP-P2-S17-S1-No140 | 0.105 | 1.22 | 0.06 | 101.72 | 1.96 | 99.76 | 51.79 |
| TP-P2-S17-S1-No100 | 0.149 | 1.16 | 0.05 | 96.83 | 1.71 | 95.12 | 56.53 |
| TP-P2-S17-S1-No60 | 0.25 | 1.16 | 0.04 | 96.74 | 1.49 | 95.25 | 64.85 |
| TP-P2-S17-S1-No40 | 0.42 | 1.64 | 0.06 | 136.8 | 1.95 | 134.85 | 69.94 |
| TP-P2-S17-S1-No20 | 0.841 | 1.83 | 0.12 | 152.53 | 3.84 | 148.68 | 39.63 |
| TP-P2-S17-S1-No10 | 2 | 2.02 | 0.13 | 167.7 | 4.35 | 163.35 | 38.51 |
| TP-P2-S17-S1-No4 | 4.76 | 2.14 | 0.32 | 177.9 | 10.13 | 167.77 | 17.56 |
| TP-P2-S17-S1 Avg* | - | 1.81 | 0.17 | 150.67 | 5.58 | 145.08 | 26.95 |
| TP-P2-S17-S2-pan | 0.037 | 1.1 | 1.86 | 91.78 | 58.25 | 33.52 | 1.57 |
| TP-P2-S17-S2-No200 | 0.074 | 1.29 | 1.42 | 107.49 | 44.49 | 63 | 2.41 |
| TP-P2-S17-S2-No140 | 0.105 | 1.28 | 0.85 | 106.25 | 26.79 | 79.45 | 3.96 |
| TP-P2-S17-S2-No100 | 0.149 | 1.06 | 0.63 | 88.41 | 19.81 | 68.6 | 4.46 |
| TP-P2-S17-S2-No60 | 0.25 | 1.04 | 0.58 | 86.48 | 18.15 | 68.32 | 4.76 |
| TP-P2-S17-S2-No40 | 0.42 | 1.17 | 0.53 | 97.29 | 16.57 | 80.71 | 5.86 |
| TP-P2-S17-S2-No20 | 0.841 | 1.31 | 0.6 | 108.91 | 18.94 | 89.96 | 5.74 |
| TP-P2-S17-S2-No10 | 2 | 1.15 | 0.74 | 95.7 | 23.42 | 72.28 | 4.08 |
| TP-P2-S17-S2-No4 | 4.76 | 1.17 | 0.84 | 97.49 | 26.27 | 71.22 | 3.71 |
| TP-P2-S17-S2 Avg* | - | 1.17 | 0.84 | 97.66 | 26.55 | 71.11 | 3.67 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.6(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| TP-P2-S17-S3-pan | 0.037 | 1.52 | 1.51 | 126.82 | 47.21 | 79.61 | 2.68 |
| TP-P2-S17-S3-No200 | 0.074 | 1.43 | 1.33 | 118.99 | 41.6 | 77.39 | 2.86 |
| TP-P2-S17-S3-No140 | 0.105 | 1.25 | 1.18 | 104.07 | 37.14 | 66.93 | 2.8 |
| TP-P2-S17-S3-No100 | 0.149 | 1.14 | 0.95 | 95.41 | 29.94 | 65.46 | 3.18 |
| TP-P2-S17-S3-No60 | 0.25 | 1.22 | 0.76 | 101.35 | 23.88 | 77.46 | 4.24 |
| TP-P2-S17-S3-No40 | 0.42 | 1.41 | 0.74 | 117.54 | 23.33 | 94.2 | 5.03 |
| TP-P2-S17-S3-No20 | 0.841 | 1.55 | 0.92 | 128.78 | 28.84 | 99.93 | 4.46 |
| TP-P2-S17-S3-No10 | 2 | 1.41 | 0.86 | 117.12 | 27.1 | 90.01 | 4.32 |
| TP-P2-S17-S3-No4 | 4.76 | 1.77 | 0.8 | 146.97 | 25.17 | 121.8 | 5.83 |
| TP-P2-S17-S3 Avg* | - | 1.75 | 0.81 | 146.05 | 25.41 | 120.64 | 5.74 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.7: Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P4-P1-S1-pan | 0.037 | 1.29 | 0.96 | 107.27 | 30.19 | 77.08 | 3.55 |
| P4-P1-S1-No200 | 0.074 | 1.03 | 0.76 | 85.88 | 23.85 | 62.03 | 3.6 |
| P4-P1-S1-No140 | 0.105 | 0.92 | 0.7 | 76.43 | 22.01 | 54.41 | 3.47 |
| P4-P1-S1-No100 | 0.149 | 0.88 | 0.73 | 73.3 | 22.96 | 50.34 | 3.19 |
| P4-P1-S1-No60 | 0.25 | 0.9 | 0.74 | 75.47 | 23.17 | 52.3 | 3.25 |
| P4-P1-S1-No40 | 0.42 | 1.13 | 1 | 93.97 | 31.45 | 62.51 | 2.98 |
| P4-P1-S1-No20 | 0.841 | 0.84 | 0.55 | 69.74 | 17.22 | 52.52 | 4.04 |
| P4-P1-S1-No10 | 2 | 0.65 | 0.65 | 54.26 | 20.53 | 33.72 | 2.64 |
| P4-P1-S1-No4 | 4.76 | 0.38 | 1.01 | 31.6 | 31.77 | -0.16 | 0.99 |
| P4-P1-S1 Avg* | - | 0.44 | 0.98 | 36.88 | 30.87 | 6 | 1.19 |
| P4-P2-S1-pan | 0.037 | 0.4 | 2.5 | 33.53 | 78.14 | -44.61 | 0.42 |
| P4-P2-S1-No200 | 0.074 | 0.42 | 2.02 | 35.42 | 63.34 | -27.92 | 0.55 |
| P4-P2-S1-No140 | 0.105 | 0.39 | 1.94 | 32.47 | 60.81 | -28.33 | 0.53 |
| P4-P2-S1-No100 | 0.149 | 0.34 | 1.8 | 28.46 | 56.41 | -27.94 | 0.5 |
| P4-P2-S1-No60 | 0.25 | 0.51 | 3.12 | 42.42 | 97.79 | -55.37 | 0.43 |
| P4-P2-S1-No40 | 0.42 | 0.3 | 1.09 | 25.65 | 34.22 | -8.56 | 0.74 |
| P4-P2-S1-No20 | 0.841 | 0.23 | 1.09 | 19.13 | 34.26 | -15.13 | 0.55 |
| P4-P2-S1-No10 | 2 | 0.21 | 0.7 | 17.8 | 21.9 | -4.1 | 0.81 |
| P4-P2-S1-No4 | 4.76 | 0.11 | 0.98 | 9.87 | 30.67 | -20.8 | 0.32 |
| P4-P2-S1 Avg* | - | 0.14 | 1.03 | 11.68 | 32.33 | -20.64 | 0.36 |
| P4-P2-S2-pan | 0.037 | 0.83 | 1.4 | 69.47 | 44.01 | 25.46 | 1.57 |
| P4-P2-S2-No200 | 0.074 | 0.6 | 0.94 | 50.12 | 29.44 | 20.67 | 1.7 |
| P4-P2-S2-No140 | 0.105 | 0.48 | 0.89 | 40.51 | 27.86 | 12.65 | 1.45 |
| P4-P2-S2-No100 | 0.149 | 0.44 | 0.94 | 36.92 | 29.58 | 7.33 | 1.24 |
| P4-P2-S2-No60 | 0.25 | 0.5 | 0.76 | 41.97 | 23.92 | 18.05 | 1.75 |
| P4-P2-S2-No40 | 0.42 | 0.61 | 0.66 | 50.89 | 20.86 | 30.02 | 2.43 |
| P4-P2-S2-No20 | 0.841 | 0.48 | 0.77 | 40.63 | 24.26 | 16.37 | 1.67 |
| P4-P2-S2-No10 | 2 | 0.43 | 1.03 | 36.36 | 32.46 | 3.9 | 1.12 |
| P4-P2-S2-No4 | 4.76 | 0.31 | 0.86 | 26.11 | 27.08 | -0.97 | 0.96 |
| P4-P2-S2 Avg* | - | 0.33 | 0.87 | 28.13 | 27.39 | 0.74 | 1.02 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.7(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P4-P3-S1-pan | 0.037 | 1.04 | 0.86 | 86.94 | 27.12 | 59.81 | 3.2 |
| P4-P3-S1-No200 | 0.074 | 0.75 | 0.57 | 62.44 | 18.1 | 44.34 | 3.44 |
| P4-P3-S1-No140 | 0.105 | 0.68 | 0.55 | 56.67 | 17.32 | 39.34 | 3.27 |
| P4-P3-S1-No100 | 0.149 | 0.59 | 0.53 | 49.12 | 16.58 | 32.53 | 2.96 |
| P4-P3-S1-No60 | 0.25 | 0.57 | 0.52 | 47.7 | 16.28 | 31.41 | 2.92 |
| P4-P3-S1-No40 | 0.42 | 0.56 | 0.57 | 47.04 | 17.95 | 29.09 | 2.62 |
| P4-P3-S1-No20 | 0.841 | 0.53 | 0.71 | 44.02 | 22.49 | 21.53 | 1.95 |
| P4-P3-S1-No10 | 2 | 0.33 | 0.84 | 28.12 | 26.39 | 1.72 | 1.06 |
| P4-P3-S1-No4 | 4.76 | 0.39 | 0.5 | 32.94 | 15.64 | 17.29 | 2.1 |
| P4-P3-S1 Avg* | - | 0.4 | 0.5 | 33.75 | 15.91 | 17.83 | 2.12 |
| P4-P4B-S1-pan | 0.037 | 0.71 | 0.04 | 59.25 | 1.35 | 57.89 | 43.64 |
| P4-P4B-S1-No200 | 0.074 | 0.6 | 0.02 | 50.53 | 0.78 | 49.74 | 64.34 |
| P4-P4B-S1-No140 | 0.105 | 0.42 | 0.02 | 35.27 | 0.67 | 34.59 | 52.16 |
| P4-P4B-S1-No100 | 0.149 | 0.44 | 0.02 | 37.31 | 0.65 | 36.66 | 57.3 |
| P4-P4B-S1-No60 | 0.25 | 0.44 | 0.01 | 36.66 | 0.56 | 36.09 | 64.47 |
| P4-P4B-S1-No40 | 0.42 | 0.49 | 0.02 | 40.81 | 0.73 | 40.07 | 55.23 |
| P4-P4B-S1-No20 | 0.841 | 0.71 | 0.02 | 59.63 | 0.88 | 58.74 | 67.53 |
| P4-P4B-S1-No10 | 2 | 0.75 | 0.03 | 62.56 | 0.99 | 61.56 | 62.82 |
| P4-P4B-S1-No4 | 4.76 | 0.95 | 0.03 | 79.62 | 1.03 | 78.59 | 77.02 |
| P4-P4B-S1 Avg* | - | 0.89 | 0.03 | 74.09 | 0.99 | 73.09 | 74.43 |
| P4-P4B-S2-pan | 0.037 | 1.78 | 0.04 | 148.14 | 1.46 | 146.68 | 101.4 |
| P4-P4B-S2-No200 | 0.074 | 1.11 | 0.03 | 92.6 | 1.02 | 91.58 | 90.59 |
| P4-P4B-S2-No140 | 0.105 | 0.92 | 0.03 | 76.75 | 0.97 | 75.77 | 78.72 |
| P4-P4B-S2-No100 | 0.149 | 0.79 | 0.02 | 65.76 | 0.83 | 64.93 | 78.9 |
| P4-P4B-S2-No60 | 0.25 | 0.89 | 0.02 | 74.39 | 0.66 | 73.72 | 111.99 |
| P4-P4B-S2-No40 | 0.42 | 1.16 | 0.03 | 96.75 | 0.96 | 95.79 | 100.75 |
| P4-P4B-S2-No20 | 0.841 | 1.35 | 0.06 | 112.48 | 1.92 | 110.55 | 58.3 |
| P4-P4B-S2-No10 | 2 | 1.52 | 0.03 | 126.34 | 1.11 | 125.22 | 113.65 |
| P4-P4B-S2-No4 | 4.76 | 1.86 | 0.23 | 154.62 | 7.44 | 147.18 | 20.76 |
| P4-P4B-S2 Avg* | - | 1.49 | 0.12 | 124.31 | 3.8 | 120.5 | 32.65 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.7(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P4-P4B-S3-pan | 0.037 | 0.66 | 1.44 | 54.89 | 45.22 | 9.66 | 1.21 |
| P4-P4B-S3-No200 | 0.074 | 0.71 | 1.43 | 59.03 | 44.95 | 14.07 | 1.31 |
| P4-P4B-S3-No140 | 0.105 | 0.67 | 1.51 | 55.84 | 47.42 | 8.41 | 1.17 |
| P4-P4B-S3-No100 | 0.149 | 0.55 | 1.65 | 46.26 | 51.86 | -5.59 | 0.89 |
| P4-P4B-S3-No60 | 0.25 | 0.41 | 1.49 | 34.36 | 46.72 | -12.36 | 0.73 |
| P4-P4B-S3-No40 | 0.42 | 0.32 | 0.85 | 26.86 | 26.85 | 0 | 1 |
| P4-P4B-S3-No20 | 0.841 | 0.24 | 0.75 | 20.09 | 23.43 | -3.34 | 0.85 |
| P4-P4B-S3-No10 | 2 | 0.17 | 0.53 | 14.37 | 16.84 | -2.46 | 0.85 |
| P4-P4B-S3 Avg* | - | 0.02 | 0.57 | 2.41 | 17.89 | -15.48 | 0.13 |
| P4-P4-S1-pan | 0.037 | 0.84 | 0.5 | 70.22 | 15.87 | 54.34 | 4.42 |
| P4-P4-S1-No200 | 0.074 | 0.59 | 0.41 | 49.59 | 12.91 | 36.67 | 3.83 |
| P4-P4-S1-No140 | 0.105 | 0.55 | 0.4 | 46.03 | 12.56 | 33.47 | 3.66 |
| P4-P4-S1-No100 | 0.149 | 0.49 | 0.39 | 41.18 | 12.42 | 28.76 | 3.31 |
| P4-P4-S1-No60 | 0.25 | 0.51 | 0.43 | 42.48 | 13.67 | 28.8 | 3.1 |
| P4-P4-S1-No40 | 0.42 | 0.56 | 0.39 | 46.88 | 12.34 | 34.54 | 3.79 |
| P4-P4-S1-No20 | 0.841 | 0.55 | 0.56 | 46.43 | 17.65 | 28.78 | 2.63 |
| P4-P4-S1-No10 | 2 | 0.37 | 0.8 | 31.33 | 25.27 | 6.05 | 1.23 |
| P4-P4-S1-No4 | 4.76 | 0.27 | 0.53 | 23.06 | 16.81 | 6.24 | 1.37 |
| P4-P4-S1 Avg* | - | 0.29 | 0.53 | 24.24 | 16.81 | 7.43 | 1.44 |
| P4-P5-S1-pan | 0.037 | 0.87 | 2.46 | 72.41 | 77.03 | -4.62 | 0.93 |
| P4-P5-S1-No200 | 0.074 | 0.84 | 2.43 | 70.43 | 76.23 | -5.79 | 0.92 |
| P4-P5-S1-No140 | 0.105 | 0.46 | 2.13 | 38.69 | 66.59 | -27.9 | 0.58 |
| P4-P5-S1-No100 | 0.149 | 0.59 | 2.84 | 49.37 | 88.98 | -39.61 | 0.55 |
| P4-P5-S1-No60 | 0.25 | 0.77 | 2.75 | 64.34 | 85.96 | -21.62 | 0.74 |
| P4-P5-S1-No40 | 0.42 | 0.27 | 1.02 | 23.06 | 32.11 | -9.05 | 0.71 |
| P4-P5-S1-No20 | 0.841 | 0.34 | 1.4 | 28.79 | 43.84 | -15.04 | 0.65 |
| P4-P5-S1-No10 | 2 | 0.18 | 0.94 | 15.04 | 29.51 | -14.47 | 0.5 |
| P4-P5-S1 Avg* | - | 0.18 | 0.95 | 15.51 | 29.99 | -14.47 | 0.51 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.7(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P4-P5-S2-pan | 0.037 | 1.05 | 0.41 | 87.78 | 12.99 | 74.79 | 6.75 |
| P4-P5-S2-No200 | 0.074 | 0.73 | 0.38 | 60.79 | 11.9 | 48.89 | 5.1 |
| P4-P5-S2-No140 | 0.105 | 0.56 | 0.36 | 46.9 | 11.37 | 35.52 | 4.12 |
| P4-P5-S2-No100 | 0.149 | 0.51 | 0.42 | 42.64 | 13.14 | 29.5 | 3.24 |
| P4-P5-S2-No60 | 0.25 | 0.53 | 0.43 | 44.09 | 13.69 | 30.39 | 3.21 |
| P4-P5-S2-No40 | 0.42 | 0.62 | 0.36 | 52.06 | 11.27 | 40.78 | 4.61 |
| P4-P5-S2-No20 | 0.841 | 0.61 | 0.43 | 51.15 | 13.51 | 37.64 | 3.78 |
| P4-P5-S2-No10 | 2 | 0.35 | 0.48 | 29.08 | 15.05 | 14.03 | 1.93 |
| P4-P5-S2-No4 | 4.76 | 0.89 | 0.41 | 74.62 | 12.91 | 61.71 | 5.78 |
| P4-P5-S2 Avg* | - | 0.84 | 0.41 | 70.51 | 12.96 | 57.54 | 5.43 |
| P4-P6-S1-pan | 0.037 | 1.04 | 2.26 | 86.65 | 70.93 | 15.72 | 1.22 |
| P4-P6-S1-No200 | 0.074 | 0.99 | 2.46 | 82.85 | 76.97 | 5.87 | 1.07 |
| P4-P6-S1-No140 | 0.105 | 0.88 | 2.74 | 73.07 | 85.65 | -12.58 | 0.85 |
| P4-P6-S1-No100 | 0.149 | 0.65 | 2.87 | 54.04 | 89.74 | -35.7 | 0.6 |
| P4-P6-S1-No60 | 0.25 | 0.49 | 1.76 | 41.37 | 55.31 | -13.93 | 0.74 |
| P4-P6-S1-No40 | 0.42 | 0.41 | 1.22 | 34.75 | 38.42 | -3.66 | 0.9 |
| P4-P6-S1-No20 | 0.841 | 0.31 | 1.35 | 26.15 | 42.39 | -16.23 | 0.61 |
| P4-P6-S1-No10 | 2 | 0.24 | 1.57 | 20.66 | 49.21 | -28.54 | 0.41 |
| P4-P6-S1-No4 | 4.76 | 0.09 | 1.25 | 7.69 | 39.2 | -31.5 | 0.19 |
| P4-P6-S1 Avg* | - | 0.14 | 1.32 | 12.07 | 41.42 | -29.35 | 0.29 |
| P4-P7-S1-pan | 0.037 | 0.53 | 0.06 | 44.72 | 2.06 | 42.65 | 21.61 |
| P4-P7-S1-No200 | 0.074 | 0.29 | 0.05 | 24.1 | 1.7 | 22.4 | 14.14 |
| P4-P7-S1-No140 | 0.105 | 0.24 | 0.05 | 20.53 | 1.62 | 18.91 | 12.67 |
| P4-P7-S1-No100 | 0.149 | 0.26 | 0.05 | 22.24 | 1.63 | 20.6 | 13.63 |
| P4-P7-S1-No60 | 0.25 | 0.31 | 0.04 | 25.74 | 1.36 | 24.38 | 18.85 |
| P4-P7-S1-No40 | 0.42 | 0.37 | 0.03 | 30.81 | 1.06 | 29.74 | 28.8 |
| P4-P7-S1-No20 | 0.841 | 0.44 | 0.07 | 36.96 | 2.44 | 34.52 | 15.12 |
| P4-P7-S1-No10 | 2 | 0.4 | 0.15 | 33.28 | 4.7 | 28.57 | 7.07 |
| P4-P7-S1-No4 | 4.76 | 0.42 | 0.04 | 35.06 | 1.33 | 33.73 | 26.34 |
| P4-P7-S1 Avg* | - | 0.41 | 0.04 | 34.6 | 1.46 | 33.14 | 23.67 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.7(Cont.): Carbon, Sulfur and Acid-Base Accounting Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Carbon (wt. %)* | *Sulfur (wt. %)* | *Neutralization Potential, NP (kg CaCO3/tonne)* | *Acid Production Potential, APP (kg CaCO3/tonne)* | *Net Neutralization Potential, NPP* | *Neutralization Potential Ratio, NPR* |
|---|---|---|---|---|---|---|---|
| P4-P7-S2-pan | 0.037 | 0.38 | 6.41 | 32.05 | 200.56 | -168.5 | 0.15 |
| P4-P7-S2-No200 | 0.074 | 0.22 | 2.99 | 18.59 | 93.62 | -75.03 | 0.19 |
| P4-P7-S2-No140 | 0.105 | 0.17 | 1.92 | 14.34 | 60.11 | -45.77 | 0.23 |
| P4-P7-S2-No100 | 0.149 | 0.16 | 1.93 | 13.77 | 60.46 | -46.68 | 0.22 |
| P4-P7-S2-No60 | 0.25 | 0.15 | 1.74 | 13.1 | 54.52 | -41.42 | 0.24 |
| P4-P7-S2-No40 | 0.42 | 0.13 | 1.53 | 11.32 | 48.06 | -36.73 | 0.23 |
| P4-P7-S2-No20 | 0.841 | 0.15 | 2.23 | 13.15 | 69.69 | -56.53 | 0.18 |
| P4-P7-S2-No10 | 2 | 0.15 | 1.91 | 12.78 | 59.86 | -47.08 | 0.21 |
| P4-P7-S2-No4 | 4.76 | 0.1 | 1.59 | 8.94 | 49.89 | -40.95 | 0.17 |
| P4-P7-S2 Avg* | - | 0.11 | 1.65 | 9.32 | 51.57 | -42.25 | 0.18 |
| P4-P8-S1-pan | 0.037 | 0.69 | 0.14 | 57.46 | 4.63 | 52.82 | 12.39 |
| P4-P8-S1-No200 | 0.074 | 0.39 | 0.1 | 33 | 3.14 | 29.86 | 10.5 |
| P4-P8-S1-No140 | 0.105 | 0.3 | 0.07 | 25.06 | 2.33 | 22.72 | 10.72 |
| P4-P8-S1-No100 | 0.149 | 0.29 | 0.07 | 24.47 | 2.41 | 22.05 | 10.11 |
| P4-P8-S1-No60 | 0.25 | 0.35 | 0.08 | 29.28 | 2.53 | 26.75 | 11.54 |
| P4-P8-S1-No40 | 0.42 | 0.47 | 0.09 | 39.65 | 2.99 | 36.66 | 13.25 |
| P4-P8-S1-No20 | 0.841 | 0.65 | 0.1 | 54.52 | 3.4 | 51.12 | 16.03 |
| P4-P8-S1-No10 | 2 | 0.47 | 0.2 | 39.64 | 6.25 | 33.39 | 6.34 |
| P4-P8-S1 Avg* | - | 0.18 | 0.16 | 15.29 | 5.23 | 10.06 | 2.92 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.8: X-Ray Fluorescence Data for WRS#3 and WRS#4 Drill Cutting Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH3-1_5.5ft | - | 65.98 | 4.45 | 3.9 | 10.68 | 8.11 | 0.08 | 2.02 | 3.27 | 0.33 | 0.05 | 592 | 460 |
| BH3-1_21ft | - | 67.54 | 2.55 | 3.48 | 10.49 | 5.29 | 0.06 | 2.04 | 3.25 | 0.33 | 0.04 | 341 | 430 |
| BH3-1_41ft | - | 60.24 | 6.21 | 9.17 | 12.01 | 7.88 | 0.19 | 1.31 | 2.23 | 0.68 | 0.12 | 425 | 500 |
| BH3-1_72ft | - | 70.53 | 2.35 | 3.09 | 9.08 | 5.23 | 0.05 | 2.26 | 2.86 | 0.21 | 0.03 | 363 | 280 |
| BH3-2_6ft | - | 67.41 | 2.69 | 5 | 12.28 | 4.36 | 0.22 | 1.74 | 3.86 | 0.45 | 0.06 | 232 | 580 |
| BH3-2_22ft | - | 65.18 | 2.71 | 4.1 | 10.7 | 5.8 | 0.05 | 1.87 | 3.19 | 0.36 | 0.05 | 414 | 460 |
| BH3-2_42ft | - | 67.12 | 3.59 | 6.69 | 11.32 | 4.96 | 0.47 | 1.78 | 2.89 | 0.46 | 0.08 | 139 | 370 |
| BH3-2_62ft | - | 55.61 | 7.57 | 12.94 | 11.84 | 8.69 | 0.45 | 1.06 | 1.78 | 0.92 | 0.18 | 396 | 420 |
| BH4-2_6ft | - | 66.57 | 2.46 | 3.97 | 10.3 | 4.15 | 0.04 | 1.87 | 3.1 | 0.36 | 0.05 | 258 | 450 |
| BH4-2_22ft | - | 60.42 | 13.23 | 10.17 | 10.69 | 7.38 | 0.84 | 1.13 | 1.93 | 0.54 | 0.14 | 439 | 390 |
| BH4-2_42ft | - | 57.96 | 8.57 | 11.24 | 12.99 | 8.5 | 0.45 | 0.81 | 2.69 | 0.71 | 0.15 | 466 | 360 |
| BH4-3_6ft | - | 58.58 | 14.67 | 9.56 | 10.57 | 7.36 | 0.65 | 1.29 | 1.89 | 0.51 | 0.12 | 558 | 470 |
| BH4-3_22ft | - | 55.46 | 11.81 | 14.27 | 11.08 | 8.89 | 2.06 | 1.21 | 0.91 | 0.65 | 0.15 | 394 | 310 |
| BH4-3_42ft | - | 62.78 | 5.28 | 8.53 | 11.24 | 6.86 | 0.52 | 1.34 | 2.69 | 0.58 | 0.11 | 339 | 360 |
| BH4-5_6ft | - | 55.85 | 22.85 | 11.72 | 8.21 | 4.87 | 0.94 | 0.58 | 0.61 | 0.42 | 0.15 | 382 | 140 |
| BH4-5_22ft | - | 55.12 | 23.11 | 11.89 | 7.79 | 5.04 | 1.07 | 0.59 | 0.61 | 0.41 | 0.15 | 378 | 130 |
| BH4-5_42ft | - | 58.69 | 8.98 | 13.77 | 12.89 | 8.17 | 0.94 | 0.73 | 2.08 | 0.82 | 0.18 | 435 | 420 |
| BH4-5_62ft | - | 60.85 | 7.66 | 8.72 | 10.69 | 4.73 | 1.05 | 1.27 | 2.11 | 0.46 | 0.09 | 294 | 240 |
| BH4-5_72ft | - | 65.08 | 8.2 | 7.31 | 10.06 | 3.61 | 1.22 | 1.43 | 2.46 | 0.31 | 0.06 | -90 | 220 |
| BH4-6_6ft | - | 56.69 | 8.09 | 11.4 | 12.77 | 10.05 | 0.35 | 0.88 | 2.08 | 0.7 | 0.16 | 464 | 340 |
| BH4-6_22ft | - | 62.13 | 5.66 | 8.69 | 12.17 | 7.04 | 0.41 | 1.35 | 2.99 | 0.59 | 0.11 | 317 | 410 |
| BH4-6_42ft | - | 67.95 | 3.08 | 4.7 | 11.03 | 4.16 | 0.1 | 1.77 | 3.24 | 0.39 | 0.06 | 157 | 490 |
| BH4-6_56ft | - | 57.5 | 7.28 | 10.76 | 12.68 | 9.14 | 0.2 | 0.95 | 2.62 | 0.75 | 0.16 | 481 | 460 |

*indicates the sample location and mid-point of the sampling depth interval (location BH4-6 actually corresponds to BH4-1 in Figure 4.1

***Table A.8(Cont.): X-Ray Fluorescence Data for WRS#3 and WRS#4 Drill Cutting Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH3-1_5.5ft | - | 29 | 37 | 32 | 11 | 153 | 352 | 57 | 13 | 67 | 948 | 120 |
| BH3-1_21ft | - | 28 | 32 | 29 | 7 | 145 | 368 | 59 | 13 | 66 | 994 | 160 |
| BH3-1_41ft | - | 82 | 68 | 59 | 3 | 179 | 242 | 42 | 11 | 157 | 756 | 120 |
| BH3-1_72ft | - | 42 | 29 | 21 | 9 | 209 | 299 | 61 | 13 | 45 | 1014 | 100 |
| BH3-2_6ft | - | 85 | 34 | 44 | -2 | 147 | 351 | 53 | 12 | 78 | 922 | 170 |
| BH3-2_22ft | - | 28 | 41 | 41 | 3 | 145 | 368 | 48 | 13 | 77 | 953 | 140 |
| BH3-2_42ft | - | 163 | 44 | 40 | 5 | 211 | 257 | 50 | 12 | 122 | 857 | 120 |
| BH3-2_62ft | - | 186 | 79 | 88 | -14 | 292 | 155 | 44 | 8 | 244 | 634 | 120 |
| BH4-2_6ft | - | 38 | 44 | 35 | 6 | 152 | 370 | 50 | 13 | 72 | 990 | 150 |
| BH4-2_22ft | - | 376 | 260 | 75 | -2 | 833 | 212 | 35 | 10 | 134 | 724 | 100 |
| BH4-2_42ft | - | 205 | 83 | 81 | -3 | 260 | 172 | 32 | 10 | 186 | 694 | 120 |
| BH4-3_6ft | - | 255 | 286 | 71 | 3 | 921 | 313 | 38 | 11 | 124 | 743 | 120 |
| BH4-3_22ft | - | 742 | 214 | 78 | -8 | 612 | 157 | 44 | 7 | 179 | 623 | 110 |
| BH4-3_42ft | - | 136 | 53 | 53 | 4 | 255 | 273 | 43 | 11 | 147 | 780 | 130 |
| BH4-5_6ft | - | 385 | 553 | 88 | -17 | 1730 | 142 | 18 | 9 | 119 | 712 | 100 |
| BH4-5_22ft | - | 411 | 526 | 93 | -13 | 1882 | 150 | 17 | 9 | 133 | 715 | 90 |
| BH4-5_42ft | - | 398 | 87 | 80 | -10 | 313 | 156 | 24 | 8 | 212 | 631 | 110 |
| BH4-5_62ft | - | 268 | 118 | 67 | 1 | 433 | 166 | 32 | 11 | 103 | 780 | 150 |
| BH4-5_72ft | - | 243 | 181 | 34 | 4 | 620 | 171 | 32 | 12 | 72 | 854 | 160 |
| BH4-6_6ft | - | 163 | 87 | 82 | -3 | 192 | 173 | 35 | 9 | 198 | 687 | 110 |
| BH4-6_22ft | - | 114 | 63 | 54 | 4 | 175 | 256 | 43 | 12 | 175 | 768 | 130 |
| BH4-6_42ft | - | 49 | 46 | 34 | 4 | 141 | 349 | 50 | 13 | 82 | 953 | 150 |
| BH4-6_56ft | - | 85 | 76 | 60 | -7 | 158 | 254 | 30 | 10 | 192 | 694 | 120 |

*Table A.9: X-Ray Fluorescence Data for WRS#3 Cover Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS3-1-1 | - | 64.18 | 2.29 | 3.36 | 10.08 | 3.9 | 0.02 | 1.9 | 2.75 | 0.36 | 0.04 | 225 | 370 |
| WRS3-1-2 | - | 62.85 | 2.65 | 3.31 | 9.49 | 5.23 | 0.04 | 2.01 | 2.3 | 0.34 | 0.04 | 341 | 410 |
| WRS3-3-1 | - | 63.55 | 2.41 | 2.99 | 8.96 | 5.13 | 0.02 | 1.98 | 2.49 | 0.3 | 0.04 | 388 | 470 |
| WRS3-3-2 | - | 62.46 | 2.93 | 3.16 | 9.24 | 6.28 | 0.04 | 2.11 | 2.31 | 0.33 | 0.04 | 439 | 400 |
| WRS3-5-1 | - | 63.67 | 2.45 | 3.49 | 9.78 | 3.89 | 0.02 | 1.87 | 2.44 | 0.36 | 0.05 | 216 | 460 |
| WRS3-5-2 | - | 61.77 | 3.11 | 4 | 9.53 | 4.29 | 0.15 | 1.83 | 2.13 | 0.37 | 0.05 | 219 | 400 |
| WRS3-9-1 | - | 63.62 | 2.75 | 3.66 | 10.01 | 4.02 | 0.02 | 1.91 | 2.66 | 0.38 | 0.05 | 266 | 460 |
| WRS3-9-2 | - | 62.56 | 2.41 | 3.87 | 9.83 | 5.07 | 0.06 | 1.89 | 2.58 | 0.39 | 0.05 | 287 | 430 |

*indicates the sample location (see Figure 4.2) and depth. Samples ending in -1 were collected approximately 0.5m above samples ending in -2 (see Section 3.2.2)

***Table A.9(Cont.): X-Ray Fluorescence Data for WRS#3 Cover Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH3-1_5.5ft | - | 28 | 30 | 30 | 6 | 127 | 365 | 55 | 13 | 66 | 1059 | 160 |
| BH3-1_21ft | - | 25 | 27 | 29 | 13 | 130 | 359 | 57 | 13 | 62 | 1041 | 150 |
| BH3-1_41ft | - | 25 | 30 | 23 | 11 | 135 | 365 | 53 | 14 | 55 | 1050 | 160 |
| BH3-1_72ft | - | 26 | 27 | 28 | 20 | 128 | 357 | 60 | 14 | 59 | 1058 | 160 |
| BH3-2_6ft | - | 31 | 30 | 30 | 12 | 112 | 366 | 55 | 14 | 76 | 1051 | 170 |
| BH3-2_22ft | - | 162 | 51 | 36 | 11 | 158 | 355 | 52 | 13 | 78 | 1014 | 180 |
| BH3-2_42ft | - | 32 | 34 | 33 | 10 | 135 | 363 | 53 | 13 | 88 | 1035 | 170 |
| BH3-2_62ft | - | 40 | 28 | 31 | 13 | 119 | 357 | 55 | 13 | 86 | 1007 | 160 |

*indicates the sample location (see Figure 4.2) and depth. Samples ending in -1 were collected approximately 0.5m above samples ending in -2 (see Section 3.2.2)

***Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P1-S1-pan | 0.037 | 44.53 | 12.33 | 21.21 | 7.02 | 5.64 | 5.62 | 0.7 | 0.28 | 0.56 | 0.14 | 519 | 250 |
| P1-P1-S1-No200 | 0.074 | 41.53 | 10.2 | 18.65 | 6.05 | 8.81 | 8.7 | 0.73 | 0.53 | 0.51 | 0.15 | 668 | 350 |
| P1-P1-S1-No140 | 0.105 | 44.44 | 9.82 | 16.58 | 6.55 | 9.79 | 8.37 | 0.7 | 0.81 | 0.55 | 0.14 | 715 | 350 |
| P1-P1-S1-No100 | 0.149 | 46.94 | 10.15 | 15.08 | 6.92 | 9.23 | 7.76 | 0.7 | 1 | 0.53 | 0.12 | 690 | 320 |
| P1-P1-S1-No60 | 0.25 | 49.96 | 10.06 | 13.83 | 7.6 | 7.4 | 5.29 | 0.73 | 0.8 | 0.54 | 0.12 | 577 | 220 |
| P1-P1-S1-No40 | 0.42 | 53.72 | 11.37 | 12.81 | 8.66 | 5.55 | 2.74 | 0.71 | 0.93 | 0.6 | 0.13 | 418 | 230 |
| P1-P1-S1-No20 | 0.841 | 58.24 | 9.57 | 11.29 | 10.16 | 5.16 | 1.15 | 0.75 | 1.47 | 0.65 | 0.13 | 366 | 320 |
| P1-P1-S1-No10 | 2 | 58.32 | 9.49 | 11.13 | 10.42 | 5.74 | 1.11 | 0.77 | 1.76 | 0.68 | 0.13 | 372 | 370 |
| P1-P1-S1-No4 | 4.76 | 62.62 | 7.98 | 10.11 | 10.3 | 4.99 | 1.06 | 0.76 | 2.5 | 0.66 | 0.11 | 351 | 300 |
| P1-P1-S1 Avg* | - | 60.93 | 8.38 | 10.66 | 10.07 | 5.21 | 1.42 | 0.76 | 2.18 | 0.65 | 0.11 | 378 | 330 |
| P1-P1-S2-pan | 0.037 | 44.52 | 13.46 | 20.89 | 6.78 | 5.94 | 5.53 | 0.64 | 0.25 | 0.57 | 0.15 | 536 | 260 |
| P1-P1-S2-No200 | 0.074 | 49.07 | 13.57 | 18.85 | 8.05 | 7 | 5.48 | 0.75 | 0.75 | 0.57 | 0.15 | 542 | 320 |
| P1-P1-S2-No140 | 0.105 | 49.3 | 13.04 | 17.58 | 8.01 | 7.8 | 6.14 | 0.76 | 0.88 | 0.57 | 0.14 | 579 | 270 |
| P1-P1-S2-No100 | 0.149 | 51.19 | 12.85 | 15.96 | 8.2 | 7.94 | 6.14 | 0.73 | 1.12 | 0.6 | 0.13 | 560 | 310 |
| P1-P1-S2-No60 | 0.25 | 52.33 | 11.76 | 14.68 | 8.28 | 7.34 | 4.89 | 0.71 | 0.88 | 0.6 | 0.13 | 533 | 280 |
| P1-P1-S2-No40 | 0.42 | 55.75 | 11.99 | 13.89 | 9.54 | 6.03 | 2.72 | 0.7 | 1.21 | 0.66 | 0.14 | 428 | 290 |
| P1-P1-S2-No20 | 0.841 | 57.94 | 11.53 | 13.04 | 10.32 | 5.76 | 1.39 | 0.67 | 1.18 | 0.71 | 0.14 | 337 | 380 |
| P1-P1-S2-No10 | 2 | 58.62 | 10.05 | 12.15 | 10.6 | 6.13 | 1.2 | 0.73 | 1.56 | 0.73 | 0.14 | 411 | 410 |
| P1-P1-S2-No4 | 4.76 | 58.18 | 10.37 | 11.63 | 11.17 | 5.99 | 1.14 | 0.84 | 1.79 | 0.8 | 0.14 | 386 | 330 |
| P1-P1-S2 Avg* | - | 58.05 | 10.41 | 11.74 | 11.11 | 6 | 1.21 | 0.84 | 1.76 | 0.8 | 0.14 | 388 | 330 |
| P1-P1-S3-pan | 0.037 | 47.39 | 13.85 | 19.93 | 7.91 | 5.1 | 4.89 | 0.89 | 0.49 | 0.53 | 0.11 | 447 | 370 |
| P1-P1-S3-No200 | 0.074 | 44.11 | 12.32 | 16.88 | 6.82 | 6.22 | 5.8 | 0.99 | 0.28 | 0.53 | 0.11 | 529 | 250 |
| P1-P1-S3-No140 | 0.105 | 51.24 | 13.3 | 16.08 | 8.3 | 6.67 | 5.67 | 1.04 | 1.15 | 0.53 | 0.11 | 498 | 300 |
| P1-P1-S3-No100 | 0.149 | 51.3 | 12.52 | 14.6 | 7.71 | 6.42 | 4.86 | 0.98 | 0.76 | 0.51 | 0.11 | 491 | 200 |
| P1-P1-S3-No60 | 0.25 | 53.54 | 13.69 | 13.8 | 8.31 | 6.61 | 4.67 | 0.86 | 1.07 | 0.51 | 0.11 | 487 | 260 |
| P1-P1-S3-No40 | 0.42 | 55.79 | 15.21 | 13.06 | 9.15 | 5.48 | 2.62 | 0.77 | 1.11 | 0.54 | 0.12 | 406 | 230 |
| P1-P1-S3-No20 | 0.841 | 57.72 | 16.21 | 12.28 | 9.85 | 5.05 | 1.21 | 0.72 | 1.05 | 0.6 | 0.13 | 334 | 270 |
| P1-P1-S3-No10 | 2 | 59.09 | 14.57 | 11.98 | 10.23 | 5.18 | 1.22 | 0.7 | 1.37 | 0.61 | 0.13 | 365 | 320 |
| P1-P1-S3-No4 | 4.76 | 60.28 | 11.9 | 10.64 | 9.76 | 5.23 | 0.94 | 0.69 | 1.48 | 0.57 | 0.12 | 415 | 250 |
| P1-P1-S3 Avg* | - | 59.7 | 12.19 | 10.99 | 9.69 | 5.26 | 1.14 | 0.7 | 1.43 | 0.57 | 0.12 | 413 | 254 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P1-S1-pan | 0.037 | 1008 | 1005 | 132 | 4 | 719 | 117 | 25 | -4 | 113 | 574 | 100 |
| P1-P1-S1-No200 | 0.074 | 1077 | 816 | 123 | 27 | 736 | 137 | 34 | 1 | 121 | 609 | 110 |
| P1-P1-S1-No140 | 0.105 | 1143 | 690 | 102 | 34 | 703 | 141 | 29 | 4 | 121 | 632 | 100 |
| P1-P1-S1-No100 | 0.149 | 925 | 580 | 92 | 34 | 694 | 146 | 32 | 7 | 133 | 672 | 100 |
| P1-P1-S1-No60 | 0.25 | 833 | 452 | 85 | 18 | 670 | 141 | 27 | 7 | 134 | 704 | 110 |
| P1-P1-S1-No40 | 0.42 | 752 | 355 | 77 | 3 | 693 | 135 | 26 | 8 | 132 | 718 | 120 |
| P1-P1-S1-No20 | 0.841 | 587 | 242 | 67 | 0 | 585 | 138 | 27 | 9 | 162 | 765 | 130 |
| P1-P1-S1-No10 | 2 | 394 | 207 | 67 | -2 | 565 | 154 | 29 | 9 | 164 | 739 | 140 |
| P1-P1-S1-No4 | 4.76 | 428 | 178 | 51 | 2 | 518 | 136 | 25 | 10 | 138 | 775 | 150 |
| P1-P1-S1 Avg* | - | 463 | 211 | 55 | 5 | 538 | 136 | 27 | 9 | 137 | 774 | 0.01 |
| P1-P1-S2-pan | 0.037 | 1043 | 1068 | 155 | 17 | 821 | 120 | 29 | -4 | 115 | 560 | 100 |
| P1-P1-S2-No200 | 0.074 | 1177 | 877 | 143 | 15 | 1059 | 131 | 33 | 1 | 131 | 594 | 100 |
| P1-P1-S2-No140 | 0.105 | 1133 | 789 | 139 | 18 | 950 | 133 | 28 | 3 | 124 | 615 | 100 |
| P1-P1-S2-No100 | 0.149 | 987 | 701 | 117 | 23 | 826 | 137 | 28 | 5 | 138 | 641 | 100 |
| P1-P1-S2-No60 | 0.25 | 819 | 591 | 107 | 17 | 767 | 141 | 29 | 7 | 134 | 666 | 100 |
| P1-P1-S2-No40 | 0.42 | 673 | 504 | 100 | 5 | 717 | 136 | 27 | 7 | 149 | 688 | 110 |
| P1-P1-S2-No20 | 0.841 | 688 | 383 | 96 | -4 | 641 | 132 | 25 | 8 | 177 | 699 | 120 |
| P1-P1-S2-No10 | 2 | 845 | 228 | 79 | 1 | 557 | 140 | 26 | 9 | 168 | 714 | 130 |
| P1-P1-S2-No4 | 4.76 | 412 | 174 | 75 | -1 | 585 | 157 | 37 | 9 | 199 | 725 | 150 |
| P1-P1-S2 Avg* | - | 426 | 185 | 76 | 0 | 589 | 156 | 36 | 9 | 197 | 723 | 0.01 |
| P1-P1-S3-pan | 0.037 | 896 | 590 | 104 | -11 | 898 | 147 | 35 | -3 | 88 | 591 | 120 |
| P1-P1-S3-No200 | 0.074 | 959 | 487 | 88 | 5 | 865 | 160 | 37 | 3 | 96 | 643 | 110 |
| P1-P1-S3-No140 | 0.105 | 1073 | 464 | 89 | 37 | 895 | 158 | 36 | 5 | 110 | 664 | 100 |
| P1-P1-S3-No100 | 0.149 | 934 | 407 | 80 | 18 | 894 | 166 | 35 | 6 | 111 | 699 | 100 |
| P1-P1-S3-No60 | 0.25 | 859 | 365 | 80 | 20 | 948 | 157 | 32 | 7 | 111 | 702 | 100 |
| P1-P1-S3-No40 | 0.42 | 721 | 317 | 80 | -2 | 971 | 141 | 26 | 8 | 126 | 713 | 110 |
| P1-P1-S3-No20 | 0.841 | 475 | 238 | 80 | 1 | 1036 | 131 | 25 | 9 | 145 | 742 | 110 |
| P1-P1-S3-No10 | 2 | 821 | 215 | 77 | -8 | 956 | 145 | 24 | 9 | 158 | 728 | 120 |
| P1-P1-S3-No4 | 4.76 | 557 | 174 | 62 | -5 | 869 | 124 | 25 | 10 | 137 | 762 | 130 |
| P1-P1-S3 Avg* | - | 580 | 190 | 64 | -4 | 878 | 126 | 24 | 9 | 136 | 755 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P2-S1-pan | 0.037 | 50.46 | 26.7 | 15.83 | 8.03 | 6.02 | 1.32 | 0.25 | -0.21 | 0.45 | 0.19 | 330 | 100 |
| P1-P2-S1-No200 | 0.074 | 51.24 | 27.45 | 15.45 | 8.76 | 6.82 | 1.17 | 0.28 | 0.11 | 0.39 | 0.21 | 345 | 50 |
| P1-P2-S1-No140 | 0.105 | 52.09 | 27.54 | 14.33 | 8.79 | 7.19 | 1.19 | 0.31 | 0.13 | 0.43 | 0.21 | 423 | 40 |
| P1-P2-S1-No100 | 0.149 | 51.87 | 26.19 | 13.85 | 8.95 | 7.39 | 1.45 | 0.32 | 0.23 | 0.44 | 0.2 | 385 | 60 |
| P1-P2-S1-No60 | 0.25 | 51.15 | 25.37 | 13.54 | 8.56 | 7.63 | 1.72 | 0.32 | 0.12 | 0.45 | 0.19 | 379 | 80 |
| P1-P2-S1-No40 | 0.42 | 51.79 | 24.92 | 12.95 | 8.61 | 6.99 | 1.02 | 0.37 | 0.07 | 0.43 | 0.18 | 380 | 100 |
| P1-P2-S1-No20 | 0.841 | 53.05 | 24.96 | 12.38 | 8.77 | 6.58 | 0.44 | 0.4 | 0.2 | 0.4 | 0.18 | 402 | 110 |
| P1-P2-S1-No10 | 2 | 53.29 | 23.19 | 11.84 | 8.84 | 6.81 | 0.52 | 0.47 | 0.34 | 0.41 | 0.17 | 413 | 110 |
| P1-P2-S1-No4 | 4.76 | 57.73 | 18.89 | 9.17 | 9.61 | 6.08 | 0.45 | 0.85 | 1.67 | 0.45 | 0.12 | 481 | 250 |
| P1-P2-S1 Avg* | - | 57.28 | 19.39 | 9.5 | 9.53 | 6.14 | 0.49 | 0.81 | 1.54 | 0.44 | 0.13 | 473 | 237 |
| P1-P2-S2-pan | 0.037 | 50.83 | 18.47 | 15.05 | 8.9 | 4.37 | 1.98 | 0.72 | 0.03 | 0.49 | 0.14 | 383 | 240 |
| P1-P2-S2-No200 | 0.074 | 32.43 | 3.53 | 13.25 | 2.9 | 4.42 | 1.47 | 0.64 | -2.61 | 0.39 | 0.15 | -398 | 40 |
| P1-P2-S2-No140 | 0.105 | 33.6 | 3.53 | 12.83 | 2.96 | 4.88 | 1.86 | 0.68 | -2.45 | 0.42 | 0.14 | -435 | 20 |
| P1-P2-S2-No100 | 0.149 | 33.41 | 3.07 | 11.34 | 2.82 | 5.52 | 2.25 | 0.67 | -2.4 | 0.36 | 0.12 | 21 | 40 |
| P1-P2-S2-No60 | 0.25 | 56.9 | 17.54 | 11.31 | 9.92 | 6.42 | 3.48 | 0.81 | 1.47 | 0.46 | 0.12 | 539 | 230 |
| P1-P2-S2-No40 | 0.42 | 57.21 | 17.59 | 11.38 | 9.99 | 6.39 | 3.5 | 0.82 | 1.41 | 0.47 | 0.12 | 534 | 190 |
| P1-P2-S2-No20 | 0.841 | 59.76 | 16.65 | 10.38 | 11.05 | 4.79 | 0.94 | 0.86 | 1.47 | 0.5 | 0.12 | 439 | 260 |
| P1-P2-S2-No10 | 2 | 59.59 | 14.83 | 10.36 | 11.01 | 5 | 0.81 | 0.9 | 1.75 | 0.53 | 0.12 | 399 | 300 |
| P1-P2-S2-No4 | 4.76 | 60.67 | 16.49 | 9.66 | 10.16 | 4.07 | 1.12 | 0.91 | 1.7 | 0.47 | 0.11 | 413 | 400 |
| P1-P2-S2 Avg* | - | 58.93 | 15.97 | 10.12 | 9.94 | 4.37 | 1.28 | 0.89 | 1.46 | 0.47 | 0.11 | 393 | 353 |
| P1-P2-S3-pan | 0.037 | 47.27 | 17.79 | 16.33 | 8.75 | 5.73 | 2.29 | 0.57 | -0.19 | 0.5 | 0.16 | 419 | 210 |
| P1-P2-S3-No200 | 0.074 | 51.84 | 18.06 | 15.63 | 10.29 | 6.21 | 2.2 | 0.76 | 0.41 | 0.52 | 0.17 | 427 | 180 |
| P1-P2-S3-No140 | 0.105 | 52.84 | 17.51 | 14.06 | 9.76 | 6.44 | 2.52 | 0.79 | 0.6 | 0.5 | 0.16 | 437 | 290 |
| P1-P2-S3-No100 | 0.149 | 52.6 | 16.68 | 12.68 | 9.4 | 6.87 | 2.98 | 0.77 | 0.65 | 0.48 | 0.14 | 462 | 150 |
| P1-P2-S3-No60 | 0.25 | 53.52 | 16.49 | 12.31 | 9.51 | 7.15 | 2.8 | 0.75 | 0.65 | 0.5 | 0.14 | 463 | 150 |
| P1-P2-S3-No40 | 0.42 | 54.61 | 18.16 | 12.45 | 10.18 | 6.56 | 1.75 | 0.69 | 0.67 | 0.53 | 0.15 | 441 | 250 |
| P1-P2-S3-No20 | 0.841 | 52.38 | 16.65 | 12 | 9.63 | 6.35 | 0.88 | 0.66 | 0.38 | 0.55 | 0.15 | 438 | 200 |
| P1-P2-S3-No10 | 2 | 55 | 18.95 | 12.19 | 10.31 | 6.22 | 0.91 | 0.67 | 0.84 | 0.55 | 0.16 | 394 | 290 |
| P1-P2-S3-No4 | 4.76 | 54.59 | 18.46 | 12.43 | 10.8 | 6.67 | 0.9 | 0.69 | 0.98 | 0.6 | 0.16 | 399 | 290 |
| P1-P2-S3 Avg* | - | 54.43 | 18.4 | 12.49 | 10.7 | 6.64 | 0.97 | 0.69 | 0.94 | 0.59 | 0.16 | 401 | 284 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P2-S1-pan | 0.037 | 657 | 995 | 134 | -17 | 2322 | 99 | 8 | 4 | 136 | 628 | 80 |
| P1-P2-S1-No200 | 0.074 | 672 | 727 | 123 | -7 | 2407 | 103 | 6 | 5 | 127 | 646 | 70 |
| P1-P2-S1-No140 | 0.105 | 673 | 638 | 114 | -7 | 2000 | 107 | 9 | 7 | 128 | 678 | 80 |
| P1-P2-S1-No100 | 0.149 | 604 | 595 | 99 | -2 | 1989 | 111 | 9 | 7 | 116 | 699 | 80 |
| P1-P2-S1-No60 | 0.25 | 520 | 603 | 99 | -3 | 2051 | 120 | 10 | 7 | 129 | 691 | 80 |
| P1-P2-S1-No40 | 0.42 | 382 | 572 | 92 | -1 | 1904 | 125 | 12 | 9 | 135 | 722 | 90 |
| P1-P2-S1-No20 | 0.841 | 239 | 574 | 90 | -3 | 1853 | 129 | 13 | 9 | 118 | 735 | 90 |
| P1-P2-S1-No10 | 2 | 331 | 547 | 87 | -5 | 1822 | 164 | 12 | 9 | 132 | 731 | 100 |
| P1-P2-S1-No4 | 4.76 | 115 | 414 | 51 | 12 | 1171 | 306 | 28 | 11 | 88 | 836 | 130 |
| P1-P2-S1 Avg* | - | 141 | 433 | 54 | 10 | 1236 | 292 | 26 | 10 | 91 | 825 | 0.01 |
| P1-P2-S2-pan | 0.037 | 772 | 798 | 124 | -14 | 1193 | 132 | 22 | 4 | 106 | 648 | 130 |
| P1-P2-S2-No200 | 0.074 | 714 | 588 | 106 | -6 | 1177 | 152 | 27 | 7 | 111 | 685 | 100 |
| P1-P2-S2-No140 | 0.105 | 723 | 544 | 103 | 11 | 1173 | 161 | 29 | 7 | 113 | 704 | 100 |
| P1-P2-S2-No100 | 0.149 | 596 | 456 | 89 | 9 | 1069 | 167 | 24 | 10 | 116 | 727 | 100 |
| P1-P2-S2-No60 | 0.25 | 498 | 413 | 86 | 16 | 1144 | 171 | 27 | 9 | 109 | 750 | 110 |
| P1-P2-S2-No40 | 0.42 | 506 | 410 | 81 | 11 | 1129 | 173 | 27 | 9 | 105 | 755 | 110 |
| P1-P2-S2-No20 | 0.841 | 303 | 312 | 90 | 3 | 1060 | 178 | 28 | 10 | 116 | 776 | 120 |
| P1-P2-S2-No10 | 2 | 309 | 289 | 61 | -1 | 811 | 182 | 28 | 10 | 121 | 778 | 130 |
| P1-P2-S2-No4 | 4.76 | 414 | 297 | 67 | -3 | 948 | 188 | 31 | 10 | 108 | 795 | 130 |
| P1-P2-S2 Avg* | - | 425 | 327 | 71 | -1 | 968 | 183 | 29 | 10 | 109 | 782 | 0.01 |
| P1-P2-S3-pan | 0.037 | 911 | 777 | 133 | -6 | 1237 | 126 | 21 | 3 | 125 | 629 | 110 |
| P1-P2-S3-No200 | 0.074 | 1035 | 599 | 116 | -1 | 1453 | 142 | 30 | 4 | 136 | 648 | 100 |
| P1-P2-S3-No140 | 0.105 | 912 | 519 | 106 | 7 | 1228 | 152 | 24 | 7 | 134 | 677 | 90 |
| P1-P2-S3-No100 | 0.149 | 757 | 426 | 91 | 15 | 1159 | 161 | 26 | 8 | 126 | 707 | 90 |
| P1-P2-S3-No60 | 0.25 | 701 | 381 | 87 | 10 | 1149 | 157 | 23 | 9 | 127 | 718 | 90 |
| P1-P2-S3-No40 | 0.42 | 527 | 367 | 89 | 1 | 1240 | 156 | 23 | 9 | 139 | 710 | 100 |
| P1-P2-S3-No20 | 0.841 | 378 | 318 | 81 | -3 | 1097 | 155 | 21 | 9 | 154 | 717 | 100 |
| P1-P2-S3-No10 | 2 | 278 | 348 | 84 | -4 | 1116 | 157 | 19 | 9 | 137 | 718 | 100 |
| P1-P2-S3-No4 | 4.76 | 288 | 337 | 80 | -7 | 1108 | 185 | 24 | 9 | 177 | 702 | 100 |
| P1-P2-S3 Avg* | - | 311 | 345 | 81 | -6 | 1114 | 181 | 23 | 8 | 173 | 701 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P3-S1-pan | 0.037 | 48.73 | 23.12 | 14.75 | 8.92 | 5.73 | 1.73 | 0.39 | -0.24 | 0.43 | 0.17 | 369 | 140 |
| P1-P3-S1-No200 | 0.074 | 45.46 | 20.86 | 14.15 | 8.21 | 5.77 | 1.63 | 0.41 | -0.76 | 0.41 | 0.2 | 365 | 60 |
| P1-P3-S1-No140 | 0.105 | 49.82 | 21.46 | 13.58 | 8.62 | 6.93 | 1.65 | 0.49 | -0.13 | 0.43 | 0.2 | 426 | 80 |
| P1-P3-S1-No100 | 0.149 | 49.87 | 20.64 | 12.46 | 8.37 | 7.14 | 1.84 | 0.5 | -0.11 | 0.42 | 0.18 | 417 | 80 |
| P1-P3-S1-No60 | 0.25 | 50.45 | 20.65 | 12.37 | 8.51 | 7.75 | 2.21 | 0.5 | 0.03 | 0.43 | 0.17 | 410 | 100 |
| P1-P3-S1-No40 | 0.42 | 50.21 | 21.29 | 12.39 | 8.64 | 7.56 | 1.76 | 0.47 | 0.11 | 0.45 | 0.17 | 395 | 100 |
| P1-P3-S1-No20 | 0.841 | 51.66 | 21.75 | 12.28 | 8.88 | 6.79 | 0.68 | 0.47 | 0 | 0.46 | 0.17 | 394 | 200 |
| P1-P3-S1-No10 | 2 | 52.02 | 22.22 | 12.32 | 8.57 | 6.79 | 0.44 | 0.46 | 0.02 | 0.45 | 0.18 | 386 | 130 |
| P1-P3-S1-No4 | 4.76 | 52.26 | 20.9 | 12.6 | 9.34 | 5.69 | 0.72 | 0.4 | 0.16 | 0.45 | 0.17 | 379 | 90 |
| P1-P3-S1 Avg* | - | 52.13 | 20.96 | 12.62 | 9.29 | 5.76 | 0.76 | 0.4 | 0.14 | 0.45 | 0.17 | 380 | 92 |
| P1-P3-S3-pan | 0.037 | 49.16 | 25.34 | 15.1 | 8.58 | 4.93 | 1.35 | 0.31 | -0.41 | 0.43 | 0.17 | 296 | 140 |
| P1-P3-S3-No200 | 0.074 | 51.92 | 27.29 | 15.49 | 9.02 | 5.6 | 1.64 | 0.36 | -0.02 | 0.41 | 0.19 | 348 | 140 |
| P1-P3-S3-No100 | 0.149 | 52.11 | 23.26 | 12.78 | 8.49 | 6.58 | 1.71 | 0.48 | 0.17 | 0.43 | 0.17 | 377 | 30 |
| P1-P3-S3-No60 | 0.25 | 52.63 | 23.5 | 12.94 | 8.68 | 7.13 | 2.27 | 0.45 | 0.16 | 0.43 | 0.17 | 380 | 130 |
| P1-P3-S3-No40 | 0.42 | 50.3 | 22.81 | 12.95 | 8.25 | 7.75 | 2.53 | 0.4 | 0.09 | 0.44 | 0.17 | 369 | 120 |
| P1-P3-S3-No20 | 0.841 | 52.01 | 24.23 | 13.05 | 8.91 | 6.35 | 1.05 | 0.36 | -0.18 | 0.46 | 0.17 | 369 | 160 |
| P1-P3-S3-No10 | 2 | 53.8 | 24.71 | 12.45 | 8.9 | 5.89 | 0.9 | 0.38 | 0 | 0.41 | 0.16 | 350 | 100 |
| P1-P3-S3-No4 | 4.76 | 52.65 | 25.87 | 12.52 | 8.02 | 6.12 | 0.57 | 0.27 | -0.2 | 0.48 | 0.17 | 360 | 250 |
| P1-P3-S3 Avg* | - | 52.59 | 25.74 | 12.62 | 8.1 | 6.13 | 0.67 | 0.28 | 0.01 | 0.48 | 0.17 | 359 | 235 |
| P1-P4-S1-pan | 0.037 | 56.09 | 7.41 | 6.5 | 9.89 | 4.73 | 1.93 | 1.57 | 1.42 | 0.43 | 0.11 | 396 | 430 |
| P1-P4-S1-No200 | 0.074 | 61.47 | 5.56 | 5.07 | 9.88 | 4.19 | 1.89 | 1.72 | 2.33 | 0.33 | 0.11 | 507 | 400 |
| P1-P4-S1-No140 | 0.105 | 62.72 | 4.99 | 4.6 | 9.53 | 3.81 | 1.79 | 1.72 | 2.38 | 0.32 | 0.1 | 79 | 290 |
| P1-P4-S1-No100 | 0.149 | 62.97 | 4.72 | 4.36 | 9.05 | 3.56 | 1.65 | 1.6 | 2.2 | 0.3 | 0.08 | 25 | 200 |
| P1-P4-S1-No60 | 0.25 | 63.58 | 5.86 | 4.77 | 9.47 | 4.03 | 1.76 | 1.53 | 2.43 | 0.28 | 0.08 | 410 | 210 |
| P1-P4-S1-No40 | 0.42 | 61.51 | 7.61 | 5.66 | 9.99 | 4.59 | 1.49 | 1.49 | 2.26 | 0.37 | 0.09 | -82 | 310 |
| P1-P4-S1-No20 | 0.841 | 60.18 | 11.07 | 7.46 | 11.12 | 5.34 | 1.04 | 1.38 | 2.26 | 0.42 | 0.11 | 235 | 300 |
| P1-P4-S1-No10 | 2 | 56.86 | 12.92 | 8.38 | 10.39 | 5.29 | 0.75 | 1.26 | 1.47 | 0.44 | 0.11 | 539 | 310 |
| P1-P4-S1-No4 | 4.76 | 55.39 | 17.48 | 10.24 | 10.49 | 8.36 | 0.64 | 0.93 | 1.34 | 0.52 | 0.16 | 458 | 310 |
| P1-P4-S1 Avg* | - | 56.18 | 15.92 | 9.56 | 10.41 | 7.73 | 0.78 | 1.02 | 1.45 | 0.49 | 0.15 | 425 | 309 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P3-S1-pan | 0.037 | 704 | 1441 | 145 | -19 | 1658 | 103 | 10 | 5 | 116 | 643 | 80 |
| P1-P3-S1-No200 | 0.074 | 616 | 1137 | 133 | -18 | 1648 | 109 | 13 | 6 | 127 | 645 | 90 |
| P1-P3-S1-No140 | 0.105 | 796 | 983 | 129 | -8 | 1586 | 121 | 17 | 7 | 148 | 684 | 80 |
| P1-P3-S1-No100 | 0.149 | 650 | 819 | 106 | -5 | 1526 | 128 | 17 | 9 | 125 | 709 | 80 |
| P1-P3-S1-No60 | 0.25 | 583 | 730 | 100 | -1 | 1562 | 131 | 15 | 9 | 120 | 704 | 80 |
| P1-P3-S1-No40 | 0.42 | 489 | 682 | 99 | -5 | 1603 | 130 | 16 | 9 | 128 | 718 | 80 |
| P1-P3-S1-No20 | 0.841 | 330 | 591 | 91 | -17 | 1535 | 125 | 16 | 8 | 134 | 713 | 90 |
| P1-P3-S1-No10 | 2 | 294 | 610 | 98 | -11 | 1819 | 136 | 17 | 9 | 127 | 720 | 90 |
| P1-P3-S1-No4 | 4.76 | 290 | 531 | 99 | -6 | 1694 | 87 | 12 | 9 | 127 | 731 | 100 |
| P1-P3-S1 Avg* | - | 303 | 551 | 99 | -6 | 1691 | 89 | 12 | 9 | 127 | 729 | 0 |
| P1-P3-S3-pan | 0.037 | 762 | 1458 | 142 | -25 | 2067 | 98 | 9 | 5 | 120 | 629 | 80 |
| P1-P3-S3-No200 | 0.074 | 948 | 1273 | 133 | -12 | 2105 | 104 | 14 | 5 | 127 | 654 | 80 |
| P1-P3-S3-No100 | 0.149 | 926 | 815 | 106 | -4 | 1722 | 132 | 15 | 8 | 118 | 723 | 80 |
| P1-P3-S3-No60 | 0.25 | 930 | 750 | 104 | -7 | 1830 | 129 | 16 | 7 | 122 | 703 | 80 |
| P1-P3-S3-No40 | 0.42 | 723 | 741 | 110 | -1 | 1858 | 129 | 14 | 8 | 120 | 705 | 80 |
| P1-P3-S3-No20 | 0.841 | 592 | 663 | 99 | -9 | 1877 | 132 | 11 | 8 | 123 | 707 | 80 |
| P1-P3-S3-No10 | 2 | 230 | 648 | 90 | -9 | 1760 | 148 | 11 | 9 | 112 | 720 | 90 |
| P1-P3-S3-No4 | 4.76 | 248 | 668 | 83 | -16 | 1660 | 209 | 10 | 8 | 133 | 711 | 80 |
| P1-P3-S3 Avg* | - | 286 | 688 | 85 | -15 | 1684 | 200 | 10 | 8 | 112 | 709 | 0 |
| P1-P4-S1-pan | 0.037 | 380 | 1998 | 155 | 15 | 427 | 340 | 47 | 12 | 103 | 889 | 240 |
| P1-P4-S1-No200 | 0.074 | 292 | 1406 | 110 | 15 | 358 | 350 | 49 | 12 | 70 | 955 | 150 |
| P1-P4-S1-No140 | 0.105 | 265 | 1233 | 96 | 13 | 338 | 342 | 49 | 13 | 70 | 991 | 110 |
| P1-P4-S1-No100 | 0.149 | 223 | 1086 | 84 | 13 | 330 | 334 | 48 | 13 | 59 | 1001 | 100 |
| P1-P4-S1-No60 | 0.25 | 221 | 1077 | 83 | 15 | 408 | 326 | 43 | 13 | 62 | 981 | 110 |
| P1-P4-S1-No40 | 0.42 | 234 | 1067 | 89 | 11 | 511 | 328 | 43 | 12 | 84 | 933 | 110 |
| P1-P4-S1-No20 | 0.841 | 288 | 903 | 96 | 8 | 706 | 320 | 39 | 12 | 105 | 856 | 110 |
| P1-P4-S1-No10 | 2 | 259 | 686 | 87 | 1 | 779 | 291 | 38 | 11 | 118 | 834 | 100 |
| P1-P4-S1-No4 | 4.76 | 225 | 531 | 84 | 8 | 939 | 222 | 30 | 10 | 146 | 765 | 90 |
| P1-P4-S1 Avg* | - | 233 | 634 | 87 | 8 | 869 | 238 | 32 | 10 | 136 | 790 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P4-S2-pan | 0.037 | 47.31 | 15.12 | 17.76 | 9.26 | 5.83 | 3.13 | 0.67 | 0.06 | 0.56 | 0.15 | 390 | 210 |
| P1-P4-S2-No200 | 0.074 | 47.99 | 14.81 | 15.34 | 9.3 | 6.11 | 3.23 | 0.81 | 0.38 | 0.57 | 0.15 | 424 | 300 |
| P1-P4-S2-No140 | 0.105 | 52.19 | 15.6 | 14.52 | 9.92 | 6.15 | 2.95 | 0.91 | 0.54 | 0.59 | 0.14 | 422 | 240 |
| P1-P4-S2-No100 | 0.149 | 52.66 | 15.19 | 13.07 | 9.53 | 6.3 | 2.89 | 0.91 | 0.77 | 0.52 | 0.13 | 391 | 290 |
| P1-P4-S2-No60 | 0.25 | 54.44 | 15.26 | 12.14 | 9.84 | 6.46 | 2.48 | 0.9 | 0.89 | 0.54 | 0.13 | 414 | 260 |
| P1-P4-S2-No40 | 0.42 | 54.77 | 15.92 | 11.78 | 10.6 | 6.38 | 1.6 | 0.86 | 0.79 | 0.55 | 0.14 | 367 | 320 |
| P1-P4-S2-No20 | 0.841 | 55.04 | 15.3 | 11.99 | 10.64 | 6.59 | 0.83 | 0.81 | 0.73 | 0.61 | 0.15 | 372 | 360 |
| P1-P4-S2-No10 | 2 | 55.47 | 15.33 | 12.39 | 10.84 | 6.61 | 0.99 | 0.78 | 0.89 | 0.62 | 0.15 | 358 | 380 |
| P1-P4-S2-No4 | 4.76 | 54.79 | 18.11 | 12.58 | 11.55 | 8.28 | 0.71 | 0.6 | 0.79 | 0.64 | 0.16 | 421 | 370 |
| P1-P4-S2 Avg* | - | 54.63 | 17.82 | 12.66 | 11.41 | 8.08 | 0.83 | 0.63 | 0.78 | 0.63 | 0.16 | 416.9 | 0.03 |
| P1-P5-S1-pan | 0.037 | 49.28 | 21.16 | 15.27 | 8.39 | 6.01 | 2.3 | 0.54 | 0.02 | 0.41 | 0.13 | 441 | 320 |
| P1-P5-S1-No200 | 0.074 | 48.5 | 19.65 | 14.15 | 8.54 | 6.97 | 2.21 | 0.63 | 0.23 | 0.43 | 0.14 | 506 | 230 |
| P1-P5-S1-No140 | 0.105 | 49.42 | 19.49 | 13.13 | 8.73 | 7.93 | 2.61 | 0.67 | 0.42 | 0.46 | 0.14 | 531 | 220 |
| P1-P5-S1-No100 | 0.149 | 48.73 | 17.58 | 11.95 | 8.36 | 8.67 | 3.32 | 0.69 | 0.34 | 0.43 | 0.13 | 562 | 210 |
| P1-P5-S1-No60 | 0.25 | 49.55 | 18.36 | 11.83 | 8.48 | 9.22 | 4.17 | 0.69 | 0.65 | 0.44 | 0.13 | 577 | 250 |
| P1-P5-S1-No40 | 0.42 | 50.52 | 19.51 | 11.82 | 9.2 | 7.7 | 2.85 | 0.69 | 0.62 | 0.45 | 0.13 | 517 | 280 |
| P1-P5-S1-No20 | 0.841 | 51.77 | 19.13 | 11.24 | 9.43 | 5.89 | 1.18 | 0.73 | 0.38 | 0.45 | 0.13 | 428 | 330 |
| P1-P5-S1-No10 | 2 | 53.27 | 18.53 | 10.92 | 10.19 | 5.18 | 0.82 | 0.85 | 0.78 | 0.47 | 0.13 | 433 | 470 |
| P1-P5-S1-No4 | 4.76 | 56.63 | 18.15 | 10.51 | 10.08 | 5.76 | 1 | 0.94 | 1.37 | 0.46 | 0.12 | 452 | 390 |
| P1-P5-S1 Avg* | - | 56.31 | 18.21 | 10.59 | 10.03 | 5.8 | 1.05 | 0.93 | 1.32 | 0.45 | 0.12 | 453 | 387 |
| P1-P5-S2-pan | 0.037 | 48.23 | 16.97 | 17.48 | 7.82 | 5.18 | 4.23 | 0.97 | 0.42 | 0.45 | 0.11 | 386 | 360 |
| P1-P5-S2-No200 | 0.074 | 45.41 | 16.38 | 16.55 | 7.39 | 4.47 | 3.59 | 0.96 | -0.29 | 0.46 | 0.11 | 343 | 250 |
| P1-P5-S2-No140 | 0.105 | 44.35 | 16.52 | 17.13 | 7.06 | 4.69 | 3.89 | 0.83 | -0.23 | 0.44 | 0.11 | 372 | 230 |
| P1-P5-S2-No100 | 0.149 | 43.81 | 15.76 | 15.97 | 6.72 | 4.58 | 3.78 | 0.78 | -0.5 | 0.42 | 0.1 | 346 | 200 |
| P1-P5-S2-No60 | 0.25 | 46.15 | 17.17 | 15.39 | 7.03 | 4.73 | 3.03 | 0.65 | -0.29 | 0.39 | 0.11 | 331 | 250 |
| P1-P5-S2-No40 | 0.42 | 47.14 | 18.73 | 14.83 | 7.19 | 5.05 | 2.55 | 0.57 | -0.41 | 0.4 | 0.12 | 353 | 220 |
| P1-P5-S2-No20 | 0.841 | 49.63 | 20.86 | 12.95 | 7.73 | 4.91 | 1.4 | 0.53 | -0.21 | 0.42 | 0.13 | 328 | 180 |
| P1-P5-S2-No10 | 2 | 51.14 | 20.81 | 12.05 | 7.92 | 5.29 | 1.3 | 0.52 | 0.01 | 0.42 | 0.13 | 378 | 210 |
| P1-P5-S2-No4 | 4.76 | 52.26 | 22.58 | 12.7 | 7.97 | 3.91 | 1.7 | 0.63 | 0.17 | 0.46 | 0.12 | 287 | 280 |
| P1-P5-S2 Avg* | - | 51.37 | 21.76 | 13.08 | 7.88 | 4.16 | 1.87 | 0.63 | 0.1 | 0.45 | 0.12 | 302 | 268 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P4-S2-pan | 0.037 | 980 | 660 | 135 | -12 | 941 | 117 | 23 | 1 | 130 | 599 | 110 |
| P1-P4-S2-No200 | 0.074 | 961 | 532 | 114 | 12 | 918 | 143 | 29 | 5 | 142 | 658 | 100 |
| P1-P4-S2-No140 | 0.105 | 1066 | 508 | 110 | 5 | 948 | 151 | 31 | 6 | 131 | 680 | 100 |
| P1-P4-S2-No100 | 0.149 | 892 | 434 | 92 | 4 | 945 | 161 | 30 | 7 | 141 | 719 | 90 |
| P1-P4-S2-No60 | 0.25 | 739 | 364 | 85 | 3 | 969 | 163 | 30 | 8 | 144 | 729 | 100 |
| P1-P4-S2-No40 | 0.42 | 623 | 305 | 86 | 0 | 949 | 162 | 30 | 9 | 151 | 735 | 100 |
| P1-P4-S2-No20 | 0.841 | 474 | 247 | 83 | -3 | 842 | 155 | 25 | 9 | 169 | 718 | 100 |
| P1-P4-S2-No10 | 2 | 430 | 260 | 83 | -7 | 844 | 153 | 25 | 8 | 166 | 711 | 100 |
| P1-P4-S2-No4 | 4.76 | 475 | 299 | 84 | -6 | 935 | 165 | 21 | 8 | 180 | 703 | 100 |
| P1-P4-S2 Avg* | - | 494.68 | 306.51 | 85.3 | -5.47 | 931.72 | 163.41 | 21.19 | 8.13 | 176.77 | 702.31 | 0.01 |
| P1-P5-S1-pan | 0.037 | 677 | 1359 | 158 | -20 | 1455 | 140 | 20 | 5 | 102 | 628 | 100 |
| P1-P5-S1-No200 | 0.074 | 636 | 1056 | 140 | -6 | 1548 | 163 | 21 | 6 | 111 | 670 | 100 |
| P1-P5-S1-No140 | 0.105 | 652 | 853 | 129 | 5 | 1510 | 176 | 20 | 8 | 127 | 692 | 90 |
| P1-P5-S1-No100 | 0.149 | 551 | 694 | 115 | 8 | 1452 | 194 | 24 | 9 | 117 | 710 | 90 |
| P1-P5-S1-No60 | 0.25 | 493 | 635 | 111 | 16 | 1521 | 198 | 25 | 9 | 101 | 731 | 100 |
| P1-P5-S1-No40 | 0.42 | 370 | 580 | 105 | 7 | 1546 | 201 | 22 | 9 | 117 | 741 | 100 |
| P1-P5-S1-No20 | 0.841 | 343 | 469 | 92 | -7 | 1432 | 205 | 23 | 10 | 111 | 738 | 110 |
| P1-P5-S1-No10 | 2 | 271 | 384 | 88 | -4 | 1248 | 239 | 28 | 10 | 118 | 779 | 120 |
| P1-P5-S1-No4 | 4.76 | 168 | 391 | 92 | 0 | 1140 | 258 | 30 | 10 | 107 | 772 | 110 |
| P1-P5-S1 Avg* | - | 182 | 404 | 92 | 0 | 1155 | 254 | 29 | 10 | 107 | 770 | 0.01 |
| P1-P5-S2-pan | 0.037 | 796 | 692 | 109 | -14 | 1365 | 150 | 27 | 2 | 86 | 640 | 120 |
| P1-P5-S2-No200 | 0.074 | 813 | 595 | 101 | -15 | 1369 | 158 | 32 | 3 | 103 | 666 | 120 |
| P1-P5-S2-No140 | 0.105 | 910 | 588 | 99 | -21 | 1422 | 144 | 26 | 2 | 94 | 652 | 100 |
| P1-P5-S2-No100 | 0.149 | 777 | 478 | 89 | -10 | 1398 | 155 | 27 | 4 | 103 | 695 | 90 |
| P1-P5-S2-No60 | 0.25 | 705 | 400 | 92 | -18 | 1552 | 140 | 22 | 4 | 98 | 680 | 90 |
| P1-P5-S2-No40 | 0.42 | 573 | 363 | 93 | -10 | 1626 | 139 | 22 | 6 | 114 | 692 | 90 |
| P1-P5-S2-No20 | 0.841 | 366 | 294 | 92 | -15 | 1620 | 130 | 16 | 8 | 115 | 714 | 90 |
| P1-P5-S2-No10 | 2 | 403 | 299 | 86 | -8 | 1543 | 138 | 17 | 9 | 116 | 742 | 90 |
| P1-P5-S2-No4 | 4.76 | 673 | 363 | 96 | -19 | 1461 | 131 | 25 | 8 | 103 | 726 | 100 |
| P1-P5-S2 Avg* | - | 648 | 373 | 95 | -17 | 1475 | 133 | 24 | 7 | 103 | 719 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P5-S3-pan | 0.037 | 52.14 | 12.23 | 9.99 | 8.55 | 7.37 | 2.09 | 1.49 | 0.96 | 0.43 | 0.09 | 515 | 420 |
| P1-P5-S3-No200 | 0.074 | 48.61 | 10.8 | 8.63 | 7.56 | 5.65 | 1.71 | 1.51 | 0.02 | 0.43 | 0.08 | -145 | 250 |
| P1-P5-S3-No140 | 0.105 | 56.01 | 11.22 | 8.37 | 8.67 | 5.34 | 1.31 | 1.65 | 1.06 | 0.38 | 0.08 | 253 | 350 |
| P1-P5-S3-No100 | 0.149 | 57.27 | 11.61 | 7.91 | 8.39 | 5.07 | 1.2 | 1.45 | 1.08 | 0.36 | 0.07 | 133 | 250 |
| P1-P5-S3-No60 | 0.25 | 54.03 | 13.41 | 8.49 | 7.92 | 5.55 | 1.2 | 1.21 | 0.66 | 0.36 | 0.08 | 335 | 310 |
| P1-P5-S3-No40 | 0.42 | 51.08 | 14.58 | 9.19 | 7.66 | 6.36 | 0.9 | 1.1 | 0.14 | 0.36 | 0.1 | 445 | 220 |
| P1-P5-S3-No20 | 0.841 | 51.34 | 19.25 | 10.93 | 8.99 | 7.08 | 0.71 | 0.75 | 0.42 | 0.42 | 0.13 | 435 | 270 |
| P1-P5-S3-No10 | 2 | 52.87 | 18.48 | 10.57 | 8.83 | 6.44 | 0.79 | 0.93 | 0.44 | 0.4 | 0.12 | 359 | 220 |
| P1-P5-S3-No4 | 4.76 | 52.02 | 20.66 | 11.44 | 7.93 | 6.19 | 1.1 | 1.14 | 0.07 | 0.44 | 0.13 | 303 | 240 |
| P1-P5-S3 Avg* | - | 52.07 | 20.2 | 11.29 | 7.97 | 6.2 | 1.11 | 1.14 | 0.11 | 0.43 | 0.13 | 306 | 243 |
| P1-P6-S2-pan | 0.037 | 48.85 | 18.75 | 13.42 | 7.54 | 6.47 | 3.26 | 0.85 | 0.12 | 0.43 | 0.13 | 413 | 280 |
| P1-P6-S2-No200 | 0.074 | 53.6 | 15.95 | 12.41 | 8.04 | 6.57 | 2.77 | 1.08 | 0.56 | 0.42 | 0.13 | 442 | 220 |
| P1-P6-S2-No140 | 0.105 | 54.66 | 15.88 | 11.46 | 7.8 | 6.33 | 2.77 | 1.08 | 0.53 | 0.4 | 0.12 | 453 | 190 |
| P1-P6-S2-No100 | 0.149 | 55.81 | 15.53 | 10.61 | 7.7 | 6.01 | 2.47 | 1.01 | 0.58 | 0.37 | 0.11 | 405 | 170 |
| P1-P6-S2-No60 | 0.25 | 53.73 | 17.23 | 10.5 | 7.19 | 5.65 | 1.91 | 0.89 | 0.22 | 0.35 | 0.11 | 369 | 210 |
| P1-P6-S2-No40 | 0.42 | 54.17 | 19.48 | 11.22 | 7.58 | 5.73 | 1.41 | 0.8 | 0.21 | 0.38 | 0.13 | 370 | 180 |
| P1-P6-S2-No20 | 0.841 | 54.09 | 23.5 | 11.76 | 7.92 | 6.23 | 1.13 | 0.66 | 0.25 | 0.39 | 0.14 | 242 | 160 |
| P1-P6-S2-No10 | 2 | 50.39 | 21.74 | 12.06 | 7.73 | 6.67 | 1 | 0.55 | -0.19 | 0.43 | 0.15 | 392 | 210 |
| P1-P6-S2-No4 | 4.76 | 49.18 | 24.34 | 12.06 | 7.29 | 8.15 | 1.01 | 0.37 | -0.36 | 0.35 | 0.19 | 352 | 140 |
| P1-P6-S2 Avg* | - | 49.24 | 24.27 | 12.06 | 7.29 | 8.12 | 1.02 | 0.38 | 0.25 | 0.35 | 0.19 | 352 | 140 |
| P1-P7-S1-pan | 0.037 | 44.54 | 19.8 | 19.42 | 7.78 | 6.66 | 5.54 | 0.69 | 0.17 | 0.48 | 0.13 | 366 | 300 |
| P1-P7-S1-No60 | 0.25 | 47.56 | 19.18 | 16.37 | 8.23 | 4.38 | 2.93 | 0.73 | -0.15 | 0.49 | 0.13 | 325 | 270 |
| P1-P7-S1-No40 | 0.42 | 48.52 | 20.4 | 15.21 | 8.62 | 4.45 | 1.98 | 0.65 | -0.28 | 0.5 | 0.14 | 291 | 300 |
| P1-P7-S1-No20 | 0.841 | 49.46 | 21.71 | 14.05 | 8.77 | 5.17 | 1.34 | 0.52 | -0.24 | 0.5 | 0.15 | 340 | 320 |
| P1-P7-S1-No10 | 2 | 50.13 | 22.7 | 13.7 | 8.77 | 5.6 | 1.15 | 0.47 | -0.19 | 0.54 | 0.16 | 364 | 300 |
| P1-P7-S1-No4 | 4.76 | 54.01 | 21.07 | 13.13 | 9.37 | 5.65 | 1.08 | 0.47 | 0.51 | 0.51 | 0.16 | 339 | 220 |
| P1-P7-S1 Avg* | - | 53.8 | 21.07 | 13.23 | 9.34 | 5.66 | 1.14 | 0.47 | 0.49 | 0.51 | 0.16 | 339 | 222 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P5-S3-pan | 0.037 | 411 | 411 | 79 | 17 | 809 | 243 | 45 | 10 | 85 | 792 | 200 |
| P1-P5-S3-No200 | 0.074 | 366 | 300 | 64 | 9 | 746 | 252 | 46 | 11 | 89 | 844 | 120 |
| P1-P5-S3-No140 | 0.105 | 439 | 266 | 62 | 12 | 726 | 248 | 48 | 11 | 88 | 869 | 110 |
| P1-P5-S3-No100 | 0.149 | 397 | 228 | 57 | 7 | 743 | 237 | 43 | 11 | 78 | 883 | 90 |
| P1-P5-S3-No60 | 0.25 | 339 | 233 | 61 | 11 | 919 | 223 | 40 | 11 | 97 | 880 | 90 |
| P1-P5-S3-No40 | 0.42 | 318 | 247 | 67 | 9 | 1103 | 201 | 34 | 11 | 95 | 834 | 100 |
| P1-P5-S3-No20 | 0.841 | 316 | 294 | 87 | 0 | 1426 | 169 | 23 | 10 | 123 | 772 | 100 |
| P1-P5-S3-No10 | 2 | 477 | 276 | 82 | 1 | 1374 | 174 | 29 | 10 | 118 | 766 | 100 |
| P1-P5-S3-No4 | 4.76 | 816 | 323 | 84 | -7 | 1513 | 125 | 38 | 10 | 112 | 740 | 90 |
| P1-P5-S3 Avg* | - | 782 | 320 | 82 | -5 | 1476 | 131 | 37 | 10 | 111 | 746 | 0 |
| P1-P6-S2-pan | 0.037 | 693 | 824 | 116 | -4 | 1222 | 180 | 27 | 7 | 92 | 691 | 130 |
| P1-P6-S2-No200 | 0.074 | 829 | 633 | 101 | 4 | 1404 | 199 | 33 | 8 | 121 | 713 | 100 |
| P1-P6-S2-No140 | 0.105 | 794 | 574 | 104 | 7 | 1252 | 206 | 35 | 10 | 108 | 750 | 90 |
| P1-P6-S2-No100 | 0.149 | 736 | 512 | 83 | 10 | 1191 | 204 | 30 | 10 | 94 | 777 | 80 |
| P1-P6-S2-No60 | 0.25 | 610 | 511 | 84 | 4 | 1276 | 198 | 31 | 10 | 83 | 782 | 90 |
| P1-P6-S2-No40 | 0.42 | 649 | 523 | 89 | -3 | 1450 | 186 | 23 | 9 | 106 | 760 | 90 |
| P1-P6-S2-No20 | 0.841 | 474 | 517 | 96 | -4 | 1580 | 170 | 19 | 9 | 125 | 733 | 80 |
| P1-P6-S2-No10 | 2 | 418 | 482 | 95 | -10 | 1622 | 198 | 20 | 9 | 122 | 715 | 80 |
| P1-P6-S2-No4 | 4.76 | 331 | 520 | 95 | -6 | 1986 | 200 | 10 | 9 | 139 | 711 | 70 |
| P1-P6-S2 Avg* | - | 335 | 520 | 94 | -5 | 1977 | 200 | 10 | 9 | 125 | 710 | 0 |
| P1-P7-S1-pan | 0.037 | 1037 | 914 | 141 | -17 | 1697 | 99 | 23 | 0 | 106 | 589 | 80 |
| P1-P7-S1-No60 | 0.25 | 814 | 595 | 107 | -24 | 1571 | 117 | 25 | 4 | 110 | 652 | 90 |
| P1-P7-S1-No40 | 0.42 | 681 | 482 | 97 | -27 | 1608 | 108 | 23 | 6 | 128 | 667 | 90 |
| P1-P7-S1-No20 | 0.841 | 574 | 395 | 109 | -20 | 1743 | 111 | 18 | 7 | 137 | 690 | 90 |
| P1-P7-S1-No10 | 2 | 464 | 367 | 97 | -23 | 1620 | 114 | 16 | 7 | 144 | 684 | 90 |
| P1-P7-S1-No4 | 4.76 | 447 | 337 | 93 | -19 | 1586 | 120 | 15 | 8 | 144 | 708 | 90 |
| P1-P7-S1 Avg* | - | 456 | 345 | 93 | -19 | 1588 | 119 | 15 | 7 | 143 | 706 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10: X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P10-S1-pan | 0.037 | 49.1 | 8.66 | 17.15 | 10.42 | 8.58 | 3.17 | 0.89 | 0.88 | 0.74 | 0.2 | 550 | 390 |
| P1-P10-S1-No200 | 0.074 | 45.78 | 7.13 | 14.61 | 8.77 | 10.85 | 5.4 | 0.99 | 1.06 | 0.67 | 0.2 | 623 | 260 |
| P1-P10-S1-No140 | 0.105 | 48.73 | 7.43 | 14.1 | 9.32 | 12.93 | 6.85 | 0.98 | 1.67 | 0.7 | 0.18 | 712 | 370 |
| P1-P10-S1-No100 | 0.149 | 49.24 | 7.17 | 13.06 | 9.13 | 13.63 | 7.6 | 0.95 | 1.97 | 0.71 | 0.16 | 797 | 370 |
| P1-P10-S1-No60 | 0.25 | 53.13 | 7.84 | 13.27 | 10.52 | 10.58 | 4.41 | 0.96 | 1.71 | 0.75 | 0.16 | 601 | 370 |
| P1-P10-S1-No40 | 0.42 | 54.27 | 8.4 | 13.06 | 11.11 | 8.57 | 1.78 | 0.95 | 1.42 | 0.78 | 0.17 | 486 | 420 |
| P1-P10-S1-No20 | 0.841 | 55.87 | 8.8 | 13.04 | 11.8 | 8.14 | 0.98 | 0.93 | 1.61 | 0.83 | 0.17 | 456 | 490 |
| P1-P10-S1-No10 | 2 | 56.29 | 8.5 | 13.2 | 12.12 | 8.09 | 1.01 | 0.97 | 1.82 | 0.87 | 0.17 | 453 | 450 |
| P1-P10-S1-No4 | 4.76 | 55.92 | 7.76 | 12.45 | 11.26 | 7.96 | 1.26 | 0.87 | 1.65 | 0.8 | 0.15 | 476 | 580 |
| P1-P10-S1 Avg* | - | 55.8 | 7.96 | 12.56 | 11.35 | 8.02 | 1.35 | 0.87 | 1.8 | 0.8 | 0.15 | 571 | 557 |
| P1-P11-S1-pan | 0.037 | 53.75 | 24.98 | 15.27 | 8.66 | 4.56 | 2.44 | 0.5 | 0.53 | 0.41 | 0.13 | 364 | 250 |
| P1-P11-S1-No200 | 0.074 | 51.15 | 21.57 | 15.09 | 7.25 | 5.69 | 2.74 | 0.55 | 0.04 | 0.41 | 0.15 | 397 | 150 |
| P1-P11-S1-No140 | 0.105 | 51.79 | 21.61 | 12.8 | 7.24 | 6.68 | 2.67 | 0.58 | 0.18 | 0.4 | 0.15 | 383 | 140 |
| P1-P11-S1-No100 | 0.149 | 50.97 | 19.72 | 11.42 | 6.93 | 7.27 | 3.04 | 0.6 | 0.22 | 0.39 | 0.14 | 456 | 140 |
| P1-P11-S1-No60 | 0.25 | 52.07 | 20.72 | 11.45 | 7.39 | 7.48 | 3.29 | 0.57 | 0.29 | 0.4 | 0.14 | 453 | 160 |
| P1-P11-S1-No40 | 0.42 | 52.78 | 21.77 | 11.75 | 7.84 | 6.08 | 1.72 | 0.54 | 0.14 | 0.43 | 0.14 | 410 | 150 |
| P1-P11-S1-No20 | 0.841 | 54.07 | 22.03 | 11.91 | 8.64 | 5.64 | 0.95 | 0.55 | 0.11 | 0.48 | 0.15 | 372 | 250 |
| P1-P11-S1-No10 | 2 | 56.93 | 20.79 | 11.66 | 9.46 | 5.18 | 1.08 | 0.6 | 0.95 | 0.5 | 0.14 | 391 | 270 |
| P1-P11-S1-No4 | 4.76 | 59.36 | 16.26 | 11.2 | 10.01 | 4.67 | 1.92 | 0.71 | 1.89 | 0.49 | 0.11 | 475 | 330 |
| P1-P11-S1 Avg* | - | 58.51 | 17.12 | 11.39 | 9.75 | 4.85 | 1.9 | 0.69 | 1.66 | 0.49 | 0.12 | 462 | 311 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.10(Cont.): X-Ray Fluorescence Data for WRS#1 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1-P10-S1-pan | 0.037 | 790 | 780 | 165 | -9 | 246 | 163 | 35 | 3 | 192 | 590 | 110 |
| P1-P10-S1-No200 | 0.074 | 755 | 610 | 150 | 17 | 250 | 182 | 39 | 6 | 184 | 641 | 100 |
| P1-P10-S1-No140 | 0.105 | 877 | 536 | 128 | 29 | 262 | 189 | 43 | 8 | 188 | 645 | 100 |
| P1-P10-S1-No100 | 0.149 | 753 | 396 | 109 | 37 | 248 | 194 | 40 | 8 | 185 | 665 | 100 |
| P1-P10-S1-No60 | 0.25 | 677 | 302 | 115 | 10 | 283 | 192 | 40 | 8 | 195 | 665 | 100 |
| P1-P10-S1-No40 | 0.42 | 576 | 195 | 95 | -6 | 304 | 185 | 38 | 8 | 212 | 675 | 110 |
| P1-P10-S1-No20 | 0.841 | 367 | 125 | 88 | -3 | 298 | 183 | 36 | 8 | 206 | 675 | 110 |
| P1-P10-S1-No10 | 2 | 285 | 94 | 79 | -10 | 259 | 182 | 41 | 8 | 247 | 662 | 120 |
| P1-P10-S1-No4 | 4.76 | 229 | 89 | 78 | -3 | 263 | 197 | 36 | 9 | 189 | 691 | 120 |
| P1-P10-S1 Avg* | - | 248 | 104 | 77 | -5 | 280 | 197 | 37 | 8 | 211 | 678 | 0.01 |
| P1-P11-S1-pan | 0.037 | 886 | 899 | 132 | -20 | 1280 | 125 | 17 | 4 | 103 | 638 | 110 |
| P1-P11-S1-No200 | 0.074 | 1019 | 787 | 130 | -13 | 1480 | 142 | 20 | 5 | 104 | 657 | 90 |
| P1-P11-S1-No140 | 0.105 | 979 | 535 | 136 | 2 | 1479 | 151 | 18 | 8 | 123 | 702 | 90 |
| P1-P11-S1-No100 | 0.149 | 850 | 432 | 99 | 4 | 1404 | 156 | 19 | 9 | 104 | 737 | 90 |
| P1-P11-S1-No60 | 0.25 | 749 | 426 | 101 | 4 | 1489 | 149 | 16 | 8 | 116 | 736 | 80 |
| P1-P11-S1-No40 | 0.42 | 669 | 420 | 119 | -5 | 1608 | 146 | 18 | 9 | 134 | 743 | 90 |
| P1-P11-S1-No20 | 0.841 | 457 | 398 | 97 | -7 | 1467 | 147 | 21 | 9 | 126 | 745 | 100 |
| P1-P11-S1-No10 | 2 | 652 | 343 | 93 | -10 | 1140 | 151 | 21 | 9 | 132 | 737 | 110 |
| P1-P11-S1-No4 | 4.76 | 252 | 379 | 63 | -9 | 901 | 160 | 23 | 9 | 94 | 744 | 140 |
| P1-P11-S1 Avg* | - | 324 | 394 | 69 | -8 | 976 | 157 | 22 | 8 | 98 | 740 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-P1-S1-pan | 0.037 | 41.82 | 19.52 | 23.68 | 6.84 | 2.38 | 2.99 | 0.7 | -0.79 | 0.47 | 0.11 | 126 | 440 |
| TP-P1-P1-S1-No200 | 0.074 | 41.12 | 18.63 | 22.34 | 7.24 | 2.71 | 3.72 | 0.93 | -0.84 | 0.51 | 0.11 | 176 | 300 |
| TP-P1-P1-S1-No140 | 0.105 | 41.16 | 18.11 | 21.69 | 7.18 | 3.92 | 4.63 | 0.92 | -0.62 | 0.5 | 0.1 | 299 | 290 |
| TP-P1-P1-S1-No100 | 0.149 | 41.06 | 18.39 | 20.91 | 6.54 | 6.02 | 6.2 | 0.76 | -0.35 | 0.46 | 0.11 | 327 | 270 |
| TP-P1-P1-S1-No60 | 0.25 | 41.81 | 19.08 | 19.62 | 6.55 | 5.68 | 5.57 | 0.63 | -0.49 | 0.45 | 0.11 | 314 | 240 |
| TP-P1-P1-S1-No40 | 0.42 | 44.1 | 21.29 | 18.27 | 6.9 | 3.35 | 2.74 | 0.52 | -0.97 | 0.44 | 0.12 | 227 | 260 |
| TP-P1-P1-S1-No20 | 0.841 | 47.47 | 24.09 | 16.15 | 7.42 | 3.56 | 1.48 | 0.38 | -0.8 | 0.44 | 0.14 | 250 | 210 |
| TP-P1-P1-S1-No10 | 2 | 49.13 | 27.04 | 13.84 | 7.21 | 5.05 | 1.83 | 0.24 | -0.45 | 0.43 | 0.15 | 298 | 160 |
| TP-P1-P1-S1-No4 | 4.76 | 48.97 | 26.05 | 13.93 | 7.22 | 4.21 | 1.18 | 0.27 | -0.65 | 0.41 | 0.15 | 285 | 160 |
| TP-P1-P1-S1 Avg* | - | 44.07 | 21.35 | 18.93 | 7.01 | 4.09 | 3.37 | 0.59 | -0.66 | 0.45 | 0.12 | 255.6 | 258.88 |
| TP-P1-S1-S2-pan | 0.037 | 43.8 | 17.84 | 25.34 | 7.24 | 4.11 | 5.21 | 1.16 | 0.24 | 0.6 | 0.13 | 231 | 430 |
| TP-P1-S1-S2-No200 | 0.074 | 43.14 | 17.57 | 23.86 | 7.83 | 3.88 | 5.12 | 1.34 | 0.02 | 0.63 | 0.12 | 149 | 330 |
| TP-P1-S1-S2-No140 | 0.105 | 43.73 | 17.27 | 23.18 | 7.66 | 4.89 | 5.74 | 1.23 | 0.23 | 0.61 | 0.12 | 326 | 370 |
| TP-P1-S1-S2-No100 | 0.149 | 45.44 | 17.98 | 21.62 | 7.88 | 6.17 | 5.86 | 0.95 | 0.38 | 0.6 | 0.12 | 363 | 290 |
| TP-P1-S1-S2-No60 | 0.25 | 46.97 | 18.47 | 19.86 | 7.79 | 6.12 | 4.77 | 0.76 | 0.37 | 0.58 | 0.14 | 363 | 310 |
| TP-P1-S1-S2-No40 | 0.42 | 50.51 | 19.88 | 17.15 | 8.6 | 5.62 | 2.31 | 0.63 | 0.22 | 0.59 | 0.16 | 291 | 270 |
| TP-P1-S1-S2-No20 | 0.841 | 51.82 | 20.23 | 14.63 | 8.88 | 6.14 | 1.3 | 0.52 | 0.36 | 0.62 | 0.17 | 356 | 240 |
| TP-P1-S1-S2-No10 | 2 | 55 | 19.54 | 13.59 | 9.34 | 6.6 | 0.84 | 0.54 | 0.65 | 0.7 | 0.19 | 378 | 310 |
| TP-P1-S1-S2-No4 | 4.76 | 53.88 | 17.52 | 13.97 | 10.37 | 7.94 | 0.8 | 0.51 | 0.81 | 0.71 | 0.2 | 409 | 290 |
| TP-P1-S1-S2 Avg* | - | 53.24 | 17.89 | 14.58 | 10.01 | 7.52 | 1.13 | 0.55 | 0.73 | 0.7 | 0.19 | 394 | 292 |
| TP-P1-S2-S1-pan | 0.037 | 62.62 | 3.75 | 3.78 | 9.63 | 4.98 | 0.14 | 1.82 | 2.34 | 0.44 | 0.05 | 315 | 480 |
| TP-P1-S2-S1-No200 | 0.074 | 64.74 | 2.94 | 3.54 | 9.52 | 4.02 | 0.14 | 1.88 | 2.57 | 0.37 | 0.05 | 264 | 510 |
| TP-P1-S2-S1-No140 | 0.105 | 64.72 | 2.2 | 2.83 | 8.96 | 3.18 | 0.12 | 1.87 | 2.17 | 0.26 | 0.03 | 268 | 320 |
| TP-P1-S2-S1-No100 | 0.149 | 67.39 | 2.72 | 3.24 | 10.57 | 3.59 | 0.08 | 1.73 | 3.39 | 0.25 | 0.04 | 290 | 260 |
| TP-P1-S2-S1-No60 | 0.25 | 63.48 | 3.79 | 4.32 | 11.58 | 4.74 | 0.12 | 1.78 | 3.29 | 0.36 | 0.06 | 308 | 420 |
| TP-P1-S2-S1-No40 | 0.42 | 62.9 | 3.63 | 4.31 | 11.41 | 4.75 | 0.11 | 1.78 | 3.29 | 0.36 | 0.06 | 302 | 410 |
| TP-P1-S2-S1-No20 | 0.841 | 62.38 | 3.73 | 4.25 | 11.39 | 4.58 | 0.09 | 1.42 | 3.07 | 0.35 | 0.05 | -228 | 450 |
| TP-P1-S2-S1-No10 | 2 | 64.04 | 3.85 | 4.74 | 11.89 | 5.21 | 0.09 | 1.75 | 3.54 | 0.42 | 0.06 | 333 | 420 |
| TP-P1-S2-S1-No4 | 4.76 | 66.56 | 4.26 | 4.37 | 10.7 | 3.88 | 0.08 | 1.76 | 3.2 | 0.32 | 0.06 | 170 | 400 |
| TP-P1-S2-S1 Avg* | - | 65.9 | 4.01 | 4.23 | 10.65 | 4.02 | 0.09 | 1.76 | 3.12 | 0.33 | 0.05 | 189 | 402 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-P1-S1-pan | 0.037 | 953 | 287 | 122 | -76 | 1682 | 64 | 29 | -10 | 72 | 552 | 90 |
| TP-P1-P1-S1-No200 | 0.074 | 1053 | 302 | 115 | -66 | 1687 | 68 | 39 | -7 | 93 | 561 | 90 |
| TP-P1-P1-S1-No140 | 0.105 | 1055 | 302 | 114 | -47 | 1666 | 67 | 30 | -5 | 74 | 590 | 90 |
| TP-P1-P1-S1-No100 | 0.149 | 1027 | 278 | 111 | -25 | 1729 | 76 | 33 | -2 | 98 | 607 | 90 |
| TP-P1-P1-S1-No60 | 0.25 | 915 | 266 | 104 | -28 | 1809 | 70 | 24 | 0 | 91 | 607 | 90 |
| TP-P1-P1-S1-No40 | 0.42 | 836 | 240 | 109 | -48 | 1920 | 68 | 20 | 1 | 94 | 619 | 90 |
| TP-P1-P1-S1-No20 | 0.841 | 480 | 233 | 114 | -32 | 2006 | 66 | 15 | 4 | 109 | 671 | 90 |
| TP-P1-P1-S1-No10 | 2 | 1138 | 450 | 116 | -21 | 2227 | 81 | 9 | 7 | 137 | 693 | 80 |
| TP-P1-P1-S1-No4 | 4.76 | 304 | 224 | 116 | -31 | 2267 | 64 | 10 | 7 | 137 | 692 | 80 |
| TP-P1-S1-S1 Avg* | - | 862 | 287 | 113 | -41 | 1887 | 69 | 23 | -1 | 100 | 621 | 88 |
| TP-P1-S1-S2-pan | 0.037 | 886 | 168 | 104 | -55 | 1372 | 71 | 34 | -12 | 101 | 516 | 90 |
| TP-P1-S1-S2-No200 | 0.074 | 1002 | 179 | 101 | -54 | 1344 | 73 | 50 | -9 | 108 | 544 | 100 |
| TP-P1-S1-S2-No140 | 0.105 | 993 | 176 | 93 | -41 | 1331 | 79 | 45 | -7 | 95 | 551 | 100 |
| TP-P1-S1-S2-No100 | 0.149 | 1002 | 170 | 88 | -28 | 1328 | 79 | 34 | -3 | 103 | 571 | 100 |
| TP-P1-S1-S2-No60 | 0.25 | 791 | 156 | 93 | -27 | 1421 | 83 | 31 | -1 | 118 | 592 | 100 |
| TP-P1-S1-S2-No40 | 0.42 | 543 | 136 | 97 | -28 | 1466 | 83 | 22 | 2 | 149 | 636 | 100 |
| TP-P1-S1-S2-No20 | 0.841 | 312 | 119 | 87 | -20 | 1333 | 84 | 18 | 6 | 160 | 667 | 100 |
| TP-P1-S1-S2-No10 | 2 | 262 | 119 | 89 | -15 | 1330 | 88 | 24 | 7 | 188 | 685 | 110 |
| TP-P1-S1-S2-No4 | 4.76 | 283 | 161 | 96 | -13 | 1243 | 105 | 21 | 7 | 207 | 659 | 100 |
| TP-P1-S1-S2 Avg* | - | 326 | 155 | 95 | -15 | 1267 | 100 | 22 | 6 | 195 | 654 | 0.01 |
| TP-P1-S2-S1-pan | 0.037 | 67 | 59 | 39 | 11 | 122 | 383 | 50 | 13 | 75 | 1013 | 260 |
| TP-P1-S2-S1-No200 | 0.074 | 63 | 49 | 30 | 9 | 168 | 374 | 49 | 13 | 76 | 1028 | 200 |
| TP-P1-S2-S1-No140 | 0.105 | 51 | 37 | 25 | 7 | 145 | 366 | 49 | 13 | 61 | 1076 | 120 |
| TP-P1-S2-S1-No100 | 0.149 | 38 | 40 | 28 | 8 | 188 | 368 | 48 | 13 | 61 | 1073 | 110 |
| TP-P1-S2-S1-No60 | 0.25 | 50 | 115 | 40 | 10 | 228 | 378 | 49 | 13 | 92 | 981 | 120 |
| TP-P1-S2-S1-No40 | 0.42 | 58 | 450 | 38 | 10 | 219 | 378 | 48 | 13 | 82 | 991 | 120 |
| TP-P1-S2-S1-No20 | 0.841 | 46 | 56 | 36 | 5 | 211 | 377 | 47 | 13 | 73 | 993 | 120 |
| TP-P1-S2-S1-No10 | 2 | 36 | 57 | 43 | 7 | 196 | 365 | 47 | 13 | 80 | 972 | 130 |
| TP-P1-S2-S1-No4 | 4.76 | 115 | 56 | 37 | 4 | 197 | 339 | 52 | 13 | 66 | 1008 | 140 |
| TP-P1-S2-S1 Avg* | - | 98 | 69 | 36 | 5 | 192 | 348 | 51 | 12 | 68 | 1010 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S2-S2-pan | 0.037 | 52.62 | 22.7 | 12.24 | 8.57 | 5.18 | 1.47 | 0.85 | 0.27 | 0.39 | 0.12 | 415 | 240 |
| TP-P1-S2-S2-No200 | 0.074 | 55.72 | 21.64 | 10.62 | 9.21 | 5.57 | 1.4 | 1.02 | 0.66 | 0.37 | 0.13 | 454 | 150 |
| TP-P1-S2-S2-No140 | 0.105 | 57.47 | 17.87 | 8.78 | 8.47 | 5.37 | 1.17 | 1.08 | 0.84 | 0.33 | 0.11 | 414 | 160 |
| TP-P1-S2-S2-No100 | 0.149 | 60.91 | 16.1 | 7.78 | 8.96 | 4.94 | 1.01 | 1.11 | 1.26 | 0.32 | 0.1 | 491 | 150 |
| TP-P1-S2-S2-No60 | 0.25 | 60.56 | 17.79 | 7.99 | 8.95 | 5.14 | 1.03 | 1.07 | 1.37 | 0.31 | 0.1 | 474 | 170 |
| TP-P1-S2-S2-No40 | 0.42 | 57.41 | 21.67 | 9.4 | 9.34 | 5.71 | 0.9 | 0.96 | 0.86 | 0.34 | 0.12 | 423 | 190 |
| TP-P1-S2-S2-No20 | 0.841 | 56.09 | 23.94 | 10.22 | 9.48 | 5.9 | 0.61 | 0.93 | 0.59 | 0.37 | 0.13 | 432 | 200 |
| TP-P1-S2-S2-No10 | 2 | 55.82 | 23.33 | 10.06 | 9.54 | 6.45 | 0.7 | 1 | 0.73 | 0.36 | 0.13 | 471 | 330 |
| TP-P1-S2-S2-No4 | 4.76 | 56.15 | 21.97 | 9.98 | 10.03 | 4.81 | 0.82 | 1.22 | 0.8 | 0.39 | 0.12 | 438 | 320 |
| TP-P1-S2-S2 Avg* | - | 56.27 | 21.89 | 9.95 | 9.82 | 5.05 | 0.85 | 1.16 | 0.8 | 0.38 | 0.12 | 440 | 296 |
| TP-P1-S3-S2-pan | 0.037 | 59.85 | 4.4 | 3.5 | 8.65 | 7.4 | 0.08 | 2.04 | 2.04 | 0.42 | 0.05 | 480 | 580 |
| TP-P1-S3-S2-No200 | 0.074 | 66.68 | 2.77 | 3.07 | 9.48 | 4.48 | 0.05 | 2.21 | 2.85 | 0.29 | 0.04 | 322 | 430 |
| TP-P1-S3-S2-No140 | 0.105 | 66.57 | 2.45 | 2.82 | 9.05 | 4.17 | 0.07 | 2.13 | 2.75 | 0.26 | 0.03 | 307 | 310 |
| TP-P1-S3-S2-No100 | 0.149 | 70.44 | 1.88 | 2.73 | 9.16 | 3.46 | 0.03 | 1.96 | 3 | 0.21 | 0.03 | 304 | 260 |
| TP-P1-S3-S2-No60 | 0.25 | 68.27 | 2.22 | 2.62 | 8.65 | 4.03 | 0.03 | 1.93 | 2.76 | 0.22 | 0.03 | 319 | 290 |
| TP-P1-S3-S2-No40 | 0.42 | 69.44 | 2.59 | 3.09 | 10.01 | 4.94 | 0.05 | 1.93 | 3.3 | 0.25 | 0.04 | 331 | 290 |
| TP-P1-S3-S2-No20 | 0.841 | 63.46 | 3.92 | 4.12 | 11.31 | 7.87 | 0.13 | 2.02 | 3.4 | 0.34 | 0.05 | 543 | 390 |
| TP-P1-S3-S2-No10 | 2 | 65.24 | 4.54 | 5.19 | 11.28 | 7.12 | 0.15 | 1.91 | 3.42 | 0.44 | 0.07 | 393 | 460 |
| TP-P1-S3-S2-No4 | 4.76 | 60.59 | 6.52 | 7.38 | 11.44 | 9.15 | 0.24 | 1.23 | 3.12 | 0.57 | 0.1 | 534 | 470 |
| TP-P1-S3-S2 Avg* | - | 64.44 | 4.11 | 4.49 | 10.12 | 6.57 | 0.12 | 1.79 | 2.94 | 0.38 | 0.06 | 423 | 413 |
| TP-P1-S4-S2-pan | 0.037 | 48.35 | 9.13 | 15.79 | 9.98 | 9.24 | 1.69 | 0.92 | 0.33 | 0.77 | 0.17 | 446 | 340 |
| TP-P1-S4-S2-No200 | 0.074 | 52.88 | 9.31 | 14.7 | 10.72 | 9.44 | 1.78 | 1.05 | 1.19 | 0.68 | 0.17 | 457 | 310 |
| TP-P1-S4-S2-No140 | 0.105 | 56.99 | 8.37 | 12.87 | 11.08 | 9.12 | 1.51 | 1.13 | 1.48 | 0.65 | 0.16 | 422 | 290 |
| TP-P1-S4-S2-No100 | 0.149 | 58.96 | 7.59 | 11.1 | 10.98 | 8.74 | 1.1 | 1.12 | 1.56 | 0.62 | 0.15 | 447 | 290 |
| TP-P1-S4-S2-No60 | 0.25 | 57.12 | 7.67 | 10.82 | 10.93 | 9.02 | 0.88 | 1.06 | 1.39 | 0.64 | 0.15 | 462 | 290 |
| TP-P1-S4-S2-No40 | 0.42 | 57.56 | 8 | 11.33 | 12.06 | 9.31 | 0.72 | 1.03 | 1.64 | 0.72 | 0.16 | 487 | 360 |
| TP-P1-S4-S2-No20 | 0.841 | 56.5 | 8.04 | 12.06 | 12.21 | 9.32 | 0.61 | 0.98 | 1.4 | 0.78 | 0.17 | 472 | 380 |
| TP-P1-S4-S2-No10 | 2 | 52.95 | 7.65 | 12.47 | 11.53 | 9.52 | 0.66 | 0.95 | 0.79 | 0.81 | 0.18 | 485 | 390 |
| TP-P1-S4-S2-No4 | 4.76 | 53.1 | 6.5 | 12.26 | 12.1 | 9.53 | 0.82 | 1.02 | 0.97 | 0.82 | 0.18 | 525 | 480 |
| TP-P1-S4-S2 Avg* | - | 53.31 | 6.92 | 12.44 | 11.88 | 9.47 | 0.88 | 1.02 | 0.99 | 0.8 | 0.18 | 510 | 448 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S2-S2-pan | 0.037 | 425 | 760 | 158 | -5 | 1322 | 160 | 25 | 9 | 87 | 704 | 140 |
| TP-P1-S2-S2-No200 | 0.074 | 381 | 525 | 129 | -2 | 1395 | 199 | 33 | 9 | 104 | 759 | 120 |
| TP-P1-S2-S2-No140 | 0.105 | 325 | 392 | 103 | 1 | 1229 | 219 | 33 | 11 | 87 | 827 | 110 |
| TP-P1-S2-S2-No100 | 0.149 | 241 | 330 | 90 | 1 | 1099 | 230 | 34 | 11 | 82 | 879 | 90 |
| TP-P1-S2-S2-No60 | 0.25 | 226 | 346 | 91 | 6 | 1175 | 221 | 33 | 12 | 88 | 868 | 90 |
| TP-P1-S2-S2-No40 | 0.42 | 229 | 419 | 110 | 4 | 1430 | 193 | 29 | 11 | 86 | 823 | 90 |
| TP-P1-S2-S2-No20 | 0.841 | 204 | 451 | 105 | 1 | 1543 | 173 | 29 | 10 | 113 | 789 | 90 |
| TP-P1-S2-S2-No10 | 2 | 172 | 465 | 88 | -1 | 1519 | 200 | 32 | 11 | 105 | 783 | 90 |
| TP-P1-S2-S2-No4 | 4.76 | 245 | 426 | 84 | -4 | 1314 | 191 | 38 | 10 | 94 | 792 | 110 |
| TP-P1-S2-S2 Avg* | - | 245 | 436 | 89 | -2 | 1335 | 192 | 35 | 10 | 95 | 793 | 0.01 |
| TP-P1-S3-S2-pan | 0.037 | 75 | 39 | 33 | 15 | 114 | 364 | 53 | 13 | 76 | 1013 | 290 |
| TP-P1-S3-S2-No200 | 0.074 | 54 | 30 | 24 | 7 | 131 | 357 | 56 | 13 | 60 | 1054 | 170 |
| TP-P1-S3-S2-No140 | 0.105 | 49 | 26 | 21 | 7 | 134 | 350 | 54 | 13 | 54 | 1074 | 130 |
| TP-P1-S3-S2-No100 | 0.149 | 44 | 25 | 17 | 10 | 157 | 330 | 52 | 13 | 47 | 1090 | 100 |
| TP-P1-S3-S2-No60 | 0.25 | 37 | 25 | 20 | 10 | 154 | 324 | 52 | 13 | 52 | 1099 | 110 |
| TP-P1-S3-S2-No40 | 0.42 | 45 | 27 | 23 | 10 | 196 | 336 | 55 | 13 | 52 | 1059 | 120 |
| TP-P1-S3-S2-No20 | 0.841 | 83 | 36 | 32 | 18 | 178 | 360 | 56 | 13 | 68 | 979 | 120 |
| TP-P1-S3-S2-No10 | 2 | 61 | 44 | 40 | 11 | 209 | 341 | 53 | 13 | 102 | 934 | 150 |
| TP-P1-S3-S2-No4 | 4.76 | 62 | 78 | 57 | 15 | 270 | 322 | 38 | 12 | 117 | 840 | 140 |
| TP-P1-S3-S2 Avg* | - | 58 | 44 | 34 | 12 | 188 | 339 | 49 | 12 | 79 | 982 | 0.01 |
| TP-P1-S4-S2-pan | 0.037 | 922 | 180 | 179 | -3 | 324 | 156 | 32 | 3 | 185 | 592 | 100 |
| TP-P1-S4-S2-No200 | 0.074 | 1101 | 152 | 152 | 2 | 353 | 172 | 42 | 5 | 185 | 616 | 100 |
| TP-P1-S4-S2-No140 | 0.105 | 1082 | 116 | 131 | 8 | 343 | 190 | 37 | 7 | 179 | 661 | 90 |
| TP-P1-S4-S2-No100 | 0.149 | 842 | 83 | 113 | 15 | 319 | 200 | 40 | 9 | 170 | 716 | 100 |
| TP-P1-S4-S2-No60 | 0.25 | 650 | 76 | 107 | 16 | 323 | 199 | 37 | 9 | 174 | 727 | 100 |
| TP-P1-S4-S2-No40 | 0.42 | 521 | 74 | 112 | 5 | 267 | 191 | 36 | 9 | 186 | 703 | 100 |
| TP-P1-S4-S2-No20 | 0.841 | 329 | 75 | 103 | -2 | 246 | 180 | 39 | 9 | 200 | 687 | 100 |
| TP-P1-S4-S2-No10 | 2 | 452 | 76 | 111 | -1 | 218 | 171 | 34 | 9 | 198 | 676 | 100 |
| TP-P1-S4-S2-No4 | 4.76 | 602 | 57 | 125 | 1 | 169 | 205 | 40 | 9 | 241 | 677 | 100 |
| TP-P1-S4-S2 Avg* | - | 618 | 69 | 125 | 1 | 196 | 198 | 39 | 8 | 228 | 673 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S4-S3-pan | 0.037 | 49.22 | 9.46 | 15.23 | 10.45 | 9.38 | 1.49 | 0.76 | 0.59 | 0.76 | 0.17 | 496 | 330 |
| TP-P1-S4-S3-No200 | 0.074 | 53.24 | 9.71 | 14.4 | 11.12 | 9.23 | 1.65 | 0.88 | 1.11 | 0.69 | 0.16 | 441 | 290 |
| TP-P1-S4-S3-No140 | 0.105 | 56.46 | 8.5 | 12.04 | 10.94 | 8.98 | 1.21 | 1 | 1.62 | 0.63 | 0.15 | 483 | 310 |
| TP-P1-S4-S3-No100 | 0.149 | 58.15 | 7.38 | 10.41 | 10.45 | 8.3 | 0.97 | 1 | 1.65 | 0.57 | 0.14 | 410 | 300 |
| TP-P1-S4-S3-No60 | 0.25 | 58.54 | 7.48 | 10.8 | 11.11 | 8.37 | 0.91 | 0.94 | 1.77 | 0.62 | 0.14 | 427 | 330 |
| TP-P1-S4-S3-No40 | 0.42 | 56.95 | 8.12 | 11.69 | 11.7 | 8.82 | 0.8 | 0.84 | 1.58 | 0.71 | 0.16 | 471 | 330 |
| TP-P1-S4-S3-No20 | 0.841 | 57.09 | 8.48 | 12.15 | 12.6 | 9.17 | 0.62 | 0.77 | 1.86 | 0.77 | 0.17 | 450 | 390 |
| TP-P1-S4-S3-No10 | 2 | 54.6 | 7.68 | 12.52 | 12.3 | 9.25 | 0.72 | 0.81 | 1.21 | 0.81 | 0.18 | 512 | 320 |
| TP-P1-S4-S3-No4 | 4.76 | 54.44 | 8.07 | 12.59 | 11.78 | 8.72 | 0.7 | 0.84 | 0.96 | 0.79 | 0.17 | 470 | 270 |
| TP-P1-S4-S3 Avg* | - | 54.53 | 8.14 | 12.62 | 11.74 | 8.8 | 0.77 | 0.84 | 1.05 | 0.77 | 0.17 | 471 | 283 |
| TP-P1-S5-S1-pan | 0.037 | 62.01 | 6.46 | 6.26 | 10.16 | 5 | 0.48 | 1.69 | 2.26 | 0.47 | 0.07 | 310 | 480 |
| TP-P1-S5-S1-No200 | 0.074 | 65.15 | 4.47 | 4.46 | 9.76 | 4.04 | 0.24 | 1.86 | 2.58 | 0.34 | 0.05 | 195 | 460 |
| TP-P1-S5-S1-No140 | 0.105 | 65.2 | 3.92 | 3.93 | 9.33 | 3.65 | 0.18 | 1.82 | 2.48 | 0.28 | 0.05 | 195 | 350 |
| TP-P1-S5-S1-No100 | 0.149 | 66.32 | 3.61 | 3.49 | 8.98 | 3.47 | 0.14 | 1.78 | 2.42 | 0.27 | 0.04 | 225 | 280 |
| TP-P1-S5-S1-No60 | 0.25 | 65.86 | 3.73 | 3.64 | 8.88 | 3.78 | 0.12 | 1.68 | 2.55 | 0.3 | 0.04 | 247 | 300 |
| TP-P1-S5-S1-No40 | 0.42 | 62.79 | 4.34 | 3.98 | 9.27 | 4.99 | 0.14 | 1.74 | 2.24 | 0.31 | 0.05 | 360 | 430 |
| TP-P1-S5-S1-No20 | 0.841 | 61.82 | 5.43 | 5.01 | 9.99 | 6.07 | 0.15 | 1.72 | 2.48 | 0.36 | 0.06 | 389 | 360 |
| TP-P1-S5-S1-No10 | 2 | 61.01 | 6.09 | 6.55 | 10.6 | 5.99 | 0.4 | 1.53 | 2.41 | 0.47 | 0.08 | 334 | 410 |
| TP-P1-S5-S1-No4 | 4.76 | 56.99 | 9.01 | 9.84 | 10.9 | 8.42 | 0.63 | 1.17 | 2.32 | 0.63 | 0.13 | 465 | 340 |
| TP-P1-S5-S1 Avg* | - | 58.7 | 7.89 | 8.47 | 10.57 | 7.45 | 0.52 | 1.32 | 2.34 | 0.56 | 0.11 | 420 | 354 |
| TP-P1-S5-S2-pan | 0.037 | 51.44 | 27.1 | 18.47 | 7.53 | 3.85 | 3 | 0.29 | 0.15 | 0.41 | 0.14 | 353 | 200 |
| TP-P1-S5-S2-No200 | 0.074 | 51.03 | 26.19 | 16.58 | 7.4 | 4.84 | 2.62 | 0.32 | 0.1 | 0.38 | 0.15 | 371 | 140 |
| TP-P1-S5-S2-No140 | 0.105 | 51.94 | 26.21 | 14.44 | 7.68 | 5.67 | 2.04 | 0.36 | 0.23 | 0.4 | 0.15 | 367 | 150 |
| TP-P1-S5-S2-No100 | 0.149 | 52.62 | 26.22 | 13.53 | 8.01 | 5.98 | 1.83 | 0.39 | 0.36 | 0.42 | 0.15 | 417 | 190 |
| TP-P1-S5-S2-No60 | 0.25 | 51.81 | 24.89 | 13.1 | 8.17 | 5.57 | 1.53 | 0.41 | 0.14 | 0.41 | 0.15 | 399 | 160 |
| TP-P1-S5-S2-No40 | 0.42 | 52.46 | 24.67 | 12.68 | 8.54 | 5.16 | 1.15 | 0.45 | 0.24 | 0.4 | 0.14 | 404 | 160 |
| TP-P1-S5-S2-No20 | 0.841 | 53.1 | 23.3 | 12.55 | 8.75 | 5.28 | 1.28 | 0.5 | 0.52 | 0.38 | 0.14 | 364 | 190 |
| TP-P1-S5-S2-No10 | 2 | 54.7 | 21.07 | 12.73 | 8.84 | 4.95 | 2.08 | 0.54 | 1.22 | 0.39 | 0.13 | 368 | 180 |
| TP-P1-S5-S2-No4 | 4.76 | 57.34 | 25.23 | 11.37 | 7.7 | 4.95 | 1.36 | 0.33 | 0.94 | 0.34 | 0.14 | 355 | 80 |
| TP-P1-S5-S2 Avg* | - | 56.82 | 25.09 | 11.68 | 7.77 | 4.96 | 1.43 | 0.34 | 0.89 | 0.34 | 0.14 | 357 | 91 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S4-S3-pan | 0.037 | 914 | 154 | 205 | -2 | 297 | 156 | 26 | 4 | 183 | 604 | 100 |
| TP-P1-S4-S3-No200 | 0.074 | 1011 | 136 | 178 | 1 | 328 | 166 | 29 | 6 | 193 | 639 | 110 |
| TP-P1-S4-S3-No140 | 0.105 | 991 | 97 | 143 | 8 | 300 | 182 | 30 | 9 | 173 | 692 | 90 |
| TP-P1-S4-S3-No100 | 0.149 | 736 | 74 | 117 | 9 | 286 | 196 | 30 | 10 | 160 | 744 | 90 |
| TP-P1-S4-S3-No60 | 0.25 | 628 | 83 | 117 | 6 | 283 | 190 | 31 | 10 | 163 | 720 | 90 |
| TP-P1-S4-S3-No40 | 0.42 | 495 | 76 | 116 | -1 | 273 | 180 | 29 | 9 | 198 | 707 | 100 |
| TP-P1-S4-S3-No20 | 0.841 | 356 | 76 | 118 | -1 | 218 | 170 | 26 | 9 | 210 | 694 | 100 |
| TP-P1-S4-S3-No10 | 2 | 395 | 65 | 111 | -3 | 195 | 165 | 24 | 8 | 222 | 680 | 100 |
| TP-P1-S4-S3-No4 | 4.76 | 241 | 109 | 110 | -4 | 275 | 132 | 28 | 9 | 227 | 672 | 100 |
| TP-P1-S4-S3 Avg* | - | 327 | 104 | 116 | -2 | 270 | 140 | 28 | 8 | 220 | 672 | 0 |
| TP-P1-S5-S1-pan | 0.037 | 231 | 164 | 53 | 15 | 315 | 331 | 46 | 13 | 89 | 917 | 240 |
| TP-P1-S5-S1-No200 | 0.074 | 156 | 78 | 39 | 7 | 238 | 346 | 51 | 13 | 65 | 1000 | 150 |
| TP-P1-S5-S1-No140 | 0.105 | 137 | 60 | 34 | 6 | 214 | 339 | 50 | 13 | 70 | 1025 | 110 |
| TP-P1-S5-S1-No100 | 0.149 | 106 | 52 | 28 | 9 | 215 | 327 | 50 | 13 | 61 | 1067 | 110 |
| TP-P1-S5-S1-No60 | 0.25 | 90 | 55 | 30 | 8 | 264 | 324 | 47 | 13 | 68 | 1055 | 130 |
| TP-P1-S5-S1-No40 | 0.42 | 67 | 54 | 32 | 11 | 285 | 331 | 51 | 13 | 74 | 1019 | 130 |
| TP-P1-S5-S1-No20 | 0.841 | 74 | 74 | 42 | 14 | 353 | 323 | 51 | 13 | 88 | 972 | 130 |
| TP-P1-S5-S1-No10 | 2 | 112 | 86 | 51 | 14 | 305 | 293 | 49 | 12 | 110 | 900 | 130 |
| TP-P1-S5-S1-No4 | 4.76 | 186 | 122 | 69 | 8 | 499 | 218 | 39 | 10 | 152 | 771 | 130 |
| TP-P1-S5-S1 Avg* | - | 166 | 110 | 61 | 8 | 439 | 247 | 41 | 11 | 132 | 829 | 0.01 |
| TP-P1-S5-S2-pan | 0.037 | 1021 | 1129 | 139 | -47 | 1650 | 85 | 12 | 0 | 87 | 558 | 90 |
| TP-P1-S5-S2-No200 | 0.074 | 996 | 865 | 131 | -32 | 1663 | 87 | 7 | 3 | 100 | 612 | 80 |
| TP-P1-S5-S2-No140 | 0.105 | 944 | 630 | 125 | -16 | 1781 | 107 | 14 | 6 | 117 | 675 | 80 |
| TP-P1-S5-S2-No100 | 0.149 | 851 | 505 | 113 | -14 | 1940 | 114 | 16 | 7 | 129 | 698 | 80 |
| TP-P1-S5-S2-No60 | 0.25 | 809 | 457 | 110 | -14 | 2016 | 123 | 15 | 8 | 129 | 706 | 90 |
| TP-P1-S5-S2-No40 | 0.42 | 636 | 426 | 108 | -11 | 2061 | 129 | 11 | 8 | 118 | 717 | 100 |
| TP-P1-S5-S2-No20 | 0.841 | 515 | 419 | 95 | -8 | 1800 | 143 | 16 | 8 | 108 | 718 | 100 |
| TP-P1-S5-S2-No10 | 2 | 534 | 536 | 81 | -11 | 1461 | 147 | 16 | 9 | 100 | 691 | 100 |
| TP-P1-S5-S2-No4 | 4.76 | 1341 | 491 | 87 | -12 | 1788 | 88 | 8 | 9 | 115 | 759 | 90 |
| TP-P1-S5-S2 Avg* | - | 1268 | 504 | 89 | -12 | 1780 | 92 | 9 | 8 | 114 | 749 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S6-S1-pan | 0.037 | 61.13 | 2.73 | 3.3 | 8.75 | 4.4 | 0.05 | 1.93 | 1.99 | 0.4 | 0.04 | 269 | 570 |
| TP-P1-S6-S1-No200 | 0.074 | 66.15 | 2.36 | 3.05 | 9.9 | 3.62 | 0.03 | 2.07 | 2.77 | 0.31 | 0.04 | 245 | 560 |
| TP-P1-S6-S1-No140 | 0.105 | 69.17 | 2.15 | 3.13 | 10.02 | 3.27 | 0.03 | 2 | 3.14 | 0.27 | 0.04 | 251 | 460 |
| TP-P1-S6-S1-No100 | 0.149 | 70.53 | 1.96 | 2.97 | 9.6 | 2.97 | 0.02 | 1.86 | 3.17 | 0.23 | 0.03 | 198 | 410 |
| TP-P1-S6-S1-No60 | 0.25 | 67.34 | 2.27 | 2.92 | 9.31 | 3.34 | 0.02 | 1.89 | 2.74 | 0.27 | 0.03 | 268 | 430 |
| TP-P1-S6-S1-No40 | 0.42 | 69.72 | 2.41 | 3.39 | 10.72 | 3.93 | 0.02 | 1.9 | 3.56 | 0.29 | 0.04 | 222 | 510 |
| TP-P1-S6-S1-No20 | 0.841 | 64.15 | 3.47 | 4 | 11.82 | 5.85 | 0.04 | 1.95 | 3.49 | 0.36 | 0.05 | 378 | 470 |
| TP-P1-S6-S1-No10 | 2 | 64.72 | 3.82 | 5.15 | 12.33 | 6.19 | 0.07 | 1.9 | 3.75 | 0.47 | 0.07 | 319 | 540 |
| TP-P1-S6-S1-No4 | 4.76 | 59.8 | 6.86 | 6.92 | 11.16 | 9.22 | 0.09 | 1.28 | 2.99 | 0.53 | 0.1 | 523 | 410 |
| TP-P1-S6-S1 Avg* | - | 65.73 | 3.28 | 3.98 | 10.3 | 4.92 | 0.04 | 1.81 | 3.03 | 0.35 | 0.05 | 304 | 474 |
| TP-P1-S6-S2-pan | 0.037 | 43.78 | 10.61 | 21.6 | 8.21 | 7.86 | 6.96 | 0.68 | 0.34 | 0.59 | 0.14 | 574 | 320 |
| TP-P1-S6-S2-No200 | 0.074 | 48.72 | 9.57 | 18.89 | 9.09 | 8.22 | 6.38 | 0.84 | 0.81 | 0.59 | 0.14 | 583 | 280 |
| TP-P1-S6-S2-No140 | 0.105 | 48.75 | 8.8 | 17.68 | 8.72 | 7.25 | 5.31 | 0.88 | 0.39 | 0.59 | 0.13 | 501 | 190 |
| TP-P1-S6-S2-No100 | 0.149 | 53 | 9.09 | 16.14 | 9.73 | 6.57 | 4.28 | 0.93 | 0.97 | 0.6 | 0.13 | 486 | 250 |
| TP-P1-S6-S2-No60 | 0.25 | 52.74 | 9.07 | 15.49 | 9.47 | 6.52 | 3.6 | 0.9 | 0.73 | 0.58 | 0.13 | 415 | 260 |
| TP-P1-S6-S2-No40 | 0.42 | 54.71 | 8.83 | 14.45 | 10.06 | 6.63 | 2.64 | 0.93 | 0.84 | 0.61 | 0.14 | 390 | 290 |
| TP-P1-S6-S2-No20 | 0.841 | 56 | 9 | 13.45 | 10.9 | 7.16 | 1.87 | 0.95 | 1.08 | 0.65 | 0.15 | 338 | 260 |
| TP-P1-S6-S2-No10 | 2 | 55.79 | 8.59 | 13.49 | 11.31 | 7.52 | 2.14 | 0.96 | 1.09 | 0.71 | 0.15 | 410 | 260 |
| TP-P1-S6-S2-No4 | 4.76 | 58.06 | 7.79 | 12.3 | 10.85 | 5.95 | 1.59 | 0.92 | 1.29 | 0.66 | 0.15 | 305 | 290 |
| TP-P1-S6-S2 Avg* | - | 56.19 | 8.29 | 13.46 | 10.62 | 6.47 | 2.25 | 0.92 | 1.13 | 0.65 | 0.14 | 352 | 281 |
| TP-P1-S8-S1-pan | 0.037 | 59.42 | 2.77 | 3.18 | 8.49 | 5.34 | 0.07 | 2.01 | 1.74 | 0.38 | 0.04 | 367 | 500 |
| TP-P1-S8-S1-No200 | 0.074 | 66.24 | 2.45 | 3.13 | 9.73 | 4.16 | 0.05 | 2.14 | 2.8 | 0.32 | 0.04 | 260 | 500 |
| TP-P1-S8-S1-No140 | 0.105 | 66.82 | 2.33 | 3.11 | 9.6 | 3.9 | 0.07 | 2.08 | 2.82 | 0.3 | 0.04 | 273 | 410 |
| TP-P1-S8-S1-No100 | 0.149 | 69.07 | 2.1 | 3.24 | 9.37 | 3.5 | 0.03 | 1.95 | 2.95 | 0.26 | 0.03 | 275 | 300 |
| TP-P1-S8-S1-No60 | 0.25 | 67.38 | 2.21 | 3.03 | 8.86 | 3.85 | 0.03 | 1.87 | 2.71 | 0.25 | 0.03 | 316 | 310 |
| TP-P1-S8-S1-No40 | 0.42 | 68.15 | 2.6 | 3.32 | 10.03 | 4.86 | 0.03 | 1.98 | 3.13 | 0.28 | 0.04 | 553 | 360 |
| TP-P1-S8-S1-No20 | 0.841 | 62.57 | 3.43 | 3.71 | 11.11 | 7.75 | 0.07 | 2.05 | 2.92 | 0.33 | 0.05 | 528 | 390 |
| TP-P1-S8-S1-No10 | 2 | 62.12 | 4.44 | 4.92 | 11.13 | 8.61 | 0.07 | 1.78 | 3.15 | 0.42 | 0.06 | 523 | 440 |
| TP-P1-S8-S1-No4 | 4.76 | 59.75 | 5.21 | 5.57 | 12.01 | 8.82 | 0.31 | 2.06 | 2.97 | 0.51 | 0.07 | 511 | 580 |
| TP-P1-S8-S1 Avg* | - | 63.28 | 3.69 | 4.24 | 10.62 | 6.62 | 0.15 | 2 | 2.86 | 0.38 | 0.05 | 449 | 460 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S6-S1-pan | 0.037 | 101 | 31 | 38 | 7 | 92 | 379 | 51 | 13 | 92 | 1033 | 270 |
| TP-P1-S6-S1-No200 | 0.074 | 57 | 27 | 28 | 5 | 122 | 375 | 56 | 13 | 63 | 1064 | 160 |
| TP-P1-S6-S1-No140 | 0.105 | 53 | 27 | 25 | 5 | 166 | 363 | 53 | 13 | 70 | 1075 | 130 |
| TP-P1-S6-S1-No100 | 0.149 | 45 | 26 | 24 | 5 | 178 | 350 | 53 | 13 | 63 | 1081 | 120 |
| TP-P1-S6-S1-No60 | 0.25 | 38 | 26 | 22 | 10 | 191 | 350 | 53 | 14 | 59 | 1088 | 140 |
| TP-P1-S6-S1-No40 | 0.42 | 44 | 30 | 25 | 7 | 189 | 356 | 53 | 13 | 54 | 1051 | 130 |
| TP-P1-S6-S1-No20 | 0.841 | 50 | 37 | 35 | 10 | 150 | 371 | 54 | 13 | 81 | 1010 | 130 |
| TP-P1-S6-S1-No10 | 2 | 72 | 43 | 46 | 10 | 198 | 349 | 56 | 13 | 86 | 957 | 140 |
| TP-P1-S6-S1-No4 | 4.76 | 47 | 104 | 62 | 17 | 318 | 297 | 39 | 12 | 121 | 865 | 120 |
| TP-P1-S6-S1 Avg* | - | 54 | 42 | 34 | 9 | 190 | 349 | 50 | 12 | 77 | 1019 | 0.01 |
| TP-P1-S6-S2-pan | 0.037 | 1203 | 257 | 110 | -19 | 570 | 110 | 27 | -4 | 138 | 539 | 90 |
| TP-P1-S6-S2-No200 | 0.074 | 1491 | 226 | 97 | -6 | 542 | 125 | 30 | 1 | 150 | 594 | 90 |
| TP-P1-S6-S2-No140 | 0.105 | 1392 | 190 | 89 | -3 | 499 | 127 | 35 | 3 | 131 | 605 | 90 |
| TP-P1-S6-S2-No100 | 0.149 | 1304 | 172 | 80 | -6 | 433 | 132 | 32 | 4 | 141 | 638 | 90 |
| TP-P1-S6-S2-No60 | 0.25 | 981 | 157 | 74 | -8 | 471 | 135 | 32 | 5 | 138 | 648 | 90 |
| TP-P1-S6-S2-No40 | 0.42 | 998 | 134 | 71 | -9 | 428 | 137 | 33 | 6 | 161 | 658 | 90 |
| TP-P1-S6-S2-No20 | 0.841 | 705 | 97 | 64 | -1 | 403 | 134 | 32 | 8 | 179 | 679 | 100 |
| TP-P1-S6-S2-No10 | 2 | 838 | 78 | 66 | -3 | 318 | 128 | 33 | 8 | 176 | 665 | 90 |
| TP-P1-S6-S2-No4 | 4.76 | 814 | 82 | 72 | -6 | 335 | 156 | 33 | 9 | 185 | 697 | 90 |
| TP-P1-S6-S2 Avg* | - | 872 | 101 | 73 | -5 | 366 | 145 | 32 | 7 | 176 | 676 | 0 |
| TP-P1-S8-S1-pan | 0.037 | 45 | 28 | 29 | 8 | 65 | 378 | 52 | 13 | 65 | 1026 | 300 |
| TP-P1-S8-S1-No200 | 0.074 | 41 | 32 | 24 | 9 | 111 | 368 | 56 | 13 | 56 | 1050 | 180 |
| TP-P1-S8-S1-No140 | 0.105 | 40 | 30 | 26 | 8 | 130 | 364 | 55 | 13 | 64 | 1059 | 150 |
| TP-P1-S8-S1-No100 | 0.149 | 38 | 30 | 22 | 9 | 191 | 346 | 53 | 13 | 48 | 1063 | 130 |
| TP-P1-S8-S1-No60 | 0.25 | 34 | 28 | 20 | 10 | 235 | 340 | 52 | 13 | 51 | 1067 | 130 |
| TP-P1-S8-S1-No40 | 0.42 | 37 | 30 | 24 | 12 | 207 | 348 | 56 | 13 | 64 | 1043 | 140 |
| TP-P1-S8-S1-No20 | 0.841 | 38 | 34 | 32 | 18 | 150 | 361 | 59 | 13 | 73 | 1000 | 130 |
| TP-P1-S8-S1-No10 | 2 | 42 | 39 | 42 | 16 | 179 | 346 | 52 | 13 | 84 | 944 | 150 |
| TP-P1-S8-S1-No4 | 4.76 | 232 | 34 | 71 | 19 | 165 | 352 | 57 | 13 | 91 | 901 | 140 |
| TP-P1-S8-S1 Avg* | - | 109 | 32 | 43 | 14 | 166 | 353 | 55 | 12 | 73 | 982 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S9-S2-pan | 0.037 | 45.23 | 10.83 | 19.45 | 7.11 | 5.15 | 5.17 | 1.04 | 0.45 | 0.51 | 0.09 | 392 | 440 |
| TP-P1-S9-S2-No200 | 0.074 | 51.35 | 10.06 | 16.44 | 7.97 | 5.25 | 4.12 | 1.21 | 1.08 | 0.48 | 0.08 | 347 | 340 |
| TP-P1-S9-S2-No140 | 0.105 | 52.03 | 10.06 | 16.14 | 7.97 | 5.11 | 4.07 | 1.18 | 0.92 | 0.44 | 0.08 | 327 | 330 |
| TP-P1-S9-S2-No100 | 0.149 | 53.46 | 10.63 | 15.54 | 8.26 | 4.73 | 3.45 | 1.09 | 1 | 0.43 | 0.08 | 284 | 270 |
| TP-P1-S9-S2-No60 | 0.25 | 51.55 | 11.53 | 15.47 | 8.17 | 4.72 | 3.06 | 0.95 | 0.6 | 0.42 | 0.09 | 288 | 270 |
| TP-P1-S9-S2-No40 | 0.42 | 52.86 | 13.31 | 15.14 | 8.93 | 4.72 | 2.03 | 0.86 | 0.55 | 0.46 | 0.11 | 252 | 230 |
| TP-P1-S9-S2-No20 | 0.841 | 50.77 | 14.13 | 13.92 | 8.68 | 4.9 | 1.33 | 0.72 | 0.03 | 0.49 | 0.12 | 257 | 230 |
| TP-P1-S9-S2-No10 | 2 | 54.21 | 15.7 | 12.96 | 10.01 | 5.67 | 1.23 | 0.64 | 0.61 | 0.55 | 0.13 | 334 | 200 |
| TP-P1-S9-S2-No4 | 4.76 | 52.4 | 15.76 | 13.85 | 9.93 | 5.94 | 1.36 | 0.54 | 0.36 | 0.62 | 0.15 | 363 | 260 |
| TP-P1-S9-S2 Avg* | - | 52.31 | 15.39 | 14.03 | 9.77 | 5.84 | 1.53 | 0.58 | 0.39 | 0.61 | 0.15 | 356 | 261 |
| TP-P1-S9-S3-pan | 0.037 | 38.93 | 15.26 | 32.23 | 4.86 | 2.35 | 6.01 | 0.46 | -0.31 | 0.44 | 0.08 | -77 | 460 |
| TP-P1-S9-S3-No200 | 0.074 | 42.28 | 17.82 | 29.97 | 5.75 | 3.79 | 6.15 | 0.36 | 0.13 | 0.46 | 0.09 | 195 | 390 |
| TP-P1-S9-S3-No140 | 0.105 | 43.57 | 18.19 | 28.68 | 5.93 | 4.8 | 6.53 | 0.37 | 0.34 | 0.45 | 0.1 | 208 | 400 |
| TP-P1-S9-S3-No100 | 0.149 | 43.92 | 18.18 | 26.14 | 6.35 | 5.48 | 6.39 | 0.35 | 0.2 | 0.46 | 0.1 | 255 | 370 |
| TP-P1-S9-S3-No60 | 0.25 | 45.58 | 19.66 | 24.03 | 6.64 | 5.14 | 5.75 | 0.36 | 0.33 | 0.44 | 0.1 | 217 | 300 |
| TP-P1-S9-S3-No40 | 0.42 | 48.58 | 21 | 20.93 | 7.4 | 3.19 | 3.25 | 0.39 | -0.27 | 0.43 | 0.11 | 195 | 200 |
| TP-P1-S9-S3-No10 | 2 | 53.13 | 22.53 | 14.54 | 7.67 | 3.87 | 1.75 | 0.31 | -0.06 | 0.43 | 0.12 | 249 | 150 |
| TP-P1-S9-S3-No4 | 4.76 | 55.09 | 22.91 | 12.8 | 8.86 | 4.04 | 1.5 | 0.39 | 0.56 | 0.44 | 0.12 | 303 | 220 |
| TP-P1-S9-S3 Avg* | - | 51.81 | 21.71 | 16.79 | 8 | 3.9 | 2.55 | 0.38 | 0.28 | 0.44 | 0.12 | 251 | 235 |
| TP-P1-S10-S1-No200 | 0.074 | 66.79 | 2.78 | 3.52 | 10.14 | 3.94 | 0.06 | 2.04 | 2.96 | 0.35 | 0.04 | 255 | 510 |
| TP-P1-S10-S1-No140 | 0.105 | 65.53 | 2.59 | 3.26 | 9.5 | 3.58 | 0.06 | 2 | 2.59 | 0.3 | 0.04 | 251 | 400 |
| TP-P1-S10-S1-No100 | 0.149 | 69.64 | 2.23 | 3.15 | 9.53 | 3.12 | 0.04 | 1.87 | 2.89 | 0.25 | 0.03 | 206 | 280 |
| TP-P1-S10-S1-No60 | 0.25 | 64.12 | 2.96 | 3.03 | 8.65 | 3.54 | 0.07 | 1.83 | 2.15 | 0.28 | 0.03 | 266 | 310 |
| TP-P1-S10-S1-No40 | 0.42 | 67.97 | 2.52 | 3.5 | 10.09 | 4.02 | 0.03 | 1.89 | 3.09 | 0.3 | 0.04 | 258 | 370 |
| TP-P1-S10-S1-No20 | 0.841 | 63.53 | 3.52 | 4.21 | 11 | 6.17 | 0.07 | 1.93 | 3.12 | 0.36 | 0.05 | 443 | 410 |
| TP-P1-S10-S1-No10 | 2 | 65.28 | 3.59 | 5.25 | 11.83 | 5.31 | 0.07 | 1.75 | 3.39 | 0.47 | 0.07 | 288 | 390 |
| TP-P1-S10-S1-No4 | 4.76 | 58.38 | 6.78 | 7.6 | 11.58 | 7.66 | 0.15 | 1.54 | 2.3 | 0.56 | 0.11 | 389 | 550 |
| TP-P1-S10-S1 Avg* | - | 64.36 | 3.45 | 4.17 | 10.09 | 4.75 | 0.07 | 1.85 | 2.65 | 0.37 | 0.05 | 294 | 417 |
| TP-P1-S9-S2-pan | 0.037 | 45.23 | 10.83 | 19.45 | 7.11 | 5.15 | 5.17 | 1.04 | 0.45 | 0.51 | 0.09 | 392 | 440 |
| TP-P1-S9-S2-No200 | 0.074 | 51.35 | 10.06 | 16.44 | 7.97 | 5.25 | 4.12 | 1.21 | 1.08 | 0.48 | 0.08 | 347 | 340 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S9-S2-pan | 0.037 | 642 | 155 | 72 | -16 | 923 | 197 | 36 | -2 | 74 | 611 | 140 |
| TP-P1-S9-S2-No200 | 0.074 | 792 | 128 | 59 | -12 | 790 | 215 | 39 | 3 | 86 | 655 | 120 |
| TP-P1-S9-S2-No140 | 0.105 | 851 | 121 | 60 | -10 | 815 | 223 | 39 | 3 | 95 | 663 | 100 |
| TP-P1-S9-S2-No100 | 0.149 | 882 | 110 | 60 | -10 | 817 | 204 | 34 | 4 | 77 | 682 | 100 |
| TP-P1-S9-S2-No60 | 0.25 | 903 | 109 | 60 | -14 | 891 | 185 | 29 | 4 | 76 | 680 | 90 |
| TP-P1-S9-S2-No40 | 0.42 | 769 | 113 | 67 | -17 | 1068 | 165 | 29 | 5 | 118 | 677 | 100 |
| TP-P1-S9-S2-No20 | 0.841 | 598 | 111 | 72 | -16 | 1138 | 144 | 21 | 7 | 125 | 694 | 100 |
| TP-P1-S9-S2-No10 | 2 | 701 | 130 | 81 | -7 | 1339 | 140 | 23 | 8 | 144 | 711 | 100 |
| TP-P1-S9-S2-No4 | 4.76 | 1106 | 163 | 77 | -11 | 929 | 128 | 22 | 7 | 177 | 689 | 90 |
| TP-P1-S9-S2 Avg* | - | 1060 | 157 | 75 | -10 | 944 | 133 | 22 | 7 | 168 | 687 | 0 |
| TP-P1-S9-S3-pan | 0.037 | 1191 | 132 | 88 | -104 | 1318 | 75 | 20 | -30 | 62 | 452 | 80 |
| TP-P1-S9-S3-No200 | 0.074 | 1443 | 131 | 82 | -87 | 1261 | 77 | 21 | -23 | 58 | 479 | 80 |
| TP-P1-S9-S3-No140 | 0.105 | 1435 | 132 | 80 | -72 | 1313 | 79 | 21 | -20 | 65 | 487 | 70 |
| TP-P1-S9-S3-No100 | 0.149 | 1482 | 132 | 80 | -56 | 1431 | 83 | 17 | -13 | 78 | 517 | 70 |
| TP-P1-S9-S3-No60 | 0.25 | 1267 | 129 | 86 | -47 | 1592 | 82 | 12 | -9 | 83 | 545 | 80 |
| TP-P1-S9-S3-No40 | 0.42 | 1272 | 127 | 90 | -52 | 1677 | 85 | 16 | -4 | 105 | 587 | 80 |
| TP-P1-S9-S3-No10 | 2 | 554 | 127 | 87 | -26 | 1737 | 94 | 14 | 6 | 138 | 702 | 90 |
| TP-P1-S9-S3-No4 | 4.76 | 420 | 193 | 82 | -19 | 1772 | 107 | 12 | 8 | 123 | 734 | 100 |
| TP-P1-S9-S3 Avg* | - | 716 | 165 | 84 | -33 | 1693 | 97 | 14 | 1 | 113 | 668 | 0 |
| TP-P1-S10-S1-No200 | 0.074 | 82 | 38 | 32 | 7 | 169 | 373 | 56 | 13 | 62 | 1042 | 180 |
| TP-P1-S10-S1-No140 | 0.105 | 61 | 34 | 25 | 8 | 151 | 362 | 54 | 13 | 61 | 1056 | 160 |
| TP-P1-S10-S1-No100 | 0.149 | 50 | 38 | 25 | 6 | 166 | 350 | 51 | 13 | 61 | 1073 | 130 |
| TP-P1-S10-S1-No60 | 0.25 | 48 | 41 | 26 | 4 | 205 | 345 | 53 | 13 | 58 | 1087 | 130 |
| TP-P1-S10-S1-No40 | 0.42 | 46 | 39 | 26 | 10 | 187 | 352 | 52 | 13 | 52 | 1046 | 140 |
| TP-P1-S10-S1-No20 | 0.841 | 48 | 48 | 34 | 15 | 229 | 371 | 54 | 13 | 79 | 982 | 130 |
| TP-P1-S10-S1-No10 | 2 | 54 | 55 | 46 | 7 | 209 | 344 | 48 | 13 | 92 | 940 | 140 |
| TP-P1-S10-S1-No4 | 4.76 | 69 | 91 | 65 | 11 | 258 | 269 | 42 | 12 | 140 | 840 | 130 |
| TP-P1-S10-S1 Avg* | - | 60 | 49 | 35 | 9 | 187 | 345 | 50 | 13 | 75 | 1008 | 0.01 |
| TP-P1-S9-S2-pan | 0.037 | 642 | 155 | 72 | -16 | 923 | 197 | 36 | -2 | 74 | 611 | 140 |
| TP-P1-S9-S2-No200 | 0.074 | 792 | 128 | 59 | -12 | 790 | 215 | 39 | 3 | 86 | 655 | 120 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S10-S2-pan | 0.037 | 60.6 | 3.29 | 3.42 | 8.33 | 6.79 | 0.13 | 2.18 | 2.13 | 0.37 | 0.05 | 470 | 540 |
| TP-P1-S10-S2-No20 | 0.074 | 57.97 | 3.57 | 2.85 | 9.94 | 10.71 | 0.09 | 2.52 | 2.58 | 0.22 | 0.04 | 651 | 300 |
| TP-P1-S10-S2-No100 | 0.105 | 67.91 | 1.33 | 1.86 | 7.31 | 3.57 | 0.01 | 1.91 | 2.28 | 0.14 | 0.02 | 376 | 150 |
| TP-P1-S10-S2-No10 | 0.149 | 55.3 | 4.88 | 4.64 | 10.17 | 14.8 | 0.21 | 2.4 | 2.61 | 0.34 | 0.06 | 685 | 410 |
| TP-P1-S10-S2-No60 | 0.25 | 61.65 | 1.5 | 1.51 | 6.4 | 4.74 | 0.02 | 1.94 | 1.51 | 0.12 | 0.02 | 558 | 90 |
| TP-P1-S10-S2-No40 | 0.42 | 59.72 | 2.15 | 1.8 | 7.31 | 7.13 | 0.03 | 2.11 | 1.77 | 0.15 | 0.02 | 543 | 210 |
| TP-P1-S10-S2-No140 | 0.841 | 66.44 | 1.65 | 2.4 | 8.27 | 4.19 | 0.03 | 2.23 | 2.45 | 0.21 | 0.03 | 405 | 290 |
| TP-P1-S10-S1-pan | 2 | 59.68 | 3.53 | 3.71 | 9.04 | 5 | 0.1 | 1.91 | 1.8 | 0.44 | 0.05 | 283 | 560 |
| TP-P1-S10-S2-No200 | 4.76 | 63.12 | 2.12 | 2.92 | 8.17 | 5.08 | 0.05 | 2.24 | 2.07 | 0.27 | 0.04 | 422 | 480 |
| TP-P1-S10-S2 Avg* | - | 61.75 | 2.34 | 2.41 | 7.82 | 6.92 | 0.06 | 2.11 | 2.06 | 0.19 | 0.03 | 524 | 232 |
| TP-P1-S11-S1-pan | 0.037 | 60.04 | 3.97 | 3.87 | 8.45 | 7.97 | 0.17 | 2.14 | 2.14 | 0.39 | 0.05 | 492 | 620 |
| TP-P1-S11-S1-No200 | 0.074 | 63.52 | 2.21 | 2.81 | 8.34 | 5.18 | 0.04 | 2.22 | 2.18 | 0.28 | 0.04 | 361 | 480 |
| TP-P1-S11-S1-No140 | 0.105 | 63.81 | 1.68 | 2.19 | 7.56 | 4.39 | 0.03 | 2.1 | 2.11 | 0.22 | 0.03 | 408 | 280 |
| TP-P1-S11-S1-No100 | 0.149 | 67.22 | 1.37 | 1.79 | 7.13 | 3.68 | 0.01 | 1.9 | 2.11 | 0.14 | 0.02 | 415 | 140 |
| TP-P1-S11-S1-No60 | 0.25 | 69.39 | 1.35 | 1.91 | 7.25 | 3.86 | 0.01 | 1.83 | 2.47 | 0.13 | 0.02 | 397 | 140 |
| TP-P1-S11-S1-No40 | 0.42 | 66.58 | 1.74 | 1.96 | 7.93 | 5.67 | 0.02 | 1.99 | 2.56 | 0.13 | 0.02 | 551 | 200 |
| TP-P1-S11-S1-No20 | 0.841 | 59 | 3.25 | 2.62 | 10.18 | 10.76 | 0.06 | 2.47 | 2.88 | 0.2 | 0.03 | 662 | 240 |
| TP-P1-S11-S1-No10 | 2 | 53.82 | 5.43 | 4.7 | 9.48 | 13.2 | 0.18 | 2.15 | 2.28 | 0.33 | 0.07 | 628 | 390 |
| TP-P1-S11-S1 Avg* | - | 56.84 | 4.53 | 4.05 | 9.09 | 11.17 | 0.14 | 2.13 | 2.31 | 0.3 | 0.06 | 587 | 361 |
| TP-P1-S11-S3-pan | 0.037 | 48.86 | 9.41 | 21.09 | 10.74 | 7.67 | 4.53 | 0.66 | 1.2 | 0.62 | 0.19 | 489 | 290 |
| TP-P1-S11-S3-No200 | 0.074 | 44.77 | 8.64 | 19.29 | 9.38 | 9.21 | 4.6 | 0.79 | 0.58 | 0.58 | 0.2 | 470 | 180 |
| TP-P1-S11-S3-No140 | 0.105 | 50.31 | 9.43 | 19.65 | 10.63 | 9.4 | 4.6 | 0.81 | 1.36 | 0.6 | 0.21 | 459 | 210 |
| TP-P1-S11-S3-No100 | 0.149 | 50.88 | 7.97 | 15.14 | 9.71 | 12.81 | 5.78 | 0.79 | 1.65 | 0.63 | 0.19 | 552 | 300 |
| TP-P1-S11-S3-No60 | 0.25 | 53.19 | 8.1 | 13.88 | 10.3 | 12.07 | 4.77 | 0.81 | 1.82 | 0.64 | 0.18 | 524 | 330 |
| TP-P1-S11-S3-No40 | 0.42 | 55.79 | 8.39 | 12.35 | 11.2 | 10.12 | 1.94 | 0.85 | 1.64 | 0.67 | 0.18 | 451 | 220 |
| TP-P1-S11-S3-No20 | 0.841 | 57.29 | 9.07 | 11.74 | 11.61 | 9.24 | 1 | 0.88 | 1.36 | 0.67 | 0.18 | 444 | 280 |
| TP-P1-S11-S3-No10 | 2 | 57.74 | 9.18 | 11.67 | 12.15 | 9.47 | 0.86 | 0.89 | 1.62 | 0.7 | 0.18 | 464 | 320 |
| TP-P1-S11-S3-No4 | 4.76 | 55.94 | 6.95 | 14.04 | 11.96 | 8.31 | 2.44 | 0.87 | 2.04 | 0.69 | 0.17 | 451 | 350 |
| TP-P1-S11-S3 Avg* | - | 55.5 | 7.25 | 14.1 | 11.8 | 8.51 | 2.47 | 0.86 | 1.94 | 0.68 | 0.17 | 453 | 338 |
| TP-P1-S10-S2-pan | 0.037 | 60.6 | 3.29 | 3.42 | 8.33 | 6.79 | 0.13 | 2.18 | 2.13 | 0.37 | 0.05 | 470 | 540 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S10-S2-pan | 0.037 | 114 | 30 | 33 | 16 | 122 | 357 | 57 | 13 | 60 | 1014 | 310 |
| TP-P1-S10-S2-No20 | 0.074 | 64 | 27 | 24 | 25 | 116 | 350 | 82 | 13 | 52 | 1025 | 100 |
| TP-P1-S10-S2-No100 | 0.105 | 26 | 19 | 14 | 3 | 117 | 307 | 55 | 13 | 39 | 1157 | 70 |
| TP-P1-S10-S2-No10 | 0.149 | 152 | 46 | 41 | 30 | 174 | 341 | 79 | 12 | 90 | 909 | 120 |
| TP-P1-S10-S2-No60 | 0.25 | 22 | 17 | 15 | 14 | 80 | 305 | 57 | 13 | 34 | 1191 | 70 |
| TP-P1-S10-S2-No40 | 0.42 | 26 | 17 | 17 | 20 | 88 | 319 | 63 | 13 | 39 | 1148 | 80 |
| TP-P1-S10-S2-No140 | 0.841 | 32 | 18 | 18 | 7 | 118 | 335 | 58 | 13 | 53 | 1096 | 100 |
| TP-P1-S10-S1-pan | 2 | 92 | 48 | 39 | 14 | 104 | 373 | 50 | 13 | 74 | 1017 | 250 |
| TP-P1-S10-S2-No200 | 4.76 | 47 | 24 | 23 | 14 | 124 | 353 | 57 | 13 | 60 | 1055 | 200 |
| TP-P1-S10-S2 Avg* | - | 52 | 23 | 21 | 15 | 112 | 322 | 62 | 12 | 49 | 1102 | 0 |
| TP-P1-S11-S1-pan | 0.037 | 166 | 35 | 44 | 20 | 143 | 355 | 55 | 13 | 69 | 983 | 380 |
| TP-P1-S11-S1-No200 | 0.074 | 44 | 22 | 21 | 10 | 99 | 348 | 55 | 13 | 65 | 1065 | 190 |
| TP-P1-S11-S1-No140 | 0.105 | 33 | 20 | 16 | 5 | 106 | 340 | 55 | 13 | 55 | 1109 | 100 |
| TP-P1-S11-S1-No100 | 0.149 | 24 | 17 | 13 | 4 | 116 | 307 | 53 | 13 | 34 | 1150 | 70 |
| TP-P1-S11-S1-No60 | 0.25 | 24 | 19 | 11 | 8 | 183 | 294 | 53 | 13 | 38 | 1144 | 70 |
| TP-P1-S11-S1-No40 | 0.42 | 25 | 15 | 15 | 16 | 158 | 308 | 58 | 13 | 31 | 1126 | 80 |
| TP-P1-S11-S1-No20 | 0.841 | 36 | 24 | 21 | 24 | 121 | 354 | 80 | 13 | 52 | 1032 | 90 |
| TP-P1-S11-S1-No10 | 2 | 171 | 53 | 42 | 31 | 211 | 330 | 73 | 12 | 84 | 931 | 130 |
| TP-P1-S11-S1 Avg* | - | 137 | 44 | 35 | 25 | 190 | 328 | 68 | 12 | 73 | 975 | 0.01 |
| TP-P1-S11-S3-pan | 0.037 | 1660 | 279 | 136 | -39 | 391 | 127 | 24 | -4 | 130 | 509 | 90 |
| TP-P1-S11-S3-No200 | 0.074 | 1629 | 208 | 125 | -20 | 350 | 125 | 27 | 0 | 153 | 536 | 80 |
| TP-P1-S11-S3-No140 | 0.105 | 1978 | 208 | 122 | -18 | 378 | 123 | 24 | -1 | 163 | 530 | 90 |
| TP-P1-S11-S3-No100 | 0.149 | 1731 | 137 | 99 | 16 | 330 | 144 | 22 | 6 | 186 | 607 | 90 |
| TP-P1-S11-S3-No60 | 0.25 | 1326 | 122 | 94 | 20 | 325 | 145 | 21 | 8 | 182 | 637 | 90 |
| TP-P1-S11-S3-No40 | 0.42 | 887 | 113 | 84 | 4 | 333 | 152 | 25 | 9 | 194 | 674 | 90 |
| TP-P1-S11-S3-No20 | 0.841 | 593 | 113 | 80 | 4 | 340 | 153 | 23 | 9 | 183 | 703 | 100 |
| TP-P1-S11-S3-No10 | 2 | 471 | 125 | 87 | 1 | 426 | 165 | 25 | 9 | 181 | 704 | 100 |
| TP-P1-S11-S3-No4 | 4.76 | 1431 | 101 | 81 | -9 | 255 | 147 | 25 | 7 | 189 | 632 | 90 |
| TP-P1-S11-S3 Avg* | - | 1363 | 109 | 84 | -7 | 272 | 146 | 24 | 6 | 185 | 632 | 0 |
| TP-P1-S10-S2-pan | 0.037 | 114 | 30 | 33 | 16 | 122 | 357 | 57 | 13 | 60 | 1014 | 310 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S14-S2-pan | 0.037 | 42.4 | 16.54 | 21.84 | 6.93 | 5.91 | 5.26 | 0.84 | -0.2 | 0.54 | 0.12 | 339 | 460 |
| TP-P1-S14-S2-No200 | 0.074 | 44.71 | 17.37 | 20.14 | 8.28 | 4.96 | 4.7 | 1.05 | -0.29 | 0.64 | 0.12 | 311 | 310 |
| TP-P1-S14-S2-No140 | 0.105 | 46.28 | 17.3 | 19.49 | 8.46 | 4.6 | 4 | 1.05 | -0.29 | 0.66 | 0.12 | 342 | 260 |
| TP-P1-S14-S2-No100 | 0.149 | 46.75 | 16.97 | 18.05 | 8.44 | 5.42 | 4.3 | 0.9 | -0.08 | 0.6 | 0.12 | 365 | 300 |
| TP-P1-S14-S2-No60 | 0.25 | 50.23 | 18.92 | 16.99 | 8.88 | 5.14 | 3.41 | 0.74 | 0.02 | 0.56 | 0.12 | 321 | 290 |
| TP-P1-S14-S2-No40 | 0.42 | 52.59 | 20.92 | 15.8 | 9.4 | 4.7 | 2.15 | 0.62 | 0.09 | 0.55 | 0.14 | 270 | 300 |
| TP-P1-S14-S2-No20 | 0.841 | 51.78 | 20.89 | 13.79 | 8.99 | 4.92 | 1.3 | 0.53 | -0.25 | 0.53 | 0.14 | 336 | 390 |
| TP-P1-S14-S2-No10 | 2 | 54.65 | 19.92 | 12.91 | 10.01 | 5.54 | 1.55 | 0.54 | 0.57 | 0.57 | 0.15 | 394 | 290 |
| TP-P1-S14-S2-No4 | 4.76 | 53.29 | 20.4 | 12.64 | 11.62 | 3.9 | 0.95 | 0.95 | -0.04 | 0.68 | 0.14 | 111 | 650 |
| TP-P1-S14-S2 Avg* | - | 49.18 | 18.8 | 16.85 | 9 | 5.01 | 3.06 | 0.8 | -0.05 | 0.59 | 0.13 | 309.87 | 361.11 |
| TP-P1-S14-S3-pan | 0.037 | 46.52 | 14.57 | 18.99 | 8.12 | 6.57 | 4.92 | 0.61 | 0.33 | 0.51 | 0.14 | 489 | 210 |
| TP-P1-S14-S3-No200 | 0.074 | 48.95 | 13.15 | 17.34 | 8.64 | 6.91 | 4.73 | 0.76 | 0.43 | 0.5 | 0.14 | 437 | 230 |
| TP-P1-S14-S3-No140 | 0.105 | 50.07 | 12.1 | 15.73 | 8.47 | 6.92 | 4.6 | 0.82 | 0.56 | 0.52 | 0.13 | 421 | 190 |
| TP-P1-S14-S3-No100 | 0.149 | 51.78 | 11.31 | 14.5 | 8.52 | 6.64 | 4.35 | 0.85 | 0.73 | 0.49 | 0.12 | 434 | 200 |
| TP-P1-S14-S3-No60 | 0.25 | 52.97 | 10.83 | 13.97 | 8.86 | 6.55 | 3.84 | 0.84 | 0.67 | 0.5 | 0.12 | 412 | 200 |
| TP-P1-S14-S3-No40 | 0.42 | 53.53 | 11.16 | 13.84 | 9.41 | 6.26 | 2.69 | 0.79 | 0.59 | 0.57 | 0.13 | 404 | 240 |
| TP-P1-S14-S3-No20 | 0.841 | 54.92 | 11.23 | 13.3 | 10.42 | 6.56 | 1.64 | 0.74 | 0.66 | 0.64 | 0.15 | 361 | 280 |
| TP-P1-S14-S3-No10 | 2 | 55.6 | 11.61 | 13.89 | 10.69 | 6.69 | 1.81 | 0.73 | 0.81 | 0.67 | 0.15 | 380 | 290 |
| TP-P1-S14-S3-No4 | 4.76 | 53.42 | 11.54 | 14.76 | 11.68 | 7.71 | 1.72 | 0.64 | 0.8 | 0.75 | 0.18 | 420 | 220 |
| TP-P1-S14-S3 Avg* | - | 53.38 | 11.57 | 14.76 | 11.52 | 7.62 | 1.81 | 0.65 | 0.79 | 0.74 | 0.18 | 419 | 222 |
| TP-P1-S15-S1-pan | 0.037 | 30.42 | 3.21 | 19.21 | 2.62 | 5.12 | 2.74 | 0.45 | -2.46 | 0.43 | 0.12 | -531 | 160 |
| TP-P1-S15-S1-No200 | 0.074 | 30.41 | 3.03 | 17.14 | 2.53 | 5.56 | 2.91 | 0.49 | -2.4 | 0.42 | 0.12 | -448 | 80 |
| TP-P1-S15-S1-No140 | 0.105 | 30.73 | 2.98 | 16.43 | 2.54 | 5.23 | 2.55 | 0.5 | -2.5 | 0.4 | 0.12 | 39 | 60 |
| TP-P1-S15-S1-No100 | 0.149 | 31.1 | 3.13 | 15.81 | 2.61 | 4.77 | 2.16 | 0.49 | -2.57 | 0.44 | 0.12 | -694 | 90 |
| TP-P1-S15-S1-No60 | 0.25 | 31.52 | 3.03 | 14.9 | 2.58 | 4.56 | 1.89 | 0.47 | -2.64 | 0.4 | 0.12 | -437 | 100 |
| TP-P1-S15-S1-No40 | 0.42 | 32.19 | 3.46 | 14.2 | 2.76 | 4.18 | 1.29 | 0.45 | -2.76 | 0.4 | 0.12 | -644 | 120 |
| TP-P1-S15-S1-No20 | 0.841 | 33.3 | 3.48 | 12.66 | 2.9 | 4.41 | 0.83 | 0.49 | -2.72 | 0.42 | 0.13 | -454 | 90 |
| TP-P1-S15-S1-No10 | 2 | 33.49 | 3.44 | 12.07 | 2.91 | 4.7 | 0.77 | 0.44 | -2.69 | 0.47 | 0.13 | -124 | 130 |
| TP-P1-S15-S1-No4 | 4.76 | 34.01 | 3.22 | 12.23 | 2.74 | 4.57 | 1.3 | 0.38 | -2.7 | 0.4 | 0.12 | -523 | 70 |
| TP-P1-S15-S1 Avg* | - | 33.52 | 3.24 | 12.83 | 2.75 | 4.61 | 1.36 | 0.4 | 0 | 0.4 | 0.12 | -485 | 81 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S14-S2-pan | 0.037 | 1098 | 203 | 122 | -28 | 1311 | 97 | 26 | -4 | 100 | 562 | 90 |
| TP-P1-S14-S2-No200 | 0.074 | 1386 | 193 | 114 | -29 | 1355 | 89 | 38 | -2 | 127 | 595 | 90 |
| TP-P1-S14-S2-No140 | 0.105 | 1468 | 186 | 103 | -31 | 1284 | 94 | 40 | -1 | 109 | 605 | 90 |
| TP-P1-S14-S2-No100 | 0.149 | 1412 | 178 | 98 | -13 | 1248 | 101 | 34 | 2 | 113 | 624 | 100 |
| TP-P1-S14-S2-No60 | 0.25 | 1255 | 166 | 94 | -19 | 1298 | 103 | 27 | 3 | 123 | 636 | 100 |
| TP-P1-S14-S2-No40 | 0.42 | 988 | 168 | 96 | -23 | 1371 | 98 | 21 | 4 | 128 | 666 | 100 |
| TP-P1-S14-S2-No20 | 0.841 | 647 | 168 | 101 | -17 | 1476 | 100 | 21 | 7 | 133 | 686 | 100 |
| TP-P1-S14-S2-No10 | 2 | 915 | 166 | 95 | -10 | 1247 | 112 | 18 | 8 | 142 | 702 | 110 |
| TP-P1-S14-S2-No4 | 4.76 | 409 | 209 | 92 | -11 | 868 | 121 | 32 | 9 | 133 | 731 | 110 |
| TP-P1-S14-S2 Avg* | - | 1064 | 182 | 102 | -20 | 1273 | 102 | 28 | 3 | 123 | 645 | 99 |
| TP-P1-S14-S3-pan | 0.037 | 1466 | 381 | 118 | -21 | 867 | 120 | 24 | 0 | 118 | 593 | 100 |
| TP-P1-S14-S3-No200 | 0.074 | 1760 | 298 | 110 | -8 | 891 | 135 | 25 | 3 | 146 | 618 | 90 |
| TP-P1-S14-S3-No140 | 0.105 | 1753 | 248 | 97 | -1 | 779 | 150 | 28 | 5 | 125 | 657 | 80 |
| TP-P1-S14-S3-No100 | 0.149 | 1570 | 210 | 86 | 5 | 716 | 157 | 28 | 6 | 123 | 688 | 80 |
| TP-P1-S14-S3-No60 | 0.25 | 1428 | 193 | 79 | 0 | 696 | 152 | 29 | 7 | 126 | 692 | 90 |
| TP-P1-S14-S3-No40 | 0.42 | 1293 | 171 | 85 | -2 | 701 | 141 | 27 | 8 | 157 | 687 | 90 |
| TP-P1-S14-S3-No20 | 0.841 | 1206 | 147 | 83 | -7 | 604 | 130 | 23 | 8 | 193 | 685 | 90 |
| TP-P1-S14-S3-No10 | 2 | 1319 | 173 | 83 | -11 | 559 | 119 | 24 | 7 | 187 | 664 | 100 |
| TP-P1-S14-S3-No4 | 4.76 | 547 | 145 | 83 | -14 | 438 | 118 | 24 | 6 | 193 | 637 | 100 |
| TP-P1-S14-S3 Avg* | - | 609 | 150 | 83 | -13 | 456 | 119 | 23 | 5 | 190 | 639 | 0 |
| TP-P1-S15-S1-pan | 0.037 | 741 | 230 | 104 | -31 | 1381 | 114 | 22 | -2 | 114 | 613 | 100 |
| TP-P1-S15-S1-No200 | 0.074 | 920 | 216 | 96 | -20 | 1250 | 128 | 25 | 2 | 104 | 636 | 90 |
| TP-P1-S15-S1-No140 | 0.105 | 1040 | 210 | 94 | -21 | 1218 | 137 | 26 | 2 | 115 | 644 | 90 |
| TP-P1-S15-S1-No100 | 0.149 | 1039 | 198 | 87 | -16 | 1223 | 140 | 20 | 4 | 94 | 659 | 90 |
| TP-P1-S15-S1-No60 | 0.25 | 931 | 185 | 90 | -19 | 1300 | 138 | 18 | 5 | 111 | 660 | 90 |
| TP-P1-S15-S1-No40 | 0.42 | 699 | 182 | 87 | -17 | 1344 | 146 | 18 | 6 | 121 | 698 | 100 |
| TP-P1-S15-S1-No20 | 0.841 | 648 | 175 | 87 | -14 | 1312 | 163 | 21 | 8 | 129 | 741 | 100 |
| TP-P1-S15-S1-No10 | 2 | 702 | 202 | 84 | -8 | 1195 | 167 | 14 | 9 | 129 | 731 | 100 |
| TP-P1-S15-S1-No4 | 4.76 | 1963 | 290 | 99 | -8 | 1280 | 153 | 17 | 8 | 138 | 728 | 100 |
| TP-P1-S15-S1 Avg* | - | 1642 | 265 | 96 | -10 | 1278 | 151 | 17 | 7 | 133 | 717 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S15-S2-pan | 0.037 | 48.37 | 10.17 | 19.58 | 9.84 | 5.96 | 3.79 | 0.71 | 0.61 | 0.62 | 0.14 | 579 | 260 |
| TP-P1-S15-S2-No200 | 0.074 | 50.88 | 9.83 | 19 | 9.99 | 6.66 | 4.76 | 0.79 | 1.08 | 0.62 | 0.14 | 591 | 280 |
| TP-P1-S15-S2-No140 | 0.105 | 54.71 | 9.48 | 15.59 | 10.34 | 7.33 | 3.92 | 0.89 | 1.29 | 0.65 | 0.14 | 537 | 260 |
| TP-P1-S15-S2-No100 | 0.149 | 53.6 | 8.89 | 13.55 | 9.54 | 7.65 | 3.84 | 0.84 | 1.07 | 0.61 | 0.13 | 505 | 270 |
| TP-P1-S15-S2-No60 | 0.25 | 54.16 | 9.08 | 12.75 | 9.63 | 7.69 | 3.29 | 0.81 | 1.16 | 0.63 | 0.13 | 512 | 230 |
| TP-P1-S15-S2-No40 | 0.42 | 57.67 | 9.3 | 12.78 | 10.82 | 6.74 | 1.65 | 0.79 | 1.45 | 0.69 | 0.14 | 436 | 260 |
| TP-P1-S15-S2-No20 | 0.841 | 55.39 | 9.28 | 12.1 | 10.62 | 6.64 | 1.05 | 0.78 | 1.13 | 0.67 | 0.14 | 381 | 320 |
| TP-P1-S15-S2-No10 | 2 | 58.25 | 8.8 | 13.05 | 11.58 | 7.07 | 1.33 | 0.84 | 1.78 | 0.73 | 0.15 | 418 | 340 |
| TP-P1-S15-S2-No4 | 4.76 | 58.74 | 7.71 | 11.88 | 12.11 | 6.69 | 0.96 | 0.87 | 1.98 | 0.74 | 0.14 | 354 | 320 |
| TP-P1-S15-S2 Avg* | - | 57.74 | 8.17 | 12.51 | 11.69 | 6.74 | 1.3 | 0.85 | 1.78 | 0.72 | 0.14 | 384 | 314 |
| TP-P1-S15-S3-pan | 0.037 | 47.64 | 7.44 | 19.07 | 9.05 | 6.92 | 2.52 | 0.71 | 0.47 | 0.79 | 0.17 | 366 | 420 |
| TP-P1-S15-S3-No200 | 0.074 | 53.62 | 7.52 | 16.46 | 10.2 | 6.83 | 2.36 | 0.92 | 1.11 | 0.73 | 0.15 | 326 | 410 |
| TP-P1-S15-S3-No140 | 0.105 | 52.38 | 7.38 | 15.48 | 9.75 | 6.67 | 2.46 | 0.92 | 0.95 | 0.72 | 0.14 | 336 | 380 |
| TP-P1-S15-S3-No100 | 0.149 | 55.54 | 7.05 | 14.3 | 10.35 | 6.64 | 1.82 | 0.95 | 1.26 | 0.75 | 0.14 | 300 | 310 |
| TP-P1-S15-S3-No60 | 0.25 | 55.09 | 7.2 | 13.92 | 10.4 | 6.8 | 1.29 | 0.86 | 1.12 | 0.77 | 0.15 | 363 | 380 |
| TP-P1-S15-S3-No40 | 0.42 | 57.31 | 7.67 | 13.71 | 11.46 | 7.15 | 0.78 | 0.81 | 1.42 | 0.84 | 0.17 | 361 | 390 |
| TP-P1-S15-S3-No20 | 0.841 | 56.02 | 8.1 | 13.6 | 11.73 | 7.74 | 0.67 | 0.76 | 1.43 | 0.87 | 0.19 | 417 | 430 |
| TP-P1-S15-S3-No10 | 2 | 56.03 | 7.72 | 14.38 | 12.03 | 7.83 | 0.87 | 0.69 | 1.6 | 0.95 | 0.2 | 461 | 400 |
| TP-P1-S15-S3-No4 | 4.76 | 56.46 | 7.02 | 14.24 | 12.14 | 7.6 | 0.78 | 0.69 | 1.66 | 1.01 | 0.2 | 426 | 500 |
| TP-P1-S15-S3 Avg* | - | 54.45 | 7.45 | 15.01 | 10.79 | 7.13 | 1.5 | 0.81 | 1.22 | 0.82 | 0.16 | 372 | 402 |
| TP-P1-S16-S1-pan | 0.037 | 50.36 | 19.14 | 15.06 | 6.87 | 4.28 | 2.05 | 0.59 | 0.15 | 0.45 | 0.15 | 323 | 170 |
| TP-P1-S16-S1-No200 | 0.074 | 55.82 | 19.26 | 13.86 | 7.43 | 4.33 | 1.74 | 0.72 | 0.7 | 0.43 | 0.15 | 342 | 160 |
| TP-P1-S16-S1-No140 | 0.105 | 55.31 | 19.5 | 12.43 | 7.24 | 4.15 | 1.39 | 0.7 | 0.39 | 0.42 | 0.13 | 315 | 110 |
| TP-P1-S16-S1-No100 | 0.149 | 56.72 | 19.05 | 11.38 | 7.6 | 4.05 | 1.2 | 0.71 | 0.43 | 0.42 | 0.13 | 307 | 130 |
| TP-P1-S16-S1-No60 | 0.25 | 56.78 | 20.47 | 11.01 | 7.64 | 3.93 | 1.01 | 0.68 | 0.61 | 0.41 | 0.13 | 338 | 170 |
| TP-P1-S16-S1-No40 | 0.42 | 54.4 | 20.84 | 11.53 | 7.86 | 4.98 | 0.71 | 0.52 | 0.19 | 0.49 | 0.15 | 343 | 170 |
| TP-P1-S16-S1-No20 | 0.841 | 54.31 | 20.7 | 11.52 | 7.87 | 4.97 | 0.67 | 0.52 | 0.15 | 0.49 | 0.15 | 364 | 180 |
| TP-P1-S16-S1-No10 | 2 | 53.43 | 18.65 | 11.85 | 8.11 | 5.57 | 0.86 | 0.53 | 0.38 | 0.54 | 0.15 | 400 | 160 |
| TP-P1-S16-S1-No4 | 4.76 | 53.79 | 19.07 | 11.94 | 8.35 | 4.02 | 1.03 | 0.57 | 0.31 | 0.51 | 0.13 | 368 | 140 |
| TP-P1-S16-S1 Avg* | - | 54.55 | 19.63 | 12.28 | 7.66 | 4.47 | 1.18 | 0.61 | 0.37 | 0.46 | 0.14 | 344 | 154 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S15-S2-pan | 0.037 | 1173 | 268 | 102 | -20 | 358 | 122 | 30 | -2 | 147 | 533 | 110 |
| TP-P1-S15-S2-No200 | 0.074 | 1364 | 224 | 134 | -4 | 391 | 125 | 30 | 0 | 138 | 555 | 100 |
| TP-P1-S15-S2-No140 | 0.105 | 1419 | 171 | 82 | 15 | 450 | 138 | 35 | 5 | 155 | 630 | 100 |
| TP-P1-S15-S2-No100 | 0.149 | 1088 | 137 | 71 | 18 | 410 | 147 | 34 | 7 | 161 | 676 | 100 |
| TP-P1-S15-S2-No60 | 0.25 | 824 | 122 | 65 | 8 | 391 | 143 | 33 | 8 | 160 | 691 | 110 |
| TP-P1-S15-S2-No40 | 0.42 | 703 | 114 | 66 | 1 | 410 | 140 | 32 | 8 | 158 | 699 | 120 |
| TP-P1-S15-S2-No20 | 0.841 | 438 | 94 | 63 | -6 | 390 | 142 | 34 | 9 | 187 | 708 | 120 |
| TP-P1-S15-S2-No10 | 2 | 573 | 100 | 66 | -7 | 434 | 140 | 36 | 8 | 185 | 672 | 120 |
| TP-P1-S15-S2-No4 | 4.76 | 306 | 71 | 55 | -3 | 319 | 152 | 36 | 9 | 191 | 712 | 130 |
| TP-P1-S15-S2 Avg* | - | 437 | 89 | 60 | -3 | 346 | 147 | 35 | 8 | 185 | 696 | 0.01 |
| TP-P1-S15-S3-pan | 0.037 | 405 | 93 | 80 | -1 | 320 | 147 | 31 | -1 | 189 | 585 | 130 |
| TP-P1-S15-S3-No200 | 0.074 | 464 | 89 | 71 | -1 | 358 | 163 | 36 | 3 | 176 | 631 | 120 |
| TP-P1-S15-S3-No140 | 0.105 | 428 | 84 | 66 | 6 | 317 | 170 | 39 | 5 | 171 | 648 | 110 |
| TP-P1-S15-S3-No100 | 0.149 | 367 | 70 | 58 | 1 | 279 | 166 | 36 | 6 | 167 | 673 | 100 |
| TP-P1-S15-S3-No60 | 0.25 | 297 | 63 | 62 | -2 | 302 | 159 | 34 | 7 | 191 | 680 | 100 |
| TP-P1-S15-S3-No40 | 0.42 | 238 | 63 | 63 | -7 | 311 | 156 | 33 | 7 | 217 | 675 | 110 |
| TP-P1-S15-S3-No20 | 0.841 | 227 | 54 | 70 | -8 | 287 | 146 | 30 | 7 | 228 | 667 | 110 |
| TP-P1-S15-S3-No10 | 2 | 378 | 44 | 66 | -8 | 253 | 130 | 27 | 7 | 261 | 635 | 120 |
| TP-P1-S15-S3-No4 | 4.76 | 226 | 41 | 79 | -12 | 320 | 154 | 28 | 7 | 263 | 636 | 120 |
| TP-P1-S15-S3 Avg* | - | 336 | 66 | 68 | -3 | 305 | 154 | 32 | 5 | 207 | 647 | 113 |
| TP-P2-S16-S1-pan | 0.037 | 634 | 797 | 138 | -20 | 1102 | 139 | 22 | 5 | 106 | 646 | 110 |
| TP-P2-S16-S1-No200 | 0.074 | 690 | 595 | 127 | -14 | 1378 | 155 | 22 | 6 | 130 | 687 | 100 |
| TP-P2-S16-S1-No140 | 0.105 | 588 | 502 | 113 | -6 | 1270 | 159 | 25 | 8 | 102 | 723 | 90 |
| TP-P2-S16-S1-No100 | 0.149 | 490 | 451 | 109 | -10 | 1308 | 168 | 26 | 9 | 104 | 754 | 90 |
| TP-P2-S16-S1-No60 | 0.25 | 422 | 432 | 107 | -9 | 1339 | 160 | 20 | 9 | 123 | 763 | 90 |
| TP-P2-S16-S1-No40 | 0.42 | 320 | 351 | 99 | -11 | 1389 | 141 | 17 | 9 | 155 | 739 | 90 |
| TP-P2-S16-S1-No20 | 0.841 | 311 | 344 | 95 | -9 | 1408 | 141 | 18 | 9 | 129 | 751 | 90 |
| TP-P2-S16-S1-No10 | 2 | 322 | 327 | 83 | -9 | 1153 | 132 | 18 | 10 | 145 | 722 | 100 |
| TP-P2-S16-S1-No4 | 4.76 | 254 | 300 | 80 | -17 | 1157 | 131 | 20 | 9 | 126 | 727 | 110 |
| TP-P1-S16-S1 Avg* | - | 447 | 455 | 105 | -11 | 1278 | 147 | 20 | 8 | 124 | 723 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11: X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S17-S1-pan | 0.037 | 52.06 | 5.67 | 8.82 | 9.02 | 7.22 | 0.76 | 1.38 | 0.66 | 0.58 | 0.11 | 350 | 330 |
| TP-P1-S17-S1-No200 | 0.074 | 62.6 | 4.7 | 6.83 | 10.45 | 5.63 | 0.56 | 1.68 | 2.25 | 0.46 | 0.08 | 217 | 400 |
| TP-P1-S17-S1-No140 | 0.105 | 63.33 | 4.01 | 6.09 | 10.01 | 5.06 | 0.53 | 1.7 | 2.33 | 0.4 | 0.07 | 189 | 350 |
| TP-P1-S17-S1-No100 | 0.149 | 66.55 | 3.33 | 5.61 | 9.68 | 4.47 | 0.47 | 1.6 | 2.43 | 0.36 | 0.07 | 175 | 280 |
| TP-P1-S17-S1-No60 | 0.25 | 63.64 | 3.73 | 5.47 | 9.38 | 5 | 0.4 | 1.55 | 2.13 | 0.39 | 0.07 | 208 | 320 |
| TP-P1-S17-S1-No40 | 0.42 | 64.96 | 4.14 | 6.34 | 10.84 | 5.91 | 0.47 | 1.57 | 2.81 | 0.47 | 0.08 | -164 | 340 |
| TP-P1-S17-S1-No20 | 0.841 | 59.99 | 5.48 | 8.07 | 11.53 | 7.82 | 0.6 | 1.44 | 2.39 | 0.56 | 0.11 | 408 | 450 |
| TP-P1-S17-S1-No10 | 2 | 57.84 | 5.5 | 9.37 | 11.76 | 7.9 | 0.49 | 1.18 | 2.01 | 0.64 | 0.13 | 393 | 420 |
| TP-P1-S17-S1-No4 | 4.76 | 56.25 | 6.77 | 10.25 | 11.29 | 8.11 | 0.45 | 1.01 | 1.51 | 0.65 | 0.15 | 438 | 310 |
| TP-P1-S17-S1 Avg* | - | 57.57 | 6.08 | 9.29 | 10.96 | 7.54 | 0.49 | 1.17 | 1.67 | 0.6 | 0.13 | 370 | 328 |
| TP-P1-S17-S3-pan | 0.037 | 46.05 | 9.96 | 20.89 | 10.17 | 7.94 | 2.98 | 0.66 | 0.35 | 0.74 | 0.2 | 471 | 320 |
| TP-P1-S17-S3-No200 | 0.074 | 48.42 | 9.1 | 17.75 | 10.4 | 10.42 | 3.2 | 0.78 | 0.75 | 0.72 | 0.2 | 519 | 330 |
| TP-P1-S17-S3-No140 | 0.105 | 49.61 | 8.25 | 15.99 | 10.14 | 10.63 | 3.43 | 0.85 | 1.02 | 0.74 | 0.18 | 542 | 320 |
| TP-P1-S17-S3-No100 | 0.149 | 49.67 | 7.45 | 14.38 | 9.93 | 10.16 | 3.53 | 0.89 | 0.71 | 0.77 | 0.17 | 600 | 290 |
| TP-P1-S17-S3-No60 | 0.25 | 50.59 | 7.45 | 14.2 | 9.93 | 9.11 | 2.67 | 0.88 | 0.58 | 0.8 | 0.17 | 533 | 350 |
| TP-P1-S17-S3-No40 | 0.42 | 52.34 | 7.8 | 13.96 | 10.8 | 8.18 | 1.45 | 0.87 | 0.74 | 0.83 | 0.18 | 450 | 330 |
| TP-P1-S17-S3-No20 | 0.841 | 53.21 | 7.64 | 13.78 | 11.17 | 7.93 | 1.08 | 0.83 | 0.87 | 0.89 | 0.18 | 441 | 350 |
| TP-P1-S17-S3-No10 | 2 | 53.74 | 6.87 | 13.86 | 11.84 | 7.48 | 1.2 | 0.88 | 1.08 | 0.94 | 0.18 | 406 | 480 |
| TP-P1-S17-S3-No4 | 4.76 | 51.07 | 8 | 15.02 | 11.33 | 6.67 | 0.77 | 0.74 | 0.74 | 1.02 | 0.2 | 335 | 560 |
| TP-P1-S17-S3 Avg* | - | 51.24 | 7.93 | 14.99 | 11.28 | 6.97 | 0.96 | 0.76 | 0.76 | 0.99 | 0.2 | 358 | 525 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.11(Cont.): X-Ray Fluorescence Data for WRS#1 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P1-S17-S1-pan | 0.037 | 395 | 105 | 121 | 18 | 185 | 269 | 42 | 10 | 135 | 790 | 190 |
| TP-P1-S17-S1-No200 | 0.074 | 315 | 68 | 76 | 17 | 173 | 295 | 46 | 12 | 118 | 882 | 140 |
| TP-P1-S17-S1-No140 | 0.105 | 268 | 57 | 67 | 13 | 176 | 297 | 46 | 12 | 97 | 903 | 120 |
| TP-P1-S17-S1-No100 | 0.149 | 224 | 54 | 54 | 10 | 218 | 290 | 45 | 12 | 93 | 940 | 100 |
| TP-P1-S17-S1-No60 | 0.25 | 185 | 49 | 52 | 12 | 214 | 287 | 46 | 13 | 90 | 947 | 100 |
| TP-P1-S17-S1-No40 | 0.42 | 185 | 52 | 54 | 9 | 215 | 289 | 46 | 12 | 114 | 898 | 110 |
| TP-P1-S17-S1-No20 | 0.841 | 197 | 55 | 64 | 9 | 198 | 270 | 43 | 11 | 132 | 808 | 120 |
| TP-P1-S17-S1-No10 | 2 | 256 | 76 | 80 | 10 | 188 | 244 | 36 | 11 | 170 | 767 | 110 |
| TP-P1-S17-S1-No4 | 4.76 | 199 | 88 | 92 | 0 | 214 | 180 | 34 | 10 | 193 | 750 | 100 |
| TP-P1-S17-S1 Avg* | - | 220 | 81 | 86 | 4 | 207 | 213 | 37 | 10 | 169 | 784 | 0.01 |
| TP-P1-S17-S3-pan | 0.037 | 803 | 206 | 132 | -22 | 434 | 107 | 27 | -3 | 193 | 535 | 100 |
| TP-P1-S17-S3-No200 | 0.074 | 876 | 148 | 105 | -3 | 404 | 122 | 30 | 2 | 185 | 577 | 100 |
| TP-P1-S17-S3-No140 | 0.105 | 774 | 115 | 91 | 6 | 341 | 132 | 31 | 5 | 173 | 614 | 100 |
| TP-P1-S17-S3-No100 | 0.149 | 624 | 92 | 74 | 8 | 282 | 137 | 32 | 7 | 187 | 641 | 100 |
| TP-P1-S17-S3-No60 | 0.25 | 496 | 85 | 74 | -1 | 319 | 138 | 33 | 7 | 197 | 649 | 110 |
| TP-P1-S17-S3-No40 | 0.42 | 408 | 64 | 75 | -8 | 275 | 130 | 34 | 7 | 205 | 651 | 110 |
| TP-P1-S17-S3-No20 | 0.841 | 251 | 60 | 67 | -12 | 260 | 133 | 33 | 7 | 222 | 648 | 120 |
| TP-P1-S17-S3-No10 | 2 | 194 | 48 | 65 | -13 | 197 | 145 | 35 | 6 | 248 | 653 | 120 |
| TP-P1-S17-S3-No4 | 4.76 | 111 | 56 | 74 | -21 | 256 | 126 | 30 | 5 | 261 | 645 | 130 |
| TP-P1-S17-S3 Avg* | - | 165 | 60 | 75 | -18 | 258 | 127 | 30 | 5 | 253 | 642 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.12: X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-3-pan | 0.037 | 46.46 | 7.2 | 19.74 | 9.42 | 8.45 | 2.31 | 0.59 | 0.19 | 0.77 | 0.19 | 463 | 390 |
| WRS-2-3-No200 | 0.074 | 50.86 | 7.38 | 17.58 | 10.45 | 9.9 | 2.55 | 0.68 | 1.06 | 0.75 | 0.18 | 519 | 290 |
| WRS-2-3-No140 | 0.105 | 50.13 | 6.43 | 15.49 | 9.89 | 10.45 | 2.86 | 0.71 | 0.8 | 0.77 | 0.17 | 604 | 260 |
| WRS-2-3-No100 | 0.149 | 50.15 | 6.45 | 13.79 | 10.04 | 11.43 | 3.81 | 0.71 | 1.11 | 0.78 | 0.16 | 579 | 270 |
| WRS-2-3-No60 | 0.25 | 49.9 | 6.06 | 13.31 | 9.68 | 10.54 | 3.02 | 0.69 | 0.81 | 0.75 | 0.16 | 558 | 270 |
| WRS-2-3-No40 | 0.42 | 52.55 | 6.68 | 13.32 | 10.78 | 9.22 | 1.5 | 0.69 | 1.04 | 0.83 | 0.17 | 498 | 380 |
| WRS-2-3-No20 | 0.841 | 53.81 | 7.32 | 13.48 | 11.59 | 8.9 | 0.85 | 0.66 | 1.05 | 0.86 | 0.18 | 452 | 430 |
| WRS-2-3-No10 | 2 | 53.05 | 7.05 | 13.5 | 11.33 | 9.39 | 0.95 | 0.65 | 1.24 | 0.86 | 0.18 | 450 | 490 |
| WRS-2-3-No4 | 4.76 | 53.83 | 7.11 | 13.58 | 10.98 | 8.75 | 0.73 | 0.58 | 1.44 | 0.91 | 0.19 | 498 | 340 |
| WRS-2-3 Avg* | - | 53.49 | 7.09 | 13.74 | 10.96 | 8.85 | 0.87 | 0.59 | 1.36 | 0.9 | 0.19 | 494 | 351 |
| WRS-2-4-pan | 0.037 | 48.33 | 6.67 | 11.92 | 7.79 | 7.81 | 2.15 | 1.36 | 0.46 | 0.53 | 0.1 | 372 | 390 |
| WRS-2-4-No200 | 0.074 | 53.83 | 5.2 | 8.67 | 8.38 | 6.88 | 2.27 | 1.77 | 1.29 | 0.42 | 0.08 | 366 | 360 |
| WRS-2-4-No140 | 0.105 | 57.06 | 4.19 | 6.72 | 8.03 | 6.11 | 1.93 | 1.85 | 1.41 | 0.35 | 0.06 | 283 | 250 |
| WRS-2-4-No100 | 0.149 | 62.23 | 3.71 | 6.05 | 7.93 | 5.31 | 1.56 | 1.63 | 1.8 | 0.29 | 0.05 | 282 | 190 |
| WRS-2-4-No60 | 0.25 | 58.45 | 5.14 | 7.62 | 7.74 | 6.12 | 1.64 | 1.36 | 1.34 | 0.36 | 0.07 | 312 | 180 |
| WRS-2-4-No40 | 0.42 | 56.68 | 7.42 | 9.86 | 9.37 | 7.33 | 1.18 | 1.19 | 1.42 | 0.49 | 0.1 | 386 | 240 |
| WRS-2-4-No20 | 0.841 | 54.29 | 9.39 | 10.9 | 10.2 | 8.85 | 0.66 | 1.03 | 1.24 | 0.59 | 0.13 | 458 | 260 |
| WRS-2-4-No10 | 2 | 52.37 | 10.82 | 12.27 | 10.51 | 9.54 | 0.85 | 0.84 | 0.87 | 0.68 | 0.15 | 441 | 190 |
| WRS-2-4-No4 | 4.76 | 53.12 | 11.96 | 13.32 | 10.64 | 7.62 | 1.07 | 0.68 | 0.78 | 0.73 | 0.16 | 430 | 280 |
| WRS-2-4 Avg* | - | 55.15 | 7.16 | 9.7 | 8.95 | 7.28 | 1.47 | 1.3 | 1.17 | 0.49 | 0.1 | 369 | 260 |
| WRS-2-5-pan | 0.037 | 48.6 | 8.98 | 18.84 | 9.51 | 6.83 | 3.06 | 0.83 | 0.55 | 0.66 | 0.15 | 507 | 220 |
| WRS-2-5-No200 | 0.074 | 50.07 | 8.29 | 16.16 | 9.42 | 7.72 | 3.31 | 0.97 | 0.75 | 0.64 | 0.14 | 446 | 250 |
| WRS-2-5-No140 | 0.105 | 51.66 | 7.57 | 13.55 | 9.4 | 8.65 | 3.54 | 1.02 | 1.01 | 0.65 | 0.13 | 518 | 230 |
| WRS-2-5-No100 | 0.149 | 51.4 | 6.64 | 12.04 | 8.92 | 10.33 | 4.93 | 0.95 | 1.04 | 0.63 | 0.12 | 582 | 280 |
| WRS-2-5-No60 | 0.25 | 51.06 | 6.42 | 11.58 | 8.73 | 11.01 | 5.2 | 0.89 | 0.98 | 0.64 | 0.13 | 635 | 270 |
| WRS-2-5-No40 | 0.42 | 52.54 | 7.14 | 11.81 | 9.7 | 8.84 | 2.71 | 0.9 | 0.77 | 0.7 | 0.14 | 474 | 380 |
| WRS-2-5-No20 | 0.841 | 53.55 | 7.66 | 12.12 | 10.4 | 7.77 | 0.91 | 0.83 | 0.8 | 0.73 | 0.15 | 480 | 300 |
| WRS-2-5-No10 | 2 | 54.31 | 7.62 | 12.63 | 11.11 | 8.14 | 1.23 | 0.85 | 1.03 | 0.76 | 0.16 | 428 | 380 |
| WRS-2-5-No4 | 4.76 | 52.6 | 7.68 | 14.03 | 10.9 | 7.63 | 1.79 | 0.89 | 0.69 | 0.87 | 0.16 | 455 | 510 |
| WRS-2-5 Avg* | - | 51.75 | 7.55 | 13.64 | 9.78 | 8.54 | 2.96 | 0.9 | 0.84 | 0.69 | 0.14 | 502 | 313 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.12(Cont.): X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-3-pan | 0.037 | 609 | 120 | 118 | -4 | 182 | 133 | 21 | -4 | 203 | 528 | 110 |
| WRS-2-3-No200 | 0.074 | 696 | 93 | 99 | 16 | 216 | 148 | 29 | 2 | 186 | 567 | 100 |
| WRS-2-3-No140 | 0.105 | 649 | 74 | 83 | 20 | 224 | 156 | 29 | 4 | 201 | 613 | 100 |
| WRS-2-3-No100 | 0.149 | 544 | 57 | 70 | 22 | 160 | 162 | 24 | 6 | 210 | 645 | 100 |
| WRS-2-3-No60 | 0.25 | 419 | 48 | 65 | 14 | 211 | 165 | 28 | 8 | 228 | 645 | 100 |
| WRS-2-3-No40 | 0.42 | 390 | 48 | 68 | 0 | 180 | 163 | 25 | 7 | 247 | 665 | 110 |
| WRS-2-3-No20 | 0.841 | 292 | 44 | 66 | -8 | 202 | 160 | 26 | 7 | 230 | 661 | 110 |
| WRS-2-3-No10 | 2 | 360 | 45 | 76 | -5 | 171 | 162 | 26 | 8 | 228 | 652 | 110 |
| WRS-2-3-No4 | 4.76 | 169 | 44 | 66 | -5 | 214 | 158 | 24 | 7 | 275 | 658 | 100 |
| WRS-2-3 Avg* | - | 210 | 46 | 68 | -4 | 209 | 157 | 24 | 7 | 266 | 653 | 0.01 |
| WRS-2-4-pan | 0.037 | 514 | 124 | 79 | 14 | 487 | 240 | 39 | 8 | 121 | 726 | 220 |
| WRS-2-4-No200 | 0.074 | 467 | 83 | 50 | 19 | 305 | 281 | 49 | 11 | 92 | 830 | 160 |
| WRS-2-4-No140 | 0.105 | 349 | 65 | 39 | 23 | 259 | 282 | 49 | 12 | 74 | 892 | 90 |
| WRS-2-4-No100 | 0.149 | 275 | 59 | 32 | 14 | 332 | 255 | 45 | 12 | 71 | 927 | 80 |
| WRS-2-4-No60 | 0.25 | 291 | 72 | 43 | 19 | 485 | 229 | 41 | 12 | 103 | 869 | 90 |
| WRS-2-4-No40 | 0.42 | 379 | 97 | 63 | 9 | 597 | 208 | 35 | 11 | 127 | 783 | 100 |
| WRS-2-4-No20 | 0.841 | 299 | 103 | 72 | 6 | 706 | 191 | 33 | 10 | 159 | 738 | 100 |
| WRS-2-4-No10 | 2 | 528 | 119 | 79 | 1 | 737 | 152 | 30 | 9 | 198 | 698 | 110 |
| WRS-2-4-No4 | 4.76 | 524 | 141 | 96 | -10 | 629 | 125 | 29 | 8 | 205 | 678 | 100 |
| WRS-2-4 Avg* | - | 402 | 95 | 61 | 10 | 504 | 218 | 38 | 10 | 127 | 793 | 116 |
| WRS-2-5-pan | 0.037 | 935 | 168 | 119 | -17 | 279 | 140 | 31 | -1 | 151 | 543 | 120 |
| WRS-2-5-No200 | 0.074 | 1150 | 133 | 101 | -2 | 343 | 148 | 31 | 4 | 165 | 595 | 100 |
| WRS-2-5-No140 | 0.105 | 1083 | 100 | 88 | 17 | 320 | 159 | 36 | 7 | 170 | 655 | 100 |
| WRS-2-5-No100 | 0.149 | 886 | 84 | 75 | 26 | 273 | 159 | 36 | 9 | 162 | 696 | 110 |
| WRS-2-5-No60 | 0.25 | 671 | 74 | 73 | 27 | 286 | 159 | 33 | 10 | 169 | 701 | 90 |
| WRS-2-5-No40 | 0.42 | 567 | 75 | 71 | 7 | 278 | 153 | 34 | 9 | 199 | 699 | 100 |
| WRS-2-5-No20 | 0.841 | 425 | 62 | 68 | -3 | 267 | 149 | 33 | 9 | 207 | 695 | 110 |
| WRS-2-5-No10 | 2 | 1266 | 73 | 93 | -9 | 229 | 147 | 35 | 8 | 222 | 687 | 110 |
| WRS-2-5-No4 | 4.76 | 972 | 81 | 70 | -7 | 200 | 130 | 37 | 7 | 222 | 647 | 110 |
| WRS-2-5 Avg* | - | 883 | 94 | 84 | 4 | 275 | 149 | 33 | 6 | 185 | 657 | 105 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.12: X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-6-pan | 0.037 | 51.44 | 14.7 | 14.21 | 9.56 | 5.66 | 2.11 | 0.9 | 0.57 | 0.52 | 0.13 | 381 | 280 |
| WRS-2-6-No200 | 0.074 | 51.75 | 13.21 | 12.87 | 8.94 | 6.13 | 2.26 | 1.03 | 0.48 | 0.5 | 0.13 | 426 | 300 |
| WRS-2-6-No140 | 0.105 | 56.13 | 12.2 | 11.24 | 9.31 | 6.08 | 2.16 | 1.14 | 1.27 | 0.48 | 0.11 | 434 | 230 |
| WRS-2-6-No100 | 0.149 | 56.48 | 11.01 | 10.26 | 9.16 | 6.15 | 2.39 | 1.12 | 1.19 | 0.48 | 0.11 | 418 | 280 |
| WRS-2-6-No60 | 0.25 | 56.72 | 11.92 | 10.39 | 9.28 | 6.01 | 2.06 | 1.04 | 1.2 | 0.46 | 0.11 | 409 | 320 |
| WRS-2-6-No40 | 0.42 | 56.52 | 12.28 | 10.66 | 10.03 | 5.8 | 1.49 | 1.05 | 1.11 | 0.5 | 0.12 | 397 | 250 |
| WRS-2-6-No20 | 0.841 | 55.87 | 12.35 | 10.92 | 10.47 | 6.03 | 0.99 | 0.96 | 1.2 | 0.55 | 0.12 | 436 | 380 |
| WRS-2-6-No10 | 2 | 56.78 | 10.98 | 10.84 | 11.17 | 6.35 | 1.12 | 1 | 1.88 | 0.62 | 0.13 | 358 | 450 |
| WRS-2-6-No4 | 4.76 | 56.81 | 9.18 | 10.31 | 11.16 | 6.34 | 0.76 | 0.94 | 1.83 | 0.6 | 0.13 | 359 | 300 |
| WRS-2-6 Avg* | - | 56.46 | 9.84 | 10.57 | 10.93 | 6.27 | 0.94 | 0.95 | 1.7 | 0.59 | 0.13 | 366 | 307 |
| WRS-2-7-pan | 0.037 | 46.47 | 7.59 | 18.34 | 9.18 | 6.76 | 3.16 | 0.96 | 0.37 | 0.69 | 0.16 | 376 | 350 |
| WRS-2-7-No200 | 0.074 | 48.73 | 7.05 | 15.79 | 9.52 | 7.47 | 3.32 | 1.13 | 0.37 | 0.68 | 0.14 | 495 | 270 |
| WRS-2-7-No140 | 0.105 | 52.75 | 6.79 | 14.58 | 9.79 | 7.54 | 3.26 | 1.16 | 1.04 | 0.67 | 0.13 | 473 | 330 |
| WRS-2-7-No100 | 0.149 | 53.34 | 6.52 | 13.15 | 9.88 | 7.73 | 3.1 | 1.13 | 1.09 | 0.67 | 0.13 | 455 | 330 |
| WRS-2-7-No60 | 0.25 | 53.73 | 6.19 | 12.64 | 9.55 | 7.79 | 2.67 | 1.08 | 0.96 | 0.66 | 0.13 | 485 | 300 |
| WRS-2-7-No40 | 0.42 | 55.37 | 7.05 | 12.25 | 10.96 | 7.54 | 1.69 | 1.09 | 1.3 | 0.71 | 0.14 | 391 | 440 |
| WRS-2-7-No20 | 0.841 | 55.86 | 7.27 | 12.16 | 11.52 | 7.66 | 0.8 | 1.1 | 1.24 | 0.77 | 0.15 | 347 | 380 |
| WRS-2-7-No10 | 2 | 56.25 | 7.22 | 11.81 | 11.67 | 7.7 | 0.74 | 1.1 | 1.3 | 0.79 | 0.15 | 315 | 450 |
| WRS-2-7-No4 | 4.76 | 54.18 | 7.36 | 14.43 | 12.41 | 7.65 | 2.3 | 1.22 | 1.37 | 0.84 | 0.16 | 383 | 400 |
| WRS-2-7 Avg* | - | 54.14 | 7.34 | 14.36 | 12.28 | 7.64 | 2.27 | 1.21 | 1.35 | 0.83 | 0.16 | 382 | 398 |
| WRS-2-8-pan | 0.037 | 48.71 | 15.81 | 14.93 | 8.66 | 6.42 | 2.21 | 0.78 | 0.19 | 0.53 | 0.15 | 407 | 230 |
| WRS-2-8-No200 | 0.074 | 51.26 | 14.95 | 14.11 | 8.69 | 6.95 | 2.45 | 0.93 | 0.55 | 0.5 | 0.14 | 421 | 300 |
| WRS-2-8-No140 | 0.105 | 54.99 | 11.68 | 10.5 | 8.77 | 6.87 | 2.09 | 1.21 | 0.99 | 0.45 | 0.12 | 418 | 170 |
| WRS-2-8-No100 | 0.149 | 56.14 | 9.9 | 8.7 | 8.47 | 6.45 | 1.97 | 1.22 | 1.04 | 0.43 | 0.1 | 304 | 200 |
| WRS-2-8-No60 | 0.25 | 57.62 | 9.7 | 8.66 | 8.6 | 6.39 | 1.69 | 1.2 | 1.13 | 0.42 | 0.1 | 395 | 250 |
| WRS-2-8-No40 | 0.42 | 56.87 | 10.87 | 9.16 | 9.33 | 6.56 | 1.16 | 1.19 | 1.17 | 0.46 | 0.11 | 400 | 240 |
| WRS-2-8-No20 | 0.841 | 51.02 | 12.27 | 10.87 | 8.86 | 7.03 | 0.81 | 0.87 | 0.1 | 0.54 | 0.14 | 468 | 200 |
| WRS-2-8-No10 | 2 | 53.45 | 12.17 | 11.6 | 10.37 | 7.25 | 1.08 | 0.89 | 1.1 | 0.65 | 0.15 | 411 | 400 |
| WRS-2-8-No4 | 4.76 | 50.6 | 12.07 | 13.23 | 10.2 | 7.78 | 1.47 | 0.67 | 0.65 | 0.67 | 0.17 | 483 | 340 |
| WRS-2-8 Avg* | - | 53.4 | 12.15 | 11.3 | 9.1 | 6.85 | 1.65 | 0.99 | 0.76 | 0.51 | 0.13 | 411 | 258 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.12(Cont.): X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-6-pan | 0.037 | 798 | 479 | 134 | -9 | 835 | 165 | 29 | 6 | 106 | 660 | 140 |
| WRS-2-6-No200 | 0.074 | 879 | 380 | 123 | -2 | 797 | 178 | 33 | 8 | 116 | 693 | 120 |
| WRS-2-6-No140 | 0.105 | 824 | 263 | 107 | 7 | 818 | 193 | 37 | 9 | 119 | 755 | 100 |
| WRS-2-6-No100 | 0.149 | 737 | 220 | 91 | 10 | 736 | 195 | 34 | 10 | 115 | 778 | 100 |
| WRS-2-6-No60 | 0.25 | 639 | 217 | 85 | 6 | 833 | 188 | 34 | 10 | 123 | 777 | 100 |
| WRS-2-6-No40 | 0.42 | 622 | 200 | 90 | 2 | 814 | 186 | 35 | 10 | 139 | 770 | 110 |
| WRS-2-6-No20 | 0.841 | 442 | 185 | 84 | -1 | 746 | 173 | 31 | 10 | 132 | 744 | 120 |
| WRS-2-6-No10 | 2 | 660 | 165 | 88 | -1 | 577 | 185 | 35 | 10 | 143 | 744 | 120 |
| WRS-2-6-No4 | 4.76 | 195 | 109 | 62 | -2 | 396 | 171 | 35 | 10 | 157 | 762 | 130 |
| WRS-2-6 Avg* | - | 292 | 140 | 69 | -1 | 467 | 173 | 34 | 9 | 150 | 755 | 0.01 |
| WRS-2-7-pan | 0.037 | 649 | 155 | 112 | -9 | 290 | 148 | 36 | 0 | 164 | 582 | 120 |
| WRS-2-7-No200 | 0.074 | 750 | 110 | 91 | 6 | 290 | 155 | 43 | 5 | 163 | 624 | 110 |
| WRS-2-7-No140 | 0.105 | 700 | 93 | 77 | 14 | 347 | 173 | 46 | 7 | 160 | 652 | 100 |
| WRS-2-7-No100 | 0.149 | 588 | 85 | 68 | 10 | 270 | 176 | 43 | 8 | 152 | 686 | 100 |
| WRS-2-7-No60 | 0.25 | 468 | 74 | 63 | 15 | 332 | 172 | 40 | 8 | 152 | 692 | 100 |
| WRS-2-7-No40 | 0.42 | 411 | 68 | 68 | 4 | 262 | 168 | 39 | 9 | 187 | 702 | 110 |
| WRS-2-7-No20 | 0.841 | 314 | 58 | 69 | -1 | 246 | 159 | 42 | 9 | 195 | 698 | 120 |
| WRS-2-7-No10 | 2 | 492 | 49 | 66 | -5 | 209 | 168 | 44 | 9 | 199 | 697 | 110 |
| WRS-2-7-No4 | 4.76 | 673 | 64 | 68 | -12 | 199 | 147 | 49 | 6 | 198 | 628 | 110 |
| WRS-2-7 Avg* | - | 660 | 65 | 68 | -10 | 203 | 148 | 48 | 6 | 196 | 631 | 0.01 |
| WRS-2-8-pan | 0.037 | 896 | 482 | 118 | -18 | 877 | 163 | 24 | 5 | 122 | 620 | 110 |
| WRS-2-8-No200 | 0.074 | 896 | 395 | 104 | -5 | 928 | 188 | 30 | 7 | 140 | 659 | 120 |
| WRS-2-8-No140 | 0.105 | 811 | 223 | 77 | 18 | 751 | 229 | 38 | 10 | 109 | 755 | 100 |
| WRS-2-8-No100 | 0.149 | 636 | 177 | 65 | 12 | 633 | 237 | 38 | 11 | 111 | 813 | 90 |
| WRS-2-8-No60 | 0.25 | 493 | 167 | 59 | 10 | 676 | 241 | 41 | 11 | 121 | 818 | 100 |
| WRS-2-8-No40 | 0.42 | 452 | 182 | 65 | 8 | 697 | 234 | 35 | 11 | 132 | 805 | 100 |
| WRS-2-8-No20 | 0.841 | 595 | 202 | 75 | -4 | 764 | 218 | 29 | 10 | 164 | 716 | 100 |
| WRS-2-8-No10 | 2 | 584 | 195 | 78 | -1 | 618 | 255 | 31 | 9 | 178 | 720 | 110 |
| WRS-2-8-No4 | 4.76 | 501 | 195 | 78 | -8 | 563 | 232 | 25 | 8 | 191 | 663 | 100 |
| WRS-2-8 Avg* | - | 651 | 246 | 80 | 1 | 722 | 221 | 32 | 9 | 140 | 729 | 103 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.12: X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-9-pan | 0.037 | 53.38 | 6.05 | 9.75 | 9.45 | 7.72 | 1.7 | 1.52 | 1.22 | 0.54 | 0.1 | 407 | 440 |
| WRS-2-9-No200 | 0.074 | 61.55 | 4.8 | 7.51 | 10.08 | 5.97 | 1.31 | 1.79 | 2.18 | 0.44 | 0.08 | 250 | 440 |
| WRS-2-9-No140 | 0.105 | 61.59 | 4.16 | 6.64 | 9.58 | 5.42 | 1.26 | 1.76 | 2.01 | 0.38 | 0.07 | 137 | 350 |
| WRS-2-9-No100 | 0.149 | 64.86 | 4.06 | 6.41 | 9.62 | 5.16 | 1.17 | 1.61 | 2.28 | 0.39 | 0.07 | 227 | 210 |
| WRS-2-9-No60 | 0.25 | 62.3 | 4.46 | 6.84 | 9.38 | 5.62 | 1.03 | 1.49 | 1.94 | 0.42 | 0.07 | 328 | 330 |
| WRS-2-9-No40 | 0.42 | 62.35 | 5.02 | 7.68 | 10.37 | 6.25 | 0.77 | 1.44 | 2.21 | 0.48 | 0.09 | 303 | 320 |
| WRS-2-9-No20 | 0.841 | 58.35 | 6.64 | 9.69 | 11.37 | 7.63 | 0.73 | 1.25 | 1.88 | 0.6 | 0.12 | 394 | 350 |
| WRS-2-9-No10 | 2 | 58.21 | 7.2 | 10.73 | 11.75 | 8.13 | 1.29 | 1.09 | 2.14 | 0.64 | 0.13 | 440 | 410 |
| WRS-2-9-No4 | 4.76 | 57.17 | 7.11 | 12.14 | 12.67 | 7.03 | 1.13 | 1.07 | 1.7 | 0.77 | 0.15 | 319 | 360 |
| WRS-2-9 Avg* | - | 57.39 | 6.95 | 11.76 | 12.42 | 7.02 | 1.14 | 1.11 | 1.73 | 0.74 | 0.15 | 322 | 361 |
| WRS-2-10-pan | 0.037 | 49.58 | 14.36 | 15.69 | 7.79 | 4.95 | 3.67 | 0.95 | 0.39 | 0.47 | 0.1 | 424 | 360 |
| WRS-2-10-No200 | 0.074 | 49.13 | 12.45 | 13.55 | 7.62 | 4.45 | 3.29 | 1.06 | 0.17 | 0.43 | 0.09 | 404 | 230 |
| WRS-2-10-No100 | 0.149 | 50.49 | 13.73 | 12.42 | 7.81 | 3.97 | 3.04 | 0.99 | 0.25 | 0.4 | 0.08 | 324 | 260 |
| WRS-2-10-No60 | 0.25 | 52.5 | 15.06 | 12.23 | 8.04 | 4.23 | 2.72 | 0.91 | 0.54 | 0.39 | 0.09 | 329 | 230 |
| WRS-2-10-No40 | 0.42 | 50.73 | 17.3 | 12.45 | 7.93 | 3.92 | 1.79 | 0.74 | -0.09 | 0.4 | 0.11 | 311 | 280 |
| WRS-2-10-No20 | 0.841 | 51.57 | 19.38 | 12.07 | 8.49 | 3.9 | 0.89 | 0.61 | -0.12 | 0.43 | 0.12 | 327 | 260 |
| WRS-2-10-No10 | 2 | 53.21 | 19.32 | 11.38 | 9.26 | 4.27 | 0.69 | 0.58 | 0.31 | 0.48 | 0.12 | 345 | 340 |
| WRS-2-10-No4 | 4.76 | 56.88 | 22.07 | 11.28 | 8.76 | 4.32 | 0.97 | 0.54 | 0.59 | 0.41 | 0.13 | 337 | 220 |
| WRS-2-10 Avg* | - | 55.91 | 21.04 | 11.51 | 8.68 | 4.3 | 1.14 | 0.58 | 0.52 | 0.41 | 0.12 | 339 | 232 |
| WRS-2-11-pan | 0.037 | 49.56 | 7.92 | 21.45 | 10.6 | 7.14 | 3.36 | 0.95 | 0.86 | 0.8 | 0.18 | 451 | 300 |
| WRS-2-11-No200 | 0.074 | 47.8 | 7.38 | 18.75 | 9.96 | 8.01 | 2.9 | 1.04 | 0.48 | 0.78 | 0.18 | 445 | 310 |
| WRS-2-11-No140 | 0.105 | 45.26 | 6.25 | 15.47 | 9.01 | 8.71 | 2.32 | 1.09 | -0.08 | 0.79 | 0.16 | 468 | 290 |
| WRS-2-11-No100 | 0.149 | 49.8 | 6.57 | 13.87 | 9.92 | 8.73 | 2.36 | 1.13 | 0.53 | 0.8 | 0.15 | 445 | 270 |
| WRS-2-11-No60 | 0.25 | 44.05 | 5.8 | 13.11 | 8.11 | 8.61 | 2.07 | 0.97 | -0.42 | 0.78 | 0.16 | 430 | 280 |
| WRS-2-11-No40 | 0.42 | 48.39 | 6.12 | 12.76 | 9.24 | 8.01 | 1.12 | 1.04 | 0.1 | 0.85 | 0.16 | 371 | 390 |
| WRS-2-11-No20 | 0.841 | 47.7 | 6.18 | 12.98 | 9.17 | 8.18 | 0.91 | 1.02 | 0.01 | 0.84 | 0.17 | 371 | 360 |
| WRS-2-11-No10 | 2 | 50.82 | 6.58 | 13.19 | 10 | 7.93 | 1.12 | 0.99 | 0.51 | 0.84 | 0.17 | 372 | 370 |
| WRS-2-11-No4 | 4.76 | 55.77 | 7.75 | 13.12 | 12.45 | 7.72 | 1.02 | 1.04 | 1.45 | 0.91 | 0.17 | 352 | 480 |
| WRS-2-11 Avg* | - | 54.1 | 7.46 | 13.42 | 11.76 | 7.79 | 1.15 | 1.03 | 1.17 | 0.89 | 0.17 | 362 | 447 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.12(Cont.): X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-9-pan | 0.037 | 468 | 101 | 83 | 15 | 177 | 270 | 45 | 10 | 110 | 786 | 220 |
| WRS-2-9-No200 | 0.074 | 445 | 73 | 58 | 11 | 250 | 287 | 47 | 11 | 95 | 857 | 130 |
| WRS-2-9-No140 | 0.105 | 403 | 65 | 52 | 14 | 222 | 286 | 46 | 12 | 96 | 884 | 110 |
| WRS-2-9-No100 | 0.149 | 378 | 58 | 45 | 14 | 208 | 272 | 45 | 12 | 87 | 910 | 100 |
| WRS-2-9-No60 | 0.25 | 328 | 58 | 46 | 10 | 319 | 256 | 43 | 12 | 90 | 879 | 110 |
| WRS-2-9-No40 | 0.42 | 403 | 66 | 49 | 12 | 251 | 250 | 43 | 12 | 117 | 846 | 110 |
| WRS-2-9-No20 | 0.841 | 407 | 71 | 61 | 6 | 317 | 220 | 39 | 11 | 147 | 768 | 110 |
| WRS-2-9-No10 | 2 | 309 | 81 | 59 | 7 | 264 | 213 | 35 | 10 | 159 | 726 | 120 |
| WRS-2-9-No4 | 4.76 | 698 | 63 | 83 | -3 | 201 | 154 | 38 | 9 | 199 | 696 | 110 |
| WRS-2-9 Avg* | - | 663 | 64 | 80 | -1 | 206 | 164 | 38 | 9 | 190 | 709 | 0.01 |
| WRS-2-10-pan | 0.037 | 784 | 354 | 88 | -5 | 1115 | 186 | 31 | 4 | 84 | 664 | 150 |
| WRS-2-10-No200 | 0.074 | 837 | 285 | 77 | 2 | 1025 | 206 | 34 | 7 | 83 | 720 | 110 |
| WRS-2-10-No100 | 0.149 | 664 | 261 | 69 | 3 | 1040 | 205 | 36 | 8 | 91 | 766 | 100 |
| WRS-2-10-No60 | 0.25 | 563 | 243 | 75 | 1 | 1195 | 190 | 29 | 9 | 95 | 764 | 110 |
| WRS-2-10-No40 | 0.42 | 488 | 246 | 80 | -7 | 1400 | 171 | 28 | 8 | 101 | 743 | 110 |
| WRS-2-10-No20 | 0.841 | 490 | 235 | 84 | -14 | 1477 | 147 | 19 | 9 | 106 | 751 | 110 |
| WRS-2-10-No10 | 2 | 363 | 225 | 87 | -12 | 1444 | 159 | 21 | 10 | 109 | 753 | 120 |
| WRS-2-10-No4 | 4.76 | 529 | 302 | 94 | -5 | 1763 | 122 | 17 | 10 | 100 | 769 | 110 |
| WRS-2-10 Avg* | - | 533 | 294 | 91 | -5 | 1681 | 131 | 18 | 10 | 99 | 763 | 0.01 |
| WRS-2-11-pan | 0.037 | 949 | 103 | 138 | -21 | 177 | 126 | 40 | -5 | 189 | 505 | 100 |
| WRS-2-11-No200 | 0.074 | 886 | 93 | 117 | 6 | 190 | 134 | 43 | 1 | 213 | 557 | 110 |
| WRS-2-11-No140 | 0.105 | 720 | 58 | 122 | 17 | 159 | 147 | 45 | 5 | 198 | 615 | 100 |
| WRS-2-11-No100 | 0.149 | 665 | 50 | 79 | 24 | 144 | 149 | 46 | 7 | 204 | 647 | 100 |
| WRS-2-11-No60 | 0.25 | 478 | 46 | 74 | 9 | 160 | 148 | 46 | 8 | 234 | 672 | 100 |
| WRS-2-11-No40 | 0.42 | 400 | 38 | 74 | 3 | 150 | 148 | 46 | 8 | 231 | 672 | 110 |
| WRS-2-11-No20 | 0.841 | 339 | 40 | 70 | 2 | 165 | 147 | 42 | 9 | 241 | 672 | 110 |
| WRS-2-11-No10 | 2 | 295 | 41 | 69 | -5 | 164 | 140 | 45 | 7 | 243 | 657 | 100 |
| WRS-2-11-No4 | 4.76 | 456 | 47 | 75 | -7 | 224 | 176 | 39 | 8 | 257 | 663 | 120 |
| WRS-2-11 Avg* | - | 456 | 47 | 76 | -5 | 209 | 167 | 40 | 7 | 250 | 657 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.12: X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-13-pan | 0.037 | 49.32 | 21.9 | 16.57 | 8.25 | 5.3 | 2.97 | 0.41 | 0.07 | 0.43 | 0.14 | 405 | 190 |
| WRS-2-13-No200 | 0.074 | 50.21 | 21.47 | 16.63 | 7.85 | 6.23 | 3.64 | 0.44 | 0.21 | 0.45 | 0.14 | 389 | 150 |
| WRS-2-13-No140 | 0.105 | 51.31 | 20.94 | 14.41 | 7.57 | 7.01 | 3.3 | 0.48 | 0.29 | 0.47 | 0.14 | 409 | 110 |
| WRS-2-13-No60 | 0.25 | 51.83 | 20.25 | 13.17 | 7.8 | 6.93 | 3.18 | 0.5 | 0.08 | 0.48 | 0.13 | 427 | 160 |
| WRS-2-13-No40 | 0.42 | 53.38 | 20.62 | 12.41 | 8.73 | 5.06 | 1.63 | 0.52 | 0.15 | 0.45 | 0.13 | 383 | 200 |
| WRS-2-13-No20 | 0.841 | 53.98 | 18.3 | 11.67 | 8.68 | 4.89 | 1.14 | 0.59 | 0.25 | 0.46 | 0.13 | 383 | 190 |
| WRS-2-13-No10 | 2 | 54.7 | 16.47 | 11.76 | 10.02 | 5.21 | 1.35 | 0.79 | 0.83 | 0.51 | 0.13 | 347 | 360 |
| WRS-2-13-No4 | 4.76 | 56 | 13 | 10.11 | 10.5 | 5.17 | 0.82 | 0.97 | 0.88 | 0.56 | 0.12 | 333 | 360 |
| WRS-2-13 Avg* | - | 55.54 | 13.86 | 10.56 | 10.26 | 5.24 | 1.01 | 0.92 | 0.81 | 0.55 | 0.12 | 339 | 341 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.12(Cont.): X-Ray Fluorescence Data for WRS#2 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WRS-2-13-pan | 0.037 | 951 | 821 | 147 | -25 | 1518 | 104 | 16 | 3 | 110 | 611 | 90 |
| WRS-2-13-No200 | 0.074 | 1111 | 756 | 132 | -15 | 1512 | 107 | 14 | 4 | 104 | 612 | 90 |
| WRS-2-13-No140 | 0.105 | 1041 | 512 | 120 | -2 | 1519 | 117 | 17 | 7 | 125 | 663 | 90 |
| WRS-2-13-No60 | 0.25 | 908 | 419 | 113 | 1 | 1575 | 128 | 17 | 8 | 125 | 700 | 90 |
| WRS-2-13-No40 | 0.42 | 679 | 369 | 100 | -5 | 1602 | 136 | 17 | 9 | 116 | 734 | 100 |
| WRS-2-13-No20 | 0.841 | 440 | 330 | 91 | -9 | 1392 | 148 | 19 | 10 | 116 | 734 | 100 |
| WRS-2-13-No10 | 2 | 441 | 308 | 83 | -8 | 1087 | 174 | 27 | 9 | 122 | 732 | 110 |
| WRS-2-13-No4 | 4.76 | 277 | 233 | 62 | 0 | 696 | 172 | 32 | 10 | 131 | 785 | 120 |
| WRS-2-13 Avg* | - | 337 | 264 | 68 | -1 | 790 | 167 | 30 | 10 | 129 | 772 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S3-pan | 0.037 | 55.16 | 16.07 | 11.67 | 8.81 | 4.87 | 1.14 | 0.95 | 0.9 | 0.46 | 0.13 | 308 | 290 |
| TP-P2-S3-No200 | 0.074 | 59 | 15.71 | 9.64 | 8.86 | 4.79 | 0.87 | 1.09 | 1.27 | 0.41 | 0.12 | 317 | 200 |
| TP-P2-S3-No140 | 0.105 | 61.37 | 13.3 | 8.03 | 8.89 | 4.32 | 0.61 | 1.22 | 1.54 | 0.37 | 0.1 | 298 | 160 |
| TP-P2-S3-No100 | 0.149 | 64.02 | 12.87 | 7.31 | 8.94 | 4.03 | 0.53 | 1.2 | 1.77 | 0.35 | 0.09 | 267 | 190 |
| TP-P2-S3-No60 | 0.25 | 61.06 | 14.24 | 7.32 | 8.82 | 4.28 | 0.48 | 1.11 | 1.35 | 0.33 | 0.09 | 298 | 240 |
| TP-P2-S3-No40 | 0.42 | 62.75 | 14.85 | 7.95 | 9.62 | 4.52 | 0.47 | 1.12 | 1.66 | 0.39 | 0.1 | 323 | 250 |
| TP-P2-S3-No20 | 0.841 | 58.54 | 19.4 | 9.76 | 9.76 | 5.84 | 0.46 | 0.82 | 1.17 | 0.45 | 0.13 | 406 | 280 |
| TP-P2-S3-No10 | 2 | 56.71 | 21 | 11.56 | 9.54 | 6.37 | 0.79 | 0.59 | 0.78 | 0.52 | 0.16 | 413 | 250 |
| TP-P2-S3-No4 | 4.76 | 53.32 | 24 | 14.95 | 9.16 | 6.68 | 1.86 | 0.44 | 0.51 | 0.51 | 0.17 | 364 | 220 |
| TP-P2-S3 Avg* | - | 54.23 | 22.9 | 14.14 | 9.17 | 6.44 | 1.69 | 0.52 | 0.62 | 0.5 | 0.17 | 360 | 223 |
| TP-P2-S5-pan | 0.037 | 54.44 | 5.58 | 8.46 | 9.04 | 7.09 | 0.91 | 1.64 | 1.13 | 0.51 | 0.09 | 291 | 360 |
| TP-P2-S5-No200 | 0.074 | 59.24 | 4.27 | 6.18 | 9.07 | 5.67 | 0.55 | 1.93 | 1.48 | 0.35 | 0.07 | 186 | 420 |
| TP-P2-S5-No140 | 0.105 | 66.73 | 3.32 | 5.42 | 9.73 | 4.55 | 0.42 | 1.92 | 2.45 | 0.26 | 0.06 | 110 | 310 |
| TP-P2-S5-No100 | 0.149 | 68.45 | 3.4 | 5.55 | 9.32 | 4.22 | 0.42 | 1.67 | 2.48 | 0.26 | 0.06 | 106 | 200 |
| TP-P2-S5-No60 | 0.25 | 60.79 | 3.67 | 5.79 | 8.27 | 5.2 | 0.41 | 1.56 | 1.39 | 0.34 | 0.06 | 238 | 190 |
| TP-P2-S5-No40 | 0.42 | 62.72 | 5.19 | 7.55 | 10.64 | 6.65 | 0.5 | 1.49 | 2.36 | 0.45 | 0.09 | 310 | 340 |
| TP-P2-S5-No20 | 0.841 | 57.01 | 6.96 | 10.33 | 11.24 | 8.14 | 0.76 | 1.19 | 1.66 | 0.6 | 0.13 | 401 | 350 |
| TP-P2-S5-No10 | 2 | 58.51 | 7.48 | 11.39 | 12.17 | 8.11 | 1.03 | 0.96 | 1.88 | 0.68 | 0.14 | 428 | 300 |
| TP-P2-S5-No4 | 4.76 | 56.19 | 7.42 | 12 | 12.54 | 7.88 | 0.94 | 1.09 | 1.48 | 0.79 | 0.15 | 345 | 440 |
| TP-P2-S5 Avg* | - | 57.54 | 6.61 | 10.53 | 11.61 | 7.34 | 0.84 | 1.25 | 1.58 | 0.67 | 0.13 | 316 | 398 |
| TP-P2-S7-pan | 0.037 | 51.46 | 9.04 | 14.65 | 9.7 | 7.42 | 3.55 | 1.18 | 1 | 0.6 | 0.14 | 475 | 280 |
| TP-P2-S7-No200 | 0.074 | 54.77 | 8.47 | 12.26 | 9.71 | 7.29 | 3.42 | 1.38 | 1.33 | 0.52 | 0.12 | 450 | 260 |
| TP-P2-S7-No140 | 0.105 | 57.64 | 6.35 | 9.35 | 9.13 | 6.25 | 2.41 | 1.56 | 1.29 | 0.45 | 0.1 | 340 | 230 |
| TP-P2-S7-No100 | 0.149 | 63.21 | 5.1 | 7.5 | 9.02 | 5.48 | 1.8 | 1.54 | 1.85 | 0.39 | 0.08 | 222 | 220 |
| TP-P2-S7-No60 | 0.25 | 60.62 | 5.32 | 7.33 | 8.73 | 5.82 | 1.29 | 1.47 | 1.48 | 0.39 | 0.08 | 296 | 200 |
| TP-P2-S7-No40 | 0.42 | 61.13 | 6.17 | 8.52 | 9.95 | 6.93 | 1.17 | 1.41 | 1.79 | 0.47 | 0.1 | 316 | 260 |
| TP-P2-S7-No20 | 0.841 | 56.62 | 7.78 | 10.24 | 10.74 | 8.32 | 1 | 1.29 | 1.43 | 0.59 | 0.13 | 396 | 300 |
| TP-P2-S7-No10 | 2 | 57.34 | 8.29 | 12.09 | 11.27 | 8.08 | 2.16 | 1.07 | 1.62 | 0.64 | 0.14 | 427 | 260 |
| TP-P2-S7-No4 | 4.76 | 55.92 | 7.6 | 10.91 | 12.06 | 8.99 | 0.91 | 1.1 | 1.75 | 0.68 | 0.15 | 427 | 340 |
| TP-P2-S7 Avg* | - | 56.23 | 7.53 | 10.83 | 11.71 | 8.67 | 1.1 | 1.13 | 1.71 | 0.66 | 0.14 | 417 | 325 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S3-pan | 0.037 | 631 | 530 | 96 | -7 | 856 | 210 | 32 | 8 | 98 | 734 | 150 |
| TP-P2-S3-No200 | 0.074 | 642 | 383 | 81 | 2 | 1002 | 233 | 30 | 10 | 102 | 800 | 130 |
| TP-P2-S3-No140 | 0.105 | 561 | 266 | 72 | 5 | 895 | 243 | 34 | 12 | 84 | 857 | 100 |
| TP-P2-S3-No100 | 0.149 | 473 | 241 | 63 | 3 | 842 | 244 | 36 | 12 | 98 | 893 | 90 |
| TP-P2-S3-No60 | 0.25 | 398 | 236 | 60 | 3 | 879 | 241 | 35 | 12 | 97 | 893 | 100 |
| TP-P2-S3-No40 | 0.42 | 404 | 260 | 70 | 4 | 1027 | 237 | 34 | 12 | 96 | 876 | 110 |
| TP-P2-S3-No20 | 0.841 | 384 | 305 | 83 | -1 | 1323 | 199 | 26 | 10 | 131 | 801 | 100 |
| TP-P2-S3-No10 | 2 | 473 | 420 | 92 | -9 | 1468 | 167 | 17 | 9 | 151 | 742 | 90 |
| TP-P2-S3-No4 | 4.76 | 363 | 431 | 119 | -19 | 2016 | 121 | 17 | 6 | 128 | 624 | 90 |
| TP-P2-S3 Avg* | - | 380 | 417 | 113 | -16 | 1878 | 134 | 19 | 6 | 125 | 652 | 0 |
| TP-P2-S5-pan | 0.037 | 511 | 99 | 76 | 16 | 155 | 286 | 48 | 11 | 104 | 830 | 220 |
| TP-P2-S5-No200 | 0.074 | 422 | 63 | 49 | 14 | 170 | 298 | 50 | 12 | 80 | 910 | 130 |
| TP-P2-S5-No140 | 0.105 | 371 | 52 | 36 | 5 | 208 | 294 | 50 | 12 | 70 | 950 | 90 |
| TP-P2-S5-No100 | 0.149 | 346 | 47 | 37 | 8 | 247 | 268 | 46 | 13 | 75 | 946 | 80 |
| TP-P2-S5-No60 | 0.25 | 314 | 46 | 37 | 10 | 269 | 255 | 46 | 12 | 98 | 935 | 90 |
| TP-P2-S5-No40 | 0.42 | 419 | 61 | 49 | 12 | 243 | 236 | 45 | 12 | 113 | 844 | 100 |
| TP-P2-S5-No20 | 0.841 | 837 | 75 | 68 | 10 | 294 | 190 | 40 | 11 | 168 | 747 | 110 |
| TP-P2-S5-No10 | 2 | 472 | 78 | 71 | 0 | 224 | 167 | 33 | 10 | 177 | 713 | 110 |
| TP-P2-S5-No4 | 4.76 | 387 | 84 | 68 | 1 | 182 | 184 | 37 | 9 | 195 | 693 | 120 |
| TP-P2-S5 Avg* | - | 407 | 79 | 64 | 3 | 192 | 207 | 39 | 9 | 165 | 748 | 0.01 |
| TP-P2-S7-pan | 0.037 | 1341 | 188 | 177 | 3 | 368 | 171 | 32 | 0 | 146 | 640 | 140 |
| TP-P2-S7-No200 | 0.074 | 1329 | 144 | 139 | 13 | 339 | 199 | 39 | 5 | 128 | 698 | 110 |
| TP-P2-S7-No140 | 0.105 | 1011 | 95 | 100 | 13 | 315 | 223 | 41 | 9 | 132 | 772 | 100 |
| TP-P2-S7-No100 | 0.149 | 744 | 71 | 78 | 12 | 272 | 230 | 42 | 10 | 103 | 850 | 80 |
| TP-P2-S7-No60 | 0.25 | 622 | 66 | 77 | 10 | 248 | 226 | 43 | 10 | 92 | 858 | 80 |
| TP-P2-S7-No40 | 0.42 | 653 | 74 | 78 | 13 | 282 | 210 | 42 | 11 | 127 | 809 | 90 |
| TP-P2-S7-No20 | 0.841 | 630 | 83 | 90 | 8 | 286 | 187 | 38 | 2 | 156 | 745 | 100 |
| TP-P2-S7-No10 | 2 | 856 | 95 | 113 | -2 | 272 | 155 | 34 | 7 | 168 | 691 | 90 |
| TP-P2-S7-No4 | 4.76 | 502 | 66 | 92 | 6 | 199 | 175 | 39 | 10 | 181 | 727 | 110 |
| TP-P2-S7 Avg* | - | 564 | 72 | 94 | 6 | 214 | 178 | 39 | 9 | 173 | 731 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S8-S2-pan | 0.037 | 51.71 | 16.06 | 13.96 | 8.89 | 6.33 | 1.83 | 0.83 | 0.54 | 0.56 | 0.14 | 404 | 230 |
| TP-P2-S8-S2-No200 | 0.074 | 53.07 | 16.36 | 12.57 | 9.16 | 6.39 | 1.77 | 0.92 | 0.83 | 0.51 | 0.14 | 393 | 240 |
| TP-P2-S8-S2-No140 | 0.105 | 53.01 | 14.18 | 10.46 | 8.86 | 6.49 | 1.71 | 1.05 | 0.81 | 0.5 | 0.12 | 533 | 280 |
| TP-P2-S8-S2-No100 | 0.149 | 52.58 | 12.46 | 9.1 | 8.06 | 6.04 | 1.44 | 1.05 | 0.56 | 0.46 | 0.11 | 385 | 240 |
| TP-P2-S8-S2-No60 | 0.25 | 55.01 | 13.81 | 9.26 | 8.86 | 6.05 | 1.16 | 1.03 | 0.85 | 0.47 | 0.11 | 357 | 220 |
| TP-P2-S8-S2-No40 | 0.42 | 52.31 | 13.29 | 10.02 | 8.69 | 6.43 | 0.75 | 0.93 | 0.51 | 0.5 | 0.13 | 420 | 230 |
| TP-P2-S8-S2-No20 | 0.841 | 55.38 | 14.07 | 11.53 | 10.4 | 6.9 | 0.79 | 0.94 | 1.02 | 0.64 | 0.15 | 386 | 350 |
| TP-P2-S8-S2-No10 | 2 | 56.62 | 14.7 | 11.69 | 10.74 | 6.97 | 0.84 | 0.77 | 1.37 | 0.64 | 0.15 | 423 | 340 |
| TP-P2-S8-S2-No4 | 4.76 | 56.39 | 13.06 | 12.8 | 10.73 | 6.52 | 1.33 | 0.78 | 1.65 | 0.76 | 0.16 | 411 | 390 |
| TP-P2-S8-S2 Avg* | - | 54.01 | 14.22 | 11.26 | 9.38 | 6.46 | 1.29 | 0.92 | 0.9 | 0.56 | 0.13 | 412 | 280 |
| TP-P2-S10-S2-pan | 0.037 | 50.06 | 8.19 | 13.42 | 9.7 | 8.39 | 2.11 | 1.14 | 0.71 | 0.61 | 0.14 | 440 | 300 |
| TP-P2-S10-S2-No200 | 0.074 | 53.82 | 7.87 | 12.48 | 10.2 | 7.92 | 1.99 | 1.26 | 1.12 | 0.59 | 0.13 | 367 | 280 |
| TP-P2-S10-S2-No140 | 0.105 | 55.51 | 6.45 | 10.67 | 9.73 | 6.86 | 1.54 | 1.38 | 1.24 | 0.52 | 0.11 | 314 | 230 |
| TP-P2-S10-S2-No100 | 0.149 | 60.06 | 5.62 | 9.4 | 9.83 | 6.13 | 1.26 | 1.39 | 1.52 | 0.48 | 0.1 | 243 | 250 |
| TP-P2-S10-S2-No60 | 0.25 | 57.83 | 5.34 | 8.79 | 9.22 | 6.1 | 0.96 | 1.34 | 1.24 | 0.46 | 0.1 | 248 | 260 |
| TP-P2-S10-S2-No40 | 0.42 | 59.33 | 6.3 | 9.48 | 10.79 | 7.26 | 0.9 | 1.28 | 1.75 | 0.54 | 0.11 | 343 | 340 |
| TP-P2-S10-S2-No20 | 0.841 | 54.98 | 7.44 | 10.93 | 11.35 | 8.58 | 0.79 | 1.1 | 1.39 | 0.63 | 0.14 | 382 | 320 |
| TP-P2-S10-S2-No10 | 2 | 54.21 | 8.2 | 12.33 | 11.66 | 8.91 | 1.02 | 0.87 | 1.47 | 0.69 | 0.17 | 446 | 290 |
| TP-P2-S10-S2-No4 | 4.76 | 52.51 | 5.93 | 13.35 | 10.27 | 8.42 | 2.93 | 0.95 | 1.29 | 0.66 | 0.14 | 535 | 280 |
| TP-P2-S10-S2 Avg* | - | 53.52 | 6.33 | 12.6 | 10.37 | 8.21 | 2.36 | 1.02 | 1.31 | 0.64 | 0.14 | 478 | 283 |
| TP-P2-S11-S2-pan | 0.037 | 48.26 | 6.01 | 17.25 | 8.39 | 6.72 | 4.08 | 1.09 | 0.51 | 0.56 | 0.11 | 455 | 390 |
| TP-P2-S11-S2-No200 | 0.074 | 46.9 | 5.62 | 14.8 | 7.98 | 7.27 | 4.93 | 1.12 | 0.51 | 0.5 | 0.11 | 586 | 240 |
| TP-P2-S11-S2-No140 | 0.105 | 45.68 | 5.38 | 14.38 | 7.45 | 7.75 | 5.4 | 1.02 | 0.26 | 0.5 | 0.11 | 670 | 250 |
| TP-P2-S11-S2-No100 | 0.149 | 49.54 | 5.48 | 13.09 | 7.9 | 8.43 | 5.59 | 0.98 | 0.82 | 0.48 | 0.11 | 612 | 340 |
| TP-P2-S11-S2-No60 | 0.25 | 44.36 | 5.07 | 12.42 | 6.63 | 9.68 | 6.4 | 0.84 | 0.2 | 0.46 | 0.11 | 639 | 340 |
| TP-P2-S11-S2-No40 | 0.42 | 51.37 | 6.82 | 12.47 | 8.83 | 6.98 | 2.45 | 0.85 | 0.45 | 0.55 | 0.13 | 372 | 270 |
| TP-P2-S11-S2-No20 | 0.841 | 49.89 | 7.39 | 12.81 | 9.08 | 7.01 | 1.46 | 0.7 | 0.16 | 0.62 | 0.15 | 360 | 280 |
| TP-P2-S11-S2-No10 | 2 | 53.7 | 7.29 | 12.69 | 10.01 | 7.24 | 1.58 | 0.67 | 0.78 | 0.65 | 0.16 | 407 | 290 |
| TP-P2-S11-S2-No4 | 4.76 | 56.93 | 8.1 | 13.82 | 10.04 | 7.8 | 2.04 | 0.57 | 0.86 | 0.64 | 0.17 | 387 | 200 |
| TP-P2-S11-S2 Avg* | - | 55.21 | 7.72 | 13.71 | 9.74 | 7.69 | 2.27 | 0.63 | 0.77 | 0.63 | 0.16 | 403 | 226 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S8-S2-pan | 0.037 | 531 | 444 | 109 | -6 | 859 | 155 | 27 | 7 | 159 | 653 | 130 |
| TP-P2-S8-S2-No200 | 0.074 | 530 | 358 | 101 | -5 | 875 | 179 | 35 | 7 | 147 | 710 | 120 |
| TP-P2-S8-S2-No140 | 0.105 | 464 | 261 | 87 | 6 | 819 | 211 | 38 | 10 | 116 | 779 | 100 |
| TP-P2-S8-S2-No100 | 0.149 | 346 | 234 | 78 | 9 | 767 | 215 | 35 | 11 | 116 | 816 | 100 |
| TP-P2-S8-S2-No60 | 0.25 | 340 | 211 | 73 | 4 | 815 | 204 | 35 | 11 | 121 | 815 | 100 |
| TP-P2-S8-S2-No40 | 0.42 | 319 | 208 | 76 | 3 | 830 | 189 | 33 | 11 | 138 | 778 | 100 |
| TP-P2-S8-S2-No20 | 0.841 | 301 | 198 | 75 | -5 | 798 | 172 | 30 | 9 | 168 | 736 | 110 |
| TP-P2-S8-S2-No10 | 2 | 250 | 217 | 74 | -6 | 752 | 169 | 25 | 9 | 176 | 720 | 120 |
| TP-P2-S8-S2-No4 | 4.76 | 233 | 218 | 71 | -3 | 725 | 193 | 27 | 9 | 175 | 702 | 100 |
| TP-P2-S8-S2 Avg* | - | 368 | 260 | 82 | 0 | 804 | 187 | 31 | 9 | 146 | 745 | 0.01 |
| TP-P2-S10-S2-pan | 0.037 | 857 | 150 | 110 | 9 | 319 | 188 | 36 | 1 | 154 | 666 | 140 |
| TP-P2-S10-S2-No200 | 0.074 | 932 | 131 | 99 | 6 | 269 | 200 | 37 | 2 | 144 | 698 | 130 |
| TP-P2-S10-S2-No140 | 0.105 | 869 | 110 | 85 | 9 | 257 | 214 | 42 | 5 | 128 | 745 | 100 |
| TP-P2-S10-S2-No100 | 0.149 | 732 | 91 | 77 | 3 | 255 | 217 | 42 | 6 | 121 | 779 | 90 |
| TP-P2-S10-S2-No60 | 0.25 | 572 | 78 | 64 | 4 | 309 | 209 | 41 | 7 | 128 | 807 | 90 |
| TP-P2-S10-S2-No40 | 0.42 | 545 | 79 | 74 | 6 | 261 | 202 | 42 | 4 | 141 | 776 | 100 |
| TP-P2-S10-S2-No20 | 0.841 | 515 | 83 | 80 | 2 | 278 | 177 | 37 | 0 | 188 | 715 | 90 |
| TP-P2-S10-S2-No10 | 2 | 406 | 92 | 82 | -2 | 256 | 151 | 29 | 9 | 182 | 687 | 100 |
| TP-P2-S10-S2-No4 | 4.76 | 753 | 79 | 63 | -9 | 179 | 146 | 35 | 8 | 177 | 639 | 90 |
| TP-P2-S10-S2 Avg* | - | 709 | 86 | 69 | -5 | 210 | 159 | 35 | 6 | 169 | 668 | 0 |
| TP-P2-S11-S2-pan | 0.037 | 978 | 83 | 80 | 0 | 215 | 193 | 32 | 3 | 105 | 632 | 150 |
| TP-P2-S11-S2-No200 | 0.074 | 1175 | 78 | 67 | 5 | 236 | 212 | 42 | 5 | 123 | 693 | 120 |
| TP-P2-S11-S2-No140 | 0.105 | 1116 | 78 | 67 | 21 | 238 | 201 | 37 | 7 | 121 | 695 | 100 |
| TP-P2-S11-S2-No100 | 0.149 | 1089 | 63 | 65 | 19 | 228 | 196 | 36 | 8 | 129 | 716 | 100 |
| TP-P2-S11-S2-No60 | 0.25 | 781 | 60 | 58 | 31 | 217 | 195 | 34 | 9 | 134 | 742 | 90 |
| TP-P2-S11-S2-No40 | 0.42 | 709 | 61 | 64 | 2 | 256 | 169 | 31 | 8 | 153 | 730 | 100 |
| TP-P2-S11-S2-No20 | 0.841 | 656 | 66 | 74 | -5 | 269 | 144 | 25 | 8 | 174 | 693 | 100 |
| TP-P2-S11-S2-No10 | 2 | 666 | 64 | 75 | -4 | 243 | 131 | 23 | 9 | 178 | 685 | 100 |
| TP-P2-S11-S2-No4 | 4.76 | 1308 | 80 | 86 | -5 | 285 | 111 | 21 | 7 | 196 | 659 | 90 |
| TP-P2-S11-S2 Avg* | - | 1169 | 76 | 81 | -3 | 273 | 124 | 23 | 7 | 185 | 667 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S11-S3-pan | 0.037 | 49.58 | 24.31 | 14.04 | 6.15 | 4.62 | 1.53 | 0.4 | -0.47 | 0.36 | 0.14 | 344 | 130 |
| TP-P2-S11-S3-No200 | 0.074 | 51.55 | 24.82 | 14.05 | 6.22 | 5.2 | 1.78 | 0.45 | 0.03 | 0.36 | 0.16 | 333 | 120 |
| TP-P2-S11-S3-No140 | 0.105 | 51.83 | 23.64 | 11.55 | 6.13 | 6.42 | 1.88 | 0.52 | 0 | 0.35 | 0.17 | 380 | 150 |
| TP-P2-S11-S3-No100 | 0.149 | 51.74 | 22.95 | 10.8 | 6.14 | 7.44 | 2.69 | 0.51 | 0.03 | 0.36 | 0.15 | 383 | 70 |
| TP-P2-S11-S3-No60 | 0.25 | 51.74 | 24.07 | 10.93 | 6.18 | 6.79 | 2.2 | 0.45 | 0.13 | 0.36 | 0.15 | 378 | 60 |
| TP-P2-S11-S3-No40 | 0.42 | 51.27 | 26.06 | 11.45 | 6.22 | 5.49 | 0.81 | 0.36 | -0.43 | 0.37 | 0.16 | 338 | 90 |
| TP-P2-S11-S3-No20 | 0.841 | 51.44 | 27.04 | 12.09 | 6.52 | 5.38 | 0.52 | 0.3 | -0.27 | 0.39 | 0.16 | 348 | 110 |
| TP-P2-S11-S3-No10 | 2 | 49.26 | 27.16 | 12.93 | 6.28 | 5.42 | 0.62 | 0.24 | -0.84 | 0.37 | 0.17 | 280 | 90 |
| TP-P2-S11-S3-No4 | 4.76 | 51.14 | 27.52 | 13.18 | 6.63 | 4.75 | 0.61 | 0.17 | -0.54 | 0.43 | 0.17 | 284 | 130 |
| TP-P2-S11-S3 Avg* | - | 51.08 | 27.25 | 13.07 | 6.57 | 4.88 | 0.7 | 0.19 | 0.12 | 0.42 | 0.17 | 291 | 125 |
| TP-P2-S12-S1-pan | 0.037 | 55.4 | 3.71 | 3.17 | 7.62 | 8.15 | 0.1 | 2.04 | 1.21 | 0.37 | 0.05 | 517 | 660 |
| TP-P2-S12-S1-No200 | 0.074 | 62.12 | 2.97 | 3.22 | 8.67 | 5.54 | 0.08 | 2.26 | 2.11 | 0.32 | 0.04 | 404 | 550 |
| TP-P2-S12-S1-No140 | 0.105 | 62.5 | 2.69 | 3.04 | 8.89 | 5.05 | 0.09 | 2.2 | 2.1 | 0.32 | 0.04 | 303 | 560 |
| TP-P2-S12-S1-No100 | 0.149 | 66.38 | 2.48 | 3.39 | 8.95 | 4.5 | 0.07 | 2.04 | 2.55 | 0.28 | 0.04 | 372 | 410 |
| TP-P2-S12-S1-No60 | 0.25 | 63.78 | 2.7 | 3.26 | 8.38 | 4.93 | 0.09 | 1.97 | 2.24 | 0.28 | 0.04 | 375 | 420 |
| TP-P2-S12-S1-No40 | 0.42 | 64 | 2.91 | 3.31 | 9.03 | 5.71 | 0.08 | 2.02 | 2.39 | 0.3 | 0.04 | 411 | 430 |
| TP-P2-S12-S1-No20 | 0.841 | 60.36 | 3.8 | 4.18 | 9.87 | 8.06 | 0.1 | 2.11 | 2.5 | 0.36 | 0.05 | 501 | 480 |
| TP-P2-S12-S1-No10 | 2 | 60.74 | 4.54 | 4.92 | 10.52 | 8.01 | 0.26 | 1.99 | 2.73 | 0.39 | 0.06 | 493 | 490 |
| TP-P2-S12-S1-No4 | 4.76 | 53.68 | 6.29 | 6.75 | 10.36 | 12.79 | 0.58 | 1.4 | 2.36 | 0.46 | 0.09 | 675 | 260 |
| TP-P2-S12-S1 Avg* | - | 60.99 | 3.56 | 3.91 | 9.14 | 6.97 | 0.16 | 2 | 2.24 | 0.34 | 0.05 | 450 | 473 |
| TP-P2-S12-S2-No200 | 0.074 | 52.14 | 9.9 | 11.59 | 8.42 | 4.08 | 1.77 | 1.58 | 0.56 | 0.43 | 0.08 | -272 | 400 |
| TP-P2-S12-S2-No140 | 0.105 | 48.49 | 23.43 | 13.33 | 6.92 | 7.18 | 1.95 | 0.35 | -0.27 | 0.44 | 0.19 | 389 | 80 |
| TP-P2-S12-S2-No100 | 0.149 | 47.58 | 21.96 | 12.21 | 6.86 | 7.1 | 1.67 | 0.35 | -0.65 | 0.46 | 0.18 | 406 | 80 |
| TP-P2-S12-S2-No60 | 0.25 | 49.38 | 23.03 | 12.34 | 7.14 | 7.17 | 1.44 | 0.35 | -0.31 | 0.44 | 0.18 | 354 | 120 |
| TP-P2-S12-S2-No40 | 0.42 | 49.92 | 21.89 | 12.22 | 7.55 | 6.85 | 0.93 | 0.4 | -0.29 | 0.47 | 0.18 | 383 | 140 |
| TP-P2-S12-S2-No20 | 0.841 | 50.67 | 21.44 | 12.34 | 7.74 | 6.65 | 0.69 | 0.42 | -0.18 | 0.49 | 0.18 | 370 | 130 |
| TP-P2-S12-S2-No10 | 2 | 21.72 | 0.6 | 0.67 | 1.22 | -0.63 | -0.02 | 0.03 | -5.7 | 0.05 | 0 | 324 | -70 |
| TP-P2-S12-S2-No4 | 4.76 | 21.72 | 0.6 | 0.67 | 1.22 | -0.63 | -0.02 | 0.03 | -5.7 | 0.05 | 0 | 324 | -70 |
| TP-P2-S12-S2 Avg* | - | 26.23 | 3.3 | 2.47 | 2.24 | 0.42 | 0.18 | 0.15 | 0.56 | 0.12 | 0.03 | 303 | -26 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* | *Au (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S11-S3-pan | 0.037 | 599 | 971 | 120 | -24 | 1591 | 122 | 12 | 6 | 94 | 653 | 100 | 0 |
| TP-P2-S11-S3-No200 | 0.074 | 662 | 899 | 123 | -16 | 1911 | 132 | 15 | 7 | 96 | 670 | 90 | 0 |
| TP-P2-S11-S3-No140 | 0.105 | 623 | 574 | 109 | -1 | 1752 | 151 | 16 | 9 | 116 | 745 | 80 | 0 |
| TP-P2-S11-S3-No100 | 0.149 | 523 | 494 | 101 | 7 | 1729 | 152 | 16 | 10 | 108 | 775 | 80 | 0 |
| TP-P2-S11-S3-No60 | 0.25 | 438 | 487 | 107 | 5 | 1933 | 148 | 16 | 10 | 115 | 763 | 80 | 0 |
| TP-P2-S11-S3-No40 | 0.42 | 409 | 524 | 107 | -8 | 2130 | 130 | 10 | 10 | 110 | 742 | 70 | 0 |
| TP-P2-S11-S3-No20 | 0.841 | 263 | 596 | 129 | -15 | 2156 | 129 | 4 | 9 | 129 | 733 | 80 | -6 |
| TP-P2-S11-S3-No10 | 2 | 334 | 636 | 106 | -20 | 2196 | 102 | 11 | 9 | 138 | 702 | 70 | 0 |
| TP-P2-S11-S3-No4 | 4.76 | 334 | 587 | 118 | -24 | 1893 | 115 | 6 | 8 | 129 | 702 | 80 | 0 |
| TP-P2-S11-S3 Avg* | - | 347 | 596 | 117 | -21 | 1911 | 116 | 6 | 7 | 114 | 704 | 0 | 0.18 |
| TP-P2-S12-S1-pan | 0.037 | 54 | 30 | 29 | 18 | 79 | 366 | 56 | 13 | 76 | 1022 | 260 | 0 |
| TP-P2-S12-S1-No200 | 0.074 | 50 | 31 | 25 | 17 | 169 | 359 | 59 | 13 | 55 | 1043 | 170 | 0 |
| TP-P2-S12-S1-No140 | 0.105 | 52 | 26 | 25 | 14 | 97 | 357 | 59 | 13 | 53 | 1052 | 160 | 0 |
| TP-P2-S12-S1-No100 | 0.149 | 51 | 29 | 24 | 14 | 237 | 337 | 54 | 13 | 59 | 1043 | 130 | 0 |
| TP-P2-S12-S1-No60 | 0.25 | 47 | 31 | 24 | 15 | 239 | 335 | 56 | 13 | 55 | 1058 | 140 | 0 |
| TP-P2-S12-S1-No40 | 0.42 | 46 | 31 | 24 | 13 | 190 | 337 | 56 | 13 | 53 | 1038 | 140 | 0 |
| TP-P2-S12-S1-No20 | 0.841 | 75 | 36 | 34 | 23 | 248 | 353 | 63 | 13 | 67 | 982 | 150 | 0 |
| TP-P2-S12-S1-No10 | 2 | 70 | 48 | 42 | 17 | 211 | 346 | 61 | 13 | 68 | 942 | 150 | 0 |
| TP-P2-S12-S1-No4 | 4.76 | 124 | 75 | 50 | 27 | 261 | 310 | 42 | 12 | 127 | 837 | 100 | 0 |
| TP-P2-S12-S1 Avg* | - | 63 | 37 | 30 | 17 | 192 | 344 | 56 | 13 | 68 | 1002 | 155 | 0 |
| TP-P2-S12-S2-No200 | 0.074 | 589 | 116 | 77 | 3 | 749 | 240 | 43 | 10 | 95 | 763 | 120 | 0 |
| TP-P2-S12-S2-No140 | 0.105 | 454 | 546 | 130 | -4 | 1830 | 115 | 14 | 8 | 132 | 688 | 80 | 1 |
| TP-P2-S12-S2-No100 | 0.149 | 393 | 450 | 111 | -2 | 1832 | 113 | 11 | 9 | 137 | 686 | 80 | 0 |
| TP-P2-S12-S2-No60 | 0.25 | 313 | 451 | 118 | -4 | 1861 | 117 | 14 | 9 | 136 | 715 | 80 | 0 |
| TP-P2-S12-S2-No40 | 0.42 | 282 | 401 | 113 | -5 | 1822 | 119 | 13 | 9 | 168 | 715 | 90 | 0 |
| TP-P2-S12-S2-No20 | 0.841 | 265 | 349 | 106 | -9 | 1572 | 122 | 17 | 9 | 154 | 705 | 90 | 1 |
| TP-P2-S12-S2-No10 | 2 | -12 | -4 | 7 | -177 | 12 | 25 | -7 | 16 | 31 | 0 | 40 | 2 |
| TP-P2-S12-S2-No4 | 4.76 | -12 | -4 | 7 | -177 | 12 | 25 | -7 | 16 | 31 | 0 | 40 | 2 |
| TP-P2-S12-S2 Avg* | - | 54 | 45 | 21 | -149 | 220 | 46 | -2 | 14 | 95 | 112 | 0 | 1.47 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S12-S3-pan | 0.037 | 51.92 | 11.35 | 10.28 | 8.3 | 8.06 | 1.35 | 1.26 | 0.69 | 0.49 | 0.11 | 415 | 360 |
| TP-P2-S12-S3-No200 | 0.074 | 56.92 | 10.04 | 8.56 | 9.12 | 7.21 | 1.16 | 1.59 | 1.32 | 0.45 | 0.1 | 421 | 320 |
| TP-P2-S12-S3-No140 | 0.105 | 56.84 | 9.4 | 7.92 | 9.01 | 6.9 | 1.06 | 1.59 | 1.27 | 0.43 | 0.1 | 385 | 300 |
| TP-P2-S12-S3-No100 | 0.149 | 59.69 | 9.02 | 7.73 | 8.94 | 6.36 | 0.94 | 1.48 | 1.48 | 0.41 | 0.1 | 506 | 280 |
| TP-P2-S12-S3-No60 | 0.25 | 59.88 | 9.73 | 7.67 | 8.73 | 6.44 | 0.79 | 1.34 | 1.34 | 0.4 | 0.1 | 505 | 220 |
| TP-P2-S12-S3-No40 | 0.42 | 57 | 10.35 | 8.37 | 8.83 | 7.18 | 0.74 | 1.29 | 1.05 | 0.45 | 0.11 | 441 | 240 |
| TP-P2-S12-S3-No20 | 0.841 | 54.92 | 14.73 | 10.47 | 9.53 | 8.1 | 0.78 | 1.04 | 1.06 | 0.52 | 0.15 | 471 | 250 |
| TP-P2-S12-S3-No10 | 2 | 54.86 | 13.98 | 11.15 | 9.94 | 8.03 | 1.2 | 0.94 | 1.33 | 0.58 | 0.15 | 529 | 240 |
| TP-P2-S12-S3-No4 | 4.76 | 53.12 | 20.52 | 11.81 | 9.16 | 7.75 | 0.8 | 0.57 | 0.78 | 0.55 | 0.17 | 415 | 210 |
| TP-P2-S12-S3 Avg* | - | 53.21 | 20.22 | 11.73 | 9.16 | 7.74 | 0.81 | 0.59 | 0.79 | 0.55 | 0.17 | 417 | 212 |
| TP-P2-S13-S2-pan | 0.037 | 52.39 | 10.12 | 16.02 | 10.52 | 6.67 | 2.86 | 1.05 | 1.18 | 0.6 | 0.15 | 391 | 330 |
| TP-P2-S13-S2-No200 | 0.074 | 52.55 | 8.18 | 12.36 | 9.49 | 6.07 | 2.18 | 1.27 | 0.87 | 0.51 | 0.12 | 247 | 250 |
| TP-P2-S13-S2-No140 | 0.105 | 58.23 | 7.07 | 10.58 | 9.77 | 5.4 | 1.62 | 1.41 | 1.59 | 0.47 | 0.11 | 176 | 230 |
| TP-P2-S13-S2-No100 | 0.149 | 60.72 | 6.53 | 9.35 | 9.43 | 5.19 | 1.34 | 1.35 | 1.71 | 0.45 | 0.09 | 171 | 270 |
| TP-P2-S13-S2-No60 | 0.25 | 58.9 | 6.49 | 9.26 | 9.06 | 5.51 | 1.2 | 1.24 | 1.3 | 0.45 | 0.1 | 257 | 230 |
| TP-P2-S13-S2-No40 | 0.42 | 57.02 | 7.56 | 10.38 | 9.73 | 6.47 | 0.93 | 1.16 | 1.19 | 0.53 | 0.12 | 327 | 240 |
| TP-P2-S13-S2-No20 | 0.841 | 57.16 | 8.81 | 11.72 | 11.06 | 7.53 | 0.91 | 1.01 | 1.47 | 0.65 | 0.15 | 331 | 320 |
| TP-P2-S13-S2-No10 | 2 | 55.98 | 8.55 | 12.4 | 11.04 | 7.5 | 1.16 | 0.93 | 1.37 | 0.69 | 0.15 | 408 | 330 |
| TP-P2-S13-S2-No4 | 4.76 | 57.43 | 8.67 | 12.23 | 12.04 | 6.46 | 1.28 | 1.22 | 1.62 | 0.66 | 0.15 | 231 | 320 |
| TP-P2-S13-S2 Avg* | - | 57.31 | 8.62 | 12.2 | 11.84 | 6.47 | 1.3 | 1.21 | 1.59 | 0.65 | 0.15 | 241 | 316 |
| TP-P2-S14-S1-pan | 0.037 | 55.22 | 3.94 | 2.77 | 7.47 | 8.64 | 0.11 | 2.24 | 1.28 | 0.32 | 0.04 | 506 | 370 |
| TP-P2-S14-S1-No200 | 0.074 | 56.17 | 4.62 | 3.1 | 7.81 | 10.44 | 0.12 | 2.19 | 1.69 | 0.39 | 0.05 | 622 | 500 |
| TP-P2-S14-S1-No140 | 0.105 | 55.93 | 2.38 | 2.68 | 6.65 | 5.58 | 0.06 | 2.1 | 0.99 | 0.25 | 0.04 | 405 | 330 |
| TP-P2-S14-S1-No100 | 0.149 | 56.29 | 2.45 | 2.29 | 6.34 | 6.15 | 0.06 | 1.99 | 0.98 | 0.22 | 0.03 | 438 | 250 |
| TP-P2-S14-S1-No60 | 0.25 | 61.38 | 2.41 | 2.32 | 6.71 | 5.85 | 0.04 | 1.87 | 1.48 | 0.19 | 0.03 | 468 | 250 |
| TP-P2-S14-S1-No40 | 0.42 | 58.91 | 3.24 | 2.63 | 7.71 | 8.6 | 0.06 | 2.01 | 1.67 | 0.23 | 0.04 | 513 | 290 |
| TP-P2-S14-S1-No20 | 0.841 | 57.35 | 4.5 | 3.46 | 9.49 | 13.23 | 0.08 | 2.25 | 2.41 | 0.28 | 0.05 | 671 | 340 |
| TP-P2-S14-S1-No10 | 2 | 54.78 | 5.31 | 3.6 | 9.2 | 16.55 | 0.09 | 2.35 | 2.44 | 0.32 | 0.06 | 744 | 350 |
| TP-P2-S14-S1 Avg* | - | 56.31 | 4.06 | 3.03 | 8.01 | 11.08 | 0.09 | 2.19 | 1.79 | 0.29 | 0.05 | 592 | 342 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S12-S3-pan | 0.037 | 367 | 280 | 98 | 16 | 607 | 235 | 38 | 10 | 111 | 761 | 170 |
| TP-P2-S12-S3-No200 | 0.074 | 347 | 203 | 74 | 16 | 555 | 254 | 40 | 12 | 108 | 814 | 130 |
| TP-P2-S12-S3-No140 | 0.105 | 329 | 182 | 72 | 18 | 517 | 255 | 46 | 12 | 89 | 842 | 130 |
| TP-P2-S12-S3-No100 | 0.149 | 302 | 176 | 66 | 9 | 582 | 247 | 42 | 11 | 98 | 851 | 110 |
| TP-P2-S12-S3-No60 | 0.25 | 242 | 165 | 66 | 10 | 707 | 235 | 41 | 12 | 95 | 847 | 110 |
| TP-P2-S12-S3-No40 | 0.42 | 243 | 200 | 69 | 8 | 770 | 223 | 41 | 11 | 124 | 830 | 110 |
| TP-P2-S12-S3-No20 | 0.841 | 268 | 245 | 102 | 8 | 942 | 188 | 33 | 10 | 125 | 762 | 110 |
| TP-P2-S12-S3-No10 | 2 | 794 | 231 | 85 | 2 | 822 | 188 | 30 | 10 | 145 | 725 | 110 |
| TP-P2-S12-S3-No4 | 4.76 | 219 | 366 | 98 | 0 | 1152 | 172 | 19 | 9 | 142 | 726 | 100 |
| TP-P2-S12-S3 Avg* | - | 224 | 361 | 97 | 0 | 1137 | 173 | 19 | 9 | 141 | 728 | 0.01 |
| TP-P2-S13-S2-pan | 0.037 | 1554 | 258 | 178 | -7 | 495 | 161 | 31 | 2 | 146 | 625 | 140 |
| TP-P2-S13-S2-No200 | 0.074 | 1243 | 170 | 126 | 8 | 385 | 197 | 36 | 7 | 141 | 720 | 110 |
| TP-P2-S13-S2-No140 | 0.105 | 1274 | 139 | 112 | 4 | 354 | 208 | 40 | 8 | 126 | 760 | 90 |
| TP-P2-S13-S2-No100 | 0.149 | 1020 | 115 | 91 | 2 | 343 | 211 | 42 | 8 | 123 | 806 | 90 |
| TP-P2-S13-S2-No60 | 0.25 | 886 | 104 | 81 | 3 | 367 | 198 | 39 | 9 | 128 | 807 | 90 |
| TP-P2-S13-S2-No40 | 0.42 | 815 | 108 | 86 | 5 | 417 | 182 | 38 | 7 | 151 | 762 | 100 |
| TP-P2-S13-S2-No20 | 0.841 | 813 | 111 | 93 | 1 | 365 | 155 | 34 | 9 | 181 | 711 | 100 |
| TP-P2-S13-S2-No10 | 2 | 1037 | 109 | 89 | -2 | 316 | 138 | 33 | 9 | 198 | 692 | 100 |
| TP-P2-S13-S2-No4 | 4.76 | 188 | 115 | 77 | -9 | 385 | 140 | 35 | 8 | 179 | 694 | 110 |
| TP-P2-S13-S2 Avg* | - | 285 | 117 | 80 | -8 | 384 | 142 | 35 | 8 | 176 | 697 | 0.01 |
| TP-P2-S14-S1-pan | 0.037 | 45 | 23 | 27 | 24 | 56 | 353 | 58 | 13 | 65 | 1053 | 200 |
| TP-P2-S14-S1-No200 | 0.074 | 53 | 25 | 29 | 23 | 51 | 352 | 55 | 12 | 60 | 1018 | 330 |
| TP-P2-S14-S1-No140 | 0.105 | 41 | 22 | 24 | 23 | 118 | 327 | 55 | 13 | 53 | 1156 | 130 |
| TP-P2-S14-S1-No100 | 0.149 | 33 | 17 | 19 | 21 | 71 | 314 | 56 | 13 | 44 | 1131 | 100 |
| TP-P2-S14-S1-No60 | 0.25 | 34 | 20 | 20 | 14 | 104 | 305 | 54 | 13 | 52 | 1118 | 100 |
| TP-P2-S14-S1-No40 | 0.42 | 34 | 20 | 21 | 21 | 92 | 330 | 54 | 13 | 52 | 1080 | 120 |
| TP-P2-S14-S1-No20 | 0.841 | 50 | 25 | 29 | 34 | 114 | 362 | 62 | 13 | 58 | 989 | 130 |
| TP-P2-S14-S1-No10 | 2 | 46 | 29 | 31 | 44 | 102 | 350 | 71 | 13 | 57 | 957 | 140 |
| TP-P2-S14-S1 Avg* | - | 43 | 23 | 26 | 29 | 88 | 340 | 61 | 13 | 56 | 1035 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S14-S2-pan | 0.037 | 41.8 | 5.11 | 22.08 | 7.81 | 8.81 | 6.57 | 0.79 | 0.22 | 0.71 | 0.14 | 793 | 380 |
| TP-P2-S14-S2-No200 | 0.074 | 44.49 | 5.63 | 19.17 | 8.65 | 10.29 | 7.26 | 0.85 | 0.94 | 0.68 | 0.14 | 874 | 370 |
| TP-P2-S14-S2-No140 | 0.105 | 46.87 | 5.49 | 18.27 | 8.78 | 10.14 | 6.99 | 0.87 | 1.03 | 0.69 | 0.13 | 906 | 400 |
| TP-P2-S14-S2-No100 | 0.149 | 47.4 | 5.24 | 16.57 | 8.82 | 9.39 | 5.67 | 0.89 | 0.81 | 0.7 | 0.13 | 746 | 360 |
| TP-P2-S14-S2-No60 | 0.25 | 49.82 | 5.62 | 15.94 | 9.27 | 9 | 4.83 | 0.83 | 0.95 | 0.72 | 0.13 | 642 | 420 |
| TP-P2-S14-S2-No40 | 0.42 | 51.02 | 5.77 | 14.89 | 9.87 | 8.03 | 2.8 | 0.8 | 0.91 | 0.76 | 0.14 | 454 | 400 |
| TP-P2-S14-S2-No20 | 0.841 | 53.99 | 6.03 | 13.51 | 10.62 | 7.63 | 1.27 | 0.78 | 1.04 | 0.81 | 0.15 | 405 | 510 |
| TP-P2-S14-S2-No10 | 2 | 54.24 | 6.63 | 13.71 | 11.23 | 7.99 | 1.34 | 0.73 | 1.17 | 0.84 | 0.16 | 467 | 460 |
| TP-P2-S14-S2-No4 | 4.76 | 56.12 | 5.97 | 12.85 | 11.06 | 7.31 | 1.25 | 0.82 | 1.32 | 0.81 | 0.16 | 377 | 330 |
| TP-P2-S14-S2 Avg* | - | 52.99 | 20.25 | 13.07 | 11.18 | 4.16 | 1.19 | 0.89 | 0.52 | 0.65 | 0.14 | 155 | 591 |
| TP-P2-S15-S2-pan | 0.037 | 44.47 | 10.93 | 19.09 | 8.17 | 7.56 | 4.78 | 0.69 | 0.38 | 0.61 | 0.13 | 528 | 350 |
| TP-P2-S15-S2-No200 | 0.074 | 48.59 | 9.56 | 16.52 | 9.59 | 7.56 | 4.09 | 0.88 | 0.78 | 0.6 | 0.13 | 479 | 310 |
| TP-P2-S15-S2-No140 | 0.105 | 49.66 | 9.44 | 15.74 | 9.61 | 6.9 | 3.39 | 0.9 | 0.81 | 0.61 | 0.12 | 443 | 270 |
| TP-P2-S15-S2-No100 | 0.149 | 51.52 | 8.78 | 14.71 | 9.82 | 6.74 | 2.71 | 0.9 | 0.88 | 0.62 | 0.13 | 410 | 290 |
| TP-P2-S15-S2-No60 | 0.25 | 52.82 | 9.35 | 14 | 10.21 | 6.82 | 2.36 | 0.84 | 1.11 | 0.63 | 0.13 | 398 | 270 |
| TP-P2-S15-S2-No40 | 0.42 | 53.45 | 9.67 | 13.35 | 10.73 | 6.97 | 1.67 | 0.81 | 1.14 | 0.67 | 0.14 | 392 | 290 |
| TP-P2-S15-S2-No20 | 0.841 | 54.15 | 9.72 | 12.89 | 11.12 | 7.3 | 1.07 | 0.73 | 1.29 | 0.72 | 0.16 | 397 | 370 |
| TP-P2-S15-S2-No10 | 2 | 54.15 | 10.33 | 12.69 | 11.32 | 7.71 | 0.94 | 0.7 | 1.25 | 0.72 | 0.16 | 444 | 350 |
| TP-P2-S15-S2-No4 | 4.76 | 54.19 | 8.96 | 12.35 | 11.22 | 7.11 | 1.18 | 0.76 | 1.44 | 0.75 | 0.15 | 383 | 410 |
| TP-P2-S15-S2 Avg* | - | 53.93 | 9.1 | 12.58 | 11.13 | 7.15 | 1.28 | 0.76 | 1.39 | 0.74 | 0.15 | 390 | 399 |
| TP-P2-S17-S1-pan | 0.037 | 56.58 | 4.39 | 3.79 | 8.09 | 8.12 | 0.17 | 2 | 1.44 | 0.4 | 0.05 | 429 | 510 |
| TP-P2-S17-S1-No200 | 0.074 | 62.52 | 3.36 | 3.61 | 8.8 | 5.53 | 0.09 | 2.21 | 2.09 | 0.33 | 0.04 | 378 | 420 |
| TP-P2-S17-S1-No140 | 0.105 | 62.77 | 3.16 | 3.26 | 8.76 | 5.32 | 0.1 | 2.15 | 2.08 | 0.29 | 0.04 | 351 | 370 |
| TP-P2-S17-S1-No100 | 0.149 | 67.34 | 2.85 | 3.33 | 8.72 | 4.56 | 0.07 | 1.99 | 2.49 | 0.26 | 0.04 | 301 | 320 |
| TP-P2-S17-S1-No60 | 0.25 | 64.17 | 3.07 | 3.11 | 8.32 | 5.08 | 0.08 | 1.92 | 2.04 | 0.26 | 0.04 | 387 | 330 |
| TP-P2-S17-S1-No40 | 0.42 | 65.45 | 3.52 | 3.74 | 9.5 | 6.02 | 0.08 | 1.98 | 2.62 | 0.31 | 0.04 | 398 | 340 |
| TP-P2-S17-S1-No20 | 0.841 | 60.7 | 5.15 | 4.67 | 10.57 | 8.88 | 0.14 | 2.02 | 2.63 | 0.37 | 0.06 | 565 | 390 |
| TP-P2-S17-S1-No10 | 2 | 59.39 | 6.76 | 5.92 | 11.14 | 9.92 | 0.15 | 1.96 | 2.4 | 0.44 | 0.08 | 581 | 400 |
| TP-P2-S17-S1-No4 | 4.76 | 53.5 | 5.68 | 6.42 | 9.58 | 15.98 | 0.29 | 1.58 | 1.89 | 0.47 | 0.09 | 622 | 360 |
| TP-P2-S17-S1 Avg* | - | 58.79 | 4.7 | 4.91 | 9.35 | 10.43 | 0.18 | 1.84 | 2.08 | 0.39 | 0.06 | 503 | 376 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S14-S2-pan | 0.037 | 875 | 87 | 95 | 41 | 167 | 144 | 33 | -8 | 158 | 525 | 100 |
| TP-P2-S14-S2-No200 | 0.074 | 1136 | 75 | 80 | 50 | 168 | 155 | 35 | -2 | 156 | 581 | 100 |
| TP-P2-S14-S2-No140 | 0.105 | 1128 | 67 | 75 | 58 | 175 | 159 | 32 | 0 | 152 | 582 | 100 |
| TP-P2-S14-S2-No100 | 0.149 | 962 | 63 | 68 | 38 | 147 | 160 | 34 | 3 | 154 | 605 | 90 |
| TP-P2-S14-S2-No60 | 0.25 | 789 | 50 | 59 | 25 | 191 | 164 | 35 | 3 | 143 | 633 | 100 |
| TP-P2-S14-S2-No40 | 0.42 | 629 | 49 | 59 | 14 | 176 | 158 | 31 | 6 | 198 | 638 | 110 |
| TP-P2-S14-S2-No20 | 0.841 | 440 | 46 | 54 | 59 | 222 | 159 | 30 | 6 | 206 | 668 | 120 |
| TP-P2-S14-S2-No10 | 2 | 422 | 47 | 59 | 18 | 186 | 159 | 28 | 7 | 193 | 658 | 120 |
| TP-P2-S14-S2-No4 | 4.76 | 377 | 40 | 65 | -5 | 176 | 135 | 35 | 8 | 220 | 676 | 120 |
| TP-P2-S14-S2 Avg* | - | 506 | 202 | 93 | -11 | 950 | 117 | 29 | 8 | 140 | 720 | 0.01 |
| TP-P2-S15-S2-pan | 0.037 | 854 | 155 | 105 | -5 | 652 | 161 | 25 | 0 | 137 | 603 | 110 |
| TP-P2-S15-S2-No200 | 0.074 | 1065 | 122 | 81 | 1 | 549 | 184 | 27 | 4 | 135 | 632 | 100 |
| TP-P2-S15-S2-No140 | 0.105 | 1033 | 108 | 80 | 0 | 495 | 187 | 32 | 5 | 152 | 658 | 100 |
| TP-P2-S15-S2-No100 | 0.149 | 902 | 94 | 69 | -5 | 477 | 185 | 31 | 6 | 160 | 668 | 100 |
| TP-P2-S15-S2-No60 | 0.25 | 674 | 87 | 68 | -1 | 478 | 185 | 29 | 7 | 176 | 682 | 100 |
| TP-P2-S15-S2-No40 | 0.42 | 510 | 85 | 67 | -5 | 472 | 182 | 29 | 7 | 177 | 702 | 100 |
| TP-P2-S15-S2-No20 | 0.841 | 408 | 75 | 68 | 5 | 437 | 178 | 25 | 8 | 197 | 680 | 100 |
| TP-P2-S15-S2-No10 | 2 | 568 | 88 | 71 | -6 | 433 | 169 | 26 | 8 | 206 | 685 | 100 |
| TP-P2-S15-S2-No4 | 4.76 | 599 | 71 | 66 | -5 | 406 | 160 | 28 | 9 | 209 | 701 | 110 |
| TP-P2-S15-S2 Avg* | - | 602 | 74 | 67 | -4 | 416 | 161 | 27 | 8 | 205 | 697 | 0.01 |
| TP-P2-S17-S1-pan | 0.037 | 114 | 59 | 38 | 21 | 115 | 352 | 53 | 13 | 77 | 992 | 280 |
| TP-P2-S17-S1-No200 | 0.074 | 83 | 45 | 27 | 15 | 191 | 345 | 54 | 13 | 57 | 1019 | 180 |
| TP-P2-S17-S1-No140 | 0.105 | 80 | 40 | 29 | 14 | 137 | 342 | 56 | 13 | 69 | 1045 | 130 |
| TP-P2-S17-S1-No100 | 0.149 | 71 | 39 | 22 | 9 | 202 | 329 | 55 | 13 | 65 | 1053 | 120 |
| TP-P2-S17-S1-No60 | 0.25 | 63 | 40 | 23 | 14 | 211 | 320 | 50 | 13 | 70 | 1062 | 130 |
| TP-P2-S17-S1-No40 | 0.42 | 73 | 46 | 28 | 15 | 220 | 327 | 56 | 13 | 58 | 1008 | 140 |
| TP-P2-S17-S1-No20 | 0.841 | 104 | 61 | 38 | 19 | 281 | 335 | 61 | 13 | 74 | 952 | 140 |
| TP-P2-S17-S1-No10 | 2 | 71 | 83 | 53 | 23 | 366 | 306 | 57 | 13 | 83 | 897 | 140 |
| TP-P2-S17-S1-No4 | 4.76 | 138 | 65 | 53 | 36 | 167 | 282 | 53 | 13 | 106 | 843 | 140 |
| TP-P2-S17-S1 Avg* | - | 104 | 57 | 40 | 24 | 195 | 312 | 54 | 12 | 83 | 939 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13: X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S17-S2-pan | 0.037 | 53.83 | 26.64 | 13.62 | 6.41 | 3.4 | 1.25 | 0.52 | 0.04 | 0.36 | 0.14 | 298 | 110 |
| TP-P2-S17-S2-No200 | 0.074 | 54.72 | 25.82 | 13.25 | 6.04 | 4.2 | 1.27 | 0.59 | 0.07 | 0.33 | 0.15 | 323 | 70 |
| TP-P2-S17-S2-No140 | 0.105 | 57.05 | 26.12 | 11.16 | 6.56 | 4.65 | 0.77 | 0.64 | 0.39 | 0.32 | 0.14 | 376 | 100 |
| TP-P2-S17-S2-No100 | 0.149 | 55.97 | 24.73 | 10.28 | 6.42 | 4.13 | 0.55 | 0.62 | 0.04 | 0.33 | 0.13 | 371 | 70 |
| TP-P2-S17-S2-No60 | 0.25 | 56.99 | 27.17 | 10.56 | 6.72 | 3.93 | 0.47 | 0.5 | 0.17 | 0.33 | 0.14 | 314 | 120 |
| TP-P2-S17-S2-No20 | 0.841 | 54.72 | 26.76 | 11.16 | 6.57 | 4.54 | 0.48 | 0.48 | -0.08 | 0.33 | 0.14 | 331 | 50 |
| TP-P2-S17-S2-No10 | 2 | 53.68 | 25.91 | 11.58 | 6.89 | 4.61 | 0.69 | 0.46 | -0.2 | 0.35 | 0.15 | 371 | 70 |
| TP-P2-S17-S2-No4 | 4.76 | 54.03 | 24.69 | 10.31 | 6.16 | 4.43 | 0.66 | 0.43 | -0.13 | 0.35 | 0.13 | 392 | 140 |
| TP-P2-S17-S2 Avg* | - | 54.23 | 24.97 | 10.52 | 6.23 | 4.39 | 0.67 | 0.45 | 0.16 | 0.34 | 0.13 | 382 | 130 |
| TP-P2-S17-S3-pan | 0.037 | 51.26 | 25.18 | 12.33 | 5.17 | 4.99 | 1.16 | 0.48 | -0.24 | 0.37 | 0.15 | 335 | 100 |
| TP-P2-S17-S3-No200 | 0.074 | 54.01 | 26.49 | 12.44 | 5.74 | 4.9 | 1.3 | 0.57 | -0.02 | 0.31 | 0.14 | 353 | 80 |
| TP-P2-S17-S3-No140 | 0.105 | 54.1 | 26.1 | 11.73 | 5.76 | 4.55 | 1.19 | 0.54 | -0.04 | 0.31 | 0.14 | 313 | 30 |
| TP-P2-S17-S3-No100 | 0.149 | 55.15 | 27.19 | 11.47 | 5.93 | 4.16 | 0.99 | 0.5 | -0.08 | 0.3 | 0.14 | 380 | 20 |
| TP-P2-S17-S3-No60 | 0.25 | 55.25 | 27.9 | 11.52 | 6.11 | 4.05 | 0.7 | 0.45 | -0.15 | 0.32 | 0.14 | 326 | 60 |
| TP-P2-S17-S3-No40 | 0.42 | 53.86 | 28.18 | 11.79 | 6.29 | 4.39 | 0.68 | 0.43 | -0.25 | 0.32 | 0.15 | 377 | 70 |
| TP-P2-S17-S3-No20 | 0.841 | 53.81 | 30.37 | 12.11 | 6.31 | 4.82 | 0.66 | 0.36 | -0.03 | 0.32 | 0.15 | 337 | 50 |
| TP-P2-S17-S3-No10 | 2 | 52.71 | 30.42 | 12.38 | 5.38 | 4.28 | 0.68 | 0.27 | -0.55 | 0.33 | 0.15 | 317 | 20 |
| TP-P2-S17-S3-No4 | 4.76 | 50.86 | 31.42 | 12.36 | 5.07 | 5.08 | 0.53 | 0.15 | -0.75 | 0.3 | 0.18 | 301 | -20 |
| TP-P2-S17-S3 Avg* | - | 50.94 | 31.31 | 12.35 | 5.09 | 5.06 | 0.55 | 0.15 | 0 | 0.3 | 0.18 | 302 | -17 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.13(Cont.): X-Ray Fluorescence Data for WRS#2 Test Pit Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TP-P2-S17-S2-pan | 0.037 | 654 | 1038 | 117 | -15 | 1571 | 119 | 13 | 7 | 95 | 680 | 100 |
| TP-P2-S17-S2-No200 | 0.074 | 649 | 894 | 113 | -14 | 1835 | 132 | 16 | 7 | 96 | 708 | 90 |
| TP-P2-S17-S2-No140 | 0.105 | 559 | 546 | 100 | -2 | 1849 | 149 | 17 | 10 | 112 | 775 | 90 |
| TP-P2-S17-S2-No100 | 0.149 | 470 | 443 | 94 | -8 | 1808 | 140 | 17 | 10 | 94 | 810 | 80 |
| TP-P2-S17-S2-No60 | 0.25 | 383 | 445 | 98 | -6 | 2031 | 124 | 14 | 10 | 111 | 805 | 80 |
| TP-P2-S17-S2-No20 | 0.841 | 254 | 515 | 88 | -5 | 2151 | 116 | 12 | 10 | 115 | 784 | 80 |
| TP-P2-S17-S2-No10 | 2 | 283 | 574 | 89 | -10 | 1963 | 115 | 13 | 9 | 102 | 764 | 90 |
| TP-P2-S17-S2-No4 | 4.76 | 244 | 679 | 189 | -19 | 1806 | 117 | -33 | 9 | 123 | 720 | 90 |
| TP-P2-S17-S2 Avg* | - | 275 | 668 | 173 | -17 | 1826 | 118 | -25 | 9 | 109 | 727 | 0 |
| TP-P2-S17-S3-pan | 0.037 | 390 | 817 | 102 | -12 | 1657 | 136 | 12 | 8 | 87 | 713 | 100 |
| TP-P2-S17-S3-No200 | 0.074 | 370 | 672 | 100 | -10 | 2082 | 145 | 16 | 9 | 87 | 721 | 80 |
| TP-P2-S17-S3-No140 | 0.105 | 325 | 583 | 94 | -16 | 2041 | 139 | 15 | 9 | 96 | 747 | 70 |
| TP-P2-S17-S3-No100 | 0.149 | 308 | 571 | 86 | -11 | 2035 | 135 | 16 | 9 | 101 | 770 | 70 |
| TP-P2-S17-S3-No60 | 0.25 | 270 | 576 | 94 | -8 | 2227 | 125 | 12 | 10 | 94 | 776 | 80 |
| TP-P2-S17-S3-No40 | 0.42 | 270 | 623 | 100 | -10 | 2351 | 124 | 13 | 9 | 98 | 765 | 80 |
| TP-P2-S17-S3-No20 | 0.841 | 270 | 651 | 91 | -11 | 2359 | 117 | 10 | 9 | 109 | 747 | 80 |
| TP-P2-S17-S3-No10 | 2 | 403 | 744 | 87 | -12 | 2312 | 101 | 6 | 9 | 111 | 742 | 70 |
| TP-P2-S17-S3-No4 | 4.76 | 231 | 764 | 94 | -11 | 2576 | 135 | 3 | 9 | 100 | 728 | 70 |
| TP-P2-S17-S3 Avg* | - | 233 | 760 | 94 | -10 | 2561 | 134 | 3 | 8 | 99 | 728 | 0 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P1-S1-pan | 0.037 | 55.71 | 12.13 | 9.09 | 9.06 | 7 | 1.5 | 1.39 | 1.33 | 0.46 | 0.1 | 389 | 340 |
| P4-P1-S1-No200 | 0.074 | 53.52 | 9.89 | 7.7 | 8.43 | 6.26 | 1.5 | 1.47 | 1.08 | 0.39 | 0.09 | 334 | 330 |
| P4-P1-S1-No140 | 0.105 | 55.61 | 9.52 | 7.39 | 8.41 | 6.08 | 1.31 | 1.45 | 1.16 | 0.4 | 0.09 | 375 | 320 |
| P4-P1-S1-No100 | 0.149 | 55.4 | 9.89 | 7.12 | 8.33 | 6.04 | 1.45 | 1.39 | 1.18 | 0.38 | 0.08 | 357 | 260 |
| P4-P1-S1-No60 | 0.25 | 56.69 | 10.31 | 7.26 | 8.39 | 6.14 | 1.37 | 1.35 | 1.24 | 0.39 | 0.09 | 537 | 290 |
| P4-P1-S1-No40 | 0.42 | 55.98 | 11.69 | 8.07 | 8.84 | 6.32 | 0.85 | 1.26 | 1.1 | 0.41 | 0.1 | 475 | 230 |
| P4-P1-S1-No20 | 0.841 | 54.44 | 13.43 | 9.53 | 9.25 | 6.79 | 0.58 | 1.06 | 1.04 | 0.5 | 0.12 | 369 | 280 |
| P4-P1-S1-No10 | 2 | 54.3 | 14.34 | 10.19 | 9.33 | 6.42 | 0.69 | 0.92 | 0.91 | 0.49 | 0.13 | 385 | 230 |
| P4-P1-S1-No4 | 4.76 | 57.33 | 12.83 | 11.75 | 10.75 | 6.25 | 1.71 | 1.08 | 1.52 | 0.52 | 0.13 | 404 | 340 |
| P4-P1-S1 Avg* | - | 57.08 | 12.76 | 11.41 | 10.54 | 6.28 | 1.63 | 1.09 | 1.47 | 0.51 | 0.13 | 403 | 332 |
| P4-P2-S1-pan | 0.037 | 49.88 | 9.37 | 17.75 | 10.1 | 7.23 | 2.81 | 0.77 | 0.78 | 0.69 | 0.16 | 434 | 280 |
| P4-P2-S1-No200 | 0.074 | 50.46 | 8.43 | 14.57 | 9.95 | 7.25 | 2.4 | 0.94 | 0.85 | 0.62 | 0.15 | 453 | 240 |
| P4-P2-S1-No140 | 0.105 | 55.79 | 8.25 | 12.61 | 10.62 | 7.63 | 2.48 | 1.02 | 1.47 | 0.63 | 0.14 | 462 | 280 |
| P4-P2-S1-No100 | 0.149 | 55.61 | 8.19 | 12.47 | 10.46 | 7.57 | 2.41 | 1.02 | 1.33 | 0.63 | 0.14 | 453 | 300 |
| P4-P2-S1-No60 | 0.25 | 53.92 | 8.38 | 12.13 | 10.19 | 7.34 | 1.66 | 0.94 | 1.01 | 0.63 | 0.14 | 410 | 340 |
| P4-P2-S1-No40 | 0.42 | 53.87 | 8.68 | 12.23 | 10.47 | 7.45 | 1.03 | 0.89 | 0.96 | 0.68 | 0.15 | 382 | 300 |
| P4-P2-S1-No20 | 0.841 | 53.71 | 9.15 | 12.94 | 11.13 | 7.68 | 0.96 | 0.79 | 1 | 0.74 | 0.16 | 372 | 370 |
| P4-P2-S1-No10 | 2 | 54.84 | 8.97 | 13.39 | 11.81 | 8.43 | 0.82 | 0.78 | 1.3 | 0.79 | 0.18 | 430 | 380 |
| P4-P2-S1-No4 | 4.76 | 54.98 | 8.01 | 13.12 | 11.28 | 7.74 | 1.04 | 0.72 | 1.25 | 0.83 | 0.17 | 382 | 340 |
| P4-P2-S1 Avg* | - | 54.83 | 8.11 | 13.17 | 11.24 | 7.75 | 1.08 | 0.74 | 1.23 | 0.82 | 0.17 | 386 | 339 |
| P4-P2-S2-pan | 0.037 | 51.69 | 12.64 | 13.08 | 8.94 | 6.62 | 2.23 | 1.11 | 0.69 | 0.52 | 0.11 | 342 | 360 |
| P4-P2-S2-No200 | 0.074 | 49.75 | 10.47 | 10.3 | 8.08 | 5.55 | 1.64 | 1.3 | 0.46 | 0.43 | 0.1 | 278 | 270 |
| P4-P2-S2-No140 | 0.105 | 52.08 | 10.64 | 10.2 | 8.52 | 5.26 | 1.49 | 1.37 | 0.59 | 0.44 | 0.1 | 238 | 340 |
| P4-P2-S2-No100 | 0.149 | 49.64 | 11.35 | 10.5 | 8.01 | 5.24 | 1.68 | 1.09 | 0.25 | 0.45 | 0.1 | 314 | 220 |
| P4-P2-S2-No60 | 0.25 | 57.24 | 9.84 | 9.01 | 8.57 | 5.2 | 0.98 | 1.2 | 0.99 | 0.4 | 0.09 | 286 | 260 |
| P4-P2-S2-No40 | 0.42 | 56.84 | 10.75 | 9.04 | 9.32 | 5.92 | 0.74 | 1.24 | 1.04 | 0.43 | 0.1 | 328 | 290 |
| P4-P2-S2-No20 | 0.841 | 55.02 | 14.65 | 11.73 | 10.33 | 6.74 | 0.73 | 0.89 | 1.08 | 0.58 | 0.14 | 397 | 350 |
| P4-P2-S2-No10 | 2 | 54.24 | 16.17 | 12.89 | 10.07 | 6.93 | 0.9 | 0.74 | 0.8 | 0.61 | 0.16 | 393 | 330 |
| P4-P2-S2-No4 | 4.76 | 54.08 | 16.56 | 12.46 | 9.69 | 6.53 | 0.77 | 0.71 | 0.69 | 0.63 | 0.16 | 486 | 380 |
| P4-P2-S2 Avg* | - | 54.05 | 16.19 | 12.35 | 9.65 | 6.49 | 0.82 | 0.74 | 0.7 | 0.62 | 0.16 | 471 | 373 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14(Cont.): X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P1-S1-pan | 0.037 | 377 | 366 | 88 | 14 | 568 | 253 | 43 | 11 | 88 | 817 | 190 |
| P4-P1-S1-No200 | 0.074 | 293 | 262 | 67 | 16 | 599 | 272 | 43 | 12 | 94 | 868 | 130 |
| P4-P1-S1-No140 | 0.105 | 317 | 228 | 63 | 16 | 587 | 275 | 43 | 12 | 89 | 895 | 120 |
| P4-P1-S1-No100 | 0.149 | 271 | 215 | 60 | 15 | 547 | 264 | 43 | 12 | 83 | 912 | 120 |
| P4-P1-S1-No60 | 0.25 | 265 | 203 | 63 | 24 | 622 | 252 | 41 | 12 | 82 | 900 | 110 |
| P4-P1-S1-No40 | 0.42 | 267 | 206 | 65 | 14 | 730 | 239 | 40 | 12 | 115 | 872 | 120 |
| P4-P1-S1-No20 | 0.841 | 266 | 212 | 74 | 4 | 873 | 207 | 33 | 11 | 146 | 803 | 110 |
| P4-P1-S1-No10 | 2 | 247 | 235 | 77 | 3 | 881 | 193 | 29 | 11 | 139 | 782 | 110 |
| P4-P1-S1-No4 | 4.76 | 466 | 236 | 70 | -7 | 772 | 192 | 35 | 9 | 141 | 728 | 100 |
| P4-P1-S1 Avg* | - | 445 | 236 | 70 | -4 | 767 | 196 | 35 | 9 | 138 | 740 | 0.01 |
| P4-P2-S1-pan | 0.037 | 798 | 355 | 122 | -15 | 305 | 140 | 27 | 2 | 167 | 586 | 110 |
| P4-P2-S1-No200 | 0.074 | 734 | 273 | 98 | -4 | 333 | 166 | 34 | 6 | 159 | 644 | 110 |
| P4-P2-S1-No140 | 0.105 | 685 | 198 | 78 | 5 | 316 | 165 | 36 | 8 | 160 | 711 | 100 |
| P4-P2-S1-No100 | 0.149 | 658 | 195 | 82 | 4 | 304 | 166 | 36 | 8 | 149 | 695 | 110 |
| P4-P2-S1-No60 | 0.25 | 569 | 174 | 75 | 3 | 285 | 156 | 34 | 9 | 170 | 716 | 100 |
| P4-P2-S1-No40 | 0.42 | 446 | 135 | 73 | -4 | 289 | 148 | 31 | 8 | 197 | 711 | 100 |
| P4-P2-S1-No20 | 0.841 | 381 | 104 | 72 | -5 | 287 | 131 | 32 | 8 | 225 | 682 | 110 |
| P4-P2-S1-No10 | 2 | 501 | 76 | 83 | -4 | 224 | 131 | 34 | 8 | 218 | 668 | 110 |
| P4-P2-S1-No4 | 4.76 | 176 | 73 | 76 | -10 | 213 | 118 | 28 | 8 | 223 | 683 | 100 |
| P4-P2-S1 Avg* | - | 219 | 82 | 76 | -9 | 220 | 120 | 28 | 7 | 220 | 681 | 0.01 |
| P4-P2-S2-pan | 0.037 | 770 | 422 | 96 | 1 | 728 | 216 | 35 | 7 | 103 | 724 | 160 |
| P4-P2-S2-No200 | 0.074 | 596 | 272 | 69 | 5 | 633 | 249 | 44 | 10 | 98 | 788 | 120 |
| P4-P2-S2-No140 | 0.105 | 647 | 263 | 72 | 7 | 687 | 241 | 44 | 10 | 113 | 811 | 90 |
| P4-P2-S2-No100 | 0.149 | 576 | 243 | 70 | 10 | 783 | 228 | 41 | 10 | 99 | 814 | 90 |
| P4-P2-S2-No60 | 0.25 | 516 | 192 | 63 | 10 | 669 | 227 | 37 | 11 | 105 | 829 | 90 |
| P4-P2-S2-No40 | 0.42 | 485 | 172 | 64 | 6 | 670 | 225 | 39 | 11 | 115 | 818 | 100 |
| P4-P2-S2-No20 | 0.841 | 457 | 195 | 85 | -6 | 869 | 185 | 30 | 9 | 177 | 737 | 100 |
| P4-P2-S2-No10 | 2 | 627 | 213 | 93 | -6 | 947 | 161 | 23 | 9 | 183 | 698 | 100 |
| P4-P2-S2-No4 | 4.76 | 428 | 222 | 95 | -8 | 993 | 147 | 26 | 9 | 178 | 710 | 100 |
| P4-P2-S2 Avg* | - | 444 | 224 | 93 | -7 | 971 | 152 | 26 | 8 | 173 | 714 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P3-S1-pan | 0.037 | 54.14 | 8.02 | 9.51 | 9.63 | 7.36 | 1.34 | 1.41 | 1.31 | 0.53 | 0.11 | 420 | 390 |
| P4-P3-S1-No200 | 0.074 | 54.35 | 6.25 | 7.48 | 8.93 | 6.16 | 0.96 | 1.56 | 1.11 | 0.45 | 0.09 | 274 | 390 |
| P4-P3-S1-No140 | 0.105 | 59.26 | 6.01 | 7.12 | 9.41 | 5.7 | 0.83 | 1.59 | 1.75 | 0.43 | 0.08 | 175 | 300 |
| P4-P3-S1-No100 | 0.149 | 60.51 | 5.7 | 6.52 | 9.04 | 5.34 | 0.72 | 1.51 | 1.74 | 0.39 | 0.07 | 275 | 280 |
| P4-P3-S1-No60 | 0.25 | 61.36 | 6.36 | 6.96 | 9.39 | 5.47 | 0.7 | 1.4 | 1.84 | 0.4 | 0.08 | 286 | 330 |
| P4-P3-S1-No40 | 0.42 | 59.7 | 7.6 | 8.09 | 10.34 | 6.19 | 0.61 | 1.34 | 1.81 | 0.47 | 0.1 | 299 | 330 |
| P4-P3-S1-No20 | 0.841 | 55.73 | 8.67 | 9.6 | 10.73 | 7.19 | 0.68 | 1.11 | 1.73 | 0.58 | 0.12 | 395 | 340 |
| P4-P3-S1-No10 | 2 | 51.14 | 9.32 | 11.03 | 9.58 | 7.5 | 0.73 | 0.83 | 1.12 | 0.62 | 0.14 | 427 | 380 |
| P4-P3-S1-No4 | 4.76 | 54.91 | 7.8 | 10.7 | 12.38 | 9.4 | 0.44 | 1.05 | 2.03 | 0.72 | 0.15 | 516 | 560 |
| P4-P3-S1 Avg* | - | 54.96 | 7.8 | 10.62 | 12.27 | 9.28 | 0.45 | 1.06 | 2 | 0.71 | 0.15 | 508 | 550 |
| P4-P4B-S1-pan | 0.037 | 57.42 | 2.44 | 3.12 | 8.46 | 4.56 | 0.08 | 2 | 1.49 | 0.41 | 0.04 | 519 | 550 |
| P4-P4B-S1-No200 | 0.074 | 51.95 | 1.87 | 2.33 | 7.02 | 3.53 | 0.06 | 1.91 | 0.64 | 0.3 | 0.03 | 301 | 580 |
| P4-P4B-S1-No140 | 0.105 | 51.59 | 1.93 | 2.34 | 7.16 | 3.63 | 0.06 | 1.95 | 0.58 | 0.28 | 0.03 | 273 | 370 |
| P4-P4B-S1-No100 | 0.149 | 60.39 | 1.85 | 2.38 | 8.27 | 3.56 | 0.04 | 2.03 | 1.83 | 0.27 | 0.03 | 204 | 340 |
| P4-P4B-S1-No60 | 0.25 | 60.29 | 1.96 | 2.26 | 8.01 | 3.6 | 0.04 | 1.91 | 1.76 | 0.26 | 0.03 | 268 | 360 |
| P4-P4B-S1-No40 | 0.42 | 63.54 | 1.9 | 2.51 | 9.08 | 3.68 | 0.02 | 1.95 | 2.67 | 0.25 | 0.03 | 290 | 340 |
| P4-P4B-S1-No20 | 0.841 | 60.17 | 2.67 | 3.48 | 10.72 | 5.39 | 0.04 | 2.06 | 2.78 | 0.33 | 0.04 | 323 | 430 |
| P4-P4B-S1-No10 | 2 | 64.6 | 2.72 | 4.11 | 11.87 | 5.49 | 0.04 | 1.97 | 3.44 | 0.4 | 0.05 | 309 | 480 |
| P4-P4B-S1-No4 | 4.76 | 65.44 | 3.74 | 4.07 | 11.55 | 6.27 | 0.03 | 1.8 | 3.33 | 0.36 | 0.05 | 384 | 460 |
| P4-P4B-S1 Avg* | - | 64.56 | 3.47 | 3.87 | 11.15 | 5.92 | 0.04 | 1.83 | 3.14 | 0.35 | 0.05 | 369 | 451 |
| P4-P4B-S2-pan | 0.037 | 57.4 | 4.66 | 3.25 | 8.34 | 10.04 | 0.1 | 2.13 | 1.91 | 0.38 | 0.05 | 583 | 490 |
| P4-P4B-S2-No200 | 0.074 | 55.5 | 2.87 | 2.68 | 7.57 | 6.71 | 0.07 | 2.17 | 1.26 | 0.3 | 0.04 | 488 | 370 |
| P4-P4B-S2-No140 | 0.105 | 57.38 | 2.9 | 2.66 | 8.05 | 6.53 | 0.08 | 2.14 | 1.56 | 0.29 | 0.04 | 487 | 460 |
| P4-P4B-S2-No100 | 0.149 | 57.25 | 2.42 | 2.43 | 7.14 | 5.69 | 0.04 | 1.97 | 1.16 | 0.25 | 0.03 | 408 | 280 |
| P4-P4B-S2-No60 | 0.25 | 62.58 | 2.37 | 2.3 | 7.92 | 5.7 | 0.04 | 1.9 | 1.83 | 0.22 | 0.03 | 426 | 270 |
| P4-P4B-S2-No40 | 0.42 | 60.94 | 2.8 | 2.54 | 8.23 | 7.22 | 0.04 | 1.95 | 2.05 | 0.24 | 0.03 | 443 | 290 |
| P4-P4B-S2-No20 | 0.841 | 61.92 | 3.73 | 3.71 | 10.31 | 7.77 | 0.06 | 2.12 | 2.65 | 0.35 | 0.05 | 523 | 500 |
| P4-P4B-S2-No10 | 2 | 61.67 | 3.93 | 3.88 | 10.41 | 8.86 | 0.04 | 2 | 2.77 | 0.38 | 0.05 | 456 | 510 |
| P4-P4B-S2-No4 | 4.76 | 61.05 | 4.85 | 4.94 | 10.8 | 9.71 | 0.19 | 1.91 | 2.78 | 0.43 | 0.07 | 567 | 500 |
| P4-P4B-S2 Avg* | - | 60.28 | 3.93 | 3.8 | 9.51 | 8.42 | 0.12 | 1.98 | 2.31 | 0.35 | 0.05 | 513 | 437 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14(Cont.): X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P3-S1-pan | 0.037 | 382 | 187 | 92 | 16 | 345 | 249 | 40 | 11 | 113 | 797 | 170 |
| P4-P3-S1-No200 | 0.074 | 292 | 116 | 65 | 17 | 327 | 271 | 48 | 12 | 108 | 871 | 150 |
| P4-P3-S1-No140 | 0.105 | 305 | 108 | 65 | 14 | 292 | 271 | 46 | 12 | 92 | 883 | 120 |
| P4-P3-S1-No100 | 0.149 | 237 | 92 | 53 | 11 | 300 | 264 | 45 | 12 | 86 | 912 | 100 |
| P4-P3-S1-No60 | 0.25 | 265 | 96 | 56 | 13 | 353 | 249 | 44 | 12 | 104 | 899 | 110 |
| P4-P3-S1-No40 | 0.42 | 253 | 102 | 62 | 11 | 415 | 236 | 42 | 12 | 122 | 857 | 110 |
| P4-P3-S1-No20 | 0.841 | 246 | 110 | 67 | 6 | 389 | 215 | 39 | 11 | 145 | 789 | 130 |
| P4-P3-S1-No10 | 2 | 342 | 136 | 73 | -1 | 461 | 188 | 35 | 10 | 173 | 742 | 110 |
| P4-P3-S1-No4 | 4.76 | 142 | 94 | 73 | 5 | 214 | 228 | 42 | 10 | 185 | 735 | 120 |
| P4-P3-S1 Avg* | - | 149 | 95 | 72 | 5 | 221 | 227 | 41 | 10 | 182 | 738 | 0.01 |
| P4-P4B-S1-pan | 0.037 | 66 | 25 | 33 | 10 | 64 | 387 | 56 | 13 | 72 | 1049 | 280 |
| P4-P4B-S1-No200 | 0.074 | 33 | 21 | 24 | 11 | 45 | 377 | 58 | 13 | 57 | 1121 | 140 |
| P4-P4B-S1-No140 | 0.105 | 36 | 19 | 19 | 16 | 53 | 361 | 58 | 14 | 48 | 1122 | 140 |
| P4-P4B-S1-No100 | 0.149 | 28 | 19 | 24 | 11 | 75 | 348 | 57 | 13 | 53 | 1140 | 120 |
| P4-P4B-S1-No60 | 0.25 | 23 | 17 | 19 | 13 | 80 | 340 | 55 | 13 | 49 | 1157 | 110 |
| P4-P4B-S1-No40 | 0.42 | 24 | 21 | 21 | 11 | 105 | 350 | 58 | 13 | 55 | 1120 | 110 |
| P4-P4B-S1-No20 | 0.841 | 25 | 29 | 32 | 13 | 111 | 390 | 57 | 13 | 76 | 1040 | 140 |
| P4-P4B-S1-No10 | 2 | 27 | 36 | 38 | 10 | 132 | 380 | 58 | 13 | 77 | 996 | 140 |
| P4-P4B-S1-No4 | 4.76 | 28 | 60 | 38 | 13 | 246 | 349 | 53 | 13 | 76 | 991 | 140 |
| P4-P4B-S1 Avg* | - | 28 | 54 | 35 | 12 | 219 | 351 | 53 | 13 | 73 | 1008 | 0.01 |
| P4-P4B-S2-pan | 0.037 | 75 | 28 | 32 | 24 | 67 | 360 | 55 | 13 | 70 | 1005 | 260 |
| P4-P4B-S2-No200 | 0.074 | 44 | 23 | 27 | 14 | 74 | 357 | 56 | 13 | 65 | 1060 | 160 |
| P4-P4B-S2-No140 | 0.105 | 51 | 20 | 23 | 16 | 72 | 361 | 58 | 13 | 58 | 1074 | 160 |
| P4-P4B-S2-No100 | 0.149 | 35 | 19 | 23 | 17 | 70 | 338 | 54 | 13 | 44 | 1106 | 110 |
| P4-P4B-S2-No60 | 0.25 | 30 | 19 | 20 | 17 | 103 | 317 | 52 | 13 | 49 | 1118 | 100 |
| P4-P4B-S2-No40 | 0.42 | 30 | 19 | 22 | 21 | 87 | 336 | 57 | 13 | 55 | 1087 | 110 |
| P4-P4B-S2-No20 | 0.841 | 47 | 29 | 33 | 17 | 98 | 353 | 62 | 13 | 62 | 1006 | 140 |
| P4-P4B-S2-No10 | 2 | 36 | 29 | 37 | 23 | 95 | 352 | 55 | 13 | 68 | 995 | 160 |
| P4-P4B-S2-No4 | 4.76 | 73 | 44 | 43 | 22 | 144 | 322 | 59 | 13 | 98 | 939 | 150 |
| P4-P4B-S2 Avg* | - | 55 | 31 | 34 | 20 | 109 | 335 | 56 | 12 | 75 | 1006 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P4B-S3-pan | 0.037 | 50.26 | 9.97 | 15.56 | 11.07 | 9.84 | 1.55 | 0.64 | 1.05 | 0.76 | 0.18 | 462 | 290 |
| P4-P4B-S3-No200 | 0.074 | 46.65 | 8.54 | 14.54 | 9.87 | 10.1 | 2.04 | 0.71 | 0.64 | 0.66 | 0.17 | 494 | 230 |
| P4-P4B-S3-No140 | 0.105 | 49.87 | 8.34 | 13.68 | 10.53 | 10.55 | 2.35 | 0.78 | 1.2 | 0.68 | 0.16 | 457 | 280 |
| P4-P4B-S3-No100 | 0.149 | 48.58 | 7.51 | 12.75 | 9.8 | 10.76 | 3.04 | 0.77 | 1.07 | 0.69 | 0.15 | 514 | 320 |
| P4-P4B-S3-No60 | 0.25 | 50.1 | 7.73 | 12.35 | 10.42 | 10.11 | 2.39 | 0.78 | 1.13 | 0.69 | 0.15 | 489 | 310 |
| P4-P4B-S3-No40 | 0.42 | 50.88 | 7.91 | 12.2 | 10.75 | 9.08 | 1.07 | 0.76 | 0.93 | 0.69 | 0.16 | 430 | 360 |
| P4-P4B-S3-No20 | 0.841 | 51.86 | 8.59 | 12.16 | 11.21 | 8.93 | 0.7 | 0.69 | 1.19 | 0.71 | 0.16 | 444 | 290 |
| P4-P4B-S3-No10 | 2 | 52.79 | 8.54 | 11.95 | 11.61 | 9.14 | 0.54 | 0.69 | 1.31 | 0.73 | 0.17 | 440 | 340 |
| P4-P4B-S3 Avg* | - | 52.67 | 8.55 | 12.02 | 11.56 | 9.16 | 0.59 | 0.69 | 1.3 | 0.73 | 0.17 | 440 | 337 |
| P4-P4-S1-pan | 0.037 | 58.36 | 4.73 | 7.25 | 9.68 | 6.46 | 0.71 | 1.65 | 1.92 | 0.52 | 0.08 | 246 | 510 |
| P4-P4-S1-No60 | 0.25 | 64.22 | 3.65 | 5.33 | 9.64 | 4.91 | 0.37 | 1.64 | 2.32 | 0.39 | 0.06 | 204 | 350 |
| P4-P4-S1-No40 | 0.42 | 62.63 | 4.65 | 6.51 | 10.27 | 6.05 | 0.4 | 1.58 | 2.43 | 0.46 | 0.08 | 254 | 390 |
| P4-P4-S1-No20 | 0.841 | 58.88 | 6.4 | 8.99 | 11.49 | 7.73 | 0.55 | 1.32 | 2.31 | 0.61 | 0.12 | 395 | 470 |
| P4-P4-S1-No10 | 2 | 56.35 | 7.44 | 10.9 | 11.99 | 8.07 | 0.83 | 1.12 | 1.99 | 0.73 | 0.14 | 430 | 420 |
| P4-P4-S1-No4 | 4.76 | 58.12 | 6.95 | 10.5 | 11.88 | 8.04 | 0.63 | 0.94 | 2.23 | 0.76 | 0.14 | 437 | 410 |
| P4-P4-S1 Avg* | - | 58.19 | 6.87 | 10.36 | 11.81 | 7.97 | 0.63 | 0.97 | 2.22 | 0.75 | 0.14 | 429 | 411 |
| P4-P5-S1-pan | 0.037 | 52.04 | 7.79 | 16.49 | 10.35 | 9.32 | 2.68 | 0.93 | 1.59 | 0.72 | 0.16 | 496 | 380 |
| P4-P5-S1-No40 | 0.42 | 53.08 | 6.37 | 11.85 | 10.61 | 8.35 | 0.86 | 0.87 | 1.37 | 0.78 | 0.16 | 449 | 480 |
| P4-P5-S1-No20 | 0.841 | 54.37 | 6.42 | 11.98 | 11.02 | 8.4 | 1.39 | 0.97 | 1.52 | 0.77 | 0.16 | 446 | 420 |
| P4-P5-S1-No10 | 2 | 52.48 | 6.33 | 12.55 | 10.71 | 8.14 | 0.83 | 0.84 | 1.26 | 0.86 | 0.18 | 467 | 400 |
| P4-P5-S1 Avg* | - | 52.48 | 6.34 | 12.58 | 10.71 | 8.15 | 0.85 | 0.84 | 1.26 | 0.86 | 0.18 | 467 | 400 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14(Cont.): X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P4B-S3-pan | 0.037 | 670 | 155 | 132 | -4 | 229 | 137 | 22 | 4 | 225 | 625 | 100 |
| P4-P4B-S3-No200 | 0.074 | 640 | 118 | 115 | 0 | 194 | 145 | 27 | 5 | 201 | 656 | 90 |
| P4-P4B-S3-No140 | 0.105 | 698 | 103 | 105 | 7 | 188 | 153 | 27 | 6 | 197 | 653 | 90 |
| P4-P4B-S3-No100 | 0.149 | 537 | 82 | 119 | 16 | 168 | 158 | 31 | 8 | 192 | 687 | 90 |
| P4-P4B-S3-No60 | 0.25 | 449 | 75 | 84 | 11 | 174 | 156 | 32 | 8 | 193 | 691 | 90 |
| P4-P4B-S3-No40 | 0.42 | 387 | 71 | 82 | 5 | 172 | 155 | 30 | 8 | 206 | 701 | 100 |
| P4-P4B-S3-No20 | 0.841 | 359 | 67 | 73 | 2 | 176 | 151 | 29 | 9 | 211 | 692 | 100 |
| P4-P4B-S3-No10 | 2 | 413 | 74 | 83 | -5 | 260 | 157 | 27 | 9 | 226 | 694 | 100 |
| P4-P4B-S3 Avg* | - | 417 | 74 | 83 | -4 | 256 | 156 | 27 | 8 | 224 | 692 | 0 |
| P4-P4-S1-pan | 0.037 | 239 | 66 | 66 | 12 | 113 | 316 | 44 | 11 | 100 | 872 | 230 |
| P4-P4-S1-No60 | 0.25 | 135 | 40 | 41 | 13 | 167 | 303 | 51 | 13 | 92 | 962 | 120 |
| P4-P4-S1-No40 | 0.42 | 162 | 47 | 48 | 16 | 191 | 286 | 49 | 12 | 112 | 906 | 120 |
| P4-P4-S1-No20 | 0.841 | 237 | 59 | 61 | 10 | 204 | 257 | 45 | 11 | 152 | 803 | 110 |
| P4-P4-S1-No10 | 2 | 367 | 60 | 72 | 2 | 198 | 214 | 41 | 10 | 190 | 742 | 110 |
| P4-P4-S1-No4 | 4.76 | 195 | 55 | 69 | 4 | 185 | 199 | 36 | 10 | 221 | 744 | 110 |
| P4-P4-S1 Avg* | - | 197 | 55 | 68 | 4 | 184 | 202 | 36 | 10 | 215 | 749 | 0.01 |
| P4-P5-S1-pan | 0.037 | 652 | 124 | 136 | 8 | 192 | 178 | 30 | 3 | 185 | 594 | 120 |
| P4-P5-S1-No40 | 0.42 | 311 | 45 | 73 | -1 | 164 | 166 | 36 | 9 | 209 | 698 | 120 |
| P4-P5-S1-No20 | 0.841 | 320 | 48 | 71 | 12 | 166 | 184 | 38 | 10 | 199 | 701 | 110 |
| P4-P5-S1-No10 | 2 | 160 | 37 | 72 | -3 | 169 | 160 | 37 | 9 | 237 | 686 | 110 |
| P4-P5-S1 Avg* | - | 165 | 38 | 72 | -3 | 169 | 160 | 37 | 8 | 236 | 685 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P5-S2-pan | 0.037 | 55.57 | 7.4 | 9.16 | 10.28 | 8.47 | 0.52 | 1.36 | 1.7 | 0.58 | 0.12 | 413 | 480 |
| P4-P5-S2-No200 | 0.074 | 54.52 | 5.71 | 6.66 | 9.22 | 6.79 | 0.41 | 1.54 | 1.43 | 0.45 | 0.09 | 327 | 400 |
| P4-P5-S2-No140 | 0.105 | 57.18 | 4.44 | 5.72 | 8.65 | 6.03 | 0.39 | 1.61 | 1.46 | 0.41 | 0.07 | 322 | 340 |
| P4-P5-S2-No100 | 0.149 | 57.84 | 3.79 | 5.04 | 8.04 | 5.66 | 0.46 | 1.53 | 1.52 | 0.36 | 0.07 | 275 | 240 |
| P4-P5-S2-No60 | 0.25 | 59.15 | 5.22 | 6.68 | 10.16 | 7.22 | 0.34 | 1.41 | 2.07 | 0.46 | 0.09 | 372 | 320 |
| P4-P5-S2-No40 | 0.42 | 60.47 | 4.37 | 5.5 | 9 | 6.15 | 0.55 | 1.48 | 1.8 | 0.38 | 0.07 | 342 | 280 |
| P4-P5-S2-No20 | 0.841 | 54.57 | 6.58 | 8.7 | 10.88 | 8.71 | 0.31 | 1.17 | 1.87 | 0.58 | 0.12 | 472 | 410 |
| P4-P5-S2-No10 | 2 | 52.06 | 6.92 | 9.78 | 10.8 | 7.79 | 0.4 | 0.95 | 1.82 | 0.66 | 0.13 | 427 | 510 |
| P4-P5-S2-No4 | 4.76 | 53.59 | 8.21 | 10.46 | 12.13 | 10.29 | 0.34 | 0.91 | 2.04 | 0.72 | 0.15 | 518 | 510 |
| P4-P5-S2 Avg* | - | 53.98 | 7.81 | 9.98 | 11.75 | 9.79 | 0.35 | 0.98 | 1.99 | 0.69 | 0.14 | 495 | 490 |
| P4-P6-S1-pan | 0.037 | 52.65 | 7.21 | 14.94 | 10.17 | 9.1 | 2.21 | 1.06 | 1.4 | 0.67 | 0.15 | 557 | 290 |
| P4-P6-S1-No200 | 0.074 | 48.92 | 6.42 | 13.61 | 9.2 | 10.47 | 3.26 | 1.08 | 1.17 | 0.61 | 0.15 | 603 | 280 |
| P4-P6-S1-No140 | 0.105 | 45.29 | 5.66 | 12.25 | 8.08 | 12.85 | 5.42 | 1.01 | 1.08 | 0.59 | 0.14 | 667 | 340 |
| P4-P6-S1-No100 | 0.149 | 42.21 | 5.19 | 11.58 | 7.2 | 14.77 | 7.45 | 0.86 | 1.18 | 0.61 | 0.14 | 741 | 350 |
| P4-P6-S1-No60 | 0.25 | 54.31 | 5.89 | 10.72 | 9.71 | 8.88 | 2.31 | 1.1 | 1.48 | 0.63 | 0.13 | 453 | 330 |
| P4-P6-S1-No40 | 0.42 | 53.63 | 6.23 | 11.52 | 10.16 | 8.13 | 1.19 | 1.03 | 1.27 | 0.7 | 0.15 | 431 | 360 |
| P4-P6-S1-No20 | 0.841 | 54.99 | 7.22 | 12.43 | 11.15 | 8.28 | 1.13 | 0.91 | 1.49 | 0.78 | 0.17 | 427 | 450 |
| P4-P6-S1-No10 | 2 | 55.51 | 7.2 | 13.32 | 11.77 | 8.11 | 1.63 | 0.92 | 1.85 | 0.82 | 0.17 | 420 | 440 |
| P4-P6-S1-No4 | 4.76 | 56.14 | 7.01 | 12.53 | 11.86 | 7.29 | 1.25 | 0.84 | 1.98 | 0.86 | 0.17 | 385 | 540 |
| P4-P6-S1 Avg* | - | 55.77 | 6.99 | 12.6 | 11.7 | 7.52 | 1.37 | 0.86 | 1.92 | 0.84 | 0.16 | 397 | 518 |
| P4-P7-S1-pan | 0.037 | 62.42 | 2.9 | 3.62 | 9.38 | 4.53 | 0.12 | 1.79 | 2.42 | 0.44 | 0.05 | 256 | 620 |
| P4-P7-S1-No200 | 0.074 | 59.16 | 2.26 | 2.64 | 8.4 | 3.61 | 0.1 | 1.81 | 1.8 | 0.3 | 0.04 | 245 | 510 |
| P4-P7-S1-No140 | 0.105 | 64.44 | 1.94 | 2.76 | 8.6 | 3.09 | 0.08 | 1.84 | 2.33 | 0.28 | 0.03 | 441 | 370 |
| P4-P7-S1-No100 | 0.149 | 65.16 | 2.06 | 2.76 | 8.8 | 3.07 | 0.06 | 1.76 | 2.35 | 0.25 | 0.03 | 205 | 350 |
| P4-P7-S1-No60 | 0.25 | 63.11 | 2.28 | 2.75 | 8.67 | 3.38 | 0.05 | 1.74 | 2.21 | 0.3 | 0.04 | 238 | 370 |
| P4-P7-S1-No40 | 0.42 | 60.89 | 2.49 | 3.15 | 8.84 | 3.89 | 0.05 | 1.71 | 2.11 | 0.34 | 0.04 | 205 | 430 |
| P4-P7-S1-No20 | 0.841 | 61.93 | 3.16 | 4.26 | 10.48 | 4.65 | 0.08 | 1.7 | 2.86 | 0.41 | 0.05 | 260 | 420 |
| P4-P7-S1-No10 | 2 | 63.55 | 3.48 | 4.56 | 10.71 | 4.51 | 0.14 | 1.67 | 3.03 | 0.42 | 0.06 | 208 | 420 |
| P4-P7-S1-No4 | 4.76 | 65.47 | 2.73 | 4.22 | 10.59 | 4.01 | 0.04 | 1.89 | 3.1 | 0.4 | 0.05 | 197 | 500 |
| P4-P7-S1 Avg* | - | 65.11 | 2.73 | 4.13 | 10.45 | 4.01 | 0.05 | 1.87 | 3.02 | 0.4 | 0.05 | 202 | 491 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14(Cont.): X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P5-S2-pan | 0.037 | 209 | 102 | 85 | 15 | 189 | 274 | 42 | 10 | 139 | 803 | 210 |
| P4-P5-S2-No200 | 0.074 | 140 | 62 | 57 | 9 | 158 | 301 | 46 | 12 | 107 | 883 | 140 |
| P4-P5-S2-No140 | 0.105 | 137 | 51 | 46 | 13 | 151 | 303 | 49 | 12 | 102 | 936 | 100 |
| P4-P5-S2-No100 | 0.149 | 108 | 43 | 39 | 14 | 135 | 291 | 46 | 13 | 86 | 967 | 90 |
| P4-P5-S2-No60 | 0.25 | 104 | 49 | 44 | 10 | 169 | 276 | 44 | 12 | 130 | 894 | 110 |
| P4-P5-S2-No40 | 0.42 | 107 | 46 | 39 | 15 | 150 | 282 | 45 | 13 | 103 | 951 | 100 |
| P4-P5-S2-No20 | 0.841 | 108 | 62 | 61 | 10 | 181 | 258 | 42 | 11 | 163 | 798 | 110 |
| P4-P5-S2-No10 | 2 | 124 | 71 | 61 | 2 | 177 | 221 | 35 | 10 | 151 | 767 | 130 |
| P4-P5-S2-No4 | 4.76 | 140 | 74 | 73 | 9 | 172 | 224 | 31 | 10 | 181 | 736 | 120 |
| P4-P5-S2 Avg* | - | 138 | 72 | 70 | 9 | 171 | 231 | 32 | 9 | 172 | 756 | 0.01 |
| P4-P6-S1-pan | 0.037 | 575 | 92 | 118 | 24 | 145 | 184 | 33 | 6 | 154 | 637 | 130 |
| P4-P6-S1-No200 | 0.074 | 566 | 75 | 95 | 29 | 153 | 198 | 38 | 7 | 151 | 664 | 110 |
| P4-P6-S1-No140 | 0.105 | 474 | 63 | 93 | 49 | 148 | 210 | 41 | 10 | 150 | 714 | 100 |
| P4-P6-S1-No100 | 0.149 | 501 | 56 | 80 | 62 | 132 | 213 | 42 | 10 | 172 | 748 | 100 |
| P4-P6-S1-No60 | 0.25 | 408 | 53 | 65 | 19 | 165 | 193 | 42 | 10 | 169 | 736 | 100 |
| P4-P6-S1-No40 | 0.42 | 334 | 44 | 68 | 18 | 168 | 175 | 42 | 10 | 189 | 713 | 110 |
| P4-P6-S1-No20 | 0.841 | 314 | 49 | 70 | 29 | 178 | 160 | 37 | 9 | 203 | 692 | 110 |
| P4-P6-S1-No10 | 2 | 355 | 55 | 70 | 8 | 174 | 154 | 35 | 8 | 214 | 666 | 110 |
| P4-P6-S1-No4 | 4.76 | 299 | 47 | 67 | -7 | 165 | 159 | 32 | 9 | 220 | 697 | 120 |
| P4-P6-S1 Avg* | - | 312 | 48 | 68 | -2 | 165 | 160 | 32 | 8 | 216 | 694 | 0.01 |
| P4-P7-S1-pan | 0.037 | 62 | 36 | 34 | 8 | 85 | 373 | 50 | 13 | 82 | 1035 | 260 |
| P4-P7-S1-No200 | 0.074 | 53 | 31 | 24 | 8 | 65 | 370 | 53 | 13 | 66 | 1099 | 130 |
| P4-P7-S1-No140 | 0.105 | 39 | 23 | 19 | 7 | 93 | 359 | 50 | 13 | 61 | 1109 | 120 |
| P4-P7-S1-No100 | 0.149 | 38 | 24 | 22 | 4 | 107 | 352 | 50 | 13 | 50 | 1106 | 140 |
| P4-P7-S1-No60 | 0.25 | 34 | 25 | 25 | 9 | 90 | 350 | 49 | 13 | 70 | 1113 | 130 |
| P4-P7-S1-No40 | 0.42 | 35 | 29 | 27 | 10 | 95 | 359 | 49 | 13 | 68 | 1086 | 150 |
| P4-P7-S1-No20 | 0.841 | 51 | 39 | 36 | 10 | 134 | 363 | 46 | 13 | 84 | 1015 | 140 |
| P4-P7-S1-No10 | 2 | 47 | 45 | 38 | 6 | 149 | 348 | 44 | 13 | 86 | 997 | 150 |
| P4-P7-S1-No4 | 4.76 | 35 | 36 | 41 | 8 | 140 | 340 | 58 | 13 | 90 | 1012 | 170 |
| P4-P7-S1 Avg* | - | 35 | 36 | 39 | 7 | 136 | 342 | 57 | 13 | 87 | 1018 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

*Table A.14: X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples*

| *Sample ID* | *Sieve Size (mm)* | *SiO2 (%)* | *MgO (%)* | *Fe2O3 (%)* | *Al2O3 (%)* | *CaO (%)* | *S (%)* | *K2O (%)* | *Na2O (%)* | *TiO2 (%)* | *MnO (%)* | *Ba (ppm)* | *P (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P7-S2-pan | 0.037 | 47.08 | 20.31 | 20.92 | 6.28 | 2.61 | 2.36 | 0.37 | -0.25 | 0.36 | 0.11 | 215 | 210 |
| P4-P7-S2-No200 | 0.074 | 45.5 | 19.12 | 18 | 5.74 | 3.13 | 2.34 | 0.38 | -0.56 | 0.32 | 0.11 | 238 | 80 |
| P4-P7-S2-No140 | 0.105 | 50.6 | 20.6 | 17.23 | 6.69 | 3.62 | 2.3 | 0.48 | 0.07 | 0.34 | 0.11 | 266 | 130 |
| P4-P7-S2-No100 | 0.149 | 50.09 | 19.89 | 16.42 | 6.71 | 3.56 | 2.36 | 0.49 | 0.12 | 0.34 | 0.1 | 294 | 170 |
| P4-P7-S2-No60 | 0.25 | 47.48 | 19.94 | 16.34 | 6.41 | 3.04 | 2.23 | 0.41 | -0.36 | 0.32 | 0.1 | 278 | 110 |
| P4-P7-S2-No40 | 0.42 | 48.02 | 20.91 | 15.9 | 6.8 | 2.71 | 1.73 | 0.4 | -0.43 | 0.32 | 0.11 | 244 | 140 |
| P4-P7-S2-No20 | 0.841 | 50.84 | 22.51 | 14.08 | 7.54 | 2.8 | 1.28 | 0.44 | -0.14 | 0.37 | 0.11 | 262 | 160 |
| P4-P7-S2-No10 | 2 | 52.89 | 22.88 | 13.38 | 7.68 | 3.13 | 1.35 | 0.41 | 0.08 | 0.38 | 0.11 | 278 | 150 |
| P4-P7-S2-No4 | 4.76 | 54.38 | 25.36 | 12.76 | 7.5 | 3.76 | 1.01 | 0.41 | 0.26 | 0.35 | 0.12 | 288 | 130 |
| P4-P7-S2 Avg* | - | 54.12 | 25.13 | 12.92 | 7.48 | 3.71 | 1.06 | 0.41 | 0.24 | 0.35 | 0.12 | 286 | 131 |
| P4-P8-S1-pan | 0.037 | 60.75 | 4.12 | 3.88 | 9.28 | 4.88 | 0.22 | 1.78 | 2.05 | 0.44 | 0.05 | 315 | 610 |
| P4-P8-S1-No200 | 0.074 | 58.81 | 3.22 | 2.95 | 8.42 | 3.79 | 0.15 | 1.77 | 1.79 | 0.3 | 0.04 | 220 | 500 |
| P4-P8-S1-No140 | 0.105 | 62.07 | 2.79 | 2.75 | 8.3 | 3.18 | 0.13 | 1.83 | 2.05 | 0.26 | 0.03 | 236 | 260 |
| P4-P8-S1-No100 | 0.149 | 62.65 | 2.72 | 2.57 | 7.98 | 3.02 | 0.14 | 1.71 | 1.93 | 0.22 | 0.03 | 244 | 270 |
| P4-P8-S1-No60 | 0.25 | 65.5 | 3.1 | 2.99 | 8.67 | 3.17 | 0.13 | 1.66 | 2.34 | 0.27 | 0.04 | 223 | 240 |
| P4-P8-S1-No40 | 0.42 | 65.15 | 4.02 | 3.64 | 9.7 | 3.9 | 0.1 | 1.72 | 2.64 | 0.31 | 0.05 | 267 | 340 |
| P4-P8-S1-No20 | 0.841 | 60.1 | 5.54 | 4.45 | 9.8 | 5.12 | 0.11 | 1.69 | 2.34 | 0.37 | 0.06 | 335 | 400 |
| P4-P8-S1-No10 | 2 | 62.54 | 5.7 | 4.75 | 10.4 | 4.4 | 0.15 | 1.63 | 2.71 | 0.4 | 0.06 | 272 | 430 |
| P4-P8-S1-No4 | 4.76 | 62.38 | 7.43 | 5.5 | 9.98 | 4.3 | 0.14 | 1.48 | 2.28 | 0.4 | 0.07 | 297 | 300 |
| P4-P8-S1 Avg* | - | 62.32 | 6.09 | 4.74 | 9.66 | 4.18 | 0.14 | 1.58 | 2.27 | 0.37 | 0.06 | 284 | 337 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

***Table A.14(Cont.): X-Ray Fluorescence Data for WRS#4 Profile Excavation Samples***

| *Sample ID* | *Sieve Size (mm)* | *Cu (ppm)* | *Ni (ppm)* | *Zn (ppm)* | *As (ppm)* | *Cr (ppm)* | *Sr (ppm)* | *Rb (ppm)* | *Pb (ppm)* | *V (ppm)* | *Rh (ppm)* | *Zr (ppm)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4-P7-S2-pan | 0.037 | 1084 | 826 | 130 | -62 | 1538 | 101 | 15 | -5 | 74 | 574 | 100 |
| P4-P7-S2-No200 | 0.074 | 1007 | 656 | 115 | -42 | 1529 | 117 | 16 | 0 | 78 | 628 | 70 |
| P4-P7-S2-No140 | 0.105 | 1079 | 573 | 116 | -34 | 1595 | 119 | 17 | 2 | 90 | 647 | 80 |
| P4-P7-S2-No100 | 0.149 | 1013 | 515 | 116 | -33 | 1635 | 122 | 18 | 3 | 99 | 674 | 80 |
| P4-P7-S2-No60 | 0.25 | 759 | 463 | 110 | -30 | 1732 | 115 | 13 | 3 | 90 | 673 | 80 |
| P4-P7-S2-No40 | 0.42 | 634 | 413 | 124 | -33 | 1916 | 106 | 13 | 4 | 100 | 680 | 80 |
| P4-P7-S2-No20 | 0.841 | 570 | 315 | 112 | -32 | 1893 | 104 | 13 | 6 | 107 | 694 | 90 |
| P4-P7-S2-No10 | 2 | 586 | 377 | 110 | -22 | 1774 | 120 | 14 | 7 | 101 | 720 | 90 |
| P4-P7-S2-No4 | 4.76 | 591 | 364 | 115 | -21 | 1933 | 105 | 14 | 8 | 111 | 730 | 80 |
| P4-P7-S2 Avg* | - | 599 | 369 | 114 | -21 | 1922 | 105 | 14 | 7 | 109 | 727 | 0 |
| P4-P8-S1-pan | 0.037 | 72 | 77 | 43 | 10 | 133 | 371 | 48 | 13 | 71 | 1017 | 260 |
| P4-P8-S1-No200 | 0.074 | 61 | 45 | 29 | 5 | 106 | 364 | 49 | 13 | 61 | 1071 | 160 |
| P4-P8-S1-No140 | 0.105 | 49 | 46 | 27 | 10 | 156 | 353 | 53 | 13 | 64 | 1095 | 120 |
| P4-P8-S1-No100 | 0.149 | 38 | 43 | 27 | 6 | 125 | 343 | 47 | 13 | 52 | 1133 | 100 |
| P4-P8-S1-No60 | 0.25 | 41 | 52 | 26 | 11 | 189 | 334 | 46 | 13 | 62 | 1099 | 110 |
| P4-P8-S1-No40 | 0.42 | 46 | 68 | 33 | 6 | 230 | 346 | 49 | 13 | 69 | 1066 | 130 |
| P4-P8-S1-No20 | 0.841 | 47 | 85 | 45 | 10 | 279 | 348 | 47 | 13 | 80 | 1002 | 140 |
| P4-P8-S1-No10 | 2 | 43 | 89 | 52 | 7 | 285 | 338 | 44 | 13 | 89 | 998 | 140 |
| P4-P8-S1-No4 | 4.76 | 40 | 122 | 52 | 8 | 511 | 312 | 42 | 13 | 106 | 968 | 130 |
| P4-P8-S1 Avg* | - | 43 | 99 | 45 | 7 | 385 | 327 | 44 | 12 | 91 | 1002 | 0.01 |

*Grain size distributions (Cash, 2014) were used to calculate a weighted average value

# Appendix B – In Situ Waste Rock Monitoring Data

Appendix B contains a detailed summary of *in situ* geochemical data collected from WRS#3 and WRS#4, the remaining historic waste rock piles at the Detour Lake mine site. The detailed results include the following data:

- Table B.1: Air Permeability Data
- Table B.2: Pore-Water Geochemical Data: BH3-1
- Table B.3: Pore-Water Geochemical Data: BH3-2
- Table B.4: Pore-Water Geochemical Data: BH4-2
- Table B.5: Pore-Water Geochemical Data: BH4-3
- Table B.6: Pore-Water Geochemical Data: BH4-4
- Table B.7: Pore-Water Geochemical Data: BH4-5
- Table B.8: BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices
- Table B.9: BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices
- Table B.10: BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices

***Table B.1: Air Permeability Data – BH3-1***

| *Location* | *Depth (mBGS)* | *Permeability Measurements ($m^2$)* | | | | |
|---|---|---|---|---|---|---|
| | | *Date* | *Maximum* | *Minimum* | *Average* | *Median* |
| *BH3-1* | *6.7* | 10/27/2012 | 1.3E-10 | 7.9E-11 | 9.1E-11 | 8.6E-11 |
| | | 6/13/2013 | 8.6E-11 | 6.3E-11 | 6.8E-11 | 6.6E-11 |
| | | 5/18/2013 | 1.3E-10 | 7.0E-11 | 7.8E-11 | 7.7E-11 |
| | | 5/18/2013 | 1.1E-10 | 6.7E-11 | 7.4E-11 | 7.2E-11 |
| | | 6/14/2013 | 1.2E-10 | 7.2E-11 | 7.9E-11 | 7.9E-11 |
| | | 6/14/2013 | 7.1E-11 | 5.3E-11 | 6.5E-11 | 6.7E-11 |
| | | 6/14/2013 | 8.8E-11 | 7.0E-11 | 7.4E-11 | 7.3E-11 |
| | | 5/7/2014 | 1.2E-10 | 6.3E-11 | 7.4E-11 | 7.0E-11 |
| | | 7/10/2014 | 1.4E-10 | 7.2E-11 | 8.6E-11 | 8.1E-11 |
| | | 8/12/2014 | 1.8E-10 | 7.9E-11 | 1.3E-10 | 1.2E-10 |
| | | 8/12/2014 | 1.9E-10 | 1.1E-10 | 1.3E-10 | 1.2E-10 |
| | | 8/12/2014 | 3.0E-10 | 1.1E-10 | 1.3E-10 | 1.2E-10 |
| | | 9/5/2014 | 1.0E-10 | 6.0E-11 | 8.0E-11 | 7.9E-11 |
| | | 9/5/2014 | 1.4E-10 | 5.9E-11 | 7.0E-11 | 6.6E-11 |
| | | 9/26/2014 | 1.1E-10 | 6.0E-11 | 7.0E-11 | 6.6E-11 |
| | | 9/26/2014 | 8.5E-11 | 5.9E-11 | 6.4E-11 | 6.2E-11 |
| | | Overall Average = 8.5E-11 | | | | |
| | *11.7* | 10/27/2012 | 6.5E-09 | 4.6E-11 | 9.3E-10 | 6.3E-10 |
| | | 10/27/2012 | 1.0E-09 | 6.3E-10 | 7.2E-10 | 7.0E-10 |
| | | 10/27/2012 | 6.7E-10 | 5.2E-10 | 5.8E-10 | 5.7E-10 |
| | | 5/18/2013 | 3.6E-09 | 3.4E-10 | 4.9E-10 | 4.2E-10 |
| | | 6/13/2013 | 7.8E-09 | 3.2E-10 | 5.0E-10 | 4.0E-10 |
| | | 6/13/2013 | 1.1E-07 | 2.5E-10 | 7.4E-09 | 3.5E-09 |
| | | 6/14/2013 | 5.7E-10 | 3.7E-10 | 4.3E-10 | 4.4E-10 |
| | | 6/14/2013 | 4.6E-10 | 2.9E-10 | 4.1E-10 | 4.4E-10 |
| | | 5/7/2014 | 6.0E-09 | 4.1E-10 | 7.3E-10 | 5.3E-10 |
| | | 5/7/2014 | 1.2E-08 | 4.6E-10 | 6.3E-10 | 5.1E-10 |
| | | 5/7/2014 | 1.3E-08 | 4.6E-10 | 6.6E-10 | 4.9E-10 |
| | | 7/10/2014 | 8.6E-09 | 4.0E-10 | 6.1E-10 | 5.3E-10 |
| | | 7/10/2014 | 1.4E-09 | 4.7E-10 | 5.3E-10 | 5.2E-10 |
| | | 8/12/2014 | 6.3E-09 | 7.8E-10 | 9.8E-10 | 8.8E-10 |
| | | 8/12/2014 | 1.4E-08 | 7.8E-10 | 1.1E-09 | 8.4E-10 |
| | | 9/5/2014 | 1.7E-09 | 2.4E-10 | 5.9E-10 | 5.9E-10 |
| | | 9/5/2014 | 9.0E-10 | 1.8E-10 | 4.7E-10 | 4.6E-10 |
| | | 9/26/2014 | 7.4E-10 | 2.5E-10 | 4.4E-10 | 4.3E-10 |
| | | 9/26/2014 | 6.2E-10 | 3.5E-10 | 4.6E-10 | 4.5E-10 |
| | | Overall Average = 9.8E-10 | | | | |
| | *16.7* | 6/13/2013 | 2.8E-09 | 2.9E-10 | 8.8E-10 | 6.3E-10 |
| | | 6/13/2013 | 2.0E-09 | 2.0E-10 | 4.5E-09 | 1.8E-09 |
| | | 9/5/2014 | 4.4E-10 | 4.3E-10 | 4.4E-10 | 4.4E-10 |
| | | Overall Average = 1.9E-09 | | | | |

***Table B.1(Cont.): Air Permeability Data – BH3-2***

| *Location* | *Depth (mBGS)* | *Permeability Measurements ($m^2$)* | | | | |
|---|---|---|---|---|---|---|
| | | *Date* | *Maximum* | *Minimum* | *Average* | *Median* |
| *BH3-2* | *7.5* | 10/27/2012 | 9.6E-11 | 6.6E-11 | 7.4E-11 | 7.1E-11 |
| | | 5/18/2013 | 7.2E-11 | 5.0E-11 | 5.6E-11 | 5.4E-11 |
| | | 6/13/2013 | 6.1E-11 | 4.5E-11 | 5.1E-11 | 5.1E-11 |
| | | 6/13/2013 | 6.0E-11 | 4.6E-11 | 5.1E-11 | 5.1E-11 |
| | | 6/14/2013 | 6.5E-11 | 5.1E-11 | 5.5E-11 | 5.4E-11 |
| | | 6/14/2013 | 6.5E-11 | 5.1E-11 | 5.4E-11 | 5.3E-11 |
| | | 5/7/2014 | 6.0E-11 | 3.8E-11 | 4.3E-11 | 4.2E-11 |
| | | 7/10/2014 | 8.1E-11 | 5.2E-11 | 6.0E-11 | 5.7E-11 |
| | | 7/10/2014 | 7.6E-11 | 4.9E-11 | 5.2E-11 | 5.2E-11 |
| | | 7/10/2014 | 6.6E-11 | 5.0E-11 | 5.4E-11 | 5.3E-11 |
| | | 8/12/2014 | 8.2E-10 | 4.5E-10 | 5.4E-10 | 5.2E-10 |
| | | 8/12/2014 | 2.1E-09 | 3.5E-10 | 5.3E-10 | 4.5E-10 |
| | | 8/12/2014 | 6.8E-10 | 3.3E-10 | 4.2E-10 | 3.9E-10 |
| | | 8/12/2014 | 8.2E-11 | 5.4E-11 | 6.2E-11 | 5.9E-11 |
| | | 8/12/2014 | 1.6E-10 | 7.7E-11 | 8.8E-11 | 8.5E-11 |
| | | 9/5/2014 | 8.3E-11 | 5.1E-11 | 5.9E-11 | 5.6E-11 |
| | | 9/26/2014 | 6.5E-11 | 4.5E-11 | 5.0E-11 | 4.8E-11 |
| | | Overall Average = 1.4E-10 | | | | |
| | *12.5* | 10/27/2012 | 1.3E-09 | 3.7E-10 | 5.0E-10 | 4.3E-10 |
| | | 5/18/2013 | 8.0E-10 | 2.5E-10 | 3.3E-10 | 2.9E-10 |
| | | 6/13/2013 | 2.6E-10 | 1.3E-10 | 2.2E-10 | 2.3E-10 |
| | | 6/14/2013 | 3.6E-10 | 2.4E-10 | 2.7E-10 | 2.6E-10 |
| | | 6/14/2013 | 3.1E-10 | 2.2E-10 | 2.5E-10 | 2.5E-10 |
| | | 7/10/2014 | 5.5E-10 | 2.2E-10 | 2.9E-10 | 2.8E-10 |
| | | 7/10/2014 | 3.5E-10 | 2.4E-10 | 2.8E-10 | 2.7E-10 |
| | | 9/5/2014 | 4.6E-09 | 9.2E-11 | 2.6E-10 | 2.1E-10 |
| | | 9/5/2014 | 2.9E-10 | 6.4E-11 | 2.2E-10 | 2.4E-10 |
| | | 9/26/2014 | 4.0E-10 | 1.6E-10 | 2.7E-10 | 2.7E-10 |
| | | 9/26/2014 | 3.8E-10 | 2.1E-10 | 2.7E-10 | 2.6E-10 |
| | | Overall Average = 2.9E-10 | | | | |
| | *17.5* | 5/18/2013 | 5.3E-10 | 2.6E-10 | 8.9E-10 | 3.0E-10 |
| | | 9/26/2014 | 5.0E-10 | 2.2E-11 | 2.2E-10 | 1.2E-10 |
| | | Overall Average = 5.5E-10 | | | | |

***Table B.1(Cont.): Air Permeability Data – WRS#3 Test Pits***

| Location | Depth (mBGS) | Permeability Measurements ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| | | Date | Maximum | Minimum | Average | Median |
| TP3-3 | 0.75 | 5/7/2014 | 3.1E-11 | 8.0E-13 | 6.9E-12 | 4.9E-12 |
| | | 7/10/2014 | 3.4E-11 | 1.6E-11 | 2.4E-11 | 2.4E-11 |
| | | 8/13/2014 | 1.8E-10 | 1.5E-10 | 1.8E-10 | 1.8E-10 |
| | | 9/4/2014 | 3.1E-11 | 1.6E-11 | 1.8E-11 | 1.7E-11 |
| | | 9/26/2014 | 2.2E-11 | 1.3E-11 | 1.7E-11 | 1.7E-11 |
| | | Overall Average = 4.9E-11 | | | | |
| TP3-4 | 0.65 | 5/7/2014 | 6.2E-11 | 3.1E-11 | 4.2E-11 | 3.1E-11 |
| | | 7/10/2014 | 1.7E-11 | 1.0E-11 | 1.5E-11 | 1.6E-11 |
| | | 7/10/2014 | 9.5E-11 | 5.8E-12 | 2.5E-11 | 1.8E-11 |
| | | 8/13/2014 | 2.3E-11 | 1.5E-11 | 1.8E-11 | 1.6E-11 |
| | | 9/4/2014 | 1.7E-11 | 1.6E-11 | 1.6E-11 | 1.6E-11 |
| | | 9/26/2014 | 6.5E-12 | 1.6E-12 | 3.3E-12 | 3.1E-12 |
| | | Overall Average = 2.0E-11 | | | | |
| TP3-5 | 0.57 | 5/7/2014 | 6.2E-11 | 3.1E-11 | 4.3E-11 | 3.1E-11 |
| | | 7/10/2014 | 3.2E-11 | 2.3E-13 | 2.1E-11 | 2.3E-11 |
| | | 8/13/2014 | 2.3E-11 | 1.4E-11 | 1.8E-11 | 1.6E-11 |
| | | 9/4/2014 | 1.2E-10 | 8.5E-12 | 2.9E-11 | 2.3E-11 |
| | | 9/26/2014 | 2.5E-11 | 1.2E-11 | 1.8E-11 | 1.9E-11 |
| | | Overall Average = 2.6E-11 | | | | |

***Table B.1(Cont.): Air Permeability Data – BH4-2***

| Location | Depth (mBGS) | Permeability Measurements ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| | | Date | Maximum | Minimum | Average | Median |
| BH4-2 | 8.0 | 6/14/2013 | 7.4E-09 | 2.0E-12 | 1.9E-09 | 1.7E-09 |
| | | 6/14/2013 | 7.4E-09 | 5.8E-10 | 1.9E-09 | 1.7E-09 |
| | | 8/13/2014 | 1.0E-08 | 8.1E-10 | 1.4E-09 | 1.3E-09 |
| | | 9/5/2014 | 1.6E-09 | 4.2E-10 | 7.1E-10 | 6.6E-10 |
| | | 9/27/2014 | 7.0E-10 | 3.8E-10 | 4.6E-10 | 4.5E-10 |
| | | Overall Average = 1.3E-09 | | | | |
| | 13.0 | 6/14/2013 | 6.4E-10 | 1.1E-10 | 2.9E-10 | 2.8E-10 |
| | | 6/14/2013 | 1.6E-08 | 3.3E-09 | 6.2E-09 | 6.0E-09 |
| | | 6/14/2013 | 6.9E-10 | 1.1E-10 | 2.9E-10 | 2.8E-10 |
| | | 9/27/2014 | 2.5E-08 | 3.9E-09 | 9.0E-09 | 6.8E-09 |
| | | Overall Average = 4.0E-09 | | | | |
| | 18.0 | 6/14/2013 | 8.7E-09 | 1.6E-09 | 3.4E-09 | 2.8E-09 |
| | | 6/14/2013 | 8.5E-09 | 3.2E-09 | 4.5E-09 | 4.1E-09 |
| | | 6/14/2013 | 8.7E-09 | 1.6E-09 | 3.4E-09 | 2.8E-09 |
| | | 6/14/2013 | 9.0E-09 | 3.2E-09 | 4.6E-09 | 4.2E-09 |
| | | 9/27/2014 | 1.2E-08 | 1.5E-09 | 4.7E-09 | 4.7E-09 |
| | | Overall Average = 4.1E-09 | | | | |

***Table B.1(Cont.): Air Permeability Data – BH4-3***

| Location | Depth (mBGS) | Permeability Measurements ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| | | Date | Maximum | Minimum | Average | Median |
| BH4-3 | 7.5 | 10/27/2012 | 3.2E-08 | 1.4E-09 | 1.2E-08 | 1.2E-08 |
| | | 6/13/2013 | 1.3E-08 | 1.1E-10 | 1.2E-09 | 7.7E-10 |
| | | 9/27/2014 | 1.2E-07 | 7.8E-10 | 1.0E-08 | 5.8E-09 |
| | | Overall Average = 7.9E-09 | | | | |
| | 12.5 | 9/27/2014 | 5.8E-09 | 8.9E-10 | 2.4E-09 | 2.1E-09 |
| | | Overall Average = 2.4E-09 | | | | |
| | 17.5 | 6/13/2013 | 1.0E-08 | 7.6E-11 | 7.6E-10 | 4.1E-10 |
| | | 9/27/2014 | 2.1E-08 | 1.5E-09 | 4.0E-09 | 2.8E-09 |
| | | Overall Average = 2.4E-09 | | | | |
| | 21.5 | 6/13/2013 | 9.2E-09 | 7.9E-11 | 9.2E-09 | 9.2E-09 |
| | | 6/14/2013 | 7.8E-09 | 2.9E-09 | 7.8E-09 | 7.8E-09 |
| | | 7/10/2014 | 5.6E-09 | 4.7E-10 | 5.6E-09 | 5.6E-09 |
| | | 9/27/2014 | 2.0E-08 | 3.9E-10 | 4.1E-09 | 3.4E-09 |
| | | Overall Average = 6.7E-09 | | | | |

***Table B.1(Cont.): Air Permeability Data – BH4-4***

| Location | Depth (mBGS) | Permeability Measurements ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| | | Date | Maximum | Minimum | Average | Median |
| BH4-4 | 4.3 | 10/27/2012 | 7.93E-09 | 2.89E-09 | 4.83E-09 | 4.99E-09 |
| | | 6/14/2013 | 3.48E-09 | 2.72E-10 | 1.06E-09 | 9.59E-10 |
| | | 6/14/2013 | 8.57E-09 | 1.61E-09 | 2.82E-09 | 2.06E-09 |
| | | 7/11/2014 | 3.53E-08 | 1.12E-09 | 7.26E-09 | 6.61E-09 |
| | | 9/5/2014 | 1.26E-08 | 1.60E-09 | 3.37E-09 | 2.99E-09 |
| | | 9/27/2014 | 1.75E-08 | 4.03E-10 | 2.62E-09 | 2.55E-09 |
| | | Overall Average = 3.7E-09 | | | | |
| | 9.3 | 6/14/2013 | 6.22E-09 | 5.47E-10 | 1.31E-09 | 8.84E-10 |
| | | 6/14/2013 | 6.08E-09 | 1.41E-10 | 1.94E-09 | 9.81E-10 |
| | | 9/27/2014 | 2.56E-09 | 2.63E-10 | 9.28E-10 | 9.71E-10 |
| | | Overall Average = 1.4E-09 | | | | |
| | 14.3 | 6/14/2013 | 1.93E-08 | 6.81E-10 | 5.82E-09 | 4.84E-09 |
| | | 7/11/2014 | 3.55E-08 | 4.53E-09 | 1.27E-08 | 1.16E-08 |
| | | 9/27/2014 | 7.65E-09 | 2.15E-10 | 1.82E-09 | 1.58E-09 |
| | | Overall Average = 6.8E-09 | | | | |
| | 19.3 | 9/27/2014 | 2.45E-08 | 8.74E-10 | 3.26E-09 | 2.06E-09 |
| | | Overall Average = 3.3E-09 | | | | |

***Table B.1(Cont.): Air Permeability Data – BH4-5***

| *Location* | *Depth (mBGS)* | *Permeability Measurements ($m^2$)* | | | | |
|---|---|---|---|---|---|---|
| | | *Date* | *Maximum* | *Minimum* | *Average* | *Median* |
| *BH4-5* | *7.5* | 6/14/2013 | 8.23E-09 | 9.11E-11 | 9.82E-10 | 8.00E-10 |
| | | 6/14/2013 | 1.28E-08 | 1.05E-09 | 3.21E-09 | 2.63E-09 |
| | | 6/14/2013 | 5.06E-08 | 3.61E-10 | 3.75E-09 | 2.39E-09 |
| | | 10/27/2014 | 2.53E-08 | 3.36E-09 | 8.37E-09 | 7.16E-09 |
| | | Overall Average = 4.1E-09 | | | | |
| | *12.5* | 6/14/2013 | 6.61E-08 | 1.04E-10 | 8.04E-09 | 5.41E-09 |
| | | 9/27/2014 | 9.79E-09 | 2.92E-09 | 5.31E-09 | 5.20E-09 |
| | | 10/27/2014 | 2.91E-08 | 6.28E-09 | 1.44E-08 | 1.37E-08 |
| | | Overall Average = 9.3E-09 | | | | |
| | *17.5* | 9/27/2014 | 2.25E-09 | 2.64E-10 | 9.71E-10 | 1.07E-09 |
| | | Overall Average = 9.7E-10 | | | | |
| | *22.5* | 10/27/2012 | 1.20E-11 | 1.13E-11 | 1.17E-11 | 1.17E-11 |
| | | 7/11/2014 | 2.78E-11 | 1.97E-11 | 2.42E-11 | 2.44E-11 |
| | | 8/13/2014 | 1.58E-11 | 1.52E-11 | 1.55E-11 | 1.56E-11 |
| | | 9/5/2014 | 1.55E-11 | 1.43E-11 | 1.49E-11 | 1.50E-11 |
| | | 9/27/2014 | 1.20E-09 | 4.74E-11 | 2.23E-10 | 1.38E-10 |
| | | Overall Average = 5.8E-11 | | | | |

***Table B.2: Pore-Water Geochemical Data: BH3-1***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (°C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-1* | *4.2* | 20-May-13 | 7.85 | 268.1 | 2.45 | 20.7 | 910 | 0.6 | 6.0 | < 0.03 | < 0.03 | 7.0 | 371 | < 0.03 | - | - |
| | | 6-Oct-13 | 7.56 | 453.5 | - | - | 533 | - | - | - | - | - | - | - | - | - |
| | | 7-Sep-14 | 8.03 | 103.7 | - | - | - | - | - | - | - | - | - | - | - | - |
| | *9.2* | 16-Jun-12 | 8.43 | 328.3 | - | - | 319 | - | - | - | - | - | - | - | - | - |
| | | 16-Jun-12 | - | - | - | - | 164 | - | - | - | - | - | - | - | - | - |
| | | 23-Jun-12 | 8.57 | 375.3 | - | - | 1550 | 5.7 | 10.0 | < 0.1 | < 0.1 | 17.4 | 102.1 | < 0.1 | - | - |
| | | 18-Aug-12 | - | - | - | - | - | | | | | | | | - | - |
| | | 14-Jun-13 | 7.62 | 459.0 | - | - | 1000 | 1.5 | 6.6 | < 0.3 | < 0.3 | 4.3 | 421.4 | < 0.3 | - | - |
| | | 27-Jul-13 | 8.39 | 375.0 | 1.87 | 25.8 | - | - | - | - | - | - | - | - | - | - |
| | | 9-May-14 | 8.43 | 395.8 | 3.03 | 19.7 | 1440 | - | - | - | - | - | - | - | - | - |
| | *14.2* | 13-Aug-14 | 8.08 | 100.6 | 2.2 | 12.6 | 614 | - | - | - | - | - | - | - | - | 0.001 |
| | | 28-Sep-14 | 8.11 | 23.5 | - | - | 635 | - | - | - | - | - | - | - | - | - |
| | | 23-Jun-12 | 8.53 | 349.3 | - | - | - | 5.7 | 10.0 | 0.17 | < 0.3 | 12.0 | 107.8 | < 0.3 | - | - |
| | *Piezo-meter* | 28-Sep-14 | 7.23 | 40.7 | 0.9 | 19.1 | 551 | < 0.1 | 3.80 | < 0.1 | < 0.1 | < 0.1 | 56.9 | < 0.1 | - | - |

***Table B.2(Cont.): Pore-Water Geochemical Data: BH3-1***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-1* | *4.2* | 20-May-13 | < DL | < DL | 232 | < DL | < DL | < DL | < DL | < DL | 11.7 | < DL | 150.3 |
| | *9.2* | 16-Jun-12 | < DL | < DL | 152.7 | < DL | < DL | < DL | < DL | < DL | 4.2 | - | 353.4 |
| | | 23-Jun-12 | < DL | < DL | 93.4 | < DL | < DL | < DL | < DL | < DL | 4.2 | - | 360.8 |
| | | 8/18/2012 | < DL | < DL | 20.2 | < DL | < DL | < DL | < DL | < DL | 4.7 | < DL | 369.2 |
| | | 14-Jun-13 | < DL | < DL | 239.2 | < DL | < DL | < DL | < DL | < DL | 8.2 | < DL | 187.6 |
| | *14.2* | 23-Jun-12 | < DL | < DL | 160.4 | < DL | < DL | < DL | < DL | < DL | 3.5 | - | 277.7 |
| | *Piezo-meter* | 28-Sep-14 | < 2 | < 1 | 136.8 | < 2 | < 1 | < 2 | < 2 | < 2 | 3.9 | < 1 | 40.7 |

***Table B.2(Cont.): Pore-Water Geochemical Data: BH3-1***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-1* | *4.2* | 20-May-13 | < DL | 26.1 | < DL | < DL | < DL | 232 | < DL | < DL | < DL | < DL | < DL |
| | *9.2* | 16-Jun-12 | < DL | 8.0 | < DL | < DL | < DL | 152.7 | < DL | < DL | < DL | < DL | < DL |
| | | 23-Jun-12 | < DL | 8.3 | < DL | < DL | < DL | 93.4 | < DL | < DL | < DL | < DL | < DL |
| | | 18-Aug-12 | < DL | 10.4 | < DL | < DL | < DL | 20.2 | < DL | < DL | < DL | < DL | < DL |
| | | 14-Jun-13 | < DL | 52.0 | < DL | < DL | < DL | 239.2 | < DL | < DL | < DL | < DL | < DL |
| | *14.2* | 23-Jun-12 | < DL | 7.8 | < DL | < DL | < DL | 160.4 | < DL | < DL | < DL | < DL | < DL |
| | *Piezo-meter* | 28-Sep-14 | < 1 | 4.6 | < 1 | < 2 | < 1 | 136.8 | < 2 | < 1 | < 2 | < 2 | < 2 |

***Table B.2(Cont.): Pore-Water Geochemical Data: BH3-1***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-1* | *4.2* | 20-May-13 | 101.3 | < 0.02 | 737.5 | 30040 | O/R | < 0.04 | 21220 | 324.7 | 13450 | - | < 0.2 | 287.3 | < 0.02 | 117 | 4.3 |
| | *9.2* | 16-Jun-12 | 286.7 | < DL | 3403 | 7029 | O/R | 13.6 | O/R | < DL | 4534 | - | < 0.287 | 974.5 | 2.6 | 19.6 | 6 |
| | | 23-Jun-12 | 292.3 | < DL | 3454 | 6594 | O/R | 27.5 | O/R | < DL | 4671 | - | < 0.287 | 996 | 2.6 | 6.8 | 53.1 |
| | | 18-Aug-12 | 316.9 | < DL | 3596 | - | - | 29.4 | O/R | < DL | - | - | < 0.1 | 1119 | 4.9 | 9.7 | 69.4 |
| | | 14-Jun-13 | 86.7 | < 0.02 | 1189 | O/R | O/R | 2 | 30450 | < 10 | 11150 | - | < 0.2 | 351 | 0.2 | 170.4 | 3.2 |
| | *14.2* | 23-Jun-12 | 349.1 | < DL | 3809 | 6501 | O/R | 93.7 | O/R | < DL | 4069 | - | 3.4 | 966.3 | 4.6 | 33.3 | 17.5 |
| | *Piezo-meter* | 28-Sep-14 | < 0.4 | < 0.08 | < 2 | - | - | < 0.5 | 7164 | < 35 | - | - | < 0.5 | 1 | < 0.3 | 247 | 152 |

***Table B.2(Cont.): Pore-Water Geochemical Data: BH3-1***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-1* | *4.2* | 20-May-13 | 1.1 | 10 | 6 | < 0.8 | 6.9 | - | 396.8 | 79.7 | < 0.004 | 0 | < 0.1 | 0.8 | 21.3 | 0 | 0.2 | 14.4 |
| | *9.2* | 16-Jun-12 | 1.2 | 6.9 | 6.7 | 529.9 | 20.7 | - | 316.1 | 157.7 | < DL | 0.1 | 7.4 | 2.2 | 48.7 | < 0.0125 | 0.6 | 14.2 |
| | | 23-Jun-12 | 1 | 4.1 | 3.9 | 91.9 | 20.2 | - | 258.3 | 165.4 | < DL | 0.1 | 9.3 | 1.5 | 28.5 | < DL | 0.4 | 12.9 |
| | | 18-Aug-12 | 1 | 4.9 | 149.9 | 105.6 | 22.9 | - | 254.1 | 183.2 | < DL | < DL | 24.3 | 3 | 29.2 | < 0.002 | 15.1 | 4 |
| | | 14-Jun-13 | 0.6 | 6 | 1.9 | 81.8 | 9.8 | - | 449.8 | 30.7 | < 0.004 | < 0.005 | 3.7 | 0.9 | 66.6 | 0 | 0 | 11.9 |
| | *14.2* | 23-Jun-12 | 1.5 | 3.5 | 3.1 | 1163 | 16.4 | - | 284.6 | 234.3 | < DL | 0.2 | 18.7 | 1.5 | 35.5 | < 0.0125 | 0.4 | 9.8 |
| | *Piezo-meter* | 28-Sep-14 | 1.1 | 2.6 | < 0.2 | < 2.5 | 6.1 | < 2 | 465.8 | 4 | 0.1 | < 0.05 | < 1.5 | 0.9 | 122.5 | 0 | < 0.04 | 4.7 |

***Table B.3: Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-2* | *5.0* | 23-Jun-12 | 7.9 | 411.3 | - | - | - | 0.1 | 5.8 | < 0.3 | < 0.3 | < 0.3 | 260 | < 0.3 | - | - |
| | | 20-May-13 | 7.1 | 251.4 | 1.4 | 19.2 | 670 | 0.9 | 1.9 | < 0.03 | < 0.03 | < 0.03 | 81.5 | < 0.03 | - | 11.4 |
| | | 14-Jun-13 | 8.1 | 420.4 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 7.5 | 418.2 | 1.2 | 17.4 | 585 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 174.3 | < 0.3 | <0.01 | 9.9 |
| | | 6-Oct-13 | 7.3 | 455.1 | - | - | 660 | 2.1 | 0.8 | < 1.0 | < 0.3 | 1.5 | 669.5 | < 1.0 | - | - |
| | | 9-May-14 | 8.5 | 408.6 | - | - | 554.4 | 0.7 | 1.4 | < 0.1 | < 0.1 | 1.1 | 143.9 | - | - | 6.9 |
| | | 14-Jun-14 | 7.3 | 455.4 | 1 | 11.8 | - | 0.4 | 0.7 | < 0.1 | < 0.1 | 0.3 | 498.1 | < 0.1 | - | - |
| | | 12-Jul-14 | 8.2 | 470.5 | 1.6 | 24.4 | 490 | - | - | - | - | - | - | - | - | - |
| | | 13-Aug-14 | 8 | 81.8 | - | - | 233.3 | - | - | - | - | - | - | - | - | - |
| | | 7-Sep-14 | 7.6 | 115.1 | - | - | 425 | - | - | - | - | - | - | - | - | - |
| | | 28-Sep-14 | 7.8 | 26.9 | 1.2 | 19.7 | 508.2 | 0.3 | 0.2 | < 0.1 | < 0.1 | 1.7 | 282.1 | < 0.1 | - | - |
| | *10.0* | 20-May-13 | 8.4 | 254.8 | 2.4 | 20.2 | 1320 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-13 | 8.1 | 437 | 1.6 | 22.6 | 700 | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 8.1 | 412.8 | 1.3 | 25.4 | 390 | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 6.9 | 420.2 | 1.1 | 17.2 | 525 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 177 | < 0.3 | 0.1 | 9.1 |
| | | 14-Jun-14 | 7.9 | 395.7 | 2.1 | 17.5 | - | - | - | - | - | - | - | - | - | - |
| | | 13-Aug-14 | 8 | 83.6 | - | - | 602 | - | - | - | - | - | - | - | - | - |
| | | 7-Sep-14 | 7.5 | 120.1 | - | - | 440 | - | - | - | - | - | - | - | - | - |
| | | 28-Sep-14 | 8.3 | 9.5 | - | - | 595.8 | - | - | - | - | - | - | - | - | - |
| | | 28-Oct-12 | 8 | 357.6 | - | - | 692.8 | - | - | - | - | - | - | - | - | - |

***Table B.3(Cont.): Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-2* | *15.0* | 16-Jun-12 | 7.3 | 366.8 | 1.6 | 20.7 | 159.5 | 0.3 | 5.5 | < 0.3 | < 0.3 | < 0.3 | 266.2 | < 0.3 | - | - |
| | | 23-Jun-12 | 8.1 | 375.3 | - | - | 600 | - | - | - | - | - | - | - | - | - |
| | | Duplicate | - | | - | - | 640 | - | - | - | - | - | - | - | - | - |
| | | 26-Jun-12 | 7.2 | 366.3 | - | - | 570 | 0.1 | 6.1 | < 0.3 | < 0.3 | < 0.3 | 285.9 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 680 | - | - | - | - | - | - | - | - | - |
| | | 20-Jul-12 | 7.8 | 259.3 | - | - | 680 | < 0.3 | 6.3 | < 0.3 | < 0.3 | < 0.3 | 325.7 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 760 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8.1 | 259.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 18-Aug-12 | 7.9 | 367.3 | - | - | 840 | < 0.3 | 7.7 | < 0.3 | < 0.3 | 0.9 | 434.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 740 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 675 | - | - | - | - | - | - | - | - | - |
| | | 25-Sep-12 | 7.5 | 425 | - | - | 609.8 | < 0.3 | 7.6 | < 0.3 | < 0.3 | 4.1 | 642.3 | < 0.3 | - | - |
| | | 20-May-13 | 7.8 | 261.4 | 1.9 | 21.3 | 715 | < 0.03 | 3.8 | < 0.03 | < 0.03 | 2.3 | 223.4 | < 0.03 | - | - |
| | | 15-Jun-13 | 8.3 | 441.7 | - | - | 642.8 | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 8.1 | 413.8 | 1.2 | 25 | - | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 7.2 | 416.4 | 1.4 | 17.3 | 625 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 264.3 | < 0.3 | - | 8.4 |
| | | 6-Oct-13 | 7.3 | 455.3 | - | - | 645.4 | 0.1 | 0.7 | < 1.0 | < 0.3 | 226.1 | 213.1 | < 1.0 | - | - |
| | | 9-May-14 | 8 | 360.6 | 1.4 | 14.5 | 485 | 0.4 | 4.8 | < 0.1 | < 0.1 | 5.9 | 415 | - | 0.1 | 8.2 |
| | | 14-Jun-14 | 7.8 | 385.1 | 1.2 | 15.4 | 380 | 0.1 | 0.9 | < 0.1 | < 0.1 | 1.2 | 315.8 | < 0.1 | - | - |
| | | 12-Jul-14 | 7.9 | 446.7 | 1.3 | 23.9 | 507.1 | - | - | - | - | - | - | - | - | - |
| | | 13-Aug-14 | 8.1 | 87 | 1.8 | 14.9 | 489.6 | - | - | - | - | - | - | - | - | - |
| | | 7-Sep-14 | 7.6 | 147.2 | - | - | 526.6 | < 0.4 | 5.3 | < 0.4 | < 0.4 | 2 | 429 | < 0.4 | - | 6.3 |
| | | 28-Sep-14 | 7.7 | 40.2 | 1.6 | 19.6 | 700.6 | < 0.1 | 6 | < 0.1 | < 0.1 | 2.5 | 434.7 | < 0.1 | - | - |
| | *Piezo-meter* | 28-Sep-14 | 7.5 | 36 | 0.4 | 19.7 | 274 | 0.1 | 3.5 | < 0.1 | < 0.1 | 1 | 12.2 | < 0.1 | - | - |
| | | Duplicate | - | - | - | - | | - | 3.6 | < 0.1 | < 0.1 | 1 | 12.4 | < 0.1 | - | - |

***Table B.3(Cont.): Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH3-2*** | ***5.0*** | 20-May-13 | < DL | < DL | 203.5 | < DL | < DL | < DL | < DL | < DL | 7.3 | < DL | 43.2 |
| | | 14-Jun-13 | < DL | < DL | 156.4 | < DL | < DL | < DL | < DL | < DL | 10.7 | < DL | 134.6 |
| | | 4-Sep-13 | < 0.2 | < 0.1 | 177.6 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 8.9 | < 0.1 | 38.4 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 358.5 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 11 | < 0.1 | 78.6 |
| | | 9-May-14 | < 2 | < 1 | 191.9 | <2 | < 1 | <2 | <2 | <2 | 6.6 | < 1 | 40.6 |
| | | 12-Jun-14 | < 2 | < 1 | 309.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 12.6 | < 1 | 40 |
| | | 7-Sep-14 | < 2 | < 1 | 340.6 | < 2 | < 1 | < 2 | < 2 | < 2 | 11.3 | < 1 | 43.3 |
| | | 28-Sep-14 | < 2 | - | 224.1 | < 2 | < 1 | < 2 | < 2 | < 2 | 11.3 | < 1 | 30.9 |
| | ***10.0*** | 14-Jun-13 | < DL | < DL | 237.9 | < DL | < DL | < DL | < DL | < DL | 6.3 | < DL | 72.5 |
| | | 29-Jul-13 | < DL | < DL | 175.3 | < DL | < DL | < DL | < DL | < DL | 7.5 | < DL | 88.5 |
| | | 4-Sep-13 | < 0.2 | < 0.1 | 177.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 8.5 | < 0.1 | 37.8 |
| | ***15.0*** | 16-Jun-12 | < DL | < DL | 265.4 | < DL | < DL | < DL | < DL | < DL | 5.3 | - | 70 |
| | | 23-Jun-12 | < DL | < DL | 260.9 | < DL | < DL | < DL | < DL | < DL | 4.9 | - | 70.7 |
| | | 26-Jun-12 | < DL | < DL | 270.5 | < DL | < DL | < DL | < DL | < DL | 4.9 | - | 69.5 |
| | | 7-20-2012 | < DL | < DL | 280.6 | < DL | < DL | < DL | < DL | < DL | 8.4 | < DL | 75.6 |
| | | 7-21-2012 | < DL | < DL | 306.4 | < DL | < DL | < DL | < DL | < DL | 8.2 | < DL | 73.8 |
| | | 18-Aug-12 | < DL | < DL | 321.9 | < DL | < DL | < DL | < DL | < DL | 7.5 | < DL | 88.6 |
| | | Duplicate | < DL | < DL | 339.3 | < DL | < DL | < DL | < DL | < DL | 7.4 | < DL | 85.1 |
| | | 25-Sep-12 | < DL | < DL | 378.4 | < DL | < DL | < DL | < DL | < DL | 7.3 | < DL | 103.6 |
| | | 20-May-13 | < DL | < DL | 222.8 | < DL | < DL | < DL | < DL | < DL | 10.6 | < DL | 69.6 |
| | | 4-Sep-13 | < 0.2 | < 0.1 | 247.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 8.9 | < 0.1 | 42.2 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 245.9 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 7.3 | < 0.1 | 33.3 |
| | | 9-May-14 | < 2 | < 1 | 279.3 | <2 | < 1 | <2 | <2 | <2 | 9.2 | < 1 | 64.8 |
| | | 12-Jun-14 | < 2 | < 1 | 266.6 | < 2 | < 1 | < 2 | < 2 | < 2 | 10.4 | < 1 | 33.2 |
| | | 7-Sep-14 | < 2 | < 1 | 315.5 | < 2 | < 1 | < 2 | < 2 | < 2 | 8.9 | < 1 | 65.4 |
| | | 28-Sep-14 | < 2 | < 1 | 304.8 | < 2 | < 1 | < 2 | < 2 | < 2 | 9.8 | < 1 | 66.9 |
| | ***Piezo-meter*** | 28-Sep-14 | < 2 | < 1 | 62.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 3.9 | < 1 | 17.8 |
| | | Duplicate | < 2 | < 1 | 62.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 4.2 | < 1 | 18 |

***Table B.3(Cont.): Pore-Water Geochemical Data: BH3-2 Table B.4(Cont.): Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH3-2*** | ***5.0*** | 20-May-13 | < DL | 17 | < DL | < DL | 32.5 | < DL | < DL | 9.5 | < 0.1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 39.2 | < DL | < DL | 122.8 | < DL | < DL | 20.5 | 0.3 | < DL | < DL |
| | | 4-Sep-13 | < 0.1 | 49.6 | < 0.1 | < 0.2 | 66.1 | < 0.09 | < 0.1 | 7.4 | 0.3 | < 0.2 | < 0.2 |
| | | 6-Oct-13 | < 1.0 | 22 | < 1.0 | < 0.2 | 218.7 | < 0.09 | < 0.1 | 16.1 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 25.7 | < 1 | <2 | 55.5 | < 0.9 | < 1 | 6 | < 1 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 7 | < 1 | < 2 | 163.9 | < 0.9 | < 1 | 5.5 | < 1 | < 2 | < 2 |
| | | 7-Sep-14 | < 1 | 9.8 | < 1 | < 2 | 194.8 | < 0.9 | < 1 | 9.6 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 22.8 | < 1 | < 2 | 101.8 | < 0.9 | < 1 | 10.5 | < 1 | < 2 | < 2 |
| | ***10.0*** | 14-Jun-13 | < DL | 19.3 | < DL | < DL | 76.1 | < DL | < DL | 18.8 | 0.4 | < DL | < DL |
| | | 29-Jul-13 | < DL | 18.8 | < DL | < DL | 91.9 | < DL | < DL | 28.6 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < 0.1 | 36 | < 0.1 | < 0.2 | 67 | < 0.09 | < 0.1 | 10.4 | 0.3 | < 0.2 | < 0.2 |
| | ***15.0*** | 16-Jun-12 | < DL | 7.4 | < DL | < DL | 89.9 | < DL | < DL | 8.7 | < 0.137 | < DL | < DL |
| | | 23-Jun-12 | < DL | 7.7 | < DL | < DL | 90.1 | < DL | < DL | 9.4 | < 0.137 | < DL | < DL |
| | | 26-Jun-12 | < DL | 7.6 | < DL | < DL | 96.8 | < DL | < DL | 7.5 | < 0.137 | < DL | < DL |
| | | 7-20-2012 | < DL | 8 | < DL | < DL | 120.8 | < DL | < DL | 15.9 | < 0.1 | < DL | < DL |
| | | 7-21-2012 | < DL | 7.8 | < DL | < DL | 129.3 | < DL | < DL | 15.6 | < 0.1 | < DL | < DL |
| | | 18-Aug-12 | < DL | 8.1 | < DL | < DL | 158.3 | < DL | < DL | 18.3 | < 0.1 | < DL | < DL |
| | | Duplicate | < DL | 7.9 | < DL | < DL | 161.2 | < DL | < DL | 18.5 | < 0.1 | < DL | < DL |
| | | 25-Sep-12 | < DL | 8.4 | < DL | < DL | 222.1 | < DL | < DL | 19.2 | < 0.1 | < DL | < DL |
| | | 20-May-13 | < DL | 33.5 | < DL | < DL | 86.5 | < DL | < DL | 15.6 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < 0.1 | 31.8 | < 0.1 | < 0.2 | 98.1 | < 0.09 | < 0.1 | 10.5 | 0.4 | < 0.2 | < 0.2 |
| | | 6-Oct-13 | < 1.0 | 29.4 | < 1.0 | < 0.2 | 72.7 | < 0.09 | < 0.1 | 13.9 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 30.8 | < 1 | <2 | 666.2 | < 0.9 | < 1 | 16.5 | < 1 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 7.6 | < 1 | < 2 | 103.6 | < 0.9 | < 1 | 7.8 | < 1 | < 2 | < 2 |
| | | 7-Sep-14 | < 1 | 8.5 | < 1 | < 2 | 153.7 | < 0.9 | < 1 | 4.8 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 9 | < 1 | < 2 | 150.6 | < 0.9 | < 1 | 8.2 | < 1 | < 2 | < 2 |
| | ***Piezo-meter*** | 28-Sep-14 | < 1 | 4.1 | < 1 | < 2 | 5.7 | < 0.9 | < 1 | 4.4 | < 0.3 | < 2 | < 2 |
| | | Duplicate | < 1 | 4.1 | < 1 | < 2 | 5.7 | < 0.9 | < 1 | 4.4 | < 0.3 | < 2 | < 2 |

***Table B.3(Cont.): Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH3-2*** | ***5.0*** | 20-May-13 | 13.3 | < 0.007 | 145.1 | 16450 | 44000 | < 0.1 | 11060 | < 10 | 7799 | - | < 0.2 | 109.5 | 0.4 | 86.1 | 4.1 |
| | | 14-Jun-13 | 59.8 | < 0.02 | 814.8 | 45150 | O/R | < 0.1 | 24600 | < 3 | 15050 | - | < 0.05 | 258.7 | 0.6 | 37.3 | 7.5 |
| | | 4-Sep-13 | 10.3 | 1 | 118.2 | O/R | - | 21 | 8231 | < DL | 11100 | - | 3.6 | 68.5 | 2.2 | 73.3 | 5.5 |
| | | 6-Oct-13 | 13.6 | < DL | 187.1 | 23030 | - | 13.3 | 16310 | < DL | 11180 | - | 1.4 | 124.1 | 2.1 | 95.2 | 10.2 |
| | | 9-May-14 | 6.3 | < 0.08 | 85.5 | 25700 | 40650 | 28.3 | 6178 | < 35 | 6927 | - | < 2 | 56.3 | 1.3 | 52 | 9.6 |
| | | 12-Jun-14 | 8 | 0.3 | 50.4 | 8103 | 42130 | 39.1 | 5879 | < 35 | 10370 | O/R | 1.6 | 16 | 0.9 | 87.7 | 29.4 |
| | | 7-Sep-14 | 7.3 | 0.1 | 68 | - | - | 21.7 | 9555 | < 35 | - | - | 1.8 | 22.3 | 0.8 | 35.5 | 2.1 |
| | | 28-Sep-14 | < 1.5 | < 0.08 | 23.5 | - | - | 17.1 | 11570 | < 35 | - | - | < 2 | 27 | 0.9 | 13.2 | 55.6 |
| | ***10.0*** | 14-Jun-13 | 61.2 | < 0.02 | 686.9 | 1571 | O/R | 4.3 | 22790 | < 10 | 9199 | - | < 0.2 | 233.1 | 0.3 | 146.2 | 5.9 |
| | | 29-Jul-13 | 46.9 | 0.3 | 632 | 20450 | - | 6.3 | 29870 | < DL | 7618 | - | 1.5 | 246.3 | 1 | 35 | 6.7 |
| | | 4-Sep-13 | 12 | 0.8 | 188.3 | 38720 | - | 1.3 | 11310 | < DL | 9719 | - | 2.5 | 86.9 | 1.3 | 96 | 8.5 |
| | ***15.0*** | 16-Jun-12 | 3 | < DL | 80.4 | 6894 | O/R | 16.7 | 9652 | < DL | 6065 | - | < 0.287 | 30.5 | 0.4 | 989.4 | 79.2 |
| | | 23-Jun-12 | 3.2 | < DL | 43.4 | 6903 | O/R | 20.8 | 9857 | < DL | 5868 | - | < 0.287 | 27.3 | 0.3 | 1054 | 42.2 |
| | | 26-Jun-12 | 1.4 | < DL | 25.6 | 7131 | O/R | 12 | 8261 | < DL | 5355 | - | < 0.287 | 8.8 | 0.2 | 911.2 | 121.4 |
| | | 7-20-2012 | < 0.1 | < DL | < 1 | - | - | 102.3 | 12110 | < DL | - | - | < 0.1 | 29.1 | < 0.02 | 621.8 | 92.5 |
| | | 7-21-2012 | < 0.1 | < DL | < 1 | - | - | 46.3 | 16400 | < DL | - | - | < 0.1 | 51.3 | < 0.02 | 709.4 | 91.5 |
| | | 18-Aug-12 | 8.1 | < DL | 156.9 | - | - | 15.7 | 18390 | < DL | - | - | < DL | 84.1 | < 0.02 | 567.1 | 17.4 |
| | | Duplicate | 7.7 | < DL | 133.6 | - | - | 16 | 18300 | < DL | - | - | < DL | 80.2 | < 0.02 | 568.1 | 19.6 |
| | | 25-Sep-12 | 10.8 | < DL | 175.6 | - | - | 27.9 | 18780 | < DL | - | - | < 0.1 | 95.8 | 1.2 | 489.7 | 40.8 |
| | | 20-May-13 | 14 | < 0.007 | 190.3 | 36590 | O/R | 7.6 | 17530 | < 3 | 8363 | - | 2.1 | 114.8 | 0.7 | 79.1 | 7.1 |
| | | 4-Sep-13 | 5.8 | < 0.02 | 90.1 | 34110 | - | 10.4 | 11380 | < DL | 10050 | - | 2.1 | 57.1 | 0.7 | 77.8 | 8.6 |
| | | 6-Oct-13 | 5.2 | < DL | 69.3 | 29510 | - | 7.4 | 13910 | < DL | 7683 | - | 4.2 | 67.7 | 1.2 | 64.2 | 11.1 |
| | | 9-May-14 | 10.8 | < 0.08 | 164 | 32830 | O/R | 1.5 | 16470 | < 35 | 9260 | - | < 2 | 91.1 | 3.1 | 17.9 | 9 |
| | | 12-Jun-14 | 2.5 | < 0.08 | 43.1 | 8043 | 34630 | 14.4 | 8657 | < 35 | 8331 | O/R | 1.6 | 25.1 | 1.1 | 53.7 | 24.2 |
| | | 7-Sep-14 | 0.4 | - | 12.5 | - | - | 12.1 | 4723 | < 35 | - | - | 1.9 | 7.9 | 0.3 | 19.1 | 6.2 |
| | | 28-Sep-14 | < 0.4 | < 0.08 | < 2 | - | - | 10.9 | 8972.1 | < 35 | - | - | 2.6 | 14.7 | 0.6 | 18.4 | 9.2 |
| | ***Piezo-meter*** | 28-Sep-14 | < 0.4 | < 0.08 | < 2 | - | - | < 0.5 | 4568.1 | < 35 | - | - | < 0.5 | 1 | 0.2 | 76.8 | 5 |
| | | Duplicate | < 0.4 | < 0.08 | < 2 | - | - | < 1.5 | 4414.9 | < 35 | - | - | < 0.5 | 1.1 | < 0.3 | 78 | 4.6 |

***Table B.3(Cont.): Pore-Water Geochemical Data: BH3-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH3-2* | *5.0* | 20-May-13 | 0.6 | 7.9 | 10.2 | 71.9 | 3.7 | - | 344.7 | 7.7 | < 0.004 | < 0.001 | 3.8 | 0.5 | 34.5 | - | 0.7 | 4.8 |
| | | 14-Jun-13 | 0.5 | 4.2 | 1 | 8.1 | 7.2 | - | 378.8 | 21.7 | < 0.004 | < 0.005 | 3.3 | 5.5 | 38.7 | - | < 0.0009 | 9.2 |
| | | 4-Sep-13 | 1.5 | 10.1 | 7.6 | 35.3 | 2.6 | 1.3 | 323.4 | 6 | 0.5 | 0.9 | 3.5 | 1.9 | 22.7 | 0.6 | 0.8 | 4.3 |
| | | 6-Oct-13 | 0.7 | 7.2 | 1.4 | 54.7 | 2.8 | < DL | 698.3 | 8.4 | < DL | < 0.05 | 1.4 | 2.8 | 37.7 | - | 0.2 | 13.3 |
| | | 9-May-14 | 0.6 | 8.8 | 3.9 | 27.5 | 1.7 | - | 305 | 4.2 | < 0.05 | < 0.05 | 3 | 0.3 | 14.3 | - | - | 3.3 |
| | | 12-Jun-14 | 1.5 | 14.1 | 3.6 | 58.4 | 0.9 | < 2 | 603 | 3.4 | 0.1 | 0.1 | 5.5 | 1.3 | 96.5 | 0.1 | 0.1 | 11.2 |
| | | 7-Sep-14 | 0.5 | 9.3 | 7.3 | 21.5 | 1.1 | < 0.2 | 722.9 | 7.3 | 0.2 | - | 1.5 | 2.4 | 273.7 | 0.1 | 0.1 | 15.4 |
| | | 28-Sep-14 | 0.2 | 6 | 3.5 | < 8.5 | 0.5 | < 2 | 459.7 | 4 | < 0.15 | < 0.02 | 1.4 | 0.3 | 48.1 | - | < 0.01 | 7.1 |
| | *10.0* | 14-Jun-13 | 0.4 | 5.1 | 1.7 | 197.1 | 4.6 | - | 479.2 | 30.5 | < 0.004 | < 0.005 | 5.1 | 0.7 | 70.8 | 0.1 | - | 10.8 |
| | | 29-Jul-13 | 0.7 | 2.6 | 2.2 | 23.5 | 5.5 | < DL | 407.6 | 21.6 | < 0.01 | 0.4 | 2.4 | 8.1 | 46.9 | 0.3 | 0.4 | 12.3 |
| | | 4-Sep-13 | 1.7 | 10.5 | 2.6 | 66.7 | 2.6 | 1.6 | 354.9 | 8.2 | 0.5 | 0.9 | 3.1 | 3.3 | 45.5 | 0.5 | 0.8 | 5 |
| | *15.0* | 16-Jun-12 | 1 | 2.8 | 33.8 | 37.4 | 0.8 | - | 506.8 | 2.2 | < DL | < DL | 1.9 | 0.2 | 55.5 | < 0.0125 | 2.2 | 2 |
| | | 23-Jun-12 | 1 | 2.6 | 12.3 | 50.1 | 0.7 | - | 522.8 | 1.8 | < DL | < DL | 1.5 | 0.1 | 60.2 | < 0.0125 | 1 | 1.9 |
| | | 26-Jun-12 | 0.8 | 2.7 | 14.4 | 65.4 | 0.7 | - | 538.8 | 1.1 | < DL | < DL | 2.3 | 0.4 | 76 | < 0.0125 | 0.9 | 1.8 |
| | | 7-20-2012 | < 0.02 | 2.1 | < 0.07 | < 0.6 | < 0.03 | - | 420.3 | 1.9 | < DL | < DL | < DL | 0.7 | 66.5 | < 0.002 | 0.7 | 1.6 |
| | | 7-21-2012 | 0.9 | 4 | 12.8 | < 0.6 | < 0.03 | - | 567.6 | 2.6 | < DL | < DL | < 0.2 | 0.9 | 87.1 | < 0.002 | 3.7 | 2.5 |
| | | 18-Aug-12 | < 0.02 | 3.9 | 7.9 | < 0.6 | < 0.03 | - | 595.1 | 5.1 | < DL | < DL | < DL | 0.8 | 100.3 | < 0.002 | 0.8 | 3 |
| | | Duplicate | < 0.02 | 3.9 | 8.8 | < 0.6 | < 0.03 | - | 595.8 | 3.5 | < 0.01 | < DL | < DL | 1.5 | 100.9 | < 0.002 | 2.6 | 3.1 |
| | | 25-Sep-12 | 0.8 | 5.1 | 10.4 | < 0.6 | 1.5 | - | 666.1 | 3.1 | < DL | < DL | < DL | 0.7 | 117 | < DL | 2.7 | 4 |
| | | 20-May-13 | 0.2 | 3.6 | 2.7 | 86.9 | 1.4 | - | 380 | 4.8 | < 0.004 | < 0.005 | 3.5 | 0.8 | 58.2 | - | 0.2 | 3.1 |
| | | 4-Sep-13 | 0.4 | 7 | 3.9 | 14 | 1.3 | 0.9 | 452.2 | 3.5 | < 0.01 | 0.1 | 3.7 | 1.7 | 64.9 | - | 1.5 | 3.7 |
| | | 6-Oct-13 | 0.2 | 6.6 | 3.1 | 18.6 | 1.2 | < DL | 441.9 | 4.4 | < DL | < DL | < 1.5 | 2.1 | 63.4 | - | 0.1 | 3 |
| | | 9-May-14 | 0.2 | 6.1 | 2.6 | 8 | 1.5 | - | 504.1 | 5.1 | < 0.05 | < 0.05 | 3.6 | 1.8 | 61.9 | - | - | 5.3 |
| | | 12-Jun-14 | 0.4 | 11 | 4.3 | 18.5 | 0.8 | < 2 | 499.3 | 2.2 | < 0.15 | < 0.02 | 2.5 | 0.8 | 75 | - | 0.2 | 4.8 |
| | | 7-Sep-14 | - | 1.7 | 5.5 | 12.4 | 0.4 | 0.9 | 458.9 | 1.5 | - | - | 3.8 | 0.6 | 335.3 | - | - | 1.4 |
| | | 28-Sep-14 | < 0.2 | 1.7 | 3.2 | 8.9 | 0.4 | < 2 | 454.8 | 0.6 | < 0.05 | < 0.02 | 2.3 | 0.1 | 86.4 | - | 0.2 | 1.4 |
| | *Piezo-meter* | 28-Sep-14 | < 0.2 | 2 | 1.2 | < 2.5 | 0.3 | < 2 | 174.9 | 9 | < 0.05 | < 0.05 | 1.9 | 0.7 | 44.1 | - | < 0.01 | 1.7 |
| | | Duplicate | 0.2 | 2 | 1.3 | < 2.5 | < 0.3 | < 2 | 174.1 | 10 | < 0.05 | < 0.02 | < 1.5 | 0.6 | 43.7 | - | < 0.01 | 1.7 |

***Table B.4: Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-2*** | ***5.5*** | 25-Jun-12 | 8.2 | 394.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-13 | 7.9 | 435.4 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 8 | 435.3 | 1.2 | 12.7 | 131.5 | < 0.3 | 2.3 | < 0.3 | < 0.3 | 5.3 | 643.1 | < 0.3 | <0.01 | 6.8 |
| | | 9-May-14 | 7.5 | 355.7 | - | - | 80 | 3.2 | 1.1 | < 0.1 | < 0.1 | 6.6 | 858.5 | < 0.1 | - | - |
| | | 14-Jun-14 | 7.9 | 362.8 | 1 | 16 | 85 | - | - | - | - | - | - | - | - | - |
| | ***10.5*** | 16-Jun-12 | 8 | 226 | 2.6 | 22 | 60 | 1.4 | 2.6 | < 0.3 | < 0.3 | < 0.3 | 1775.6 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 55 | - | - | - | - | - | - | - | - | - |
| | | 26-Jun-12 | 8.1 | 369.3 | - | - | 44 | 1.2 | 2.4 | < 0.3 | < 0.3 | < 0.3 | 1797.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 44 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8 | 415.3 | - | - | 80 | 0.9 | 2.6 | < 0.3 | < 0.3 | < 0.3 | 1737.5 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 38 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 34 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 8.1 | 416.3 | - | - | 60 | 0.9 | 2.5 | < 0.3 | < 0.3 | < 0.3 | 1767.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 42 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 44 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 8 | 425.8 | 2.6 | 20.2 | 41.5 | < 0.3 | < 2.0 | < 0.3 | < 0.3 | < 0.3 | 1773.3 | < 0.3 | - | 5.5 |
| | | 28-Oct-12 | 7.8 | 467.7 | 3.1 | 19.6 | 130 | < 0.5 | 1.8 | < 0.5 | < 0.5 | < 0.5 | 1773.3 | < 0.5 | - | 6.4 |
| | | 20-May-13 | 7.5 | 274.1 | 3.1 | 20.7 | 93.7 | 0.4 | 2.2 | < 0.03 | < 0.03 | < 0.03 | 1751.2 | < 0.03 | - | - |
| | | 14-Jun-13 | 7.6 | 430.5 | 2.9 | 23.6 | 195 | < 0.3 | 1.4 | < 0.3 | < 0.3 | < 0.3 | 1768.3 | < 0.3 | - | - |
| | | 27-Jul-13 | 7.8 | 486.9 | 2.5 | 25.6 | 95 | < 0.3 | 1.3 | < 0.3 | < 0.3 | < 0.3 | 1725.8 | < 0.3 | - | - |
| | | 4-Sep-13 | 8.1 | 451.6 | 0.9 | 13.3 | 59 | < 0.3 | 3.4 | < 0.3 | < 0.3 | < 0.3 | 1697.9 | < 0.3 | <0.01 | 2.9 |
| | | 5-Oct-13 | 7.7 | 404.8 | 2.5 | 10.3 | 88.2 | 0.1 | 1.3 | < 1.0 | < 0.3 | 0.1 | 1672 | < 1.0 | - | - |
| | | 9-May-14 | 7.2 | 375.5 | 2.6 | 10.1 | - | 0.2 | 1.6 | < 0.1 | < 0.1 | < 0.1 | 1665.6 | - | - | 2.1 |
| | | 14-Jun-14 | 7.6 | 362 | 1.9 | 16.3 | 50 | 0.1 | 2.2 | < 0.1 | < 0.1 | < 0.1 | 1773.8 | <0.003 | - | 1.6 |
| | | 12-Jul-14 | 7.8 | 294.1 | 2.6 | 21.6 | 42.8 | 0.3 | 1.9 | < 0.1 | < 0.1 | < 0.1 | 1893.3 | < 0.01 | - | - |
| | | 29-Sep-14 | 7.7 | 35.1 | 2.4 | 13.3 | 86 | < 0.1 | 1.4 | < 0.1 | < 0.1 | < 0.1 | 1607.9 | < 0.1 | - | - |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *15.5* | 16-Jun-12 | 7.7 | 225.3 | - | - | 60 | 0.2 | 2.1 | < 0.3 | < 0.3 | < 0.3 | 1737 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 55 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 40 | - | - | - | - | - | - | - | - | - |
| | | 26-Jun-12 | 8.4 | 367.3 | - | - | 27 | 0.2 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 1751.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 28 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 7.9 | 400.8 | - | 22.2 | 26 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1754 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 19.1 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 8.3 | 415.3 | - | - | 38 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1768.9 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 27 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 30 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 8.2 | 446.7 | 2.5 | 19.4 | 49.4 | < 0.3 | 1.5 | < 0.3 | < 0.3 | < 0.3 | 1770.6 | < 0.3 | - | 4.4 |
| | | 28-Oct-12 | 8 | 457.6 | 2.6 | 18.7 | 70.5 | < 0.5 | 1.3 | < 0.5 | < 0.5 | < 0.5 | 1744.1 | < 0.5 | - | 6.5 |
| | | 20-May-13 | 7.4 | 273.2 | 3.6 | 21.1 | 82.3 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-13 | 7.7 | 469.1 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 15-Jun-13 | 7.7 | 497.5 | 2.6 | 22.7 | 95.2 | < 0.3 | 2.1 | < 0.3 | < 0.3 | < 0.3 | 1704.1 | < 0.3 | - | - |
| | | 27-Jul-13 | 8 | 479 | 2.5 | 24.6 | 60 | < 0.3 | 2.6 | < 0.3 | < 0.3 | < 0.3 | 1746.8 | < 0.3 | <0.01 | 3.9 |
| | | 5-Oct-13 | 7.5 | 408.8 | 2.6 | 10.6 | 72.2 | < 0.3 | 1.6 | < 1.0 | < 0.3 | < 1.0 | 1792.2 | < 1.0 | - | - |
| | | 9-May-14 | 7.1 | 450.1 | 2.5 | 14.6 | 41 | 0.1 | 2.2 | < 0.1 | < 0.1 | 0.2 | 1733.1 | < 0.1 | - | - |
| | | 14-Jun-14 | 7.7 | 441 | 2.5 | 17.7 | - | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8 | 273.6 | 2.4 | 23.6 | 49 | 0.1 | 2.4 | < 0.1 | < 0.1 | < 0.1 | 1756.7 | < 0.01 | - | <1.0 |
| | | 29-Sep-14 | 7.7 | 31.3 | 2.5 | 15.1 | 72.7 | < 0.1 | 2.1 | < 0.1 | < 0.1 | < 0.1 | 1781.8 | < 0.1 | - | - |
| | *20.5* | 16-Jun-12 | 8 | 238.3 | - | - | 72 | 2.2 | 8.5 | < 0.3 | < 0.3 | 1.3 | 1698.7 | < 0.3 | - | - |
| | | Duplicate | 8 | 372.3 | - | - | 58 | 2.2 | 7.6 | < 0.3 | < 0.3 | 1.7 | 1804.3 | < 0.3 | - | - |
| | | Triplicate | - | | - | - | 63.3 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 7.9 | 359.3 | - | - | 47.5 | 1.6 | 6.2 | < 0.3 | < 0.3 | < 0.3 | 1824 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 55 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 7.9 | 373.3 | - | - | 50 | 2.9 | 5.7 | < 0.3 | < 0.3 | 1.2 | 1826.4 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 60 | - | - | - | - | - | - | - | - | - |
| | | 23-Sep-12 | 7.8 | 393.9 | - | - | 86.9 | < 2.0 | 3.2 | < 0.3 | < 0.3 | < 0.3 | 1858.7 | < 0.3 | - | - |
| | | 28-Oct-12 | 7.8 | 439.5 | - | - | 100 | 1.8 | 3.6 | < 0.5 | < 0.5 | 2.5 | 1883.4 | < 0.5 | - | - |
| | | 20-May-13 | 7.6 | 271.5 | 3 | 20.9 | 114.2 | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 8 | 480.2 | 2.6 | 25.5 | 180 | 0.6 | 2.1 | < 0.3 | < 0.3 | < 0.3 | 1800.4 | < 0.3 | - | - |
| | | 4-Sep-13 | 8.1 | 425.3 | - | - | 130 | < 0.3 | 2.1 | < 0.3 | < 0.3 | < 0.3 | 1837.3 | < 0.3 | - | - |
| | | 5-Oct-13 | 7.8 | 399.1 | 2.6 | 11.6 | 77.7 | < 0.3 | 1.7 | < 1.0 | < 0.3 | < 1.0 | 1839 | < 1.0 | <0.01 | - |
| | | 9-May-14 | 7.2 | 435.3 | - | - | 60 | 0.9 | 1.9 | < 0.1 | < 0.1 | 0.3 | 1783.1 | - | - | - |
| | | 14-Jun-14 | 8 | 427.8 | 0.7 | 17.8 | - | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8.1 | 282.4 | 2.5 | 23.4 | 63.6 | 0.5 | 2.5 | < 0.1 | < 0.1 | 0.2 | 1793.1 | < 0.1 | - | - |
| | | 29-Sep-14 | 8 | 26.5 | 2.5 | 14.2 | 92.6 | 0.5 | 2.3 | < 0.1 | < 0.1 | < 0.1 | 1830.3 | < 0.1 | - | - |

*Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2*

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25-Jun-12 | 7.4 | 357.3 | - | - | 460 | 1.3 | 3.6 | < 0.3 | < 0.3 | < 0.3 | 275.9 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 650 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 525 | - | - | - | - | - | - | - | - | - |
| | | 26-Jun-12 | 7.4 | 362.3 | - | - | 556.6 | 0.2 | 2.9 | < 0.3 | < 0.3 | < 0.3 | 280.5 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 600 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 7.3 | 299.7 | - | 22.4 | 557.1 | < 0.3 | 3.2 | < 0.3 | < 0.3 | < 0.3 | 284.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 585.7 | < 0.3 | 3.2 | < 0.3 | < 0.3 | < 0.3 | 277.5 | < 0.3 | - | - |
| | | 19-Aug-12 | 7.2 | 345.3 | - | - | 630 | < 0.3 | 2.6 | < 0.3 | < 0.3 | < 0.3 | 276.7 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 640 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 630 | - | - | - | - | - | - | - | - | - |
| | | 23-Sep-12 | 7.1 | 269 | 1.4 | 18.9 | 612 | < 0.3 | 2.7 | < 0.3 | < 0.3 | < 0.3 | 278.5 | < 0.3 | - | 7.6 |
| | | 28-Oct-12 | 7.1 | 372.9 | 1.4 | 18.9 | 625 | < 0.3 | 3.1 | < 0.3 | < 0.3 | < 0.3 | 271.3 | < 0.3 | - | 6.9 |
| | | Duplicate | - | | - | - | - | < 0.3 | 3 | < 0.3 | < 0.3 | < 0.3 | 273.6 | < 0.3 | - | 7.2 |
| ***BH4-2*** | ***25.5*** | 20-May-13 | 7.2 | 311.6 | 1.7 | 15.5 | 670 | < 0.03 | 3.4 | < 0.03 | < 0.03 | < 0.03 | 249.6 | < 0.03 | - | 7.7 |
| | | Duplicate | - | - | - | - | - | < 0.03 | 3.5 | < 0.03 | < 0.03 | < 0.03 | 250.2 | < 0.03 | - | - |
| | | 14-Jun-13 | 7 | 287.7 | 1.4 | 22.6 | 620 | < 0.3 | 3 | < 0.3 | < 0.3 | < 0.3 | 231.9 | < 0.3 | - | - |
| | | 27-Jul-13 | 6.9 | 304.1 | - | 25 | 670 | < 0.3 | 3.5 | < 0.3 | < 0.3 | < 0.3 | 240.4 | < 0.3 | <0.01 | 8 |
| | | 4-Sep-13 | 7.4 | 248.6 | 1.3 | 13.2 | 618.1 | < 0.3 | 2.7 | < 0.3 | < 0.3 | < 0.3 | 236.7 | < 0.3 | <0.01 | 7.6 |
| | | Duplicate | - | | - | - | - | < 0.3 | 2.8 | < 0.3 | < 0.3 | < 0.3 | 238 | < 0.3 | <0.01 | 6.6 |
| | | 5-Oct-13 | 7 | 196.9 | 1.3 | 11.2 | 625 | < 0.3 | 2.8 | < 1.0 | < 0.3 | < 1.0 | 242.6 | < 1.0 | - | - |
| | | Duplicate | 7 | 209.5 | 1.3 | 12 | 631.5 | < 0.3 | 2.8 | < 1.0 | < 0.3 | < 1.0 | 242 | < 1.0 | - | - |
| | | 9-May-14 | 7.8 | 355.5 | - | - | - | - | 3 | < 0.1 | < 0.1 | < 0.1 | 226.8 | - | - | 7.6 |
| | | Duplicate | 7.8 | 407.3 | - | - | 400 | < 0.1 | 2.9 | < 0.1 | < 0.1 | < 0.1 | 225.1 | - | - | 28.7 |
| | | 14-Jun-14 | 7.8 | 405.2 | 1.2 | 14.9 | 510 | < 0.1 | 3 | < 0.1 | < 0.1 | < 0.1 | 206.1 | <0.003 | - | 4.8 |
| | | Duplicate | 7.9 | 423.3 | 1.2 | 14.9 | 550 | < 0.1 | 2.8 | < 0.1 | < 0.1 | < 0.1 | 203.5 | <0.003 | - | - |
| | | 12-Jul-14 | 7.5 | 296.6 | 1.2 | 23.2 | 675.1 | 0.1 | 3 | < 0.1 | < 0.1 | < 0.1 | 203.8 | < 0.01 | - | <1.0 |
| | | 29-Sep-14 | 7.4 | -17.6 | 1.3 | 13.5 | 711.8 | < 0.1 | 3.1 | < 0.1 | < 0.1 | < 0.1 | 196.8 | < 0.1 | - | - |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *5.5* | 14-Jun-13 | < DL | < DL | 266.3 | < DL | < DL | < DL | < DL | < DL | 38.44 | < DL | 49.25 |
| | | 4-Sep-13 | < DL | < DL | 203.7 | < DL | < DL | < DL | < DL | < DL | 15.4 | < DL | 30.96 |
| | | 9-May-14 | < 2 | < 1 | 268.4 | <2 | < 1 | <2 | <2 | <2 | 16.27 | < 1 | 53.19 |
| | *10.5* | 16-Jun-12 | < DL | < DL | 464.9 | < DL | < DL | < DL | < DL | < DL | 30.49 | - | 145.4 |
| | | 26-Jun-12 | < DL | < DL | 493.6 | < DL | < DL | < DL | < DL | < DL | 30.01 | - | 142.4 |
| | | Duplicate | < DL | < DL | 489 | < DL | < DL | < DL | < DL | < DL | 30.46 | - | 142 |
| | | 21-Jul-12 | < DL | < DL | 466.3 | < DL | < DL | < DL | < DL | < DL | 34.04 | < DL | 143.3 |
| | | 19-Aug-12 | < DL | < DL | 470 | < DL | < DL | < DL | < DL | < DL | 32.45 | < DL | 142.4 |
| | | 24-Sep-12 | < DL | < DL | 496.5 | < DL | < DL | < DL | < DL | < DL | 33.05 | < DL | 136.7 |
| | | 28-Oct-12 | < DL | < DL | 522.1 | < DL | < DL | < DL | < DL | < DL | 32.2 | < DL | 141.8 |
| | | 20-May-13 | < DL | < DL | 500.3 | < DL | < DL | < DL | < DL | < DL | 31.91 | < DL | 151.7 |
| | | 14-Jun-13 | < DL | < DL | 501.3 | < DL | < DL | < DL | < DL | < DL | 32.03 | < DL | 145.2 |
| | | 27-Jul-13 | < DL | < DL | 500.7 | < DL | < DL | < DL | < DL | < DL | 31.56 | < DL | 129.5 |
| | | 4-Sep-13 | < DL | < DL | 499.1 | < DL | < DL | < DL | < DL | < DL | 32.73 | < DL | 123.2 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 507.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 32.56 | < 0.1 | 108.3 |
| | | 9-May-14 | < 2 | < 1 | 514.6 | <2 | < 1 | <2 | <2 | <2 | 27.85 | < 1 | 108.2 |
| | | 12-Jun-14 | < 2 | < 1 | 500.2 | < 2 | < 1 | < 2 | < 2 | < 2 | 30.41 | < 1 | 144.9 |
| | | 12-Jul-14 | < 2 | < 1 | 504.2 | < 2 | < 1 | < 2 | < 2 | < 2 | 29.01 | < 1 | 148.8 |
| | | 28-Sep-14 | < 2 | < 1 | 494.9 | < 2 | < 1 | < 2 | < 2 | < 2 | 26.03 | < 1 | 96.16 |
| | *15.5* | 16-Jun-12 | < DL | < DL | 463 | < DL | < DL | < DL | < DL | < DL | 24.09 | - | 139.9 |
| | | 26-Jun-12 | < DL | < DL | 474.6 | < DL | < DL | < DL | < DL | < DL | 24.42 | - | 139.9 |
| | | 21-Jul-12 | < DL | < DL | 485.1 | < DL | < DL | < DL | < DL | < DL | 26.62 | < DL | 141.5 |
| | | Duplicate | < DL | < DL | 485.1 | < DL | < DL | < DL | < DL | < DL | 26.1 | < DL | 142.4 |
| | | 19-Aug-12 | < DL | < DL | 465.6 | < DL | < DL | < DL | < DL | < DL | 26.4 | < DL | 144.9 |
| | | 24-Sep-12 | < DL | < DL | 490.5 | < DL | < DL | < DL | < DL | < DL | 24.65 | < DL | 134.7 |
| | | 28-Oct-12 | < DL | < DL | 496.3 | < DL | < DL | < DL | < DL | < DL | 23.5 | < DL | 150.9 |
| | | 21-May-13 | < DL | < DL | 482.5 | < DL | < DL | < DL | < DL | < DL | 22.65 | < DL | 146.9 |
| | | 14-Jun-13 | < DL | < DL | 479.2 | < DL | < DL | < DL | < DL | < DL | 30.71 | < DL | 149.8 |
| | | 15-Jun-13 | < DL | < DL | 505.8 | < DL | < DL | < DL | < DL | < DL | 20.21 | < DL | 146.7 |
| | | 27-Jul-13 | < DL | < DL | 517.5 | < DL | < DL | < DL | < DL | < DL | 22.29 | < DL | 143.3 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 499.3 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 24.36 | < 0.1 | 143 |
| | | 9-May-14 | < 2 | < 1 | 479.1 | <2 | < 1 | <2 | <2 | <2 | 20.41 | < 1 | 150.1 |
| | | 12-Jul-14 | < 2 | < 1 | 503.6 | < 2 | < 1 | < 2 | < 2 | < 2 | 21.37 | < 1 | 147.9 |
| | | 28-Sep-14 | < 2 | < 1 | 504 | < 2 | < 1 | < 2 | < 2 | < 2 | 22.03 | < 1 | 140.4 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-2*** | ***20.5*** | 16-Jun-12 | < DL | < DL | 485.8 | < DL | < DL | < DL | < DL | < DL | 13.19 | - | 133.8 |
| | | 26-Jun-12 | < DL | < DL | 493.7 | < DL | < DL | < DL | < DL | < DL | 13.83 | - | 140.4 |
| | | 21-Jul-12 | < DL | < DL | 525.3 | < DL | < DL | < DL | < DL | < DL | 17.75 | < DL | 144.4 |
| | | 19-Aug-12 | < DL | < DL | 515.9 | < DL | < DL | < DL | < DL | < DL | 16.94 | < DL | 151.2 |
| | | 23-Sep-12 | < DL | < DL | 529.9 | < DL | < DL | < DL | < DL | < DL | 16.91 | < DL | 147.3 |
| | | 28-Oct-12 | < DL | < DL | 529.1 | < DL | < DL | < DL | < DL | < DL | 17.2 | < DL | 171.5 |
| | | 20-May-13 | < DL | < DL | 526.1 | < DL | < DL | < DL | < DL | < DL | 19.58 | < DL | 153.4 |
| | | 27-Jul-13 | < DL | < DL | 513.9 | < DL | < DL | < DL | < DL | < DL | 22.1 | < DL | 152.5 |
| | | 4-Sep-13 | < DL | < DL | 515.6 | < DL | < DL | < DL | < DL | < DL | 24.17 | < DL | 153.6 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 498.4 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 23.17 | < 0.1 | 149.1 |
| | | 9-May-14 | < 2 | < 1 | 505.7 | <2 | < 1 | <2 | <2 | <2 | 20.47 | < 1 | 150.9 |
| | | 12-Jul-14 | < 2 | < 1 | 515 | < 2 | < 1 | < 2 | < 2 | < 2 | 20.75 | < 1 | 152.5 |
| | | 28-Sep-14 | < 2 | < 1 | 478.2 | < 2 | < 1 | < 2 | < 2 | < 2 | 20.37 | < 1 | 140.1 |
| | ***25.5*** | 25-Jun-12 | < DL | < DL | 211.2 | < DL | < DL | < DL | < DL | < DL | 6.808 | - | 64.4 |
| | | 26-Jun-12 | < DL | < DL | 224.4 | < DL | < DL | < DL | < DL | < DL | 6.033 | - | 69.37 |
| | | 21-Jul-12 | < DL | < DL | 232.3 | < DL | < DL | < DL | < DL | < DL | 7.861 | < DL | 70.06 |
| | | 22-Jul-12 | < DL | < DL | 243.5 | < DL | < DL | < DL | < DL | < DL | 7.5 | < DL | 70.3 |
| | | 19-Aug-12 | < DL | < DL | 243.0 | < DL | < DL | < DL | < DL | < 0.7 | 6.9 | < DL | 71.4 |
| | | 23-Sep-12 | < DL | < DL | 239.6 | < DL | < DL | < DL | < DL | < DL | 6.532 | < DL | 69.78 |
| | | 28-Oct-12 | < DL | < DL | 231.7 | < DL | < DL | < DL | < DL | < 0.7 | 5.4 | < DL | 77.0 |
| | | Duplicate | < DL | < DL | 222.3 | < DL | < DL | < DL | < DL | < 0.7 | < 0.4 | < DL | 73.67 |
| | | 20-May-13 | < DL | < DL | 232.6 | < DL | < DL | < DL | < DL | < DL | 6.13 | < DL | 70.48 |
| | | Duplicate | < DL | < DL | 229.3 | < DL | < DL | < DL | < DL | < DL | 6.381 | < DL | 69.25 |
| | | 14-Jun-13 | < DL | < DL | 226.8 | < DL | < DL | < DL | < DL | < DL | 4.343 | < DL | 69.22 |
| | | 27-Jul-13 | < DL | < DL | 226 | < DL | < DL | < DL | < DL | < DL | 4.868 | < DL | 69.76 |
| | | 4-Sep-13 | < DL | < DL | 229.7 | < DL | < DL | < DL | < DL | < DL | 6.436 | < DL | 69.81 |
| | | Duplicate | < DL | < DL | 225.4 | < DL | < DL | < DL | < DL | < DL | 6.107 | < DL | 68.23 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 224.6 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | 0.9594 | 5.496 | < 0.1 | 68.87 |
| | | Duplicate | < 0.2 | < 0.1 | 226.1 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | 0.7516 | 5.585 | < 0.1 | 68.79 |
| | | 9-May-14 | < 2 | < 1 | 224.4 | <2 | < 1 | <2 | <2 | <2 | 5.252 | < 1 | 68.79 |
| | | Duplicate | < 2 | < 1 | 225 | <2 | < 1 | <2 | <2 | <2 | 5.205 | < 1 | 71.96 |
| | | 12-Jun-14 | < 2 | < 1 | 220.8 | < 2 | < 1 | < 2 | < 2 | < 2 | 6.392 | < 1 | 66.3 |
| | | Duplicate | < 2 | < 1 | 217.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 6.308 | < 1 | 65.26 |
| | | 12-Jul-14 | < 2 | < 1 | 224.9 | < 2 | < 1 | < 2 | < 2 | < 2 | 4.677 | < 1 | 68.86 |
| | | 28-Sep-14 | < 2 | < 1 | 207.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 4.372 | < 1 | 61.7 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *5.5* | 14-Jun-13 | < DL | 33.02 | < DL | < DL | 278.3 | < DL | < DL | 30.74 | 0.6656 | < DL | < DL |
| | | 4-Sep-13 | < DL | 41.47 | < DL | < DL | 219 | < DL | < DL | 9.412 | 0.45 | < DL | < DL |
| | | 9-May-14 | < 1 | 36.4 | < 1 | <2 | 1048 | < 0.9 | < 1 | 43.44 | < 1 | <2 | <2 |
| | *10.5* | 16-Jun-12 | < DL | 8.899 | < DL | < DL | 547.6 | < DL | < DL | 22.38 | 1.374 | < DL | < DL |
| | | 26-Jun-12 | < DL | 8.33 | < DL | < DL | 572.1 | < DL | < DL | 19.85 | < 0.137 | < DL | < DL |
| | | Duplicate | < DL | 8.272 | < DL | < DL | 569 | < DL | < DL | 19.85 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 8.674 | < DL | < DL | 570.2 | < DL | < DL | 22.16 | 1.301 | < DL | < DL |
| | | 19-Aug-12 | < DL | 8.885 | < DL | < DL | 574.9 | < DL | < DL | 25.92 | 1.292 | < DL | < DL |
| | | 24-Sep-12 | < DL | 8.13 | < DL | < DL | 589.9 | < DL | < DL | 20.88 | 1.252 | < DL | < DL |
| | | 28-Oct-12 | < DL | 8.7 | < DL | < DL | 592.8 | < DL | < DL | 24.3 | 1.189 | < DL | < DL |
| | | 20-May-13 | < DL | 8.271 | < DL | < DL | 564.6 | < DL | < DL | 39.09 | 1.089 | < DL | < DL |
| | | 14-Jun-13 | < DL | 11.84 | < DL | < DL | 585.9 | < DL | < DL | 11.21 | 1.093 | < DL | < DL |
| | | 27-Jul-13 | < DL | 10.93 | < DL | < DL | 577.4 | < DL | < DL | 14.21 | 0.99 | < DL | < DL |
| | | 4-Sep-13 | < DL | 9.281 | < DL | < DL | 576.2 | < DL | < DL | 8.955 | 0.95 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 9.54 | < 1.0 | < 0.2 | 545.3 | < 0.09 | < 0.1 | 6.378 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 8.418 | < 1 | <2 | 937.7 | < 0.9 | < 1 | 7.211 | < 1 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 7.37 | < 1 | < 2 | 581.9 | < 0.9 | < 1 | 5.802 | < 1 | < 2 | < 2 |
| | | 12-Jul-14 | < 1 | 5.372 | < 1 | < 2 | 613.8 | < 0.9 | < 1 | 4.241 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 6.901 | < 1 | < 2 | 543 | < 0.9 | < 1 | 5.147 | < 1 | < 2 | < 2 |
| | *15.5* | 16-Jun-12 | < DL | 10.29 | < DL | < DL | 547.1 | < DL | < DL | 8.917 | < 0.137 | < DL | < DL |
| | | 26-Jun-12 | < DL | 10.09 | < DL | < DL | 561.5 | < DL | < DL | 11.09 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 10.34 | < DL | < DL | 597.4 | < DL | < DL | 11.35 | 0.9566 | < DL | < DL |
| | | Duplicate | < DL | 10.3 | < DL | < DL | 604.6 | < DL | < DL | 11.2 | 0.94 | < DL | < DL |
| | | 19-Aug-12 | < DL | 10.5 | < DL | < DL | 584.7 | < DL | < DL | 12.7 | 0.98 | < DL | < DL |
| | | 24-Sep-12 | < DL | 9.382 | < DL | < DL | 587.4 | < DL | < DL | 9.948 | 0.9302 | < DL | < DL |
| | | 28-Oct-12 | < DL | 10.7 | < DL | < DL | 591.4 | < DL | < DL | 9.8 | 0.92 | < DL | < DL |
| | | 21-May-13 | < DL | 9.378 | < DL | < DL | 544.9 | < DL | < DL | 13.06 | 0.8785 | < DL | < DL |
| | | 14-Jun-13 | < DL | 9.496 | < DL | < DL | 573.4 | < DL | < DL | 15.53 | 0.8764 | < DL | < DL |
| | | 15-Jun-13 | < DL | 9.483 | < DL | < DL | 582.6 | < DL | < DL | 10.17 | 0.89 | < DL | < DL |
| | | 27-Jul-13 | < DL | 9.325 | < DL | < DL | 590.2 | < DL | < DL | 9.27 | < 0.1 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 8.996 | < 1.0 | < 0.2 | 578.6 | < 0.09 | < 0.1 | 3.869 | 0.88 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 8.583 | < 1 | <2 | 1327 | < 0.9 | < 1 | 8.925 | < 1 | <2 | <2 |
| | | 12-Jul-14 | < 1 | 6.262 | < 1 | < 2 | 610 | < 0.9 | < 1 | 4.159 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 7.545 | < 1 | < 2 | 581.5 | < 0.9 | < 1 | 2.838 | < 1 | < 2 | < 2 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *20.5* | 16-Jun-12 | < DL | 15.84 | < DL | < DL | 536.1 | < DL | < DL | 29.02 | < 0.137 | < DL | < DL |
| | | 26-Jun-12 | < DL | 15.97 | < DL | < DL | 556.7 | < DL | < DL | 32.41 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 15.74 | < DL | < DL | 625.2 | < DL | < DL | 38.21 | 0.8771 | < DL | < DL |
| | | 19-Aug-12 | < DL | 16.24 | < DL | < DL | 609.1 | < DL | < DL | 40.85 | < 0.1 | < DL | < DL |
| | | 23-Sep-12 | < DL | 14.91 | < DL | < DL | 625.4 | < DL | < DL | 41.92 | < 0.1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 16.6 | < DL | < DL | 600.6 | < DL | < DL | 39.4 | 0.91 | < DL | < DL |
| | | 20-May-13 | < DL | 11.71 | < DL | < DL | 584 | < DL | < DL | 42.12 | 0.8826 | < DL | < DL |
| | | 27-Jul-13 | < DL | 10.14 | < DL | < DL | 603.6 | < DL | < DL | 25.48 | 0.9156 | < DL | < DL |
| | | 4-Sep-13 | < DL | 10.51 | < DL | < DL | 608.3 | < DL | < DL | 31.04 | 0.95 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 9.159 | < 1.0 | < 0.2 | 584.4 | < 0.09 | < 0.1 | 12.31 | 0.92 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 9.229 | < 1 | <2 | 620.5 | < 0.9 | < 1 | 19.82 | 0.90 | <2 | <2 |
| | | 12-Jul-14 | < 1 | 6.807 | < 1 | < 2 | 623.1 | < 0.9 | < 1 | 12.79 | 0.8999 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 7.97 | < 1 | < 2 | 605.6 | < 0.9 | < 1 | 10.44 | < 1 | < 2 | < 2 |
| | *25.5* | 25-Jun-12 | < DL | 8.16 | < DL | < DL | 92.89 | < DL | < DL | 10.84 | < DL | < DL | < DL |
| | | 26-Jun-12 | < DL | 8.128 | < DL | < DL | 92.71 | < DL | < DL | 10.62 | < DL | < DL | < DL |
| | | 21-Jul-12 | < DL | 8.519 | < DL | < DL | 101.8 | < DL | < DL | 12.77 | < 0.1 | < DL | < DL |
| | | 22-Jul-12 | < DL | 8.5 | < DL | < DL | 103.5 | < DL | < DL | 13.2 | < 0.1 | < DL | < DL |
| | | 19-Aug-12 | < DL | 8.5 | < DL | < DL | 103.1 | < DL | < DL | 11.9 | < 0.1 | < DL | < DL |
| | | 23-Sep-12 | < DL | 8.218 | < DL | < DL | 99.48 | < DL | < DL | 11.64 | < 0.1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 9.2 | < DL | < DL | 91.1 | < DL | < DL | 10.5 | < 0.1 | < DL | < DL |
| | | Duplicate | < DL | 8.657 | < DL | < DL | 91.33 | < DL | < DL | 10.44 | < 0.1 | < DL | < DL |
| | | 20-May-13 | < DL | 8.04 | < DL | < DL | 87.9 | < DL | < DL | 9.513 | < 0.1 | < DL | < DL |
| | | Duplicate | < DL | 8.126 | < DL | < DL | 88.43 | < DL | < DL | 9.591 | < 0.1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 7.732 | < DL | < DL | 85.21 | < DL | < DL | 8.498 | 0.3297 | < DL | < DL |
| | | 27-Jul-13 | < DL | 8.02 | < DL | < DL | 87.23 | < DL | < DL | 8.488 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < DL | 7.881 | < DL | < DL | 87.86 | < DL | < DL | 8.253 | 0.32 | < DL | < DL |
| | | Duplicate | < DL | 7.901 | < DL | < DL | 87.91 | < DL | < DL | 8.291 | 0.32 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 7.378 | < 1.0 | < 0.2 | 83.11 | < 0.09 | < 0.1 | 7.849 | < 0.1 | < 0.2 | < 0.2 |
| | | Duplicate | < 1.0 | 7.47 | < 1.0 | < 0.2 | 83.33 | < 0.09 | < 0.1 | 7.879 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 7.546 | < 1 | <2 | 83.17 | < 0.9 | < 1 | 7.708 | < 1 | <2 | <2 |
| | | Duplicate | < 1 | 7.692 | < 1 | <2 | 85.42 | < 0.9 | < 1 | 7.987 | < 1 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 7.684 | < 1 | < 2 | 69.59 | < 0.9 | < 1 | 7.425 | < 1 | < 2 | < 2 |
| | | Duplicate | < 1 | 7.235 | < 1 | < 2 | 69.31 | < 0.9 | < 1 | 7.398 | < 1 | < 2 | < 2 |
| | | 12-Jul-14 | < 1 | 5.867 | < 1 | < 2 | 75.15 | < 0.9 | < 1 | 7.477 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 7.103 | < 1 | < 2 | 69.26 | < 0.9 | < 1 | 7.648 | < 1 | < 2 | < 2 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *5.5* | 14-Jun-13 | 52.1 | < 0.02 | 338.9 | 36970 | O/R | 2.7 | 35640 | < 3 | 47240 | - | < 0.2 | 299.9 | 0.6 | 4.7 | 37.4 |
| | | 4-Sep-13 | 9.1 | 0.3 | 77 | 43270 | - | 15.8 | 10240 | < DL | 19020 | - | 3.4 | 92.6 | 1 | 10.9 | 28 |
| | | 9-May-14 | 19.1 | < 0.08 | 217.1 | 38500 | O/R | < 1.5 | 42930 | < 35 | 16240 | - | < 2 | 179.5 | 1 | 6.9 | 9.2 |
| | *10.5* | 16-Jun-12 | 21.7 | < DL | 121.2 | 7255 | O/R | 2.4 | 22810 | < DL | O/R | - | < DL | 86.7 | 0.9 | 9 | 3.5 |
| | | 26-Jun-12 | 16.1 | < DL | 92.5 | 7436 | O/R | 31.3 | 20890 | < DL | O/R | - | < 0.287 | 71.8 | 1.2 | 8.5 | 11.9 |
| | | 26-Jun-12 | 16.4 | < DL | 91.3 | O/R | O/R | 31.7 | O/R | < DL | O/R | - | < 0.287 | 71.3 | 1.1 | 8.4 | 12.7 |
| | | 21-Jul-12 | 14.4 | < DL | 81.8 | - | - | 19.1 | 19450 | < DL | - | - | < 0.1 | 57.7 | 1 | 8.5 | 40.6 |
| | | 19-Aug-12 | 19.3 | < DL | 107.3 | - | - | 22.2 | 24970 | < DL | - | - | < DL | 72.3 | 1.3 | 8.5 | 116.3 |
| | | 24-Sep-12 | 16.8 | < DL | 78.6 | - | - | < 0.1 | 20510 | < DL | - | - | < DL | 55.4 | < 0.02 | 8.9 | 31.8 |
| | | 28-Oct-12 | 18.9 | < DL | 90.8 | - | - | 1.8 | 25410 | < DL | - | - | < 0.2 | 59.9 | 0.6 | 9.1 | 3.7 |
| | | 20-May-13 | 23.1 | < 0.007 | 126.8 | 8833 | O/R | < 0.04 | 42120 | < 3 | 32870 | - | < 0.05 | 71.4 | 0.8 | 11 | 5.1 |
| | | 14-Jun-13 | 19.1 | < 0.02 | 42.7 | 12850 | O/R | < 0.04 | 13860 | < 3 | 37360 | - | < 0.05 | 24.1 | < 0.007 | 24.8 | < 0.2 |
| | | 27-Jul-13 | 16.6 | < 0.02 | 44.1 | 3306 | - | < DL | 14680 | < DL | 35200 | - | < 0.2 | 25.8 | 1 | 15.1 | 204 |
| | | 4-Sep-13 | 13.8 | 2.3 | 45.4 | 8991 | - | 3.1 | 10070 | < DL | 39820 | - | 3.3 | 23.2 | 5.6 | 20.9 | 8.8 |
| | | 5-Oct-13 | 10.9 | < DL | 28.6 | 8738 | - | < DL | 6051 | < DL | 27340 | - | < DL | 15.5 | 0.5 | 18.2 | 5.1 |
| | | 9-May-14 | 12.9 | < 0.08 | 43.9 | 8690 | O/R | < 1.5 | 7207 | < 35 | 29180 | - | < 0.5 | 17.9 | 1 | 16 | 9.6 |
| | | 12-Jun-14 | 18.1 | < 0.25 | 48 | 7826 | O/R | 7.4 | 6227 | < 35 | 28750 | O/R | 1.6 | 14.2 | 1 | 34.4 | 20.3 |
| | | 12-Jul-14 | 18.1 | < 0.25 | 34.2 | - | - | < 1.5 | 4292 | < 35 | - | - | < 0.5 | 10.3 | 0.5 | 41.5 | 8.8 |
| | | 28-Sep-14 | 7.3 | < 0.08 | < 2 | - | - | < 1.5 | 5250.5 | < 35 | - | - | < 0.5 | 12.3 | 0.5 | 20.6 | 4.3 |
| | *15.5* | 16-Jun-12 | 7.7 | < DL | 88.4 | 3304 | O/R | 2.6 | 9100 | < DL | 24310 | - | < DL | 28.6 | 0.4 | 6.6 | 3.8 |
| | | 26-Jun-12 | 6.2 | < DL | 93.4 | 2579 | O/R | 3.9 | 11570 | < DL | O/R | - | < DL | 33.6 | 1 | 4.5 | 3.2 |
| | | 21-Jul-12 | < 0.1 | < DL | 99 | - | - | 13.4 | 11060 | < DL | - | - | < DL | 29.3 | 1 | 4 | 41.3 |
| | | 21-Jul-12 | < 0.1 | < DL | 97.2 | - | - | 12.4 | 10860 | < DL | - | - | < DL | 30.3 | 1.2 | 3.6 | 33 |
| | | 19-Aug-12 | 7.9 | < DL | 110.8 | - | - | 7.6 | 12280 | < DL | - | - | < DL | 33.8 | 1.6 | 2.8 | 42.1 |
| | | 24-Sep-12 | < 0.1 | < DL | 79.7 | - | - | 16.4 | 9545 | < DL | - | - | < 0.1 | 26.4 | 2.3 | 3.9 | 55.3 |
| | | 28-Oct-12 | 5.2 | < DL | 80.6 | - | - | 4.7 | 7201 | < DL | - | - | < DL | 24.7 | 0.6 | 2.6 | 5.4 |
| | | 21-May-13 | 7.3 | < 0.02 | 123.7 | 9777 | O/R | < 0.04 | 14480 | < 3 | 24010 | - | < 0.05 | 32.5 | 1.2 | 2.6 | 7.8 |
| | | 14-Jun-13 | 8.3 | < 0.007 | 134.9 | 10600 | O/R | < 0.1 | 18700 | < 3 | 38090 | - | < 0.2 | 35.4 | 1 | 3.5 | 17.8 |
| | | 15-Jun-13 | 5.8 | < 0.02 | 94.4 | 10640 | O/R | < 0.04 | 12940 | < 3 | 26310 | - | < 0.05 | 23.9 | 0.3 | 3.6 | 3.6 |
| | | 27-Jul-13 | 5.1 | 0.3 | 62.8 | 8110 | - | < DL | 9335 | < DL | 22070 | - | < 0.2 | 23.9 | 0.5 | 3.5 | 5.3 |
| | | 5-Oct-13 | 3 | < DL | 34.1 | 8556 | - | < DL | 3883 | < DL | 20980 | - | < DL | 10.6 | 0.2 | 4.8 | 6.7 |
| | | 9-May-14 | 5.9 | < 0.08 | 80 | 8070 | O/R | 1.6 | 9073 | < 35 | 21600 | - | < 0.5 | 26.4 | 2.3 | 3.5 | 9.1 |
| | | 12-Jul-14 | 7.4 | < 0.25 | 46.7 | - | - | 1.7 | 4200 | < 35 | - | - | < 0.5 | 11.8 | 0.3 | 5 | 7.4 |
| | | 28-Sep-14 | < 0.4 | < 0.08 | < 5.5 | - | - | 3.5 | 2585.7 | < 35 | - | - | < 0.5 | 7.2 | 0.2 | 4.2 | 11.3 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *20.5* | 16-Jun-12 | 23.8 | < DL | 166.5 | 14990 | O/R | 3.7 | O/R | < DL | 14210 | - | < DL | 163 | < 0.0179 | 14.2 | < 0.250 |
| | | 26-Jun-12 | 21.8 | < DL | 159.6 | 15050 | O/R | 9.7 | O/R | < DL | 14930 | - | < DL | 155.9 | < 0.0179 | 12.8 | 14 |
| | | 21-Jul-12 | 22.6 | < DL | 152.5 | - | - | 13.6 | O/R | < DL | - | - | < 0.1 | 135.3 | < 0.02 | 11.1 | < 0.09 |
| | | 19-Aug-12 | 26.4 | < DL | 175.2 | - | - | 10.4 | O/R | < DL | - | - | < 0.1 | 149.5 | 1.9 | 12.3 | 36.8 |
| | | 23-Sep-12 | 27.1 | < DL | 179.3 | - | - | < 0.1 | O/R | < DL | - | - | < DL | 150.1 | 1 | 12.5 | 26.9 |
| | | 28-Oct-12 | 27.2 | < DL | 174.9 | - | - | 16.2 | 41570 | < DL | - | - | 1.8 | 154.6 | 0.7 | 12.7 | 25.4 |
| | | 20-May-13 | 18 | < 0.02 | 165.2 | 12360 | O/R | 4.9 | 45230 | < 3 | 20340 | - | < 0.2 | 128.7 | 1 | 9.7 | 20.8 |
| | | 27-Jul-13 | 5 | < 0.02 | 61.9 | 6373 | - | < DL | 26530 | < DL | 23150 | - | < 0.2 | 57.2 | 0.2 | 13.7 | 4.6 |
| | | 4-Sep-13 | 5.3 | 0.3 | 78.4 | 10030 | - | < 0.1 | 32950 | < DL | 27420 | - | 1.8 | 66.3 | 1 | 12.4 | 4.9 |
| | | 5-Oct-13 | 1.8 | < DL | 34 | 8799 | - | 7.3 | 11830 | < DL | 21120 | - | 1.6 | 24.6 | 0.5 | 15.4 | 17.2 |
| | | 9-May-14 | 3 | < 0.08 | 53.9 | 9241 | O/R | < 0.5 | 19640 | < 35 | 22160 | - | < 0.5 | 36.1 | 1 | 10.8 | 10.6 |
| | | 12-Jul-14 | 3.9 | < 0.08 | 43.5 | - | - | 1.3 | O/R | < 35 | - | - | < 2 | 20.7 | 0.4 | 10.1 | 12.5 |
| | | 28-Sep-14 | < 0.4 | < 0.08 | 5.6 | - | - | < 0.5 | 11043.4 | < 35 | - | - | < 0.5 | 14.7 | 0.7 | 7.5 | 44.1 |
| | *25.5* | 25-Jun-12 | 52.3 | < DL | 129.9 | 7461 | O/R | < 0.0940 | 11000 | < DL | 6975 | - | < DL | 28.7 | < 0.0219 | 194.6 | 927.5 |
| | | 26-Jun-12 | 19.3 | < DL | 38.5 | 7451 | O/R | 1.7 | 10950 | < DL | 6387 | - | < DL | 1 | < 0.0219 | 185.9 | 23.9 |
| | | 21-Jul-12 | 16.8 | < DL | < 1 | - | - | 15 | 12940 | < DL | - | - | < DL | 6.9 | < DL | 172 | 259.6 |
| | | 22-Jul-12 | 12.7 | < DL | < 1 | - | - | < 0.1 | 11590 | < DL | - | - | < DL | < 0.03 | < DL | 169.5 | 97.2 |
| | | 19-Aug-12 | 12.7 | < DL | < 1 | - | - | < 0.1 | 11250 | < DL | - | - | < DL | 2 | < DL | 179.6 | 3164 |
| | | 23-Sep-12 | 10.9 | < DL | < DL | - | - | < DL | 10050 | < DL | - | - | < DL | < 0.03 | < DL | 161.3 | 1129 |
| | | 28-Oct-12 | 13.6 | < DL | 26.1 | - | - | 3 | 10170 | < DL | - | - | < DL | 0.6 | < DL | 198.6 | 2358 |
| | | Duplicate | 13 | < DL | 24.8 | - | - | 1.5 | 9997 | < DL | - | - | < DL | 0.3 | < DL | 193 | 2256 |
| | | 20-May-13 | 13 | < 0.007 | 24.3 | 10330 | O/R | < 0.04 | 11470 | < 3 | 8727 | - | < 0.05 | 0.8 | < 0.02 | 201.2 | 913 |
| | | Duplicate | 13.3 | < 0.007 | 22.7 | 8544 | O/R | < 0.04 | 11110 | < 3 | 6305 | - | < 0.05 | 0.6 | < 0.007 | 200.2 | 362.4 |
| | | 14-Jun-13 | 14.4 | < 0.007 | 20.3 | 8644 | O/R | < 0.04 | 11780 | < 3 | 6399 | - | < 0.05 | 0.5 | < 0.007 | 207.6 | 1048 |
| | | 27-Jul-13 | 13.3 | 2.4 | 17.5 | 7300 | - | 4.4 | 7492 | < DL | 4405 | - | 4.2 | 3.8 | 5 | 202.7 | 506 |
| | | 4-Sep-13 | 11.5 | < 0.02 | 25.1 | 7978 | - | < DL | 9185 | < DL | 7361 | - | < 0.2 | 0.6 | 0.3 | 212.7 | 327.1 |
| | | Duplicate | 11.5 | < 0.02 | 25.1 | 7933 | - | < DL | 8967 | < DL | 7195 | - | < 0.2 | 0.6 | 0.3 | 208.9 | 509.5 |
| | | 5-Oct-13 | 9.1 | < DL | 9.9 | 7299 | - | < DL | 7748 | < DL | 4930 | - | 1.2 | 0.5 | < DL | 209.7 | 935 |
| | | Duplicate | 9.3 | < DL | 10.3 | 7391 | < DL | 7600 | < DL | 6342 | 0.7 | - | 0.4 | < DL | 208.9 | 1262 | < 0.2 |
| | | 9-May-14 | 8.4 | < 0.08 | 15.8 | 8186 | O/R | < 0.5 | 7981 | < 35 | 5244 | - | < 0.5 | 0.5 | 0.3 | 224.4 | 96.3 |
| | | Duplicate | 8.7 | < 0.08 | 16.1 | 7834 | O/R | < 0.5 | 8057 | < 35 | 5472 | - | < 0.5 | 0.7 | 0.3 | 227.5 | 894.6 |
| | | 12-Jun-14 | 12.6 | < 0.08 | 26.9 | 7946 | O/R | 7.9 | 7936 | < 35 | 5067 | O/R | < 0.5 | < 0.25 | 0.4 | 235.4 | 562.3 |
| | | Duplicate | 12.6 | < 0.25 | 27.7 | 7768 | O/R | 4.9 | 7886 | < 35 | 5013 | O/R | < 0.5 | 0.2 | 0.5 | 232.6 | 400.2 |
| | | 12-Jul-14 | 11.2 | < 0.08 | 14.2 | - | - | < 1.5 | O/R | < 35 | - | - | < 0.5 | 0.3 | < 0.3 | 223.5 | 21.7 |
| | | 28-Sep-14 | 3.1 | < 0.08 | < 2 | - | - | < 0.5 | 7871.9 | < 35 | - | - | < 0.5 | < 0.25 | < 0.3 | 248.3 | 19.9 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *5.0* | 14-Jun-13 | < 0.02 | 6.7 | 2.9 | 27 | 1.3 | - | 716.6 | 20.9 | < 0.004 | < 0.005 | < 0.1 | 7.1 | 11.5 | - | 0.1 | 0.7 |
| | | 4-Sep-13 | 0.6 | 13.1 | 3.8 | 11.7 | 1.9 | 2.9 | 468.4 | 7.7 | 0.6 | 0.3 | 4.7 | 5.6 | 14.4 | 0.3 | 1.8 | 0.9 |
| | | 9-May-14 | 0.3 | 5.7 | 1.6 | < 8.5 | 1.9 | - | 611.4 | 11.1 | < 0.05 | < 0.05 | 4 | 0.7 | 14.8 | - | - | 0.2 |
| | *10.0* | 16-Jun-12 | 0.2 | 9.1 | 0.9 | 89.8 | 1.7 | - | 1352 | 9.8 | < DL | < DL | 7.2 | 0.1 | 11.9 | < 0.0125 | 0.1 | 1.6 |
| | | 26-Jun-12 | 0.3 | 9 | 5.2 | 41.5 | 1.5 | - | 1330 | 5.9 | < DL | < DL | 2.2 | 0.1 | 11.9 | < 0.0125 | 0.5 | 1.6 |
| | | 26-Jun-12 | 0.3 | 9.2 | 0.8 | 37.9 | 1.7 | - | 1311 | 5.9 | 0.1 | < DL | 1.8 | 0.1 | 11.7 | < 0.0125 | 0.2 | 1.6 |
| | | 21-Jul-12 | < DL | 6.9 | 39.6 | 50.9 | 1.9 | - | 1124 | 4.5 | < DL | < DL | 11.9 | 0.3 | 10.7 | < 0.002 | 4.9 | 1.2 |
| | | 19-Aug-12 | < 0.02 | 7.6 | 29.3 | 41.3 | 3 | - | 1222 | 8.5 | < DL | < 0.007 | < DL | 4 | 11.1 | 0.2 | 4.9 | 1.5 |
| | | 24-Sep-12 | < DL | 9.2 | < 0.07 | < 0.6 | < 0.03 | - | 1215 | 3 | < DL | < DL | < 0.2 | < 0.006 | 10.6 | < 0.002 | 3 | 1.2 |
| | | 28-Oct-12 | 0.2 | 8.1 | 3 | 21.5 | 1.1 | - | 1247 | 3.9 | 0.3 | < DL | 2.1 | 0.2 | 11.1 | - | 0.4 | 1.1 |
| | | 20-May-13 | 0.2 | 5.4 | 4.4 | 23 | 1.6 | - | 1148 | 5.8 | < 0.004 | < 0.001 | 2.7 | 0.2 | 8.9 | - | 1.1 | 1 |
| | | 14-Jun-13 | 1.1 | 32.9 | < 0.05 | 13.3 | 0.5 | - | 1166 | 1.8 | < 0.004 | < 0.001 | 2.7 | 0.1 | 9.9 | - | < 0.0009 | 0.7 |
| | | 27-Jul-13 | 0.8 | 19.1 | < DL | 13.6 | 1 | 10.5 | 1034 | 9.1 | 0.1 | 0.2 | 1.1 | 3.4 | 11.6 | 0.2 | 0.2 | 0.9 |
| | | 4-Sep-13 | 4.3 | 36.2 | 5.5 | 23.5 | 11.6 | 45.2 | 1004 | 22.4 | 3 | 3.5 | 4.6 | 25.6 | 14.7 | 2.2 | 15.1 | 0.6 |
| | | 5-Oct-13 | 0.8 | 45.7 | < 0.5 | 8.1 | 0.5 | 8.5 | 880.7 | 1.1 | < DL | < DL | < 1.5 | 0.6 | 9.3 | - | 0.1 | 0.7 |
| | | 9-May-14 | 1 | 43.2 | 0.6 | 49.5 | 0.4 | - | 872.9 | 1.8 | < 0.05 | < 0.05 | 5.3 | 0.7 | 10.1 | - | - | 0.8 |
| | | 12-Jun-14 | 3.4 | 62.8 | 1.2 | 24 | 0.4 | 5.7 | 870.4 | 0.8 | 0.1 | < 0.02 | 6.2 | 0.3 | 9.6 | 0.1 | - | 0.5 |
| | | 12-Jul-14 | 4.6 | 70.4 | 1.3 | 15.8 | 0.8 | 9.7 | 880.6 | 3.1 | 0.2 | 0.1 | 7.2 | 2.8 | 10.2 | 0.1 | 0.1 | 0.6 |
| | | 28-Sep-14 | 1.9 | 49.2 | 1 | 28.1 | 0.3 | 8.4 | 730.5 | 0.8 | < 0.05 | < 0.02 | 4.5 | 0.1 | 9.4 | - | < 0.04 | 0.6 |
| | *15.0* | 16-Jun-12 | < 0.0209 | 1.9 | 1.2 | 96.1 | 0.8 | - | 916.3 | 5.1 | < DL | < DL | 4.3 | 0.3 | 16.1 | < 0.0125 | - | 1.8 |
| | | 26-Jun-12 | < 0.0209 | 1.5 | 1 | 25.1 | 0.8 | - | 927 | 4.8 | < 0.0135 | < DL | 1.7 | 0.2 | 15 | < 0.0125 | 0.1 | 1.5 |
| | | 21-Jul-12 | < DL | < 0.04 | 7.6 | < 0.6 | < 0.03 | - | 918.9 | 3.4 | < DL | < DL | < 0.2 | 0.4 | 13.8 | < 0.002 | 1.1 | 1.5 |
| | | 21-Jul-12 | < DL | < 0.04 | 13.3 | < 0.6 | < 0.03 | - | 899.8 | 3.8 | < DL | < DL | < 0.2 | 0.7 | 13.2 | < 0.002 | 4.1 | 1.4 |
| | | 19-Aug-12 | < DL | < 0.04 | 6.5 | < 0.6 | < 0.03 | - | 911.5 | 5.7 | < DL | < DL | < 0.2 | 1 | 13 | < 0.002 | 2.1 | 1.5 |
| | | 24-Sep-12 | < DL | 4.4 | 9.1 | < 0.6 | < 0.03 | - | 900.3 | 2.8 | < DL | < DL | < DL | 0.8 | 13.4 | < 0.002 | 0.8 | 1.6 |
| | | 28-Oct-12 | < 0.02 | 0.9 | 4 | 12.1 | 0.6 | - | 798.1 | 2.5 | < DL | < DL | 1.2 | 0.3 | 10.8 | - | 0.1 | 1.3 |
| | | 21-May-13 | < 0.02 | 0.4 | 3.2 | 63 | 1.8 | - | 932.8 | 4.3 | < 0.004 | < 0.005 | 1.7 | 0.2 | 10.1 | - | 0.6 | 1.7 |
| | | 14-Jun-13 | < 0.02 | 1 | 0.6 | 36.9 | 1.3 | - | 933.4 | 4.9 | < 0.004 | < 0.001 | 1.3 | 5.9 | 13.1 | - | 0.3 | 1.6 |
| | | 15-Jun-13 | < 0.02 | 1.9 | < 0.05 | < 0.8 | 0.7 | - | 950.2 | 2.5 | < 0.004 | < 0.001 | < 0.03 | 1.6 | 12.1 | - | < 0.0009 | 1.2 |
| | | 27-Jul-13 | 0.5 | 3.5 | 80.1 | 51.1 | 1.1 | 11.7 | 900.8 | 2.6 | 0.3 | 0.3 | < DL | 1.6 | 11.8 | 0.3 | 1.2 | 1.1 |
| | | 5-Oct-13 | 0.2 | 4 | < DL | 19.7 | 0.5 | 12.7 | 932.1 | 2.6 | < DL | < DL | < 1.5 | 0.6 | 12.6 | - | 0.1 | 0.8 |
| | | 9-May-14 | 0.1 | 2.1 | < 0.5 | 35.5 | 0.8 | - | 867.4 | 4 | < 0.05 | < 0.02 | 3.8 | 0.3 | 10 | - | - | 1 |
| | | 12-Jul-14 | 0.3 | 5.4 | 0.6 | 10.7 | 0.7 | 10.9 | 873.3 | 2.8 | 1.5 | < 0.05 | 6.6 | 1.4 | 10.5 | 0.1 | - | 0.8 |
| | | 28-Sep-14 | 0.3 | 7.2 | 0.9 | < 2.5 | < 0.3 | 12.5 | 832.1 | 0.9 | < 0.05 | < 0.02 | < 1.5 | - | 10.9 | < 0.03 | < 0.01 | 0.6 |

***Table B.4(Cont.): Pore-Water Geochemical Data: BH4-2***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-2* | *20.5* | 16-Jun-12 | < 0.0113 | 1.9 | 4 | 67.3 | 3.6 | - | 782.3 | 17.7 | 2.1 | < DL | 7.7 | 1.4 | 47.5 | 0.2 | 0.4 | 4.8 |
| | | 26-Jun-12 | 1.2 | 1.9 | 13 | 54.3 | 3.5 | - | 823.8 | 12.6 | < 0.0137 | < DL | < 0.0979 | 1.4 | 39.4 | 0.1 | 1.2 | 4.9 |
| | | 21-Jul-12 | < 0.02 | < 0.04 | < DL | < 0.6 | 3.2 | - | 816.4 | 11.1 | < DL | < DL | < 0.2 | 1 | 31.1 | 0.1 | 0.1 | 2.5 |
| | | 19-Aug-12 | < 0.02 | 2.4 | 16.5 | 31.3 | 3.1 | - | 819.6 | 12.9 | < DL | < DL | < 0.2 | 1.3 | 27.5 | < 0.002 | 2.6 | 3.5 |
| | | 23-Sep-12 | < 0.02 | 2 | 22.5 | < 0.6 | 2.8 | - | 843.7 | 12.5 | < DL | < DL | < DL | 0.4 | 24.2 | < 0.002 | 3.6 | 2.9 |
| | | 28-Oct-12 | 0.2 | 1.8 | 4.9 | 11.6 | 2.9 | - | 935.4 | 13.4 | < DL | < 0.005 | < 0.1 | 0.4 | 24.5 | 0.1 | 0.1 | 3.5 |
| | | 20-May-13 | 0.2 | 1.4 | 5 | 18.5 | 3.5 | - | 929.5 | 12.9 | < 0.004 | < 0.005 | 2.3 | 0.4 | 15.5 | - | 1.2 | 2.4 |
| | | 27-Jul-13 | 0.2 | 1.4 | < DL | < 0.8 | 1.6 | 8.7 | 929.7 | 6 | < 0.01 | - | < DL | 2.4 | 14.8 | 0.1 | - | 4.5 |
| | | 4-Sep-13 | 0.3 | 1.7 | < 0.05 | 5.8 | 2.7 | 9.4 | 983 | 9.1 | 0.5 | 0.3 | 3.4 | 4.5 | 15.5 | 0.3 | 1 | 4.1 |
| | | 5-Oct-13 | < 0.2 | 3.3 | 7.1 | 9.4 | 0.8 | 10 | 943.1 | 4.3 | < 0.15 | < DL | < 1.5 | 0.9 | 13.9 | - | 0.3 | 4 |
| | | 9-May-14 | < 0.2 | 3.3 | 0.7 | 15.4 | 1.2 | - | 937.9 | 8.1 | < 0.05 | < 0.05 | 8.6 | 1.3 | 14.3 | - | - | 4 |
| | | 12-Jul-14 | 0.1 | 2.4 | 4.3 | < 8.5 | 0.7 | 9.9 | 938.4 | 4 | 0.4 | - | 8.1 | 1 | 11.6 | 0.1 | 0.1 | 4.4 |
| | | 28-Sep-14 | < 0.2 | 2.3 | 1.3 | 8.6 | 0.6 | 10.7 | 905.9 | 2.7 | < 0.15 | - | 1.1 | 0.2 | 12 | 0.1 | - | 3.8 |
| | *25.5* | 25-Jun-12 | 1.7 | 5.4 | 7.3 | 30.3 | 0.9 | - | 334.8 | 52.2 | < 0.0135 | < DL | 3.6 | 0.4 | 53.7 | < DL | 0.6 | 7.9 |
| | | 26-Jun-12 | 0.3 | 1.4 | 4 | 20.5 | 0.3 | - | 339.2 | 10 | < DL | < DL | 0.7 | 0.1 | 69.6 | < DL | 0.5 | 4.7 |
| | | 21-Jul-12 | < 0.02 | < 0.04 | < 0.07 | < 0.6 | < DL | - | 334.3 | 7.8 | 3 | < DL | < DL | 0.7 | 67 | < 0.002 | 1.4 | 4.3 |
| | | 22-Jul-12 | < DL | < 0.04 | 5.5 | < DL | < 0.03 | - | 309.6 | 2.5 | < DL | < DL | < 0.2 | 0.3 | 59.7 | < DL | 3.8 | 3.1 |
| | | 19-Aug-12 | < DL | < 0.04 | 7.7 | < DL | < 0.03 | - | 332.9 | 1.7 | 0.6 | < DL | < 0.2 | 0.6 | 68.1 | < DL | 1.1 | 3.1 |
| | | 23-Sep-12 | < DL | 3.7 | 14 | < DL | < 0.03 | - | 290.7 | 1.2 | < DL | < DL | < DL | < 0.006 | 58.3 | < DL | 3.4 | 2.4 |
| | | 28-Oct-12 | < DL | 0.5 | 2.1 | < DL | < 0.03 | - | 355.7 | 1.3 | < DL | < DL | < 0.1 | 0.1 | 74.6 | < 0.002 | < 0.003 | 3.2 |
| | | Duplicate | < 0.02 | 0.4 | 8.9 | < 0.8 | 0.3 | - | 347 | 1.2 | < DL | < DL | < 0.1 | 0.1 | 73.3 | < 0.002 | 0.7 | 3.1 |
| | | 20-May-13 | < 0.02 | < 0.04 | < 0.02 | < 0.2 | 0.9 | - | 349.1 | 1.7 | < 0.004 | < 0.001 | < 0.03 | 0.4 | 66.3 | < 0.002 | 0.6 | 2.6 |
| | | Duplicate | < 0.02 | 0.4 | 3.4 | < 0.2 | 0.9 | - | 348.5 | 1.9 | < 0.004 | < 0.001 | < 0.03 | 0.6 | 65.1 | < 0.002 | 1 | 2.7 |
| | | 14-Jun-13 | < 0.005 | < 0.04 | < 0.05 | < 0.2 | < 0.03 | - | 347.2 | 1.2 | < 0.004 | < 0.001 | < 0.03 | 0.1 | 71.3 | < 0.002 | < 0.0009 | 2.2 |
| | | 27-Jul-13 | 2.8 | 3.5 | 4.5 | 11 | 12.8 | 40.2 | 334.2 | 22.1 | 1.8 | 3.7 | < DL | 29.1 | 70.3 | 2.1 | 14.7 | 2.1 |
| | | 4-Sep-13 | 0.2 | 0.6 | < 0.05 | 1.6 | 0.7 | 1.4 | 345.4 | 1.5 | 0.2 | 0.2 | 1.9 | 2.5 | 64.7 | 0.1 | 0.3 | 1.8 |
| | | Duplicate | 0.2 | 0.7 | 3.4 | 3.1 | 1.1 | 2.6 | 341.9 | 1.8 | 0.2 | 0.2 | 1.9 | 2.6 | 65.3 | 0.1 | 0.4 | 1.9 |
| | | 5-Oct-13 | < 0.2 | 1 | < 0.5 | 2.5 | < 0.3 | < DL | 334 | 0.8 | < 0.15 | < DL | < DL | 0.7 | 60.4 | < DL | 0.2 | 1.6 |
| | | Duplicate | 0.5 | < 0.5 | 5.8 | 0.3 | < DL | - | 334 | 0.8 | < DL | < DL | < DL | 0.5 | 62.2 | < DL | 0.3 | 1.6 |
| | | 9-May-14 | 0.2 | 0.7 | < 0.5 | < 8.5 | 0.5 | - | 327.2 | 0.9 | < 0.05 | < 0.02 | 2.3 | 1 | 65.3 | < 0.03 | 0.1 | 1.7 |
| | | Duplicate | 0.2 | 0.5 | < 0.5 | < 2.5 | 0.5 | - | 329 | 0.7 | < 0.05 | < 0.02 | 1.8 | 1.1 | 66.2 | < 0.03 | < 0.04 | 1.7 |
| | | 12-Jun-14 | < 0.2 | < 0.5 | 0.5 | 24.1 | 0.3 | < 2 | 323.6 | 0.9 | < 0.15 | < 0.02 | 5.3 | 0.2 | 61.8 | - | - | 1.5 |
| | | Duplicate | < 0.05 | < 0.5 | 0.1 | 3.5 | 0.3 | < 2 | 318.1 | 0.7 | < 0.15 | < 0.02 | 1.5 | 0.1 | 61.2 | - | - | 1.5 |
| | | 12-Jul-14 | < 0.2 | < 0.5 | 1.3 | < 8.5 | < 0.3 | < 2 | 331.7 | 1.5 | < 0.15 | - | 5 | 0.7 | 58.2 | - | - | 1.6 |
| | | 28-Sep-14 | 0.2 | < 0.15 | < 0.5 | < 2.5 | < 0.3 | < 2 | 321.9 | 0.5 | 0.3 | < 0.05 | 1.3 | < 0.09 | 60.1 | - | < 0.04 | 1.5 |

***Table B.5: Pore-Water Geochemical Data: BH4-3***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-3* | *5.0* | 14-Jun-13 | 7.8 | 454.1 | 3.2 | 22.9 | 75 | 0.9 | 2.8 | < 0.3 | < 0.3 | < 0.3 | 2400.6 | < 0.3 | - | - |
| | | 9-May-14 | 7.6 | 320.1 | 3.6 | 18.5 | 130 | 3.3 | 3.5 | < 0.1 | < 0.1 | 1.3 | 2717.9 | - | - | - |
| | | 14-Jun-14 | 7.9 | 375.5 | 2.5 | 15.6 | 100 | - | - | - | - | - | - | - | - | - |
| | | 29-Sep-14 | 7.8 | 33.5 | 2.3 | 16.4 | 76.1 | 0.6 | 1.7 | < 0.1 | < 0.1 | 0.2 | 1643.6 | < 0.1 | - | - |
| | *10.0* | 17-Jun-12 | 7.7 | 299.3 | - | - | 79.4 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8 | 245.2 | - | 21.7 | - | - | - | - | - | - | - | - | - | - |
| | | 9-May-14 | 7.9 | 318.8 | - | - | 182 | - | - | - | - | - | - | - | - | - |
| | *15.0* | 17-Jun-12 | 8 | 316.3 | - | - | 130 | 6 | 16.5 | < 0.3 | 0.2 | 8.7 | 771.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 132 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8.1 | 217.3 | - | - | 150 | 3.9 | 15.7 | < 0.3 | < 0.3 | 6.7 | 1582.6 | < 0.3 | - | - |
| | | 14-Jun-13 | 8.3 | 431.7 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 8.2 | 451 | 3.2 | 25.6 | 183.3 | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 8.2 | 321.7 | 3 | 16.1 | 147 | < 0.3 | 2.1 | < 0.3 | < 0.3 | < 0.3 | 1761.7 | < 0.3 | <0.01 | 2.8 |
| | | 5-Oct-13 | 7.7 | 314 | - | - | 150 | - | 3 | < 1.0 | < 0.3 | < 1.0 | 60.9 | < 1.0 | - | - |
| | | 9-May-14 | 8 | 315.7 | - | - | 160 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-14 | 8 | 467.1 | 3.1 | 17.6 | 180 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8.1 | 284.6 | 2.8 | 23.5 | 124.7 | - | - | - | - | - | - | - | - | - |
| | | 29-Sep-14 | 8 | 27.9 | 3 | 18.5 | 154.1 | - | - | - | - | - | - | - | - | - |
| | *20.0* | 17-Jun-12 | 7.8 | 300.3 | - | - | 77.5 | - | - | - | - | - | - | - | - | - |
| | | 27-Jun-12 | 8.1 | 435.3 | - | - | 92.5 | 6.5 | 15.3 | < 0.3 | 0.2 | 15.6 | 348 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 92.8 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8.2 | 213.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 23-Jul-12 | 8.3 | 419.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| | | 28-Oct-12 | 8.1 | 364.4 | - | - | - | - | - | - | - | - | - | - | - | - |

*Table B.5(Cont.): Pore-Water Geochemical Data: BH4-3*

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 27-Jun-12 | 7.5 | 425.3 | - | - | 322 | 1.6 | 6.3 | < 0.3 | < 0.3 | < 0.3 | 775.4 | < 0.3 | - | - |
| | | Duplicate | - | - | - | - | 355 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 7.8 | 173.7 | - | 22.4 | 562.5 | < 0.3 | 3.5 | < 0.3 | < 0.3 | < 0.3 | 260.3 | < 0.3 | - | - |
| | | Duplicate | - | - | - | - | 520 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | - | - | - | 500 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 7.4 | 411.3 | - | - | 570 | - | - | - | - | - | - | - | - | - |
| | | Duplicate | - | - | - | - | 580 | < 0.3 | 2.8 | < 0.3 | < 0.3 | < 0.3 | 73 | < 0.3 | - | - |
| | | 23-Sep-12 | 7.5 | 402.9 | 1 | 19 | 539.1 | - | 2.9 | < 0.3 | < 0.3 | < 0.3 | 52.5 | < 0.3 | - | 10 |
| ***BH4-3*** | ***25.0*** | Duplicate | - | - | - | - | 536.3 | - | - | - | - | - | - | - | - | - |
| | | 28-Oct-12 | 7.4 | 356.7 | 1 | 18.2 | 575 | - | 2.9 | < 0.05 | < 0.05 | < 0.05 | 41 | < 0.05 | 0.1 | 4.5 |
| | | 20-May-13 | 7.6 | 253.3 | 1 | 19 | 560 | < 0.03 | 2.5 | < 0.03 | < 0.03 | < 0.03 | 34 | < 0.03 | - | - |
| | | 14-Jun-13 | 7.2 | 375.4 | 1 | 22.1 | 675 | < 0.3 | 3.1 | < 0.3 | < 0.3 | < 0.3 | 42.2 | < 0.3 | - | - |
| | | 27-Jul-13 | 7.2 | 290.1 | 0.9 | 22.6 | 525 | < 0.3 | 3.3 | < 0.3 | < 0.3 | < 0.3 | 46.6 | < 0.3 | <0.01 | 4.4 |
| | | 4-Sep-13 | 8 | 369.7 | 0.8 | 14.5 | 480 | < 0.3 | 2.8 | < 0.3 | < 0.3 | < 0.3 | 52.1 | < 0.3 | <0.01 | 2.7 |
| | | 5-Oct-13 | 7.3 | 372.5 | 0.8 | 13 | 472.7 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 7.3 | 286.7 | 0.8 | 23.4 | 460.8 | 0.1 | 3.1 | < 0.1 | < 0.1 | < 0.1 | 74.7 | < 0.01 | - | 4.1 |
| | | 29-Sep-14 | 7.9 | 62.1 | 0.8 | 16.8 | 512.9 | < 0.1 | 3.2 | < 0.1 | < 0.1 | < 0.1 | 80.5 | < 0.1 | - | - |

***Table B.5(Cont.): Pore-Water Geochemical Data: BH4-3***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-3* | *5.0* | 14-Jun-13 | < DL | < DL | 463.1 | < DL | < DL | < DL | < DL | < DL | 24.1 | < DL | 287.8 |
| | | 9-May-14 | < 2 | < 1 | 476.8 | <2 | < 1 | <2 | <2 | <2 | 26.8 | < 1 | 379.9 |
| | | 28-Sep-14 | < 2 | < 1 | 461.1 | < 2 | < 1 | < 2 | < 2 | < 2 | 17.4 | < 1 | 109.3 |
| | *15.0* | 17-Jun-12 | < DL | < DL | 254.2 | < DL | < DL | < DL | < DL | < DL | 8.9 | - | 66.3 |
| | | 21-Jul-12 | < DL | < DL | 377.1 | < DL | < DL | < DL | < DL | < DL | 16.7 | < DL | 142.1 |
| | | 14-Jun-13 | < DL | < DL | 503.4 | < DL | < DL | < DL | < DL | < DL | 56.4 | < DL | 198.5 |
| | | 29-Jul-13 | < DL | < DL | 538.7 | < DL | < DL | < DL | < DL | < DL | 20.9 | < DL | 243.5 |
| | | 4-Sep-13 | < DL | < DL | 504.1 | < DL | < DL | < DL | < DL | < DL | 23.3 | < DL | 143.2 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 514.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 23.4 | < 0.1 | 257.4 |
| | | 12-Jul-14 | < 2 | < 1 | 520.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 19.5 | < 1 | 191.5 |
| | *20.0* | 27-Jun-12 | < DL | < DL | 148.2 | < DL | < DL | < DL | < DL | < DL | 7.8 | - | 28.2 |
| | | Duplicate | < DL | < DL | 148.8 | < DL | < DL | < DL | < DL | < DL | 8 | - | 28.7 |
| | | 21-Jul-12 | < DL | < DL | 158.1 | < DL | < DL | < DL | < DL | < DL | 8.5 | < DL | 29 |
| | | 23-Jul-12 | < DL | < DL | 168.3 | < DL | < DL | < DL | < DL | < DL | 395.7 | < DL | 35.6 |
| | *25.0* | 27-Jun-12 | < DL | < DL | 300.3 | < DL | < DL | < DL | < DL | < DL | 10.4 | - | 89.7 |
| | | 21-Jul-12 | < DL | < DL | 218.6 | < DL | < DL | < DL | < DL | < DL | 7.7 | < DL | 60.1 |
| | | 19-Aug-12 | < DL | < DL | 177.9 | < DL | < DL | < DL | < DL | < DL | 5.1 | < DL | 48.7 |
| | | 23-Sep-12 | < DL | < DL | 164.3 | < DL | < DL | < DL | < DL | < DL | 4.6 | < DL | 44.7 |
| | | 28-Oct-12 | < DL | < DL | 161 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 48.2 |
| | | 20-May-13 | < DL | < DL | 155.3 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 44.5 |
| | | 14-Jun-13 | < DL | < DL | 141.8 | < DL | < DL | < DL | < DL | < DL | 1.9 | < DL | 43.4 |
| | | 27-Jul-13 | < DL | < DL | 138.9 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 43.8 |
| | | 4-Sep-13 | < DL | < DL | 137 | < DL | < DL | < DL | < DL | < DL | 4.1 | < DL | 43 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 133.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 4.3 | < 0.1 | 43.4 |
| | | 12-Jul-14 | < 2 | < 1 | 124.1 | < 2 | < 1 | < 2 | < 2 | < 2 | 2.4 | < 1 | 41.7 |
| | | 28-Sep-14 | < 2 | < 1 | 128.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 3.8 | < 1 | 41.1 |

***Table B.5(Cont.): Pore-Water Geochemical Data: BH4-3***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-3* | *5.0* | 14-Jun-13 | < DL | 43.6 | < DL | < DL | 759.9 | < DL | < DL | 20.2 | 0.8 | < DL | < DL |
| | | 9-May-14 | < 1 | 40.6 | < 1 | <2 | 922.2 | < 0.9 | < 1 | 41.7 | 0.8 | <2 | <2 |
| | | 28-Sep-14 | < 1 | 52.2 | < 1 | < 2 | 545.4 | < 0.9 | < 1 | 28.9 | < 1 | < 2 | < 2 |
| | *15.0* | 17-Jun-12 | < DL | 16.3 | < DL | < DL | 244.2 | < DL | < DL | 35.8 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 25 | < DL | < DL | 464.8 | < DL | < DL | 36.4 | < 0.1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 26 | < DL | < DL | 620.9 | < DL | < DL | 34 | 0.7 | < DL | < DL |
| | | 29-Jul-13 | < DL | 29.5 | < DL | < DL | 728.6 | < DL | < DL | 37.9 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < DL | 9.7 | < DL | < DL | 604.1 | < DL | < DL | 5.2 | 0.8 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 29.2 | < 1.0 | < 0.2 | 710.1 | < 0.09 | < 0.1 | 33.7 | < 0.1 | < 0.2 | < 0.2 |
| | | 12-Jul-14 | < 1 | 15.8 | < 1 | < 2 | 665.8 | < 0.9 | < 1 | 34.2 | < 1 | < 2 | < 2 |
| | *20.0* | 27-Jun-12 | < DL | 10.7 | < DL | < DL | 115 | < DL | < DL | 35.1 | < DL | < DL | < DL |
| | | Duplicate | < DL | 10.9 | < DL | < DL | 115.3 | < DL | < DL | 35.2 | < DL | < DL | < DL |
| | | 21-Jul-12 | < DL | 11.5 | < DL | < DL | 126.8 | < DL | < DL | 43.2 | < DL | < DL | < DL |
| | | 23-Jul-12 | < DL | 13.7 | < DL | < DL | 145.2 | < DL | < DL | 43.3 | < DL | < DL | < DL |
| | *25.0* | 27-Jun-12 | < DL | 11.3 | < DL | < DL | 247.4 | < DL | < DL | 17 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 8.6 | < DL | < DL | 94.9 | < DL | < DL | 17.9 | < 0.1 | < DL | < DL |
| | | 19-Aug-12 | < DL | 7.3 | < DL | < DL | 29.9 | < DL | < DL | 16.1 | < 0.1 | < DL | < DL |
| | | 23-Sep-12 | < DL | 6.9 | < DL | < DL | 21.6 | < DL | < DL | 16.2 | < 0.1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 7.3 | < DL | < DL | 17.2 | < DL | < DL | 16.5 | < 0.1 | < DL | < DL |
| | | 20-May-13 | < DL | 6.7 | < DL | < DL | 15 | < DL | < DL | 14.5 | < 0.1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 6.7 | < DL | < DL | 17.2 | < DL | < DL | 10.8 | 0.3 | < DL | < DL |
| | | 27-Jul-13 | < DL | 6.8 | < DL | < DL | 19.2 | < DL | < DL | 9.7 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < DL | 6.9 | < DL | < DL | 22.8 | < DL | < DL | 9.8 | 0.3 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 6.6 | < 1.0 | < 0.2 | 23.4 | < 0.09 | < 0.1 | 8 | < 0.1 | < 0.2 | < 0.2 |
| | | 12-Jul-14 | < 1 | 4.5 | < 1 | < 2 | 29.5 | < 0.9 | < 1 | 8.8 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 8.6 | < 1 | < 2 | 29.9 | < 0.9 | < 1 | 7.8 | < 1 | < 2 | < 2 |

***Table B.5(Cont.): Pore-Water Geochemical Data: BH4-3***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-3* | *5.0* | 14-Jun-13 | 29.1 | < 0.02 | 87.2 | 47480 | O/R | < 0.1 | 24000 | < 3 | 28860 | - | < 0.2 | 123 | < 0.02 | 28.4 | 2.8 |
| | | 9-May-14 | 30.4 | < 0.08 | 131.3 | 39300 | O/R | < 1.5 | 42860 | < 35 | 29040 | - | < 2 | 178.8 | 0.9 | 13.8 | 13 |
| | | 29-Sep-14 | 11.9 | < 0.08 | 34.7 | - | - | < 0.5 | 31868 | < 35 | - | - | < 2 | 73.1 | 0.4 | 8.1 | 20.1 |
| | *15.0* | 17-Jun-12 | 214.1 | < DL | 543.8 | 15480 | O/R | 5.3 | O/R | < DL | 8477 | - | < DL | 499.8 | 2.6 | 26 | 13.9 |
| | | 21-Jul-12 | 136.9 | < DL | 390.7 | - | - | 20.5 | O/R | < DL | - | - | < 0.1 | 347.3 | 2.6 | 28.2 | 85.6 |
| | | 14-Jun-13 | 80.6 | < 0.02 | 306.6 | 29450 | O/R | 2.7 | 39100 | < 3 | O/R | - | < 0.2 | 240.9 | 0.7 | 13 | 25.2 |
| | | 29-Jul-13 | 72.3 | < 0.02 | 223.3 | 31650 | - | 6.5 | 38570 | < DL | 20890 | - | 2.1 | 234.8 | 0.4 | 10.2 | 19.6 |
| | | 4-Sep-13 | 3.8 | < 0.02 | 61.4 | 9505 | - | < 0.1 | 5735 | < DL | 26660 | - | < 0.2 | 15 | 0.4 | 4.7 | 6.1 |
| | | 5-Oct-13 | 32.3 | < DL | 119.1 | 27940 | - | 0.9 | 33810 | < DL | 20760 | - | 0.7 | 211.7 | 0.5 | 12 | 11.3 |
| | | 12-Jul-14 | 20.4 | < 0.08 | 80.7 | - | - | 6.6 | O/R | < 35 | - | - | < 2 | 142.4 | 0.6 | 11.2 | 15.2 |
| | *20.0* | 27-Jun-12 | 349.3 | < DL | 684.3 | 3563 | O/R | 33.7 | O/R | < DL | 7911 | - | < DL | 645.2 | 10.8 | 7.8 | 98.7 |
| | | Duplicate | 354.3 | < DL | 704.9 | 3042 | O/R | 34 | O/R | < DL | 7867 | - | < 0.228 | 648.7 | 10.3 | 8 | 112.2 |
| | | 21-Jul-12 | 283.8 | < DL | 705.4 | - | - | 34.1 | O/R | < DL | - | - | < DL | 497.6 | 11.2 | 6.6 | 77.2 |
| | | 23-Jul-12 | 284.7 | < DL | 738.3 | - | - | 23.4 | O/R | < DL | - | - | < 0.1 | 512.7 | 8.1 | 4.8 | 101.5 |
| | *25.0* | 27-Jun-12 | 35.2 | 2.6 | 87.6 | 570.8 | O/R | 4.2 | 17820 | < DL | 10460 | - | < DL | 27.4 | 5.3 | 1785 | 73.7 |
| | | 21-Jul-12 | 16.6 | < DL | < 1 | - | - | 16.4 | 16970 | < DL | - | - | < 0.1 | 7.8 | < 0.02 | 845.9 | 51.2 |
| | | 19-Aug-12 | 9 | < DL | < 1 | - | - | 13.5 | 15340 | < DL | - | - | < 0.1 | 1.3 | < DL | 482.2 | 760.1 |
| | | 23-Sep-12 | 7.8 | < DL | < DL | - | - | < DL | 15850 | < DL | - | - | < DL | < 0.03 | < DL | 454.3 | 42.4 |
| | | 28-Oct-12 | 7.6 | < DL | 18.8 | - | - | < 0.1 | 16730 | < DL | - | - | < DL | 0.5 | < DL | 542.8 | 43.2 |
| | | 20-May-13 | 8.5 | < 0.007 | 16.3 | 6950 | 46930 | < 0.04 | 16450 | < 3 | 3954 | - | < 0.05 | 1.7 | < 0.007 | 455.8 | 11.9 |
| | | 14-Jun-13 | 9.9 | < 0.007 | 13.6 | 7326 | 46200 | < 0.04 | 14530 | < 3 | 4159 | - | < 0.2 | 0.2 | < 0.007 | 318.3 | 80.1 |
| | | 27-Jul-13 | 9.2 | 0.2 | 8.6 | 6354 | - | 9.5 | 8683 | < DL | 3309 | - | 1.8 | 0.6 | 0.4 | 271.5 | 836 |
| | | 4-Sep-13 | 8.1 | < 0.02 | 18.4 | 6905 | - | < DL | 10730 | < DL | 4323 | - | 1.1 | 1.3 | 0.2 | 231.3 | 11.3 |
| | | 5-Oct-13 | 6.3 | < DL | 4.1 | 6592 | - | 1 | 7842 | < DL | 3694 | - | < DL | 0.3 | < DL | 186.2 | 10 |
| | | 12-Jul-14 | 8.2 | < 0.08 | 9.9 | - | - | < 0.5 | O/R | < 35 | - | - | < 0.5 | 0.8 | 0.3 | 135.4 | 10.7 |
| | | 29-Sep-14 | < 1.5 | < 0.08 | < 2 | - | - | < 0.5 | 8138.3 | < 35 | - | - | < 0.5 | 0.6 | < 0.3 | 163.5 | 11.3 |

***Table B.5(Cont.): Pore-Water Geochemical Data: BH4-3***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-3* | *5.0* | 14-Jun-13 | 1.4 | 134.3 | 1 | 10.4 | 1.5 | - | 839.7 | 3.5 | < 0.004 | < 0.001 | < 0.1 | 0.2 | 11.8 | 0 | < 0.0009 | 0.8 |
| | | 9-May-14 | 1.1 | 19.3 | 2.8 | 8.9 | 3.3 | - | 918.4 | 7.9 | < 0.05 | < 0.05 | 6.2 | 0.5 | 11.5 | 0 | 0.1 | 1.1 |
| | | 29-Sep-14 | 0.6 | 36.3 | 3.7 | 14.4 | 1 | < 2 | 634.2 | 3.8 | < 0.15 | < 0.05 | 1.1 | 0.1 | 11.6 | 0 | 0.1 | 0.4 |
| | *15.0* | 17-Jun-12 | 2.2 | 8.9 | 5.8 | 171.8 | 5.4 | - | 420.7 | 251.1 | < 0.0137 | < 0.00528 | 19.3 | 1.8 | 21.8 | < 0.00373 | 0.6 | 8.6 |
| | | 21-Jul-12 | 1.2 | 4.1 | < 0.07 | 140.9 | 5.2 | - | 629 | 148.6 | < DL | < 0.007 | 15.3 | 1.1 | 36.8 | < 0.002 | 1.3 | 8.6 |
| | | 14-Jun-13 | 0.6 | 3.8 | 2.3 | 195.1 | 5.3 | - | 752.6 | 73.2 | < 0.004 | 0 | 11.6 | 9.8 | 26 | 0 | 0.2 | 10.4 |
| | | 29-Jul-13 | 0.9 | 2.6 | < DL | 52.1 | 4.7 | 9.5 | 826.4 | 50.9 | < 0.01 | 0.1 | 1.5 | 5.9 | 23.2 | 0.1 | 0.1 | 8.8 |
| | | 4-Sep-13 | 0.3 | 4 | < 0.05 | 9.9 | 0.9 | 14.1 | 941.1 | 3 | 0.2 | 0.2 | 3 | 1.9 | 13.9 | 0.2 | 0.4 | 0.9 |
| | | 5-Oct-13 | 0.7 | 2.1 | 1.2 | 56.8 | 3.7 | 9.8 | 886.3 | 33.5 | 0.2 | 0 | < 1.5 | 2.3 | 21.3 | 0 | 0.8 | 4.9 |
| | | 12-Jul-14 | 0.5 | 2.1 | 14 | 50.1 | 2.6 | < 7 | 913.2 | 17.7 | 2.1 | 0 | 8.3 | 1 | 16.6 | 0.1 | 0.3 | 4.4 |
| | *20.0* | 27-Jun-12 | 1.3 | 22.8 | 25.6 | 290 | 4.9 | - | 231.8 | 407.5 | 0.7 | 0.4 | 28.6 | 2.1 | 27.4 | < 0.00373 | 1.5 | 4.4 |
| | | Duplicate | 1.3 | 23.6 | 26 | 281.7 | 5.5 | - | 237.9 | 422.7 | < 0.0137 | 0.3 | 27.4 | 2 | 13.7 | < 0.00373 | 1.8 | 4.4 |
| | | 21-Jul-12 | 1.5 | 35 | 62.6 | 321.4 | 10.1 | - | 219.8 | 254.7 | < 0.01 | < 0.007 | 49.4 | 9.1 | 14.4 | < 0.002 | 12 | 4.6 |
| | | 23-Jul-12 | 1.4 | 22.2 | 23.5 | 90.9 | 5.4 | - | 244.5 | 365.7 | < 0.01 | < 0.007 | 21 | 1.8 | 16.8 | 0.4 | 6.7 | 4.5 |
| | *25.0* | 27-Jun-12 | 8.9 | 7.6 | 9.7 | 63 | 10.3 | - | 641.1 | 48.5 | 1.4 | 3.9 | < 0.0979 | 24.5 | 48.2 | 2.5 | 9.8 | 4.6 |
| | | 21-Jul-12 | 1.6 | < 0.04 | 15.1 | < 0.6 | < DL | - | 444.4 | 15.9 | < DL | < DL | < 0.2 | 0.4 | 46.5 | < 0.002 | 5.6 | 1.8 |
| | | 19-Aug-12 | 1.6 | < 0.04 | 22.8 | < 0.6 | < 0.03 | - | 363.2 | 2.5 | < DL | < DL | < DL | 0.4 | 58 | < DL | 3.3 | 0.9 |
| | | 23-Sep-12 | < DL | < 0.04 | 7.1 | < 0.6 | < DL | - | 370.6 | 0.9 | < DL | < DL | < DL | < 0.006 | 68.3 | < DL | 1.6 | 0.7 |
| | | 28-Oct-12 | 0.2 | < 0.04 | 2.5 | < 0.8 | 0.4 | - | 391.9 | 1 | < DL | < DL | < 0.1 | 0.2 | 58.1 | < 0.002 | 0 | 0.7 |
| | | 20-May-13 | < 0.02 | < 0.04 | 2.4 | < 0.8 | 0.5 | - | 381.3 | 1.6 | < 0.004 | < 0.001 | < 0.03 | 0.7 | 46.3 | < 0.002 | 0.7 | 0.6 |
| | | 14-Jun-13 | < 0.02 | < 0.04 | < 0.02 | < 0.2 | 0.3 | - | 363.8 | 0.9 | < 0.004 | < 0.001 | < 0.03 | 0.1 | 42.3 | < 0.002 | < 0.0009 | 0.5 |
| | | 27-Jul-13 | 0.4 | 2.1 | < DL | < DL | 0.7 | < DL | 340.8 | 2.3 | 0.2 | 0.2 | < DL | 5.9 | 42.7 | 0.2 | 0.7 | 0.4 |
| | | 4-Sep-13 | 0.3 | 1.3 | 0.5 | 7.9 | 0.5 | < DL | 347.4 | 1.3 | 0.1 | 0.1 | 2.2 | 1.3 | 39.5 | 0.1 | 0.2 | 0.4 |
| | | 5-Oct-13 | < 0.02 | 0.6 | 0.6 | 13.6 | < 0.3 | < DL | 335.4 | 1.2 | 0.3 | < DL | < DL | 0.4 | 36.8 | < 0.003 | 0.1 | 0.3 |
| | | 12-Jul-14 | 0.2 | 0.5 | 1 | < 8.5 | 0.3 | < 2 | 333.2 | 1.5 | 0.1 | 0 | 6.1 | 0.4 | 37.3 | 0.1 | 0 | 0.6 |
| | | 29-Sep-14 | 0.3 | < 0.15 | 0.9 | < 2.5 | < 0.1 | < 2 | 338.3 | 1.3 | < 0.15 | < 0.02 | 11.6 | < 0.03 | 40.7 | < 0.03 | < 0.01 | 0.5 |

***Table B.6: Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (°C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *1.8* | 26-Jun-12 | 8.2 | 426.3 | - | - | 100 | 1.7 | 0.7 | < 0.3 | < 0.3 | < 0.3 | 186.1 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 115 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 8.6 | 365.3 | - | - | 60 | - | - | - | - | - | - | - | - | - |
| | | Duplicate | - | | - | - | 52 | 0.8 | 0.4 | < 0.3 | < 0.3 | < 0.3 | 170.4 | < 0.3 | - | - |
| | | 29-Oct-12 | 8.4 | 504.6 | 1.8 | 18.7 | 79 | - | - | - | - | - | - | - | - | - |
| | | 21-May-13 | 8.2 | 160.2 | 1.3 | 20.9 | 119 | < 0.03 | 2.6 | < 0.03 | < 0.03 | 4.9 | 341 | < 0.03 | - | - |
| | | 27-Jul-13 | 8 | 488.4 | - | - | | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 8.5 | 364.7 | 1 | 16.2 | 100 | < 0.3 | 1.9 | < 0.3 | < 0.3 | 3.6 | 494.3 | < 0.3 | - | - |
| | | 6-Oct-13 | 7.5 | 457.1 | - | - | 92.3 | - | - | - | - | - | - | - | - | - |
| | | 9-May-14 | 7.5 | 456.1 | 0.8 | 12.6 | 82.6 | 0.3 | 1.3 | < 0.1 | < 0.1 | 3 | 340.8 | - | - | - |
| | | 14-Jun-14 | 8.2 | 447.9 | 0.5 | 13.7 | 105 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8.2 | 286.4 | 0.7 | 24 | 101.1 | 0.8 | 1.2 | < 0.1 | < 0.1 | 2.8 | 238 | < 0.01 | - | - |
| | | 29-Sep-14 | 8.1 | -5.6 | 0.6 | 17.6 | 95.2 | 0.4 | 0.5 | < 0.1 | < 0.1 | 2.3 | 242.2 | < 0.1 | - | - |
| | *6.8* | 26-Jun-12 | 8 | 418.3 | - | - | 80 | - | - | - | - | - | - | - | - | - |
| | | 22-Jul-12 | 7.2 | 457.3 | - | - | | - | - | - | - | - | - | - | - | - |
| | | 29-Oct-12 | 7.6 | 504.7 | - | - | 53.1 | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 7.9 | 381.3 | - | - | 55.5 | 1.3 | 1.2 | < 0.3 | < 0.3 | 3 | 1384.6 | < 0.3 | - | - |
| | | 6-Oct-13 | 7.3 | 452.8 | - | - | 70.5 | 1.8 | 1.2 | < 1.0 | < 0.3 | 2.6 | 1553.7 | < 1.0 | - | - |
| | | 9-May-14 | 7.4 | 427.9 | - | - | 68.1 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-14 | 7.7 | 467.5 | 2.1 | 17.4 | 50 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 7.8 | 309.2 | 2.3 | 24.2 | 68.6 | - | - | - | - | - | - | - | - | - |
| | | 29-Sep-14 | 7.7 | 38.1 | 1.7 | 18.2 | 62.5 | - | - | - | - | - | - | - | - | - |
| | *11.8* | 12-Jul-14 | 7.9 | 274 | 2.6 | 24.3 | 61.3 | 0.2 | 1.8 | < 0.1 | < 0.1 | < 0.1 | 1820.4 | 0.1 | 0.2 | - |
| | | 26-Jun-12 | 8 | 423.3 | - | - | 66 | 1.2 | 2.7 | < 0.3 | < 0.3 | 1.8 | 1784.3 | < 0.3 | - | - |
| | | 22-Jul-12 | 8 | 391.3 | - | - | 80 | 1 | 2.1 | < 0.3 | < 0.3 | 1.5 | 1810.1 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 44 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 46.6 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 7.9 | 375.3 | - | - | 60 | 0.5 | 0.8 | < 0.3 | < 0.3 | 2.5 | 1834.2 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 50 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 48 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 7.8 | 424.9 | 2.9 | 20.7 | 52.5 | < 2.0 | < 2.0 | < 0.3 | < 0.3 | 1.5 | 1861.7 | < 0.3 | - | - |
| | | 21-May-13 | 7.7 | 170.5 | 2.9 | 19.4 | 65 | 0.3 | 2.7 | < 0.03 | < 0.03 | 3.2 | 1763.2 | < 0.03 | - | - |
| | | 15-Jun-13 | 7.9 | 491.3 | 2.7 | 22.2 | 65 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1756.1 | < 0.3 | - | - |
| | | 27-Jul-13 | 7.8 | 469 | 0.8 | 25.1 | 85 | < 0.3 | 2.8 | < 0.3 | < 0.3 | 1.3 | 734.4 | < 0.3 | <0.01 | - |
| | | 4-Sep-13 | 8 | 376.3 | - | - | 83.3 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1849.9 | < 0.3 | <0.01 | - |
| | | 6-Oct-13 | 7.3 | 453.2 | 2.8 | 11.9 | 65.2 | < 0.3 | 1.9 | < 1.0 | < 0.3 | 0.7 | 1967.7 | < 1.0 | - | - |
| | | 9-May-14 | 7.4 | 438.2 | - | - | 82.7 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-14 | 7.6 | 464.7 | 2.7 | 13.2 | 65 | 0.1 | 2.2 | < 0.1 | < 0.1 | 0.4 | 1830.4 | < 0.1 | - | - |
| | | 29-Sep-14 | 7.8 | 35.3 | 2.6 | 17.7 | 66.6 | < 0.1 | 2 | < 0.1 | < 0.1 | 0.7 | 1859.7 | < 0.1 | - | - |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-4*** | ***16.8*** | 24-Jun-12 | 7.9 | 433.3 | - | - | 42 | 0.2 | 1.8 | < 0.3 | < 0.3 | 0.4 | 1769.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 50 | - | - | - | - | - | - | - | - | - |
| | | 27-Jun-12 | 8.1 | 447.3 | - | - | 52 | 0.1 | 1.7 | < 0.3 | < 0.3 | 0.2 | 1823.2 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 44 | - | - | - | - | - | - | - | - | - |
| | | 22-Jul-12 | 7.9 | 346.8 | - | 22.3 | 40 | < 0.3 | 1.4 | < 0.3 | < 0.3 | < 0.3 | 1712.6 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 35.7 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 8.1 | 376.3 | - | - | 43.3 | < 0.3 | 1 | < 0.3 | < 0.3 | < 0.3 | 1816.4 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 34 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 40 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 8 | 435.9 | 2.7 | 20.5 | 46.1 | < 2.0 | < 2.0 | < 0.3 | < 0.3 | < 0.3 | 1850.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | | < 2.0 | < 2.0 | < 0.3 | < 0.3 | < 0.3 | 1850.9 | < 0.3 | - | - |
| | | 29-Oct-12 | 7.9 | 505.1 | 2.9 | 18.4 | 46.6 | - | - | - | - | - | - | - | - | - |
| | | 21-May-13 | 7.5 | 176.6 | 3.3 | 20.7 | 153.3 | < 0.03 | 1.7 | < 0.03 | < 0.03 | < 0.03 | 1737.5 | < 0.03 | - | - |
| | | 15-Jun-13 | 7.8 | 452.9 | 2.8 | 23.6 | 75 | < 0.3 | 1.8 | < 0.3 | < 0.3 | < 0.3 | 1755.5 | < 0.3 | <0.01 | - |
| | | 27-Jul-13 | 7.5 | 535.8 | 2.8 | 25.2 | 50 | < 0.3 | 3 | < 0.3 | < 0.3 | < 0.3 | 1784 | < 0.3 | <0.01 | - |
| | | 4-Sep-13 | 7.9 | 392.5 | - | - | 66.6 | < 0.3 | 2.3 | < 0.3 | < 0.3 | < 0.3 | 1862.7 | < 0.3 | <0.01 | - |
| | | 6-Oct-13 | 7.4 | 452.2 | 2.7 | 11.7 | 72.7 | < 0.3 | 2.1 | < 1.0 | < 0.3 | < 1.0 | 1921.7 | < 1.0 | - | - |
| | | 14-Jun-14 | 7.5 | 425.7 | 2.7 | 15.1 | 65 | < 0.1 | 2.3 | < 0.1 | < 0.1 | < 0.1 | 2005 | < 0.1 | - | - |
| | | 12-Jul-14 | 7.8 | 291.4 | 2.3 | 24.6 | 56.6 | < 0.1 | 1.5 | < 0.1 | < 0.1 | < 0.1 | 1646.4 | < 0.01 | - | - |
| | | 29-Sep-14 | 7.8 | 40.8 | 2.7 | 16.9 | 47.8 | < 0.1 | 2.2 | < 0.1 | < 0.1 | < 0.1 | 1865.3 | < 0.1 | - | - |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-4*** | ***21.8*** | 21-May-13 | 7.7 | 245.2 | 3.1 | 20.2 | 193.3 | < 0.03 | 2.2 | < 0.03 | < 0.03 | < 0.03 | 1693.8 | < 0.03 | - | - |
| | | 24-Jun-12 | 7.9 | 425.3 | - | - | 86 | 0.3 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 1750.9 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 88 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 92 | - | - | - | - | - | - | - | - | - |
| | | 27-Jun-12 | 8 | 428.3 | - | - | 95 | 0.3 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 1761.7 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 98.3 | - | - | - | - | - | - | - | - | - |
| | | 22-Jul-12 | 7.9 | 319.6 | - | 22.6 | 82 | < 0.3 | 1.8 | < 0.3 | < 0.3 | < 0.3 | 1571.2 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 87.1 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 86.1 | - | - | - | - | - | - | - | - | - |
| | | 19-Aug-12 | 7.8 | 387.3 | - | - | 75 | < 0.3 | 1.1 | < 0.3 | < 0.3 | < 0.3 | 1331.4 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 78 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 80 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 7.9 | 441.6 | 2.1 | 18 | 66 | < 1.0 | < 1.0 | < 0.3 | < 0.3 | < 0.3 | 1397.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 59.2 | - | - | - | - | - | - | - | - | - |
| | | 29-Oct-12 | 8 | 497.8 | - | - | 60.5 | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 7.4 | 486.7 | 2.6 | 24.5 | 75 | < 0.3 | 2.3 | < 0.3 | < 0.3 | < 0.3 | 1760.5 | < 0.3 | <0.01 | - |
| | | 4-Sep-13 | 7.9 | 405.4 | 2.5 | 16.6 | 60 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1700.6 | < 0.3 | <0.01 | - |
| | | 6-Oct-13 | 7.1 | 451.8 | 2.5 | 12 | 90.9 | < 0.3 | 1.6 | < 1.0 | < 0.3 | < 1.0 | 1760.8 | < 1.0 | - | - |
| | | 9-May-14 | 7.6 | 351.1 | 2.5 | 17.7 | 285 | 0.1 | 2.5 | < 0.1 | < 0.1 | 0.2 | 1782.9 | < 0.1 | - | - |
| | | 29-Sep-14 | 7.9 | 44 | 2.5 | 17 | 70.8 | < 0.1 | 2.1 | < 0.1 | < 0.1 | < 0.1 | 1766.2 | < 0.1 | - | - |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *1.8* | 26-Jun-12 | < DL | < DL | 63.8 | < DL | < DL | < DL | < DL | < DL | 5.2 | - | 18.8 |
| | | 19-Aug-12 | < DL | < DL | 67.8 | < DL | < DL | < DL | < DL | < DL | 7 | < DL | 13.8 |
| | | 29-Oct-12 | < DL | < DL | 87.8 | < DL | < DL | < DL | < DL | < DL | 5.1 | < DL | 21.5 |
| | | 21-May-13 | < DL | < DL | 62.9 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 13.8 |
| | | 4-Sep-13 | < DL | < DL | 111.1 | < DL | < DL | < DL | < DL | < DL | 7.8 | < DL | 21.2 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 182.9 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 8.8 | < 0.1 | 36.7 |
| | | 9-May-14 | < 2 | < 1 | 159.7 | <2 | < 1 | <2 | <2 | <2 | 6.3 | < 1 | 36.8 |
| | | 12-Jul-14 | < 2 | < 1 | 60.1 | < 2 | < 1 | < 2 | < 2 | < 2 | 3.8 | < 1 | 13.9 |
| | | 28-Sep-14 | < 2 | < 1 | 67.6 | < 2 | < 1 | < 2 | < 2 | < 2 | 4.5 | < 1 | 13.8 |
| | *6.8* | 4-Sep-13 | < DL | < DL | 376.4 | < DL | < DL | < DL | < DL | < DL | 32.3 | < DL | 83.4 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 464.5 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 34.3 | < 0.1 | 82.5 |
| | | 9-May-14 | < 2 | < 1 | 487.5 | <2 | < 1 | <2 | <2 | <2 | 33.7 | < 1 | 109.5 |
| | | 12-Jul-14 | < 2 | < 1 | 446.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 29.8 | < 1 | 100.6 |
| | | 28-Sep-14 | < 2 | < 1 | 309.6 | < 2 | < 1 | < 2 | < 2 | < 2 | 26.5 | < 1 | 65.8 |
| | *11.8* | 12-Jul-14 | < 2 | < 1 | 479.3 | < 2 | < 1 | < 2 | < 2 | < 2 | 31.7 | < 1 | 173.5 |
| | | 26-Jun-12 | < DL | < DL | 447.3 | < DL | < DL | < DL | < DL | < DL | 35.1 | - | 177.1 |
| | | 22-Jul-12 | < DL | < DL | 452.1 | < DL | < DL | < DL | < DL | < DL | 40.1 | < DL | 178.7 |
| | | 19-Aug-12 | < DL | < DL | 472.1 | < DL | < DL | < DL | < DL | < DL | 38.5 | < DL | 158.7 |
| | | 24-Sep-12 | < DL | < DL | 503.9 | < DL | < DL | < DL | < DL | < DL | 39.8 | < DL | 154.2 |
| | | 21-May-13 | < DL | < DL | 512.9 | < DL | < DL | < DL | < DL | < DL | 37.8 | < DL | 194.6 |
| | | 15-Jun-13 | < DL | < DL | 477.6 | < DL | < DL | < DL | < DL | < DL | 33.6 | < DL | 163.2 |
| | | 27-Jul-13 | < DL | < DL | 208.9 | < DL | < DL | < DL | < DL | < DL | 15.3 | < DL | 65.6 |
| | | 4-Sep-13 | < DL | < DL | 482.5 | < DL | < DL | < DL | < DL | < DL | 39.5 | < DL | 167.4 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 503.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 39.5 | < 0.1 | 170.7 |
| | | 9-May-14 | < 2 | < 1 | 509.8 | <2 | < 1 | <2 | <2 | <2 | 35.7 | < 1 | 191.7 |
| | | 12-Jun-14 | < 2 | < 1 | 491.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 33.5 | < 1 | 165.4 |
| | | 28-Sep-14 | < 2 | < 1 | 479.7 | < 2 | < 1 | < 2 | < 2 | < 2 | 35.4 | < 1 | 174.5 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-4*** | ***16.8*** | 24-Jun-12 | < DL | < DL | 437.8 | < DL | < DL | < DL | < DL | < DL | 33.4 | - | 166.1 |
| | | 27-Jun-12 | < DL | < DL | 456.8 | < DL | < DL | < DL | < DL | < DL | 33.7 | - | 168.4 |
| | | 22-Jul-12 | < DL | < DL | 495.6 | < DL | < DL | < DL | < DL | < DL | 35.8 | < DL | 161.9 |
| | | Duplicate | < DL | < DL | 447.6 | < DL | < DL | < DL | < DL | < DL | 38.9 | < DL | 182.8 |
| | | 19-Aug-12 | < DL | < DL | 479.3 | < DL | < DL | < DL | < DL | < DL | 37.2 | < DL | 162.5 |
| | | Duplicate | < DL | < DL | 441.1 | < DL | < DL | < DL | < DL | < DL | 37 | < DL | 156.6 |
| | | 24-Sep-12 | < DL | < DL | 501.6 | < DL | < DL | < DL | < DL | < DL | 37.7 | < DL | 153.1 |
| | | Duplicate | < DL | < DL | 490.5 | < DL | < DL | < DL | < DL | < DL | 38.7 | < DL | 156.2 |
| | | 29-Oct-12 | < DL | < DL | 502.9 | < DL | < DL | < DL | < DL | < DL | 36.3 | < DL | 172.1 |
| | | 21-May-13 | < DL | < DL | 476.6 | < DL | < DL | < DL | < DL | < DL | 32.3 | < DL | 177.7 |
| | | 15-Jun-13 | < DL | < DL | 469 | < DL | < DL | < DL | < DL | < DL | 31.7 | < DL | 171.5 |
| | | 27-Jul-13 | < DL | < DL | 477.2 | < DL | < DL | < DL | < DL | < DL | 32.9 | < DL | 171.9 |
| | | 4-Sep-13 | < DL | < DL | 481.9 | < DL | < DL | < DL | < DL | < DL | 36.7 | < DL | 171.9 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 479.9 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 34.1 | < 0.1 | 173.6 |
| | | 12-Jun-14 | < 2 | < 1 | 442.9 | < 2 | < 1 | < 2 | < 2 | < 2 | 44.4 | < 1 | 238 |
| | | 12-Jul-14 | < 2 | < 1 | 476.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 20.9 | < 1 | 128.9 |
| | | 28-Sep-14 | < 2 | < 1 | 458.9 | < 2 | < 1 | < 2 | < 2 | < 2 | 34 | < 1 | 181.3 |
| | ***21.8*** | 21-May-13 | < DL | < DL | 482 | < DL | < DL | < DL | < DL | < DL | 29.1 | < DL | 159.1 |
| | | 24-Jun-12 | < DL | < DL | 444.6 | < DL | < DL | < DL | < DL | < DL | 30 | - | 164.7 |
| | | 27-Jun-12 | < DL | < DL | 436.5 | < DL | < DL | < DL | < DL | < DL | 29.9 | - | 170.1 |
| | | 22-Jul-12 | < DL | < DL | 407.4 | < DL | < DL | < DL | < DL | < DL | 27.8 | < DL | 136.6 |
| | | 19-Aug-12 | < DL | < DL | 346.6 | < DL | < DL | < DL | < DL | < DL | 27.2 | < DL | 124.3 |
| | | 24-Sep-12 | < DL | < DL | 368.8 | < DL | < DL | < DL | < DL | < DL | 25.4 | < DL | 117.1 |
| | | 29-Oct-12 | < DL | < DL | 341.5 | < DL | < DL | < DL | < DL | < DL | 22.9 | < DL | 117.4 |
| | | 27-Jul-13 | < DL | < DL | 470.5 | < DL | < DL | < DL | < DL | < DL | 30.3 | < DL | 165.8 |
| | | 4-Sep-13 | < DL | < DL | 443.2 | < DL | < DL | < DL | < DL | < DL | 33.3 | < DL | 157.4 |
| | | 6-Oct-13 | < 0.2 | < 0.1 | 458.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 28.5 | < 0.1 | 157.7 |
| | | 9-May-14 | < 2 | < 1 | 486 | <2 | < 1 | <2 | <2 | <2 | 28.4 | < 1 | 174.2 |
| | | 28-Sep-14 | < 2 | < 1 | 452.5 | < 2 | < 1 | < 2 | < 2 | < 2 | 27.9 | < 1 | 154.9 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *1.8* | 26-Jun-12 | < DL | < DL | < DL | < DL | 59.2 | < DL | < DL | 43.8 | < DL | < DL | < DL |
| | | 19-Aug-12 | < DL | < DL | < DL | < DL | 57.9 | < DL | < DL | 20.5 | < DL | < DL | < DL |
| | | 29-Oct-12 | < DL | 79.7 | < DL | < DL | 121.4 | < DL | < DL | 16.5 | < 0.1 | < DL | < DL |
| | | 21-May-13 | < DL | 109 | < DL | < DL | 110.2 | < DL | < DL | 18 | < DL | < DL | < DL |
| | | 4-Sep-13 | < DL | 102 | < DL | < DL | 170.4 | < DL | < DL | 11 | 0.3 | < DL | < DL |
| | | 6-Oct-13 | < 1.0 | 117.4 | < 1.0 | < 0.2 | 244.9 | < 0.09 | < 0.1 | 21.5 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 62.4 | < 1 | <2 | 724.6 | < 0.9 | < 1 | 25.7 | < 1 | <2 | <2 |
| | | 12-Jul-14 | < 1 | 51.6 | < 1 | < 2 | 81.1 | < 0.9 | < 1 | 17.6 | < 0.3 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 49 | < 1 | < 2 | 82 | < 0.9 | < 1 | 13.2 | < 0.3 | < 2 | < 2 |
| | *6.8* | 4-Sep-13 | < DL | 28.2 | < DL | < DL | 432 | < DL | < DL | 31.8 | 0.4 | < DL | < DL |
| | | 6-Oct-13 | < 1.0 | 30.8 | < 1.0 | < 0.2 | 486.2 | < 0.09 | < 0.1 | 34.5 | < 0.1 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 30.4 | < 1 | <2 | 1153 | < 0.9 | < 1 | 41.2 | < 1 | <2 | <2 |
| | | 12-Jul-14 | < 1 | 25.7 | < 1 | < 2 | 515.9 | < 0.9 | < 1 | 36.3 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 27.1 | < 1 | < 2 | 353.1 | < 0.9 | < 1 | 39.5 | < 1 | < 2 | < 2 |
| | *11.8* | 12-Jul-14 | < 1 | 10.7 | < 1 | < 2 | 621.5 | < 0.9 | < 1 | 17.3 | 0.8 | < 2 | < 2 |
| | | 26-Jun-12 | < DL | 9.2 | < DL | < DL | 570.7 | < DL | < DL | 28.5 | < 0.137 | < DL | < DL |
| | | 22-Jul-12 | < DL | 9.1 | < DL | < DL | 584.2 | < DL | < DL | 33.8 | 0.9 | < DL | < DL |
| | | 19-Aug-12 | < DL | 8.3 | < DL | < DL | 593.2 | < DL | < DL | 36.3 | 0.9 | < DL | < DL |
| | | 24-Sep-12 | < DL | 8.3 | < DL | < DL | 621.9 | < DL | < DL | 31.7 | 0.9 | < DL | < DL |
| | | 21-May-13 | < DL | 9.7 | < DL | < DL | 614 | < DL | < DL | 43.5 | 0.9 | < DL | < DL |
| | | 15-Jun-13 | < DL | 11.1 | < DL | < DL | 594 | < DL | < DL | 19.4 | 0.9 | < DL | < DL |
| | | 27-Jul-13 | < DL | 58.2 | < DL | < DL | 273 | < DL | < DL | 28.1 | < 0.1 | < DL | < DL |
| | | 4-Sep-13 | < DL | 8.8 | < DL | < DL | 614.6 | < DL | < DL | 28.5 | 0.8 | < DL | < DL |
| | | 6-Oct-13 | < 1.0 | 8.1 | < 1.0 | < 0.2 | 620.5 | < 0.09 | < 0.1 | 18.2 | 0.9 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 8.8 | < 1 | <2 | 1676 | < 0.9 | < 1 | 39.3 | 0.9 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 9.1 | < 1 | < 2 | 594.5 | < 0.9 | < 1 | 15.3 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 9.2 | < 1 | < 2 | 635.1 | < 0.9 | < 1 | 19 | 0.9 | < 2 | < 2 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-4*** | ***16.8*** | 24-Jun-12 | < DL | 9.2 | < DL | < DL | 548.9 | < DL | < DL | < 0.650 | < 0.137 | < DL | < DL |
| | | 27-Jun-12 | < DL | 9 | < DL | < DL | 564.2 | < DL | < DL | < 0.650 | < 0.137 | < DL | < DL |
| | | 22-Jul-12 | < DL | 9.1 | < DL | < DL | 624.6 | < DL | < DL | 4.3 | 0.9 | < DL | < DL |
| | | Duplicate | < DL | 10.2 | < DL | < DL | 578.1 | < DL | < DL | 4.2 | 0.9 | < DL | < DL |
| | | 19-Aug-12 | < DL | 9.4 | < DL | < DL | 601.1 | < DL | < DL | 4.1 | 1 | < DL | < DL |
| | | Duplicate | < DL | 9.1 | < DL | < DL | 553.4 | < DL | < DL | 4.1 | 0.9 | < DL | < DL |
| | | 24-Sep-12 | < DL | 9 | < DL | < DL | 624.7 | < DL | < DL | 3.7 | 1 | < DL | < DL |
| | | Duplicate | < DL | 9.1 | < DL | < DL | 614.7 | < DL | < DL | 3.6 | 1 | < DL | < DL |
| | | 29-Oct-12 | < DL | 10.3 | < DL | < DL | 597.7 | < DL | < DL | 3.5 | 1 | < DL | < DL |
| | | 21-May-13 | < DL | 9.7 | < DL | < DL | 574.9 | < DL | < DL | 4 | 0.9 | < DL | < DL |
| | | 15-Jun-13 | < DL | 9 | < DL | < DL | 586.8 | < DL | < DL | 2.7 | 0.9 | < DL | < DL |
| | | 27-Jul-13 | < DL | 9.7 | < DL | < DL | 607.2 | < DL | < DL | 2.6 | 0.9 | < DL | < DL |
| | | 4-Sep-13 | < DL | 9.2 | < DL | < DL | 622.4 | < DL | < DL | 2.8 | 0.9 | < DL | < DL |
| | | 6-Oct-13 | < 1.0 | 8.7 | < 1.0 | < 0.2 | 616.8 | < 0.09 | < 0.1 | 2.5 | 0.9 | < 0.2 | < 0.2 |
| | | 12-Jun-14 | < 1 | 10.8 | < 1 | < 2 | 651.6 | < 0.9 | < 1 | 3 | 1 | < 2 | < 2 |
| | | 12-Jul-14 | < 1 | 3.5 | < 1 | < 2 | 563.3 | < 0.9 | < 1 | 2.1 | < 1 | < 2 | < 2 |
| | | 28-Sep-14 | < 1 | 9 | < 1 | < 2 | 633.6 | < 0.9 | < 1 | 2 | 0.9 | < 2 | < 2 |
| | ***21.8*** | 21-May-13 | < DL | 11.6 | < DL | < DL | 542.1 | < DL | < DL | 26.3 | 0.8 | < DL | < DL |
| | | 24-Jun-12 | < DL | 11.9 | < DL | < DL | 552.7 | < DL | < DL | 14.3 | < 0.137 | < DL | < DL |
| | | 27-Jun-12 | < DL | 12.1 | < DL | < DL | 525.2 | < DL | < DL | 13.3 | < 0.137 | < DL | < DL |
| | | 22-Jul-12 | < DL | 10.1 | < DL | < DL | 514.9 | < DL | < DL | 16.5 | < 0.1 | < DL | < DL |
| | | 19-Aug-12 | < DL | 9 | < DL | < DL | 434.5 | < DL | < DL | 10.2 | < 0.1 | < DL | < DL |
| | | 24-Sep-12 | < DL | 8.2 | < DL | < DL | 460.7 | < DL | < DL | 8.8 | < 0.1 | < DL | < DL |
| | | 29-Oct-12 | < DL | 8.5 | < DL | < DL | 408.8 | < DL | < DL | 7.3 | < 0.1 | < DL | < DL |
| | | 27-Jul-13 | < DL | 9.8 | < DL | < DL | 590.2 | < DL | < DL | 6.5 | 0.9 | < DL | < DL |
| | | 4-Sep-13 | < DL | 9.4 | < DL | < DL | 567.5 | < DL | < DL | 5.6 | 0.8 | < DL | < DL |
| | | 6-Oct-13 | < 1.0 | 8.5 | < 1.0 | < 0.2 | 559.2 | < 0.09 | < 0.1 | 4.3 | 0.8 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 10.4 | < 1 | <2 | 1440 | < 0.9 | < 1 | 30.1 | 0.8 | <2 | <2 |
| | | 28-Sep-14 | < 1 | 8.9 | < 1 | < 2 | 613.4 | < 0.9 | < 1 | 6.3 | 0.9 | < 2 | < 2 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *1.8* | 26-Jun-12 | 6.7 | < 0.0171 | 70.1 | 1270 | 18210 | 11.1 | O/R | < DL | 5265 | - | < DL | 125.9 | 2.2 | 7.7 | 17.6 |
| | | 19-Aug-12 | < 0.1 | < DL | < 1 | - | - | < 0.1 | 20010 | < DL | - | - | < DL | 43.4 | < 0.02 | 1.7 | 49.9 |
| | | 28-Oct-12 | 6.2 | < DL | 31.4 | - | - | 4.4 | 17200 | < DL | - | - | < 0.2 | 29.6 | 0.6 | 0.9 | 2.1 |
| | | 21-May-13 | 6.1 | < 0.007 | 22.9 | O/R | 14520 | < 0.04 | 19230 | < 3 | 5172 | - | < 0.2 | 23.9 | 0.6 | 1.1 | 2 |
| | | 4-Sep-13 | 5.1 | < 0.02 | 30.3 | 108500 | - | < DL | 11880 | < DL | 8685 | - | 1.2 | 12.1 | 1.1 | 1.2 | 2.8 |
| | | 6-Oct-13 | 6.2 | < DL | 36.9 | 107800 | - | < DL | 21420 | < DL | 7909 | - | 0.8 | 20.2 | 1.5 | 1.8 | 5.3 |
| | | 9-May-14 | 4.4 | < 0.08 | 52.2 | O/R | 38330 | < 0.5 | 26020 | < 35 | 6417 | - | < 2 | 24.1 | 1.1 | 1 | 5.1 |
| | | 12-Jul-14 | 4.3 | < 0.08 | 27.4 | - | - | 1.4 | O/R | < 35 | - | - | < 2 | 18.3 | 1.2 | 0.8 | 9.3 |
| | | 29-Sep-14 | < 0.4 | < 0.08 | < 2 | - | - | < 0.5 | 13773 | < 35 | - | - | < 2 | 11.5 | 1.2 | 1.3 | 14.9 |
| | *6.8* | 4-Sep-13 | 21.5 | < 0.02 | 212.2 | 29720 | - | 9.1 | 33900 | < DL | 35080 | - | < 0.2 | 180.7 | 1 | 4.9 | 18.5 |
| | | 6-Oct-13 | 12 | < DL | 106 | 30080 | - | 0.7 | 35300 | < DL | 30260 | - | 0.5 | 147.3 | 0.4 | 4.5 | 5.5 |
| | | 9-May-14 | 28 | < 0.08 | 193.9 | 31340 | O/R | < 1.5 | 41520 | < 35 | 32250 | - | < 0.5 | 179.6 | 2.6 | 5.8 | 7.7 |
| | | 12-Jul-14 | 14.2 | < 0.08 | 110 | - | - | < 0.5 | O/R | < 35 | - | - | < 2 | 124.9 | 0.8 | 5.2 | 6.9 |
| | | 29-Sep-14 | 4.7 | < 0.08 | 52.8 | - | - | < 0.5 | 42776 | < 35 | - | - | < 2 | 121.4 | 0.5 | 3.7 | 12.5 |
| | *11.8* | 12-Jul-14 | 14.4 | < 0.08 | 38.4 | - | - | < 0.5 | O/R | < 35 | - | - | < 2 | 32.9 | 0.4 | 13.5 | 7.9 |
| | | 26-Jun-12 | 51 | < DL | 340.5 | 7934 | O/R | 8.5 | O/R | < DL | O/R | - | < DL | 155.9 | 3.5 | 10.2 | 15.7 |
| | | 22-Jul-12 | 28.5 | < DL | 283.4 | - | - | < 0.1 | O/R | < DL | - | - | < DL | 141.2 | 2.2 | 9.4 | 13.3 |
| | | 19-Aug-12 | 32.6 | < DL | 288 | - | - | < DL | O/R | < DL | - | - | < DL | 170.8 | 1.7 | 7.2 | 56.3 |
| | | 24-Sep-12 | 25.5 | < DL | 222.9 | - | - | 10.4 | O/R | < DL | - | - | < DL | 139.5 | 1.2 | 7.8 | 22.8 |
| | | 21-May-13 | 27.5 | 0.2 | 276.4 | 6950 | O/R | < 0.04 | 46630 | < 3 | 41550 | - | < 0.2 | 134.5 | 1.3 | 8.9 | 6.5 |
| | | 15-Jun-13 | 21.3 | < 0.02 | 88.1 | 13080 | O/R | < 0.04 | 23160 | < 3 | 42210 | - | < 0.2 | 51.9 | < 0.02 | 12.8 | 3.1 |
| | | 27-Jul-13 | 14.6 | 2.6 | 57.8 | 60160 | - | 3.5 | 28690 | < DL | 14900 | - | 3.8 | 42.4 | 3.7 | 6.3 | 16.6 |
| | | 4-Sep-13 | 21.1 | < DL | 99.5 | 8420 | - | < 0.1 | 30170 | < DL | 41350 | - | < DL | 68 | 0.6 | 8.9 | 300.2 |
| | | 6-Oct-13 | 14.5 | < DL | 47.4 | 7925 | - | < DL | 18220 | < DL | 34870 | - | 0.5 | 53.6 | 0.3 | 9.2 | 9.3 |
| | | 9-May-14 | 16.7 | < 0.08 | 98.4 | 7955 | O/R | < 1.5 | 39560 | < 35 | 37440 | - | < 2 | 84.5 | 1.7 | 9.2 | 12.9 |
| | | 12-Jun-14 | 18.6 | < 0.08 | 68.3 | 5885 | O/R | 4.1 | 16340 | < 35 | 31620 | O/R | 3.4 | 36.4 | < 0.3 | 21.6 | 27.8 |
| | | 29-Sep-14 | 10.3 | < 0.08 | 21.3 | - | - | < 0.5 | 19929 | < 35 | - | - | < 0.5 | 35.6 | 0.4 | 8.6 | 19.2 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-4*** | ***16.8*** | 24-Jun-12 | 13.7 | < DL | 72.6 | 7194 | O/R | 9 | 4737 | < DL | O/R | - | < DL | 35.8 | 1.4 | 174.5 | < 0.250 |
| | | 27-Jun-12 | 9.8 | < DL | 55 | 6957 | O/R | 6.6 | 4275 | < DL | O/R | - | < DL | 27.2 | 1 | 182.2 | 3.3 |
| | | 22-Jul-12 | 11 | < DL | < 1 | - | - | 8.6 | 4186 | < DL | - | - | < DL | 27.9 | 1.2 | 178.7 | 12.6 |
| | | 22-Jul-12 | 10.8 | < DL | < 1 | 0 | 0 | 9.1 | 4318 | < DL | 0 | 0 | < DL | 24.9 | < 0.02 | 182 | 11.1 |
| | | 19-Aug-12 | 11.7 | < DL | < 1 | 0 | 0 | 9 | 3888 | < DL | 0 | 0 | < DL | 23 | < 0.02 | 176 | 27.5 |
| | | 19-Aug-12 | 11.2 | < DL | < 1 | 0 | 0 | 7.7 | 3852 | < DL | 0 | 0 | < DL | 20.9 | < 0.02 | 179.1 | 20.6 |
| | | 24-Sep-12 | 10 | < DL | < 1 | 0 | 0 | 13.7 | 2857 | < DL | 0 | 0 | < DL | 15.8 | 1 | 142.1 | 28.1 |
| | | 24-Sep-12 | 10.8 | < DL | < 1 | 0 | 0 | 12.1 | 3250 | < DL | 0 | 0 | < DL | 16.3 | 4.8 | 165 | 39.2 |
| | | 28-Oct-12 | 12.6 | < DL | 64.5 | 0 | 0 | 13 | 3947 | < DL | 0 | 0 | 1.6 | 20.6 | 0.7 | 176.3 | 3.1 |
| | | 21-May-13 | 12 | < 0.02 | 63.4 | 10010 | O/R | 6.5 | 4878 | < 3 | 36300 | 0 | < 0.05 | 19.4 | 0.7 | 92.4 | 2.4 |
| | | 15-Jun-13 | 12.6 | < 0.02 | 54.1 | 10360 | O/R | 10 | 3256 | < 3 | 38770 | 0 | < 0.05 | 10.4 | < 0.007 | 115.8 | < 0.2 |
| | | 27-Jul-13 | 11.8 | < 0.02 | 32.1 | 6761 | 0 | 12.3 | 2661 | < DL | 33770 | 0 | < 0.2 | 8.9 | < 0.02 | 92.7 | 6.7 |
| | | 4-Sep-13 | 11.3 | < DL | 46.7 | 9197 | 0 | 15.8 | 3049 | < DL | 38810 | 0 | < DL | 11.2 | 0.6 | 58.8 | 6.9 |
| | | 6-Oct-13 | 7.1 | < DL | 24.7 | 8711 | 0 | 20.6 | 2539 | < DL | 33140 | 0 | < DL | 9.7 | 0.9 | 41.9 | 19.8 |
| | | 12-Jun-14 | 11.1 | < 0.08 | 54.6 | 134.2 | O/R | 15.1 | 3108 | < 35 | 41940 | O/R | < 2 | 10.2 | 0.4 | 156.2 | 20.3 |
| | | 12-Jul-14 | 7.6 | < 0.08 | 19.3 | 0 | 0 | 9.4 | 2007 | < 35 | 0 | 0 | < 0.5 | 4.3 | 0.4 | 119.7 | 9.6 |
| | | 29-Sep-14 | 3.9 | < 0.08 | < 2 | 0 | 0 | 15.5 | 1532.3 | < 35 | 0 | 0 | < 0.5 | 5 | 0.3 | 91.7 | 14.3 |
| | ***21.8*** | 21-May-13 | 3.5 | < 0.02 | 48.9 | 11530 | O/R | < 0.1 | 28240 | < 3 | 31130 | 0 | 4.2 | 27 | 0.2 | 108.9 | 8.5 |
| | | 24-Jun-12 | 3 | < DL | 31.8 | 95.8 | O/R | 5 | 14720 | < DL | O/R | 0 | < DL | 35.1 | < 0.0179 | 655.8 | 13.8 |
| | | 27-Jun-12 | 1.5 | < DL | 26.1 | 787 | O/R | 7.1 | 12800 | < DL | O/R | 0 | < 0.228 | 22.9 | < 0.0179 | 670.8 | < 0.250 |
| | | 22-Jul-12 | < 0.1 | < DL | < 1 | 0 | 0 | 67.3 | 16160 | < DL | 0 | 0 | < 0.1 | 22.6 | < 0.02 | 496.7 | 24.8 |
| | | 19-Aug-12 | < 0.1 | < DL | < 1 | 0 | 0 | < 0.1 | 10190 | < DL | 0 | 0 | < DL | 14.3 | < DL | 440.7 | 24.3 |
| | | 24-Sep-12 | < 0.1 | < DL | < 1 | 0 | 0 | 7.7 | 8784 | < DL | 0 | 0 | < DL | 12 | < DL | 336.2 | 15.9 |
| | | 28-Oct-12 | < 0.1 | < DL | 27.6 | 0 | 0 | < 0.1 | 6429 | < DL | 0 | 0 | < 0.2 | 9.4 | < DL | 298.4 | 2.7 |
| | | 27-Jul-13 | 1.6 | < 0.02 | 26.3 | 5499 | 0 | < DL | 6391 | < DL | 30950 | 0 | < 0.2 | 6.6 | < DL | 201.9 | 4.3 |
| | | 4-Sep-13 | < 0.1 | < DL | 34.8 | 9283 | 0 | < DL | 6571 | < DL | 35200 | 0 | 1 | 5.8 | < 0.02 | 171.1 | 8.6 |
| | | 6-Oct-13 | 0.5 | < DL | 16.4 | 9047 | 0 | < DL | 4488 | < DL | 28510 | 0 | 0.6 | 4.8 | < DL | 149.1 | 5.9 |
| | | 9-May-14 | 4.5 | < 0.08 | 59.6 | 11130 | O/R | < 1.5 | 30350 | < 35 | 28820 | 0 | 2.1 | 29.9 | 0.8 | 34.9 | 8.3 |
| | | 29-Sep-14 | < 0.4 | < 0.08 | < 2 | 0 | 0 | < 0.5 | 5626 | < 35 | 0 | 0 | < 2 | 5 | < 0.3 | 150.8 | 12.7 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *1.8* | 26-Jun-12 | 0.6 | 3.1 | 6.4 | 57.7 | 3.6 | - | 152.6 | 11.6 | 1.6 | < 0.00528 | 5.1 | 5.7 | 21.2 | 0.3 | 1.9 | 0.2 |
| | | 19-Aug-12 | < DL | 3.8 | 8.4 | < 0.6 | < 0.03 | - | 139.2 | 3.5 | < 0.01 | < DL | < DL | 4.9 | 23.9 | < DL | 1.5 | 0.6 |
| | | 28-Oct-12 | < 0.02 | 3.1 | 5.1 | < 0.8 | 1.2 | - | 285.9 | 6.2 | < DL | < DL | 2.5 | 2.4 | 33.2 | 0 | 0 | 2.1 |
| | | 21-May-13 | < 0.02 | 2.5 | 3.6 | < 0.2 | 1.1 | - | 183.7 | 4.5 | < 0.004 | < 0.001 | < 0.1 | 0.9 | 9.7 | < 0.002 | 0.5 | 2.1 |
| | | 4-Sep-13 | 0.3 | 3.8 | 6.2 | 9 | 1.5 | 1.1 | 357.5 | 6.6 | 0.2 | 0.2 | 3 | 2.9 | 39 | 0.2 | 0.5 | 2.1 |
| | | 6-Oct-13 | 0.5 | 3.2 | 4 | 6.3 | 1.1 | < DL | 553.8 | 4 | < DL | < DL | < DL | 2.9 | 53.2 | 0 | 0.1 | 1.5 |
| | | 9-May-14 | 0.6 | 3.2 | 2.8 | < 8.5 | 1 | - | 423.7 | 1.8 | < 0.15 | < 0.05 | 2.8 | 1.2 | 27.9 | 0 | 0.1 | 1.6 |
| | | 12-Jul-14 | 0.7 | 2.1 | 15.8 | < 8.5 | 1.3 | < 2 | 201.5 | 5.4 | < 0.15 | < 0.02 | 4.2 | 1.2 | 17.3 | < 0.03 | 0.1 | 1.3 |
| | | 29-Sep-14 | 0.2 | 1.6 | 13.6 | 12 | 0.8 | < 2 | 216.7 | 3 | < 0.15 | < 0.05 | 2 | 0.7 | 25 | < 0.03 | < 0.04 | 1.1 |
| | *6.8* | 4-Sep-13 | 0.6 | 6.9 | 2.1 | 19.2 | 1.5 | 1.4 | 452.2 | 10 | 0.1 | 0.1 | 4.1 | 3 | 10 | 0.1 | 0.2 | 0.2 |
| | | 6-Oct-13 | 0.3 | 3.8 | 1.9 | 22.3 | 1.4 | < DL | 517.2 | 7.5 | 1 | < DL | 1.6 | 1.8 | 10.1 | 0.1 | 0.1 | 0.3 |
| | | 9-May-14 | 0.5 | 2.9 | 1.5 | 34.7 | 1.9 | - | 546 | 19 | < 0.05 | 0 | 4.3 | 0.8 | 9 | 0.1 | 0.1 | 0.1 |
| | | 12-Jul-14 | 0.2 | 3.6 | 7.1 | < 8.5 | 1.4 | < 2 | 494.1 | 6 | < 0.15 | < 0.05 | 6.4 | 0.6 | 7.7 | 0 | 0 | 0.5 |
| | | 29-Sep-14 | < 0.2 | 1.8 | 1.8 | < 8.5 | 1.2 | < 2 | 370.5 | 5.3 | < 0.15 | < 0.02 | < 1.5 | 0.4 | 9.4 | 0 | < 0.01 | 0.2 |
| | *11.8* | 12-Jul-14 | 1.3 | 189.8 | 5.5 | < 8.5 | 0.7 | 8 | 924.9 | 1.1 | < 0.15 | < 0.02 | 4.1 | 0.3 | 7.8 | 0 | < 0.04 | 1.3 |
| | | 26-Jun-12 | 0.7 | 10.2 | 4.1 | 329.1 | 5.3 | - | 834.5 | 37.3 | 1.1 | < 0.00528 | 24.5 | 3.4 | 14.8 | 0.2 | 0.7 | 3.5 |
| | | 22-Jul-12 | < 0.02 | 26.2 | < 0.07 | 39.8 | 2.9 | - | 805.3 | 17.9 | < DL | < DL | < 0.2 | 0.3 | 12.9 | < 0.002 | 1.4 | 2.8 |
| | | 19-Aug-12 | < 0.02 | 28 | 5.3 | 34.2 | 3.5 | - | 901.5 | 14.4 | < DL | < DL | < 0.2 | 0.6 | 14.5 | < 0.002 | 1.8 | 2.2 |
| | | 24-Sep-12 | < 0.02 | 27.9 | 3.5 | 65.8 | 4 | - | 917.1 | 10.1 | < 0.01 | < 0.007 | < 0.2 | 1.4 | 18.2 | 0.1 | 4 | 1.6 |
| | | 21-May-13 | 0.4 | 28.2 | 0.6 | 44 | 3.8 | - | 947.2 | 10.7 | < 0.004 | < 0.001 | 2.9 | 0.3 | 9.2 | 0 | 0.1 | 1.9 |
| | | 15-Jun-13 | 0.7 | 146.4 | 0.5 | 10.8 | 0.9 | - | 970.1 | 1.6 | < 0.004 | < 0.001 | < 0.1 | 1.8 | 9.5 | 0 | < 0.0009 | 1.4 |
| | | 27-Jul-13 | 2.9 | 40.9 | 3.5 | 14 | 3.7 | < 0.7 | 492.4 | 7.2 | 1.8 | 2.8 | < DL | 5 | 23.9 | 1.8 | 2.2 | 1.3 |
| | | 4-Sep-13 | 0.5 | 80.8 | 3 | 38.8 | 1.6 | 6.4 | 951.9 | 3.4 | 0.1 | 0 | 3.1 | 1.4 | 11.3 | 0.1 | 0.6 | 1.1 |
| | | 6-Oct-13 | 0.6 | 107.8 | 2.7 | 22.9 | 1 | 7.8 | 1004 | 4.1 | < DL | < 0.05 | 4.3 | 1.3 | 12.2 | 0 | 0.2 | 0.8 |
| | | 9-May-14 | 0.7 | 60 | 1 | 76.7 | 2.2 | - | 948 | 6.5 | < 0.05 | < 0.05 | 5.6 | 0.5 | 9.1 | 0 | 0.1 | 1.8 |
| | | 12-Jun-14 | 2.7 | 85.5 | 1.3 | 31 | 0.9 | 5.3 | 884.7 | 1.5 | < 0.15 | < 0.02 | 6.9 | 0.1 | 8.8 | 0 | 0 | 0.9 |
| | | 29-Sep-14 | 0.9 | 132.4 | 1.1 | 9.6 | 0.9 | 7.9 | 961.6 | 5 | 0.1 | 0 | 1.4 | 2.2 | 10 | 0.1 | 0.1 | 1 |

***Table B.6(Cont.): Pore-Water Geochemical Data: BH4-4***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-4* | *16.8* | 24-Jun-12 | 4 | 95.6 | < 0.0711 | 83.4 | 1.7 | - | 910.7 | 9.9 | 2.8 | 0.3 | 7 | 2 | 14.1 | 0.3 | 0.9 | 1.7 |
| | | 27-Jun-12 | 3.6 | 91.8 | 2.6 | 18.6 | 1 | - | 932.5 | 3.5 | 0.3 | < DL | 1.2 | 0.2 | 13.5 | < 0.0125 | 0.2 | 1.7 |
| | | 22-Jul-12 | 3.6 | 91.9 | 6.3 | < 0.6 | < 0.03 | - | 940.4 | 3.9 | < DL | < DL | < 0.2 | 0.4 | 13.4 | < 0.002 | 3.7 | 1.6 |
| | | 22-Jul-12 | 3.5 | 92.6 | 68.5 | 70.8 | < 0.03 | 0 | 945.7 | 3.4 | 1.1 | < DL | < 0.2 | < 0.006 | 13.6 | < 0.002 | 6.2 | 1.6 |
| | | 19-Aug-12 | 4.4 | 90.3 | < DL | < 0.6 | < 0.03 | 0 | 939.1 | 2.7 | < DL | < DL | < DL | < 0.006 | 13.3 | < 0.002 | 0.5 | 1.4 |
| | | 19-Aug-12 | 4.3 | 89.7 | < 0.07 | < 0.6 | < DL | 0 | 935.3 | 2.5 | < DL | < DL | < DL | 0.4 | 13.7 | < 0.002 | 0.6 | 1.4 |
| | | 24-Sep-12 | 3.9 | 73.9 | 72 | 45 | < DL | 0 | 801.1 | 2.2 | < DL | < DL | < 0.2 | 0.6 | 15.2 | < 0.002 | 18.6 | 1.1 |
| | | 24-Sep-12 | 4.3 | 83.3 | 9.6 | < 0.6 | < 0.03 | 0 | 906.6 | 3 | < DL | < DL | < DL | 0.6 | 13.1 | < 0.002 | 3.7 | 1.2 |
| | | 28-Oct-12 | 4.9 | 92.5 | 14.5 | 13.1 | 0.6 | 0 | 1051 | 2.6 | < DL | < 0.005 | 1.8 | 0.3 | 14.5 | 0.1 | 0.1 | 1.5 |
| | | 21-May-13 | 5.2 | 113.3 | 0.6 | 31.4 | 0.8 | 0 | 1011 | 2.6 | < 0.004 | < 0.005 | 1.3 | 0.2 | 10.8 | 0 | 0.1 | 1.8 |
| | | 15-Jun-13 | 6.7 | 115 | 0.5 | < 0.8 | 0.4 | 0 | 985.3 | 1.7 | < 0.004 | < 0.005 | < 0.1 | 1.1 | 13.9 | 0.1 | < 0.0009 | 1.3 |
| | | 27-Jul-13 | 6.3 | 112.8 | 1.7 | 8 | 0.3 | < 0.7 | 953.4 | 2.8 | 0.1 | 0.1 | < 0.1 | 1.5 | 13 | 0.1 | < DL | 1.4 |
| | | 4-Sep-13 | 5.1 | 109.7 | < 0.05 | 11 | 0.6 | 7.9 | 1012 | 1.9 | < 0.01 | 0 | 2.6 | 1.2 | 13.7 | 0.1 | 0.1 | 1.3 |
| | | 6-Oct-13 | 4.4 | 139.8 | 9.8 | 38.6 | 0.4 | 6.9 | 1019 | 1.7 | < DL | < 0.05 | < 1.5 | 0.5 | 14.4 | 0 | 0.2 | 1.1 |
| | | 12-Jun-14 | 6.6 | 112.5 | 1 | 13.9 | 0.3 | 4.1 | 1106 | 1.4 | < 0.15 | < 0.05 | 4 | 0.1 | 9.8 | 0 | 0 | 1.5 |
| | | 12-Jul-14 | 4.8 | 99.1 | 3 | 11.2 | < 0.3 | < 7 | 819.7 | 0.9 | < 0.15 | < 0.05 | 4.4 | 0.2 | 8.5 | 0 | 0 | 1.2 |
| | | 29-Sep-14 | 5.5 | 111.9 | 1 | 8.1 | 0.4 | 9.4 | 1025 | 1.8 | < 0.15 | 0 | 1.1 | 0.7 | 12.8 | 0.1 | 0 | 1.3 |
| | *21.8* | 21-May-13 | 1.3 | 8.6 | 1.5 | 46.8 | 0.8 | 0 | 913.9 | 5.2 | < 0.004 | < 0.005 | 1.4 | 0.3 | 15.6 | 0 | 0.5 | 4.5 |
| | | 24-Jun-12 | 4.8 | 32.7 | 12.9 | 45.4 | < 0.0257 | 0 | 861.3 | 8 | 3.7 | < 0.00528 | < 0.0979 | 1.7 | 21.7 | 0.1 | 1.4 | 4.2 |
| | | 27-Jun-12 | 4.9 | 35.3 | 20.9 | 26.2 | 2.2 | 0 | 811.1 | 12.2 | 62.7 | < 0.00528 | < DL | 5.9 | 19.9 | 0.2 | 2 | 4.2 |
| | | 22-Jul-12 | 3.8 | 26.3 | 11.3 | 29.4 | < 0.03 | 0 | 729 | 6.2 | 0.7 | < DL | < 0.2 | 0.5 | 18.2 | < 0.002 | 1.6 | 3.5 |
| | | 19-Aug-12 | 3.8 | 22.1 | < 0.07 | < 0.6 | < DL | 0 | 661.3 | 13.7 | < DL | < 0.007 | < 0.2 | 0.9 | 16.4 | 0.1 | 0.7 | 2.9 |
| | | 24-Sep-12 | 2.8 | 15.1 | 43.7 | 71.9 | < DL | 0 | 700.6 | 4.7 | < DL | < DL | < 0.2 | 0.4 | 16.6 | < 0.002 | 4.8 | 2.1 |
| | | 28-Oct-12 | 2.8 | 13.9 | 1 | 12.5 | < 0.03 | 0 | 679.3 | 5 | < DL | < 0.005 | < 0.1 | 0.3 | 15.9 | 0 | < DL | 2.6 |
| | | 27-Jul-13 | 2.6 | 16.1 | < DL | 8.6 | 0.3 | 8.3 | 936.9 | 3.8 | < 0.01 | 0.1 | < DL | 1 | 17.6 | 0.1 | < DL | 2.9 |
| | | 4-Sep-13 | 2.3 | 15.8 | < DL | 9.7 | 0.3 | 7.5 | 925.2 | 3.4 | < 0.01 | 0.1 | 1.9 | 0.9 | 17.3 | 0 | 2.1 | 2.5 |
| | | 6-Oct-13 | 2.5 | 15.5 | < 0.5 | 12.2 | < 0.3 | 7.8 | 939.5 | 3.4 | 2.8 | 0 | < 1.5 | 0.4 | 15.8 | 0 | 0.1 | 2.1 |
| | | 9-May-14 | 0.8 | 1.2 | < 0.5 | 53.7 | 0.7 | 0 | 923.5 | 5.4 | < 0.05 | < 0.05 | 3.1 | 0.4 | 13.1 | 0 | 0 | 4.8 |
| | | 29-Sep-14 | 1.6 | 10.4 | 0.7 | < 8.5 | < 0.3 | 9 | 943.2 | 3.1 | < 0.15 | 0 | < 1.5 | 0.3 | 13.5 | 0 | < 0.04 | 2.7 |

***Table B.7: Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *pH* | *Eh (mV)* | *EC (mS/cm)* | *Temp (˚C)* | *Total Alk. (mg/L)* | *$F^-$ (mg/L)* | *$Cl^-$ (mg/L)* | *$NO_2^-$ (mg/L)* | *$Br^-$ (mg/L)* | *$NO_3^-$ (mg/L)* | *$SO_4^{2-}$ (mg/L)* | *$PO_4^{3-}$ (mg/L)* | *$NH_3$-N (mg/L)* | *TOC (mg/L)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *5.0* | 17-Jun-12 | 8 | 332.3 | - | - | 42 | 0.4 | 1.8 | < 0.3 | < 0.3 | 0.3 | 921.5 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 45 | - | - | - | - | - | - | - | - | - |
| | | 25-Jun-12 | 7.5 | 401.3 | - | - | | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8 | 158 | - | 22 | 70 | 0.1 | 2 | < 0.3 | < 0.3 | < 0.3 | 911.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 44 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | - | | - | - | 28.5 | - | - | - | - | - | - | - | - | - |
| | | 18-Aug-12 | 8 | 365.3 | - | - | 60 | 0.4 | 3.3 | < 0.3 | < 0.3 | < 0.3 | 1081.9 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 34 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 36 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 7.9 | 424.3 | - | - | 57.7 | < 0.3 | 2 | < 0.3 | < 0.3 | < 0.3 | 1398.8 | < 0.3 | - | - |
| | | 28-Oct-12 | 7.8 | 374.2 | - | - | 90 | < 1.0 | 3.3 | < 1.0 | < 1.0 | < 1.0 | 1443.7 | < 1.0 | - | - |
| | | 21-May-13 | 7.7 | 168.9 | 2.4 | 20.5 | 70 | < 0.03 | 3.9 | < 0.03 | < 0.03 | 1.2 | 1464.8 | < 0.03 | - | - |
| | | 14-Jun-13 | 7.6 | 420.6 | 2 | 22.9 | 341.6 | < 0.3 | 1.5 | < 0.3 | < 0.3 | < 0.3 | 1069.1 | < 0.3 | <0.01 | - |
| | | 27-Jul-13 | 7.7 | 502.4 | 1.7 | 25.5 | 64.7 | < 0.3 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 1079.9 | < 0.3 | - | - |
| | *10.0* | 17-Jun-12 | 7.7 | 303.3 | - | - | 53.3 | - | - | - | - | - | - | - | - | - |
| | | 14-Jun-13 | 7.9 | 455 | 2.5 | 24.2 | 95 | 1.2 | 3 | < 0.3 | < 0.3 | 2.7 | 1503.1 | < 0.3 | - | - |
| | | 9-May-14 | 7.6 | 503.4 | 2.7 | 20.2 | 50 | - | - | - | - | - | - | - | - | - |
| | *15.0* | 17-Jun-12 | 8.3 | 351.3 | - | - | 35 | 0.4 | 1.8 | < 0.3 | < 0.3 | < 0.3 | 1863.2 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 37.5 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8.4 | 134.9 | - | 20.6 | 25 | < 0.3 | 1.1 | < 0.3 | < 0.3 | < 0.3 | 1894.4 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 25 | - | - | - | - | - | - | - | - | - |
| | | 18-Aug-12 | 8.2 | 362.3 | - | - | 24 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | 1855.5 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 32 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 30 | - | - | - | - | - | - | - | - | - |
| | | 24-Sep-12 | 8.2 | 426.9 | - | - | 35 | < 2.0 | < 2.0 | < 0.3 | < 0.3 | < 0.3 | 1909.4 | < 0.3 | - | 6.2 |
| | | Duplicate | - | | - | - | | - | - | - | - | - | - | - | - | - |
| | | 28-Oct-12 | 7.7 | 377.8 | - | - | 46.6 | < 0.5 | 1.2 | < 0.5 | < 0.5 | < 0.5 | 1891.3 | < 0.5 | - | - |
| | | 21-May-13 | 7.6 | 169.1 | 3.4 | 20.2 | 95 | 0.5 | 2.3 | < 0.03 | < 0.03 | < 0.03 | 1979.5 | < 0.03 | - | - |
| | | 14-Jun-13 | 7.8 | 463.6 | 3.2 | 23.2 | 90 | 0.4 | 3.2 | < 0.3 | < 0.3 | < 0.3 | 2027.1 | < 0.3 | - | - |
| | | 27-Jul-13 | 7.9 | 512.4 | 2.8 | 25.2 | 55 | < 0.3 | 1.8 | < 0.3 | < 0.3 | < 0.3 | 1925.8 | < 0.3 | - | - |
| | | 4-Sep-13 | 8 | 387 | 2.7 | 15.7 | 100 | < 0.3 | 1.6 | < 0.3 | < 0.3 | < 0.3 | 1857.7 | < 0.3 | - | - |
| | | 5-Oct-13 | 7.6 | 379.7 | 2.7 | 13.7 | 66.6 | < 0.3 | 0.9 | < 1.0 | < 0.3 | < 1.0 | 1919.7 | < 1.0 | <0.01 | - |
| | | 9-May-14 | 7.7 | 542.8 | 2.8 | 19 | #VALUE! | 0.4 | 2.7 | < 0.1 | < 0.1 | < 0.1 | 1930.9 | < 0.1 | - | - |
| | | 14-Jun-14 | 7.8 | 378.8 | 2.5 | 16.9 | 50 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8 | 274 | 2.7 | 24.6 | 51.6 | 0.3 | 2 | < 0.1 | < 0.1 | < 0.1 | 1974.9 | < 0.1 | - | - |
| | | 29-Sep-14 | 8 | 27.3 | 2.6 | 18.6 | 236.8 | 0.2 | 1.6 | < 0.1 | < 0.1 | < 0.1 | 1849.1 | < 0.1 | - | - |

*Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5*

| Location | Depth (mBGS) | Sample Date | pH | Eh (mV) | EC (mS/cm) | Temp (°C) | Total Alk. (mg/L) | $F^-$ (mg/L) | $Cl^-$ (mg/L) | $NO_2^-$ (mg/L) | $Br^-$ (mg/L) | $NO_3^-$ (mg/L) | $SO_4^{2-}$ (mg/L) | $PO_4^{3-}$ (mg/L) | $NH_3$-N (mg/L) | TOC (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH4-5 | 20.0 | 17-Jun-12 | 8.2 | 308.3 | - | - | 100 | 2.8 | 8 | < 0.3 | < 0.3 | 4.4 | 1761.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 101 | - | - | - | - | - | - | - | - | - |
| | | 25-Jun-12 | 8.2 | 389.3 | - | - | 66.6 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 8.1 | 155.3 | - | - | 74 | 1.9 | 4.9 | < 0.3 | < 0.3 | 3.3 | 2042.7 | < 0.3 | - | - |
| | | 18-Aug-12 | 8.2 | 376.3 | - | - | | 2.2 | 5.9 | < 0.3 | < 0.3 | 5.3 | 2067.3 | < 0.3 | - | - |
| | | 28-Oct-12 | 8 | 375 | - | - | 110 | 1.7 | 3.6 | < 0.5 | < 0.5 | < 0.5 | 2084.2 | < 0.5 | - | - |
| | | Duplicate | - | | - | - | | - | - | - | - | - | - | - | - | - |
| | | 21-May-13 | 7.9 | 159.8 | 3.4 | 20.6 | 113.3 | < 0.03 | 2.9 | < 0.03 | < 0.03 | < 0.03 | 227.1 | < 0.03 | - | - |
| | | 15-Jun-13 | 8.2 | 442.7 | - | - | 170 | - | - | - | - | - | - | - | - | - |
| | | 27-Jul-13 | 8.2 | 463.2 | 3.1 | 25.5 | 146.6 | - | - | - | - | - | - | - | - | - |
| | | 4-Sep-13 | 8.2 | 381.8 | - | - | | 0.8 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 2143.3 | < 0.3 | - | - |
| | | 9-May-14 | 7.8 | 309.3 | 3 | 16.9 | 92 | 1.7 | 2.8 | < 0.1 | < 0.1 | 3.7 | 2148.1 | < 0.1 | - | - |
| | | 14-Jun-14 | 8.1 | 455.3 | 2.6 | 15.7 | 120 | - | - | - | - | - | - | - | - | - |
| | | 12-Jul-14 | 8.1 | 269.6 | 3 | 25.1 | 105.9 | - | - | - | - | - | - | - | - | - |
| | | 29-Sep-14 | 8.1 | 31.1 | 2.9 | 18.6 | 114.2 | 0.5 | 2.8 | < 0.1 | < 0.1 | 0.9 | 2386.1 | < 0.1 | - | - |
| | 25.0 | 25-Jun-12 | 7.9 | 368.3 | - | - | 250 | 0.6 | 2.6 | < 0.3 | < 0.3 | < 0.3 | 137.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 270 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 270 | - | - | - | - | - | - | - | - | - |
| | | 21-Jul-12 | 7.6 | 146.3 | - | - | 300 | < 0.3 | 1.9 | < 0.3 | < 0.3 | < 0.3 | 182.8 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 337.5 | - | - | - | - | - | - | - | - | - |
| | | 18-Aug-12 | 7.9 | 357.3 | - | - | 275.7 | < 0.3 | 1.6 | < 0.3 | < 0.3 | < 0.3 | 191.3 | < 0.3 | - | - |
| | | Duplicate | - | | - | - | 400 | - | - | - | - | - | - | - | - | - |
| | | Triplicate | - | | - | - | 362.5 | - | - | - | - | - | - | - | - | - |
| | | 23-Sep-12 | 7.6 | 352.8 | 0.8 | 19.7 | 242.5 | < 0.3 | 2.8 | < 0.3 | < 0.3 | < 0.3 | 203.2 | < 0.3 | - | 4.1 |
| | | 28-Oct-12 | 7.7 | 359.6 | 0.9 | 18.6 | 337.5 | < 0.3 | 2.7 | < 0.3 | < 0.3 | < 0.3 | 217.7 | < 0.3 | - | 4.2 |
| | | 21-May-13 | 7.5 | 250.7 | 1.4 | 20.8 | 370 | < 0.03 | 2.3 | < 0.03 | < 0.03 | < 0.03 | 238.7 | < 0.03 | - | 6.4 |
| | | 14-Jun-13 | 7.6 | 454.3 | 0.8 | 20.8 | 365 | < 0.3 | 2.5 | < 0.3 | < 0.3 | < 0.3 | 284.7 | < 0.3 | - | - |
| | | 27-Jul-13 | 7.5 | 502.2 | 1.3 | 25.8 | 335 | < 0.3 | 2.2 | < 0.3 | < 0.3 | < 0.3 | 297.6 | < 0.3 | - | 4.2 |
| | | 4-Sep-13 | 7.6 | 248.9 | 1 | 16.3 | 365 | < 0.3 | 2.9 | < 0.3 | < 0.3 | < 0.3 | 323 | < 0.3 | - | 3.2 |
| | | 5-Oct-13 | 7.1 | 234.6 | 1.1 | 13.7 | 326 | < 0.3 | 2.6 | < 1.0 | < 0.3 | < 1.0 | 351.4 | < 1.0 | 0.1 | - |
| | | 9-May-14 | 8.1 | 392.8 | 1.1 | 19 | 290 | < 0.1 | 2.9 | < 0.1 | < 0.1 | < 0.1 | 353.2 | - | - | 4.2 |
| | | 14-Jun-14 | 8 | 412.3 | 1.2 | 14.8 | 290 | < 0.1 | 3.2 | < 0.1 | < 0.1 | < 0.1 | 429.2 | <0.003 | - | 2.2 |
| | | 12-Jul-14 | 7.6 | 300.4 | 1.2 | 24.1 | 365.8 | < 0.1 | 3.2 | < 0.1 | < 0.1 | < 0.1 | 434.9 | <0.01 | 0.1 | 1.5 |
| | | Duplicate | 7.3 | 301.4 | 1.2 | 23.7 | 345.6 | 0.1 | 3.2 | < 0.1 | < 0.1 | < 0.1 | 437.2 | <0.01 | 0.1 | <1.0 |
| | | 29-Sep-14 | 7.8 | 55.4 | 1.2 | 18 | 370.8 | < 0.1 | 3.2 | < 0.1 | < 0.1 | < 0.1 | 425.2 | < 0.1 | - | - |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *5.0* | 17-Jun-12 | < DL | < DL | 286.9 | < DL | < DL | < DL | < DL | < DL | 14.9 | - | 49.5 |
| | | Duplicate | < DL | < DL | 282 | < DL | < DL | < DL | < DL | < DL | 14.3 | - | 49.4 |
| | | 21-Jul-12 | < DL | < DL | 297.4 | < DL | < DL | < DL | < DL | < DL | 18.4 | < DL | 44.7 |
| | | 24-Sep-12 | < DL | < DL | 413.6 | < DL | < DL | < DL | < DL | < DL | 21.4 | < DL | 68.8 |
| | | 28-Oct-12 | < DL | < DL | 466.2 | < DL | < DL | < DL | < DL | < DL | 19 | < DL | 77.8 |
| | | 21-May-13 | < DL | < DL | 519 | < DL | < DL | < DL | < DL | < DL | 16.1 | < DL | 82.6 |
| | | 14-Jun-13 | < DL | < DL | 363.9 | < DL | < DL | < DL | < DL | < DL | 12.6 | < DL | 56.9 |
| | | 27-Jul-13 | < DL | < DL | 364.6 | < DL | < DL | < DL | < DL | < DL | 15.9 | < DL | 51.9 |
| | *10.0* | 14-Jun-13 | < DL | < DL | 476.8 | < DL | < DL | < DL | < DL | < DL | 15.6 | < DL | 106 |
| | *15.0* | 17-Jun-12 | < DL | < DL | 420.6 | < DL | < DL | < DL | < DL | < DL | 26.2 | - | 193.2 |
| | | 21-Jul-12 | < DL | < DL | 450.8 | < DL | < DL | < DL | < DL | < DL | 27.9 | < DL | 194.9 |
| | | 24-Sep-12 | < DL | < DL | 472.3 | < DL | < DL | < DL | < DL | < DL | 26.4 | < DL | 177.9 |
| | | Duplicate | < DL | < DL | 480.3 | < DL | < DL | < DL | < DL | < DL | 26.5 | < DL | 176 |
| | | 28-Oct-12 | < DL | < DL | 481.4 | < DL | < DL | < DL | < DL | < DL | 25.3 | < DL | 200.8 |
| | | 21-May-13 | < DL | < DL | 463.9 | < DL | < DL | < DL | < DL | < DL | 23.1 | < DL | 235.3 |
| | | 14-Jun-13 | < DL | < DL | 485.7 | < DL | < DL | < DL | < DL | < DL | 22.4 | < DL | 230.4 |
| | | 27-Jul-13 | < DL | < DL | 468.1 | < DL | < DL | < DL | < DL | < DL | 25.2 | < DL | 208.1 |
| | | 4-Sep-13 | < DL | < DL | 478.3 | < DL | < DL | < DL | < DL | < DL | 24.9 | < DL | 185.4 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 476.8 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | < 0.2 | 23.9 | < 0.1 | 180.5 |
| | | 9-May-14 | < 2 | < 1 | 482.4 | <2 | < 1 | <2 | <2 | <2 | 21.5 | < 1 | 196.7 |
| | | 12-Jul-14 | < 2 | < 1 | 462 | < 2 | < 1 | < 2 | < 2 | < 2 | 21.3 | < 1 | 214.1 |
| | | 29-Sep-14 | < 2 | < 1 | 449.5 | < 2 | < 1 | < 2 | < 2 | < 2 | 20.9 | < 1 | 176.4 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Al* | *As* | *Ca* | *Cd* | *Co* | *Cr* | *Cu* | *Fe* | *K* | *Li* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *20.0* | 17-Jun-12 | < DL | < DL | 404.7 | < DL | < DL | < DL | < DL | < DL | 20.8 | - | 194.9 |
| | | 21-Jul-12 | < DL | < DL | 485.8 | < DL | < DL | < DL | < DL | < DL | 25.3 | < DL | 220.1 |
| | | 28-Oct-12 | < DL | < DL | 507 | < DL | < DL | < DL | < DL | < DL | 25.7 | < DL | 247.3 |
| | | Duplicate | < DL | < DL | 498.9 | < DL | < DL | < DL | < DL | < DL | 23.9 | < DL | 244.6 |
| | | 21-May-13 | < DL | < DL | 498.5 | < DL | < DL | < DL | < DL | < DL | 23.5 | < DL | 244.8 |
| | | 29-Jul-13 | < DL | < DL | 495.3 | < DL | < DL | < DL | < DL | < DL | 25.4 | < DL | 250 |
| | | 4-Sep-13 | < DL | < DL | 490.6 | < DL | < DL | < DL | < DL | < DL | 25.5 | < DL | 248 |
| | | 9-May-14 | < 2 | < 1 | 494.4 | <2 | < 1 | <2 | <2 | <2 | 22.6 | < 1 | 254.3 |
| | | 29-Sep-14 | < 2 | < 1 | 468.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 22.6 | < 1 | 247 |
| | *25.0* | 25-Jun-12 | < DL | < DL | 97.1 | < DL | < DL | < DL | < DL | < DL | 3.5 | - | 37.6 |
| | | 21-Jul-12 | < DL | < DL | 127.5 | < DL | < DL | < DL | < DL | < DL | 4.7 | < DL | 43.5 |
| | | 23-Sep-12 | < DL | < DL | 133.8 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 41.5 |
| | | 28-Oct-12 | < DL | < DL | 135.4 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 48.2 |
| | | 21-May-13 | < DL | < DL | 149.6 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 47.9 |
| | | 14-Jun-13 | < DL | < DL | 159 | < DL | < DL | < DL | < DL | < DL | 2.5 | < DL | 51.8 |
| | | 27-Jul-13 | < DL | < DL | 161.4 | < DL | < DL | < DL | < DL | < DL | < 0.4 | < DL | 52.4 |
| | | 4-Sep-13 | < DL | < DL | 166.2 | < DL | < DL | < DL | < DL | < DL | 4 | < DL | 54.5 |
| | | 5-Oct-13 | < 0.2 | < 0.1 | 176.2 | < 0.2 | < 0.1 | < 0.2 | < 0.2 | 0.3 | 5.5 | < 0.1 | 57.6 |
| | | 9-May-14 | < 2 | < 1 | 176.1 | <2 | < 1 | <2 | <2 | <2 | 3.5 | < 1 | 58.8 |
| | | 12-Jun-14 | < 2 | < 1 | 194.3 | < 2 | < 1 | < 2 | < 2 | < 2 | 5.2 | < 1 | 63 |
| | | 12-Jul-14 | < 2 | < 1 | 202.1 | < 2 | < 1 | < 2 | < 2 | < 2 | 2.1 | < 1 | 65.6 |
| | | Duplicate | < 2 | < 1 | 200.3 | < 2 | < 1 | < 2 | < 2 | < 2 | 1.4 | < 1 | 65.2 |
| | | 29-Sep-14 | < 2 | < 1 | 198.4 | < 2 | < 1 | < 2 | < 2 | < 2 | 4.1 | < 1 | 64.8 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *5.0* | 17-Jun-12 | < DL | 8.5 | < DL | < DL | 292.6 | < DL | < DL | 13.5 | < 0.137 | < DL | < DL |
| | | Duplicate | < DL | 8.4 | < DL | < DL | 287.8 | < DL | < DL | 13.6 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 9.8 | < DL | < DL | 315 | < DL | < DL | 17.3 | < 0.1 | < DL | < DL |
| | | 24-Sep-12 | < DL | 13.7 | < DL | < DL | 416.9 | < DL | < DL | 18.7 | < 0.1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 14.9 | < DL | < DL | 457.3 | < DL | < DL | 21.2 | < 0.1 | < DL | < DL |
| | | 21-May-13 | < DL | 12.4 | < DL | < DL | 488.3 | < DL | < DL | 25 | < 0.1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 8.2 | < DL | < DL | 353.8 | < DL | < DL | 10.4 | 0.5 | < DL | < DL |
| | | 27-Jul-13 | < DL | 9.1 | < DL | < DL | 360.8 | < DL | < DL | 11.4 | < 0.1 | < DL | < DL |
| | *10.0* | 14-Jun-13 | < DL | 11.4 | < DL | < DL | 515.8 | < DL | < DL | 32.4 | 0.6 | < DL | < DL |
| | *15.0* | 17-Jun-12 | < DL | 15.2 | < DL | < DL | 576 | < DL | < DL | 13.8 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 15.3 | < DL | < DL | 630.8 | < DL | < DL | 14.4 | 1 | < DL | < DL |
| | | 24-Sep-12 | < DL | 14.1 | < DL | < DL | 637.5 | < DL | < DL | 17.7 | 1 | < DL | < DL |
| | | Duplicate | < DL | 14 | < DL | < DL | 647.5 | < DL | < DL | 17.8 | 1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 16.1 | < DL | < DL | 634.9 | < DL | < DL | 20.3 | 1 | < DL | < DL |
| | | 21-May-13 | < DL | 16.7 | < DL | < DL | 631.4 | < DL | < DL | 43.1 | 1 | < DL | < DL |
| | | 14-Jun-13 | < DL | 17.4 | < DL | < DL | 665.5 | < DL | < DL | 35.8 | 1 | < DL | < DL |
| | | 27-Jul-13 | < DL | 14.4 | < DL | < DL | 649 | < DL | < DL | 28.8 | 0.9 | < DL | < DL |
| | | 4-Sep-13 | < DL | 12.3 | < DL | < DL | 627.1 | < DL | < DL | 25.2 | 0.9 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 11.5 | < 1.0 | < 0.2 | 609.6 | < 0.09 | < 0.1 | 22.1 | 0.9 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | 12 | < 1 | <2 | 999.7 | < 0.9 | < 1 | 38.3 | 0.9 | <2 | <2 |
| | | 12-Jul-14 | < 1 | 11.5 | < 1 | < 2 | 665.9 | < 0.9 | < 1 | 28.4 | 0.9 | < 2 | < 2 |
| | | 29-Sep-14 | < 1 | 10.5 | < 1 | < 2 | 624.6 | < 0.9 | < 1 | 26.6 | 0.9 | < 2 | < 2 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Mn* | *Na* | *Ni* | *Pb* | *S* | *Sb* | *Se* | *Si* | *Sr* | *Tl* | *Zn* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *20.0* | 17-Jun-12 | < DL | 22.2 | < DL | < DL | 551.7 | < DL | < DL | 21.5 | < 0.137 | < DL | < DL |
| | | 21-Jul-12 | < DL | 20.1 | < DL | < DL | 693.5 | < DL | < DL | 20 | 1 | < DL | < DL |
| | | 28-Oct-12 | < DL | 21.9 | < DL | < DL | 694.4 | < DL | < DL | 25.1 | 1.1 | < DL | < DL |
| | | Duplicate | < DL | 20.5 | < DL | < DL | 683 | < DL | < DL | 25.3 | 1.1 | < DL | < DL |
| | | 21-May-13 | < DL | 19.4 | < DL | < DL | 660.2 | < DL | < DL | 36 | 1.1 | < DL | < DL |
| | | 29-Jul-13 | < DL | 17.4 | < DL | < DL | 718 | < DL | < DL | 21.5 | 1.1 | < DL | < DL |
| | | 4-Sep-13 | < DL | 16.6 | < DL | < DL | 708.1 | < DL | < DL | 22.9 | 1.1 | < DL | < DL |
| | | 9-May-14 | < 1 | 17 | < 1 | <2 | 1219 | < 0.9 | < 1 | 35.6 | 1.1 | <2 | <2 |
| | | 29-Sep-14 | < 1 | 14.8 | < 1 | < 2 | 714.6 | < 0.9 | < 1 | 21.7 | 1.1 | < 2 | < 2 |
| | *25.0* | 25-Jun-12 | < DL | < 0.587 | < DL | < DL | 45.8 | < DL | < DL | 12.1 | < DL | < DL | < DL |
| | | 21-Jul-12 | < DL | < 0.5 | < DL | < DL | 65.6 | < DL | < DL | 13 | < DL | < DL | < DL |
| | | 23-Sep-12 | < DL | < 0.5 | < DL | < DL | 70.8 | < DL | < DL | 9.1 | < DL | < DL | < DL |
| | | 28-Oct-12 | < DL | 5.4 | < DL | < DL | 75 | < DL | < DL | 9 | < DL | < DL | < DL |
| | | 21-May-13 | < DL | < 0.5 | < DL | < DL | 81 | < DL | < DL | 6.9 | < DL | < DL | < DL |
| | | 14-Jun-13 | < DL | 4.7 | < DL | < DL | 99.3 | < DL | < DL | 6.3 | 0.2 | < DL | < DL |
| | | 27-Jul-13 | < DL | < 0.5 | < DL | < DL | 104.1 | < DL | < DL | 6.6 | < DL | < DL | < DL |
| | | 4-Sep-13 | < DL | 5.1 | < DL | < DL | 115.9 | < DL | < DL | 6.4 | 0.2 | < DL | < DL |
| | | 5-Oct-13 | < 1.0 | 4.6 | < 1.0 | < 0.2 | 116 | < 0.09 | < 0.1 | 6.3 | < 0.03 | < 0.2 | < 0.2 |
| | | 9-May-14 | < 1 | < 5 | < 1 | <2 | 127.9 | < 0.9 | < 1 | 6.2 | < 0.3 | <2 | <2 |
| | | 12-Jun-14 | < 1 | 4.9 | < 1 | < 2 | 139 | < 0.9 | < 1 | 5.9 | < 0.3 | < 2 | < 2 |
| | | 12-Jul-14 | < 1 | 2.7 | < 1 | < 2 | 149.1 | < 0.9 | < 1 | 6 | < 0.3 | < 2 | < 2 |
| | | Duplicate | < 1 | 2.6 | < 1 | < 2 | 149.9 | < 0.9 | < 1 | 6 | < 0.3 | < 2 | < 2 |
| | | 29-Sep-14 | < 1 | 5.1 | < 1 | < 2 | 146.5 | < 0.9 | < 1 | 6 | < 0.3 | < 2 | < 2 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *5.0* | 17-Jun-12 | 4 | < DL | 49.9 | 7601 | O/R | 6 | 14050 | < DL | 15440 | - | < DL | 41.5 | 1.4 | 4.8 | 22.6 |
| | | Duplicate | 4 | < DL | 50.1 | 7849 | O/R | 7.5 | 13950 | < DL | 15530 | - | < DL | 42.6 | < 0.0179 | 2.6 | < DL |
| | | 21-Jul-12 | 10 | < DL | 106 | - | - | 8.5 | 16380 | < DL | - | - | < DL | 53.6 | < 0.02 | 2.5 | 13.9 |
| | | 24-Sep-12 | 13 | < DL | 129.8 | - | - | 5.7 | 16920 | < DL | - | - | < DL | 48.7 | < 0.02 | 1.5 | 76.9 |
| | | 28-Oct-12 | 16 | < DL | 180.6 | - | - | 2.1 | 21890 | < DL | - | - | < DL | 57.7 | 0.7 | 2.3 | 20.2 |
| | | 21-May-13 | 9 | < 0.02 | 104.5 | 8544 | O/R | < 0.1 | 26980 | < 3 | 18240 | - | < 0.2 | 38.4 | 0.5 | 2.4 | 2.7 |
| | | 14-Jun-13 | 5 | < 0.007 | 46 | 9361 | O/R | < 0.04 | 13560 | < 3 | 15410 | - | < 0.05 | 17.4 | < 0.02 | 1.7 | 2.8 |
| | | 27-Jul-13 | 6 | < DL | 58 | 8377 | 0 | 3.7 | 11100 | < DL | 15700 | - | < DL | 19.2 | 0.5 | 1.4 | 3.4 |
| | *10.0* | 14-Jun-13 | 105 | < 0.02 | 343.1 | 13190 | O/R | < 0.04 | 37160 | < 3 | 20000 | - | < 0.2 | 363.5 | 0.8 | 14.1 | 3.2 |
| | *15.0* | 17-Jun-12 | 20 | < DL | 129.9 | 14300 | O/R | 8.4 | 14010 | < DL | O/R | - | < DL | 50 | 1.5 | 21.6 | < 0.250 |
| | | 21-Jul-12 | 17 | < DL | 95.7 | - | - | < 0.1 | 13440 | < DL | - | - | < DL | 37.9 | 1.1 | 17.8 | 8.1 |
| | | 24-Sep-12 | 21 | < DL | 135.5 | - | - | < 0.1 | 17820 | < DL | - | - | < DL | 54.8 | 2.9 | 8.3 | 21.7 |
| | | Duplicate | 19 | < DL | 130 | - | - | < 0.1 | 16840 | < DL | - | - | < DL | 52.6 | 2.6 | 6.1 | 12.8 |
| | | 28-Oct-12 | 28 | < DL | 198.6 | - | - | 1.8 | 20350 | < DL | - | - | < DL | 68 | 5.2 | 7.6 | 5.4 |
| | | 21-May-13 | 49 | < 0.02 | 417.4 | 10330 | O/R | < 0.04 | 46150 | < 3 | 25250 | - | < 0.2 | 109 | 9.6 | 7.4 | 4.3 |
| | | 14-Jun-13 | 38 | < 0.02 | 304.8 | 8797 | O/R | < 0.04 | 40530 | < 3 | 28740 | - | < 0.05 | 88.1 | 4 | 16.1 | 3.4 |
| | | 27-Jul-13 | 18 | < 0.02 | 109.4 | 10720 | - | < DL | 27590 | < DL | 25310 | - | < 0.2 | 63.8 | 0.5 | 14.1 | 4.9 |
| | | 4-Sep-13 | 15 | 0.4 | 95.9 | 9380 | - | < 0.1 | 26610 | < DL | 27210 | - | 1.7 | 65.6 | 1.1 | 13.7 | 5.5 |
| | | 5-Oct-13 | 8 | < DL | 50.4 | 11130 | - | < DL | 22220 | < DL | 21290 | - | < DL | 49.8 | 0.8 | 14.2 | 12.5 |
| | | 9-May-14 | 17 | < 0.08 | 106 | 11310 | O/R | < 0.5 | 38800 | < 35 | 23510 | - | < 0.5 | 76.6 | 2.7 | 9 | 11.7 |
| | | 12-Jul-14 | 11 | < 0.08 | 68.1 | - | - | < 0.5 | O/R | < 35 | - | - | < 2 | 55.5 | 0.7 | 15.8 | 9.7 |
| | | 29-Sep-14 | 4 | < 0.08 | 21.8 | - | - | < 0.5 | 27516.4 | < 35 | - | - | < 0.5 | 57.9 | 0.4 | 10 | 13 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Li* | *Be* | *B* | *Na* | *Mg* | *Al* | *Si* | *P* | *K* | *Ca* | *Ti* | *V* | *Cr* | *Mn* | *Fe* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BH4-5*** | ***20.0*** | 17-Jun-12 | 70 | < DL | 215 | 21260 | O/R | 4.4 | 22030 | < DL | 21420 | - | < DL | 166.9 | < 0.0179 | 61 | < 0.250 |
| | | 21-Jul-12 | 39 | < DL | 151.8 | - | - | 13.5 | 20000 | < DL | 0 | - | < DL | 108.5 | < 0.02 | 75.6 | 31.2 |
| | | 28-Oct-12 | 31 | < DL | 142.6 | - | - | 3.3 | 25890 | < DL | 0 | - | < 0.2 | 126 | 0.3 | 66.5 | 6.7 |
| | | Duplicate | 30 | < DL | 142.9 | - | - | 5.4 | 26410 | < DL | 0 | - | < 0.2 | 127.3 | 0.3 | 67.3 | 9.7 |
| | | 21-May-13 | 29 | < 0.02 | 142.7 | 16450 | O/R | < 0.04 | 38860 | < 3 | 26010 | - | < 0.2 | 141 | 0.5 | 40 | 5.1 |
| | | 29-Jul-13 | 12 | 5.5 | 75.7 | 18530 | - | 5.5 | 21540 | < DL | 24290 | - | 5.4 | 72.9 | 5.5 | 56.9 | 74.5 |
| | | 4-Sep-13 | 10 | < 0.02 | 78.1 | 1248 | - | < DL | 24170 | < DL | 27870 | - | 1.2 | 62.2 | 0.4 | 58.5 | 6.5 |
| | | 9-May-14 | 12 | < 0.08 | 96.4 | 18090 | O/R | < 0.5 | 35530 | < 35 | 23970 | - | < 2 | 90.7 | 0.7 | 33.1 | 9.3 |
| | | 29-Sep-14 | < 0.4 | < 0.08 | 10.8 | - | - | < 0.5 | 22031.9 | < 35 | - | - | < 2 | 38.9 | 0.2 | 38.3 | 23.5 |
| | ***25.0*** | 25-Jun-12 | 37 | < 0.0171 | 131.2 | 4892 | O/R | 4.2 | 12630 | < DL | 4206 | - | < DL | 31.4 | 2.6 | 8.7 | < 0.250 |
| | | 21-Jul-12 | 11 | < DL | < 1 | - | - | < DL | 12980 | < DL | - | - | < DL | 8.2 | < DL | 31.8 | 49.8 |
| | | 23-Sep-12 | 8 | < DL | < DL | - | - | < DL | 7921 | < DL | - | - | < DL | 2.1 | < DL | 54 | 21.9 |
| | | 28-Oct-12 | 9 | < 0.02 | 27.2 | - | - | < 0.1 | 7879 | < DL | - | - | < DL | 0.7 | < 0.02 | 71.9 | 15.4 |
| | | 21-May-13 | 10 | < 0.007 | 17.3 | 5105 | 49820 | < 0.04 | 8182 | < 3 | 4313 | - | < 0.05 | 0.6 | < 0.02 | 82.9 | 31.7 |
| | | 14-Jun-13 | 11 | < 0.007 | 12.4 | 5725 | 41540 | < 0.04 | 9291 | < 3 | 4451 | - | < 0.05 | 0.3 | < 0.007 | 86.3 | 26.8 |
| | | 27-Jul-13 | 10 | 0.3 | 11.3 | 4616 | - | < DL | 6611 | < DL | 3593 | - | 2 | 1.2 | 1.1 | 86.8 | 10.1 |
| | | 4-Sep-13 | 8 | 0.2 | 17 | 5087 | - | 3.1 | 6783 | < DL | 4718 | - | < 0.2 | 0.4 | 0.2 | 83.8 | 161 |
| | | 5-Oct-13 | 6 | < DL | 4 | 4907 | - | < DL | 5811 | < DL | 3797 | - | < DL | < 0.25 | < DL | 92.4 | 345.8 |
| | | 9-May-14 | 6 | < 0.08 | 7.8 | 5663 | O/R | < 0.5 | 6318 | < 35 | 4077 | - | < 0.5 | 0.2 | 0.4 | 91.8 | 13.9 |
| | | 12-Jun-14 | 9 | < 0.08 | 16.5 | 5718 | O/R | 6.7 | 6253 | < 35 | 4125 | O/R | < 2 | < 0.07 | 0.6 | 96.4 | 28.6 |
| | | 12-Jul-14 | 6 | < 0.08 | < 5.5 | - | - | < 0.5 | O/R | < 35 | - | - | < 0.5 | < 0.25 | < 0.3 | 95.7 | 14.2 |
| | | Duplicate | 5 | < 0.08 | < 5.5 | - | - | < 0.5 | O/R | < 35 | - | - | < 0.5 | < 0.25 | 0.2 | 94.2 | 10.9 |
| | | 29-Sep-14 | < 1.5 | < 0.08 | < 2 | - | - | < 0.5 | 5549.7 | < 35 | - | - | < 0.5 | 0.3 | 0.2 | 102.8 | 27.1 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *5.0* | 17-Jun-12 | < 0.0113 | 5.1 | 22.2 | 22.8 | 1.6 | - | 510.4 | 8.8 | 0.9 | < 0.00528 | < 0.0979 | 2 | 18 | 0.2 | 7.9 | 2.8 |
| | | Duplicate | < 0.0113 | 4.9 | 6.8 | < 0.268 | 1.4 | - | 523.8 | 8.5 | 0.8 | 0.2 | < 0.0979 | 2.1 | 18.3 | 0.2 | 0.8 | 2.8 |
| | | 21-Jul-12 | < DL | 3.9 | 37.1 | < 0.6 | 1.8 | - | 492.4 | 10.9 | < DL | < DL | < 0.2 | 1.7 | 22.6 | < 0.002 | 4.8 | 1.6 |
| | | 24-Sep-12 | < DL | 3.4 | 5.3 | < DL | 1.7 | - | 703.4 | 11 | < DL | < DL | < DL | 1.9 | 25.2 | < 0.002 | 2.7 | 2.1 |
| | | 28-Oct-12 | 0.1 | 3.1 | 15.8 | < 0.8 | 1.4 | - | 818.5 | 12.8 | < DL | < 0.005 | 2.6 | 1.6 | 25.3 | 0.1 | 1.1 | 2.9 |
| | | 21-May-13 | 0.1 | 3.9 | 1.6 | < 0.2 | 2.1 | - | 838.7 | 7.9 | < 0.004 | < 0.001 | < 0.1 | 1.2 | 15.2 | 0 | 0 | 4.4 |
| | | 14-Jun-13 | < 0.005 | 4.6 | 3.4 | < 0.2 | 0.8 | - | 616 | 6.1 | < 0.004 | < 0.001 | < 0.03 | 1.1 | 12.3 | 0 | < 0.0009 | 3 |
| | | 27-Jul-13 | 0.2 | 3.4 | 2 | < DL | 0.8 | < DL | 615.4 | 9.2 | < 0.01 | < 0.005 | < DL | 3.4 | 17.2 | 0 | < DL | 2 |
| | *10.0* | 14-Jun-13 | 0.8 | 3.3 | 1 | 38.8 | 1.6 | - | 710.1 | 63.6 | < 0.004 | 0 | 8 | 1.9 | 14.4 | 0 | 0 | 1.5 |
| | *15.0* | 17-Jun-12 | < 0.0113 | 7.2 | < 0.0711 | 81.6 | 2.6 | - | 939.2 | 12.6 | O/R | 0.4 | < 0.0979 | 5.5 | 17.6 | 1.3 | 0.5 | 1.3 |
| | | 21-Jul-12 | < DL | 7.7 | 7.3 | < 0.6 | < 0.03 | - | 970.6 | 4.3 | < DL | < DL | < 0.2 | 0.3 | 13.8 | < 0.002 | 3.5 | 1.2 |
| | | 24-Sep-12 | < DL | 2.6 | 9.4 | 32.3 | 1.6 | - | 1039 | 7.9 | < DL | < DL | < 0.2 | 0.8 | 14.2 | < 0.002 | 4.1 | 1 |
| | | Duplicate | < DL | 2.9 | < 0.07 | 31.5 | 1.6 | - | 968.3 | 7.2 | < DL | < DL | < 0.2 | 0.8 | 13.2 | < 0.002 | 2 | 0.9 |
| | | 28-Oct-12 | < 0.02 | 2.2 | 1.6 | 25.9 | 1.6 | - | 1102 | 8.7 | < DL | < DL | 2.1 | 0.2 | 13.6 | 0 | < 0.003 | 1.1 |
| | | 21-May-13 | 0.1 | 4.1 | < 0.05 | 33.1 | 4.3 | - | 1068 | 22.8 | < 0.004 | < 0.005 | 1.7 | 0.4 | 9.2 | 0 | 0.1 | 1.2 |
| | | 14-Jun-13 | < 0.02 | 4.7 | < 0.05 | 19.4 | 2.9 | - | 1148 | 12.5 | < 0.004 | < 0.001 | 1.6 | 0.7 | 13.3 | 0 | 0 | 1.1 |
| | | 27-Jul-13 | 0.3 | 5.3 | < DL | 11.1 | 1.5 | < DL | 1029 | 3.4 | < DL | 0.1 | 18.2 | 1.5 | 11.4 | 0.1 | < DL | 1.2 |
| | | 4-Sep-13 | 0.7 | 6.7 | 0.6 | 15.8 | 1.8 | 3.3 | 1045 | 5.1 | 0.4 | 0.4 | 3.4 | 1.7 | 11.9 | 0.4 | 0.6 | 1 |
| | | 5-Oct-13 | 0.2 | 9.2 | 4 | 17.2 | 1 | < DL | 1057 | 3.4 | 0.4 | < 0.05 | < 1.5 | 1.2 | 11.3 | 0 | 0.2 | 0.9 |
| | | 9-May-14 | 0.4 | 3.8 | < 0.5 | 52 | 2.1 | - | 1020 | 7.5 | < 0.05 | < 0.05 | 2.8 | 0.6 | 9.5 | 0 | 0 | 0.7 |
| | | 12-Jul-14 | 0.3 | 8.6 | 3.4 | 8.2 | 1.1 | < 2 | 1032 | 3.1 | 0.5 | < 0.05 | 7.1 | 0.2 | 8.7 | 0 | 0.1 | 1 |
| | | 29-Sep-14 | < 0.2 | 6.3 | < 0.5 | 10 | 0.8 | < 2 | 1008 | 4.3 | < 0.05 | < 0.02 | 1.2 | 0.3 | 9 | 0 | < 0.04 | 0.9 |

***Table B.7(Cont.): Pore-Water Geochemical Data: BH4-5***

| *Location* | *Depth (mBGS)* | *Sample Date* | *Co* | *Ni* | *Cu* | *Zn* | *As* | *Se* | *Sr* | *Mo* | *Ag* | *Cd* | *Sn* | *Sb* | *Ba* | *Tl* | *Pb* | *U* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *BH4-5* | *20.0* | 17-Jun-12 | 1.4 | 9.4 | 18.8 | 220.9 | 3.3 | - | 866.7 | 69.4 | 3.2 | < 0.00528 | 17.7 | 2.5 | 27.6 | 0.2 | 2.1 | 10.6 |
| | | 21-Jul-12 | 1.1 | 6.7 | 5.4 | 98.6 | 2.2 | - | 1097 | 34.7 | < DL | < 0.007 | < 0.2 | 0.6 | 26.3 | < 0.002 | 2.4 | 9.4 |
| | | 28-Oct-12 | 0.9 | 2.4 | 2.4 | 49.2 | 2.4 | - | 1202 | 22.6 | < DL | < 0.005 | 3.2 | 0.5 | 23.2 | 0.1 | 0 | 8.2 |
| | | Duplicate | 0.9 | 2.4 | 2.5 | 48 | 2.2 | - | 1201 | 23 | < DL | < 0.005 | 3 | 0.5 | 23.1 | 0.1 | 0.2 | 8.2 |
| | | 21-May-13 | 1 | 4.1 | 2.5 | 54.2 | 4 | - | 1180 | 25.3 | < 0.004 | < 0.005 | 3.7 | 2.6 | 16.2 | 0.1 | 0.9 | 7.5 |
| | | 29-Jul-13 | 6 | 8.7 | 5.7 | 28.2 | 6.1 | < 0.7 | 1222 | 16.2 | 3.7 | 5.8 | < 0.1 | 37.3 | 21.1 | 3.8 | 5.2 | 4.1 |
| | | 4-Sep-13 | 1 | 5.7 | 0.6 | 19.6 | 1.8 | 4.7 | 1266 | 11.6 | 0.2 | 0.2 | 4.7 | 2.5 | 15.4 | 0.2 | 0.3 | 4 |
| | | 9-May-14 | 0.9 | 4.3 | 0.8 | 30.9 | 2.2 | - | 1206 | 14.6 | < 0.05 | < 0.05 | 4.8 | 0.6 | 12.5 | 0 | 0 | 4.4 |
| | | 29-Sep-14 | 0.8 | 5.6 | < 0.5 | < 8.5 | 1.1 | < 7 | 1240 | 5.1 | < 0.15 | < 0.05 | 2.2 | 0.2 | 11.2 | 0 | < 0.01 | 2.8 |
| | *25.0* | 25-Jun-12 | 0.5 | 3.6 | 7.9 | 36.5 | 1.9 | - | 203.2 | 22.3 | 0.9 | < 0.00528 | < 0.0979 | 1.7 | 8.7 | 0.2 | 1.1 | 1.9 |
| | | 21-Jul-12 | < DL | < 0.04 | 33.6 | < 0.6 | < 0.03 | - | 188.6 | 3.1 | < DL | < DL | < DL | < DL | 22.3 | < DL | 3.6 | 1.6 |
| | | 23-Sep-12 | < DL | < DL | 14.9 | < DL | < 0.03 | - | 162.9 | 1.8 | 1.2 | < DL | < 0.2 | 3.6 | 22.1 | < DL | 10 | 1.1 |
| | | 28-Oct-12 | < 0.02 | 0.5 | 3.4 | 10.4 | < 0.03 | - | 204.4 | 1.1 | < DL | < 0.005 | < 0.1 | 0.6 | 26.3 | < 0.002 | 0.2 | 1.4 |
| | | 21-May-13 | < 0.02 | < 0.04 | 1.9 | < 0.2 | 0.4 | - | 217.5 | 1.4 | < 0.004 | < 0.001 | < 0.03 | 0.2 | 24.3 | < 0.0007 | 0.6 | 1.3 |
| | | 14-Jun-13 | < 0.005 | < 0.04 | < 0.05 | < 0.8 | 0.4 | - | 232 | 0.8 | < 0.004 | < 0.001 | < 0.03 | 0.4 | 24.7 | 0 | < 0.0009 | 1.2 |
| | | 27-Jul-13 | 0.3 | 0.6 | 0.6 | < DL | 1.5 | < DL | 223.3 | 2.4 | 0.8 | 0.2 | < DL | 2.8 | 27.1 | 0.4 | 1 | 1.1 |
| | | 4-Sep-13 | 0.3 | 0.4 | < 0.05 | 5.7 | 0.5 | < DL | 240.5 | 0.8 | 0.2 | 0.2 | 2.2 | 2.1 | 30.4 | 0.2 | 0.3 | 1.2 |
| | | 5-Oct-13 | < 0.2 | < 0.5 | < 0.5 | 5.7 | < 0.3 | < DL | 238.9 | 0.3 | < DL | < DL | < DL | 0.7 | 30.5 | < DL | 0 | 1.1 |
| | | 9-May-14 | < 0.05 | < 0.5 | 0.6 | < 8.5 | < 0.3 | - | 245.6 | 0.3 | < 0.05 | < 0.02 | 1.7 | 0.2 | 31.3 | < 0.03 | < 0.04 | 1.2 |
| | | 12-Jun-14 | < 0.05 | < 0.15 | 0.1 | 19.7 | 0.1 | < 2 | 267.5 | 0.3 | < 0.15 | < 0.02 | 3.5 | 0 | 30.3 | 0 | 0.1 | 1.3 |
| | | 12-Jul-14 | < 0.2 | < 0.5 | 0.9 | < 8.5 | < 0.3 | < 2 | 264.8 | 0.3 | < 0.15 | < 0.02 | 4.2 | 0.1 | 29.5 | < 0.007 | < 0.04 | 1.4 |
| | | Duplicate | < 0.2 | < 0.5 | 2.6 | < 8.5 | < 0.3 | < 2 | 258.6 | 0.3 | < 0.15 | < 0.02 | 5.9 | 0.1 | 29.3 | < 0.007 | 0 | 1.4 |
| | | 29-Sep-14 | 0.3 | 0.4 | 0.8 | 15 | < 0.1 | < 2 | 267.2 | 0.5 | < 0.15 | 0.1 | 1.1 | < 0.09 | 30 | 0.1 | < 0.04 | 1.6 |

***Table B.8: BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| Adularia | $KAlSi_3O_8$ | -2.7 | 0.3 | 0.7 | -1.3 | -0.8 | -0.8 |
| $Al(OH)_3(a)$ | $Al(OH)_3$ | -5.2 | -2.5 | -2.2 | -2.7 | -2.9 | -2.2 |
| $AlAsO_4:2H_2O$ | $AlAsO_4:2H_2O$ | -13.3 | -10.3 | -11.2 | -11.0 | -11.0 | -11.1 |
| Albite | $NaAlSi_3O_8$ | -4.7 | -1.6 | -1.3 | -3.3 | -2.6 | -2.9 |
| AlumK | $KAl(SO_4)_2:12H_2O$ | -22.2 | -21.5 | -23.0 | -19.0 | -17.3 | -18.7 |
| Alunite | $KAl_3(SO4)_2(OH)_6$ | -14.7 | -9.4 | -9.5 | -5.9 | -4.5 | -5.2 |
| Analcime | $NaAlSi_2O_6:H_2O$ | -6.5 | -3.6 | -3.2 | -4.8 | -4.4 | -4.5 |
| Anglesite | $PbSO_4$ | -7.1 | -8.2 | -5.4 | -6.7 | -5.6 | -6.3 |
| Anhydrite | $CaSO_4$ | -1.2 | -1.7 | -1.8 | -1.2 | -1.4 | -1.0 |
| Annite | $KFe_3AlSi_3O_{10}(OH)_2$ | -3.6 | -3.9 | -4.7 | -4.8 | -8.9 | -2.7 |
| Anorthite | $CaAl_2Si_2O_8$ | -8.3 | -2.8 | -0.9 | -4.1 | -3.9 | -3.0 |
| Antlerite | $Cu_3(OH)_4SO_4$ | -8.6 | -10.4 | -9.7 | -8.8 | -10.1 | -8.9 |
| Aragonite | $CaCO_3$ | 1.4 | 1.5 | - | 1.1 | 1.1 | 1.1 |
| Arsenolite | $As_2O_3$ | -36.7 | -42.0 | -46.8 | -40.0 | -47.0 | -41.5 |
| Artinite | $MgCO_3:Mg(OH)_2:3H_2O$ | -3.4 | -2.2 | - | -5.0 | -4.5 | -4.8 |
| $As_2O_5(cr)$ | $As_2O_5$ | -35.5 | -35.0 | -37.4 | -36.0 | -35.6 | -37.1 |
| As_native | As | -43.6 | -50.6 | -54.8 | -47.5 | -56.4 | -48.4 |
| Atacamite | $Cu_2(OH)_3Cl$ | -6.9 | -7.6 | -6.7 | -8.0 | -9.6 | -7.4 |
| Azurite | $Cu_3(OH)_2(CO_3)_2$ | -4.9 | -6.2 | - | -5.5 | -6.5 | -5.5 |
| $B\text{-}UO_2(OH)_2$ | $UO_2(OH)_2$ | -6.9 | -4.7 | -2.3 | -5.2 | -6.2 | -6.8 |
| $Ba_3(AsO_4)_2$ | $Ba_3(AsO_4)_2$ | 6.0 | 7.9 | 9.3 | 5.9 | 7.0 | 5.2 |
| $BaF_2$ | $BaF_2$ | -10.8 | -9.2 | -8.6 | -10.4 | -11.5 | -11.4 |
| Barite | $BaSO_4$ | -0.2 | -0.2 | -0.5 | 0.0 | 0.1 | 0.4 |
| Basaluminite | $Al_4(OH)_{10}SO_4$ | -18.9 | -10.4 | -8.9 | -7.3 | -6.5 | -6.4 |
| Beidellite | $(NaKMg_{0.5})_{0.11}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | -5.6 | 1.4 | 1.9 | -0.9 | -0.4 | 0.4 |
| Bianchite | $ZnSO_4:6H_2O$ | -10.8 | -9.5 | -7.1 | -8.6 | -7.9 | -9.1 |
| Birnessite | $MnO_2$ | -9.7 | -7.3 | -4.2 | -8.6 | -4.8 | -8.1 |
| Bixbyite | $Mn_2O_3$ | -7.3 | -5.4 | -0.4 | -6.7 | -2.7 | -5.8 |
| Boehmite | AlOOH | -3.0 | -0.3 | 0.0 | -0.4 | -0.7 | 0.0 |
| Brochantite | $Cu_4(OH)_6SO_4$ | -9.6 | -11.7 | -10.4 | -9.9 | -12.1 | -10.1 |
| Brucite | $Mg(OH)_2$ | -3.7 | -3.3 | -2.0 | -4.4 | -4.2 | -4.4 |
| Bunsenite | NiO | -6.1 | -5.4 | -2.9 | -5.7 | -6.3 | -6.5 |
| $Ca_3(AsO_4)_2:4w$ | $Ca3(AsO_4)_2:4H_2O$ | -11.3 | -11.7 | -9.3 | -12.5 | -11.9 | -13.6 |
| Calcite | $CaCO_3$ | 1.5 | 1.6 | - | 1.2 | 1.2 | 1.3 |
| $Cd(BO_2)_2$ | $Cd(BO_2)_2$ | -12.3 | -10.8 | -8.9 | -14.5 | -12.5 | -16.3 |
| Cd(gamma) | Cd | -32.5 | -36.6 | -34.5 | -34.4 | -37.3 | -32.7 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| $Cd(OH)_2$ | $Cd(OH)_2$ | -7.8 | -7.2 | -5.6 | -8.3 | -7.5 | -8.2 |
| $Cd(OH)_2$(a) | $Cd(OH)_2$ | -7.8 | -7.3 | -5.7 | -8.4 | -7.6 | -8.3 |
| $Cd_3(OH)_2(SO_4)_2$ | $Cd_3(OH)_2(SO_4)_2$ | -26.2 | -27.9 | -23.8 | -27.5 | -24.3 | -27.0 |
| $Cd_3(OH)_4SO_4$ | $Cd_3(OH)_4SO_4$ | -23.4 | -24.4 | -19.1 | -25.1 | -23.1 | -24.6 |
| $Cd_4(OH)_6SO_4$ | $Cd_4(OH)_6SO_4$ | -23.4 | -24.3 | -16.9 | -25.7 | -23.5 | -25.0 |
| $CdCl_2$ | $CdCl_2$ | -16.8 | -17.1 | -15.6 | -19.0 | -18.6 | -18.0 |
| $CdCl_2$:2.5$H_2O$ | $CdCl_2$:2.5$H_2O$ | -15.6 | -15.8 | -14.4 | -17.7 | -17.4 | -16.8 |
| $CdCl_2$:$H_2O$ | $CdCl_2$:$H_2O$ | -15.8 | -16.1 | -14.6 | -18.0 | -17.6 | -17.0 |
| $CdF_2$ | $CdF_2$ | -16.1 | -15.4 | -13.6 | -16.3 | -15.8 | -17.4 |
| CdMetal | Cd | -32.4 | -36.5 | -34.4 | -34.3 | -37.2 | -32.6 |
| CdOHCl | CdOHCl | -9.3 | -9.5 | -7.7 | -10.7 | -10.4 | -10.2 |
| $CdSiO_3$ | $CdSiO_3$ | -6.7 | -5.9 | -4.5 | -7.5 | -6.4 | -7.5 |
| $CdSO_4$ | $CdSO_4$ | -12.6 | -13.4 | -12.5 | -12.9 | -11.4 | -12.8 |
| $CdSO_4$:2.7$H_2O$ | $CdSO_4$:2.67$H_2O$ | -10.8 | -11.6 | -10.7 | -11.2 | -9.7 | -11.0 |
| $CdSO_4$:$H_2O$ | $CdSO_4$:$H_2O$ | -11.0 | -11.9 | -10.9 | -11.4 | -9.9 | -11.2 |
| Celestite | $SrSO_4$ | -2.0 | -2.4 | -2.7 | -2.0 | -2.2 | -1.9 |
| Cerrusite | $PbCO_3$ | -3.2 | -3.6 | - | -3.4 | -3.0 | -2.8 |
| Chalcanthite | $CuSO_4$:5$H_2O$ | -9.9 | -11.0 | -11.6 | -9.7 | -9.3 | -9.7 |
| Chalcedony | $SiO_2$ | 0.1 | 0.2 | 0.1 | -0.2 | 0.0 | -0.2 |
| Chlorite14A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -2.1 | 6.2 | 12.8 | -1.4 | 0.1 | -0.2 |
| Chlorite7A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -5.5 | 2.8 | 9.4 | -4.8 | -3.2 | -3.6 |
| Chrysotile | $Mg_3Si_2O_5(OH)_4$ | 0.1 | 1.9 | 5.5 | -2.6 | -1.3 | -2.4 |
| Claudetite | $As_2O_3$ | -36.7 | -42.0 | -46.8 | -40.1 | -47.0 | -41.5 |
| Clinoenstatite | $MgSiO_3$ | -1.7 | -1.1 | 0.1 | -2.7 | -2.2 | -2.6 |
| $CO_2$(g) | $CO_2$ | -1.9 | -2.0 | - | -1.9 | -2.0 | -1.9 |
| Coffinite | $USiO_4$ | -12.9 | -13.4 | -12.4 | -12.9 | -17.3 | -14.6 |
| Cotunnite | $PbCl_2$ | -14.9 | -15.4 | -12.2 | -16.4 | -16.4 | -14.7 |
| Cristobalite | $SiO_2$ | 0.1 | 0.3 | 0.2 | -0.2 | 0.1 | -0.1 |
| $Cu(OH)_2$ | $Cu(OH)_2$ | -2.6 | -2.1 | -2.3 | -2.7 | -3.0 | -2.7 |
| $Cu_2(OH)_3NO_3$ | $Cu_2(OH)_3NO_3$ | -8.3 | -9.1 | -8.2 | -9.7 | -11.1 | -9.2 |
| $Cu_2SO_4$ | $Cu_2SO_4$ | -23.8 | -30.8 | -29.3 | -25.7 | -27.6 | -25.2 |
| $Cu_3(AsO_4)_2$:6w | $Cu_3(AsO_4)_2$:6$H_2O$ | -16.1 | -14.4 | -17.1 | -17.0 | -17.5 | -18.2 |
| $CuCO_3$ | $CuCO_3$ | -4.3 | -4.8 | - | -4.5 | -4.9 | -4.5 |
| CuF | CuF | -23.2 | -25.9 | -24.7 | -24.0 | -25.5 | -24.5 |
| $CuF_2$ | $CuF_2$ | -18.3 | -17.8 | -17.6 | -18.0 | -18.6 | -19.3 |
| $CuF_2$:2$H_2O$ | $CuF_2$:2$H_2O$ | -14.4 | -13.9 | -13.6 | -14.0 | -14.7 | -15.4 |
| CuMetal | Cu | -7.2 | -9.7 | -11.0 | -8.7 | -12.7 | -8.9 |
| $CuOCuSO_4$ | CuO:$CuSO_4$ | -18.0 | -19.4 | -19.3 | -18.0 | -18.4 | -18.0 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| CupricFerrite | $CuFe_2O_4$ | 11.0 | 12.0 | 12.3 | 10.5 | 10.8 | 11.7 |
| Cuprite | $Cu_2O$ | -5.6 | -7.6 | -9.1 | -7.3 | -11.6 | -7.5 |
| CuprousFerrite | $CuFeO_2$ | 10.7 | 10.0 | 9.5 | 9.7 | 7.9 | 10.2 |
| $CuSO_4$ | $CuSO_4$ | -15.5 | -16.6 | -17.2 | -15.4 | -15.0 | -15.3 |
| Diaspore | AlOOH | -1.3 | 1.5 | 1.7 | 1.3 | 1.1 | 1.7 |
| Diopside | $CaMgSi_2O_6$ | -0.7 | -0.1 | 2.5 | -2.2 | -1.4 | -2.1 |
| Dioptase | $CuSiO_3{:}H_2O$ | -3.9 | -3.3 | -3.5 | -4.3 | -4.4 | -4.3 |
| Dolomite | $CaMg(CO_3)_2$ | 3.2 | 3.9 | - | 2.1 | 2.3 | 2.2 |
| Dolomite(d) | $CaMg(CO_3)_2$ | 2.7 | 3.3 | - | 1.6 | 1.8 | 1.7 |
| Epsomite | $MgSO_4{:}7H_2O$ | -3.4 | -3.4 | -3.6 | -3.9 | -4.1 | -3.7 |
| $Fe(OH)_{2.7}Cl_{.3}$ | $Fe(OH)_{2.7}Cl_{0.3}$ | 4.9 | 5.3 | 5.3 | 4.7 | 4.8 | 5.3 |
| $Fe(OH)_3(a)$ | $Fe(OH)_3$ | 0.5 | 0.8 | 1.0 | 0.3 | 0.6 | 0.9 |
| $Fe_3(OH)_8$ | $Fe_3(OH)_8$ | -3.5 | -3.9 | -3.9 | -4.6 | -5.6 | -2.9 |
| Fluorite | $CaF_2$ | -1.3 | -0.3 | 0.4 | -1.2 | -2.4 | -2.4 |
| Forsterite | $Mg_2SiO_4$ | -5.6 | -4.5 | -2.1 | -7.3 | -6.5 | -7.2 |
| Gibbsite | $Al(OH)_3$ | -2.5 | 0.2 | 0.5 | 0.0 | -0.2 | 0.5 |
| Goethite | FeOOH | 6.4 | 6.7 | 6.9 | 6.2 | 6.5 | 6.8 |
| Goslarite | $ZnSO_4{:}7H_2O$ | -10.7 | -9.3 | -6.9 | -8.4 | -7.7 | -8.9 |
| Greenalite | $Fe_3Si_2O_5(OH)_4$ | -9.8 | -12.7 | -14.1 | -13.0 | -17.0 | -11.3 |
| Gummite | $UO_3$ | -11.8 | -9.5 | -7.2 | -10.0 | -11.1 | -11.7 |
| Gypsum | $CaSO_4{:}2H_2O$ | -0.9 | -1.5 | -1.6 | -1.0 | -1.2 | -0.8 |
| H2(g) | $H_2$ | -24.8 | -27.6 | -28.9 | -26.2 | -29.8 | -26.4 |
| H2O(g) | $H_2O$ | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 |
| Halite | NaCl | -8.5 | -8.4 | -8.8 | -9.5 | -9.9 | -9.0 |
| Halloysite | $Al_2Si_2O_5(OH)_4$ | -8.3 | -2.4 | -2.1 | -3.8 | -3.7 | -2.8 |
| Hausmannite | $Mn_3O_4$ | -8.8 | -7.3 | -0.5 | -8.5 | -4.3 | -7.3 |
| Hematite | $Fe_2O_3$ | 14.8 | 15.4 | 15.8 | 14.4 | 15.0 | 15.6 |
| Huntite | $CaMg_3(CO_3)_4$ | 2.2 | 4.0 | - | -0.5 | 0.1 | -0.2 |
| Hydrocerrusite | $Pb(OH)_2{:}2PbCO_3$ | -11.4 | -12.6 | - | -12.0 | -10.8 | -10.4 |
| Hydromagnesite | $Mg_5(CO_3)_4(OH)_2{:}4H_2O$ | -5.8 | -2.9 | - | -9.9 | -8.7 | -9.4 |
| Illite | $K_{0.6}Mg_{0.25}Al_{2.3}Si_{3.5}O_{10}(OH)_2$ | -5.4 | 1.5 | 2.4 | -0.9 | -0.4 | 0.3 |
| Jarosite(ss) | $(K_{0.77}Na_{0.03}H_{0.2})Fe_3(SO_4)_2(OH)_6$ | -7.8 | -8.1 | -10.0 | -7.5 | -5.3 | -6.1 |
| Jarosite-K | $KFe_3(SO_4)_2(OH)_6$ | -7.6 | -7.9 | -9.8 | -7.3 | -5.3 | -6.0 |
| Jarosite-Na | $NaFe_3(SO_4)_2(OH)_6$ | -11.0 | -11.1 | -13.1 | -10.7 | -8.3 | -9.5 |
| JarositeH | $(H_3O)Fe_3(SO_4)_2(OH)_6$ | -15.7 | -15.9 | -18.0 | -15.1 | -12.3 | -13.7 |
| Jurbanite | $AlOHSO_4$ | -9.8 | -8.2 | -8.7 | -6.6 | -5.5 | -6.3 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| Kaolinite | $Al_2Si_2O_5(OH)_4$ | -3.2 | 2.6 | 3.0 | 1.3 | 1.4 | 2.3 |
| Kmica | $KAl_3Si_3O_{10}(OH)_2$ | -2.1 | 6.3 | 7.3 | 4.4 | 4.5 | 5.8 |
| Langite | $Cu_4(OH)_6SO_4:H_2O$ | -11.0 | -13.1 | -11.8 | -11.4 | -13.5 | -11.5 |
| Larnakite | $PbO:PbSO_4$ | -10.8 | -12.2 | -5.5 | -10.4 | -9.4 | -9.8 |
| Laumontite | $CaAl_2Si_4O_{12}:4H_2O$ | -4.1 | 1.9 | 3.6 | -0.4 | 0.3 | 0.8 |
| Laurionite | PbOHCl | -8.6 | -9.0 | -5.4 | -9.3 | -9.4 | -8.3 |
| Leonhardite | $Ca_2Al_4Si_8O_{24}:7H_2O$ | -0.3 | 11.6 | 15.0 | 7.0 | 8.4 | 9.3 |
| Litharge | PbO | -9.0 | -7.5 | -5.3 | -8.9 | -8.7 | -8.6 |
| Magadiite | $NaSi_7O_{13}(OH)_3:3H_2O$ | -5.4 | -4.2 | -4.6 | -7.7 | -5.7 | -7.5 |
| Maghemite | $Fe_2O_3$ | 4.4 | 5.0 | 5.5 | 4.1 | 4.6 | 5.2 |
| Magnesite | $MgCO_3$ | 1.1 | 1.7 | - | 0.3 | 0.5 | 0.4 |
| Magnetite | $Fe_3O_4$ | 13.0 | 12.6 | 12.6 | 11.9 | 10.9 | 13.6 |
| Malachite | $Cu_2(OH)_2CO_3$ | -2.7 | -3.5 | - | -3.1 | -3.7 | -3.1 |
| Manganite | MnOOH | -3.8 | -2.8 | -0.4 | -3.5 | -1.5 | -3.0 |
| Massicot | PbO | -9.2 | -7.7 | -5.5 | -9.1 | -8.9 | -8.8 |
| Matlockite | PbClF | -11.0 | -11.1 | -7.6 | -11.5 | -11.5 | -11.2 |
| Melanothallite | $CuCl_2$ | -21.0 | -21.6 | -21.7 | -22.7 | -23.5 | -21.4 |
| Melanterite | $FeSO_4:7H_2O$ | -10.4 | -13.5 | -13.9 | -11.0 | -10.4 | -10.2 |
| Minium | $Pb_3O_4$ | -37.7 | -30.4 | -22.7 | -36.1 | -31.8 | -35.0 |
| Mirabilite | $Na_2SO_4:10H_2O$ | -7.8 | -8.3 | -9.5 | -8.1 | -7.7 | -8.4 |
| $Mn_2(SO_4)_3$ | $Mn_2(SO_4)_3$ | -58.0 | -55.5 | -57.1 | -56.2 | -52.9 | -55.7 |
| $Mn_3(AsO_4)_2:8H_2O$ | $Mn_3(AsO_4)_2:8H_2O$ | -13.3 | -14.2 | -11.0 | -14.9 | -14.0 | -15.0 |
| $MnCl_2:4H_2O$ | $MnCl_2:4H_2O$ | -16.9 | -17.5 | -16.5 | -19.0 | -19.8 | -17.2 |
| $MnSO_4$ | $MnSO_4$ | -12.1 | -13.2 | -12.7 | -12.3 | -12.0 | -11.9 |
| Monteponite | CdO | -7.9 | -7.3 | -5.8 | -8.4 | -7.6 | -8.4 |
| Montmorillonite-A | $(HNaK)_{0.14}Mg_{0.45}Fe_{0.33}Al_{1.47}Si_{3.82}O_{10}(OH)_2$ | 0.2 | - | - | - | - | - |
| Montmorillonite-B | $(HNaK)_{0.09}Mg_{0.29}Fe_{0.24}Al_{1.57}Si_{3.93}O_{10}(OH)_2$ | 0.3 | - | - | - | - | - |
| Montmorillonite-C | $Ca_{0.165}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | -5.4 | - | - | - | - | - |
| Morenosite | $NiSO_4:7H_2O$ | -9.9 | -11.0 | -8.7 | -9.4 | -9.0 | -9.9 |
| $Na_4UO_2(CO_3)_3$ | $Na_4UO_2(CO_3)_3$ | -25.9 | -26.4 | - | -26.3 | -26.1 | -27.9 |
| Nahcolite | $NaHCO_3$ | -4.3 | -4.3 | - | -4.6 | -4.6 | -4.9 |
| Nantokite | CuCl | -8.5 | -11.7 | -10.7 | -10.4 | -11.9 | -9.5 |
| Natron | $Na_2CO_3:10H_2O$ | -9.1 | -8.9 | - | -9.6 | -9.4 | -10.1 |
| Nesquehonite | $MgCO_3:3H_2O$ | -1.3 | -0.8 | - | -2.1 | -1.9 | -2.0 |
| $Ni(OH)_2$ | $Ni(OH)_2$ | -4.5 | -3.7 | -1.3 | -4.0 | -4.6 | -4.8 |
| $Ni_2SiO_4$ | $Ni_2SiO_4$ | -5.4 | -3.7 | 1.1 | -4.8 | -5.7 | -6.3 |
| $Ni_3(AsO_4)_2:8H_2O$ | $Ni_3(AsO_4)_2:8H_2O$ | -25.0 | -22.2 | -17.3 | -24.1 | -25.5 | -27.7 |
| $Ni_4(OH)_6SO_4$ | $Ni_4(OH)_6SO_4$ | -25.3 | -27.2 | -14.5 | -24.3 | -26.3 | -26.4 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| $NiCO_3$ | $NiCO_3$ | -6.9 | -7.3 | - | -6.9 | -7.1 | -7.3 |
| Nsutite | $MnO_2$ | -8.6 | -6.2 | -3.1 | -7.6 | -3.8 | -7.1 |
| $O_2(g)$ | $O_2$ | -33.7 | -27.9 | -25.5 | -30.8 | -23.5 | -30.5 |
| Otavite | $CdCO_3$ | -2.0 | -2.2 | - | -2.6 | -1.9 | -2.6 |
| $Pb(BO_2)_2$ | $Pb(BO_2)_2$ | -12.2 | -9.7 | -7.3 | -13.9 | -12.4 | -14.7 |
| $Pb(OH)_2$ | $Pb(OH)_2$ | -4.4 | -2.9 | -0.8 | -4.4 | -4.1 | -4.0 |
| $Pb_2(OH)_3Cl$ | $Pb_2(OH)_3Cl$ | -13.0 | -13.7 | -6.2 | -13.7 | -13.9 | -12.5 |
| $Pb_2O(OH)_2$ | $PbO:Pb(OH)_2$ | -18.7 | -15.8 | -11.5 | -18.6 | -18.1 | -18.0 |
| $Pb_2O_3$ | $Pb_2O_3$ | -28.8 | -23.0 | -17.4 | -27.3 | -23.2 | -26.5 |
| $Pb_2OCO_3$ | $PbO:PbCO_3$ | -12.1 | -12.8 | - | -12.4 | -11.6 | -11.4 |
| $Pb_2SiO_4$ | $Pb_2SiO_4$ | -15.8 | -12.6 | -8.4 | -16.0 | -15.2 | -15.3 |
| $Pb_3(AsO_4)_2$ | $Pb_3(AsO_4)_2$ | -22.9 | -18.0 | -13.8 | -23.2 | -22.1 | -23.4 |
| $Pb_3O_2CO_3$ | $PbCO_3:2PbO$ | -19.9 | -20.9 | - | -20.4 | -19.1 | -18.8 |
| $Pb_3O_2SO_4$ | $PbSO_4:2PbO$ | -17.8 | -19.5 | -8.9 | -17.3 | -16.4 | -16.5 |
| $Pb_4(OH)_6SO_4$ | $Pb_4(OH)_6SO_4$ | -24.8 | -26.7 | -12.2 | -24.3 | -23.5 | -23.1 |
| $Pb_4O_3SO_4$ | $PbSO_4:3PbO$ | -25.8 | -27.7 | -13.2 | -25.3 | -24.5 | -24.1 |
| $PbF_2$ | $PbF_2$ | -13.8 | -13.3 | -9.7 | -13.3 | -13.2 | -14.3 |
| PbMetal | Pb | -25.3 | -26.7 | -25.8 | -26.7 | -30.1 | -26.5 |
| $PbO:0.3H_2O$ | $PbO:0.33H_2O$ | -9.2 | -7.8 | -5.6 | -9.2 | -9.0 | -8.9 |
| PbSiO3 | $PbSiO_3$ | -7.1 | -5.4 | -3.4 | -7.3 | -6.8 | -6.9 |
| Phillipsite | $Na_{0.5}K_{0.5}AlSi_3O_8:H_2O$ | -3.2 | -0.1 | 0.3 | -1.7 | -1.1 | -1.3 |
| Phlogopite | $KMg_3AlSi_3O_{10}(OH)_2$ | -4.6 | -0.2 | 4.0 | -5.3 | -4.0 | -4.7 |
| Phosgenite | $PbCl_2:PbCO_3$ | -16.1 | -17.1 | - | -18.2 | -17.0 | -15.7 |
| Plattnerite | $PbO_2$ | -20.8 | -16.5 | -13.1 | -19.3 | -15.4 | -18.8 |
| Portlandite | $Ca(OH)_2$ | -9.7 | -10.0 | -8.4 | -9.9 | -9.9 | -9.9 |
| Prehnite | $Ca_2Al_2Si_3O_{10}(OH)_2$ | -6.8 | -1.3 | 2.1 | -3.0 | -2.5 | -1.9 |
| Pyrochroite | $Mn(OH)_2$ | -6.0 | -6.5 | -4.6 | -6.4 | -6.2 | -6.1 |
| Pyrolusite | $MnO_2$ | -7.5 | -5.0 | -2.0 | -6.4 | -2.6 | -5.9 |
| Pyrophyllite | $Al_2Si_4O_{10}(OH)_2$ | 0.2 | 6.4 | 6.6 | 4.1 | 4.7 | 5.2 |
| Quartz | $SiO_2$ | 0.5 | 0.7 | 0.6 | 0.2 | 0.4 | 0.2 |
| Retgersite | $NiSO_4:6H_2O$ | -10.2 | -11.3 | -9.0 | -9.7 | -9.3 | -10.2 |
| Rhodochrosite | $MnCO_3$ | 0.3 | -0.2 | - | -0.3 | -0.1 | 0.2 |
| Rhodochrosite(d) | $MnCO_3$ | -0.5 | - | - | - | - | - |
| Rutherfordine | $UO_2CO_3$ | -6.9 | -7.8 | - | -6.5 | -6.4 | -6.9 |
| Schoepite | $UO_2(OH)_2:H_2O$ | -6.8 | -4.5 | -2.2 | -5.0 | -6.1 | -6.7 |
| Scorodite | $FeAsO_4:2H_2O$ | -9.1 | -8.5 | -9.5 | -9.5 | -9.0 | -9.5 |
| Sepiolite | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -0.1 | 1.5 | 3.7 | -2.3 | -1.1 | -2.1 |
| Sepiolite(d) | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -3.0 | -1.4 | 0.8 | -5.2 | -4.0 | -5.0 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| Siderite | $FeCO_3$ | -3.1 | -5.6 | - | -3.6 | -5.7 | -3.5 |
| Siderite(d)(3) | $FeCO_3$ | -3.6 | -6.1 | - | -4.0 | -6.1 | -4.0 |
| Silicagel | $SiO_2$ | -0.5 | -0.3 | -0.4 | -0.8 | -0.5 | -0.7 |
| $SiO_2$(a) | $SiO_2$ | -0.8 | -0.6 | -0.7 | -1.1 | -0.8 | -1.0 |
| Smithsonite | $ZnCO_3$ | -4.1 | -2.0 | - | -2.2 | -1.9 | -2.7 |
| $SrF_2$ | $SrF_2$ | -6.5 | -5.3 | -4.7 | -6.3 | -7.5 | -7.6 |
| Strontianite | $SrCO_3$ | -0.8 | -0.5 | - | -1.0 | -1.0 | -1.0 |
| Talc | $Mg_3Si_4O_{10}(OH)_2$ | 3.9 | 6.1 | 9.5 | 0.7 | 2.4 | 1.0 |
| Tenorite | CuO | -1.5 | -1.1 | -1.2 | -1.7 | -2.0 | -1.7 |
| Thenardite | $Na_2SO_4$ | -8.8 | -9.3 | -10.4 | -9.0 | -8.7 | -9.4 |
| Thermonatrite | $Na_2CO_3$:$H_2O$ | -10.5 | -10.4 | - | -11.0 | -10.9 | -11.5 |
| Tremolite | $Ca2Mg_5Si_8O_{22}(OH)_2$ | 7.1 | 10.5 | 19.1 | 0.8 | 4.3 | 1.4 |
| Trona | $NaHCO_3$:$Na_2CO_3$:$2H_2O$ | -14.5 | -14.3 | - | -15.2 | -15.1 | -16.0 |
| $U(OH)_2SO_4$ | $U(OH)_2SO_4$ | -32.5 | -39.5 | -34.0 | -32.8 | -33.3 | -33.3 |
| $U_3O_8$(c) | $U_3O_8$ | -22.2 | -18.4 | -12.6 | -18.5 | -25.3 | -23.6 |
| $U_4O_9$(c) | $U_4O_9$ | -40.2 | -39.9 | -34.2 | -37.5 | -52.7 | -44.6 |
| $UF_4$(c) | $UF_4$ | -48.5 | -53.1 | -47.1 | -48.1 | -49.5 | -51.3 |
| $UF_4$:$2.5H_2O$ | $UF_4$:$2.5H_2O$ | -39.5 | -44.1 | -38.2 | -39.1 | -40.5 | -42.3 |
| $UO_2$(a) | $UO_2$ | -17.2 | -17.8 | -16.7 | -16.9 | -21.6 | -18.7 |
| $UO_3$(gamma) | $UO_3$ | -9.1 | -6.8 | -4.5 | -7.3 | -8.4 | -9.0 |
| Uraninite(c) | $UO_2$ | -12.3 | -12.9 | -11.8 | -12.0 | -16.7 | -13.8 |
| Uranophane | $Ca(UO_2)_2(SiO_3OH)_2$ | -14.1 | -9.5 | -3.5 | -11.5 | -13.0 | -14.6 |
| Wairakite | $CaAl_2Si_4O_{12}$:$2H_2O$ | -8.3 | -2.4 | -0.7 | -4.7 | -4.0 | -3.5 |
| Willemite | $Zn_2SiO_4$ | -6.9 | -0.9 | 4.7 | -3.0 | -2.3 | -4.3 |
| Witherite | $BaCO_3$ | -3.0 | -2.4 | - | -3.0 | -2.8 | -2.8 |
| Zincite(c) | ZnO | -5.2 | -2.3 | 0.6 | -3.1 | -2.8 | -3.8 |
| Zincosite | $ZnSO_4$ | -15.6 | -14.2 | -11.9 | -13.4 | -12.7 | -13.9 |
| $Zn(BO_2)_2$ | $Zn(BO_2)_2$ | -10.7 | -6.7 | -3.6 | -10.3 | -8.8 | -12.1 |
| $Zn(NO_3)_2$:$6H_2O$ | $Zn(NO_3)_2$:$6H_2O$ | -19.9 | -18.1 | -15.1 | -20.1 | -20.1 | -19.6 |
| $Zn(OH)_2$-a | $Zn(OH)_2$ | -6.5 | -3.6 | -0.7 | -4.4 | -4.2 | -5.1 |
| $Zn(OH)_2$-b | $Zn(OH)_2$ | -5.8 | -2.9 | 0.0 | -3.7 | -3.5 | -4.4 |
| $Zn(OH)_2$-c | $Zn(OH)_2$ | -6.2 | -3.3 | -0.5 | -4.1 | -3.9 | -4.8 |
| $Zn(OH)_2$-e | $Zn(OH)_2$ | -5.5 | -2.6 | 0.2 | -3.4 | -3.2 | -4.1 |
| $Zn(OH)_2$-g | $Zn(OH)_2$ | -5.7 | -2.8 | 0.0 | -3.7 | -3.4 | -4.3 |
| $Zn_2(OH)_2SO_4$ | $Zn_2(OH)_2SO_4$ | -14.1 | -10.6 | -4.6 | -10.0 | -9.9 | -11.1 |

***Table B.8(Cont.): BH3-1 and BH3-2 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***3-1*** | | | ***3-2*** | | |
|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***4.2*** | ***9.2*** | ***14.2*** | ***5.0*** | ***10.0*** | ***15.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | |
| $Zn_2(OH)_3Cl$ | $Zn_2(OH)_3Cl$ | -14.9 | -10.7 | -3.9 | -11.9 | -12.9 | -12.4 |
| $Zn_3(AsO_4)_2$:2.5w | $Zn_3(AsO_4)_2$:2.5$H_2O$ | -24.0 | -14.8 | -8.6 | -18.3 | -17.2 | -21.4 |
| $Zn_3O(SO_4)_2$ | ZnO:2$ZnSO_4$ | -38.3 | -33.3 | -25.0 | -31.9 | -31.1 | -33.5 |
| $Zn_4(OH)_6SO_4$ | $Zn_4(OH)_6SO_4$ | -23.1 | -15.2 | -2.1 | -15.1 | -16.1 | -17.4 |
| $Zn_5(OH)_8Cl_2$ | $Zn_5(OH)_8Cl_2$ | -32.0 | -21.3 | -4.2 | -23.9 | -26.7 | -25.6 |
| $ZnCl_2$ | $ZnCl_2$ | -24.4 | -22.5 | -19.6 | -24.1 | -24.5 | -23.3 |
| $ZnCO_3$:$H_2O$ | $ZnCO_3$:$H_2O$ | -3.8 | -1.8 | - | -2.0 | -1.6 | -2.4 |
| $ZnF_2$ | $ZnF_2$ | -17.5 | -14.5 | -11.3 | -15.1 | -15.5 | -17.0 |
| ZnMetal | Zn | -44.5 | -44.5 | -42.9 | -43.9 | -47.3 | -44.7 |
| ZnO(a) | ZnO | -5.3 | -2.4 | 0.4 | -3.3 | -3.0 | -3.9 |
| $ZnSiO_3$ | $ZnSiO_3$ | -0.4 | 2.6 | 5.4 | 1.3 | 1.8 | 0.7 |
| $ZnSO_4$:$H_2O$ | $ZnSO_4$:$H_2O$ | -12.0 | -10.7 | -8.3 | -9.8 | -9.1 | -10.3 |

***Table B.9: BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| Adularia | $KAlSi_3O_8$ | 0.0 | -0.9 | -1.4 | -0.5 | -2.6 | -0.9 | 0.0 | 1.8 | -2.6 |
| $Al(OH)_3(a)$ | $Al(OH)_3$ | -3.0 | -3.4 | -3.3 | -3.3 | -3.3 | -4.1 | -3.4 | -2.4 | -3.3 |
| $AlAsO_4:2H_2O$ | $AlAsO_4:2H_2O$ | -11.6 | -12.4 | -13.1 | -11.9 | -12.3 | -12.7 | -12.3 | -11.2 | -12.1 |
| Albite | $NaAlSi_3O_8$ | -2.1 | -3.8 | -4.1 | -2.9 | -4.8 | -2.9 | -2.3 | -0.9 | -4.3 |
| AlumK | $KAl(SO_4)_2:12H_2O$ | -18.8 | -18.7 | -19.0 | -19.1 | -19.4 | -19.2 | -20.1 | -20.2 | -21.3 |
| Alunite | $KAl_3(SO4)_2(OH)_6$ | -6.7 | -7.7 | -7.5 | -7.9 | -8.1 | -9.6 | -9.4 | -6.9 | -10.4 |
| Analcime | $NaAlSi_2O_6:H_2O$ | -4.0 | -5.5 | -5.6 | -4.9 | -6.3 | -4.9 | -4.3 | -3.0 | -5.9 |
| Anglesite | $PbSO_4$ | -5.5 | -5.1 | -5.4 | -5.3 | -6.5 | -6.2 | -5.4 | -5.4 | -7.1 |
| Anhydrite | $CaSO_4$ | -0.8 | -0.3 | -0.3 | -0.4 | -1.2 | -0.3 | -0.5 | -1.1 | -1.8 |
| Annite | $KFe_3AlSi_3O_{10}(OH)_2$ | -5.9 | -5.9 | -6.7 | -5.0 | 0.6 | -2.5 | -3.1 | -0.8 | -1.5 |
| Anorthite | $CaAl_2Si_2O_8$ | -3.6 | -4.8 | -4.8 | -4.2 | -6.1 | -5.8 | -3.6 | -1.3 | -5.7 |
| Antlerite | $Cu_3(OH)_4SO_4$ | -8.0 | -8.4 | -8.3 | -7.6 | -12.5 | -8.1 | -11.8 | -5.7 | -10.7 |
| Aragonite | $CaCO_3$ | 0.4 | 0.5 | 0.4 | 0.6 | 0.7 | 0.4 | 1.0 | 0.6 | 0.8 |
| Arsenolite | $As_2O_3$ | -47.2 | -45.8 | -46.5 | -45.3 | -36.9 | -37.5 | -43.8 | -45.7 | -39.8 |
| Artinite | $MgCO_3:Mg(OH)_2:3H_2O$ | -5.7 | -4.8 | -4.8 | -4.8 | -5.8 | -4.7 | -3.6 | -4.7 | -5.3 |
| $As_2O_5(cr)$ | $As_2O_5$ | -36.5 | -37.3 | -38.6 | -36.6 | -36.8 | -36.5 | -37.1 | -36.9 | -36.8 |
| As_native | As | -56.0 | -53.6 | -53.6 | -53.6 | -42.8 | -43.9 | -51.3 | -53.8 | -46.6 |
| Atacamite | $Cu_2(OH)_3Cl$ | -7.3 | -7.7 | -7.5 | -6.8 | -9.8 | -7.4 | -9.1 | -4.5 | -8.1 |
| Azurite | $Cu_3(OH)_2(CO_3)_2$ | -6.5 | -7.7 | -7.7 | -6.2 | -9.0 | -7.1 | -8.5 | -4.1 | -6.5 |
| $B\text{-}UO_2(OH)_2$ | $UO_2(OH)_2$ | -4.7 | -4.9 | -4.6 | -4.9 | -6.4 | -5.5 | -4.8 | -3.2 | -7.1 |
| $Ba_3(AsO_4)_2$ | $Ba_3(AsO_4)_2$ | 4.3 | 2.5 | 1.9 | 4.2 | 3.2 | 2.8 | 5.9 | 7.4 | 4.2 |
| $BaF_2$ | $BaF_2$ | -10.8 | -11.8 | -12.2 | -10.7 | -11.7 | -10.7 | -10.1 | -8.4 | -11.6 |
| Barite | $BaSO_4$ | 0.0 | -0.1 | 0.0 | 0.2 | 0.2 | 0.0 | 0.2 | 0.1 | -0.3 |
| Basaluminite | $Al_4(OH)_{10}SO_4$ | -9.1 | -11.0 | -10.4 | -10.9 | -10.4 | -13.7 | -12.2 | -7.8 | -11.8 |
| Beidellite | $(NaKMg_{0.5})_{0.11}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | -0.1 | -1.9 | -2.4 | -0.9 | -2.6 | -2.4 | -0.7 | 2.2 | -2.2 |
| Bianchite | $ZnSO_4:6H_2O$ | -8.4 | -7.7 | -8.3 | -8.4 | -9.7 | -7.9 | -7.5 | -7.1 | -10.2 |
| Birnessite | $MnO_2$ | -5.7 | -6.7 | -7.3 | -6.5 | -10.7 | -10.5 | -7.0 | -5.8 | -8.5 |
| Bixbyite | $Mn_2O_3$ | -4.2 | -4.9 | -5.9 | -4.7 | -8.8 | -8.9 | -4.7 | -3.3 | -6.0 |
| Boehmite | AlOOH | -0.7 | -1.2 | -1.1 | -1.1 | -1.1 | -1.9 | -1.1 | -0.2 | -1.1 |
| Brochantite | $Cu_4(OH)_6SO_4$ | -8.9 | -9.6 | -9.3 | -8.5 | -15.0 | -9.2 | -13.8 | -5.5 | -12.4 |
| Brucite | $Mg(OH)_2$ | -4.3 | -3.9 | -3.8 | -4.0 | -5.0 | -3.9 | -3.2 | -3.5 | -4.7 |
| Bunsenite | NiO | -4.8 | -4.8 | -5.8 | -6.0 | -8.0 | -4.5 | -5.2 | -3.1 | -8.1 |
| $Ca_3(AsO_4)_2:4w$ | $Ca3(AsO_4)_2:4H_2O$ | -12.3 | -12.6 | -13.4 | -12.1 | -15.7 | -12.4 | -10.5 | -10.4 | -14.7 |
| Calcite | $CaCO_3$ | 0.5 | 0.6 | 0.5 | 0.7 | 0.9 | 0.6 | 1.2 | 0.8 | 0.9 |
| $Cd(BO_2)_2$ | $Cd(BO_2)_2$ | -13.8 | -15.3 | -15.8 | -14.7 | -16.9 | -15.5 | -13.1 | -11.8 | -16.6 |
| Cd(gamma) | Cd | -37.4 | -37.0 | -35.5 | -37.0 | -33.0 | -33.6 | -34.7 | -35.7 | -33.5 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| $Cd(OH)_2$ | $Cd(OH)_2$ | -8.0 | -8.5 | -8.8 | -8.2 | -8.9 | -9.0 | -7.3 | -7.2 | -8.4 |
| $Cd(OH)_2$(a) | $Cd(OH)_2$ | -8.0 | -8.5 | -8.9 | -8.3 | -9.0 | -9.1 | -7.4 | -7.3 | -8.5 |
| $Cd_3(OH)_2(SO_4)_2$ | $Cd_3(OH)_2(SO_4)_2$ | -24.7 | -26.8 | -27.3 | -25.7 | -28.3 | -28.2 | -26.6 | -22.1 | -28.2 |
| $Cd_3(OH)_4SO_4$ | $Cd_3(OH)_4SO_4$ | -22.5 | -24.8 | -25.4 | -23.5 | -26.3 | -26.3 | -23.8 | -18.8 | -25.5 |
| $Cd_4(OH)_6SO_4$ | $Cd_4(OH)_6SO_4$ | -22.2 | -25.5 | -26.3 | -23.7 | -27.4 | -27.4 | -23.9 | -17.0 | -26.1 |
| $CdCl_2$ | $CdCl_2$ | -17.6 | -18.4 | -18.4 | -17.9 | -17.7 | -18.6 | -17.2 | -14.9 | -17.4 |
| $CdCl_2$:2.5$H_2O$ | $CdCl_2$:2.5$H_2O$ | -16.4 | -17.1 | -17.1 | -16.6 | -16.4 | -17.4 | -16.0 | -13.6 | -16.1 |
| $CdCl_2$:$H_2O$ | $CdCl_2$:$H_2O$ | -16.6 | -17.3 | -17.4 | -16.9 | -16.6 | -17.6 | -16.2 | -13.9 | -16.3 |
| $CdF_2$ | $CdF_2$ | -15.6 | -17.4 | -18.2 | -16.4 | -18.2 | -16.6 | -16.0 | -12.9 | -17.4 |
| CdMetal | Cd | -37.3 | -36.9 | -35.4 | -36.9 | -32.9 | -33.5 | -34.6 | -35.6 | -33.4 |
| CdOHCl | CdOHCl | -9.6 | -10.4 | -10.6 | -10.0 | -10.3 | -10.8 | -9.6 | -7.5 | -9.9 |
| $CdSiO_3$ | $CdSiO_3$ | -6.8 | -7.6 | -8.2 | -7.0 | -8.2 | -7.7 | -6.1 | -5.8 | -7.6 |
| $CdSO_4$ | $CdSO_4$ | -11.9 | -12.5 | -12.7 | -12.2 | -13.1 | -13.0 | -12.7 | -11.4 | -13.3 |
| $CdSO_4$:2.7$H_2O$ | $CdSO_4$:2.67$H_2O$ | -10.1 | -10.8 | -10.9 | -10.5 | -11.3 | -11.2 | -11.0 | -9.6 | -11.5 |
| $CdSO_4$:$H_2O$ | $CdSO_4$:$H_2O$ | -10.4 | -11.0 | -11.1 | -10.7 | -11.5 | -11.4 | -11.2 | -9.9 | -11.7 |
| Celestite | $SrSO_4$ | -1.5 | -1.0 | -1.1 | -1.3 | -2.1 | -1.1 | -1.3 | -2.0 | -2.5 |
| Cerrusite | $PbCO_3$ | -3.0 | -2.9 | -3.3 | -2.8 | -3.3 | -4.1 | -2.8 | -2.3 | -3.1 |
| Chalcanthite | $CuSO_4$:5$H_2O$ | -9.3 | -9.4 | -9.5 | -9.1 | -10.5 | -9.1 | -10.9 | -9.3 | -10.6 |
| Chalcedony | $SiO_2$ | 0.1 | -0.1 | -0.3 | 0.2 | -0.3 | 0.2 | 0.2 | 0.4 | -0.1 |
| Chlorite14A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -0.1 | 0.3 | 0.7 | 0.7 | -5.6 | -0.1 | 4.8 | 5.8 | -4.4 |
| Chlorite7A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -3.5 | -3.1 | -2.7 | -2.7 | -8.9 | -3.5 | 1.4 | 2.4 | -7.8 |
| Chrysotile | $Mg_3Si_2O_5(OH)_4$ | -1.3 | -0.7 | -0.6 | -0.3 | -4.5 | 0.0 | 2.1 | 1.6 | -3.2 |
| Claudetite | $As_2O_3$ | -47.2 | -45.8 | -46.6 | -45.4 | -36.9 | -37.5 | -43.9 | -45.7 | -39.9 |
| Clinoenstatite | $MgSiO_3$ | -2.2 | -2.1 | -2.1 | -1.8 | -3.4 | -1.7 | -1.0 | -1.1 | -2.9 |
| $CO_2$(g) | $CO_2$ | -2.8 | -3.1 | -3.2 | -2.8 | -1.5 | -2.8 | -3.0 | -3.2 | -1.8 |
| Coffinite | $USiO_4$ | -15.3 | -14.6 | -14.3 | -14.5 | -12.2 | -11.2 | -13.4 | -12.6 | -14.1 |
| Cotunnite | $PbCl_2$ | -14.8 | -14.5 | -14.8 | -14.2 | -14.7 | -15.5 | -13.5 | -12.5 | -14.9 |
| Cristobalite | $SiO_2$ | 0.2 | -0.1 | -0.2 | 0.2 | -0.2 | 0.3 | 0.2 | 0.4 | -0.1 |
| $Cu(OH)_2$ | $Cu(OH)_2$ | -2.4 | -2.7 | -2.6 | -2.4 | -4.1 | -2.7 | -3.0 | -1.3 | -3.1 |
| $Cu_2(OH)_3NO_3$ | $Cu_2(OH)_3NO_3$ | -8.2 | -10.4 | -10.1 | -9.2 | -12.8 | -9.7 | -11.2 | -6.0 | -11.3 |
| $Cu_2SO_4$ | $Cu_2SO_4$ | -27.4 | -26.8 | -27.1 | -26.7 | -25.5 | -23.0 | -27.0 | -28.4 | -26.0 |
| $Cu_3(AsO_4)_2$:6w | $Cu_3(AsO_4)_2$:6$H_2O$ | -16.8 | -18.4 | -19.4 | -16.7 | -22.0 | -17.4 | -18.9 | -13.6 | -19.8 |
| $CuCO_3$ | $CuCO_3$ | -5.2 | -5.6 | -5.7 | -5.0 | -5.5 | -5.4 | -5.9 | -4.5 | -4.8 |
| CuF | CuF | -25.0 | -25.2 | -25.6 | -24.8 | -24.7 | -22.8 | -24.6 | -24.4 | -24.5 |
| $CuF_2$ | $CuF_2$ | -17.9 | -18.9 | -19.6 | -17.9 | -20.3 | -17.6 | -19.1 | -15.6 | -19.7 |
| $CuF_2$:2$H_2O$ | $CuF_2$:2$H_2O$ | -14.0 | -15.0 | -15.6 | -13.9 | -16.4 | -13.7 | -15.1 | -11.7 | -15.8 |
| CuMetal | Cu | -11.8 | -10.7 | -10.5 | -10.5 | -8.2 | -7.2 | -9.6 | -9.7 | -8.9 |
| $CuOCuSO_4$ | CuO:$CuSO_4$ | -17.4 | -17.6 | -17.6 | -17.1 | -20.2 | -17.3 | -20.1 | -16.2 | -19.4 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| CupricFerrite | $CuFe_2O_4$ | 12.4 | 11.3 | 10.9 | 12.6 | 12.2 | 10.3 | 11.8 | 14.9 | 11.8 |
| Cuprite | $Cu_2O$ | -10.1 | -9.3 | -9.0 | -8.7 | -8.2 | -5.7 | -8.4 | -6.8 | -7.9 |
| CuprousFerrite | $CuFeO_2$ | 9.2 | 9.1 | 9.1 | 9.9 | 10.8 | 10.4 | 9.9 | 11.4 | 10.3 |
| $CuSO_4$ | $CuSO_4$ | -15.0 | -15.0 | -15.2 | -14.8 | -16.2 | -14.8 | -16.6 | -14.9 | -16.2 |
| Diaspore | AlOOH | 1.0 | 0.5 | 0.6 | 0.6 | 0.6 | -0.2 | 0.6 | 1.5 | 0.6 |
| Diopside | $CaMgSi_2O_6$ | -1.0 | -1.0 | -1.1 | -0.6 | -3.7 | -0.5 | 1.0 | 1.0 | -2.8 |
| Dioptase | $CuSiO_3{:}H_2O$ | -3.7 | -4.2 | -4.2 | -3.7 | -5.8 | -3.8 | -4.2 | -2.3 | -4.7 |
| Dolomite | $CaMg(CO_3)_2$ | 0.6 | 1.1 | 0.9 | 1.3 | 1.6 | 1.2 | 2.3 | 1.2 | 1.7 |
| Dolomite(d) | $CaMg(CO_3)_2$ | 0.1 | 0.5 | 0.3 | 0.7 | 1.0 | 0.6 | 1.7 | 0.6 | 1.2 |
| Epsomite | $MgSO_4{:}7H_2O$ | -3.5 | -2.9 | -2.9 | -3.0 | -3.8 | -2.6 | -3.0 | -3.9 | -4.3 |
| $Fe(OH)_{2.7}Cl_{.3}$ | $Fe(OH)_{2.7}Cl_{0.3}$ | 5.3 | 5.1 | 4.8 | 5.3 | 6.4 | 4.5 | 5.5 | 6.3 | 5.7 |
| $Fe(OH)_3(a)$ | $Fe(OH)_3$ | 1.2 | 0.8 | 0.5 | 0.9 | 1.9 | 0.2 | 1.1 | 1.8 | 1.3 |
| $Fe_3(OH)_8$ | $Fe_3(OH)_8$ | -3.8 | -4.3 | -5.1 | -3.9 | 1.0 | -4.3 | -3.0 | -1.4 | -1.5 |
| Fluorite | $CaF_2$ | -1.1 | -1.6 | -2.1 | -0.9 | -2.8 | -0.6 | -0.4 | 0.8 | -2.7 |
| Forsterite | $Mg_2SiO_4$ | -6.6 | -6.1 | -6.0 | -5.9 | -8.5 | -5.7 | -4.3 | -4.7 | -7.8 |
| Gibbsite | $Al(OH)_3$ | -0.3 | -0.7 | -0.6 | -0.6 | -0.6 | -1.4 | -0.7 | 0.3 | -0.6 |
| Goethite | FeOOH | 7.1 | 6.7 | 6.4 | 6.8 | 7.8 | 6.1 | 7.0 | 7.7 | 7.2 |
| Goslarite | $ZnSO_4{:}7H_2O$ | -8.2 | -7.5 | -8.1 | -8.2 | -9.5 | -7.7 | -7.3 | -6.9 | -10.1 |
| Greenalite | $Fe_3Si_2O_5(OH)_4$ | -14.6 | -14.5 | -15.4 | -13.8 | -5.4 | -10.1 | -11.8 | -10.9 | -9.1 |
| Gummite | $UO_3$ | -9.6 | -9.7 | -9.5 | -9.7 | -11.2 | -10.3 | -9.6 | -8.0 | -11.9 |
| Gypsum | $CaSO_4{:}2H_2O$ | -0.5 | -0.1 | -0.1 | -0.2 | -1.0 | -0.1 | -0.3 | -0.9 | -1.6 |
| H2(g) | $H_2$ | -29.5 | -28.4 | -28.1 | -28.5 | -24.2 | -24.6 | -27.5 | -28.5 | -25.7 |
| H2O(g) | $H_2O$ | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 |
| Halite | NaCl | -8.8 | -9.4 | -9.3 | -9.1 | -9.3 | -8.6 | -8.5 | -8.4 | -9.2 |
| Halloysite | $Al_2Si_2O_5(OH)_4$ | -3.6 | -4.9 | -5.2 | -4.3 | -5.1 | -5.7 | -4.3 | -2.1 | -4.9 |
| Hausmannite | $Mn_3O_4$ | -6.4 | -6.9 | -8.4 | -6.7 | -10.8 | -11.2 | -6.3 | -4.6 | -7.3 |
| Hematite | $Fe_2O_3$ | 16.1 | 15.4 | 14.8 | 15.7 | 17.6 | 14.2 | 16.0 | 17.4 | 16.4 |
| Huntite | $CaMg_3(CO_3)_4$ | -3.5 | -2.5 | -2.8 | -1.9 | -1.3 | -2.0 | 0.1 | -2.4 | -1.1 |
| Hydrocerrusite | $Pb(OH)_2{:}2PbCO_3$ | -10.1 | -9.5 | -10.5 | -9.5 | -12.1 | -13.4 | -9.1 | -7.4 | -11.1 |
| Hydromagnesite | $Mg_5(CO_3)_4(OH)_2{:}4H_2O$ | -12.9 | -11.0 | -11.3 | -10.6 | -11.1 | -10.4 | -7.8 | -11.0 | -10.4 |
| Illite | $K_{0.6}Mg_{0.25}Al_{2.3}Si_{3.5}O_{10}(OH)_2$ | 0.1 | -1.5 | -2.0 | -0.7 | -2.9 | -2.2 | -0.2 | 2.7 | -2.7 |
| Jarosite(ss) | $(K_{0.77}Na_{0.03}H_{0.2})Fe_3(SO_4)_2(OH)_6$ | -5.1 | -5.3 | -6.6 | -5.3 | -2.5 | -6.9 | -5.6 | -4.7 | -6.5 |
| Jarosite-K | $KFe_3(SO_4)_2(OH)_6$ | -4.9 | -4.9 | -6.3 | -5.0 | -2.4 | -6.6 | -5.3 | -4.5 | -6.5 |
| Jarosite-Na | $NaFe_3(SO_4)_2(OH)_6$ | -8.2 | -9.2 | -10.4 | -8.9 | -6.0 | -10.0 | -9.0 | -8.0 | -9.6 |
| JarositeH | $(H_3O)Fe_3(SO_4)_2(OH)_6$ | -13.0 | -13.4 | -14.8 | -13.2 | -9.6 | -14.8 | -13.8 | -12.7 | -13.5 |
| Jurbanite | $AlOHSO_4$ | -6.9 | -7.3 | -7.3 | -7.3 | -7.0 | -7.8 | -8.1 | -7.4 | -7.9 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| Kaolinite | $Al_2Si_2O_5(OH)_4$ | 1.4 | 0.1 | -0.1 | 0.8 | 0.0 | -0.7 | 0.7 | 3.0 | 0.1 |
| Kmica | $KAl_3Si_3O_{10}(OH)_2$ | 5.1 | 3.3 | 2.9 | 3.9 | 1.8 | 1.9 | 4.3 | 8.0 | 1.7 |
| Langite | $Cu_4(OH)_6SO_4{:}H_2O$ | -10.4 | -11.0 | -10.8 | -9.9 | -16.5 | -10.6 | -15.2 | -7.0 | -13.8 |
| Larnakite | $PbO{:}PbSO_4$ | -8.3 | -7.5 | -8.0 | -7.8 | -10.6 | -10.0 | -7.5 | -7.0 | -11.0 |
| Laumontite | $CaAl_2Si_4O_{12}{:}4H_2O$ | 0.8 | -0.8 | -1.2 | 0.2 | -2.5 | -1.2 | 1.0 | 3.6 | -1.9 |
| Laurionite | PbOHCl | -8.1 | -7.7 | -7.9 | -7.6 | -8.7 | -8.9 | -7.1 | -6.3 | -8.6 |
| Leonhardite | $Ca_2Al_4Si_8O_{24}{:}7H_2O$ | 9.4 | 6.3 | 5.5 | 8.3 | 2.9 | 5.5 | 9.8 | 15.0 | 4.1 |
| Litharge | PbO | -7.5 | -7.6 | -7.8 | -7.7 | -9.3 | -9.0 | -7.3 | -5.1 | -8.9 |
| Magadiite | $NaSi_7O_{13}(OH)_3{:}3H_2O$ | -4.6 | -6.9 | -8.1 | -5.0 | -8.7 | -3.9 | -4.2 | -3.1 | -7.6 |
| Maghemite | $Fe_2O_3$ | 5.7 | 5.0 | 4.4 | 5.3 | 7.2 | 3.8 | 5.6 | 7.0 | 6.0 |
| Magnesite | $MgCO_3$ | -0.5 | -0.2 | -0.2 | 0.0 | 0.1 | 0.0 | 0.5 | -0.2 | 0.2 |
| Magnetite | $Fe_3O_4$ | 12.7 | 12.2 | 11.4 | 12.5 | 17.5 | 12.2 | 13.5 | 15.1 | 15.0 |
| Malachite | $Cu_2(OH)_2CO_3$ | -3.5 | -4.1 | -4.1 | -3.3 | -5.6 | -3.8 | -4.8 | -1.7 | -3.8 |
| Manganite | MnOOH | -2.2 | -2.6 | -3.1 | -2.5 | -4.6 | -4.6 | -2.5 | -1.8 | -3.1 |
| Massicot | PbO | -7.7 | -7.8 | -8.0 | -7.9 | -9.5 | -9.2 | -7.4 | -5.3 | -9.1 |
| Matlockite | PbClF | -10.3 | -10.5 | -11.0 | -9.9 | -11.4 | -11.0 | -9.4 | -8.0 | -11.4 |
| Melanothallite | $CuCl_2$ | -22.0 | -22.2 | -22.2 | -21.4 | -22.2 | -21.7 | -22.4 | -19.7 | -21.7 |
| Melanterite | $FeSO_4{:}7H_2O$ | -11.4 | -11.2 | -11.8 | -11.4 | -7.8 | -9.8 | -10.3 | -12.7 | -10.0 |
| Minium | $Pb_3O_4$ | -28.7 | -30.1 | -30.8 | -30.2 | -39.3 | -37.9 | -29.8 | -22.3 | -36.8 |
| Mirabilite | $Na_2SO_4{:}10H_2O$ | -7.1 | -8.2 | -8.1 | -8.1 | -9.0 | -6.7 | -7.7 | -8.4 | -9.5 |
| $Mn_2(SO_4)_3$ | $Mn_2(SO_4)_3$ | -54.0 | -53.7 | -54.8 | -53.2 | -56.8 | -57.1 | -57.0 | -53.5 | -56.9 |
| $Mn_3(AsO_4)_2{:}8H_2O$ | $Mn_3(AsO_4)_2{:}8H_2O$ | -16.7 | -16.9 | -19.4 | -16.1 | -16.1 | -16.6 | -15.1 | -14.3 | -14.2 |
| $MnCl_2{:}4H_2O$ | $MnCl_2{:}4H_2O$ | -18.8 | -18.5 | -18.9 | -18.0 | -17.0 | -18.3 | -17.3 | -16.9 | -16.6 |
| $MnSO_4$ | $MnSO_4$ | -12.5 | -12.1 | -12.6 | -12.0 | -11.7 | -12.0 | -12.2 | -12.8 | -11.9 |
| Monteponite | CdO | -8.1 | -8.6 | -9.0 | -8.3 | -9.1 | -9.1 | -7.4 | -7.3 | -8.6 |
| Montmorillonite-A | $(HNaK)_{0.14}Mg_{0.45}Fe_{0.33}Al_{1.47}Si_{3.82}O_{10}(OH)_2$ | 3.8 | 2.3 | 1.8 | 3.4 | 1.4 | 2.4 | 4.0 | 6.2 | 1.7 |
| Montmorillonite-B | $(HNaK)_{0.09}Mg_{0.29}Fe_{0.24}Al_{1.57}Si_{3.93}O_{10}(OH)_2$ | 4.2 | 2.6 | 2.0 | 3.7 | 1.8 | 2.6 | 4.1 | 6.4 | 2.2 |
| Montmorillonite-C | $Ca_{0.165}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | 0.1 | -1.7 | -2.1 | -0.6 | -2.3 | -2.2 | -0.5 | 2.4 | -1.9 |
| Morenosite | $NiSO_4{:}7H_2O$ | -8.6 | -7.9 | -9.0 | -9.2 | -10.8 | -7.4 | -9.0 | -8.7 | -11.7 |
| $Na_4UO_2(CO_3)_3$ | $Na_4UO_2(CO_3)_3$ | -26.7 | -29.3 | -29.1 | -28.2 | -28.7 | -26.7 | -27.0 | -27.7 | -29.1 |
| Nahcolite | $NaHCO_3$ | -5.1 | -6.0 | -6.0 | -5.7 | -5.0 | -5.1 | -5.3 | -5.7 | -5.1 |
| Nantokite | CuCl | -11.1 | -10.8 | -10.9 | -10.5 | -9.6 | -8.9 | -10.3 | -10.4 | -9.5 |
| Natron | $Na_2CO_3{:}10H_2O$ | -9.7 | -11.1 | -11.2 | -10.8 | -10.8 | -9.7 | -10.0 | -10.4 | -10.7 |
| Nesquehonite | $MgCO_3{:}3H_2O$ | -2.9 | -2.6 | -2.7 | -2.4 | -2.3 | -2.4 | -1.9 | -2.6 | -2.2 |
| $Ni(OH)_2$ | $Ni(OH)_2$ | -3.2 | -3.1 | -4.1 | -4.4 | -6.3 | -2.9 | -3.5 | -1.4 | -6.4 |
| $Ni_2SiO_4$ | $Ni_2SiO_4$ | -2.7 | -2.8 | -5.0 | -5.1 | -9.4 | -2.0 | -3.3 | 1.0 | -9.5 |
| $Ni_3(AsO_4)_2{:}8H_2O$ | $Ni_3(AsO_4)_2{:}8H_2O$ | -22.1 | -22.8 | -27.0 | -25.8 | -31.6 | -21.1 | -23.7 | -17.3 | -31.8 |
| $Ni_4(OH)_6SO_4$ | $Ni_4(OH)_6SO_4$ | -21.5 | -19.2 | -23.1 | -24.2 | -31.8 | -18.0 | -21.8 | -19.0 | -32.7 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| $NiCO_3$ | $NiCO_3$ | -6.9 | -6.7 | -7.8 | -7.7 | -8.5 | -6.2 | -7.3 | -6.5 | -8.7 |
| Nsutite | $MnO_2$ | -4.7 | -5.6 | -6.3 | -5.4 | -9.7 | -9.5 | -6.0 | -4.7 | -7.5 |
| $O_2(g)$ | $O_2$ | -24.2 | -26.4 | -26.9 | -26.2 | -34.8 | -33.9 | -28.2 | -26.1 | -31.7 |
| Otavite | $CdCO_3$ | -2.7 | -3.7 | -4.2 | -3.5 | -2.9 | -4.2 | -2.8 | -1.6 | -2.7 |
| $Pb(BO_2)_2$ | $Pb(BO_2)_2$ | -12.0 | -13.0 | -13.2 | -12.8 | -16.5 | -14.3 | -11.7 | -8.5 | -16.4 |
| $Pb(OH)_2$ | $Pb(OH)_2$ | -3.0 | -3.1 | -3.2 | -3.2 | -4.7 | -4.4 | -2.7 | -0.6 | -4.4 |
| $Pb_2(OH)_3Cl$ | $Pb_2(OH)_3Cl$ | -11.5 | -10.8 | -11.2 | -10.8 | -13.4 | -13.4 | -9.8 | -8.5 | -13.1 |
| $Pb_2O(OH)_2$ | $PbO:Pb(OH)_2$ | -15.9 | -16.0 | -16.4 | -16.2 | -19.4 | -18.8 | -15.3 | -11.0 | -18.7 |
| $Pb_2O_3$ | $Pb_2O_3$ | -21.2 | -22.5 | -23.1 | -22.6 | -30.0 | -29.0 | -22.6 | -17.3 | -27.9 |
| $Pb_2OCO_3$ | $PbO:PbCO_3$ | -10.9 | -10.4 | -11.0 | -10.5 | -12.7 | -13.1 | -10.2 | -8.9 | -11.9 |
| $Pb_2SiO_4$ | $Pb_2SiO_4$ | -12.8 | -13.3 | -13.8 | -13.2 | -16.8 | -15.7 | -12.2 | -7.7 | -15.9 |
| $Pb_3(AsO_4)_2$ | $Pb_3(AsO_4)_2$ | -19.6 | -20.7 | -22.5 | -20.2 | -25.4 | -24.0 | -19.3 | -12.7 | -24.8 |
| $Pb_3O_2CO_3$ | $PbCO_3:2PbO$ | -17.6 | -16.8 | -17.6 | -17.0 | -21.0 | -20.9 | -16.4 | -14.5 | -19.7 |
| $Pb_3O_2SO_4$ | $PbSO_4:2PbO$ | -14.2 | -13.1 | -13.8 | -13.5 | -17.9 | -17.0 | -12.8 | -11.7 | -18.0 |
| $Pb_4(OH)_6SO_4$ | $Pb_4(OH)_6SO_4$ | -20.1 | -18.8 | -19.6 | -19.3 | -25.2 | -24.0 | -18.1 | -16.4 | -25.0 |
| $Pb_4O_3SO_4$ | $PbSO_4:3PbO$ | -21.1 | -19.8 | -20.6 | -20.2 | -26.2 | -25.0 | -19.1 | -17.4 | -26.0 |
| $PbF_2$ | $PbF_2$ | -12.4 | -13.0 | -13.8 | -12.3 | -14.6 | -13.1 | -11.9 | -10.1 | -14.6 |
| PbMetal | Pb | -28.6 | -27.6 | -27.5 | -27.8 | -25.1 | -25.2 | -26.3 | -25.2 | -26.1 |
| $PbO:0.3H_2O$ | $PbO:0.33H_2O$ | -7.8 | -7.9 | -8.1 | -8.0 | -9.6 | -9.3 | -7.5 | -5.4 | -9.2 |
| PbSiO3 | $PbSiO_3$ | -5.6 | -5.9 | -6.2 | -5.7 | -7.7 | -6.9 | -5.2 | -2.9 | -7.2 |
| Phillipsite | $Na_{0.5}K_{0.5}AlSi_3O_8:H_2O$ | -0.5 | -1.8 | -2.2 | -1.1 | -3.1 | -1.3 | -0.5 | 1.1 | -2.9 |
| Phlogopite | $KMg_3AlSi_3O_{10}(OH)_2$ | -3.5 | -3.3 | -3.3 | -3.1 | -8.3 | -3.3 | -0.2 | 0.8 | -7.8 |
| Phosgenite | $PbCl_2:PbCO_3$ | -15.9 | -15.6 | -16.2 | -15.1 | -16.2 | -17.8 | -14.2 | -12.9 | -16.1 |
| Plattnerite | $PbO_2$ | -14.6 | -15.8 | -16.3 | -15.8 | -21.7 | -20.9 | -16.3 | -13.2 | -19.9 |
| Portlandite | $Ca(OH)_2$ | -9.7 | -9.5 | -9.4 | -9.6 | -10.7 | -9.7 | -8.9 | -8.9 | -10.4 |
| Prehnite | $Ca_2Al_2Si_3O_{10}(OH)_2$ | -2.0 | -3.1 | -3.2 | -2.5 | -5.8 | -4.1 | -1.0 | 1.4 | -5.1 |
| Pyrochroite | $Mn(OH)_2$ | -6.8 | -6.6 | -7.0 | -6.6 | -6.5 | -6.8 | -6.1 | -5.9 | -5.9 |
| Pyrolusite | $MnO_2$ | -3.5 | -4.4 | -5.1 | -4.3 | -8.5 | -8.3 | -4.8 | -3.5 | -6.3 |
| Pyrophyllite | $Al_2Si_4O_{10}(OH)_2$ | 5.0 | 3.3 | 2.7 | 4.4 | 2.7 | 3.1 | 4.4 | 7.1 | 3.2 |
| Quartz | $SiO_2$ | 0.6 | 0.3 | 0.2 | 0.6 | 0.2 | 0.7 | 0.6 | 0.8 | 0.3 |
| Retgersite | $NiSO_4:6H_2O$ | -8.9 | -8.2 | -9.3 | -9.5 | -11.2 | -7.8 | -9.4 | -9.1 | -12.1 |
| Rhodochrosite | $MnCO_3$ | -1.5 | -1.4 | -2.0 | -1.2 | 0.1 | -1.4 | -1.0 | -1.2 | 0.5 |
| Rhodochrosite(d) | $MnCO_3$ | -2.2 | -2.2 | -2.8 | -1.9 | -0.7 | -2.2 | -1.7 | -1.9 | -0.2 |
| Rutherfordine | $UO_2CO_3$ | -6.6 | -6.3 | -6.0 | -5.8 | -6.3 | -6.5 | -6.4 | -6.0 | -7.0 |
| Schoepite | $UO_2(OH)_2:H_2O$ | -4.6 | -4.7 | -4.5 | -4.7 | -6.3 | -5.3 | -4.7 | -3.0 | -6.9 |
| Scorodite | $FeAsO_4:2H_2O$ | -9.0 | -9.7 | -10.6 | -9.2 | -8.4 | -9.9 | -9.3 | -8.5 | -8.9 |
| Sepiolite | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -0.9 | -0.9 | -1.1 | -0.2 | -3.6 | 0.2 | 1.5 | 1.5 | -2.6 |
| Sepiolite(d) | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -3.8 | -3.8 | -4.0 | -3.1 | -6.5 | -2.7 | -1.4 | -1.4 | -5.5 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| Siderite | $FeCO_3$ | -5.5 | -5.8 | -6.1 | -5.5 | -0.9 | -4.3 | -4.7 | -6.3 | -2.7 |
| Siderite(d)(3) | $FeCO_3$ | -6.0 | -6.3 | -6.5 | -5.9 | -1.3 | -4.8 | -5.1 | -6.7 | -3.1 |
| Silicagel | $SiO_2$ | -0.4 | -0.6 | -0.8 | -0.4 | -0.8 | -0.3 | -0.3 | -0.2 | -0.7 |
| $SiO_2$(a) | $SiO_2$ | -0.7 | -0.9 | -1.1 | -0.7 | -1.1 | -0.6 | -0.6 | -0.5 | -1.0 |
| Smithsonite | $ZnCO_3$ | -3.0 | -2.6 | -3.3 | -3.0 | -3.5 | -2.9 | -1.8 | -1.1 | -3.4 |
| $SrF_2$ | $SrF_2$ | -6.1 | -6.7 | -7.3 | -6.1 | -8.0 | -5.7 | -5.5 | -4.4 | -7.7 |
| Strontianite | $SrCO_3$ | -1.7 | -1.6 | -1.7 | -1.6 | -1.5 | -1.8 | -1.1 | -1.6 | -1.2 |
| Talc | $Mg_3Si_4O_{10}(OH)_2$ | 2.6 | 2.8 | 2.5 | 3.7 | -1.3 | 4.2 | 6.2 | 6.0 | 0.2 |
| Tenorite | CuO | -1.4 | -1.7 | -1.6 | -1.4 | -3.1 | -1.6 | -1.9 | -0.2 | -2.1 |
| Thenardite | $Na_2SO_4$ | -8.0 | -9.1 | -9.0 | -9.0 | -9.9 | -7.6 | -8.7 | -9.4 | -10.4 |
| Thermonatrite | $Na_2CO_3:H_2O$ | -11.1 | -12.6 | -12.6 | -12.2 | -12.2 | -11.2 | -11.4 | -11.9 | -12.1 |
| Tremolite | $Ca2Mg_5Si_8O_{22}(OH)_2$ | 5.2 | 5.4 | 5.0 | 7.1 | -4.0 | 7.9 | 12.7 | 12.6 | -0.7 |
| Trona | $NaHCO_3:Na_2CO_3:2H_2O$ | -15.8 | -18.2 | -18.3 | -17.5 | -16.8 | -15.9 | -16.3 | -17.2 | -16.8 |
| $U(OH)_2SO_4$ | $U(OH)_2SO_4$ | -34.9 | -33.4 | -33.4 | -33.9 | -30.5 | -30.1 | -32.1 | -37.1 | -33.2 |
| $U_3O_8$(c) | $U_3O_8$ | -20.4 | -19.8 | -18.8 | -19.9 | -20.2 | -17.8 | -18.7 | -14.8 | -23.6 |
| $U_4O_9$(c) | $U_4O_9$ | -45.5 | -42.9 | -41.2 | -43.3 | -36.5 | -34.1 | -40.0 | -36.5 | -43.4 |
| $UF_4$(c) | $UF_4$ | -50.7 | -51.1 | -52.3 | -49.9 | -48.3 | -45.4 | -47.5 | -49.5 | -50.6 |
| $UF_4:2.5H_2O$ | $UF_4:2.5H_2O$ | -41.7 | -42.2 | -43.3 | -41.0 | -39.4 | -36.4 | -38.5 | -40.5 | -41.6 |
| $UO_2$(a) | $UO_2$ | -19.7 | -18.8 | -18.3 | -18.9 | -16.1 | -15.6 | -17.8 | -17.2 | -18.2 |
| $UO_3$(gamma) | $UO_3$ | -6.9 | -7.0 | -6.8 | -7.1 | -8.6 | -7.6 | -7.0 | -5.3 | -9.2 |
| Uraninite(c) | $UO_2$ | -14.8 | -13.9 | -13.4 | -14.0 | -11.2 | -10.7 | -12.9 | -12.3 | -13.3 |
| Uranophane | $Ca(UO_2)_2(SiO_3OH)_2$ | -9.5 | -10.1 | -9.9 | -9.7 | -14.7 | -10.9 | -8.8 | -5.2 | -15.4 |
| Wairakite | $CaAl_2Si_4O_{12}:2H_2O$ | -3.5 | -5.0 | -5.4 | -4.0 | -6.7 | -5.4 | -3.3 | -0.7 | -6.1 |
| Willemite | $Zn_2SiO_4$ | -2.0 | -1.9 | -3.0 | -2.9 | -6.5 | -2.5 | 0.3 | 2.5 | -6.0 |
| Witherite | $BaCO_3$ | -4.3 | -4.6 | -4.6 | -4.1 | -3.2 | -4.7 | -3.7 | -3.5 | -3.0 |
| Zincite(c) | ZnO | -2.8 | -2.6 | -3.0 | -3.2 | -4.8 | -3.1 | -1.7 | -0.6 | -4.6 |
| Zincosite | $ZnSO_4$ | -13.1 | -12.4 | -13.1 | -13.2 | -14.5 | -12.7 | -12.3 | -11.9 | -15.0 |
| $Zn(BO_2)_2$ | $Zn(BO_2)_2$ | -9.5 | -10.2 | -10.7 | -10.5 | -14.1 | -10.6 | -8.4 | -6.2 | -14.2 |
| $Zn(NO_3)_2:6H_2O$ | $Zn(NO_3)_2:6H_2O$ | -18.0 | -21.0 | -21.2 | -20.6 | -22.4 | -20.3 | -18.2 | -15.6 | -22.8 |
| $Zn(OH)_2$-a | $Zn(OH)_2$ | -4.1 | -3.9 | -4.4 | -4.5 | -6.1 | -4.4 | -3.0 | -1.9 | -5.9 |
| $Zn(OH)_2$-b | $Zn(OH)_2$ | -3.4 | -3.2 | -3.7 | -3.8 | -5.4 | -3.7 | -2.3 | -1.2 | -5.2 |
| $Zn(OH)_2$-c | $Zn(OH)_2$ | -3.8 | -3.7 | -4.1 | -4.3 | -5.9 | -4.1 | -2.7 | -1.7 | -5.7 |
| $Zn(OH)_2$-e | $Zn(OH)_2$ | -3.1 | -3.0 | -3.4 | -3.6 | -5.2 | -3.4 | -2.0 | -1.0 | -5.0 |
| $Zn(OH)_2$-g | $Zn(OH)_2$ | -3.4 | -3.2 | -3.6 | -3.8 | -5.4 | -3.6 | -2.2 | -1.2 | -5.2 |
| $Zn_2(OH)_2SO_4$ | $Zn_2(OH)_2SO_4$ | -9.7 | -8.4 | -9.5 | -9.8 | -12.6 | -9.1 | -7.4 | -6.1 | -12.9 |

***Table B.9(Cont.): BH4-2 and BH4-3 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-2*** | | | | | ***4-3*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | |
| $Zn_2(OH)_3Cl$ | $Zn_2(OH)_3Cl$ | -11.5 | -10.3 | -11.3 | -11.4 | -14.0 | -11.1 | -8.4 | -6.3 | -13.8 |
| $Zn_3(AsO_4)_2$:2.5w | $Zn_3(AsO_4)_2$:2.5$H_2O$ | -17.9 | -18.2 | -20.7 | -19.4 | -23.5 | -18.7 | -15.2 | -11.8 | -23.8 |
| $Zn_3O(SO_4)_2$ | ZnO:2$ZnSO_4$ | -31.3 | -29.3 | -31.1 | -31.4 | -35.6 | -30.3 | -28.2 | -26.5 | -36.4 |
| $Zn_4(OH)_6SO_4$ | $Zn_4(OH)_6SO_4$ | -14.7 | -12.2 | -14.3 | -14.9 | -20.8 | -13.8 | -9.7 | -6.5 | -20.6 |
| $Zn_5(OH)_8Cl_2$ | $Zn_5(OH)_8Cl_2$ | -23.1 | -20.2 | -22.7 | -23.0 | -29.8 | -22.1 | -15.5 | -10.3 | -29.3 |
| $ZnCl_2$ | $ZnCl_2$ | -23.5 | -22.9 | -23.4 | -23.1 | -23.7 | -23.0 | -21.4 | -20.0 | -23.9 |
| $ZnCO_3$:$H_2O$ | $ZnCO_3$:$H_2O$ | -2.7 | -2.4 | -3.0 | -2.8 | -3.2 | -2.7 | -1.6 | -0.8 | -3.2 |
| $ZnF_2$ | $ZnF_2$ | -15.2 | -15.5 | -16.6 | -15.3 | -17.8 | -14.6 | -13.9 | -11.7 | -17.8 |
| ZnMetal | Zn | -46.9 | -45.6 | -45.8 | -46.4 | -43.2 | -42.3 | -43.8 | -43.8 | -45.1 |
| ZnO(a) | ZnO | -3.0 | -2.8 | -3.2 | -3.4 | -5.0 | -3.2 | -1.8 | -0.8 | -4.8 |
| $ZnSiO_3$ | $ZnSiO_3$ | 2.0 | 2.0 | 1.3 | 1.6 | -0.4 | 1.8 | 3.2 | 4.4 | -0.1 |
| $ZnSO_4$:$H_2O$ | $ZnSO_4$:$H_2O$ | -9.6 | -8.9 | -9.5 | -9.6 | -10.9 | -9.1 | -8.7 | -8.3 | -11.4 |

***Table B.10: BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | | ***Saturation Indices*** | | | | | | | | |
| Adularia | $KAlSi_3O_8$ | -1.8 | 0.1 | -0.9 | -2.1 | -1.2 | -1.1 | -1.9 | -1.2 | -0.5 | -3.6 |
| $Al(OH)_3(a)$ | $Al(OH)_3$ | -4.2 | -3.4 | -3.8 | -2.6 | -3.5 | -3.4 | -5.3 | -4.5 | -3.7 | -3.9 |
| $AlAsO_4:2H_2O$ | $AlAsO_4:2H_2O$ | -13.9 | -11.8 | -12.4 | -12.0 | -13.5 | -12.2 | -14.1 | -13.7 | -12.7 | -13.4 |
| Albite | $NaAlSi_3O_8$ | -3.1 | -2.3 | -3.7 | -5.0 | -4.0 | -3.6 | -4.4 | -3.8 | -2.9 | -5.9 |
| AlumK | $KAl(SO_4)_2:12H_2O$ | -22.3 | -17.6 | -19.2 | -17.7 | -18.9 | -19.2 | -21.1 | -20.4 | -20.2 | -21.5 |
| Alunite | $KAl_3(SO4)_2(OH)_6$ | -12.6 | -5.5 | -9.0 | -5.0 | -7.7 | -8.3 | -13.8 | -11.5 | -10.0 | -11.5 |
| Analcime | $NaAlSi_2O_6:H_2O$ | -4.9 | -4.4 | -5.5 | -6.0 | -5.6 | -5.3 | -6.4 | -5.7 | -4.8 | -7.2 |
| Anglesite | $PbSO_4$ | -6.3 | -5.2 | -5.2 | -5.3 | -5.1 | -5.2 | -6.1 | -5.4 | -5.5 | -6.6 |
| Anhydrite | $CaSO_4$ | -1.4 | -0.4 | -0.4 | -0.3 | -0.4 | -0.5 | -0.4 | -0.3 | -0.4 | -1.2 |
| Annite | $KFe_3AlSi_3O_{10}(OH)_2$ | -5.9 | -3.2 | -7.3 | -7.8 | -7.0 | -4.6 | -12.9 | -5.3 | 0.0 | -5.7 |
| Anorthite | $CaAl_2Si_2O_8$ | -5.8 | -4.3 | -5.3 | -4.6 | -5.0 | -4.8 | -7.7 | -6.1 | -4.7 | -6.9 |
| Antlerite | $Cu_3(OH)_4SO_4$ | -7.7 | -7.8 | -8.7 | -8.2 | -8.9 | -6.6 | -9.0 | -9.9 | -8.6 | -10.4 |
| Aragonite | $CaCO_3$ | 0.4 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.7 | 0.5 | 0.9 | 0.7 |
| Arsenolite | $As_2O_3$ | -45.4 | -40.2 | -46.5 | -45.4 | -47.1 | -43.0 | -51.1 | -44.1 | -39.9 | -41.8 |
| Artinite | $MgCO_3:Mg(OH)_2:3H_2O$ | -4.9 | -5.6 | -4.8 | -4.9 | -4.8 | -5.4 | -4.8 | -4.2 | -3.5 | -5.1 |
| $As_2O_5(cr)$ | $As_2O_5$ | -38.4 | -36.1 | -36.5 | -38.1 | -38.7 | -36.9 | -37.0 | -37.6 | -37.4 | -38.1 |
| As_native | As | -52.4 | -47.5 | -55.1 | -52.5 | -54.3 | -50.5 | -60.5 | -51.3 | -46.3 | -48.0 |
| Atacamite | $Cu_2(OH)_3Cl$ | -6.9 | -7.5 | -7.8 | -7.5 | -8.0 | -6.3 | -7.8 | -8.7 | -7.4 | -8.4 |
| Azurite | $Cu_3(OH)_2(CO_3)_2$ | -6.1 | -7.0 | -7.9 | -7.2 | -7.3 | -5.5 | -7.9 | -9.2 | -6.9 | -7.5 |
| $B\text{-}UO_2(OH)_2$ | $UO_2(OH)_2$ | -5.2 | -5.3 | -4.7 | -4.7 | -4.7 | -4.7 | -5.2 | -4.8 | -4.5 | -6.4 |
| $Ba_3(AsO_4)_2$ | $Ba_3(AsO_4)_2$ | 5.6 | 3.2 | 3.5 | 1.7 | 1.4 | 4.0 | 3.7 | 3.1 | 5.0 | 2.8 |
| $BaF_2$ | $BaF_2$ | -11.1 | -10.5 | -11.8 | -12.8 | -12.3 | -12.1 | -10.5 | -11.9 | -10.9 | -12.1 |
| Barite | $BaSO_4$ | 0.0 | -0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 |
| Basaluminite | $Al_4(OH)_{10}SO_4$ | -14.7 | -8.6 | -12.8 | -7.7 | -11.0 | -11.4 | -18.7 | -15.7 | -13.3 | -13.6 |
| Beidellite | $(NaKMg_{0.5})_{0.11}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | -3.3 | -0.5 | -2.3 | -2.4 | -2.3 | -1.8 | -4.9 | -3.5 | -1.8 | -4.5 |
| Bianchite | $ZnSO_4:6H_2O$ | -9.0 | -7.6 | -7.5 | -8.1 | -8.0 | -9.4 | -7.5 | -7.8 | -7.6 | -9.3 |
| Birnessite | $MnO_2$ | -7.6 | -9.5 | -6.0 | -6.2 | -5.2 | -8.6 | -3.7 | -7.4 | -8.5 | -8.7 |
| Bixbyite | $Mn_2O_3$ | -6.1 | -8.5 | -4.3 | -3.6 | -2.3 | -7.5 | -1.8 | -5.5 | -5.7 | -6.6 |
| Boehmite | AlOOH | -1.9 | -1.2 | -1.5 | -0.4 | -1.2 | -1.2 | -3.0 | -2.3 | -1.5 | -1.7 |
| Brochantite | $Cu_4(OH)_6SO_4$ | -8.2 | -8.9 | -9.9 | -9.3 | -10.1 | -7.1 | -10.3 | -11.4 | -9.6 | -12.0 |
| Brucite | $Mg(OH)_2$ | -3.8 | -4.3 | -3.9 | -3.9 | -3.9 | -4.2 | -3.9 | -3.5 | -3.1 | -4.4 |
| Bunsenite | NiO | -5.3 | -5.6 | -4.3 | -4.0 | -4.9 | -5.5 | -5.5 | -5.0 | -4.9 | -7.5 |
| $Ca_3(AsO_4)_2:4w$ | $Ca3(AsO_4)_2:4H_2O$ | -13.1 | -12.3 | -11.9 | -13.7 | -14.4 | -12.2 | -11.8 | -12.1 | -11.3 | -15.2 |
| Calcite | $CaCO_3$ | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.8 | 0.7 | 1.0 | 0.9 |
| $Cd(BO_2)_2$ | $Cd(BO_2)_2$ | -15.4 | -14.1 | -14.8 | -16.1 | -16.5 | -16.0 | -13.0 | -14.3 | -14.1 | -16.7 |
| Cd(gamma) | Cd | -33.4 | -33.2 | -37.6 | -36.0 | -37.0 | -37.2 | -38.9 | -35.5 | -33.1 | -35.3 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| $Cd(OH)_2$ | $Cd(OH)_2$ | -7.6 | -8.1 | -8.5 | -8.7 | -8.5 | -9.5 | -7.8 | -8.0 | -7.7 | -8.5 |
| $Cd(OH)_2$(a) | $Cd(OH)_2$ | -7.7 | -8.1 | -8.6 | -8.8 | -8.6 | -9.6 | -7.8 | -8.1 | -7.8 | -8.6 |
| $Cd_3(OH)_2(SO_4)_2$ | $Cd_3(OH)_2(SO_4)_2$ | -27.0 | -24.2 | -27.1 | -27.2 | -26.7 | -30.2 | -25.3 | -26.1 | -27.2 | -28.2 |
| $Cd_3(OH)_4SO_4$ | $Cd_3(OH)_4SO_4$ | -23.7 | -21.8 | -25.0 | -25.4 | -24.8 | -28.1 | -23.0 | -23.8 | -24.5 | -25.6 |
| $Cd_4(OH)_6SO_4$ | $Cd_4(OH)_6SO_4$ | -23.5 | -21.3 | -25.6 | -26.3 | -25.5 | -29.8 | -22.9 | -24.0 | -24.8 | -26.3 |
| $CdCl_2$ | $CdCl_2$ | -18.7 | -18.0 | -18.4 | -18.4 | -18.3 | -19.3 | -17.5 | -18.3 | -18.2 | -18.1 |
| $CdCl_2$:2.5$H_2O$ | $CdCl_2$:2.5$H_2O$ | -17.4 | -16.7 | -17.2 | -17.1 | -17.1 | -18.0 | -16.3 | -17.0 | -16.9 | -16.8 |
| $CdCl_2$:$H_2O$ | $CdCl_2$:$H_2O$ | -17.6 | -17.0 | -17.4 | -17.4 | -17.3 | -18.3 | -16.5 | -17.2 | -17.1 | -17.0 |
| $CdF_2$ | $CdF_2$ | -17.1 | -15.2 | -17.5 | -18.7 | -17.8 | -18.9 | -15.6 | -17.2 | -16.8 | -18.3 |
| CdMetal | Cd | -33.3 | -33.1 | -37.5 | -35.9 | -36.9 | -37.1 | -38.8 | -35.4 | -33.0 | -35.2 |
| CdOHCl | CdOHCl | -10.2 | -9.7 | -10.5 | -10.6 | -10.4 | -11.4 | -9.7 | -10.2 | -10.2 | -10.3 |
| $CdSiO_3$ | $CdSiO_3$ | -6.6 | -6.7 | -7.5 | -8.4 | -7.7 | -8.5 | -6.4 | -6.8 | -6.9 | -7.9 |
| $CdSO_4$ | $CdSO_4$ | -13.0 | -11.8 | -12.7 | -12.6 | -12.5 | -13.7 | -12.1 | -12.4 | -12.9 | -13.2 |
| $CdSO_4$:2.7$H_2O$ | $CdSO_4$:2.67$H_2O$ | -11.3 | -10.0 | -10.9 | -10.8 | -10.7 | -12.0 | -10.4 | -10.6 | -11.2 | -11.4 |
| $CdSO_4$:$H_2O$ | $CdSO_4$:$H_2O$ | -11.5 | -10.2 | -11.1 | -11.0 | -10.9 | -12.2 | -10.6 | -10.8 | -11.4 | -11.6 |
| Celestite | $SrSO_4$ | -2.0 | -1.4 | -1.1 | -1.1 | -1.1 | -1.3 | -1.2 | -1.0 | -1.1 | -2.2 |
| Cerrusite | $PbCO_3$ | -3.1 | -3.7 | -3.1 | -3.3 | -2.7 | -2.9 | -3.7 | -3.2 | -3.0 | -3.2 |
| Chalcanthite | $CuSO_4$:5$H_2O$ | -9.9 | -8.9 | -9.5 | -9.2 | -9.5 | -8.9 | -9.7 | -10.1 | -9.8 | -10.2 |
| Chalcedony | $SiO_2$ | 0.0 | 0.3 | 0.1 | -0.7 | -0.2 | 0.0 | 0.3 | 0.2 | 0.2 | -0.4 |
| Chlorite14A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -0.2 | -0.7 | 0.3 | 0.0 | 0.9 | -1.2 | -2.3 | 1.3 | 3.5 | -3.4 |
| Chlorite7A | $Mg_5Al_2Si_3O_{10}(OH)_8$ | -3.6 | -4.1 | -3.1 | -3.4 | -2.5 | -4.5 | -5.7 | -2.1 | 0.1 | -6.7 |
| Chrysotile | $Mg_3Si_2O_5(OH)_4$ | -0.2 | -1.1 | -0.3 | -1.9 | -1.0 | -1.4 | 0.1 | 1.1 | 2.2 | -2.8 |
| Claudetite | $As_2O_3$ | -45.5 | -40.2 | -46.5 | -45.4 | -47.2 | -43.0 | -51.1 | -44.1 | -40.0 | -41.8 |
| Clinoenstatite | $MgSiO_3$ | -1.8 | -2.0 | -1.9 | -2.7 | -2.2 | -2.3 | -1.7 | -1.4 | -1.0 | -2.8 |
| $CO_2$(g) | $CO_2$ | -3.2 | -2.8 | -3.0 | -3.0 | -2.9 | -2.9 | -2.9 | -3.3 | -3.1 | -2.1 |
| Coffinite | $USiO_4$ | -14.1 | -12.5 | -15.1 | -14.8 | -14.9 | -13.3 | -17.4 | -13.3 | -10.0 | -14.0 |
| Cotunnite | $PbCl_2$ | -15.5 | -15.0 | -14.6 | -14.9 | -14.5 | -14.4 | -15.1 | -15.0 | -14.4 | -15.0 |
| Cristobalite | $SiO_2$ | 0.1 | 0.4 | 0.1 | -0.7 | -0.2 | 0.0 | 0.3 | 0.2 | 0.2 | -0.3 |
| $Cu(OH)_2$ | $Cu(OH)_2$ | -2.1 | -2.6 | -2.8 | -2.6 | -2.7 | -2.0 | -2.9 | -3.1 | -2.5 | -3.2 |
| $Cu_2(OH)_3NO_3$ | $Cu_2(OH)_3NO_3$ | -8.2 | -8.6 | -9.8 | -10.4 | -10.5 | -8.7 | -9.4 | -11.4 | -9.6 | -11.3 |
| $Cu_2SO_4$ | $Cu_2SO_4$ | -24.5 | -27.6 | -28.0 | -26.0 | -26.1 | -24.7 | -30.4 | -26.6 | -23.5 | -26.1 |
| $Cu_3(AsO_4)_2$:6w | $Cu_3(AsO_4)_2$:6$H_2O$ | -17.6 | -16.9 | -17.8 | -18.9 | -20.0 | -16.0 | -18.5 | -19.9 | -17.8 | -20.8 |
| $CuCO_3$ | $CuCO_3$ | -5.1 | -5.3 | -5.7 | -5.5 | -5.4 | -4.9 | -5.7 | -6.2 | -5.4 | -5.3 |
| CuF | CuF | -23.7 | -24.9 | -25.8 | -25.4 | -25.2 | -24.4 | -26.4 | -25.2 | -23.2 | -25.0 |
| $CuF_2$ | $CuF_2$ | -18.9 | -17.1 | -19.1 | -19.9 | -19.7 | -18.9 | -18.0 | -19.7 | -18.6 | -20.1 |
| $CuF_2$:2$H_2O$ | $CuF_2$:2$H_2O$ | -14.9 | -13.2 | -15.2 | -15.9 | -15.8 | -14.9 | -14.1 | -15.8 | -14.7 | -16.2 |
| CuMetal | Cu | -9.6 | -8.7 | -11.8 | -10.4 | -10.8 | -9.1 | -13.9 | -9.8 | -7.8 | -9.1 |
| $CuOCuSO_4$ | CuO:$CuSO_4$ | -17.5 | -17.1 | -17.8 | -17.4 | -17.9 | -16.4 | -18.1 | -18.7 | -17.9 | -19.0 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | | ***4-5*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| CupricFerrite | $CuFe_2O_4$ | 11.5 | 10.7 | 11.5 | 10.8 | 10.8 | 12.1 | 10.4 | 10.3 | 11.2 | 11.2 |
| Cuprite | $Cu_2O$ | -7.6 | -7.2 | -10.4 | -8.8 | -9.3 | -7.0 | -12.6 | -8.8 | -6.2 | -8.2 |
| CuprousFerrite | $CuFeO_2$ | 9.8 | 9.9 | 8.7 | 9.0 | 8.9 | 10.3 | 7.1 | 9.1 | 10.5 | 9.9 |
| $CuSO_4$ | $CuSO_4$ | -15.6 | -14.6 | -15.1 | -14.8 | -15.1 | -14.5 | -15.4 | -15.7 | -15.5 | -15.9 |
| Diaspore | AlOOH | -0.2 | 0.5 | 0.2 | 1.3 | 0.5 | 0.5 | -1.3 | -0.5 | 0.2 | 0.0 |
| Diopside | $CaMgSi_2O_6$ | -0.4 | -0.8 | -0.7 | -2.3 | -1.4 | -1.1 | -0.1 | 0.2 | 0.9 | -2.6 |
| Dioptase | $CuSiO_3:H_2O$ | -3.4 | -3.7 | -4.1 | -4.8 | -4.3 | -3.5 | -4.0 | -4.4 | -3.8 | -5.0 |
| Dolomite | $CaMg(CO_3)_2$ | 0.9 | 0.6 | 0.9 | 0.9 | 1.1 | 0.8 | 1.3 | 1.3 | 2.0 | 1.6 |
| Dolomite(d) | $CaMg(CO_3)_2$ | 0.3 | 0.0 | 0.4 | 0.4 | 0.6 | 0.3 | 0.7 | 0.7 | 1.5 | 1.0 |
| Epsomite | $MgSO_4:7H_2O$ | -4.1 | -3.1 | -2.8 | -2.8 | -2.8 | -3.3 | -3.0 | -2.7 | -2.8 | -3.7 |
| $Fe(OH)_{2.7}Cl_{.3}$ | $Fe(OH)_{2.7}Cl_{0.3}$ | 4.5 | 5.1 | 5.2 | 4.8 | 4.8 | 5.1 | 4.7 | 4.7 | 4.7 | 5.3 |
| $Fe(OH)_3(a)$ | $Fe(OH)_3$ | 0.5 | 0.4 | 0.9 | 0.5 | 0.5 | 0.8 | 0.4 | 0.4 | 0.6 | 0.9 |
| $Fe_3(OH)_8$ | $Fe_3(OH)_8$ | -4.9 | -4.4 | -4.4 | -5.1 | -5.3 | -3.7 | -7.1 | -4.9 | -3.5 | -2.8 |
| Fluorite | $CaF_2$ | -2.1 | -0.3 | -1.7 | -2.7 | -2.3 | -2.2 | -0.4 | -1.8 | -1.0 | -2.8 |
| Forsterite | $Mg_2SiO_4$ | -5.8 | -6.5 | -5.9 | -6.7 | -6.3 | -6.6 | -5.7 | -5.0 | -4.3 | -7.4 |
| Gibbsite | $Al(OH)_3$ | -1.5 | -0.7 | -1.1 | 0.1 | -0.8 | -0.8 | -2.6 | -1.8 | -1.0 | -1.2 |
| Goethite | FeOOH | 6.4 | 6.3 | 6.8 | 6.4 | 6.4 | 6.7 | 6.2 | 6.3 | 6.5 | 6.8 |
| Goslarite | $ZnSO_4:7H_2O$ | -8.8 | -7.4 | -7.3 | -7.9 | -7.8 | -9.2 | -7.3 | -7.6 | -7.4 | -9.1 |
| Greenalite | $Fe_3Si_2O_5(OH)_4$ | -14.1 | -11.6 | -15.1 | -16.2 | -16.1 | -12.6 | -19.4 | -13.6 | -9.3 | -11.1 |
| Gummite | $UO_3$ | -10.0 | -10.2 | -9.6 | -9.6 | -9.6 | -9.6 | -10.0 | -9.6 | -9.4 | -11.2 |
| Gypsum | $CaSO_4:2H_2O$ | -1.2 | -0.2 | -0.1 | -0.1 | -0.2 | -0.3 | -0.1 | -0.1 | -0.2 | -1.0 |
| H2(g) | $H_2$ | -27.7 | -26.2 | -29.1 | -28.0 | -28.6 | -27.2 | -31.2 | -27.4 | -26.1 | -26.0 |
| H2O(g) | $H_2O$ | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 |
| Halite | NaCl | -8.6 | -9.1 | -9.4 | -9.5 | -9.4 | -9.3 | -9.1 | -9.3 | -8.9 | -10.0 |
| Halloysite | $Al_2Si_2O_5(OH)_4$ | -6.2 | -4.2 | -5.5 | -4.6 | -5.2 | -4.9 | -8.0 | -6.6 | -5.3 | -6.6 |
| Hausmannite | $Mn_3O_4$ | -8.3 | -11.2 | -6.4 | -4.8 | -3.1 | -10.3 | -3.7 | -7.3 | -6.7 | -8.3 |
| Hematite | $Fe_2O_3$ | 14.8 | 14.6 | 15.6 | 14.8 | 14.8 | 15.4 | 14.5 | 14.7 | 15.0 | 15.6 |
| Huntite | $CaMg_3(CO_3)_4$ | -2.9 | -3.5 | -2.6 | -2.6 | -2.2 | -3.2 | -2.1 | -1.8 | -0.3 | -1.3 |
| Hydrocerrusite | $Pb(OH)_2:2PbCO_3$ | -9.8 | -12.2 | -10.0 | -10.5 | -9.0 | -9.4 | -11.9 | -10.2 | -9.5 | -11.3 |
| Hydromagnesite | $Mg_5(CO_3)_4(OH)_2:4H_2O$ | -11.5 | -12.7 | -11.1 | -11.1 | -10.8 | -12.4 | -10.8 | -9.8 | -7.9 | -10.4 |
| Illite | $K_{0.6}Mg_{0.25}Al_{2.3}Si_{3.5}O_{10}(OH)_2$ | -3.0 | -0.4 | -1.9 | -2.0 | -1.9 | -1.7 | -4.7 | -3.0 | -1.4 | -4.6 |
| Jarosite(ss) | $(K_{0.77}Na_{0.03}H_{0.2})Fe_3(SO_4)_2(OH)_6$ | -9.6 | -4.6 | -5.1 | -6.0 | -6.1 | -5.7 | -7.2 | -6.9 | -7.5 | -6.7 |
| Jarosite-K | $KFe_3(SO_4)_2(OH)_6$ | -9.2 | -4.4 | -4.7 | -5.7 | -5.8 | -5.4 | -6.9 | -6.6 | -7.2 | -6.7 |
| Jarosite-Na | $NaFe_3(SO_4)_2(OH)_6$ | -11.8 | -8.1 | -8.9 | -10.0 | -9.9 | -9.3 | -10.7 | -10.5 | -10.9 | -10.4 |
| JarositeH | $(H_3O)Fe_3(SO_4)_2(OH)_6$ | -17.0 | -12.7 | -13.3 | -14.1 | -14.1 | -13.7 | -15.1 | -15.1 | -15.7 | -13.7 |
| Jurbanite | $AlOHSO_4$ | -9.1 | -6.4 | -7.8 | -6.4 | -7.4 | -7.5 | -9.4 | -8.7 | -8.3 | -8.3 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***5.5*** | ***10.5*** | ***15.5*** | ***20.5*** | ***25.5*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| Kaolinite | $Al_2Si_2O_5(OH)_4$ | -1.1 | 0.9 | -0.4 | 0.4 | -0.2 | 0.1 | -2.9 | -1.6 | -0.2 | -1.5 |
| Kmica | $KAl_3Si_3O_{10}(OH)_2$ | 0.9 | 4.2 | 2.5 | 3.7 | 2.9 | 3.0 | -1.5 | 0.8 | 2.9 | -0.5 |
| Langite | $Cu_4(OH)_6SO_4{:}H_2O$ | -9.6 | -10.3 | -11.3 | -10.7 | -11.6 | -8.5 | -11.8 | -12.9 | -11.0 | -13.5 |
| Larnakite | $PbO{:}PbSO_4$ | -8.7 | -8.2 | -7.7 | -8.1 | -7.5 | -7.6 | -9.3 | -7.8 | -7.8 | -10.1 |
| Laumontite | $CaAl_2Si_4O_{12}{:}4H_2O$ | -1.5 | 0.5 | -1.1 | -1.9 | -1.1 | -0.7 | -2.9 | -1.7 | -0.2 | -3.5 |
| Laurionite | PbOHCl | -8.2 | -8.3 | -7.8 | -8.1 | -7.8 | -7.7 | -8.4 | -8.0 | -7.6 | -8.6 |
| Leonhardite | $Ca_2Al_4Si_8O_{24}{:}7H_2O$ | 4.8 | 8.8 | 5.6 | 4.0 | 5.6 | 6.4 | 2.0 | 4.5 | 7.5 | 0.9 |
| Litharge | PbO | -7.6 | -8.6 | -7.8 | -7.9 | -7.5 | -7.6 | -8.5 | -7.7 | -7.4 | -8.8 |
| Magadiite | $NaSi_7O_{13}(OH)_3{:}3H_2O$ | -5.0 | -3.5 | -5.8 | -11.5 | -7.9 | -6.3 | -4.1 | -4.7 | -4.5 | -9.6 |
| Maghemite | $Fe_2O_3$ | 4.4 | 4.2 | 5.2 | 4.4 | 4.4 | 5.0 | 4.1 | 4.3 | 4.6 | 5.2 |
| Magnesite | $MgCO_3$ | -0.3 | -0.5 | -0.2 | -0.2 | -0.1 | -0.4 | -0.1 | 0.0 | 0.5 | 0.1 |
| Magnetite | $Fe_3O_4$ | 11.6 | 12.1 | 12.1 | 11.4 | 11.2 | 12.8 | 9.4 | 11.6 | 13.0 | 13.7 |
| Malachite | $Cu_2(OH)_2CO_3$ | -3.0 | -3.8 | -4.3 | -3.9 | -3.9 | -2.7 | -4.3 | -5.1 | -3.6 | -4.3 |
| Manganite | MnOOH | -3.2 | -4.4 | -2.3 | -1.9 | -1.3 | -3.9 | -1.0 | -2.9 | -3.0 | -3.4 |
| Massicot | PbO | -7.8 | -8.8 | -7.9 | -8.1 | -7.7 | -7.8 | -8.6 | -7.9 | -7.6 | -9.0 |
| Matlockite | PbClF | -11.2 | -10.1 | -10.5 | -11.3 | -10.8 | -10.6 | -10.6 | -10.9 | -10.2 | -11.6 |
| Melanothallite | $CuCl_2$ | -22.5 | -22.1 | -22.3 | -22.0 | -22.3 | -21.4 | -22.1 | -23.0 | -22.0 | -22.1 |
| Melanterite | $FeSO_4{:}7H_2O$ | -11.5 | -11.3 | -11.5 | -11.0 | -11.2 | -10.8 | -13.3 | -11.4 | -10.3 | -10.2 |
| Minium | $Pb_3O_4$ | -30.6 | -35.1 | -29.7 | -31.7 | -30.3 | -32.1 | -29.7 | -31.7 | -32.2 | -35.9 |
| Mirabilite | $Na_2SO_4{:}10H_2O$ | -6.8 | -7.1 | -8.0 | -8.2 | -8.1 | -8.1 | -8.0 | -7.8 | -7.6 | -10.3 |
| $Mn_2(SO_4)_3$ | $Mn_2(SO_4)_3$ | -60.2 | -53.2 | -53.1 | -52.5 | -51.5 | -56.7 | -51.1 | -55.0 | -57.3 | -56.3 |
| $Mn_3(AsO_4)_2{:}8H_2O$ | $Mn_3(AsO_4)_2{:}8H_2O$ | -18.7 | -17.8 | -16.3 | -15.2 | -15.0 | -18.7 | -16.2 | -16.6 | -13.7 | -16.6 |
| $MnCl_2{:}4H_2O$ | $MnCl_2{:}4H_2O$ | -19.7 | -19.3 | -18.6 | -17.7 | -17.3 | -19.1 | -18.1 | -18.7 | -17.5 | -17.5 |
| $MnSO_4$ | $MnSO_4$ | -13.5 | -12.5 | -12.1 | -11.2 | -10.8 | -12.9 | -12.1 | -12.1 | -11.6 | -12.0 |
| Monteponite | CdO | -7.8 | -8.2 | -8.6 | -8.8 | -8.6 | -9.6 | -7.9 | -8.1 | -7.8 | -8.7 |
| Montmorillonite-A | $(HNaK)_{0.14}Mg_{0.45}Fe_{0.33}Al_{1.47}Si_{3.82}O_{10}(OH)_2$ | 1.4 | 3.6 | 2.3 | 0.9 | 2.0 | 2.3 | 0.9 | 1.8 | 3.0 | 0.0 |
| Montmorillonite-B | $(HNaK)_{0.09}Mg_{0.29}Fe_{0.24}Al_{1.57}Si_{3.93}O_{10}(OH)_2$ | 1.7 | 4.0 | 2.5 | 1.2 | 2.2 | 2.7 | 1.0 | 2.0 | 3.1 | 0.3 |
| Montmorillonite-C | $Ca_{0.165}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ | -2.9 | -0.3 | -2.1 | -2.2 | -2.1 | -1.6 | -4.7 | -3.2 | -1.6 | -4.1 |
| Morenosite | $NiSO_4{:}7H_2O$ | -9.7 | -8.3 | -7.4 | -7.1 | -8.0 | -8.7 | -8.8 | -8.4 | -8.7 | -11.0 |
| $Na_4UO_2(CO_3)_3$ | $Na_4UO_2(CO_3)_3$ | -24.6 | -27.8 | -28.8 | -29.2 | -28.6 | -28.4 | -28.6 | -28.5 | -27.1 | -31.7 |
| Nahcolite | $NaHCO_3$ | -4.8 | -5.4 | -5.9 | -6.0 | -5.8 | -5.8 | -5.7 | -5.8 | -5.5 | -6.0 |
| Nantokite | CuCl | -9.5 | -11.4 | -11.4 | -10.4 | -10.5 | -9.7 | -12.4 | -10.8 | -8.9 | -10.0 |
| Natron | $Na_2CO_3{:}10H_2O$ | -8.8 | -10.3 | -11.1 | -11.2 | -11.0 | -10.9 | -10.8 | -10.7 | -10.1 | -12.1 |
| Nesquehonite | $MgCO_3{:}3H_2O$ | -2.7 | -2.9 | -2.6 | -2.6 | -2.5 | -2.8 | -2.5 | -2.4 | -2.0 | -2.3 |
| $Ni(OH)_2$ | $Ni(OH)_2$ | -3.7 | -4.0 | -2.6 | -2.4 | -3.3 | -3.8 | -3.9 | -3.3 | -3.3 | -5.9 |
| $Ni_2SiO_4$ | $Ni_2SiO_4$ | -3.8 | -4.1 | -1.6 | -2.0 | -3.3 | -4.1 | -3.9 | -3.0 | -2.9 | -8.7 |
| $Ni_3(AsO_4)_2{:}8H_2O$ | $Ni_3(AsO_4)_2{:}8H_2O$ | -25.5 | -24.1 | -20.4 | -21.5 | -24.9 | -24.4 | -24.6 | -23.7 | -23.3 | -31.8 |
| $Ni_4(OH)_6SO_4$ | $Ni_4(OH)_6SO_4$ | -23.0 | -21.7 | -17.1 | -16.4 | -20.1 | -22.1 | -22.4 | -20.3 | -20.4 | -30.7 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| $NiCO_3$ | $NiCO_3$ | -7.4 | -7.3 | -6.1 | -5.9 | -6.7 | -7.3 | -7.3 | -7.1 | -7.1 | -8.6 |
| Nsutite | $MnO_2$ | -6.5 | -8.5 | -4.9 | -5.1 | -4.2 | -7.5 | -2.7 | -6.4 | -7.5 | -7.6 |
| $O_2(g)$ | $O_2$ | -27.8 | -30.8 | -24.9 | -27.2 | -25.9 | -28.8 | -20.8 | -28.4 | -31.0 | -31.2 |
| Otavite | $CdCO_3$ | -3.2 | -3.4 | -3.9 | -4.0 | -3.7 | -4.7 | -3.1 | -3.5 | -3.3 | -3.1 |
| $Pb(BO_2)_2$ | $Pb(BO_2)_2$ | -14.3 | -13.4 | -12.6 | -14.8 | -15.1 | -12.7 | -12.4 | -12.6 | -12.5 | -16.1 |
| $Pb(OH)_2$ | $Pb(OH)_2$ | -3.0 | -4.0 | -3.2 | -3.4 | -3.0 | -3.1 | -3.9 | -3.1 | -2.8 | -4.2 |
| $Pb_2(OH)_3Cl$ | $Pb_2(OH)_3Cl$ | -11.3 | -11.9 | -10.9 | -11.5 | -10.9 | -10.7 | -12.3 | -11.1 | -10.5 | -12.8 |
| $Pb_2O(OH)_2$ | $PbO:Pb(OH)_2$ | -15.9 | -17.9 | -16.3 | -16.6 | -15.8 | -16.0 | -17.7 | -16.1 | -15.5 | -18.3 |
| $Pb_2O_3$ | $Pb_2O_3$ | -23.1 | -26.6 | -22.0 | -23.9 | -22.8 | -24.5 | -21.3 | -24.1 | -24.9 | -27.2 |
| $Pb_2OCO_3$ | $PbO:PbCO_3$ | -10.6 | -12.2 | -10.7 | -11.1 | -10.2 | -10.4 | -12.1 | -10.8 | -10.4 | -11.9 |
| $Pb_2SiO_4$ | $Pb_2SiO_4$ | -13.0 | -14.7 | -13.3 | -14.5 | -13.2 | -13.1 | -14.5 | -13.0 | -12.7 | -15.8 |
| $Pb_3(AsO_4)_2$ | $Pb_3(AsO_4)_2$ | -21.6 | -22.3 | -20.2 | -23.0 | -22.3 | -20.1 | -22.8 | -21.1 | -19.9 | -24.9 |
| $Pb_3O_2CO_3$ | $PbCO_3:2PbO$ | -17.0 | -19.6 | -17.3 | -17.8 | -16.5 | -16.8 | -19.3 | -17.3 | -16.8 | -19.5 |
| $Pb_3O_2SO_4$ | $PbSO_4:2PbO$ | -14.4 | -14.3 | -13.3 | -14.0 | -13.2 | -13.2 | -15.7 | -13.5 | -13.3 | -16.9 |
| $Pb_4(OH)_6SO_4$ | $Pb_4(OH)_6SO_4$ | -20.0 | -20.5 | -19.0 | -19.9 | -18.8 | -18.8 | -22.2 | -19.1 | -18.8 | -23.7 |
| $Pb_4O_3SO_4$ | $PbSO_4:3PbO$ | -21.0 | -21.5 | -20.0 | -20.9 | -19.8 | -19.8 | -23.1 | -20.1 | -19.8 | -24.7 |
| $PbF_2$ | $PbF_2$ | -13.6 | -11.7 | -13.1 | -14.3 | -13.6 | -13.6 | -12.7 | -13.4 | -12.7 | -14.7 |
| PbMetal | Pb | -26.8 | -26.3 | -28.4 | -27.1 | -26.9 | -25.5 | -31.2 | -26.1 | -24.4 | -26.3 |
| $PbO:0.3H_2O$ | $PbO:0.33H_2O$ | -7.9 | -8.9 | -8.0 | -8.2 | -7.8 | -7.9 | -8.7 | -7.9 | -7.6 | -9.0 |
| PbSiO3 | $PbSiO_3$ | -5.7 | -6.4 | -5.9 | -6.8 | -5.9 | -5.8 | -6.3 | -5.7 | -5.5 | -7.3 |
| Phillipsite | $Na_{0.5}K_{0.5}AlSi_3O_8:H_2O$ | -2.0 | -0.5 | -1.7 | -3.0 | -2.0 | -1.7 | -2.6 | -1.9 | -1.1 | -4.2 |
| Phlogopite | $KMg_3AlSi_3O_{10}(OH)_2$ | -3.8 | -3.6 | -3.1 | -4.4 | -3.0 | -4.3 | -4.3 | -2.1 | -0.9 | -7.0 |
| Phosgenite | $PbCl_2:PbCO_3$ | -16.7 | -16.4 | -15.8 | -16.3 | -15.5 | -15.3 | -16.9 | -16.4 | -15.7 | -16.4 |
| Plattnerite | $PbO_2$ | -16.5 | -19.0 | -15.2 | -16.9 | -16.3 | -17.9 | -13.8 | -17.4 | -18.5 | -19.4 |
| Portlandite | $Ca(OH)_2$ | -9.4 | -9.8 | -9.6 | -9.6 | -9.6 | -9.6 | -9.4 | -9.3 | -9.0 | -10.1 |
| Prehnite | $Ca_2Al_2Si_3O_{10}(OH)_2$ | -3.8 | -2.6 | -3.6 | -3.7 | -3.3 | -3.2 | -5.5 | -4.0 | -2.4 | -5.9 |
| Pyrochroite | $Mn(OH)_2$ | -6.9 | -7.3 | -6.7 | -5.8 | -5.4 | -7.4 | -6.5 | -6.4 | -5.6 | -6.3 |
| Pyrolusite | $MnO_2$ | -5.4 | -7.3 | -3.8 | -4.0 | -3.0 | -6.3 | -1.5 | -5.2 | -6.3 | -6.5 |
| Pyrophyllite | $Al_2Si_4O_{10}(OH)_2$ | 2.4 | 4.9 | 3.0 | 2.3 | 2.8 | 3.4 | 1.0 | 2.1 | 3.5 | 1.0 |
| Quartz | $SiO_2$ | 0.5 | 0.8 | 0.5 | -0.3 | 0.2 | 0.4 | 0.7 | 0.6 | 0.6 | 0.1 |
| Retgersite | $NiSO_4:6H_2O$ | -10.1 | -8.6 | -7.7 | -7.4 | -8.3 | -9.0 | -9.1 | -8.7 | -9.0 | -11.3 |
| Rhodochrosite | $MnCO_3$ | -1.9 | -2.0 | -1.6 | -0.6 | -0.1 | -2.1 | -1.3 | -1.4 | -0.5 | -0.2 |
| Rhodochrosite(d) | $MnCO_3$ | -2.6 | -2.7 | -2.3 | -1.4 | -0.9 | -2.9 | -2.0 | -2.2 | -1.3 | -1.0 |
| Rutherfordine | $UO_2CO_3$ | -6.5 | -6.3 | -5.9 | -5.9 | -5.8 | -5.8 | -6.3 | -6.4 | -6.0 | -6.7 |
| Schoepite | $UO_2(OH)_2:H_2O$ | -5.0 | -5.2 | -4.6 | -4.6 | -4.6 | -4.6 | -5.0 | -4.6 | -4.4 | -6.2 |
| Scorodite | $FeAsO_4:2H_2O$ | -10.6 | -9.5 | -9.2 | -10.5 | -10.8 | -9.5 | -10.0 | -10.2 | -9.9 | -10.0 |
| Sepiolite | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -0.3 | -0.4 | -0.3 | -2.7 | -1.3 | -1.2 | 0.4 | 0.8 | 1.5 | -2.7 |
| Sepiolite(d) | $Mg_2Si_3O_{7.5}OH:3H_2O$ | -3.2 | -3.3 | -3.2 | -5.6 | -4.2 | -4.1 | -2.6 | -2.1 | -1.4 | -5.6 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***100*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| Siderite | $FeCO_3$ | -5.9 | -4.9 | -6.0 | -5.9 | -6.0 | -5.1 | -7.5 | -5.6 | -4.3 | -3.6 |
| Siderite(d)(3) | $FeCO_3$ | -6.3 | -5.3 | -6.5 | -6.3 | -6.5 | -5.5 | -8.0 | -6.0 | -4.7 | -4.0 |
| Silicagel | $SiO_2$ | -0.5 | -0.2 | -0.5 | -1.3 | -0.8 | -0.6 | -0.3 | -0.4 | -0.4 | -0.9 |
| $SiO_2$(a) | $SiO_2$ | -0.8 | -0.5 | -0.8 | -1.6 | -1.1 | -0.9 | -0.6 | -0.7 | -0.7 | -1.2 |
| Smithsonite | $ZnCO_3$ | -3.2 | -2.9 | -2.4 | -3.1 | -2.8 | -4.1 | -2.2 | -2.8 | -2.1 | -3.0 |
| $SrF_2$ | $SrF_2$ | -7.0 | -5.6 | -6.8 | -7.8 | -7.5 | -7.4 | -5.6 | -6.8 | -6.0 | -8.1 |
| Strontianite | $SrCO_3$ | -1.5 | -2.0 | -1.7 | -1.7 | -1.6 | -1.7 | -1.6 | -1.5 | -1.1 | -1.5 |
| Talc | $Mg_3Si_4O_{10}(OH)_2$ | 3.6 | 3.3 | 3.5 | 0.3 | 2.2 | 2.2 | 4.4 | 5.1 | 6.2 | 0.2 |
| Tenorite | CuO | -1.1 | -1.6 | -1.8 | -1.6 | -1.7 | -1.0 | -1.8 | -2.1 | -1.5 | -2.2 |
| Thenardite | $Na_2SO_4$ | -7.7 | -8.1 | -8.9 | -9.1 | -9.0 | -9.0 | -8.9 | -8.7 | -8.6 | -11.2 |
| Thermonatrite | $Na_2CO_3:H_2O$ | -10.2 | -11.8 | -12.5 | -12.7 | -12.5 | -12.3 | -12.2 | -12.1 | -11.6 | -13.6 |
| Tremolite | $Ca2Mg_5Si_8O_{22}(OH)_2$ | 7.3 | 6.2 | 6.7 | 0.3 | 4.0 | 4.6 | 8.9 | 10.2 | 12.5 | -0.5 |
| Trona | $NaHCO_3:Na_2CO_3:2H_2O$ | -14.6 | -16.9 | -18.0 | -18.3 | -17.9 | -17.7 | -17.5 | -17.6 | -16.7 | -19.2 |
| $U(OH)_2SO_4$ | $U(OH)_2SO_4$ | -32.5 | -34.5 | -34.0 | -32.4 | -32.7 | -32.2 | -36.7 | -32.6 | -29.7 | -32.9 |
| $U_3O_8$(c) | $U_3O_8$ | -19.9 | -18.9 | -20.1 | -18.9 | -19.5 | -18.2 | -23.5 | -18.4 | -15.7 | -21.9 |
| $U_4O_9$(c) | $U_4O_9$ | -41.9 | -38.0 | -44.6 | -41.1 | -43.0 | -38.8 | -52.6 | -39.5 | -32.6 | -41.7 |
| $UF_4$(c) | $UF_4$ | -50.1 | -49.0 | -51.8 | -52.1 | -51.6 | -50.9 | -52.0 | -50.8 | -46.4 | -51.4 |
| $UF_4:2.5H_2O$ | $UF_4:2.5H_2O$ | -41.1 | -40.0 | -42.8 | -43.2 | -42.6 | -42.0 | -43.1 | -41.8 | -37.4 | -42.4 |
| $UO_2$(a) | $UO_2$ | -18.3 | -17.0 | -19.4 | -18.2 | -18.9 | -17.5 | -21.9 | -17.7 | -15.5 | -17.9 |
| $UO_3$(gamma) | $UO_3$ | -7.3 | -7.5 | -6.9 | -6.9 | -6.9 | -6.9 | -7.4 | -6.9 | -6.7 | -8.5 |
| Uraninite(c) | $UO_2$ | -13.4 | -12.1 | -14.5 | -13.3 | -14.0 | -12.6 | -17.0 | -12.8 | -10.6 | -13.0 |
| Uranophane | $Ca(UO_2)_2(SiO_3OH)_2$ | -10.3 | -10.5 | -9.6 | -11.2 | -10.2 | -9.8 | -9.9 | -9.2 | -8.2 | -14.3 |
| Wairakite | $CaAl_2Si_4O_{12}:2H_2O$ | -5.8 | -3.8 | -5.4 | -6.1 | -5.4 | -5.0 | -7.2 | -5.9 | -4.4 | -7.7 |
| Willemite | $Zn_2SiO_4$ | -2.5 | -2.4 | -1.3 | -3.5 | -2.6 | -5.1 | -0.8 | -1.4 | -0.3 | -4.7 |
| Witherite | $BaCO_3$ | -3.5 | -4.7 | -4.7 | -4.7 | -4.4 | -4.3 | -4.4 | -4.6 | -3.9 | -3.5 |
| Zincite(c) | ZnO | -3.0 | -3.0 | -2.4 | -3.1 | -2.9 | -4.2 | -2.2 | -2.5 | -1.9 | -3.8 |
| Zincosite | $ZnSO_4$ | -13.8 | -12.4 | -12.2 | -12.9 | -12.7 | -14.2 | -12.2 | -12.6 | -12.4 | -14.0 |
| $Zn(BO_2)_2$ | $Zn(BO_2)_2$ | -11.9 | -10.1 | -9.5 | -12.1 | -12.4 | -11.6 | -8.4 | -9.7 | -9.3 | -13.3 |
| $Zn(NO_3)_2:6H_2O$ | $Zn(NO_3)_2:6H_2O$ | -19.2 | -18.1 | -19.2 | -21.6 | -21.0 | -21.6 | -18.0 | -21.2 | -19.3 | -22.1 |
| $Zn(OH)_2$-a | $Zn(OH)_2$ | -4.3 | -4.4 | -3.7 | -4.4 | -4.2 | -5.5 | -3.6 | -3.8 | -3.3 | -5.2 |
| $Zn(OH)_2$-b | $Zn(OH)_2$ | -3.6 | -3.7 | -3.0 | -3.7 | -3.5 | -4.8 | -2.9 | -3.1 | -2.6 | -4.5 |
| $Zn(OH)_2$-c | $Zn(OH)_2$ | -4.0 | -4.1 | -3.5 | -4.1 | -3.9 | -5.3 | -3.3 | -3.6 | -3.0 | -4.9 |
| $Zn(OH)_2$-e | $Zn(OH)_2$ | -3.3 | -3.4 | -2.8 | -3.4 | -3.2 | -4.6 | -2.6 | -2.9 | -2.3 | -4.2 |
| $Zn(OH)_2$-g | $Zn(OH)_2$ | -3.5 | -3.6 | -3.0 | -3.7 | -3.4 | -4.8 | -2.8 | -3.1 | -2.5 | -4.4 |
| $Zn_2(OH)_2SO_4$ | $Zn_2(OH)_2SO_4$ | -9.9 | -8.7 | -8.0 | -9.4 | -9.1 | -11.8 | -7.8 | -8.5 | -7.6 | -11.2 |

***Table B.10(Cont.): BH4-4 and BH4-5 Geochemical Speciation Results – Mean Saturation Indices***

| ***Location*** | | ***4-4*** | | | | | ***4-5*** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Depth (mBGS)*** | | ***1.8*** | ***6.8*** | ***11.8*** | ***16.8*** | ***21.8*** | ***5.0*** | ***10.0*** | ***15.0*** | ***20.0*** | ***25.0*** |
| ***Phase*** | ***Formula*** | ***Saturation Indices*** | | | | | | | | | |
| $Zn_2(OH)_3Cl$ | $Zn_2(OH)_3Cl$ | -11.1 | -11.0 | -9.9 | -11.4 | -11.2 | -13.5 | -9.5 | -10.3 | -9.0 | -12.5 |
| $Zn_3(AsO_4)_2$:2.5w | $Zn_3(AsO_4)_2$:2.5$H_2O$ | -20.3 | -18.2 | -16.7 | -20.7 | -20.2 | -22.5 | -16.7 | -18.2 | -16.2 | -22.8 |
| $Zn_3O(SO_4)_2$ | ZnO:2$ZnSO_4$ | -32.1 | -29.6 | -28.7 | -30.7 | -30.4 | -34.4 | -28.6 | -29.6 | -28.5 | -33.8 |
| $Zn_4(OH)_6SO_4$ | $Zn_4(OH)_6SO_4$ | -14.0 | -13.3 | -11.3 | -14.3 | -13.9 | -18.8 | -10.9 | -12.1 | -10.1 | -17.5 |
| $Zn_5(OH)_8Cl_2$ | $Zn_5(OH)_8Cl_2$ | -21.9 | -21.9 | -19.1 | -22.9 | -22.3 | -28.1 | -18.1 | -20.1 | -16.8 | -25.8 |
| $ZnCl_2$ | $ZnCl_2$ | -24.0 | -23.2 | -22.7 | -23.4 | -23.2 | -24.3 | -22.3 | -23.2 | -22.2 | -23.5 |
| $ZnCO_3$:$H_2O$ | $ZnCO_3$:$H_2O$ | -2.9 | -2.6 | -2.2 | -2.9 | -2.5 | -3.9 | -1.9 | -2.5 | -1.8 | -2.8 |
| $ZnF_2$ | $ZnF_2$ | -16.2 | -14.0 | -15.3 | -17.0 | -16.4 | -17.6 | -14.0 | -15.8 | -14.6 | -17.4 |
| ZnMetal | Zn | -45.3 | -43.9 | -46.1 | -45.7 | -46.1 | -44.4 | -48.1 | -44.5 | -42.0 | -43.8 |
| ZnO(a) | ZnO | -3.1 | -3.2 | -2.6 | -3.3 | -3.0 | -4.4 | -2.4 | -2.7 | -2.1 | -4.0 |
| $ZnSiO_3$ | $ZnSiO_3$ | 1.8 | 2.0 | 2.3 | 0.8 | 1.5 | 0.4 | 2.7 | 2.3 | 2.9 | 0.4 |
| $ZnSO_4$:$H_2O$ | $ZnSO_4$:$H_2O$ | -10.2 | -8.8 | -8.7 | -9.3 | -9.2 | -10.6 | -8.7 | -9.0 | -8.8 | -10.5 |

# Appendix C – Waste Rock Microbiology Data

Appendix C contains a detailed summary DNA data associated with the waste rock and cover samples retrieved from WRS#1 at the Detour Lake mine site. The detailed results include the following data:

- Table C.1: Bacterial DNA Data
- Table C.2: Fungal DNA Data

## *Table C.1: Bacterial DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Thiobacillus* | **12.65** | **14.62** | *10.44* | **11.32** | **22.77** | **18.07** | **27.45** | **17.36** | 3.27 | **13.63** | **32.74** | **30.29** | 11.92 |
| *Acidithiobacillus* | *8.84* | *5.98* | **11.69** | 4.78 | 2.53 | *9.71* | 3.98 | 3.01 | 0.91 | 4.27 | 3.67 | 4.97 | 6.81 |
| *Arthrobacter* | 1.95 | *5.06* | 2.84 | *5.38* | 2.78 | 3.7 | *7.85* | 4.39 | 2.28 | *6.13* | 0 | *6.36* | 3.37 |
| *Candidatus_Chloracidobacterium* | *5.61* | 3.79 | 3.92 | 3.68 | 1.41 | 1.32 | 0.24 | 1.72 | 4.14 | 0.77 | 0 | 0.24 | 3 |
| *Flexibacter* | 1.92 | 3.19 | 3.14 | 3.66 | 2.32 | 3.69 | *5.97* | 1.86 | 3.06 | 2.81 | 4.03 | 2.2 | 2.92 |
| *Azospira* | *5.04* | 3.44 | 2.14 | 2.46 | 1.84 | 2.02 | 1.38 | 3.53 | 3.44 | 2.04 | 0.23 | 0.81 | 2.88 |
| *Nitrosococcus* | 4.6 | 3.02 | 3.03 | 3.89 | 2.6 | 3.2 | 1.81 | 2.24 | 3.76 | 1.72 | 0.35 | 1.62 | 2.75 |
| *Gemmatimonas* | 2.45 | 1.9 | 1.8 | 2.19 | 2.92 | 1.58 | 0.78 | 0.9 | 0.76 | 1.22 | 3.44 | 2.25 | 1.77 |
| *Caldilinea* | 3.12 | 2.02 | 4.33 | 2.91 | 3.63 | 2.98 | 1.52 | 1.33 | 1.33 | 0.81 | 0.23 | 1.97 | 1.73 |
| *Leptospirillum* | 0.15 | 0.21 | 0.87 | 0.12 | 0.33 | 0.27 | 0.78 | 0.04 | 0.55 | 0.54 | 1.3 | 0.07 | 1.66 |
| *Achromobacter* | 3.74 | 2.13 | 1.69 | 1.89 | 1.15 | 1.32 | 0.85 | 0.76 | 1.95 | 1.72 | 0.59 | 1.7 | 1.53 |
| *Dokdonella* | 0.03 | 0.09 | 1.46 | 0.44 | 0.53 | 0.14 | 0.03 | 0.14 | 1.38 | 0.45 | 0 | 0.35 | 1.5 |
| *Dermatophilus* | 2.05 | 1.03 | 1.95 | 1.06 | 1.33 | 1.89 | 3.8 | 1.19 | 0.7 | 0.54 | 0 | 0.24 | 1.47 |
| *Coprothermobacter* | 0.55 | 0.23 | 0.16 | 0.21 | 0.4 | 0.3 | 0.03 | 0.47 | 0.53 | 0.27 | 0 | 0.05 | 1.44 |
| *Pirellula* | 0.89 | 1.67 | 1.2 | 1.76 | 0.76 | 1.49 | 0.78 | 1.29 | 3.02 | 1.45 | 0 | 0.75 | 1.35 |
| *Sphingomonas* | 0.41 | 1.32 | 0.33 | 1.76 | 2.28 | 0.89 | 1.2 | 2.77 | 1.14 | 2.68 | 0.94 | 1.88 | 1.21 |
| *Rhodopirellula* | 0.51 | 1.13 | 0.65 | 0.7 | 1.88 | 1.15 | 1.42 | 1.72 | 2.73 | 0.22 | 0.94 | 0.16 | 1.21 |
| *Roseiflexus* | 0.24 | 1 | 0.33 | 0.72 | 0.51 | 0.61 | 0 | 1 | **4.94** | 0.81 | 0 | 0.01 | 1.2 |
| *Thermomonas* | 1.02 | 0.28 | 1.59 | 1.36 | 0.65 | 0.68 | 0.17 | 0.28 | 0.85 | 0.45 | 0.83 | 0.85 | 1.15 |
| *Chthoniobacter* | 0.64 | 1.57 | 0.87 | 0.65 | 1.01 | 0.74 | 0.32 | 0.19 | 3.11 | 0.59 | 0 | 0.24 | 1.1 |
| *Arenimonas* | 1.21 | 0.59 | 0.57 | 0.72 | 0.65 | 0.56 | 0.88 | 1.76 | 0.43 | 2.77 | *10.79* | 0.72 | 1.07 |
| *Massilia* | 1.54 | 1.02 | 1.48 | 1.02 | 0.63 | 1.16 | 1.31 | 0.52 | 1.17 | 2.36 | 0.11 | 0.85 | 1.06 |
| *Opitutus* | 1.17 | 1.27 | 1.5 | 1.65 | 0.46 | 4.01 | 0.67 | 1.29 | 0.85 | 0.27 | 0.11 | 2.07 | 1 |
| *Pseudomonas* | 0.26 | 0.34 | 0.21 | 0.61 | 0.44 | 0.66 | 0.46 | 0.76 | 1 | 0.31 | *11.38* | 0.51 | 0.98 |
| *Ferruginibacter* | 0.3 | 0.84 | 0.7 | 1.51 | 0.78 | 1 | 0 | 1.91 | 1.78 | 1.63 | 0.71 | 1.59 | 0.98 |
| *Steroidobacter* | 0 | 0.01 | 0.02 | 0.06 | 0.1 | 0 | 0 | 0 | 0.13 | 0.31 | 0 | 0.01 | 0.45 |
| *Ktedonobacter* | 0 | 0 | 0 | 0 | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0.26 |
| *Escherichia_Shigella* | 0.62 | 0.55 | 0.72 | 1.27 | 0.37 | 0.68 | 0.53 | 0.47 | 1.55 | 0.59 | 0 | 0 | 0.87 |
| *Terrimonas* | 0.34 | 0.46 | 0.36 | 0.44 | 0.42 | 0.48 | 0 | 0.62 | 1.55 | 0.4 | 0.35 | 0.01 | 0.84 |
| *Novosphingobium* | 0.7 | 0.61 | 0.61 | 1 | 0.81 | 0.35 | 0.28 | 1.38 | 1.16 | 1.09 | 0.35 | 0.72 | 0.84 |
| *Rhodanobacter* | 0.05 | 0.53 | 1.25 | 0.63 | 2 | 0.93 | 0.32 | 2.1 | 0.64 | 2.63 | 0.35 | 1.7 | 0.81 |
| *Blastopirellula* | 0.55 | 1.3 | 1.2 | 0.68 | 0.44 | 0.69 | 0.28 | 0.95 | 1.95 | 0.4 | 0.11 | 0.12 | 0.78 |
| *Gemmata* | 0.43 | 0.73 | 0.42 | 0.68 | 0.58 | 0.56 | 0.03 | 0.38 | 0.87 | 0.18 | 0.11 | 0.09 | 0.77 |
| *Phycisphaera* | 0.51 | 1.07 | 0.33 | 1.1 | 1.04 | 0.29 | 0.24 | 1.14 | 1.46 | 0.22 | 0 | 0.73 | 0.77 |
| *Cryobacterium* | 0.79 | 1.05 | 0.46 | 1.17 | 0.54 | 1.1 | 0.35 | 0.47 | 0.74 | 0.72 | 0.59 | 0.24 | 0.76 |
| *Lysobacter* | 0.53 | 0.36 | 0.44 | 0.53 | 1.82 | 0.66 | 1.92 | 1.29 | 0.26 | 3.13 | 0.47 | 1.35 | 0.69 |

*indicates sample recovered from oxidized zone

## *Table C.1(Cont.): Bacterial DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Thiobacillus* | *5.98* | 2.47 | 5 | **47.93** | 0.61 | 1.82 | 0.42 | 1.07 | 0.35 | 2.75 | 0.17 | 2.83 | 11.92 |
| *Acidithiobacillus* | *8.08* | 3.07 | **6.47** | 1.39 | 1.67 | **18.8** | 1.72 | **31.14** | 0.23 | *17.57* | 0.28 | **8.55** | 6.81 |
| *Arthrobacter* | 1.8 | *5.84* | 4.13 | 4.22 | 3.49 | 2.42 | 1.48 | 0.39 | 2.76 | 1.42 | 3.26 | 0.98 | 3.37 |
| *Candidatus_Chloracidobacterium* | **8.39** | 3.64 | 3.6 | 0 | 3.27 | 2.31 | 4.5 | 2.19 | *5.13* | 1.6 | **6.83** | 3.7 | 3 |
| *Flexibacter* | 3.68 | 1.98 | 3.41 | 0.53 | 3.84 | 1.93 | **5.25** | 0.93 | 3.36 | 1.68 | 3.66 | 2.1 | 2.92 |
| *Azospira* | 3.8 | 1.85 | 3.81 | 0.16 | **5.07** | 2.48 | *5.1* | 1.46 | **6.12** | 3.32 | 4.12 | 3.4 | 2.88 |
| *Nitrosococcus* | 3.29 | 2.42 | 2.95 | 0.66 | 3.1 | 1.87 | 2.81 | 2.84 | 4.29 | 2.69 | 4.24 | 2.96 | 2.75 |
| *Gemmatimonas* | 2.32 | 2.82 | 2.13 | 0.16 | 1.4 | 0.71 | 2.65 | 0.31 | 1.55 | 1.22 | 1.49 | 3.47 | 1.77 |
| *Caldilinea* | 1.89 | 0.97 | 2.61 | 0.26 | 1.32 | 1.37 | 1.63 | 0.36 | 1.57 | 0.47 | 0.9 | 1.88 | 1.73 |
| *Leptospirillum* | 0.06 | 0.71 | 0.37 | 0.76 | 0.29 | 3.58 | 0.72 | *5.72* | 0.33 | **18.82** | 0.13 | 3.22 | 1.66 |
| *Achromobacter* | 1.49 | 1.13 | 1.67 | 0.03 | 2.01 | 0.6 | 2.08 | 1.07 | 2.66 | 0.71 | 1.95 | 1.78 | 1.53 |
| *Dokdonella* | 0.17 | 1.05 | 1.07 | 0.59 | 0.59 | *11.19* | 0.42 | *7.75* | 0.83 | 1.72 | 0.76 | 4.79 | 1.5 |
| *Dermatophilus* | 1.97 | 1.11 | 1.73 | 0.03 | 2.21 | 0.6 | 2.44 | 0.45 | 1.79 | 1.34 | 2.53 | 3.25 | 1.47 |
| *Coprothermobacter* | 1.15 | **6.3** | 0.9 | 1.46 | 1.37 | 3.75 | 1.2 | *6.93* | 0.91 | 3 | 1.78 | 2.66 | 1.44 |
| *Pirellula* | 2.4 | 1.18 | 2.26 | 0.06 | 1.62 | 1.26 | 0.99 | 0.93 | 2.74 | 0.67 | 2.2 | 0.98 | 1.35 |
| *Sphingomonas* | 0.91 | 1.92 | 1.46 | 1.29 | 1.13 | 0.49 | 0.51 | 0.16 | 1.19 | 0.83 | 0.69 | 0.91 | 1.21 |
| *Rhodopirellula* | 1.74 | 0.38 | 0.65 | 0.03 | 2.38 | 0.93 | 2.05 | 0.67 | 2.32 | 0.81 | 2.43 | 1.37 | 1.21 |
| *Roseiflexus* | 1.64 | 0.72 | 1.83 | 0 | 3.84 | 1.1 | 1.93 | 1.12 | 1.77 | 1 | 3.12 | 0.61 | 1.2 |
| *Thermomonas* | 1.46 | 2.27 | 1.04 | 0.03 | 1.47 | 1.1 | 3.71 | 2.05 | 1.27 | 1.06 | 1.32 | 1.89 | 1.15 |
| *Chthoniobacter* | 0.69 | 1.73 | 1.27 | 0.03 | 1.94 | 1.43 | 2.35 | 0.76 | 1.63 | 0.83 | 2.83 | 0.92 | 1.1 |
| *Arenimonas* | 0.48 | 0.37 | 0.84 | 0.06 | 0.64 | 0.16 | 0.18 | 0.28 | 0.35 | 0.01 | 0.46 | 0.11 | 1.07 |
| *Massilia* | 1.46 | 0.99 | 1.32 | 1.36 | 1.69 | 0.16 | 2.14 | 0.11 | 0.45 | 0.39 | 1.01 | 1.09 | 1.06 |
| *Opitutus* | 0.77 | 0.54 | 1.09 | 0 | 1.25 | 0.82 | 0.87 | 0.14 | 0.63 | 0.67 | 1.28 | 0.64 | 1 |
| *Pseudomonas* | 0.48 | 0.28 | 0.4 | 0.93 | 0.88 | 0.33 | 0.9 | 0.08 | 0.55 | 0.19 | 0.46 | 1.2 | 0.98 |
| *Ferruginibacter* | 0.48 | 0.99 | 2.15 | 0.26 | 0.78 | 0.66 | 0.27 | 0.47 | 2.28 | 0.51 | 1.07 | 0.91 | 0.98 |
| *Steroidobacter* | 0.02 | 0.05 | 0.1 | *9.07* | 0.27 | 0 | 0.09 | 0.05 | 0.13 | 0.05 | 0.01 | 0.3 | 0.45 |
| *Ktedonobacter* | 0 | *5.61* | 0.01 | 0.26 | 0 | 0.05 | 0 | 0.08 | 0 | 0.17 | 0 | 0 | 0.26 |
| *Escherichia_Shigella* | 1.5 | 0.69 | 0.63 | 0 | 1.37 | 1.1 | 2.26 | 0.25 | 1.71 | 0.79 | 2.01 | 1.23 | 0.87 |
| *Terrimonas* | 1.95 | 0.54 | 1.16 | 0 | 2.11 | 0.6 | 1.54 | 1.35 | 2.38 | 0.59 | 1.88 | 0.71 | 0.84 |
| *Novosphingobium* | 0.92 | 0.82 | 0.9 | 0.16 | 1.42 | 1.54 | 0.9 | 0.64 | 1.45 | 0.53 | 1.03 | 0.85 | 0.84 |
| *Rhodanobacter* | 0.19 | 0.23 | 0.08 | 3.98 | 0.02 | 0.27 | 0.3 | 0.08 | 0.03 | 0.49 | 0.24 | 0.39 | 0.81 |
| *Blastopirellula* | 1.65 | 0.76 | 0.79 | 0.03 | 0.86 | 0.38 | 0.84 | 0.19 | 1.47 | 0.51 | 1.49 | 0.95 | 0.78 |
| *Gemmata* | 0.74 | 1.33 | 1.2 | 0.03 | 2.06 | 0.93 | 1.57 | 0.7 | 1.51 | 0.75 | 1.86 | 0.84 | 0.77 |
| *Phycisphaera* | 0.55 | 1.24 | 0.95 | 0.06 | 1.03 | 0.93 | 0.78 | 0.42 | 2.04 | 0.61 | 0.99 | 0.77 | 0.77 |
| *Cryobacterium* | 0.21 | 2.45 | 0.42 | 2.02 | 1.15 | 0.38 | 0.33 | 0.16 | 0.63 | 0.41 | 0.9 | 0.86 | 0.76 |
| *Lysobacter* | 0.19 | 1.34 | 0.58 | 0.96 | 0.14 | 0 | 0.15 | 0.08 | 0.07 | 0.07 | 0.09 | 0.19 | 0.69 |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.1: Bacterial DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Polaromonas* | 0.97 | 0.57 | 0.16 | 0.59 | 0.6 | 0.79 | 0.78 | 0.81 | 0.38 | 0.95 | 0.83 | 0.49 | 0.67 |
| *Frateuria* | 0.53 | 0.75 | 0.36 | 0.57 | 0.26 | 0.4 | 0.42 | 0.33 | 0.22 | 1.54 | 3.32 | 3.81 | 0.63 |
| *Acidobacterium* | 0.24 | 0.59 | 0.21 | 0.38 | 0.31 | 0.16 | 0 | 0.19 | 0.2 | 0.4 | 0 | 0.22 | 0.63 |
| *Haliangium* | 0.36 | 1.09 | 0.65 | 0.59 | 0.56 | 0.5 | 0.28 | 0.52 | 0.81 | 0.45 | 0.83 | 0.77 | 0.6 |
| *Bacillus* | 0.49 | 0.13 | 1.82 | 0.61 | 0.42 | 0.51 | 4.55 | 0.19 | 0.09 | 0.27 | 0 | 0.14 | 0.59 |
| *Hyphomicrobium* | 0.72 | 0.57 | 0.4 | 0.44 | 0.58 | 0.46 | 0.39 | 0.33 | 0.7 | 0.9 | 1.66 | 0.55 | 0.58 |
| *Planctomyces* | 0.95 | 1.05 | 0.91 | 0.7 | 0.6 | 0.76 | 0.85 | 0.86 | 0.95 | 0.86 | 0 | 0.25 | 0.57 |
| *Acidimicrobiales* | 0.74 | 0.44 | 0.57 | 0.74 | 0.4 | 0.29 | 0.56 | 0.66 | 0.58 | 0.31 | 0 | 0.62 | 0.55 |
| *Angustibacter* | 0.28 | 0.15 | 0.4 | 0.06 | 2.55 | 0.53 | 0.96 | 1.14 | 0 | 0.45 | 0.83 | 0.83 | 0.55 |
| *Sufflavibacter* | 1.12 | 1 | 0.48 | 0.74 | 0.31 | 0.34 | 0.17 | 0.81 | 0.43 | 0.04 | 0.11 | 0.16 | 0.53 |
| *Rubrobacter* | 0.26 | 0.51 | 0.23 | 0.4 | 0.42 | 0.21 | 0.39 | 0.19 | 0.51 | 0.04 | 1.06 | 0.2 | 0.52 |
| *Ws3 (Candidate Division)* | 0.05 | 0.19 | 0.29 | 0.34 | 0.1 | 0.22 | 0 | 0.28 | 0.66 | 0.5 | 0.11 | 0.05 | 0.5 |
| *Corynebacteriales* | 0.38 | 0.46 | 0.78 | 0.65 | 0.4 | 0.56 | 0 | 0.28 | 0.19 | 0.27 | 0 | 0.12 | 0.49 |
| *Leeia* | 1.08 | 0.53 | 1.18 | 1.1 | 1.04 | 0.72 | 1.06 | 0.95 | 0.11 | 1 | 0.35 | 0.31 | 0.48 |
| *Candidatus_Xiphinematobacter* | 0.32 | 0.46 | 0.25 | 0.23 | 0.26 | 0.63 | 0.07 | 0.43 | 0.89 | 0.63 | 0.47 | 0.68 | 0.46 |
| *Cystobacterineae* | 0.36 | 0.71 | 0.65 | 0.65 | 0.42 | 0.24 | 0.35 | 0.38 | 0.15 | 0.27 | 0.47 | 0.98 | 0.44 |
| *Ferritrophicum* | 1.19 | 0.86 | 0.42 | 0.57 | 0.33 | 0.29 | 0.03 | 0.28 | 0.17 | 0.27 | 0.11 | 0.09 | 0.4 |
| *Oryzihumus* | 0.01 | 0.11 | 0 | 0.19 | 0.05 | 0.14 | 0.03 | 0.19 | 1.29 | 0.04 | 0 | 0 | 0.39 |
| *Pedobacter* | 0.17 | 0.23 | 0 | 0.59 | 1.18 | 0.34 | 0.39 | 1.09 | 0.32 | 0.63 | 0 | 0.33 | 0.38 |
| *Acidovorax* | 0.11 | 0.28 | 0.12 | 0.21 | 0.46 | 0.06 | 0.03 | 0.52 | 0.66 | 0.22 | 0.71 | 0.11 | 0.36 |
| *Sulfuricella* | 1 | 0.67 | 0.33 | 0.31 | 0.81 | 0.19 | 0.39 | 0.28 | 0.03 | 0.09 | 0 | 0.07 | 0.36 |
| *Kaistobacter* | 0.39 | 0.44 | 0.21 | 0.4 | 0.26 | 0.66 | 0.17 | 1.57 | 0.13 | 1.13 | 0.11 | 0.53 | 0.35 |
| *Candidatus_Solibacter* | 0.15 | 0.26 | 0.46 | 0.27 | 0.19 | 0.43 | 0 | 0.33 | 0.53 | 0.09 | 0 | 0.2 | 0.34 |
| *Sorangiineae* | 0.13 | 0.44 | 0.12 | 0.21 | 0.05 | 0.93 | 0 | 0.23 | 1.08 | 0.81 | 0.35 | 0.24 | 0.34 |
| *Caenimonas* | 0.05 | 0.26 | 0.04 | 0.38 | 0.54 | 0.04 | 0.85 | 0.66 | 0.19 | 1 | 0 | 1.59 | 0.32 |
| *Aquicella* | 0.72 | 0.17 | 0.16 | 0.97 | 0.14 | 0.5 | 0.07 | 0.33 | 0.32 | 0 | 0 | 0.27 | 0.32 |
| *Zavarzinella* | 0.13 | 0.15 | 0.1 | 0.23 | 0.24 | 0.25 | 0 | 0.28 | 0.24 | 0.27 | 0.23 | 0.01 | 0.32 |
| *Streptomyces* | 0.19 | 0.28 | 0.23 | 0.48 | 0.15 | 0.11 | 0.17 | 0.43 | 0.41 | 0.4 | 0 | 0.07 | 0.32 |
| *Patulibacter* | 0.79 | 0.5 | 0.31 | 0.14 | 1.24 | 0.53 | 0.1 | 0.47 | 0.38 | 0.18 | 0 | 0.09 | 0.31 |
| *Parvibaculum* | 2.03 | 0.5 | 0.53 | 0.21 | 0.88 | 0.53 | 0.17 | 0.62 | 0.01 | 0.45 | 0.23 | 1.07 | 0.31 |
| *Flavisolibacter* | 0.05 | 0.34 | 0.06 | 0.36 | 0.15 | 0.06 | 0 | 0.23 | 0.43 | 0.04 | 0 | 0.11 | 0.3 |
| *Comamonas* | 0.09 | 0.28 | 0.16 | 0.31 | 0.49 | 0.63 | 1.03 | 0.9 | 0.51 | 0.45 | 0.11 | 0.31 | 0.3 |
| *Solitalea* | 0.13 | 0.4 | 0.25 | 1.02 | 0.3 | 0.22 | 0 | 0.23 | 0.15 | 0.4 | 0.59 | 0.92 | 0.29 |
| *Nitrosovibrio* | 0.57 | 0.59 | 1.08 | 0.72 | 0.21 | 1.1 | 0.46 | 0.62 | 0 | 0.18 | 0 | 0.27 | 0.29 |
| *Spam (Candidate Division)* | 0.95 | 0.26 | 0.57 | 0.38 | 0.17 | 0.8 | 0 | 0.09 | 0.15 | 0.04 | 0 | 0.01 | 0.29 |

*indicates sample recovered from oxidized zone

## *Table C.1(Cont.): Bacterial DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Polaromonas* | 1.11 | 1.43 | 0.7 | 0.26 | 1.47 | 0.16 | 1.75 | 0.08 | 0.13 | 0.13 | 0.55 | 0.44 | 0.67 |
| *Frateuria* | 0.35 | 0.28 | 0.47 | 0 | 0.61 | 0 | 0.18 | 0.11 | 0.29 | 0.01 | 0.07 | 0.19 | 0.63 |
| *Acidobacterium* | 0.77 | 1.49 | 0.58 | 0.33 | 0.78 | 1.26 | 0.93 | 2.79 | 0.83 | 0.87 | 0.7 | 0.82 | 0.63 |
| *Haliangium* | 0.84 | 0.53 | 0.63 | 0 | 1.03 | 0.16 | 0.3 | 0.47 | 0.85 | 0.47 | 1.3 | 0.47 | 0.6 |
| *Bacillus* | 0.55 | 0.38 | 0.37 | 0 | 0.66 | 0.11 | 2.23 | 0 | 0.25 | 0.19 | 0.05 | 0.18 | 0.59 |
| *Hyphomicrobium* | 0.76 | 0.26 | 0.54 | 0.13 | 0.98 | 0.71 | 0.69 | 0.28 | 0.41 | 0.21 | 0.51 | 0.67 | 0.58 |
| *Planctomyces* | 0.89 | 0.22 | 0.84 | 0.16 | 0.24 | 0.22 | 0.57 | 0 | 0.97 | 0.21 | 0.28 | 0.3 | 0.57 |
| *Acidimicrobiales* | 0.44 | 0.78 | 0.77 | 1.16 | 0.64 | 0.27 | 0.72 | 0.5 | 0.69 | 0.71 | 0.26 | 0.43 | 0.55 |
| *Angustibacter* | 0.16 | 0.68 | 0.14 | 3.12 | 0 | 0.11 | 0 | 0.05 | 0 | 0.53 | 0 | 0.19 | 0.55 |
| *Sufflavibacter* | 0.61 | 0.2 | 0.79 | 0.23 | 0.14 | 0.11 | 0.93 | 0.22 | 1.51 | 1 | 0.65 | 0.57 | 0.53 |
| *Rubrobacter* | 0.32 | 1.15 | 0.45 | 0.06 | 0.83 | 0.22 | 1.72 | 0.59 | 0.65 | 0.41 | 0.99 | 0.64 | 0.52 |
| *Ws3 (Candidate Division)* | 0.59 | 0.39 | 0.45 | 0 | 1.57 | 0.66 | 1.32 | 0.31 | 1.05 | 0.73 | 1.2 | 0.98 | 0.5 |
| *Corynebacteriales* | 1.29 | 0.28 | 0.22 | 0 | 0.83 | 0.22 | 1.45 | 0.08 | 0.97 | 0.23 | 1.51 | 0.71 | 0.49 |
| *Leeia* | 0.59 | 0.11 | 0.24 | 0.06 | 0 | 0 | 0.06 | 0.19 | 0 | 0.17 | 0 | 0.77 | 0.48 |
| *Candidatus_Xiphinematobacter* | 0.5 | 0.19 | 0.42 | 0 | 0.88 | 0.93 | 0.66 | 0.16 | 0.81 | 0.19 | 0.76 | 0.35 | 0.46 |
| *Cystobacterineae* | 0.57 | 0.29 | 0.63 | 0 | 0.51 | 0.16 | 0.51 | 0.25 | 0.75 | 0.15 | 0.78 | 0.4 | 0.44 |
| *Ferritrophicum* | 0.44 | 0.75 | 1.09 | 0 | 0.34 | 0.22 | 0.87 | 0.16 | 0.27 | 0.13 | 0.13 | 0.6 | 0.4 |
| *Oryzihumus* | 0.43 | 0.31 | 0.21 | 0 | 1.23 | 0.44 | 0.18 | 1.18 | 1.31 | 0.01 | 1.97 | 0.09 | 0.39 |
| *Pedobacter* | 0.02 | 0.93 | 0.72 | 1.16 | 0.09 | 0 | 0.12 | 0.14 | 0.49 | 0.01 | 0.15 | 0.02 | 0.38 |
| *Acidovorax* | 0.51 | 1.55 | 0.47 | 0.03 | 0.61 | 0.27 | 0.36 | 0.16 | 0.51 | 0.09 | 0.36 | 0.16 | 0.36 |
| *Sulfuricella* | 0.62 | 0.19 | 1.71 | 0.03 | 0.36 | 0.05 | 0.09 | 0 | 0.27 | 0.27 | 0.05 | 0.72 | 0.36 |
| *Kaistobacter* | 0.77 | 0.63 | 0.38 | 0.06 | 0.09 | 0 | 0 | 0.05 | 0.17 | 0.01 | 0.05 | 0.19 | 0.35 |
| *Candidatus_Solibacter* | 0.2 | 0.47 | 0.63 | 0 | 0.76 | 0.71 | 0.33 | 0.08 | 0.73 | 0.21 | 0.61 | 0.56 | 0.34 |
| *Sorangiineae* | 0.16 | 0.04 | 0.24 | 0 | 0.71 | 0.22 | 0.39 | 0.11 | 0.57 | 0.35 | 0.38 | 0.32 | 0.34 |
| *Caenimonas* | 0.39 | 0.35 | 0.4 | 0.19 | 0.17 | 0.05 | 0.15 | 0.02 | 0.11 | 0.01 | 0.32 | 0.02 | 0.32 |
| *Aquicella* | 0.2 | 0.35 | 0.33 | 0.06 | 0.44 | 0.27 | 0.21 | 0.56 | 0.67 | 0.41 | 0.32 | 0.28 | 0.32 |
| *Zavarzinella* | 0.34 | 0.68 | 0.7 | 0 | 0.64 | 0.16 | 0.42 | 0.08 | 0.53 | 0.53 | 0.84 | 0.58 | 0.32 |
| *Streptomyces* | 0.35 | 0.29 | 0.37 | 0 | 0.36 | 0.11 | 1.02 | 0.19 | 0.79 | 0.27 | 0.61 | 0.32 | 0.32 |
| *Patulibacter* | 0.31 | 0.16 | 0.22 | 0 | 0.14 | 0.22 | 0.3 | 0.11 | 0.25 | 0.17 | 0.23 | 0.61 | 0.31 |
| *Parvibaculum* | 0.09 | 0 | 0.05 | 0.03 | 0 | 0.05 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.31 |
| *Flavisolibacter* | 0.25 | 0.56 | 0.91 | 0.03 | 0.96 | 0.16 | 0.72 | 0.05 | 0.71 | 0.19 | 0.4 | 0.46 | 0.3 |
| *Comamonas* | 0.21 | 0.1 | 0.19 | 0.03 | 0.07 | 0.11 | 0.03 | 0.11 | 0.21 | 0.23 | 0.24 | 0.32 | 0.3 |
| *Solitalea* | 0.17 | 0.22 | 0.31 | 0 | 0.51 | 0.22 | 0.12 | 0.08 | 0.23 | 0.03 | 0.19 | 0.36 | 0.29 |
| *Nitrosovibrio* | 0.34 | 0.1 | 0.15 | 0.03 | 0.32 | 0.11 | 0.09 | 0 | 0.05 | 0.03 | 0 | 0.04 | 0.29 |
| *Spam (Candidate Division)* | 0.4 | 0.13 | 0.21 | 0 | 0.34 | 0.05 | 1.17 | 0.02 | 0.13 | 0.09 | 0.51 | 0.47 | 0.29 |
| *Polaromonas* | 1.11 | 1.43 | 0.7 | 0.26 | 1.47 | 0.16 | 1.75 | 0.08 | 0.13 | 0.13 | 0.55 | 0.44 | 0.67 |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.1: Bacterial DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Herbaspirillum* | 0.03 | 0.48 | 0.12 | 0.59 | 0.4 | 0.06 | 1.17 | 0.14 | 0.07 | 0.68 | 1.54 | 0.24 | 0.29 |
| *Nitriliruptor* | 0.34 | 0.42 | 0.16 | 0.17 | 0 | 0.01 | 0.49 | 0.04 | 0.45 | 0.13 | 0.11 | 0.01 | 0.28 |
| *Pseudoxanthomonas* | 0.01 | 0.5 | 0.08 | 0.21 | 0 | 0.06 | 0 | 1.14 | 0.55 | 0.45 | 0.23 | 0 | 0.27 |
| *Flavobacterium* | 1.25 | 0.23 | 0.14 | 0.31 | 0.03 | 0.32 | 0.03 | 0.33 | 0.79 | 0.31 | 0 | 0 | 0.27 |
| *Ectothiorhodospira* | 0.2 | 0.07 | 0.12 | 0.04 | 0.05 | 0.25 | 0 | 0 | 0.26 | 0.13 | 0.83 | 0.2 | 0.27 |
| *Nocardioides* | 0 | 0.3 | 0 | 0.23 | 0.15 | 0.19 | 0.67 | 0.47 | 0.6 | 0.54 | 0.35 | 0.29 | 0.27 |
| *Pedomicrobium* | 0.26 | 0.15 | 0.23 | 0.48 | 0.07 | 0.21 | 0.03 | 0.23 | 0.38 | 0.31 | 0.11 | 0 | 0.26 |
| *Barnesiella* | 0.74 | 0.78 | 0.57 | 0.82 | 0.21 | 0.19 | 0.07 | 0.23 | 0.09 | 0 | 0 | 0.25 | 0.25 |
| *Longilinea* | 0.15 | 0.4 | 0.25 | 0.63 | 0.12 | 0.16 | 0 | 0.19 | 0.76 | 0.09 | 0 | 0 | 0.25 |
| *Nitrospira* | 0.22 | 0 | 0.04 | 0.14 | 0.12 | 0.04 | 0.1 | 0.09 | 0.34 | 0 | 0 | 0 | 0.25 |
| *Gelria* | 0.15 | 0.13 | 0.31 | 0.25 | 0.01 | 0.09 | 0.03 | 0.14 | 0.34 | 0.22 | 0 | 0.16 | 0.24 |
| *Leucothrix* | 0.47 | 0.32 | 0.89 | 0.89 | 0.14 | 0.97 | 0.17 | 0.04 | 0 | 0.04 | 0 | 0.77 | 0.24 |
| *Bradyrhizobium* | 0.09 | 0.4 | 0.02 | 0.17 | 0.15 | 0.25 | 0.17 | 0.19 | 0.7 | 0.18 | 0.23 | 0.24 | 0.23 |
| *Xanthomonas* | 0.17 | 0.65 | 0.38 | 0.04 | 0.4 | 0.17 | 0.1 | 0.38 | 0.3 | 0.36 | 0 | 0.31 | 0.23 |
| *Couchioplanes* | 0 | 0.28 | 0.06 | 0 | 0.01 | 0.06 | 0 | 0.43 | 0.7 | 2.13 | 0.83 | 0.05 | 0.23 |
| *Hgci_Clade* | 0.28 | 0.13 | 0.02 | 0.25 | 0.26 | 0.08 | 0.99 | 0.23 | 0.34 | 0.18 | 0 | 0.07 | 0.22 |
| *Thiomonas* | 0 | 0 | 2.5 | 0 | 0.01 | 0.08 | 0 | 0 | 0.03 | 0.13 | 0 | 0 | 0.2 |
| *Cellulomonas* | 0.03 | 0.26 | 0 | 0.1 | 0.01 | 0.12 | 0.03 | 0.47 | 0.41 | 0.18 | 0 | 0 | 0.2 |
| *Prosthecobacter* | 0.11 | 0.4 | 0.12 | 0.63 | 0.4 | 0.19 | 0.03 | 0.14 | 0.24 | 0 | 0 | 0.07 | 0.19 |
| *Flavihumibacter* | 0.13 | 0.11 | 0.12 | 0.23 | 0.05 | 0.08 | 0.07 | 0.09 | 0.38 | 0.13 | 0.35 | 0.01 | 0.19 |
| *Sideroxydans* | 0 | 0 | 1.29 | 0 | 0.05 | 0.03 | 0.1 | 0 | 0.05 | 0 | 0 | 0 | 0.19 |
| *Haliea* | 0.58 | 0.55 | 0.33 | 0.27 | 0.44 | 0.66 | 0.03 | 0.38 | 0.01 | 0.22 | 0.35 | 0.48 | 0.18 |
| *Devosia* | 0.24 | 0.11 | 0.06 | 0.14 | 0.19 | 0.04 | 0.17 | 0.14 | 0.36 | 0.63 | 0.11 | 0.49 | 0.18 |
| *Iamia* | 0.15 | 0.11 | 0.21 | 0.12 | 0.51 | 0.06 | 0.1 | 0.09 | 0.03 | 0.72 | 0.35 | 0.09 | 0.18 |
| *Owenweeksia* | 0.34 | 0.48 | 0.14 | 0.36 | 0.39 | 0.22 | 0.07 | 0.43 | 0.2 | 0.27 | 0 | 0.57 | 0.18 |
| *Brevundimonas* | 0.05 | 0.11 | 0.04 | 0.06 | 1.11 | 0.11 | 0.21 | 0.43 | 0.24 | 0.4 | 0.11 | 0.33 | 0.17 |
| *Kineosporia* | 0.01 | 0.26 | 0 | 0.04 | 0.07 | 0.04 | 0 | 0.33 | 1.36 | 0.5 | 0 | 0.03 | 0.17 |
| *Phaselicystis* | 0.05 | 0.21 | 0.33 | 0.04 | 0.12 | 0.04 | 0 | 0.23 | 0.49 | 0.18 | 0 | 0.22 | 0.17 |
| *Salinibacterium* | 0.24 | 0.09 | 0.04 | 0.04 | 0.37 | 0.04 | 0.39 | 0.09 | 0.32 | 0.09 | 0.35 | 0.29 | 0.17 |
| *Sphingopyxis* | 0.15 | 0.17 | 0 | 0.31 | 0.37 | 0.04 | 0.14 | 0.43 | 0.19 | 0.36 | 0.35 | 0.33 | 0.17 |
| *Pseudofulvimonas* | 0.24 | 0.88 | 0.87 | 0.61 | 0.07 | 0.24 | 0 | 0.38 | 0 | 0.09 | 0 | 0.11 | 0.16 |
| *Aeromicrobium* | 0 | 0 | 0 | 0.12 | 0 | 0 | 0.03 | 0.19 | 0.28 | 0 | 0 | 0.01 | 0.16 |
| *Silanimonas* | 0.41 | 0.21 | 0.48 | 0.34 | 0.42 | 0.17 | 0.32 | 0.19 | 0.01 | 0.18 | 0 | 0.53 | 0.16 |
| *Pseudonocardia* | 0.01 | 0 | 0 | 0.08 | 0.03 | 0.01 | 0.07 | 0.62 | 0.28 | 0.72 | 0 | 0.11 | 0.16 |
| *Anaerolinea* | 0.01 | 0 | 0.12 | 0.04 | 0.1 | 0.01 | 0 | 0.09 | 0.09 | 0.04 | 0.35 | 0.01 | 0.16 |

*indicates sample recovered from oxidized zone

## *Table C.1(Cont.): Bacterial DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Herbaspirillum* | 0.04 | 0.63 | 0.22 | 0.33 | 0.02 | 0 | 0.03 | 0 | 0.07 | 0 | 0.01 | 0.04 | 0.29 |
| *Nitriliruptor* | 0.27 | 0.19 | 0.47 | 0 | 0.34 | 0.22 | 0.54 | 0.08 | 0.47 | 0.41 | 1.05 | 0.28 | 0.28 |
| *Pseudoxanthomonas* | 0.27 | 0.11 | 0.15 | 0 | 0.39 | 0.11 | 0.18 | 0.14 | 0.63 | 0.19 | 0.15 | 1.06 | 0.27 |
| *Flavobacterium* | 0.1 | 0.2 | 0.47 | 0 | 0.93 | 0.22 | 0.03 | 0.14 | 0.01 | 0 | 0.05 | 0.58 | 0.27 |
| *Ectothiorhodospira* | 0.65 | 0.13 | 0.54 | 0 | 0.32 | 0 | 1.75 | 0 | 0.21 | 0.15 | 0.07 | 0.43 | 0.27 |
| *Nocardioides* | 0.05 | 0.38 | 0.26 | 0 | 0.27 | 0.16 | 0.03 | 0.02 | 0.57 | 0.35 | 0.32 | 0.18 | 0.27 |
| *Pedomicrobium* | 0.43 | 0.34 | 0.3 | 0 | 0.32 | 0.11 | 0.42 | 0.33 | 0.37 | 0.15 | 0.38 | 0.74 | 0.26 |
| *Barnesiella* | 0.08 | 0.05 | 0.01 | 0.23 | 0.27 | 0 | 0.12 | 0.25 | 0.37 | 0.39 | 0.28 | 0.12 | 0.25 |
| *Longilinea* | 0.46 | 0.02 | 0.3 | 0 | 0.32 | 0.16 | 0.75 | 0.11 | 0.47 | 0.09 | 0.44 | 0.19 | 0.25 |
| *Nitrospira* | 0.55 | 0.32 | 0.61 | 0 | 1.05 | 0.44 | 0.72 | 0.25 | 0.11 | 0.17 | 0.21 | 0.37 | 0.25 |
| *Gelria* | 0.16 | 1.09 | 0.08 | 0.23 | 0.64 | 0.22 | 0.48 | 0.05 | 0.31 | 0.19 | 0.32 | 0.22 | 0.24 |
| *Leucothrix* | 0.55 | 0.02 | 0.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0.03 | 0 | 0.01 | 0.24 |
| *Bradyrhizobium* | 0.39 | 0.25 | 0.03 | 0 | 0.36 | 0.05 | 0.15 | 0.25 | 0.41 | 0.27 | 0.46 | 0.23 | 0.23 |
| *Xanthomonas* | 0.16 | 0.25 | 1.14 | 0 | 0.04 | 0 | 0 | 0.08 | 0.13 | 0.01 | 0.32 | 0.25 | 0.23 |
| *Couchioplanes* | 0.02 | 0.04 | 0.08 | 0 | 0.07 | 0.27 | 0 | 0.02 | 0.23 | 0.01 | 0.03 | 0.15 | 0.23 |
| *Hgci_Clade* | 0.44 | 0.01 | 0.15 | 0.06 | 0.22 | 0.38 | 0.36 | 0.02 | 0.31 | 0.11 | 0.17 | 0.23 | 0.22 |
| *Thiomonas* | 0 | 0 | 0 | 0.13 | 0 | 0.44 | 0 | 1.38 | 0 | 0.07 | 0 | 0.21 | 0.2 |
| *Cellulomonas* | 0.05 | 0.59 | 0.1 | 0.09 | 1 | 0.05 | 0 | 0.33 | 0.35 | 0.09 | 0.36 | 0.08 | 0.2 |
| *Prosthecobacter* | 0.48 | 0.08 | 0.31 | 0 | 0.07 | 0.49 | 0.09 | 0.02 | 0.29 | 0.09 | 0.3 | 0.11 | 0.19 |
| *Flavihumibacter* | 0.06 | 0.56 | 0.33 | 0.06 | 0.14 | 0.22 | 0.12 | 0.31 | 0.15 | 0.15 | 0.44 | 0.28 | 0.19 |
| *Sideroxydans* | 0 | 0.26 | 0.01 | 0.09 | 0 | 0.55 | 0 | 1.49 | 0 | 0.33 | 0 | 0.33 | 0.19 |
| *Haliea* | 0.01 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0.18 |
| *Devosia* | 0.12 | 0.19 | 0.15 | 0 | 0.27 | 0 | 0.06 | 0.02 | 0.21 | 0.11 | 0.11 | 0.39 | 0.18 |
| *Iamia* | 0.08 | 0.2 | 0.21 | 0 | 0.12 | 0.16 | 0.33 | 0.02 | 0.19 | 0.05 | 0.24 | 0.14 | 0.18 |
| *Owenweeksia* | 0.12 | 0.01 | 0.08 | 0 | 0.07 | 0.05 | 0 | 0 | 0.13 | 0.11 | 0.13 | 0.08 | 0.18 |
| *Brevundimonas* | 0.02 | 0.19 | 0.07 | 0.49 | 0 | 0.05 | 0 | 0 | 0.01 | 0 | 0.03 | 0.15 | 0.17 |
| *Kineosporia* | 0.17 | 0.16 | 0.14 | 0 | 0.04 | 0.05 | 0 | 0.19 | 0.27 | 0.03 | 0.26 | 0.15 | 0.17 |
| *Phaselicystis* | 0.19 | 0.11 | 0.22 | 0 | 0.22 | 0 | 0.45 | 0.16 | 0.33 | 0.11 | 0.13 | 0.25 | 0.17 |
| *Salinibacterium* | 0.17 | 0.17 | 0 | 0.73 | 0.09 | 0.05 | 0.03 | 0 | 0.15 | 0.03 | 0.15 | 0.14 | 0.17 |
| *Sphingopyxis* | 0.28 | 0.16 | 0.05 | 0.09 | 0.14 | 0.05 | 0.12 | 0 | 0.03 | 0.01 | 0.17 | 0.11 | 0.17 |
| *Pseudofulvimonas* | 0.23 | 0 | 0.08 | 0 | 0 | 0 | 0 | 0 | 0.03 | 0 | 0.15 | 0 | 0.16 |
| *Aeromicrobium* | 0.04 | 0.02 | 0.05 | 0 | 0.29 | 0.38 | 0.24 | 0 | 0.79 | 0.17 | 1.18 | 0.15 | 0.16 |
| *Silanimonas* | 0.12 | 0.13 | 0.24 | 0 | 0.04 | 0 | 0.06 | 0 | 0 | 0.01 | 0 | 0.04 | 0.16 |
| *Pseudonocardia* | 0 | 0.5 | 0 | 0.06 | 0.02 | 1.15 | 0 | 0 | 0.11 | 0.09 | 0 | 0.01 | 0.16 |
| *Anaerolinea* | 0.2 | 0.04 | 0.37 | 0 | 0.34 | 0.05 | 0.24 | 0 | 0.71 | 0.13 | 0.8 | 0.11 | 0.16 |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.1: Bacterial DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Legionella* | 0.07 | 0.19 | 0.29 | 0.12 | 0.35 | 0.22 | 0.17 | 0.38 | 0.36 | 0 | 0 | 0.42 | 0.07 |
| *Rhodoplanes* | 0.09 | 0.25 | 0.08 | 0.29 | 0.1 | 0.06 | 0.03 | 0.19 | 0.26 | 0.13 | 0 | 0.01 | 0.09 |
| *Hymenobacter* | 0 | 0.03 | 0 | 0.21 | 0.07 | 0.09 | 0.07 | 0 | 0 | 0.31 | 0 | 0.11 | 0 |
| *Bdellovibrio* | 0.24 | 0.09 | 0.06 | 0.06 | 0.24 | 0.17 | 0.14 | 0.38 | 0.11 | 0 | 0 | 0 | 0.24 |
| *Acidiphilium* | 0 | 0 | 0.29 | 0 | 0.01 | 0 | 0.03 | 0 | 0.01 | 0.09 | 0 | 0.03 | 0 |
| *Nannocystineae* | 0.2 | 0.05 | 0.16 | 0.29 | 0.05 | 0.11 | 0.07 | 0.09 | 0.36 | 0.13 | 0 | 0.25 | 0.2 |
| *Verrucomicrobium* | 0.36 | 0.11 | 0.67 | 0.46 | 0.54 | 0.48 | 0.17 | 0 | 0.07 | 0 | 0 | 0.51 | 0.36 |
| *Defluviicoccus* | 0.05 | 0.13 | 0.19 | 0.06 | 0.12 | 0.12 | 0.07 | 0.14 | 0.13 | 0.13 | 0.71 | 0.29 | 0.05 |
| *Rhodoferax* | 0.03 | 0.03 | 0 | 0.06 | 0.03 | 0.17 | 0.17 | 0 | 0.96 | 0.09 | 0 | 0.03 | 0.03 |
| *Anaerobaculum* | 0.01 | 0.01 | 0.16 | 0.02 | 0.15 | 0.08 | 0.03 | 0.04 | 0.03 | 0 | 0 | 0.09 | 0.01 |
| *Erythrobacter* | 0.07 | 0.11 | 0.04 | 0.02 | 1.25 | 0.04 | 0.17 | 0.38 | 0.05 | 0.18 | 0 | 0.2 | 0.07 |
| *Frondihabitans* | 0.15 | 0.09 | 0.04 | 0.04 | 0.1 | 0.06 | 0 | 0 | 0.07 | 0 | 0 | 0.01 | 0.15 |
| *Ferrithrix* | 0 | 0 | 0.12 | 0 | 0.05 | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 | 0 |
| *Frankiales* | 0.11 | 0.11 | 0.04 | 0.17 | 0.23 | 0.01 | 0.81 | 0.19 | 0 | 0.04 | 0 | 0.29 | 0.11 |
| *Sulfobacillus* | 0 | 0 | 0.27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 |
| *Sphaerobacter* | 0.15 | 0.01 | 0.12 | 0.17 | 0.05 | 0.12 | 0.28 | 0.04 | 0.05 | 0.13 | 0 | 0.25 | 0.15 |
| *Solirubrobacter* | 0.03 | 0.28 | 0.06 | 0.12 | 0.07 | 0.12 | 0 | 0.19 | 0.36 | 0.18 | 0.11 | 0.01 | 0.03 |
| *Metyhlovirgula* | 0 | 0 | 0.08 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nc10 (Candidate Division)* | 0.03 | 0.46 | 0.08 | 0.21 | 0.1 | 0.56 | 0.35 | 0 | 0.07 | 0.04 | 0 | 0 | 0.03 |
| *Perlucidibaca* | 0.11 | 0.11 | 0.02 | 0 | 0.47 | 0.3 | 0 | 0.33 | 0.09 | 0.18 | 0.94 | 0.2 | 0.11 |
| *Rhodobium* | 0.03 | 0.07 | 0.02 | 0.1 | 0.08 | 0.04 | 0.03 | 0 | 0.28 | 0.13 | 0 | 0.01 | 0.03 |
| *Schlesneria* | 0.66 | 0.13 | 0.08 | 0.08 | 0.15 | 0.17 | 0 | 0 | 0.19 | 0 | 0 | 0.03 | 0.66 |
| *Conexibacter* | 0.11 | 0.01 | 0 | 0.06 | 0.03 | 0.04 | 0 | 0 | 0.22 | 0 | 0 | 0 | 0.11 |
| *Thermosinus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.17 | 0 | 0 | 0 | 0 |
| *Altererythrobacter* | 0.13 | 0.05 | 0.04 | 0.06 | 0.05 | 0.11 | 0 | 0.09 | 0.38 | 0.36 | 0 | 0.01 | 0.13 |
| *Humicoccus* | 0 | 0.03 | 0 | 0.02 | 0.03 | 0.03 | 0 | 0.23 | 0.58 | 0.36 | 0 | 0.01 | 0 |
| *Ksb1 (Candidate Division)* | 0.03 | 0.05 | 0.02 | 0.1 | 0.07 | 0.11 | 0 | 0 | 0.07 | 0 | 0 | 0 | 0.03 |
| *Euzebya* | 0.09 | 0.23 | 0.19 | 0.17 | 0.07 | 0.12 | 0 | 0 | 0.19 | 0.18 | 0 | 0 | 0.09 |
| *Thermacetogenium* | 0.01 | 0.01 | 0.02 | 0 | 0.03 | 0 | 0.03 | 0.09 | 0.19 | 0.04 | 0 | 0 | 0.01 |
| *Others ** | *5.76* | *5.73* | *6.69* | *6.66* | *5.64* | *6* | *8.56* | *8.28* | *8.19* | *10.13* | 4.02 | *5.66* | *5.76* |

*indicates sample recovered from oxidized zone

## *Table C.1(Cont.): Bacterial DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Legionella* | 0.04 | 0.07 | 0.1 | 0.33 | 0 | 0.05 | 0.09 | 0.05 | 0.09 | 0.17 | 0.03 | 0.11 | 0.15 |
| *Rhodoplanes* | 0.12 | 0.31 | 0.05 | 0.03 | 0.29 | 0.11 | 0.24 | 0.08 | 0.25 | 0.13 | 0.32 | 0.26 | 0.15 |
| *Hymenobacter* | 0.08 | 0.42 | 0.38 | 1.59 | 0.02 | 0.16 | 0.12 | 0 | 0 | 0.01 | 0.03 | 0 | 0.15 |
| *Bdellovibrio* | 0.13 | 0.07 | 0.22 | 0.16 | 0.04 | 0 | 0.81 | 0 | 0.53 | 0 | 0.13 | 0.08 | 0.15 |
| *Acidiphilium* | 0.01 | 0.14 | 0.07 | 1.49 | 0 | 0.27 | 0 | 0.42 | 0 | 0.57 | 0 | 0.23 | 0.15 |
| *Nannocystineae* | 0.31 | 0.11 | 0.35 | 0 | 0.02 | 0.16 | 0.12 | 0 | 0.09 | 0.03 | 0.55 | 0.07 | 0.15 |
| *Verrucomicrobium* | 0.06 | 0.05 | 0.08 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0.01 | 0.15 |
| *Defluviicoccus* | 0.34 | 0.1 | 0.14 | 0 | 0.04 | 0 | 0.21 | 0.02 | 0.11 | 0.11 | 0.13 | 0.16 | 0.15 |
| *Rhodoferax* | 0.31 | 0.16 | 0.22 | 0 | 0.49 | 0 | 0.24 | 0.22 | 0.07 | 0.07 | 0.07 | 0.04 | 0.14 |
| *Anaerobaculum* | 0 | 0.13 | 0.05 | 0.03 | 0 | 0.66 | 0 | 1.07 | 0.03 | 0.43 | 0 | 0.39 | 0.14 |
| *Erythrobacter* | 0.08 | 0.1 | 0.05 | 0.46 | 0 | 0 | 0.06 | 0 | 0.01 | 0 | 0.03 | 0.02 | 0.14 |
| *Frondihabitans* | 0 | 0.38 | 0.22 | 1.16 | 0.12 | 0.05 | 0.03 | 0.08 | 0.11 | 0.19 | 0.28 | 0.07 | 0.13 |
| *Ferrithrix* | 0 | 0.22 | 0 | 0.29 | 0 | 0.77 | 0 | 0.73 | 0 | 0.75 | 0 | 0.25 | 0.13 |
| *Frankiales* | 0.06 | 0.35 | 0.15 | 0.33 | 0 | 0 | 0.06 | 0.02 | 0.07 | 0.03 | 0.05 | 0.02 | 0.13 |
| *Sulfobacillus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.88 | 0 | 0.05 | 0.13 |
| *Sphaerobacter* | 0.14 | 0.57 | 0.17 | 0.16 | 0.07 | 0.05 | 0.03 | 0.11 | 0.05 | 0.15 | 0.13 | 0.07 | 0.13 |
| *Solirubrobacter* | 0.06 | 0.16 | 0.14 | 0 | 0.14 | 0.11 | 0 | 0 | 0.45 | 0.09 | 0.32 | 0.02 | 0.13 |
| *Metyhlovirgula* | 0 | 0.01 | 0.01 | 0.49 | 0 | 1.26 | 0.03 | 0.76 | 0.01 | 0.03 | 0 | 0.33 | 0.12 |
| *Nc10 (Candidate Division)* | 0.16 | 0.02 | 0.08 | 0 | 0.09 | 0 | 0.3 | 0 | 0.05 | 0.07 | 0.13 | 0.09 | 0.12 |
| *Perlucidibaca* | 0.08 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0.12 |
| *Rhodobium* | 0.09 | 0.11 | 0.17 | 0 | 0.32 | 0.05 | 0.6 | 0.14 | 0.11 | 0.01 | 0.28 | 0.11 | 0.12 |
| *Schlesneria* | 0.53 | 0.07 | 0.19 | 0 | 0.22 | 0 | 0.27 | 0 | 0.03 | 0 | 0.01 | 0.01 | 0.12 |
| *Conexibacter* | 0.05 | 0.2 | 0.08 | 0 | 0.04 | 0.11 | 0.12 | 0.33 | 0.33 | 0.25 | 0.67 | 0.15 | 0.12 |
| *Thermosinus* | 0 | 0.07 | 0.05 | 0.09 | 0.07 | 0 | 0.33 | 0.62 | 0.01 | 1.14 | 0.05 | 0.18 | 0.11 |
| *Altererythrobacter* | 0.13 | 0.01 | 0.24 | 0 | 0.04 | 0.05 | 0.18 | 0.05 | 0.29 | 0.01 | 0.36 | 0.04 | 0.11 |
| *Humicoccus* | 0.05 | 0.2 | 0.14 | 0 | 0 | 0 | 0 | 0.02 | 0.35 | 0.25 | 0.19 | 0.07 | 0.11 |
| *Ksb1 (Candidate Division)* | 0.2 | 0.14 | 0.15 | 0 | 0.27 | 0.16 | 0.63 | 0.05 | 0.17 | 0.03 | 0.24 | 0.04 | 0.1 |
| *Euzebya* | 0.1 | 0.07 | 0.15 | 0 | 0.12 | 0.05 | 0.24 | 0.02 | 0.09 | 0 | 0.38 | 0.09 | 0.1 |
| *Thermacetogenium* | 0.01 | 0.14 | 0.01 | 0.06 | 0 | 0.71 | 0 | 0.62 | 0.03 | 0.25 | 0.01 | 0.11 | 0.1 |
| Others ** | *7.49* | *8.43* | *8.62* | 4.25 | *10.29* | *11.63* | *9.9* | *5.43* | *9.25* | *6.68* | *8.88* | *10.23* | *6.49* |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.2: Fungal DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fungi* | *6.13* | *5.63* | 1.64 | *11.4* | *8.27* | *11.53* | **34.71** | **18.72** | **14.4** | *10.53* | 0 | *10.8* | *9.99* |
| *Pycnopeziza* | *7.97* | 2.1 | **59.77** | 1.7 | 3.92 | *8.62* | 0.94 | 0.87 | 4.5 | 0.23 | 0 | *5.94* | *9.23* |
| *Leptosphaeria* | **24.7** | **16.85** | 1.92 | **12.15** | *7.3* | *9.44* | 0.43 | 3.16 | 2.14 | 2.39 | 0.1 | **12.07** | *6.06* |
| *Tetracladium* | *19.82* | *13.45* | 0.71 | *6.39* | **12.16** | *10.71* | 0.47 | *5.51* | 3.87 | 2.28 | 0 | 2.8 | *5.75* |
| *Cucurbitaria* | *6.47* | *7.24* | 0.59 | *8.37* | *10.21* | **13.13** | *10.26* | *14.23* | 4.04 | *18.96* | 0 | *7.7* | *5.33* |
| *Sclerotinia* | 0.69 | *8.09* | 0.24 | 1.74 | 0.12 | 2.74 | 0.02 | *6.79* | 3.85 | **22.54** | 0 | 0.03 | 4.67 |
| *Chaetomium* | 0.4 | 2.16 | 0.18 | 0.95 | 0.24 | 0.41 | 1.37 | 2.6 | 4.16 | 4.54 | 0 | 2.18 | 4.38 |
| *Chytridiomycota* | 1.07 | 2.3 | 0 | *7.66* | 5 | 0.33 | *17.83* | 1.2 | 0.19 | 4.24 | 0 | 0.13 | 3.6 |
| *Anguillospora* | 0.4 | 0.54 | 1.73 | 0.26 | 0.58 | 0.25 | 0.04 | 0.85 | 0.45 | 0.8 | 0 | 1.14 | 3.23 |
| *Juncigena* | 4.24 | 3.74 | 0.11 | *6.87* | *7.29* | 1.21 | 2.68 | *5.68* | *5.01* | 1.86 | 0 | *8.48* | 3.02 |
| *Chaetothyriales* | 0.25 | 0.92 | 0 | 0.17 | 0.28 | 0.37 | 0.14 | 0.85 | 2.67 | 0.03 | 0 | 0.09 | 2.76 |
| *Oidiodendron* | 1.32 | 1.09 | *7.5* | 1.09 | 3.29 | 2.41 | 1.16 | 0.31 | 0.7 | 0.28 | 0.1 | *8.39* | 2.31 |
| *Ascomycota* | 0.56 | 0.63 | 0.63 | 0.36 | 0.49 | 0.49 | 0.12 | 1.68 | 3.24 | 1.91 | 0 | 0.71 | 2.31 |
| *Malassezia* | 0.02 | 0 | 0 | 0 | 0.1 | 0.05 | 1.06 | 0.02 | 0 | 0.01 | **53.23** | 0.58 | 2.3 |
| *Kionochaeta* | 0.38 | 1.64 | 0.01 | 0.22 | 0.38 | 0.87 | 0.01 | 0.01 | 0.03 | 0.03 | *41.11* | 0 | 1.88 |
| *Spizellomyces* | 0.02 | 1.2 | 0 | 2.43 | 0.95 | 0.21 | 1.29 | 0.12 | 0.17 | 0.79 | 0 | 0.19 | 1.52 |
| *Humicola* | 0.15 | 1.26 | 0.24 | 0.27 | 0.05 | 0.39 | 0.11 | 1.41 | 1.06 | 1.12 | 0 | 0.88 | 1.51 |
| *Didymella* | 1.22 | 1.7 | 0.14 | 4.64 | 0.44 | 0.67 | *6.17* | 3.19 | 1.78 | 3.48 | 0 | 0.97 | 1.29 |
| *Powellomyces* | 0.76 | 4.77 | 0 | 3.01 | *8.98* | 0.07 | 0.77 | 1.41 | 0.47 | 4.97 | 0 | 0.03 | 1.25 |
| *Podosphaera* | 0.89 | 0.27 | 4.93 | 0.34 | 0.93 | 1.15 | 0.22 | 0.1 | 0.21 | 0.04 | 0 | 2.08 | 1.09 |
| *Berkleasmium* | 0.46 | 0.27 | *9.28* | 0.87 | 1.26 | 2.41 | 0.11 | 0.47 | 0.31 | 0.12 | 0.1 | 0.22 | 1 |
| *Byssoascus* | 0.46 | 0.26 | 0.18 | 0.4 | 1.88 | 0.53 | 1.09 | 0.07 | 0.07 | 0.06 | 0 | *7.99* | 0.97 |
| *Cladosporium* | 0.86 | 0.13 | 0.91 | 0.4 | 0.59 | *7.39* | 0.63 | 0.17 | 0.47 | 0.68 | 0 | 1.3 | 0.88 |
| *Hygrocybe* | 0 | 0 | 0 | 0 | 0 | 0.03 | 2.48 | 0.32 | *8.74* | 0 | 0 | 0.09 | 0.86 |
| *Phoma* | 0.89 | 1.17 | 0.08 | 2.31 | 1.35 | 1.77 | 1.05 | 1.99 | 0.82 | 1.39 | 0 | 0.91 | 0.77 |
| *Pyrenochaeta* | 0.33 | 0.96 | 0.03 | 1.6 | 1.7 | 2.64 | 0.18 | *5.81* | 0.19 | 1.14 | 0 | 0.32 | 0.75 |
| *Teratosphaeria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.7 |
| *Calvatia* | 0 | 0 | 0 | 0.03 | 0.1 | 0 | 0 | 0.02 | 0.01 | 0 | 0 | 0.09 | 0.66 |
| *Phialophora* | 0.2 | 0.27 | 0 | 0.08 | 0.28 | 0.13 | 0 | 0.49 | *12.22* | 0.88 | 0 | 0 | 0.63 |
| *Catenomyces* | 0 | 0.84 | 0.02 | *9.54* | 0.4 | 0 | 0.36 | 0.17 | 0.13 | 0.45 | 0 | 0.09 | 0.62 |
| *Valdensinia* | 0 | 0.02 | 0.05 | 0 | 0 | 0.03 | 0.26 | 0 | 0.03 | 0 | 0 | 0.52 | 0.61 |
| *Mycosphaerella* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.03 | 0.05 | 0 | 0 | 0 | 0.51 |
| *Psoroglaena* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 | 0 | 0 | 0 | 0 | 0.5 |
| *Glomeromycota* | 0 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0.03 | 0.01 | 0 | 0 | 0 | 0.32 |
| *Massariosphaeria* | 0.1 | 1.98 | 0 | 0.12 | 0.01 | 0.29 | 0.05 | 2.45 | 0.45 | 1.31 | 0 | 0.03 | 0.5 |
| *Potebniamyces* | 0.2 | 0.05 | 3.75 | 0.01 | 0.14 | 0.25 | 0.28 | 0.01 | 0.03 | 0.01 | 0 | 0.52 | 0.47 |

*indicates sample recovered from oxidized zone

## *Table C.2(Cont.): Fungal DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fungi* | *16.07* | 3.62 | *8.57* | 1.97 | 4.57 | 3.33 | **16.35** | *5.24* | **18.29** | 5 | **15.56** | *7.42* | *9.99* |
| *Pycnopeziza* | 1.61 | *6.27* | *5.12* | *9.22* | 4.73 | *16.8* | 0.33 | 2.83 | 0.59 | **60.53** | 4.56 | *12.3* | *9.23* |
| *Leptosphaeria* | 1.25 | 3.44 | **13.94** | 0.2 | 3.87 | 1.06 | *5.94* | 0.08 | *13.12* | 1.4 | 2.3 | *6.31* | *6.06* |
| *Tetracladium* | 1.82 | 2.44 | 2.95 | 1.93 | *14.75* | 1.43 | 4.24 | 0.72 | *8.98* | 0.34 | *7.57* | **12.64** | *5.75* |
| *Cucurbitaria* | 0.51 | 1.12 | 3.53 | 0.96 | 0.34 | 1.3 | 3.95 | 0.45 | 4.23 | 0.29 | 1.15 | *8.95* | *5.33* |
| *Sclerotinia* | *6.62* | 1.67 | *8.75* | 0.4 | **28.34** | 1.67 | 2.2 | 3.4 | *5.59* | 0.81 | 3.97 | 1.73 | 4.67 |
| *Chaetomium* | **31.66** | 0.07 | 1.48 | 0 | *8.42* | 0.89 | *10.28* | *7.97* | *14.34* | 0.27 | *6.29* | 4.23 | 4.38 |
| *Chytridiomycota* | 0.51 | 0.79 | 1.11 | 0.59 | 0.1 | 0.44 | 0.02 | **42.49** | 0.05 | 0 | 0.2 | 0.05 | 3.6 |
| *Anguillospora* | 0.32 | **47.53** | 2.26 | *11.93* | 3.25 | 1.13 | 0.16 | 0.88 | 0.18 | 1.25 | 0.35 | 1.2 | 3.23 |
| *Juncigena* | *5.54* | 1.06 | 2.41 | 0.39 | 0.67 | 1.09 | 2.47 | 1.11 | *5.22* | 0.46 | 3.49 | 1.46 | 3.02 |
| *Chaetothyriales* | 0.01 | 1.53 | 0.76 | **53.48** | 0 | 1.25 | 0.02 | 2.59 | 0.05 | 0.04 | 0.16 | 0.49 | 2.76 |
| *Oidiodendron* | 0.92 | 2.91 | 2.23 | 1.93 | 3.98 | 2.25 | 1.06 | 0.83 | 0.82 | 2.97 | 1.12 | *6.87* | 2.31 |
| *Ascomycota* | 2.07 | 1.65 | 0.66 | 1.48 | 0.34 | 1.23 | *9.02* | *7.74* | 1.08 | 0.71 | *13.87* | 4.71 | 2.31 |
| *Malassezia* | 0 | 0.03 | 0 | 0 | 0.02 | 0.02 | 0 | 0 | 0 | 0 | 0.06 | 0.01 | 2.3 |
| *Kionochaeta* | 0.19 | 0 | 0.11 | 0 | 0 | 0.07 | 0 | 0 | 0.01 | 0 | 0 | 0.1 | 1.88 |
| *Spizellomyces* | 3.42 | *9.51* | *9.3* | 0.05 | 1.13 | 0.15 | 0.24 | 0.28 | 2.26 | 0.02 | 1.9 | 0.86 | 1.52 |
| *Humicola* | *5.52* | 0.13 | 1.18 | 0 | 3.36 | 0.42 | *5.58* | 3.58 | 4.55 | 0.17 | 2.63 | 2.26 | 1.51 |
| *Didymella* | 0.36 | 0.3 | 1.75 | 0.14 | 0.1 | 0.37 | 0.43 | 0.31 | 1.06 | 0.1 | 0.98 | 0.56 | 1.29 |
| *Powellomyces* | 0.11 | 0.91 | 1.11 | 0.62 | 0 | 0.12 | 0 | 0.77 | 0.01 | 0 | 1.15 | 0 | 1.25 |
| *Podosphaera* | 0.32 | 1.19 | 0.71 | 1.13 | 1.07 | 2.02 | 0.19 | 0.45 | 0.09 | *5.94* | 0.35 | 1.51 | 1.09 |
| *Berkleasmium* | 0.59 | 1.13 | 0.35 | 0.26 | 1.53 | 1.05 | 0.02 | 0.03 | 0.05 | 1.94 | 0.12 | 1 | 1 |
| *Byssoascus* | 0.42 | 1.19 | 1.33 | 0.33 | 1.88 | 0.57 | 0.89 | 0.16 | 0.39 | 0.5 | 0.48 | 2.24 | 0.97 |
| *Cladosporium* | 0.25 | 1.15 | 0.51 | 1.16 | 0.1 | 0.15 | 0.31 | 0.44 | 0.69 | 0.44 | 0.58 | 1.94 | 0.88 |
| *Hygrocybe* | 0.73 | 0 | *7.27* | 0 | 0 | 0.05 | 0 | 0.69 | 0 | 0 | 0.16 | 0.13 | 0.86 |
| *Phoma* | 0.4 | 0.31 | 0.53 | 0.14 | 0.1 | 0.23 | 0.43 | 0.12 | 0.86 | 0.09 | 0.23 | 1.29 | 0.77 |
| *Pyrenochaeta* | 0.17 | 0.08 | 0.36 | 0.04 | 0.08 | 0.03 | 0.09 | 0.04 | 0.93 | 0.07 | 0.18 | 1.03 | 0.75 |
| *Teratosphaeria* | 0 | 0 | 0.01 | 0 | 0 | **16.85** | 0 | 0 | 0 | 0 | 0 | 0 | 0.7 |
| *Calvatia* | 0 | 0.02 | 0.06 | 0.01 | 0.16 | 0.05 | *11.04* | 0.32 | 0.39 | 0 | 3.59 | 0.05 | 0.66 |
| *Phialophora* | 0.11 | 0 | 0.2 | 0.11 | 0 | 0.17 | 0 | 0.01 | 0.01 | 0 | 0.02 | 0.03 | 0.63 |
| *Catenomyces* | 0.21 | 0.14 | 0.9 | 0 | 0.02 | 0.01 | 0.21 | 0.94 | 0.31 | 0.01 | 0.14 | 0.05 | 0.62 |
| *Valdensinia* | 0.13 | 0.46 | 0 | 0.77 | 2.55 | 1.5 | 0 | 0.05 | 0.03 | *7.99* | 0.06 | 0.2 | 0.61 |
| *Mycosphaerella* | 0.01 | 0.04 | 0 | 0 | 0 | *12.24* | 0 | 0.01 | 0 | 0 | 0 | 0.01 | 0.51 |
| *Psoroglaena* | 0 | 0.01 | 0 | 0 | 0 | *10.2* | 0.04 | 0 | 0 | 0 | 0 | 0.05 | 0.5 |
| *Glomeromycota* | 0.19 | 0.03 | 0 | 0 | 0.18 | 0.1 | 0.21 | 0.05 | 0 | 0.03 | *6.48* | 0.27 | 0.32 |
| *Massariosphaeria* | 0.26 | 0.07 | 0.5 | 0 | 0.02 | 0.69 | 0 | 1.35 | 1.74 | 0 | 0.39 | 0.18 | 0.5 |
| *Potebniamyces* | 0.09 | 0.18 | 0.15 | 0.39 | 0.32 | 1 | 0.02 | 0.27 | 0.01 | 2.79 | 0.12 | 0.68 | 0.47 |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.2: Fungal DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Glomeraceae* | 0 | 0.04 | 0 | 0.1 | 0 | 0.05 | 0.12 | 0.02 | 0.01 | 0 | 0 | 0 | 0.41 |
| *Coniochaeta* | 0.1 | 0.61 | 0.04 | 0.12 | 0 | 0.13 | 0.07 | 0.58 | 0.15 | 1.99 | 0 | 0.06 | 0.35 |
| *Acremonium* | 1.38 | 0.15 | 0.33 | 0.08 | 0.45 | 1.01 | 0.02 | 0.16 | 0.72 | 0.01 | 0 | 0.42 | 0.35 |
| *Triparticalcar* | 0.2 | 1.14 | 0 | 0.4 | 4.29 | 0 | 0 | 0.25 | 0 | 0.14 | 0 | 0 | 0.34 |
| *Plectosphaerella* | 2.58 | 0.22 | 0 | 0.19 | 0.79 | 0.07 | 0.08 | 0.37 | 0.17 | 0.15 | 0 | 1.14 | 0.34 |
| *Trichocladium* | 0 | 0.39 | 0.02 | 0.03 | 0.07 | 0.13 | 0.01 | 0.19 | 0.17 | 0.09 | 0 | 0.19 | 0.34 |
| *Paraphoma* | 0.38 | 0.54 | 0.03 | 0.19 | 0.73 | 0.87 | 0.68 | 0.95 | 0.15 | 0.6 | 0 | 0.84 | 0.32 |
| *Ascomycete* | 0.07 | 0.23 | 0.49 | 0.29 | 0.45 | 0.23 | 0.15 | 0.24 | 0.17 | 0.14 | 0 | 0.35 | 0.32 |
| *Rhizophlyctis* | 0.02 | 0.05 | 0 | 0.36 | 0 | 0.15 | 0 | 0.01 | 0.03 | 0 | 0 | 0.26 | 0.3 |
| *Thyridium* | 0.46 | 0.13 | 0.76 | 0.06 | 0.24 | 0.41 | 0.14 | 0.05 | 0.29 | 0 | 0 | 0.26 | 0.27 |
| *Astrosphaeriella* | 0 | 0.17 | 0.34 | 0.31 | 0.15 | 0.61 | 0.28 | 0.25 | 0.82 | 0.12 | 0 | 0.45 | 0.25 |
| *Mortierella* | 0 | 0.22 | 0 | 0.24 | 0.28 | 1.41 | 0 | 0.12 | 0.94 | 0.39 | 0 | 0.09 | 0.23 |
| *Paraglomerales* | 0 | 0 | 0.01 | 0.12 | 0.07 | 0.11 | 0.14 | 0.01 | 0.53 | 0.01 | 0 | 0 | 0.23 |
| *Trechispora* | 1.53 | 0.03 | 0 | 0.05 | 0 | 0 | 0 | 0.53 | 0.03 | 0.17 | 0 | 0 | 0.22 |
| *Hysterobrevium* | 0.48 | 0.17 | 0.76 | 0.33 | 0.17 | 0.41 | 0.08 | 0.08 | 0.17 | 0.01 | 0.1 | 0.35 | 0.22 |
| *Lobulomycetaceae* | 0.05 | 0.15 | 0 | 0.05 | 0 | 0 | 0 | 0 | 0.09 | 0 | 0 | 0 | 0.21 |
| *Hysteropatella* | 1.02 | 0.73 | 0.04 | 0.8 | 0.54 | 0.43 | 0.02 | 0.1 | 0 | 0.12 | 0 | 0.03 | 0.21 |
| *Cladophialophora* | 0.02 | 0.4 | 0 | 0.31 | 0.14 | 0.23 | 0 | 0.78 | 0.6 | 0.12 | 0 | 0 | 0.2 |
| *Sarcosomataceae* | 0 | 0.42 | 0 | 0 | 0.03 | 0.09 | 0 | 0 | 1.41 | 0 | 0 | 0 | 0.2 |
| *Rhinocladiella* | 0.05 | 0.13 | 0 | 0.05 | 0.07 | 0 | 0 | 0.01 | 4.2 | 0.07 | 0 | 0 | 0.2 |
| *Delphinella* | 1.02 | 0.17 | 0.1 | 0.55 | 0.24 | 0.55 | 0.08 | 0.11 | 0.27 | 0.25 | 0 | 0.32 | 0.2 |
| *Myrothecium* | 0.46 | 0.3 | 0 | 0.36 | 0.4 | 0.21 | 0.29 | 0.15 | 0.21 | 0.12 | 0 | 0.75 | 0.19 |
| *Acantholichen* | 0.69 | 0 | 0 | 0.03 | 0.12 | 0.15 | 0.01 | 0.12 | 0.31 | 0.12 | 0 | 0.06 | 0.19 |
| *Mycopepon* | 0.07 | 0.11 | 0 | 0.38 | 0.45 | 0.07 | 0.22 | 0.18 | 0.21 | 0.2 | 0 | 1.04 | 0.19 |
| *Preussia* | 0.02 | 0.11 | 0 | 0.12 | 1.02 | 2.31 | 0.05 | 0.08 | 0.03 | 0.15 | 0 | 0.06 | 0.18 |
| *Hypomyces* | 0.46 | 0.21 | 0 | 0.41 | 0.66 | 0.01 | 0.16 | 0.49 | 0.17 | 0.04 | 0 | 0.52 | 0.18 |
| *Mrakia* | 0 | 0.01 | 0 | 0 | 0.28 | 0 | 0 | 0 | 0.09 | 0 | 3.63 | 0 | 0.18 |
| *Chalara* | 0.02 | 0.1 | 0.1 | 0.19 | 0.01 | 0.21 | 0.07 | 0.07 | 0.15 | 0.19 | 0 | 0.19 | 0.18 |
| *Chlorociboria* | 0.15 | 0.01 | 0.14 | 0 | 0.03 | 0.07 | 0.07 | 0.01 | 0.07 | 0 | 0 | 0.16 | 0.17 |
| *Pezizomycotina* | 0.99 | 0.07 | 0.1 | 0.1 | 0.4 | 0.51 | 0.04 | 0.04 | 0.29 | 0 | 0 | 0.29 | 0.17 |
| *Mucor* | 0 | 0.01 | 0 | 0.69 | 0.03 | 0 | 0 | 0 | 0.11 | 0.14 | 0 | 1.73 | 0.16 |
| *Collophora* | 0.17 | 0.15 | 0 | 0 | 0.08 | 0.09 | 0.02 | 0.01 | 0 | 0.06 | 0 | 0.22 | 0.16 |
| *Aureobasidium* | 0.4 | 0.21 | 0 | 0.01 | 0.1 | 0.45 | 0.02 | 0.02 | 0.11 | 0.01 | 0 | 0 | 0.16 |
| *Magnaporthe* | 0.25 | 0.19 | 0.07 | 0.01 | 0.29 | 0.33 | 0.02 | 0.09 | 0.09 | 0 | 0 | 0.52 | 0.15 |
| *Mortierellaceae* | 0 | 0 | 0 | 0.03 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.14 |
| *Catenaria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.58 | 0 | 0 | 0 | 0.14 |

*indicates sample recovered from oxidized zone

## *Table C.2(Cont.): Fungal DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Glomeraceae* | 0.36 | 0.04 | 0.06 | 0 | 1.1 | 0.21 | 4.58 | 0.72 | 0.41 | 0.06 | 2.02 | 0.08 | 0.41 |
| *Coniochaeta* | 1.82 | 0.06 | 0.41 | 0 | 0.34 | 0.05 | 0.41 | 0.34 | 0.43 | 0.04 | 0.41 | 0.37 | 0.35 |
| *Acremonium* | 0.07 | 0.26 | 0.7 | 0.08 | 0.24 | 0.2 | 0 | 0.19 | 0.01 | 0.43 | 0.5 | 1.07 | 0.35 |
| *Triparticalcar* | 0.05 | 0.06 | 1.6 | 0.1 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.34 |
| *Plectosphaerella* | 0.8 | 0.15 | 0.9 | 0 | 0 | 0 | 0 | 0.05 | 0.09 | 0.41 | 0 | 0.03 | 0.34 |
| *Trichocladium* | 0.42 | 0.02 | 0.28 | 0 | 0.24 | 0 | 3.56 | 0.98 | 0.73 | 0 | 0.27 | 0.35 | 0.34 |
| *Paraphoma* | 0.07 | 0.09 | 0.11 | 0.04 | 0 | 0.03 | 0.24 | 0.01 | 0.37 | 0 | 0.06 | 0.64 | 0.32 |
| *Ascomycete* | 0.28 | 1.24 | 0.51 | 0.13 | 0.1 | 0.47 | 0 | 0.87 | 0.13 | 0.54 | 0.29 | 0.25 | 0.32 |
| *Rhizophlyctis* | 0.34 | 0.14 | 0.13 | 0 | 0 | 0.02 | 0.04 | 4.75 | 0.2 | 0 | 0.46 | 0.22 | 0.3 |
| *Thyridium* | 0.23 | 0.11 | 0.31 | 0.2 | 0.18 | 0.56 | 0 | 0.25 | 0.05 | 0.95 | 0.12 | 0.74 | 0.27 |
| *Astrosphaeriella* | 0.3 | 0.06 | 0.25 | 0.02 | 0.32 | 0.06 | 0.12 | 0.17 | 0.14 | 0.09 | 0.29 | 0.73 | 0.25 |
| *Mortierella* | 0.51 | 0.01 | 0.03 | 0 | 0 | 0.02 | 0.02 | 0.09 | 1.21 | 0 | 0.06 | 0 | 0.23 |
| *Paraglomerales* | 0.07 | 0.02 | 0.65 | 0 | 0.1 | 0.03 | 1.81 | 0.11 | 0.14 | 0 | 1.54 | 0 | 0.23 |
| *Trechispora* | 0.59 | 0.18 | 1.8 | 0.05 | 0 | 0.01 | 0 | 0.01 | 0.18 | 0.03 | 0.02 | 0.08 | 0.22 |
| *Hysterobrevium* | 0.03 | 0.09 | 0.45 | 0.05 | 0.08 | 0.15 | 0 | 0.08 | 0.05 | 0.33 | 0.1 | 0.73 | 0.22 |
| *Lobulomycetaceae* | 0.59 | 0.05 | 0.13 | 0 | 2.26 | 0.06 | 0.77 | 0.09 | 0.63 | 0.02 | 0.23 | 0 | 0.21 |
| *Hysteropatella* | 0.05 | 0.02 | 0.13 | 0 | 0.4 | 0 | 0.09 | 0 | 0.26 | 0.02 | 0.06 | 0.23 | 0.21 |
| *Cladophialophora* | 0.13 | 0.12 | 0.03 | 1.32 | 0 | 0.17 | 0 | 0.1 | 0 | 0 | 0.31 | 0.17 | 0.2 |
| *Sarcosomataceae* | 0.01 | 0.04 | 0.1 | 0 | 0.1 | 0.35 | 2.06 | 0.04 | 0.13 | 0 | 0.06 | 0 | 0.2 |
| *Rhinocladiella* | 0 | 0.02 | 0.01 | 0.08 | 0 | 0 | 0 | 0.05 | 0 | 0 | 0.04 | 0 | 0.2 |
| *Delphinella* | 0.03 | 0.08 | 0.15 | 0 | 0.02 | 0.18 | 0 | 0.01 | 0.07 | 0.08 | 0.06 | 0.35 | 0.2 |
| *Myrothecium* | 0.34 | 0.05 | 0.23 | 0.01 | 0.08 | 0 | 0.09 | 0.03 | 0.33 | 0 | 0.2 | 0.06 | 0.19 |
| *Acantholichen* | 0.05 | 0.13 | 0.7 | 0.05 | 0.43 | 0.07 | 0.43 | 0.1 | 0.09 | 0.02 | 0.89 | 0.06 | 0.19 |
| *Mycopepon* | 0.63 | 0.04 | 0.03 | 0.07 | 0.02 | 0.12 | 0.07 | 0.12 | 0.29 | 0 | 0.2 | 0.08 | 0.19 |
| *Preussia* | 0.11 | 0.04 | 0.15 | 0.01 | 0 | 0.02 | 0 | 0.05 | 0 | 0.01 | 0.02 | 0.06 | 0.18 |
| *Hypomyces* | 0.13 | 0.05 | 0.15 | 0 | 0 | 0.02 | 0.14 | 0.01 | 0.37 | 0 | 0.37 | 0.05 | 0.18 |
| *Mrakia* | 0 | 0.09 | 0.15 | 0.05 | 0.05 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0.03 | 0.18 |
| *Chalara* | 0.15 | 0.54 | 0.18 | 0.11 | 0.83 | 0.37 | 0.07 | 0.05 | 0.14 | 0.18 | 0.2 | 0.11 | 0.18 |
| *Chlorociboria* | 0.03 | 0.03 | 0.08 | 0 | 0 | 2.94 | 0 | 0.04 | 0 | 0.17 | 0.06 | 0.15 | 0.17 |
| *Pezizomycotina* | 0.11 | 0.09 | 0.11 | 0.01 | 0.02 | 0.06 | 0.04 | 0.12 | 0 | 0.06 | 0.31 | 0.37 | 0.17 |
| *Mucor* | 0.17 | 0.02 | 0.1 | 0.61 | 0 | 0.03 | 0 | 0.01 | 0.22 | 0 | 0 | 0 | 0.16 |
| *Collophora* | 0.17 | 0.5 | 0.16 | 0.14 | 1.07 | 0.42 | 0.07 | 0.03 | 0 | 0.21 | 0.08 | 0.13 | 0.16 |
| *Aureobasidium* | 0 | 0.05 | 0.36 | 0.01 | 0.08 | 0.7 | 0 | 0.05 | 0.01 | 0.01 | 0.04 | 1.12 | 0.16 |
| *Magnaporthe* | 0.03 | 0.1 | 0.15 | 0.02 | 0.53 | 0.03 | 0.07 | 0.08 | 0.03 | 0.12 | 0.12 | 0.49 | 0.15 |
| *Mortierellaceae* | 0.05 | 0.1 | 0.05 | 0 | 1.23 | 0.11 | 0.63 | 0.01 | 0.41 | 0 | 0.41 | 0.49 | 0.14 |
| *Catenaria* | 0 | 0 | 0.08 | 0 | 0 | 0 | 2.59 | 0.24 | 0 | 0 | 0.06 | 0 | 0.14 |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples

## *Table C.2: Fungal DNA Data*

| *Genus* | *1M* | *1D* | *2M** | *2D* | *3M* | *3D* | *4M* | *4D* | *5M* | *5D* | *6M* | *6D* | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Botryosphaeria* | 0.07 | 0.13 | 0.02 | 0.13 | 0.07 | 0.89 | 0.07 | 0.17 | 0.05 | 0.12 | 0 | 0.22 | 0.14 |
| *Basidiomycete* | 0.53 | 0.02 | 0.01 | 0.03 | 0.05 | 0.01 | 0.29 | 0.47 | 0.13 | 0.11 | 0 | 0 | 0.14 |
| *Microglossum* | 0 | 0 | 0 | 0.03 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0.03 | 0.13 |
| *Cryptendoxyla* | 0.05 | 0.19 | 0 | 0.31 | 0.01 | 0.05 | 0.07 | 0.16 | 0.33 | 0.33 | 0 | 0.09 | 0.13 |
| *Aspergillus* | 0 | 0.07 | 0 | 0 | 0.01 | 0.17 | 0 | 0.04 | 0.07 | 0 | 0 | 2.31 | 0.13 |
| *Calycellinopsis* | 0.02 | 0.15 | 0 | 0.1 | 0.19 | 0.03 | 0.16 | 0.03 | 0.17 | 0 | 0 | 0.78 | 0.13 |
| *Mitosporic* | 0.38 | 0.28 | 0 | 0.01 | 0.31 | 0.11 | 0 | 0.02 | 0.03 | 0 | 0 | 1.69 | 0.12 |
| *Marcelleina* | 0.05 | 0.03 | 0 | 0.2 | 0.19 | 0 | 0.01 | 0.07 | 0.09 | 0 | 0 | 0 | 0.12 |
| *Agaricomycotina* | 0 | 0.14 | 0 | 0.1 | 0.33 | 0.19 | 0.81 | 0.09 | 0.29 | 0.06 | 0 | 0.06 | 0.12 |
| *Graphium* | 0.2 | 0.05 | 0.08 | 0.15 | 0.15 | 0.27 | 0 | 0.07 | 0.13 | 0.77 | 0 | 0.26 | 0.11 |
| *Lachnum* | 0 | 0.09 | 0.07 | 0.05 | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.04 | 0 | 0.29 | 0.11 |
| *Versicolorisporium* | 0.2 | 0.58 | 0 | 0.01 | 0.05 | 0.11 | 0.04 | 0.47 | 0.11 | 0.22 | 0 | 0.03 | 0.11 |
| *Monilinia* | 0 | 0.29 | 0 | 0.01 | 0 | 0.15 | 0 | 0.18 | 0.35 | 0.15 | 0 | 0 | 0.11 |
| *Phaeosphaeria* | 0.12 | 0.21 | 0.04 | 0.66 | 0.12 | 0.11 | 0.02 | 0.17 | 0.01 | 0.12 | 0 | 0.16 | 0.1 |
| *Rhytisma* | 0.1 | 0.02 | 0 | 0.01 | 0.15 | 0.05 | 1.18 | 0.01 | 0 | 0 | 0 | 0.39 | 0.1 |
| *Others ** * | 3.98 | *8.13* | 1.42 | *5.5* | *6.69* | *5.39* | *7.9* | *9.19* | *7.9* | *5.27* | 1.61 | *5.77* | *5.25* |

*indicates sample recovered from oxidized zone

## *Table C.2(Cont.): Fungal DNA Data*

| *Genus* | *7M-1* | *7M-2** | *8M-1* | *8M-2** | *9C* | *9S** | *10C* | *10S** | *11C* | *11S** | *12C* | *12S** | *% of Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Botryosphaeria* | 0.01 | 0.22 | 0.16 | 0.3 | 0 | 0.18 | 0.02 | 0.02 | 0.11 | 0 | 0.08 | 0.28 | 0.14 |
| *Basidiomycete* | 0.26 | 0.32 | 0.73 | 0 | 0.05 | 0.02 | 0.02 | 0.01 | 0.09 | 0.01 | 0.04 | 0.08 | 0.14 |
| *Microglossum* | 0 | 0.01 | 0.01 | 0.02 | 0.08 | 3.09 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.13 |
| *Cryptendoxyla* | 0.3 | 0.02 | 0.06 | 0.02 | 0.1 | 0 | 0.19 | 0.09 | 0.43 | 0.01 | 0.14 | 0.3 | 0.13 |
| *Aspergillus* | 0.23 | 0 | 0.05 | 0 | 0 | 0.03 | 0 | 0.01 | 0 | 0.12 | 0 | 0.17 | 0.13 |
| *Calycellinopsis* | 0.01 | 0.04 | 0.21 | 0 | 0.21 | 0.07 | 0.19 | 0.08 | 0.07 | 0 | 0.16 | 0.51 | 0.13 |
| *Mitosporic* | 0.05 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.12 |
| *Marcelleina* | 0.17 | 0.04 | 0.1 | 0.01 | 0.13 | 0.07 | 0.21 | 0.18 | 0.14 | 0 | 1.06 | 0.11 | 0.12 |
| *Agaricomycotina* | 0 | 0.01 | 0.23 | 0 | 0 | 0.01 | 0.07 | 0.02 | 0.37 | 0 | 0.08 | 0.01 | 0.12 |
| *Graphium* | 0.03 | 0.02 | 0.13 | 0.01 | 0 | 0.03 | 0 | 0.09 | 0 | 0.16 | 0.02 | 0.13 | 0.11 |
| *Lachnum* | 0.05 | 0.09 | 0.1 | 0.85 | 0.08 | 0.2 | 0 | 0.03 | 0.11 | 0.31 | 0.1 | 0.11 | 0.11 |
| *Versicolorisporium* | 0.01 | 0.03 | 0.13 | 0.01 | 0.02 | 0.01 | 0 | 0.21 | 0.31 | 0.02 | 0.06 | 0.05 | 0.11 |
| *Monilinia* | 0.05 | 0.32 | 0.26 | 0.14 | 0.13 | 0.21 | 0.04 | 0.11 | 0.01 | 0 | 0.06 | 0.13 | 0.11 |
| *Phaeosphaeria* | 0.09 | 0.03 | 0.05 | 0 | 0.08 | 0 | 0.04 | 0 | 0.28 | 0 | 0.06 | 0.08 | 0.1 |
| *Rhytisma* | 0.01 | 0 | 0.05 | 0 | 0.08 | 0 | 0.04 | 0.02 | 0.01 | 0 | 0 | 0.28 | 0.1 |
| *Others ** | *7.14* | 2.85 | *5.9* | *5.55* | 2.93 | *6.33* | *5.21* | 2.65 | 4.64 | 1.04 | *7.69* | *5.32* | *5.25* |

*indicates sample recovered from oxidized zone

** "Others" is the sum of all genera which accounted for < 0.1 % of the DNA across all 24 samples