



GENERAL Moly, Inc.

455 8th Street
Elko, Nevada 89801
Phone: 775-753-5009
Fax: 775-753-7722
Email: progers@generalmoly.com
Website: www.generalmoly.com

January 29, 2008

Ms. Angelica Ordaz
Bureau of Land Management
Battle Mountain Field Office
50 Bastian Road
Battle Mountain, Nevada 89820

Re: Mt Hope Waste Rock Geochemistry Report

Dear Ms Ordaz,

Attached is General Moly, Inc.'s (GMI) Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report. This report summarizes the waste rock geochemical analyses and interpretations for the Mt Hope Project. It is intended to accompany the Waste Rock Management Plan submitted under separate cover, and provides baseline information for the Mt Hope Environmental Impact Statement (EIS).

Sincerely,

Pat Rogers
Director of Environmental and Permitting

Attachment: *Mount Hope Project Waste Rock and Pit Wall Rock Characterization Report* (2 copies)

Cc: Richard Delong, EnviroScientists w/ attachment (2 copies)
Judy Overton, Eureka County w/ attachment
Brian Musser, GMI without attachment
Val Sawyer, SRK Consulting, without attachment



GENERAL MOLY

General Moly, Inc.

MOUNT HOPE PROJECT WASTE ROCK AND PIT WALL ROCK CHARACTERIZATION REPORT

Prepared for:



GENERAL MOLY

General Moly, Inc.

2215 North 5th Street

Elko, NV 89801

Phone: (775) 753-4988

Fax: (775) 753-7722

Internet Web Address: <http://www.generalmoly.com>

Prepared by:



SRK Consulting (U.S.), Inc.

5250 Neil Road, Suite 300

Reno, Nevada, 89502

Phone: (775) 828-6800

Fax: (775) 828-6820

Internet Web Address: <http://www.srk.com>

e-mail: reno@srk.com

January 28, 2008

SRK Project No. 157503

NDEP 00114

Table of Contents

1	Introduction.....	1-1
1.1	Purpose and Scope	1-1
1.2	Overview of Methodology	1-2
1.3	Regulatory Context	1-3
1.4	Document Organization	1-4
2	Site Description and Background.....	2-1
2.1	Overview	2-1
2.2	Location and Access	2-2
2.3	Historic Mining Disturbance.....	2-2
2.4	Physical Setting.....	2-2
2.5	Climate	2-5
2.6	Surface Water.....	2-5
2.7	Hydrology	2-6
2.8	Groundwater Hydrogeology	2-6
2.9	Project Geology.....	2-8
2.9.1	Mineralization and Alteration.....	2-10
2.9.2	Structural Geology.....	2-11
2.10	Mining and Exploration History	2-11
2.11	Local Petrology	2-12
2.12	Previous Studies.....	2-14
3	Approach	3-1
3.1	Overview	3-1
3.2	Objectives.....	3-2
3.3	Selection of Samples for Geochemical Testing	3-2
3.4	Objectives of the Field Screening Pre-Testing Program	3-2
3.5	Objectives of the Static Test Program.....	3-4
3.6	Objectives of the Kinetic Test Program	3-4
4	Methodology	4-1
4.1	Overview	4-1
4.2	Sample Collection	4-2
4.2.1	Historic Drill Core.....	4-2
4.2.2	Recent Drill Core.....	4-2
4.2.3	Historic Pulps and Core.....	4-3
4.3	Sample Testing Strategy	4-3
4.3.1	Field Screening and Preliminary Assessment of Reactivity	4-3
4.3.2	Static Tests.....	4-6
4.3.3	Kinetic Tests.....	4-6
5	Field Screening and Pre-Testing Results	5-1
5.1	Overview	5-1
5.2	Mineralogical Analysis Results.....	5-2
5.3	Contact Test Results.....	5-3
5.4	Whole Rock Analysis Results.....	5-5
6	Static Test Results.....	6-1
6.1	Overview	6-1
6.2	Introduction.....	6-2
6.3	Meteoric Water Mobility Procedure Results.....	6-2
6.4	Acid Base Accounting Results.....	6-6

6.4.1	ABA Results for Core Samples	6-7
6.4.2	ABA Results for Pulp Samples.....	6-12
6.5	Net Acid Generation Results.....	6-16
6.6	Comparison of Mount Hope Data to Other Mineral Deposit Types	6-21
6.7	Comparison of Historic and Recent Core	6-22
7	Kinetic Test Results	7-1
7.1	Overview.....	7-1
7.2	Introduction.....	7-2
7.3	Sample Selection and Pre-HCT Material Characterization.....	7-5
7.3.1	Phase 1 HCT Program	7-5
7.3.2	Phase 2 HCT Program	7-7
7.4	Humidity Test Cell Average Release Rates	7-8
7.5	Summary of Humidity Cell Chemistry Trends	7-9
7.5.1	Intermediate Phase Quartz Porphyry	7-9
7.5.2	Early Phase Quartz Porphyry	7-11
7.5.3	Rhyolite Tuff and Flow	7-14
7.5.4	Vinini Sediments	7-16
7.6	Comparison of Static Test Results to HCT Results	7-20
7.7	Phase 1 HCT Termination Test Results	7-27
7.7.1	Mineralogy of HCT Residues.....	7-28
7.7.2	Sequential Extraction Assessment.....	7-28
7.7.3	Summary of Termination Tests	7-30
8	Predicted Geochemical Behavior	8-1
8.1	Overview.....	8-1
8.2	Waste Rock Geochemistry	8-2
8.2.1	Intermediate Phase Quartz Porphyry	8-3
8.2.2	Early Phase Quartz Porphyry	8-3
8.2.3	Rhyolite	8-4
8.2.4	Garden Valley Formation	8-6
8.2.5	Vinini Sediments	8-6
8.3	Waste Rock Management Classification System.....	8-8
9	Geologic and Geochemical Modeling.....	9-9
9.1	Overview.....	9-9
9.2	Geologic Modeling and Estimated Pit Wall Geology.....	9-10
9.3	Waste Rock Geochemical Modeling.....	9-12
9.4	Waste Rock Source Term Modeling	9-16
9.4.1	Modeling Approach.....	9-16
9.4.2	Source Term Modeling Results	9-16
10	Conclusions.....	10-1
11	References.....	11-1

Tables

Table 2-1: Summary of Mount Hope Material Types	2-14
Table 2-2: Summary of Geochemical Static Test Data (after Geochimica, 1995)	2-15
Table 4-1: Sample Frequency and Testing Matrix	4-4
Table 5-1: Contact Test Results	5-4
Table 5-2: Summary of Whole Rock Analysis Results	5-6
Table 6-1: Summary of MWMP Results	6-3
Table 6-2: Criteria Used in the Determination of Acid Generation Potential	6-7
Table 6-3: Acid Base Accounting Results for Pulp Samples	6-14
Table 6-4: Acid Generation Criteria for NAG Results	6-17
Table 6-5: Summary of NAG Results.....	6-17
Table 7-1: Sample Frequency for Kinetic Testing.....	7-2
Table 7-2: Pre-HCT ABA Results for Phase I HCT Samples	7-5
Table 7-3: Mineralogy Results for Phase I HCT Samples.....	7-6
Table 7-4: ABA Test Results for Phase 2 HCT Samples	7-7
Table 7-5: Phase 1 HCT Average Release Rates for Key Constituents	7-8
Table 7-6: Results of Humidity Cell Testing and Static Tests	7-21
Table 8-1: Summary of Predicted Waste Rock Geochemistry	8-2
Table 9-1: Final Pit Wall Material Type Percentages.....	9-14
Table 9-2: Predicted Tonnage of Waste Rock	9-15
Table 9-3: Source Term Predictions	9-17

Figures

Figure 2-1: Mount Hope Site Location Map	2-3
Figure 2-2: Site Map for the Mount Hope Project.....	2-4
Figure 2-3: Mount Hope Geology Map	2-9
Figure 3-1: Characterization Program Flow Diagram	3-3
Figure 5-1: Contact Test Results According to Material Type.....	5-4
Figure 6-1: Ficklin Diagram	6-4
Figure 6-2: Oxyanions vs. pH.....	6-5
Figure 6-3: Molybdenum vs. pH.....	6-5
Figure 6-4: Neutralization Potential vs. Acidification Potential	6-8
Figure 6-5: Sulfide vs. Total Sulfur	6-9

Figure 6-6: NPR vs. Total Sulfur	6-9
Figure 6-7: NNP vs. Sulfide	6-11
Figure 6-8: AP vs. NP for Pulp Samples	6-13
Figure 6-9: NNP vs. Total Sulfur for Pulp Samples	6-13
Figure 6-10: Total Sulfur Histogram	6-15
Figure 6-11: Total Carbon Histogram	6-15
Figure 6-12: Final NAG pH vs. NAG.....	6-18
Figure 6-13: Sulfide Sulfur vs. NAG.....	6-20
Figure 6-14 Total Sulfur vs. NAG	6-20
Figure 6-15: Comparison of ABA Data for Mineral Deposit Types	6-21
Figure 6-16: Comparison of NAG Data for Mineral Deposit Types	6-22
Figure 6-17: Sulfide Sulfur vs. Sulfate Sulfur for Historic and Recent Core	6-23
Figure 6-18: pH vs. TDS for Historic and Recent Core	6-24
Figure 6-19: Ficklin Metals for Historic and Recent Core	6-24
Figure 7-1: Intermediate Phase Quartz Porphyry – HCT Trends	7-10
Figure 7-2: Early Phase Quartz Porphyry – HCT Trends.....	7-13
Figure 7-3: Rhyolite Tuff and Flow – HCT Trends.....	7-15
Figure 7-4: Vinini Sediments – HCT Trends.....	7-17
Figure 7-5: Total Sulfur vs. Average HCT pH	7-22
Figure 7-6: Total Sulfur vs. Average Acidity Load.....	7-23
Figure 7-7: Total Sulfur vs. Final Percent NP Remaining.....	7-23
Figure 7-8 NPR vs. Average HCT pH.....	7-24
Figure 7-9: NPR vs. Final Percent NP Remaining	7-25
Figure 7-10: NAG vs. Average HCT pH.....	7-26
Figure 7-11: NAG vs. Final Percent Neutralization Potential Remaining	7-26
Figure 9-1: Final Pit Wall Lithologies.....	9-11
Figure 9-2: Final Pit Alteration Assemblages.....	9-12
Figure 9-3: Alteration and Geochemical Characteristics of Final Pit Walls	9-13

Appendices

- Appendix A: Geochimica, Inc. Static Testing Summary Report (1995)
- Appendix B: Geochemical Testing and Evaluation Protocols
- Appendix C: Sample Descriptions and Contact Test Results
- Appendix D: Whole Rock Analysis Results
- Appendix E: Mineralogy Results
- Appendix F: Acid Base Accounting Results (Modified ABA, NAG and TIC)
- Appendix G: Meteoric Water Mobility Procedure (MWMP) Test Results¹
- Appendix H: Total Sulfur, Total Carbon and Metals Results for Historic Pulps
- Appendix I: Phase 1 HCT Results¹
- Appendix J: Phase 1 HCT Termination Test Results²
- Appendix K: Phase 2 HCT Results¹
- Appendix L: Geologic and Geochemical Modeling Diagram

¹ Final reports from Western Environmental Testing Laboratory for Profile II chemistry results are provided on the enclosed CD-ROM only.

² Final reports from ACZ Laboratories for Phase 1 HCT Selective Extraction results are provided on the enclosed CD-ROM only.

1 INTRODUCTION

General Moly, Inc. (GMI) is currently developing mine plans to extract molybdenum ore from the Mount Hope deposit located in Eureka County, Nevada. The approximately one billion-ton molybdenite ore body will produce an estimated 1.3 billion pounds of recoverable molybdenum during its 44-year lifetime.

GMI currently plans to use open pit hard rock mining methods to deliver molybdenum sulfide ore to a conventional flotation mill. The mine plans to deliver an average of 60,625 tons per day (tpd) of ore to the plant during years 1 through 32 and simultaneously stockpile lower grade ore. During years 32 to 44, the stockpiled ore will be processed at an average rate of 60,625 tpd (22,100 kt/yr). The total mining rate is planned to average 261,600 tpd (95.5 million tons per year). Other components at the Mount Hope Project will include waste rock storage facilities, tailings storage facilities, and a water supply well field.

Sulfide minerals in the ore at Mount Hope, such as pyrite, are unstable under atmospheric conditions. Following exposure to oxygen and water, these minerals will oxidize, releasing metals, acidity and sulfate. Where acidification exceeds the buffering potential of mined material, an environmental impact to receiving water can occur. Further, some metals have the potential to be mobile under neutral or alkaline conditions. The potential for water resource impacts can be predicted from the geochemical properties of the material. On the basis of these predictions, mine waste can be managed and engineered to mitigate potential environmental impacts.

1.1 Purpose and Scope

The primary purpose of this investigation is to provide an understanding of the geochemical characteristics of geological materials specific to the Mount Hope deposit. In order to accomplish the objectives of the study, field work (including logging and field testing), laboratory geochemical characterization tests, and geochemical modeling were conducted to characterize potential impacts from proposed mining operations and identify useful management strategies.

The two main considerations of this baseline environmental geochemical characterization are:

- Acid generation due to oxidation of sulfide minerals, which can potentially lead to development of Acid Rock Drainage (ARD); and
- Potential for leaching of metals (e.g., cadmium and manganese) and salts (e.g., sulfate and fluoride).

The processes of acid generation and leaching can operate independently, although the development of acidic conditions enhances the leachability of many metals. To address these issues, an extensive characterization program has been completed to define the geochemical characteristics of the waste rock and pit walls.

Characterization activities included:

- Review of historic core and identification of the primary material types;
- Collection of samples representative of waste rock from past exploration drill core (i.e., archived historic core) stored in the on-site core shed and from recent exploration drill core;
- Screening assessment of hand specimens using field contact tests to select samples for static and kinetic analysis;
- Static laboratory testing of core samples;
- Kinetic laboratory testing of core samples; and
- Re-assay of historic pulps and core representing the entire deposit, including ICP metals, total carbon and total sulfur analysis.

1.2 Overview of Methodology

The testing program was designed to address mineralogy, bulk geochemical characteristics, and the potential of the waste rock and pit wall rock to generate acid or release metals in drainage. Using the results of the initial static test program, suitable samples were selected for kinetic testing of solute release in response to chemical weathering over time. Release rates calculated using these data was then used as input to a PHREEQC model to derive a source term for evaluating potential impacts from the proposed facilities, as a basis for evaluating best management practice.

Field screening and pre-test analyses were completed, which included:

- Mineralogy description of core in hand specimens;
- Contact testing for pH and conductivity; and
- Bulk geochemical analysis using four-acid digest and ICP analysis to determine total metal and metalloid chemistry for 48 elements (ALS Chemex Method ME-MS61).

Static tests were conducted, which included:

- Mineralogical analysis using optical mineralogy and x-ray diffraction methods;
- Net Acid Generating (NAG) test reporting final NAG pH and final NAG value after a two-stage hydrogen peroxide digest (EGI, 2002);
- Acid Base Accounting (ABA) using the Modified Sobek method with LECO sulfur speciation analysis (Price, 1997);
- Acid Base Accounting using total sulfur and total carbon analysis by LECO analysis; and
- Nevada Meteoric Water Mobility Procedure (MWMP, ASTM E-2242-02) with geochemical analysis of the leachate for NDEP Profile II constituents.

Kinetic tests conducted include:

- Humidity Cell Testing (HCT) using the ASTM D5744-96 procedure completed for nine samples that represent the most common material types associated with the Mount Hope Project; and
- Twenty additional HCTs that are currently in progress, using the same ASTM method. As with the first batch of humidity cells, these tests will be continued until “steady state” conditions are attained and terminated with agency approval.

This work has been supervised by SRK Consulting (U.S.) Inc at McClelland Laboratories of Sparks, Nevada with analysis by Western Environmental Testing Laboratory (WetLab) of Sparks, Nevada; ALS Chemex of Reno, Nevada and ACZ Laboratories of Steamboat Springs, Colorado. All of these laboratories are certified and approved by the State of Nevada.

1.3 Regulatory Context

Waste rock characterization and management of potential run-off and/or infiltration of affected meteoric water, as well as groundwater impacts resulting from formation of pit lakes and associated facilities, are regulated in Nevada by the Nevada Division of Environmental Protection- Bureau of Mining Regulation and Reclamation (NDEP-BMRR) (on private and public lands) and the United States Bureau of Land Management (BLM) (on public lands).

The BMRR regulates mining in Nevada under the authority of the NRS 445A.300-NRS 445A.730 and the NAC 445A.350-NAC 445A.447. The branch issues a Water Pollution Control Permit (WPCP) to an operator prior to the construction of any mining, milling or other beneficiation process activity that uses water from any source or quality that is biologically, chemically or physically altered because of this use. Under this authority, the reviews a mine’s proposed strategies for handling all “process” waters on a site, including potential infiltration or run-off from waste rock facilities, process waters used in the milling process (tailings, ponds, tanks and piping), and heap leaching activities. To protect waters of the State, the permit requires characterization of waste rock and prediction of potential impacts to surface or groundwater. The permit will also include a schedule for ongoing operational sampling of waste rock, process waters at various locations and monitoring wells.

The BLM regulates mining on public lands in Nevada under the authorization of 43 CFR 3802/3809. The BLM evaluates the proposed operations and issues a decision letter to authorize surface disturbances. The Plan of Operations (POO) is prepared early in the planning process and presented to the BLM so they can determine the appropriate level of NEPA evaluation (as discussed below). The POO is required to contain sufficient detail about the proposed activities, including geochemical characterization of ore and waste rock, waste rock management plans, and operating plans, for the BLM to initially determine whether the action might have impacts to the environment that may require mitigation.

With respect to waste rock, the 3809 regulations specifically state that waste characterization and mitigation information must be supplied in order for BLM to evaluate the adequacy of the operator’s proposed action and reclamation measures. These

instructions are provided in BLM's Instruction Memorandum (IM) 96-79 and Acid Rock Drainage Policy and IM NV-2004-064.

1.4 Document Organization

This document summarizes methods and results used to provide baseline environmental geochemistry for Mount Hope waste rock and pit facilities. Each section begins with a brief summary of key points in bulleted format.

Section 2, *Site Description and Background*, provides background information on the location, physiography, geology and mining history of the Project Area are provided.

Section 3, *Approach*, provides a description of sample selection and an overview of the general approach to waste rock and pit wall rock characterization.

Section 4, *Methods*, provides a summary of the geochemical characterization program including a description of field investigation activities, drill core history, sampling methods and physical characteristics of the rock types as well as a description of the laboratory testing methods employed during the program.

Section 5, *Field Screening and Pre-Testing Results*, provides a summary of the pre-test characterization of the materials including mineralogy, whole rock analysis, and contact testing.

Section 6, *Static Test Results*, presents the static test results including ABA and NAG results as well as leachate chemistry from Meteoric Water Mobility Procedure testwork.

Section 7, *Kinetic Test Results*, provides the results of the initial kinetic testing program (Phase 1), a description of the ongoing Phase 2 kinetic test program, and results of the termination testwork completed for the Phase 1 humidity cells.

Section 8, *Predicted Geochemical Behavior*, provides a qualitative evaluation of the geochemical data.

Section 9, *Waste Rock Source Term Modeling*, provides a more quantitative assessment using mass balance and reactivity calculations to determine the potential implications of waste rock disposal on site.

Conclusions are provided in **Section 10** and the references in **Section 11**.

The appendices are arranged in the order of the various tests that were completed on the Mount Hope lithologies. Appendix A provides data from the previous static testwork of waste rock by Geochimica, Inc (Westec, 1995). Appendix B presents the geochemical testing and evaluation protocols. The contact test protocols and results are presented in Appendix C along with sample descriptions collected in the field. Whole rock analysis results are presented in Appendix D and mineralogy in Appendix E. The results of the ABA testing, including TIC and NAG results, are provided in Appendix F. MWMP results are provided in Appendix G. The total sulfur, carbon and metals results for historic pulp samples are provided in Appendix H. The results of the Phase 1 kinetic test data are provided in Appendix I and the results of termination testing in Appendix J. The results of Phase 2 kinetic testing (to date) are provided in Appendix K. Diagrams summarizing the geological and geochemical model for the Mount Hope deposit are provided in Appendix L.

2 SITE DESCRIPTION AND BACKGROUND

2.1 Overview

- The Mount Hope deposit is located in the central Great Basin section of the Basin and Range Physiographic Province, which is characterized by north-south trending topography;
- The climate of the site is typical of central Nevada, with low precipitation (average annual precipitation 12.06 inches) and high evaporation (greater than 50 inches pan evaporation);
- Two springs are located within areas planned for mining disturbance; the Mount Hope Spring (SP-4) and an un-named spring (SP-7);
- Groundwater moves in a radial manner away from Mount Hope and into the adjacent valleys. The hydraulic gradient appears to be steep in the low permeability bedrock within the proposed Project Area. As groundwater moves into the alluvial valleys, the gradient flattens considerably;
- The Mount Hope deposit is a molybdenum porphyry deposit hosted within quartz porphyry, rhyolite, and Vinini hornfels host rocks;
- The Mount Hope deposit is a low-sulfur system with low base metal, low mercury and arsenic content and high fluoride content. There is limited carbonate mineralization within the Mount Hope deposit;
- The adjacent contact skarn-sulfide deposit contains predominantly zinc and lead mineralization and is semi-massive in nature;
- The most important waste rock material types in terms of volume are the Argillic Rhyolite Tuff, Potassic Vinini Sediments and Potassic Early Phase Quartz Porphyry. Less than 3 percent of the waste rock will consist of the Intermediate Phase Quartz Porphyry; and
- Potassic Vinini Sediments, Argillic Rhyolite Tuff and Potassic and Silicic Early Phase Quartz Porphyry will be exposed in the final pit walls. Intermediate Quartz Porphyry will be exposed in a small area at the deepest point within the pit.

2.2 Location and Access

The Mount Hope Project Area is located approximately 23 miles northwest of the town of Eureka and about three miles west of Nevada State Highway 278 in Eureka County, Nevada, as shown in Figures 2-1 and 2-2.

2.3 Historic Mining Disturbance

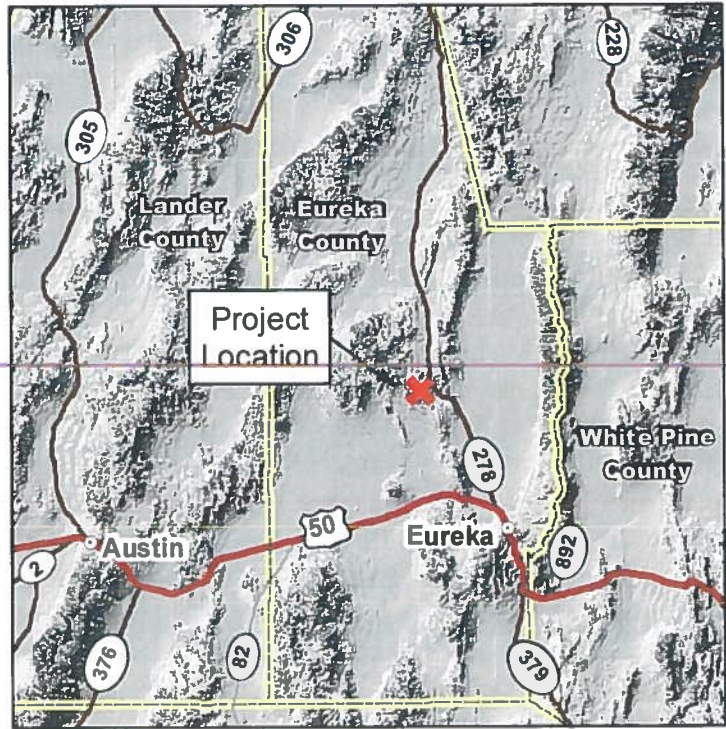
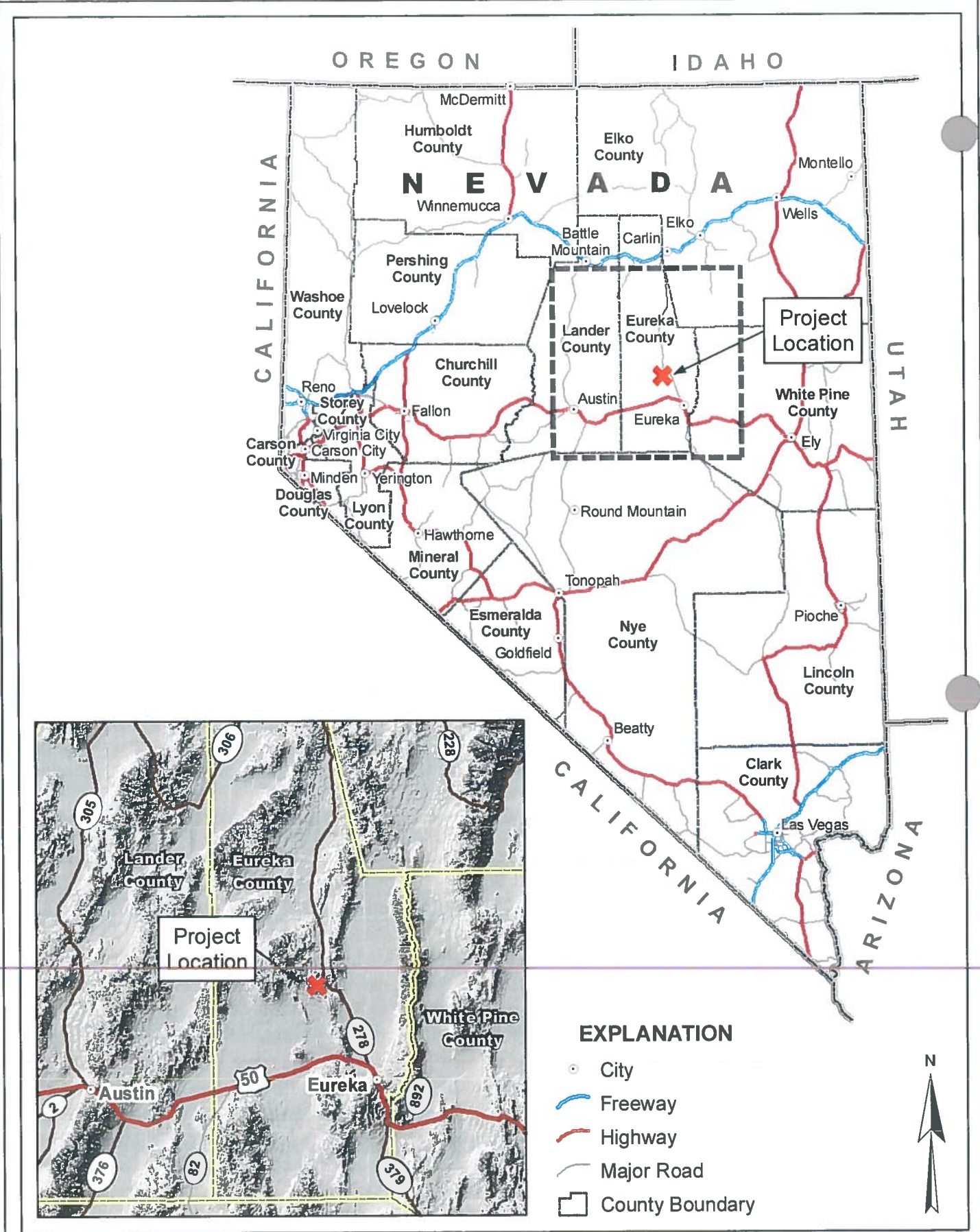
Disturbances associated with historic mining operations are primarily located on patented claims and consist of a core shed and storage building surrounded by a fence, underground mining operations, waste rock storage areas, and mill tailings. Three recognizable adits remain on the site along with some relatively small waste rock piles. One adit drains to a small man-made stock pond.

Based on the field assessment and review of the 7.5 minute provisional USGS Garden Gate Map (1986 edition), numerous historic mine workings are located within the Mount Hope Project Area. These workings include several unsecured and abandoned shafts, adits, open stopes, drifts and prospects scattered throughout the site. The depth of many of the abandoned shafts, adits, and stopes is unknown and they may intercept groundwater (IGMI, 2005).

2.4 Physical Setting

The Mount Hope deposit is located in the central Great Basin section of the Basin and Range Physiographic Province and underlies Mount Hope, a mountain range with a maximum altitude of about 8,380 feet above mean sea level (amsl) surrounded by Diamond Valley to the east, Kobeh Valley to the southwest, and Pine Valley to the north and northeast. Block faulting in the area has produced generally north-south trending topography. Structural deformation has resulted in a series of valleys separated by mountain ranges and filled with unconsolidated sediment that was derived from erosion of the surrounding mountain ranges.

The Natural Resource Conservation Service (NRCS) Order Three soil survey for the Eureka County Area, Nevada, and the NRCS Soil Survey of Diamond Valley Area, Nevada define the soil map units and erosion risks for the study area. Soil characteristics, current vegetation cover, and potential vegetation for each map unit were included in the erosion risk evaluation. Fifteen soil map units are delineated, which identify 25 different soils within the Project Area. Within these units, there can be up to three dominant soils or non-soil components (i.e. rock outcrop, talus, or scree) that comprise the soil map unit. Vegetation surveys were conducted aurally to obtain existing vegetation data for the Project Area, and potential natural vegetation was obtained using the NRCS soil surveys and ecological site descriptions. Upland vegetation was the predominant type identified within the Project Area, which includes piñon-juniper, big sagebrush, piñon-juniper/big sagebrush, big sagebrush/piñon-juniper, big sagebrush/low sagebrush, big sagebrush/black sagebrush, and black sagebrush/big sagebrush. Wetlands and riparian areas occupy less than 0.1 percent of the Project Area and are generally limited in size, but support a variety of plant species both within the water body as emergents (e.g., rush, sedges) and along the edges. Small, isolated wetlands/riparian areas are scattered along the Project Area boundary.

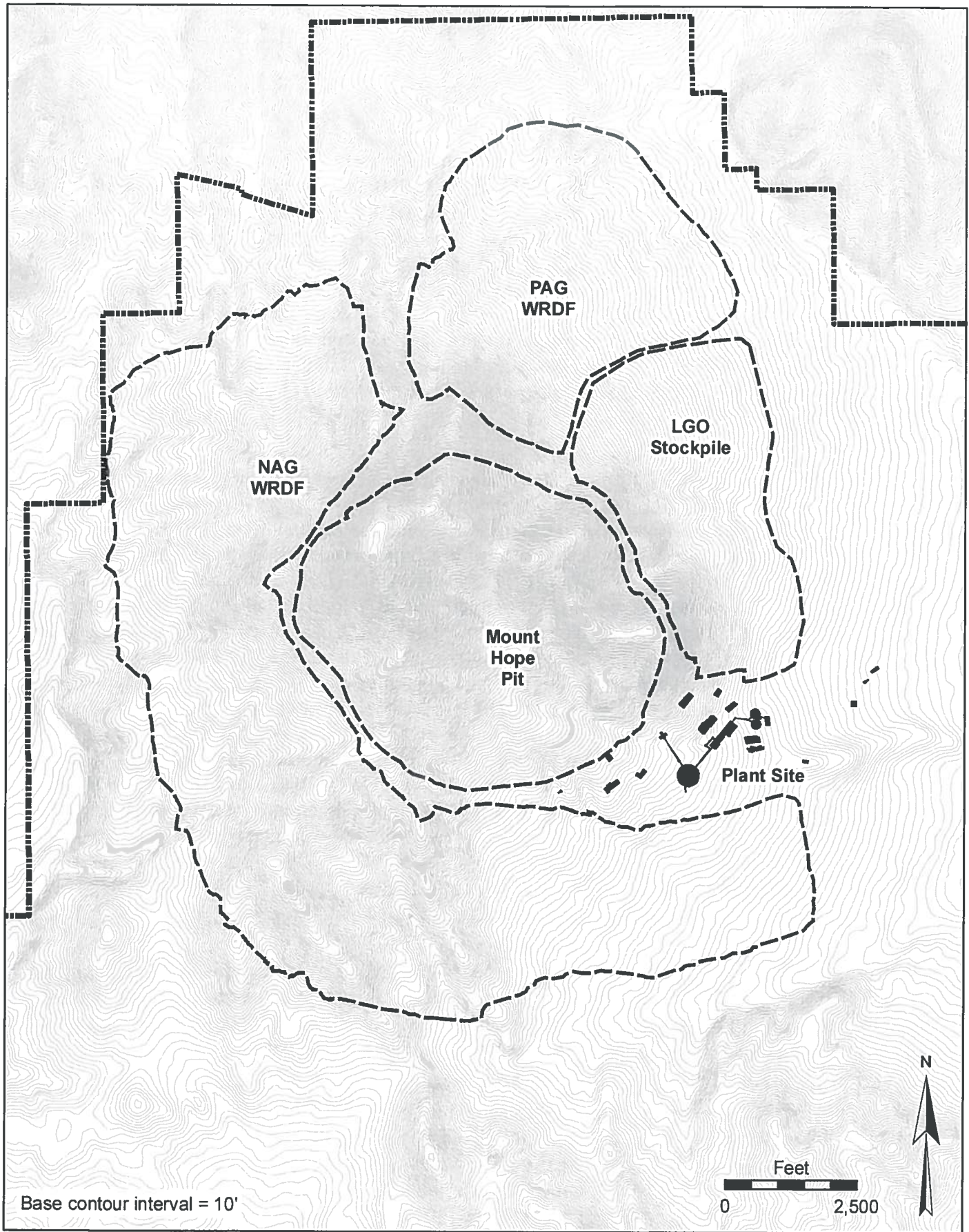


SRK Consulting
Engineers and Scientists

DESIGN: EMLLC	DRAWN: DVN	REVIEWED: VS
SCALE: NTS	DATE: 10/2009	
FILE NAME: WPCP FIG01 General Loc DVN 200910.mxd		

**EUREKA MOLY, LLC
MOUNT HOPE PROJECT**

DRAWING TITLE: LOCATION MAP	
ISSUED FOR: PIT WALL & WASTE ROCK CHARACTERIZATION REPORT	
DRAWING NO: FIGURE 2 - 1	REVISION NO.:
SRK JOB NO: 157508-300	B



SRK Consulting
Engineers and Scientists

DESIGN: EMLLC	DRAWN: BVB	REVIEWED: VS
SCALE: 1 inch = 2,500 feet	DATE: 10/2009	
FILE NAME: WPCP_FIG02_Site_Plan_BVB_200910.mxd		

**EUREKA MOLY, LLC
MOUNT HOPE PROJECT**

DRAWING TITLE: SITE PLAN	
ISSUED FOR: PIT WALL & WASTE ROCK CHARACTERIZATION REPORT	
DRAWING NO: FIGURE 2 - 2	REVISION NO:
SRK JOB NO: 157908-300	B

2.5 Climate

The climate of the area is semi-arid with warm summers and cold winters. Average annual precipitation as computed by the National Climatic Data Center (NCDC) for the period from 1971 through 2000 is 9.14 inches at the Diamond Valley U.S. Department of Agriculture (USDA) station, which is at an altitude of about 5,970 feet amsl. At the Eureka station, which has an altitude of about 6,545 feet amsl, the 1971-2000 average annual precipitation is 12.06 inches. The temporal variation in precipitation is similar at both stations with May being the wettest month and July among the driest. According to the Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by the Spatial Climate Analysis Service (2006) at Oregon State University, 1971-2000 annual normal precipitation is about 13.6 inches at Mount Hope, which is at an elevation of about 8,400 feet amsl (SRK 2006).

Two weather stations that measure pan evaporation are located near Mount Hope. During the period from 1948 through 2002, annual pan evaporation averaged 51.5 inches at the Ruby Lake station, located at an altitude of 6,010 feet amsl about 46 miles to the northeast of the site. At the Beowawe University of Nevada Ranch station, located at an altitude of 5,740 feet amsl about 22 miles northwest of the site, annual pan evaporation averaged 51.2 inches during the period from 1972 through 2002. Due to freezing conditions, pan evaporation is not measured in the winter months (November through March) at either station. The U.S. Bureau of Reclamation (USBR) has established a series of weather stations in agricultural regions in the western U.S. At each of these AgriMet Stations, weather data necessary to compute reference, or potential, evapotranspiration using the Kimberly-Penman 1982 procedure are measured on a daily basis. Because potential evaporation and lake evaporation are typically presumed to be equivalent, the computation results provide reasonable estimates of lake evaporation in the area. The Eureka AgriMet Station (EURN) is located in eastern Diamond Valley about 19 miles east-southeast of Mount Hope and was established in August 2001. Average annual potential evapotranspiration through the end of 2005 was about 58.5 inches (Pacific Northwest Cooperative Agricultural Network, 2006).

2.6 Surface Water

Surface water, in the form of streams or lakes, is rare in the area. Virtually all of the surface water flows are ephemeral and contain water only during storms or intense snowmelt. Clearly defined swales or tributaries tend to be confined to the margins of the basins where slopes are steepest and runoff is greatest during precipitation events. Springs along the northern margin of the Roberts Mountain, about three miles north of Mount Hope, maintain Henderson Creek as the only perennial stream in the immediate area.

The northern and eastern faces of Mount Hope drain into Garden Pass Creek. Tyrone Creek drains the south face of the mountain and joins Garden Pass Creek southeast of the mountain just upstream of where the latter cuts through the Sulphur Spring Range and empties into Diamond Valley. Two ephemeral surface water swales or tributaries drain the western face of Mount Hope and join to become a relatively well-defined tributary that persists a substantial distance to the south into Kobeh Valley. The only connection of Mount Hope to Pine Valley to the north is a small portion of one storage area located in the uplands above the Henderson Creek drainage.

Fourteen springs are shown within the Henderson Creek watershed on U.S. Geological Survey (USGS) maps. Seven springs are located within the Project Area. Of these, only the Mount Hope Spring (SP-4) and an un-named spring (SP-7) are located within areas planned for mining disturbance.

The Mount Hope spring is located on the north east side of the site and consists of a buried metal pipe that daylights for about 30 feet before terminating into a cattle trough. The flow has been measured over a two year period and ranges from 0.03 gallons per minute (gpm) to 0.32 gpm. There is no evidence the cattle trough has overflowed during the monitoring period. This low flow spring will be covered by a waste rock disposal facility, which will be constructed with a drainage system to route any flow from the spring away from the WRDF without contacting the waste rock.

Spring SP-7 is located on the southern end of the site and consists of a small (2 feet by 2 feet) depression in the ground with standing water. Quarterly observations since 3rd quarter 2006 indicate no evidence of flow from SP-7.

2.7 Hydrology

The Mount Hope pit straddles the divide between Diamond, Kobeh, and Pine Valleys. Much of the mine area drains into the Diamond Valley, from which groundwater has been exploited extensively for agricultural irrigation. Irrigated agriculture dominates the southern half of Diamond Valley. Because it is a topographic closed basin, surface drainage does not occur, and numerous alkali and salt flats exist in the northern half of the valley.

Kobeh Valley, the largest of the three basins in the area, is an alluvial basin bounded on the east by Whistler Range, on the north by the Roberts Mountains, on the west by the Simpson Park Range, and on the south by the Monitor Range and Mahogany Hills. Kobeh Valley is hydraulic connected to Monitor Valley to the southwest and Antelope Valley to the south. Surface discharge into Diamond Valley through Devil's Gate Gap at the southeast corner of Kobeh Valley may occur in response to large precipitation events.

Pine Valley is located north of the proposed mine and is bounded on the north and west by the northeast trending Cortez Mountains, on the south by the Roberts Mountains, and on the southeast by the Sulphur Spring Range. An ephemeral stream drains a small area on the north flank of Mount Hope to Garden Valley and Henderson Creek, the only perennial stream in the study area.

2.8 Groundwater Hydrogeology

On a regional basis, five hydrogeologic units have been identified in the vicinity of Mount Hope (SRK 2006):

- Eastern Assemblage which consists of limestone and dolomite with minor amounts of shale and quartzite. Based on studies in other basins, this assemblage is presumed to transmit large quantities of groundwater but this has not been confirmed in wells constructed in the Mount Hope vicinity.
- Western Assemblage which consists mainly of shale, siliceous shale, chert, quartzite and siltstone with minor amounts of limestone and andesitic volcanic rocks. Near

Mount Hope and the Roberts Mountains, the Western Assemblage is represented by the Vinini Formation, typically considered to be of limited water production capacity.

- Overlap Assemblage which consists of conglomerate, sandstone, shale, siltstone and limestone. Except where highly fractured, rocks of the Overlap Assemblage do not have sufficient permeability to transmit significant quantities of water.
- Tertiary Igneous Rocks consisting of volcanic and intrusive rocks that crop out in the Roberts Mountains. Experience during exploration drilling at Mount Hope indicates that these rocks typically produce only limited quantities of water.
- Valley Fill Alluvium that represents the most permeable and productive unit in the area and can be divided into two major sub-units. Alluvial fans and pediment surfaces consisting of unconsolidated to poorly consolidated, poorly sorted gravel, sand and silt comprise the older alluvium. Younger alluvium ranges from poorly sorted sands and gravels to fine-grained lacustrine sediments and playa deposits. Significant thickness of Valley Fill Alluvium occurs in Diamond, Kobeh and Pine Valleys.

Of the five major hydrogeologic units, only the Valley Fill Alluvium has been a source of large quantities of groundwater in this area. The carbonate rocks of the Eastern Assemblage may have developed sufficient secondary permeability due to faulting or dissolution to produce large quantities of water, but this hypothesis has not been proven in the immediate area of the Mount Hope pit. Preliminary drilling to test potentially productive zones in the carbonates beneath valley fill sediments indicates that relatively high-producing wells can be developed west of the pit, in the area of the planned well field. Secondary permeability associated with faulting and fracturing of the Western Assemblage, Overlap Assemblage, and Tertiary Igneous Rocks may be present in localized areas but none are believed to be major water producing units.

Hydraulic properties of rocks in the vicinity of the pit have been measured with packer tests in exploration drill holes (SRK 2007a). Review of well logs and driller's reports for the exploration program indicates that groundwater did not create drilling problems. Rocks beneath the mountain tend to be associated with the Overlap Assemblage and Tertiary Igneous Rocks and would be expected to have limited hydraulic conductivity except in isolated zones that are highly fractured.

Depth to water measurements in recent drill holes and monitor wells in the proposed mine area have been combined with historic water level data for the surrounding valleys to allow groundwater flow directions to be inferred in the area. Generally, groundwater recharge originates in mountains that bound the valleys. Recharge that enters the groundwater system at Mount Hope appears to move in a radial manner away from the mountain and into the three adjacent valleys. The hydraulic gradient appears to be steep in the low permeability rocks that comprise the mountain. As groundwater moves into the valleys, characterized by low topographic relief and thick sequences of valley fill sediments, the gradient flattens considerably.

Recent groundwater data collected by SRK is provided in the *Mount Hope Project Baseline Surface Water and Ground Water Report* (SRK 2008a). As part of this study, baseline water quality data has been collected from Henderson Creek, 24 spring locations, 13 groundwater wells, and one from discharge from a collapsed adit associated with the historic Mount Hope

Mine. The Henderson Creek surface water and the offsite springs share similar calcium-bicarbonate chemistry, low TDS and low metals concentrations. By contrast, the chemistry of the onsite springs is more similar to that of the onsite groundwater with elevated TDS and mixed anion water type and a dominance of the calcium cation. Baseline groundwater quality data for bedrock groundwater wells within the Project Area indicate that elevated manganese, arsenic, fluoride, TDS and to a lesser extent aluminum, iron, nickel, and sulfate constituents are present, reflecting the geochemical influence of the local geology rather than an impact from past mining activities.

2.9 Project Geology

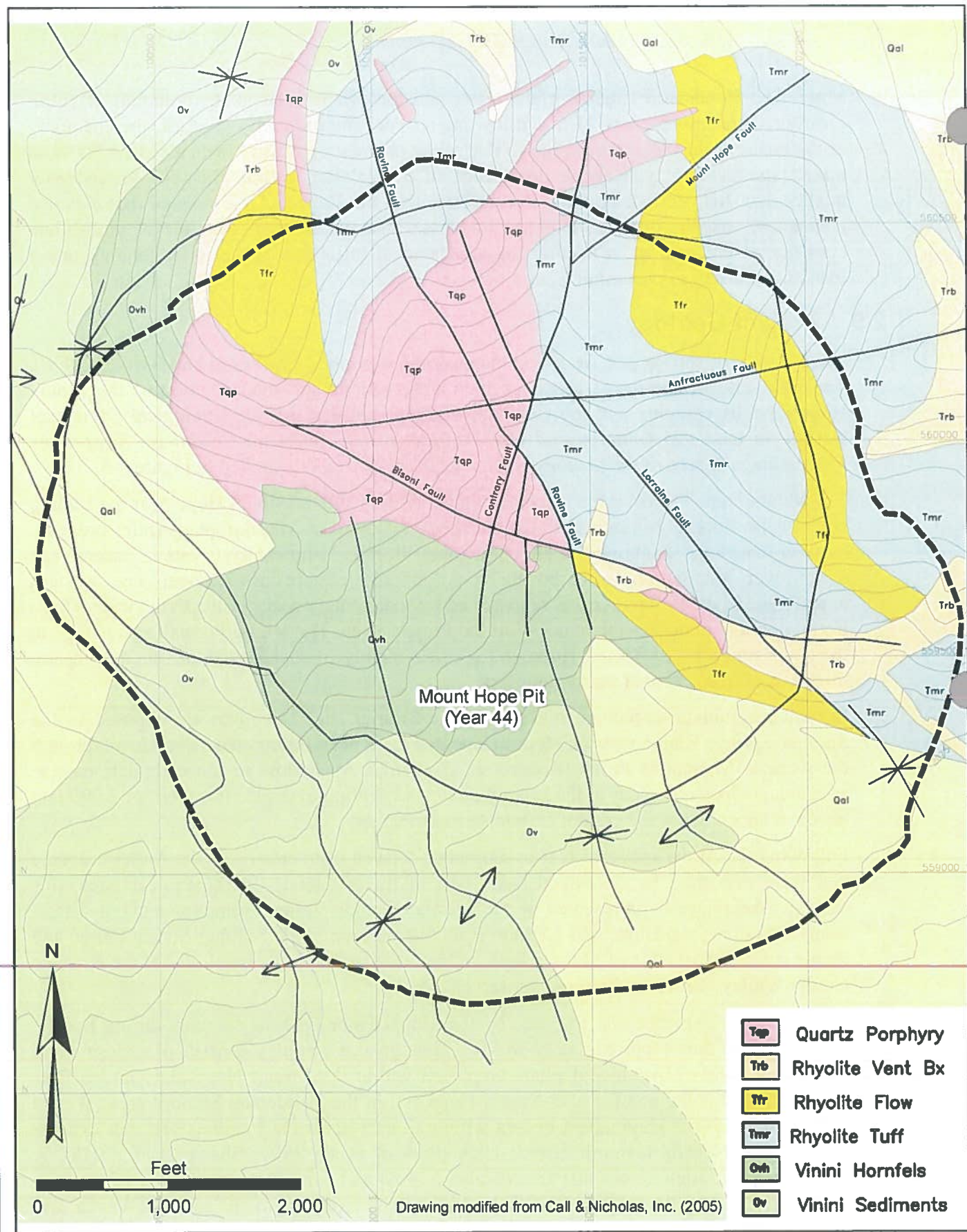
The geology of the Project Area was mapped and described by Westra and Riedell (1996). The following discussion is based on their observations and interpretation of the Mount Hope igneous complex and molybdenum deposit published by the Geological Society of Nevada in the *1996 Geology and Ore Deposits of the American Cordillera, Symposium Proceedings*. A map of the geology within the Project Area is provided in Figure 2-3.

The Mount Hope Project Area is located on the eastern side of Mount Hope near the leading edge of the Roberts Mountains thrust. During the Devonian-Mississippian Antler orogeny, east-vergent thrust faults placed allochthonous siliceous sedimentary (western) assemblage rocks over autochthonous carbonate rocks of the eastern assemblage. The western assemblage in the Project Area is represented by sedimentary rocks of the Ordovician Vinini Formation that underlies the majority of the Project Area. The Vinini Formation outcrops to the south and west of Mount Hope and consists mainly of shale, siltstone, chert with rare interbeds of quartzite and sandy limestone.

Eastern assemblage carbonate rocks from the Silurian and Devonian are exposed in the Sulphur Springs Range west of Mount Hope and have been interpreted as windows through the Roberts Mountains thrust (Roberts et al., 1967). A window to the carbonate eastern assemblage does not occur in the Project Area, and drilling to depths in excess of 2,000 feet have not encountered the eastern carbonate assemblage.

Following the Antler orogeny, clastic sediments derived from erosion of the Antler orogenic belt were deposited in a foreland basin east of the highlands. In the Project Area, this overlap assemblage is represented by the Permian Garden Valley Formation and consists of sandy limestone, sandstone and conglomerate that outcrop in the Sulphur Spring Range and on the southeastern edge of Mount Hope. In the latter location, the basal unit of the Permian Garden Valley Formation has been preserved.

The Paleozoic sequence was intruded by the Mount Hope igneous complex during Eocene and Oligocene time (approximately 38 Ma). This igneous complex consists of andesitic and high-silica rhyolite hypabyssal plugs emplaced within the Mount Hope and Garden Pass areas and as rhyolite ash flows at Mount Hope and in the Henderson Summit area (Westra and Riedell, 1996). Magmatism occurs within an east-northeast trending belt that extends from central Nevada to north central Utah (Stewart et al., 1997; Shawe et al., 1978). A single magnetic high across this area (Mabey, 1996) and similar chemistry and mineralogy of the igneous rocks suggest that they share a common magmatic source (Westra and Riedell, 1996).



- Quartz Porphyry
- Rhyolite Vent Bx
- Rhyolite Flow
- Rhyolite Tuff
- Vinini Hornfels
- Vinini Sediments



DESIGN: EMLLC	DRAWN: DVN	REVIEWED: VS
SCALE: 1 inch = 1,000 feet	DATE: 10/2009	
FILE NAME: WPCP FIG03 Geology Map BVB 200910.mxd		

EUREKA MOLY, LLC MOUNT HOPE PROJECT

DRAWING TITLE: GEOLOGY MAP	
ISSUED FOR: PIT WALL & WASTE ROCK CHARACTERIZATION REPORT	
DRAWING NO. FIGURE 2 - 3	REVISION NO.
SRK JOB NO. 157508-300	B

The initial phase of igneous activity in the area is marked by intrusion of an early quartz porphyry phase as evidenced only by autoliths. Following this initial event, ash-flow eruptions formed the variably welded Mount Hope Tuff that comprises the northwest portion of the volcanic complex. The tuffs are distinguished from the other volcanic units with an abundance of broken quartz and feldspar grains, shards and pumice and sparse lithic fragments. Following the ash-flow eruption, rhyolite vent breccias form steeply dipping ring-dikes that were emplaced in the caldera fracture zone (Riedell, 1996). Similar to the tuffs, the rhyolite vent breccia contains abundant broken quartz and feldspar grains, but is distinguished from the tuff by an absence of shards and pumice and an increase in size and abundance of lithic fragments.

The core of the Mount Hope complex consists of non-fragmental rhyolite quartz porphyries which intrude both the Mount Hope tuff and rhyolite vent breccia. These porphyries characteristic contain subhedral to euhedral quartz, K-feldspar and plagioclase phenocrysts with an aphanitic groundmass that becomes coarser with depth. Along the margins of the complex, the porphyry occurs as a chilled border phase with prolific xenoliths of Vinini Hornfels. The main phase of the quartz porphyry is exposed in the west central portion of the complex and as numerous dikes cutting the Vinini Formation. Subsequent porphyry phases include an aplitic quartz porphyry with a distinctively sugary groundmass; a very coarse grained quartz porphyry and granite porphyry with phenocrysts greater than 3 mm in size; and minor dikes of fine-grained granite or aplite (Riedell, 1996).

2.9.1 Mineralization and Alteration

Hydrothermal alteration and mineralization in the Mount Hope area is related to the intrusion of the Mount Hope igneous complex. The effects of this intrusion are wide spread throughout the area and extend into the adjacent sedimentary wall rocks. Igneous and sedimentary rocks in the region are host to the porphyry molybdenum deposit that exhibits distinctive zoned alteration and mineralization patterns. Alteration zones are well developed within the deposit and can be correlated between the various host lithologies. Riedell and Westra (1996) classified the effects of alteration, regardless of host, into the following categories (arranged from periphery to core of the hydrothermal system): weak argillic-propylitic, argillic, potassic-phyllitic, potassic, high silica, and biotite.

Argillic alteration is wide spread and well developed in the Mount Hope Tuff and rhyolite vent breccia in the eastern half of the complex. Clays and carbonates replace plagioclase and form distinctive orbicular aggregates associated with sulfide mineralization. Argillic Vinini Formation is a gray to brown biotite-sericite hornfels. Within the argillic zone, lead, zinc, silver and manganese values are anomalously high and occur in distinct haloes. High grade zinc-rich mineralization occurs where this zone intersects carbonates of the Garden Valley Formation. Hydrothermal fluids recrystallized the carbonate and produced isolated lenses of retro-grade altered garnet-pyroxene skarn.

Molybdenum mineralization, in the typical grade range of 0.04-0.08 percent molybdenum by weight, occurs within the potassic-phyllitic and potassic zones and within a thin zone near the top of the biotite alteration zone. However, ore grade molybdenum mineralization is generally associated with the potassic zone. Mineralization occurs in a stockwork of quartz-molybdenite+K-feldspar+fluorite veins with lesser “blue quartz” veins and molybdenite

“paint” on late fractures. Disseminated molybdenum is rare. The geometry of the molybdenum mineralization suggests two stacked molybdenum shells lying side by side where the highest molybdenum grades are encountered in a zone of spatial overlap between the two hydrothermal systems (Westra and Riedell, 1996).

2.9.2 Structural Geology

Two sets of faults occur within the Project Area; high angle structures trending west-northwest and moderate to high-angle ring-shaped structures that truncate the earlier set. These faults generally show post-mineral normal displacement down to the northeast or east (Riedell, 1996). The Bisoni and Tia faults trend west-northwest and dip about 70 degrees to the north. Both of these faults are cut by the Mount Hope fault, an east-dipping listric fault that is the most significant structural feature in the area. Normal movement along this fault, estimated at 650 to 800 feet, has juxtaposed argillic alteration from the periphery of the molybdenum system directly against higher grade molybdenum mineralization in the footwall (Riedell, 1996). Other significant structures in the area include the Lorraine fault, that dips southwest at a moderate angle and is confined to the hanging wall of the Mount Hope fault, and the Ravine fault in the footwall of the Mount Hope fault. The Ravine fault displays near vertical listric movement that flattens with depth toward the east (Westra and Riedell, 1996).

During the Tertiary, post mineralization basin and range block faulting rotated the area 10 to 20 degrees east (Westra and Riedell, 1996). Valleys that formed as a result of basin and range faulting have become depositional sites for unconsolidated to weakly consolidated gravel, sand and silt.

2.10 Mining and Exploration History

The Project Area is located within the Mount Hope Mining District and includes the historical workings of the Mount Hope Mine, the only productive property in the district to date. Zinc-rich ores hosted in altered limestone of the Garden Valley Formation were discovered on the eastern flank of Mount Hope in 1870 and mined intermittently until the middle 1940s from four principal areas: the Lorraine Area; the Whim Shaft; the Mount Hope No. 1 adit, and the No. 2 adit. The major workings in the Lorraine Area were opened in 1886 and consist of a main adit about 240 feet in length, two shafts about 90 and 135 feet, and drifts on four levels. The Mount Hope No. 2 adit was driven in 1890 along with the Whim shaft. The No. 2 adit is about 1,350 feet long with about 1,745 feet of sub drifts, crosscuts, and raises. The Whim shaft is about 90 feet deep.

In 1926 the U.S. Smelting, Refining, and Mining Company drove the Mount Hope No. 1 adit, which is about 800 feet long and has about 3,255 feet of drifts, crosscuts, raises, and winzes. The property was optioned to Universal Exploration Company in 1928, who subsequently purchased the property in 1930. Additional exploration work was conducted under a number of leases until the 1940s when Callahan Zinc-Lead Company obtained a long-term lease and initiated an extensive drilling and development program. A power plant and concentrating mill and tailings impoundments were constructed by the Callahan Company. Exploration in 1943, 1944, and 1945 included a drilling program conducted by the U.S. Bureau of Mines. The first concentrates were shipped in 1945, but the mine was

shut down in 1947 after a fire destroyed the powerhouse. Since then, mining activity has been limited to exploratory drilling in the mine area, intermittent toll milling of ores and advancement of a decline adit by Mount Hope Mines, Inc. that intercepted the Mount Hope No. 1 adit through an air raise shaft (Westec, 1995). Through 1965, the district produced 10,189,454 pounds of zinc, 441,103 pounds of lead, 63,697 ounces of silver, 57,675 pounds of copper and 83 ounces of gold, with an historic value of \$1,335,393 (Roberts et al., 1967).

Several companies including Bear Creek Mining Company, Phelps Dodge, Phillips Petroleum Company, AMAX, ASARCO, and Gulf Mineral Resources examined the property during the 1970s. An extensive drilling and development program by the Mount Hope Mining Company and Phillips Petroleum Company during 1970 and 1971 confirmed that substantial copper mineralization occurred at depth in association with a low grade but continuous molybdenum mineralization (Westec, 1995).

From 1979 to 1982, 23 core holes were drilled by the Exxon exploration group totaling 42,831 feet. This drilling program revealed substantial molybdenum mineralization at depth for future exploration and development. Continued evaluation of the Mount Hope mineral system by the Exxon mineral group included drilling an additional 104 drill holes, resource estimation, mine planning, metallurgical studies, and rock mechanic studies. From 1989 to 1990, Cyprus drilled four additional holes on the property under an agreement with Exxon.

In 1995 Kennecott Exploration entered into an agreement with Exxon that allowed them to evaluate the property with the intent to execute a purchase. The extensive Exxon technical backup volumes were made available for the Kennecott study from which Kennecott conducted the economic evaluations using Davey McKee cost estimates. In 2004, the property was purchased by GMI.

2.11 Local Petrology

In this report, the term *rock type* refers to the basic lithological characteristics of the waste rock. *Alteration type* refers to the mineral assemblage that has been formed as a result of hot saline water contacting a pre-existing rock and modifying the mineralogy and geochemistry of that rock by hydrothermal alteration during the ore mineralization process. The term *material type* denotes a unique combination of rock type and alteration type.

The common rock types for the Mount Hope project include:

1. *Alluvium* – undifferentiated Quaternary alluvium.
2. *Intermediate Phase Quartz Porphyry – Tqpa*: yellow-grey weakly porphyritic intrusive rhyolite with small quartz and K-feldspar phenocrysts in a relatively coarse grained sugary groundmass, commonly silicified. Molybdenum host.
3. *Early Phase Quartz Porphyry – Tqp*: yellow-grey strongly porphyritic intrusive rhyolite with medium unbroken phenocrysts of quartz and K-feldspar in a fine grained aphanitic groundmass. Principal molybdenum host. The distinction between early and intermediate phase porphyries is a function of intrusion timing with the intermediate porphyry observed cross-cutting or intruding the earlier phase of porphyry.

4. *Rhyolite Breccia – Trb*: breccia mix of sub-rounded quartz porphyry clasts with broken quartz phenocrysts and sub-angular clasts of fresh (grey) to altered (brown) laminated shale (Ov) in a quartz-clay+/-sulfide (pyrite) matrix.
5. *Rhyolite Tuff/Flow – Tmr/Tfr*: yellow-white strongly porphyritic extrusive rhyolite ash-flow tuff with 2-4mm broken phenocrysts of quartz and less oligoclase in an aphanitic groundmass containing minor pumice, glass shards and lithic fragments.
6. *Garden Valley – Pg*: pale-grey, very fine grained massive marine carbonate (limestone) with narrow silty interbeds and some dissolution textures. Commonly altered to skarn adjacent to igneous rock. Eastern assemblage.
7. *Vinini Sediments – Ov*: grey to black medium bedded-to-laminated carbonaceous shale, siltstone, chert and rare conglomerate. Commonly metamorphosed to brown biotite hornfels adjacent to igneous rock. Significant molybdenum host. Western assemblage; Upper plate.

The main alteration types for the Mount Hope Project include:

1. *Argillic – Ar*: replacement of primary silicates by clay minerals, most varied of the alteration types;
2. *Phyllic – Ph*: an assemblage of quartz, sericite and pyrite ± calcite;
3. *Potassic – Po*: dominance of potassium feldspar, biotite and co-existing sulfides;
4. *Biotite – Bi*: similar to potassic alteration, with a greater abundance of biotite, only associated with the Tqpa rock type;
5. *Silicic – Si*: heavily silicified rock, occasionally complete replacement by silica; and
6. *Hornfels – Hnfls*: contact metamorphosed, fine-grained siliceous sedimentary rocks of the Vinini Formation.

Two other alteration types that occur at the site, but are not captured in the current mine model include; *skarn (Sk)* alteration from contact metamorphism of eastern assemblage carbonate rocks, and *propylitic (Pr)* alteration, an assemblage of carbonate, chlorite and sulfide associated with weakly argillized zones.

Based on published geologic data for the site Westra and Riedell (1996) and a review of the archived core, a total of 23 common material types demonstrating unique combinations of rock type and alteration type have been identified for the Mount Hope Project. These material types have been the focus of the baseline characterization study and are summarized in Table 2-1 below. Of these 23 material types, the most significant in terms of volume to be mined include Potassic Early Phase Quartz Porphyry, Argillic Rhyolite Tuff and Potassic Vinini Sediments.

Table 2-1: Summary of Mount Hope Material Types

Material Type	Rock Type	Primary Alteration
1	Alluvium (Qal)	Various
2	Intermediate Phase Quartz Porphyry (Tqpa)	Potassic
3		Biotite
4		Silicic
5		Argillic
6	Early Phase Quartz Porphyry (Tqp)	Phyllic
7		Potassic
8		Silicic
9		Argillic
10	Rhyolite Breccia (Trb)	Phyllic
11		Potassic
12		Silicic
13		Argillic
14	Rhyolite Tuff (Tmr) and Rhyolite Flow (Tfr)	Phyllic
15		Potassic
16		Skarn
17	Garden Valley (Pg)	Unaltered
18		Propylitic
19		Argillic
20		Phyllic
21		Potassic
22		Silicic
23		Skarn

2.12 Previous Studies

Although in terms of mining, Mount Hope is a “greenfields” site, there have been several previous studies of the property that provide data pertinent to this evaluation, the majority of which were exploration studies. However, in 1995 a Phase 1 Environmental Due Diligence was initiated by Kennecott (Westec, 1995). As a part of this study, an initial geochemical assessment by Geochimica, Inc. included preliminary static testing that showed potential for acid generation. A copy of the Geochimica, Inc. memorandum is provided in Appendix A.

In this initial geochemical assessment, nine samples were collected from Kennecott drill core to cover a range of lithologies and molybdenum grade. Seven samples were lithology specific over short intervals while the remaining two were composites over a wider interval and covered more than one lithology and/or alteration type. The general characteristics of the Kennecott drill core samples, including critical MWMP and ABA results, are shown in Table 2-2. The results show that Mount Hope waste rock has “significant” potential for acid generation. The report states that all waste with more than 0.7 weight percent sulfide should be considered likely to generate acidic conditions and in need of “special handling”. The evaluation concluded that for the porphyry and rhyolite waste rock, kinetic testing would be required to determine the potential for these waste types to react with water to generate acid or release metals. The report further provides a conceptual view of waste rock stating that

“Compositing of waste rock will not suffice as a means of controlling ARD and leaching of metals,” implying that segregation of waste is desirable. Based on a qualitative evaluation of potential pit lake chemistry, the report concludes that the “final pit lake water quality may exceed ambient water quality criteria for some metals and could approach drinking water quality criteria for some components such as TDS, sulfate, iron, manganese and (perhaps) arsenic and selenium”.

Table 2-2: Summary of Geochemical Static Test Data (after Geochimica, 1995)

Sample	Rock Type	Alteration	ABA Results		MWMP Results								
			Total Sulfur	NPR ¹	pH	TDS	Sulfate	As	Fe	Mn	Mo	Se	Zn
			wt %	ratio	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MH-1	Ov	Potassic	8.79	0.05	5.63	2040	1300	0.14	39	64.4	<0.05	<0.005	186
MH-2	Ov	Potassic	0.57	1.28	8.27	170	20	<0.05	<0.03	0.07	2.23	<0.005	<0.01
MH-3	Ov	Potassic	0.19	0.64	7.05	110	30	<0.05	0.18	0.58	0.7	<0.005	0.54
MH-4	Tqp	Silicic	0.74	0.16	5.77	340	160	<0.05	0.04	3.38	<0.05	<0.005	0.95
MH-5	Tqp	Potassic	0.1	1.64	7.96	290	100	<0.05	<0.03	0.09	0.85	<0.005	<0.01
MH-6	Tqp	Potassic	<0.01	>26	6.95	120	30	<0.05	<0.03	0.02	<0.05	<0.005	0.24
MH-7	Tmr	Phyllic	0.26	7.08	8.02	230	60	<0.05	<0.03	0.07	<0.05	<0.005	<0.01
MH-8	NA - Composite		2.44	1.3	7.97	440	170	<0.05	<0.03	0.24	<0.05	0.012	0.03
MH-9	NA - Composite		2.73	0.28	6.28	1330	800	0.09	0.26	103	<0.05	0.008	28.5

¹ NPR refers to Neutralization Potential Ratio = Neutralization Potential/Acidification Potential

3 APPROACH

3.1 Overview

- The purpose of the Project was to develop a geochemical characterization of Mount Hope waste rock and pit wall rock for use in generating a source term for evaluation of potential environmental impacts associated with facilities at Mount Hope;
- Representative samples of the main material types for the Mount Hope Project were collected from historic and recent core for static and kinetic testing;
- The approach to sampling was to ensure that the end-member mineralogy, as assessed by initial field screening and contact testing, was sufficiently sampled to provide a comprehensive and representative understanding of the full range of geochemical characteristics for each of the material types;
- Prior to static testing, bulk whole rock geochemistry was determined to confirm the classification of materials and representative nature of sampling;
- The static testing program was structured to quantify potential metal leaching and acid generation;
- The kinetic test program was designed to assess the rate of sulfide weathering and of constituent release from the waste rock and pit wall rock as weathering proceeds. This testing allows use of time-related loading of constituents in predictive modeling, rather than a fixed mass of solute resulting from a single dissolution event as is achieved through static testing; and
- The rationale for the development of a source term for the waste rock facilities and for the pit wall was to determine potential runoff chemistry.

3.2 Objectives

The objectives of the baseline geochemical characterization program were to:

- Characterize the geochemistry of material types in the deposit and classify their potential reactivity;
- Provide sufficient data to develop a comprehensive sampling plan to ensure all material types are characterized for acid generation and metal leaching properties; and
- Provide chemical data as a source term for input to predictive geochemical models being used for environmental assessment of waste rock facilities and pit wall rock.

Archived and recent core was logged to identify and collect samples for field and laboratory geochemical testing. Tests of static and kinetic geochemical behavior useful in predicting potential impacts from proposed mining operations and developing strategies for mine closure were completed. Figure 3-1 is a flow chart summarizing the geochemical characterization program for the Mount Hope Project, which shows the progression of the data collection activities and the intended end uses of the data.

3.3 Selection of Samples for Geochemical Testing

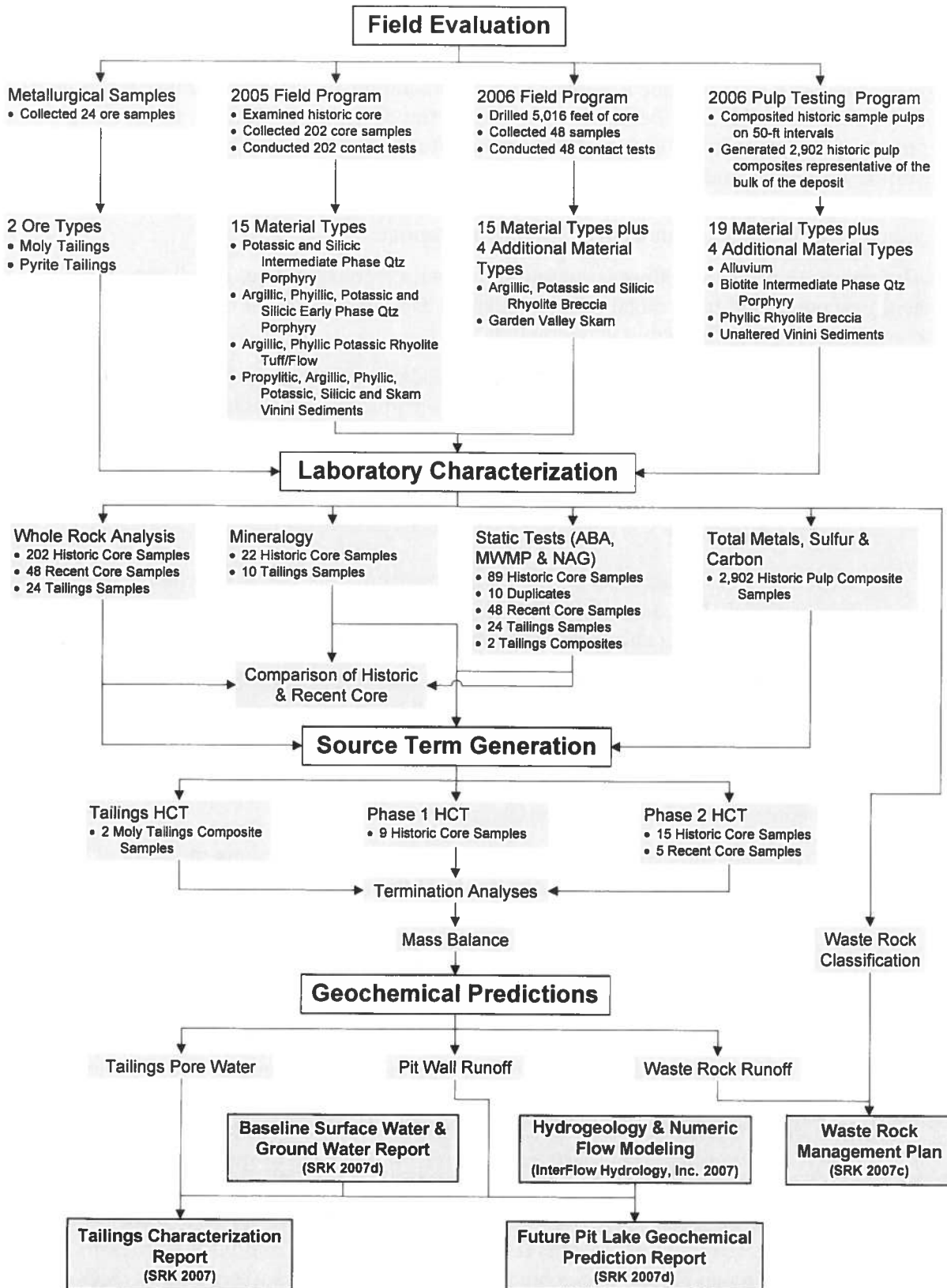
The approach to sampling sought to ensure that samples with the end-member reactivity, based on contact testing and laboratory screening, were sufficiently sampled to provide a comprehensive and representative understanding of the geochemical characteristics of the geological material types. To this end, SRK focused on understanding the geology of the deposit and geological controls on the geochemical behavior of the different materials as the basis for initial sample selection. As additional mineralogical and geochemical data became available through sample analysis, these were combined with the previous data to define subsequent sample sets.

3.4 Objectives of the Field Screening Pre-Testing Program

The value of the geochemical data developed for the Mount Hope Project depends directly on analysis of samples that fully represent the range of mineralization to be mined. For this reason, core was described in hand specimen and contact tests were completed to ensure that appropriate samples were collected for further characterization. Tests included:

- Mineralogical description of waste rock hand specimens identified in archived core using historical drill logs and grade control assays;
- Contact pH and electrical conductivity (EC) to determine the degree of oxidation and accumulation of secondary mineral phases in the core sample (i.e., after SRK SOP 20, Appendix B). Contact tests are paste tests designed to determine potential reactivity of a material by reacting crushed rock with a 1:1 ratio of distilled water to rock; and
- Quantitative chemical analysis of the samples after complete dissolution in four strong acid digests to assess total chemical composition (ALS Chemex method ME-MS61).

Figure 3-1: Characterization Program Flow Diagram



3.5 Objectives of the Static Test Program

“Static test” is a general term describing those analytical methods applied to characterize acid generation and metal leaching characteristics of material at the time of testing, without consideration of temporal changes that may occur in the material as chemical weathering proceeds. Such tests provide a balance of acid generating and acid consuming reactions at an end point, and also may be used to determine the potential magnitude of leaching metals from a given material. They are distinguished from kinetic tests which evaluate the rate of sulfide oxidation and metal release over time. Because chemical weathering kinetics are known to strongly affect solute release over time, the shorter and less expensive static tests are confirmed using kinetic methods where appropriate.

The objective of static testing is therefore to obtain a conservative, initial approximation of acid generation and trace metal release potential as a foundation for determining where more comprehensive kinetic testing is warranted.

The static data collected for this project includes total acid generating or neutralizing potential of the samples, concentration of constituents in leachates derived from the material, and the mineralogy of regulated elements. Static testing was accomplished using the following methodology:

- Examination of material by scanning electron microscopy and X-Ray diffraction to assess mineralogy;
- Reactive acid generation using the protocol of Environmental Geochemistry International, Pty, Ltd. (EGi, 2002), for net acid generation. This test assessed the acid or neutralizing character of the material when reacted with hydrogen peroxide;
- Quantitative estimate of sulfur speciation chemistry using LECO analysis to assess maximum acid potential, coupled with titration and back titration tests to assess extent of neutralizing capacity (Modified Sobek method); and
- Meteoric leaching of trace element using the Nevada Meteoric Water Mobility Procedure with subsequent solution analysis.

Static tests indicate the total potential outcome of material reactions in terms of release of acid, salt, and metal but provide no assessment of the rates at which the rock will react with water and air.

3.6 Objectives of the Kinetic Test Program

Kinetic tests evaluate net oxidation, dissolution, and desorption reaction rates and leachate chemistry over time, through the sequential leaching of the rock weathered in a regular cycle of exposure to dry and wet air in a controlled laboratory environment. These cycles simulate and accelerate the chemical weathering rates observed under field conditions, using test conditions that are specifically designed to target oxidation of sulfide minerals. The goal of kinetic tests is to confirm static tests results and, on the basis of the mass released, provide data to support prediction of the leachate chemistry that would likely develop during meteoric rinsing of waste rock storage area facilities. Kinetic test data were also used to predict concentrations of constituents that would be released from pit wall rock in response to meteoric rinsing and to develop a prediction of future pit lake water quality (SRK 2008b).

4 METHODOLOGY

4.1 Overview

- Representative samples of waste rock were obtained from archived historic drill core, recent drill core, and historic pulps and core;
- Visual observation of the historic core during sampling activities indicated there has been no significant oxidation or degradation of the core material during storage;
- Geochemical samples were collected to represent the main waste rock material types, with sampling frequency based on the amount of rock to be mined and the geochemical variability observed for each material type in the field screening tests;
- Samples from the inventory of historic and recently drilled core were field screened using contact pH and EC tests in order to determine the basic characteristics of the materials and to validate the material type delineations prior to selecting larger core samples for static and kinetic test work;
- Samples for static geochemical testing were submitted for ABA, NAG and the MWMP;
- A sub-set of samples representing the most significant waste rock and pit wall rock types were selected from the static test samples for kinetic testing;
- Nine Phase 1 kinetic tests were conducted for 69 weeks until steady state conditions were achieved in the HCT. Following a two-week rest period, the cells were rinsed again in order to determine if significant salt accumulation has occurred during the resting period;
- Following the final rinse, a series of termination tests were completed on the HCT residue material to measure changes in mineralogy, mass of key elements, and acid generation potential. These HCT residue samples were submitted for mineralogy, selective extraction, ABA including sulfur speciation by LECO analysis; and whole rock analysis by a four-acid digest; and
- Twenty additional samples were collected for subsequent kinetic testing (Phase 2). These tests are currently in progress with results reported herein up to Week 25 for Profile II results and Week 30 for weekly results including pH, EC, sulfate, iron, alkalinity and acidity.

4.2 Sample Collection

Waste rock was classified and tested according to material type as summarized in the sample inventory matrix shown in Table 4-1. The number of samples selected for testing was based on the relative percentage of each material type predicted to be mined according to the current block model, along with the geochemical variability observed in hand specimen and contact tests. There are, however, a few exceptions to this statement, depending upon the degree of variation observed during field screening. Homogenous geologic units with low geochemical variability require fewer samples for adequate characterization, while heterogeneous units with high variability require more samples. Geochemical variability of each of the material types is described in more detail in Section 5.

Mount Hope geochemistry samples were collected from three different sources including historic drill core, fresh drill core, and historic pulps.

4.2.1 Historic Drill Core

The first phase of sampling was completed in November 2005 and provided 250 samples from archived historic drill core collected during previous investigations conducted by Exxon from 1970 through 1980. Cut and un-cut core remaining in archive boxes after completion of assay sampling was examined in hand specimen and where necessary, with X-Ray diffraction (XRD). Representative samples were collected from core intervals containing sufficient material of a particular type for geochemical testing. For the selected sample intervals, lithology, alteration, bulk geochemical characteristics and major mineralogy were consistent across the entire interval. As a result of these efforts and to the extent possible, the spatial and vertical distribution of the selected samples is representative of the majority of the mineralized deposit that will be mined.

Visual inspection of the archived core during sampling activities indicated there has been no significant oxidation or degradation of the core material as a result of being stored in the core shed in boxes for approximately 25 years. In the small number of instances where tertiary salts had formed or there was potential degradation of the core observed in the box, samples were not collected to minimize storage artifacts on geochemistry of the core. Consequently, this core is considered representative of waste rock that will be mined as part of the Mount Hope Project.

4.2.2 Recent Drill Core

To augment the samples collected from archived core, drill core samples were also collected by SRK from recent exploration of the zinc-skarn deposit and wall rock located on the eastern flank of Mount Hope. The recent drilling in this area produced samples of material types not encountered during previous drilling activities and also provided an opportunity to compare fresh rock to samples of the same type of rock that has been stored in the Mount Hope core shed for approximately 25 years.

A total of 48 representative samples were collected from core intervals containing eight to ten kg for geochemical testing. For the selected samples, lithology, alteration, and mineralogy were consistent across the entire interval.

4.2.3 Historic Pulps and Core

Composites that are representative of a single rock/alteration material type were obtained from historic assay pulps and core from past exploration drill holes (pre-2006). The spatial and vertical distribution of these pulps is representative of the bulk of the material to be mined and provides tightly spaced geochemical sampling control across the portion of the deposit that was drilled during past exploration activities. Static testing of the numerous historic pulps and core allows the smaller dataset of comprehensive mineralogy, static and kinetic data obtained for samples of historic and recent core to be extrapolated across the ore body.

The drill samples for this evaluation were composited to represent approximately 50 feet of continuous drill core. However, the length of the sample interval varied based upon the location of the geologic contacts and sample interval lengths were adjusted to ensure that the lithology, alteration, and mineralogy were consistent for each composited interval. Samples with molybdenum values greater than 0.034 percent were not included in this evaluation, as this material will be mined and processed as ore. This approach yielded a waste rock dataset consisting of 1,546 sub-samples that were analyzed and can be directly related to the existing mine model and volumes of waste rock to be mined. These samples were analyzed for whole rock analysis, sulfur and carbon chemistry.

4.3 Sample Testing Strategy

A complete list of sampled lithologies and the corresponding number of samples selected for field screening, static, and kinetic testing is provided in the sample matrix shown in Table 4-1.

The geochemical characterization approach was phased, with the selection of samples and types of analysis for each phase predicated on the results of the previous phases. For instance, the results of the initial field tests and observations were used to validate the material type delineations prior to selecting larger core samples for static and Phase 1 kinetic testing. Static and Phase 1 kinetic test samples were selected to represent the variability within each material type based on the field screening results as well as to represent the material types in relative proportion of their abundance in the mine plan. Phase 2 kinetic test samples were chosen using the results of previous field, static and kinetic tests. This process ensured that the geochemistry data is representative of all materials to be excavated and processed.

4.3.1 Field Screening and Preliminary Assessment of Reactivity

A total of 202 samples from the archived core and 48 samples from recent drilling activities were screened in the field to determine the basic characteristics of the materials. All core samples were screened using the following procedures:

- Mineralogy and physical characteristics: hand specimen description by a qualified geologist coupled with XRD, as required; and
- Contact tests for parameters: pH and electrical conductivity, in reactant leachate (see SRK-Standard Operating Procedure 20 and 21 included in Appendix B); and

- Bulk geochemical analysis: using the CHEMEX ME-MS61 four-acid digest to determine total metal, metalloid, and cation chemistry for 48 elements for each sample.

Table 4-1: Sample Frequency and Testing Matrix

Rock Type	Primary Alteration	Material Type	Contact Tests ¹		Multi-Element Analysis		Static Tests ²		Humidity Cell Tests		Total Sulfur, Carbon and Metals	
			Historic Core ³	Recent Core ⁴	Historic Core ³	Recent Core ⁴	Historic Core ³	Recent Core ⁴	Phase 1	Phase 2	Historic Pulps (Waste)	Historic Pulps (Ore)
Alluvium (Qal)	NA	1									5	4
Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	2	6		6		4			1	21	30
	Biotite	3									7	51
	Silicic	4	6		6		4		2		46	159
Early Phase Quartz Porphyry (Tqp)	Argillic	5	13		13		5		1	1	44	11
	Phyllic	6	12		12		8			2	95	63
	Potassic	7	31	8	31	8	9	8	1	2	257	564
	Silicic	8	10		10		5			2	24	35
Rhyolite Breccia (Trb)	Argillic	9		6		6		6			24	2
	Phyllic	10									8	
	Potassic	11		1		1		1			9	4
	Silicic ⁵	12		5		5		5				
Rhyolite Tuff/Flow (Tmr/Tfr)	Argillic	13	37	12	37	12	23	12	4	1	382	10
	Phyllic	14	16	1	16	1	6	1		2	80	13
	Potassic	15									24	29
Garden Valley (Pg)	Skarn ⁵	16		3		3		3			8	
Vinini Sediments (Ov)	Unaltered ⁵	17									15	
	Propylitic	18	3		3		3			2		
	Argillic	19	8	4	8	4	5	4	1	2	53	28
	Phyllic	20	12		12		12			2	142	10
	Potassic	21	44	7	44	7	12	7	2		290	314
	Silicic	22	3	1	3	1	2	1		1	10	29
	Skarn ⁵	23	1		1		1				2	
Totals	23 Material Types	202	48	202	48	99	48	9	20	1,546	1,356	
		250	250	147	29	2,902						

NA = Not Applicable

¹ Contact tests are designed to determine potential reactivity of a material by reacting crushed rock with a 1:1 ratio of distilled water to rock.

² Static tests include; Acid Base Accounting, Net Acid Generation and Meteoric Water Mobility Procedure test.

³ Historic core was collected during previous investigations conducted by Exxon during 1970 through 1980.

⁴ Recent core was collected during the 2006 exploration program.

⁵ Material type that does not occur within the proposed pit boundary and will not be mined but is included in the geochemical characterization program for completeness.

The field screening results were confirmed with static laboratory tests of a smaller sub-set of samples including;

- Meteoric Water Mobility testing;
- Acid Base Accounting; and
- Net Acid Generation testing.

4.3.1.1 Contact Tests

Contact pH and EC were measured to determine the degree of oxidation and accumulation of secondary mineral phases in the core samples. Contact tests were conducted by mixing a sample of the fine-grained portion of the material (minus 4.75 mm) with de-ionized water in a ratio of 1:1 by weight to volume. The contact solution was decanted and measurements were made directly on the leachate produced.

As a general rule, low pH readings in contact tests indicate that sulfide and/or metal oxidation resulting in acid generation has occurred. Conversely, high pH values generally indicate a sample that is not generating acid or has neutralized any acidity produced during oxidation through mineral buffering. High EC levels indicate the accumulation of soluble secondary minerals, such as sulfates or metal salts. This method is qualitative and cannot be used to calculate the total amount of acidity or neutralization that will be produced from a particular rock but is indicative of the degree of oxidation and accumulation of secondary mineral phases that have occurred prior to sampling.

A discussion of the results of the contact testing is provided in Section 5.2 and results are provided in Appendix C.

4.3.1.2 Whole Rock Analysis

Whole rock chemistry involves the near-complete digestion of a solid sample into solution using multiple strong acids. The solution is then analyzed for chemical composition using inductively-coupled plasma/mass spectrometry (ICP/MS). Sample material remaining from the contact tests were submitted to Chemex for 4-acid digestion and ICP/MS (ME-MS61) to determine total metal, metalloid and cation chemistry for 48 elements.

Samples for whole rock analysis were submitted to ALS Chemex Labs in Reno, Nevada. A discussion of the results of the whole rock analysis is provided in Section 5.3 and results are provided in Appendix D.

4.3.1.3 Detailed Mineralogy

Samples were submitted for detailed mineralogy to identify mineral composition and abundance in the samples, with particular attention to the sulfide, sulfate, metal, and carbonate mineralogy of the samples. Fifty samples from the 2004 field program were analyzed by Scanning Electron Microscope (SEM) and XRD.

SEM analyses were performed at the Department of Geological Sciences at Cardiff University, Cardiff, UK. The SEM instrument was a SEM-JEOL 6200 SEM coupled to a Link WDA mineral analysis system. XRD analyses were also performed at the Department of Geological Sciences at Cardiff University. The XRD equipment was a Phillips 1390 PW and the identification method was by PCIdentify software. XRD analysis provided a semi-

quantitative analysis of the relative percentages of each mineral phase present. Weighting factors published by Biscaye (1964) were used to interpret the clay peaks.

Mineralogical information obtained for the samples is presented in Appendix E. A discussion of the results of the mineralogy is provided in Section 5.1.

4.3.2 Static Tests

Static testing includes those analytical methods applied in the characterization of acid generation and metal release potential at a fixed point in time. Such tests provide a conservative estimate of the balance of acid generating and acid consuming reactions and can also be used to estimate the potential concentrations of metals that will leach from a given material. However, static tests do not provide an assessment of the rates of reaction of the material with water and air, and instead provide a total potential capacity of the material to release metals and acid at the time of testing.

Static data collected for the Mount Hope waste rock include acid generation potential, concentration of constituents in leachates derived from the material, and the mineralogy of regulated constituents.

This was accomplished using the following methods:

- Net Acid Generating (NAG) test reporting final NAG pH and final NAG value after a two-stage hydrogen peroxide digest;
- Acid Base Accounting (ABA) using the British Columbia Acid Mine Drainage Task Force (BCAMDTF) Modified Sobek with LECO sulfur speciation analysis including Total Inorganic Carbon Analysis (TIC); and
- Nevada Meteoric Water Mobility Procedure (MWMP - ASTM E2242-02) and analysis of leachate for Nevada Profile II constituents.

Samples were submitted to McClelland Laboratories (MLI) in Sparks, Nevada for sample preparation including compositing and MWMP extraction. The MWMP extracts were submitted to WetLab in Sparks, Nevada for analysis. A separate split of each composite sample was sent to SVL Analytical in Kellogg, Idaho for ABA, TIC and NAG testwork.

A discussion of the results of the material characterization static test results is provided in Section 6, and results are provided in Appendix F and G.

4.3.3 Kinetic Tests

Kinetic testing involves the sequential leaching of the material types through a regular cycle of exposure to dry and wet air in a controlled laboratory environment. This simulation accelerates the chemical weathering rates observed under field conditions.

Kinetic testing in this report refers to the standard humidity cell test procedure designed to simulate water-rock interactions in order to evaluate the rate of sulfide mineral oxidation and thereby predict acid generation and metals mobility (ASTM D-5744-96, Appendix B). Under ASTM methodology, the test typically runs for a minimum of 20 weeks and follows a seven-day cycle, unless uncertain chemistry requires that it be run longer to achieve steady state conditions. During the seven-day cycle, water is trickled over the rock for two days.

Air that is humidified slightly above room temperature is introduced at the bottom of the column for two days of each cycle followed by two days of dry air. On the seventh day, the sample is rinsed with distilled water and the extracted solution is collected for analysis. Key parameters including; pH, alkalinity, acidity, electrical conductivity, iron and sulfate are measured on a weekly basis. Metals are typically measured on a weekly basis until "steady state" conditions have been achieved. After ten weeks of testing, the frequency of metals analysis was reduced to specific weeks dependent on key parameters that continue to be collected on a weekly basis.

In this study steady state was assumed once constituent concentrations remain constant for more than four consecutive weeks following evidence of sulfide leaching in previous leaching cycles. After the leaching reactions have been adequately characterized in the HCT, the cell was rested for two weeks and rinsed again to determine if significant salt accumulation has occurred during the resting period.

Typically, the results of the field screening and static test work are used to refine the material type classifications and determine if any materials exhibit uncertain or highly variable geochemical behavior that requires more extensive characterization using kinetic test methods. However, in order to expedite the Mount Hope waste rock characterization program, an initial phase of kinetic testing was initiated in conjunction with the static tests to determine the rates and character of longer-term leaching for five key rock types. These HCTs were run until steady state effluent chemistry was observed (69 weeks). At which time the tests were terminated with the approval of the BLM.

Using effluent analysis from the kinetic tests, the mass loading and rate of leaching or acid generation was assessed to predict reaction rates and potential leachate chemistry for future waste rock facilities. On the basis of the mass loading analysis, a source term was developed for waste rock materials (see Section 9 this report).

A second phase of kinetic testing was initiated in March 2007 to further characterize materials associated with the Mount Hope deposit. The Phase 2 samples were selected based on the results of the static test results to fill gaps in coverage of the waste rock types and exposed pit wall material types, which were not addressed in the first humidity cell program. These HCTs are in Week 35 of the test (as of November 2007) with basic data available through Week 30 and leachate analysis for Nevada Profile II constituents available through Week 25.

4.3.3.1 Termination Tests

Termination analyses are performed after the HCT is allowed to rest for two weeks following the final rinse. At this time, the column was dismantled, and the sample was homogenized and split into sub-samples. These sub-samples were submitted for the following tests:

- Mineralogy by SEM and XRD analysis;
- ABA using Modified Sobek with LECO sulfur speciation analysis and total inorganic carbon analysis;
- Total element content by a four-acid digest (such as Chemex ME-MS61); and

- Selective extraction (according to the SRK-developed method described below).

The purpose of the selective extraction test is to determine metal speciation in terminated humidity cell test residues. This test involves sequential leaching of 5 grams of material in a Teflon beaker with 10 milliliters (mL) of each solution added in the order shown below.

1. Deionized water (to extract water-soluble metals);
2. 1M MgCl₂ (for ionically-bound metals);
3. 1M NaH₂PO₄ (for strongly adsorbed metals);
4. 1M HCl (for acid volatile sulfides, carbonates and Mn-oxides);
5. 0.2 M oxalate/oxalic acid (for amorphous Fe oxyhydroxides);
6. 0.05 M Ti(III)–citrate-EDTA-bicarbonate (for crystalline Fe oxyhydroxides);
7. 16MHNO₃ (for pyrite, arsenopyrite, chalcopyrite, and pyrrhotite); and
8. Difference of the sum of steps [1] to [7] from the total whole rock concentration assumed to be the fraction associated with residual minerals such as silicates

Based on comparison with the static tests, the termination tests results describe the mineralogical processes that occurred during the HCT test.

5 FIELD SCREENING AND PRE-TESTING RESULTS

5.1 Overview

- Mineralogical assessment of the core revealed negligible carbonate and limited sulfide content, typically less than one percent total sulfide minerals. The most common sulfides were molybdenite and pyrite;
- No clear relationship between pyrite and molybdenite abundance was observed, although both generally occurred in the same portion of the core;
- Abundant sphalerite (over 20 percent) was observed in contact skarn zones to the east of the proposed mined deposits, suggesting that small pods (of limited tonnage) may occur within the proposed mine area;
- Skarn formed in the Vinini Sediments are generally calcite-poor with the maximum observed concentration around eight weight percent calcite. In some cores, wollastonite and quartz are present together indicating the system was limited by carbonate;
- Majority of contact pH values are above 5 s.u., with the values ranging from 2.33 to 9.16 s.u. EC values in contact tests ranged from 8,578 μS to less than 30 μS ;
- Lowest pH values and the highest EC values were obtained from the Potassic Vinini Sediments (Ov-Po), Argillic Rhyolite Tuff (Tmr-Ar), and the Phyllic Early Phase Quartz Porphyry (Tqp-Ph); and
- Samples of each of the material types commonly contained concentrations of silver, arsenic, cadmium, molybdenum, sulfur, antimony, selenium, tin and zinc above average crustal composition in whole rock analysis. In addition, although not analyzed, fluoride is likely present above crustal abundance average based on the widespread fluorite content. These elements can be considered potentially significant for environmental assessment.

5.2 Mineralogical Analysis Results

Mineralogical analysis of the core from the Mount Hope deposit has described the nature and type of potentially acid generating and acid consuming minerals, as well as secondary minerals.

The major and trace mineralogy for the different rock and alteration types are provided in Appendix E. The bulk mineralogy of the altered lithologies are essentially the same and are dominated by quartz, feldspar, and illite.

The mineralogy of hydrothermally altered rocks at Mount Hope has been described previously (Westra & Riedell, 1996). The inner, potassically altered core zone of the deposit is comprised of biotite, secondary orthoclase feldspar, quartz, chlorite, fluorite, topaz, pyrite, chalcopyrite, arsenopyrite, and bornite after plagioclase and orthoclase feldspar, quartz, hornblende and magnetite-ilmenite. This zone generally hosts the highest ore grade molybdenum mineralization, and is unlikely to be mined as waste rock.

On the flanks of this zone is an extensive silicified halo that may contain some molybdenite and other sulfides, although sulfide content is generally low (much less than 1 percent). Regardless of precursor rock, the majority of the molybdenite orebody lies in the potassically altered halo of the deposit in which primary plagioclase feldspars are altered to orthoclase feldspars with minor biotite and illite. This alteration halo is partially overprinted, particularly along fractures and near surface, by a style of clay alteration termed 'phyllic'. Where overprinted, primary silicate minerals (particularly feldspars) have been replaced by illite and to a lesser extent kaolinite. In addition monazite, zircon and apatite have been observed in alteration assemblages of the quartz porphyries.

In more distal areas of the deposit, some propylitic alteration is observed with chlorite, epidote, muscovite, pyrite and calcite partially replacing clay minerals and primary silicate minerals. A wide argillic halo partially overprints the upper part of the deposit in which kaolinite and illite replace primary and secondary silicates associated with pyritization of magnetite and ilmenite.

Potentially acid generating minerals identified at Mount Hope include sulfide and secondary sulfur minerals. Sulfide occurs in most rock/alteration types in low concentrations, the most common of which is pyrite. Apart from the ore mineral, molybdenite, the other sulfides present in minor concentrations include: ~~acanthite, arsenopyrite, bismuthinite, bornite, chalcopyrite, chalcocite, digenite, galena, hawleyite, sphalerite, and tetrahedrite-tennantite.~~ The majority of sulfides observed in polished sections are encapsulated within silicate minerals particularly potassic feldspar and quartz.

Potentially neutralizing minerals, such as carbonate and feldspars, were also identified. However silicate minerals have very slow reaction kinetics (Sverdrup, 1990) and do not necessarily act as efficient buffers of generated acid in nature. Carbonate minerals are minor, except within the propylitic halo where calcite is present up to 4 percent of the matrix in the most altered material. Siderite is also present in the phyllic and argillic alteration zones and within the massive sulfide material. In the latter, ankerite and kutnahorite have also been identified.

Skarns formed in the Vinini Sediments are generally calcite-poor with a maximum observed concentration of eight weight percent calcite. In some cores, wollastonite and quartz are present together, indicating that the system was limited by carbonate.

Although the majority of mineralization shows no oxidation and little post-placement alteration, some secondary minerals of molybdenum are developed along deep fractures and near surface, presumably from the oxidation of molybdenite. The most common mineral of this type is ferrimolybdate, which is usually associated with illite and goethite, and occasionally with jarosite. Other secondary molybdenum minerals observed are bamfordite and possibly ilsemannite although the latter mineral is only tentatively identified by color, as XRD of the phase proved inconclusive. These minerals suggest that molybdenum was transported in only mildly acidic and oxidizing solutions during sulfide oxidation, and precipitation was most likely in response to iron ferrolysis or buffering in a near-neutral pH regime.

The secondary copper minerals cuprite and brochantite were identified, formed through chalcopyrite and bornite oxidation. Their formation in place of malachite indicates near-neutral rather than alkaline buffering of weathering solutions. The only secondary zinc minerals identified were from an out-of-place sample found near the underground mine adit, which contained hemimorphite.

5.3 Contact Test Results

Contact test were completed for a total of 250 core samples. In Figure 5-1, the contact pH values are plotted against contact EC values. The minimum, maximum, and average values from the contact test results are summarized in Table 5-1, according to material type.

For the entire data set, contact pH values range from 2.33 to 9.16 s.u. and EC values range from 8,578 μS to less than 30 μS . The lowest pH values and the highest EC values were obtained from:

- Potassic Vinini Sediments (Ov-Po);
- Argillic Rhyolite Tuff (Tmr-Ar); and
- Phyllic overprint on Potassic Early Phase Quartz Porphyry (Tqp-Ph).

However, the majority of contact pH values are above 5 s.u., suggesting that there is a lag time in the water-rock reactions between acid generation and salt release or non-carbonate mineral dissolution. In addition it implies that mineral reactivity is generally low.

Figure 5-1: Contact Test Results According to Material Type

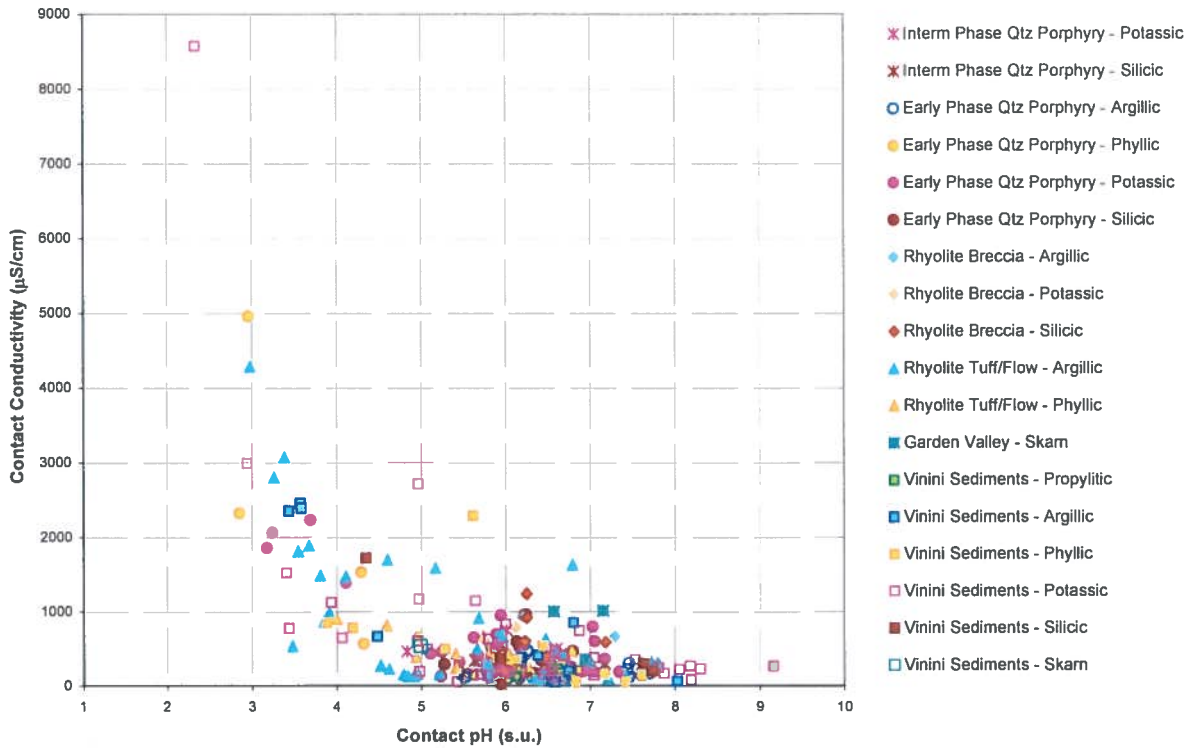


Table 5-1: Contact Test Results

Material Type	Rock Type	Primary Alteration	n	Contact pH (s.u.)			Contact EC (µS/cm)		
				Min	Max	Mean	Min	Max	Mean
1	Alluvium (Qal)	Various	--	--	--	--	--	--	--
2	Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	6	4.83	6.6	5.88	149	749	407
3		Biotite	--	--	--	--	--	--	--
4		Silicic	6	5.09	7.17	5.86	164	601	379
5	Early Phase Quartz Porphyry (Tqp)	Argillic	13	5.51	7.70	6.68	110	480	197
6		Phyllic	13	2.85	6.69	5.43	161	4,961	906
7		Potassic	38	3.18	7.58	6.01	101	2,229	536
8		Silicic	10	5.27	6.79	6.18	27.2	960	381
9	Rhyolite Breccia (Trb)	Argillic	6	5.77	7.59	6.80	87.6	929	477
10		Phyllic	--	--	--	--	--	--	--
11		Potassic	1	6.12	6.12	--	790	790	--
12		Silicic	5	6.23	7.18	6.48	396.5	1,240	749
13	Rhyolite Tuff (Tmr) and Rhyolite Flow (Tfr)	Argillic	49	2.98	7.81	5.64	85	4,289	655
14		Phyllic	17	4.00	6.85	5.75	156	904	391
15		Potassic	--	--	--	--	--	--	--
16	Garden Valley (Pg)	Skarn	3	6.57	7.15	6.89	359.1	1,011	791
17	Vinini Sediments (Ov)	Unaltered	--	--	--	--	--	--	--
18		Propylitic	3	6.12	6.66	6.46	137	234	183
19		Argillic	12	3.44	8.03	5.76	53	2,449	831
20		Phyllic	12	3.88	7.61	6.11	42.1	2,290	518
21		Potassic	51	2.33	9.16	6.13	57.4	8,578	647
22		Silicic	4	4.35	7.73	6.41	203	1,723	648
23		Skarn	1	4.99	4.99	--	539	539	--

5.4 Whole Rock Analysis Results

The whole rock geochemistry of the material types has been compared to average crustal igneous and sedimentary rock composition (Hem, 1985). Where the total concentration exceeds three times the crustal abundance, the element is considered to be anomalously enriched and has the *potential* to be leached in sufficient concentration to have an environmental impact (Price, 1997). It should be emphasized that the actual leachability of such elements must be determined empirically in a metal mobility test (MWMP) to properly account for factors like mineral habit, rock texture, and site specific conditions that affect solubility.

The tabulated whole rock results are provided in Appendix C along with plots of the whole rock chemistry for key constituents. These plots present the median and upper and lower quartiles as well as the full range of compositions of the samples by material type. Values representing three times the crustal abundance are included in the plots as a reference point to aid in the evaluation of the data. Some of these plots are shown on a logarithmic scale in order to show the lower concentration data ranges. Elements are considered enriched if the 3rd quartile line is at or above the three times the average crustal igneous rock composition for that element. Table 5-2 provides a summary of those elements for each material type that occurs at significant concentrations as shown on the plots.

As shown in Table 5-2, each of the material types commonly had concentrations of silver, arsenic, cadmium, molybdenum, sulfur, antimony, selenium, tin and zinc above average crustal composition. These elements are enriched throughout the Mount Hope system relative to crustal abundance. It should be noted that although fluoride could not be analyzed using the available whole rock data due to use of hydrofluoric acid in the digestion, it is most likely present in anomalous concentrations in the skarn, biotite and potassic zones based on the abundance of fluorite.

As a general rule, enrichment of total metals in hydrothermally altered rocks is more proportional to the intensity of alteration and driven less by primary lithology. The most notable enrichment occurs in the skarn zone developed on the east side of the pit in association with zinc sulfide replacement mineralization. The skarn is carbonate-poor, due to formation at high temperature (above 350 °C at 1 bar), as indicated by the joint presence of quartz and wollastonite in the assemblage. Beryllium, iron, lead, manganese, tin, sulfur and zinc concentrations are all elevated in comparison to the other alteration types.

The potassic alteration zone has chemical anomalies that are similar to those observed for the argillic and phyllic alteration types, although anomalous elements generally occur at lower concentrations. Despite the fact that much of the silicate matrix is altered to quartz, the silica alteration assemblage does have an anomalous chemistry similar to the phyllic and argillic alteration types due to the presence of mica and sulfides.

Moving away from the center of mineralization, the more distal phyllic and the argillic alteration halos have a more diffused amplification of the anomalous elements. In part, the preservation of the halo enrichment is due to the higher portion of low temperature alteration minerals, particularly clay minerals. Thallium, lead and copper are enriched in the phyllic and argillic alteration halos relative to the other alteration types.

Propylitic alteration rims the deposit and is the lowest temperature assemblage. Arsenic and antimony are enriched within the propylitic halo relative to the other alteration types.

Table 5-2: Summary of Whole Rock Analysis Results

Rock Type	Primary Alteration	Material Type	n	Al	Sb	As	Cd	Cu	Fe	Pb	Mn	Mo	Se	S	Tl	Zn
Alluvium (Qal)	Various	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intermediate Phase Qtz Porphyry (Tqpa)	Potassic	2	6		X	X						X	X	X		X
	Biotite	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Silicic	4	6		X	X	X			X		X	X	X		X
Early Phase Quartz Porphyry (Tqp)	Argillic	5	13		X	X	X			X		X	X	X		X
	Phyllic	6	13		X	X	X	X		X		X	X	X	X	X
	Potassic	7	38		X	X	X					X	X	X		X
	Silicic	8	10		X	X	X			X		X	X	X		X
Rhyolite Breccia (Trb)	Argillic	9	6		X	X	X	X			X	X	X	X		X
	Phyllic	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Potassic	11	1		X	X	X	X		X	X	X	X	X		X
	Silicic	12	5		X	X	X	X		X	X	X	X	X		X
Rhyolite Tuff (Tmr) and Flow (Tfr)	Argillic	13	49		X	X	X	X	X	X	X	X	X	X	X	X
	Phyllic	14	17		X	X	X			X	X	X	X	X	X	X
	Potassic	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Garden Valley (Pg)	Skarn	16	3		X	X	X	X	X	X		X	X		X	
Vinini Sediments (Ov)	Unaltered	17	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Propylitic	18	3		X	X	X			X	X	X	X	X		
	Argillic	19	12		X	X	X	X		X	X	X	X	X	X	X
	Phyllic	20	12		X	X	X	X				X	X	X		X
	Potassic	21	51		X	X	X	X				X	X	X		
	Silicic	22	4		X	X	X	X				X	X	X		X
	Skarn	23	1			X	X	X				X	X	X		

X = The upper quartile of the data range is greater than 3X the Crustal Abundance as reported by Hem (1985).

6 STATIC TEST RESULTS

6.1 Overview

- MWMP leachates show exceedences of an order of magnitude for some constituents when compared to NDEP comparative values. The primary constituents of concern include aluminum, cadmium, copper, fluoride, iron, lead, manganese, pH (acidic), sulfate, zinc and to a lesser extent arsenic and nickel;
- Because there is a relative lack of carbonate in the rock assemblage at Mount Hope and a resulting deficit of neutralizing capacity in the system, the potential for acid generation and metal leaching is primarily controlled by the amount of sulfide in the rock, which can be quantified by the measurement of total sulfur;
- There is no direct correlation between the various rock/alteration (i.e., material types) and sulfide content. Therefore, each material type has both potentially acid forming and non-acid forming rocks;
- Acid Base Accounting results indicate the potential for acid generating increases with increasing sulfide content suggesting sulfide percent in the material type can be used to predict the acid generation capacity. However, the majority of the samples have a low or uncertain prediction for ARD potential; and
- The NAG results are generally consistent with the ABA assessment and indicate the sulfide percent can be used to predict acid generation capacity. For the most part, those samples with total sulfur content above 0.5 weight percent are predicted by the NAG assessment to be acid generating and those samples with total sulfur content less than 0.5 weight percent are predicted to be non-acid generating.

6.2 Introduction

Static testing includes those analytical methods applied in the characterization of acid generation and metal release potential at a fixed point in time. Such tests provide a conservative estimate of the balance of acid generating and acid consuming reactions and can also be used to estimate the potential concentrations of metals that will leach from a given material. However, static tests do not provide an assessment of the rates of reaction of the material with water and air, and instead provide a total potential capacity of the material to release metals and acid at the time of testing.

6.3 Meteoric Water Mobility Procedure Results

Leachable metals are a potential source of toxicity in mine waste drainage. The Nevada MWMP test was developed to simulate the leaching of mine waste materials with meteoric water during high precipitation events that occur periodically under the generally more arid conditions that are normal for Nevada. The results of the MWMP test can be used to identify the presence of leachable metals and readily soluble salts stored in the material as well as provide an indication of their availability for dissolution and transport in response to a precipitation event.

MWMP tests were conducted on 89 historic core samples and 48 recent core samples for a total of 147 samples. For quality assurance, ten duplicate samples were also submitted for MWMP testing. Results of the MWMP testing are provided in Appendix G. Plots of the MWMP chemistry are also provided in Appendix G for key constituents. These plots present the median and upper and lower quartiles as well as the full range of compositions of these elements by material type. NDEP comparative values (from Form 0090 for Profile II constituents) are included in the plots as a reference point to aid in the evaluation of the data. Some of these plots are shown on a logarithmic scale in order to show the lower concentration data ranges. Table 6-1 provides a summary of those elements for each material type that occur in concentrations above the NDEP reference level as shown on the plots. The material is considered to leach significant concentrations of the element if the 3rd quartile line is at or above the respective NDEP comparative value.

A Ficklin diagram was also generated using the MWMP results to compare the observed metal mobility for different material types. Figure 6-1 plots total metal concentration (Cd + Cu + Fe + Pb + Mn + Ni + Zn) versus pH for each rock type. In addition to the leachable metals, the MWMP test also provides an assessment of the potential for acid release during dissolution of soluble acid salts (Ficklin et al., 1992). The final pH of the MWMP extract is representative of leachate that could be produced from waste rock with readily soluble acid-producing salts under field conditions.

The leaching of oxyanions in the MWMP effluent can be directly related to pH conditions. Typically, elements such as arsenic, antimony and selenium occur as oxyanions, such as $H_nAsO_4^{3-n}$. The concentration of these three elements is plotted against pH for all material types in Figure 6-2. As shown, the trend reflects strong attenuation between pH 4 to 7 s.u. Above a pH of 7 s.u., these oxyanions increase in concentration due to a change in mineral surface chemistry promoting desorption of oxyanions. In Figure 6-3, molybdenum shows a similar trend as it too occurs as an oxyanion (i.e., MoO_3 or MoO_4).

Table 6-1: Summary of MWMP Results

Rock Type	Alteration Type	Material Type	n	Constituents Commonly Elevated in MWMP Extracts ¹
Alluvium (Qal)	NA	1	0	No data available
Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	2	4	No elevated constituents
	Biotite	3	0	No data available
	Silicic	4	4	Cd, Mn
Early Phase Quartz Porphyry (Tqp)	Argillic	5	5	F, Mn
	Phyllic	6	8	Al, Cd, Cu, Fe, Mn, Pb, Tl, Zn, pH <6.5
	Potassic	7	17	F, Mn
	Silicic	8	5	Mn
Rhyolite Breccia (Trb)	Argillic	9	6	Mn
	Phyllic	10	0	No data available
	Potassic	11	1	Cd, Mn, Zn
	Silicic	12	5	Mn, Ni, Tl
Rhyolite Tuff/Flow (Tmr/Tfr)	Argillic	13	35	Al, Cd, Fe, Mn, pH <6.5
	Phyllic	14	7	Al, Cd, Mn, Zn
	Potassic	15	0	No data available
Garden Valley (Pg)	Skarn	16	3	Cd, Mn, Tl, Zn
Vinini Sediments (Ov)	Unaltered	17	0	No data available
	Propylitic	18	3	pH >8.5
	Argillic	19	9	Al, As, Cd, Cu, F, Fe, Mn, Ni, Pb, pH <6.5
	Phyllic	20	12	Al, Mn, Ni, pH >8.5
	Potassic	21	19	Al, F, Mn
	Silicic	22	3	Al, Cd, Cu, Fe, Mn, Ni, Pb, Tl, Zn, SO ₄ , TDS, pH <6.5
	Skarn	23	1	pH >8.5

¹ The material is considered to leach significant concentrations of the element if the 3rd quartile line from Appendix G is at or above the respective NDEP comparative value from Form 0900 for Profile II constituents.

The majority of the material types show significant variability with respect to metal leaching potential, suggesting that rock type and alteration are not very sensitive indicators of geochemical behavior for the Mount Hope system. Some trends in the MWMP data can be distinguished, however, including:

- Early and Intermediate Phase Quartz Porphyry rock (Tqp and Tqpa) units demonstrate an overall lower potential to leach metals and metalloids regardless of alteration type. The exceptions to this are samples of Early Phase Quartz Porphyry that have been phyllically altered and thus have a greater potential to leach metals;
- Rhyolite Tuff and Flow (Tmr/Tfr) that has undergone argillic or phyllic alteration and Vinini Sediments (Ov) that have undergone argillic, potassic, or phyllic alteration have relatively higher sulfide content and demonstrate the greatest potential to generate acid or leach metals and metalloids at concentrations above NDEP comparative values;
- The highest pH values, and lowest metal and metalloid concentrations, were obtained from Vinini Sediments that have undergone propylitic and skarn alteration; and

- Rhyolite Breccia has a moderate potential to leach metals, regardless of alteration type, but has pH values that are consistently above 7 s.u. and thus has a low potential to release acid and metals.

Samples of Potassic Early Phase Quartz Porphyry and Potassic Vinini Sediments have the highest molybdenum content. Other material types with significant concentrations of molybdenum include; Silicic Intermediate Phase Quartz Porphyry and Argillic Early Phase Quartz Porphyry, Argillic Rhyolite Breccia, and Argillic Vinini Sediments.

Figure 6-1: Ficklin Diagram

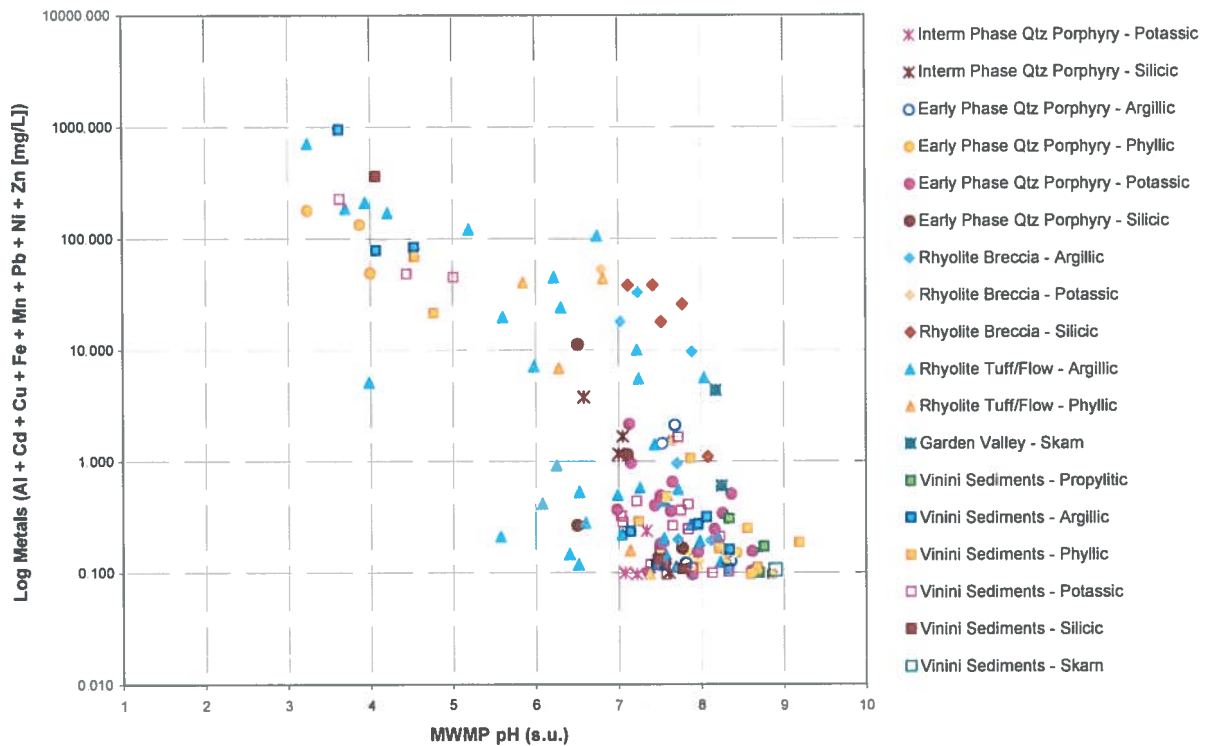


Figure 6-2: Oxyanions vs. pH

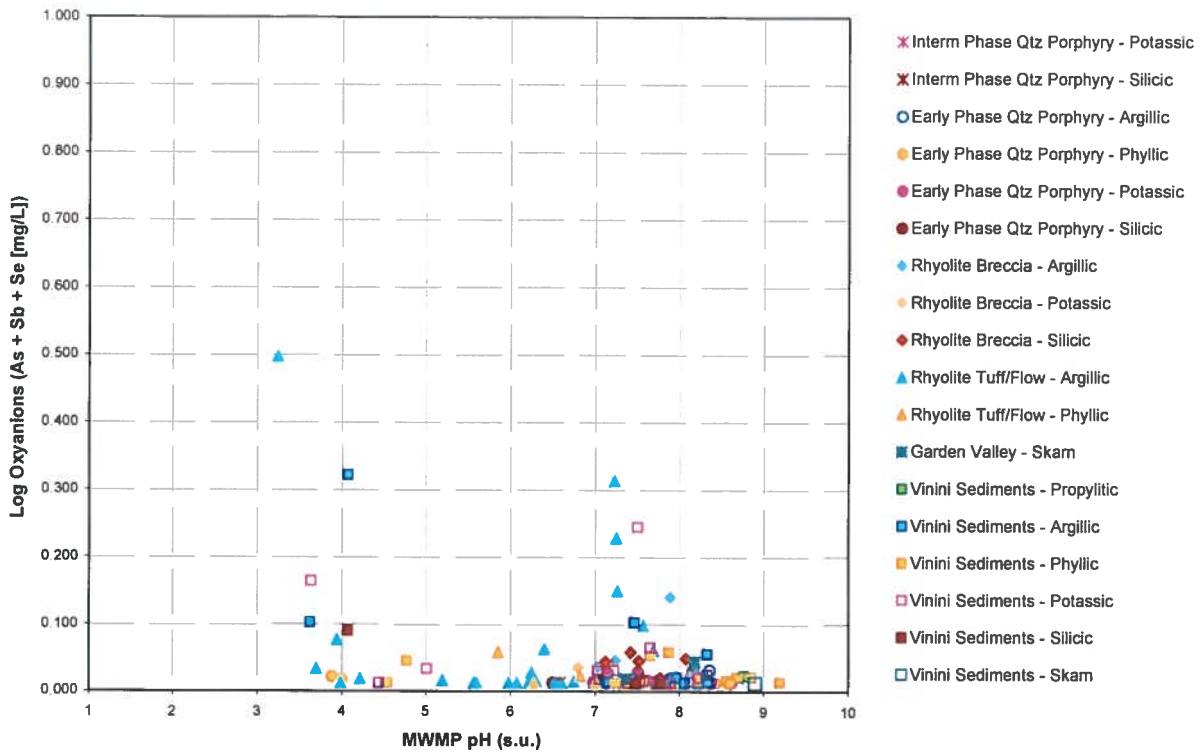
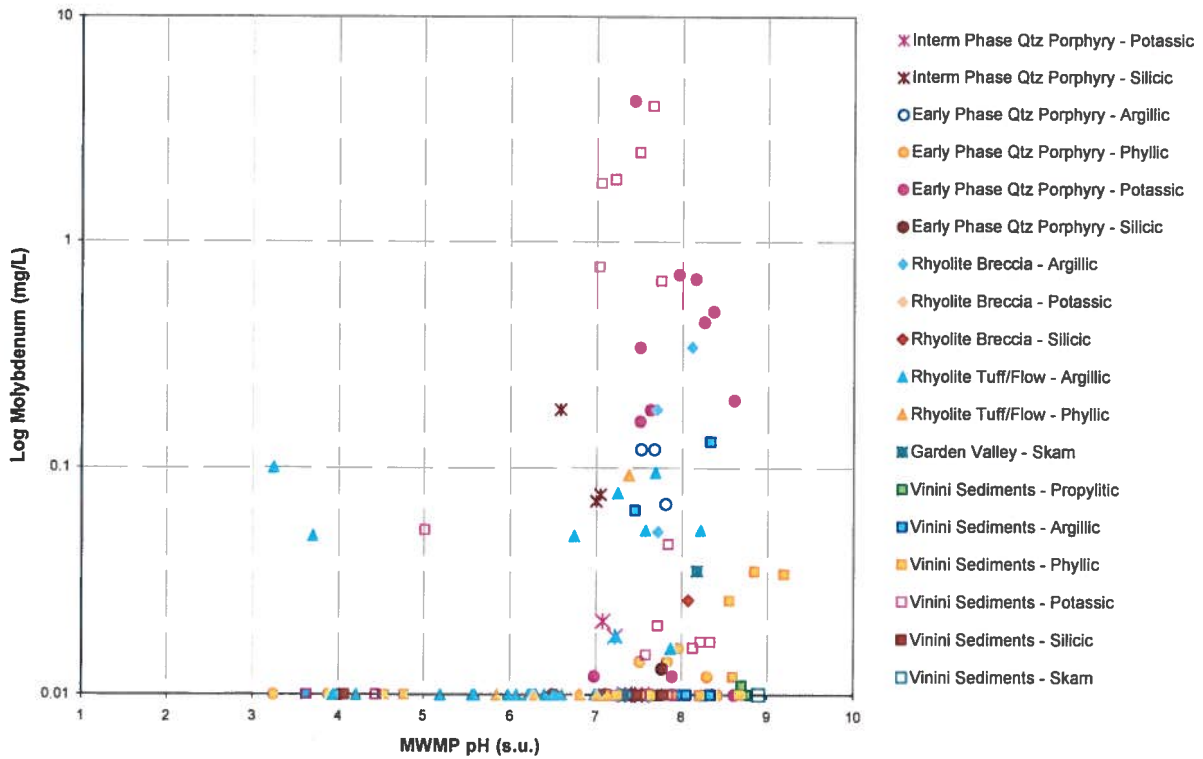


Figure 6-3: Molybdenum vs. pH



6.4 Acid Base Accounting Results

Acid-base accounting (ABA) provides a standardized approach to assessment of the acid generation or acid neutralization potential of rock materials. The ABA method used for this study is the Modified Sobek ABA method (Memorandum No. 96-79), which includes both laboratory analysis and theoretical calculations based on two parameters; acidification potential (AP) and neutralizing potential (NP). First, the total mass of potentially acid generating and acid neutralizing components in a sample is quantified through laboratory analysis. Then an estimate of acid generation is made by assuming complete reaction between all of the minerals with acid potential (i.e., sulfide oxidation, iron oxidation and hydrolysis, dissolution of secondary minerals that induce proton release or metal oxidation) and all of the minerals with neutralizing potential (essentially dissolution of carbonate minerals and to a very limited extent silicate minerals as the latter have very slow reaction kinetics, *Bowell et al., 2000*).

The ABA test assumes that, in theory, all alkaline and acid phases react completely and that all available sulfide is FeS_2 (i.e., pyritic). If total sulfur is used to estimate the AP of the sample, the result is a more conservative estimate of AP, because it includes non-sulfide species such as sulfate and organic sulfur, which do not contribute significantly to the overall acid generation potential of the material. For the core samples, AP was determined from sulfide-sulfur content.

For the pulp samples the prediction of acid generation is based on total sulfur and the potential for acid neutralization is based on total carbon. Total sulfur content accounts for both sulfide sulfur and sulfate sulfur in the rock and therefore provides a conservative estimate of acid generation. Likewise, total carbon in the rock provides a conservative and valid measurement of acid neutralization. Laboratory titration methods, like those used in the Modified Sobek method, can overestimate acid neutralization because calcium silicates in the sample provide some neutralization capacity during titration. In reality, carbonate minerals provide the only source of buffering unless the acid generation rates are extremely slow (*Sverdrup, 1990*). Thus, if it is assumed that all carbon is present as carbonate minerals, the total carbon analysis by LECO provides a valid quantification of the acid neutralizing potential of waste rock materials. Because the content of non-carbonate carbon in the rocks was shown to be negligible in the static testing results, this approach is considered appropriate for this site.

Values of NP are indicative of the capacity of rock materials to buffer acidity produced by sulfide oxidation or other proton-generating reactions. For the core samples, NP was determined using two techniques. First NP was determined using the Modified Sobek protocol that includes a digestion to expel any CO_2 followed by a back titration with NaOH to a pH of 8.3 s.u. Neutralizing potential is reported as CaCO_3 equivalent tons per 1,000 tons of rock. In addition, core samples were analyzed for total inorganic carbon (TIC) by LECO analysis.

The balance between the acid generating mineral phases and acid neutralizing mineral phases is referred to as the net neutralization potential (NNP), which by convention is equal to the difference between NP and AP, reported in units of equivalent (eq.) kg CaCO_3 per ton. The NNP value allows classification of the samples as potentially acid consuming or acid producing. As such, a positive value of NNP indicates the sample neutralizes more acid than

is produced during oxidation. A negative NNP value indicates there are more acid producing constituents and as such is classified as a potentially acid generating material. Material that would be considered to have a high potential for acid neutralization would produce a net neutralizing potential of greater than 20 eq. kg CaCO₃/ton.

Another criterion used to evaluate the ABA data is the Neutralization Potential Ratio (NPR) which is calculated by dividing the NP by the AP. The NPR provides another predictive tool for distinguishing between potentially acid generating and non-acid generating samples.

Numerous criteria for evaluating the ABA results have been published and used as general guidance for decision-making purposes. In general, these criteria use different thresholds to classify samples as potentially acid generating (PAG), non-acid generating (NAG) or uncertain in terms of acid generation potential. Samples with low concentrations of either or both NP and AP are not likely to generate much acid or alkalinity and the prediction of material behavior is therefore less certain based on the ABA results.

The ranges of NNP and NPR values that were used to define the acid generating potential of the material in this study are summarized in Table 6-2 and are based on NPR criteria provided by the BLM Washington Office (Instruction Memorandum (IM) No. 96-79 Acid Rock Drainage Policy for Activities Authorized under 43 CFR 3802/3809) that considers non-acid generating rock to have a NP value three times larger than the AP and a NNP greater than 20 equivalent kg CaCO₃/ton of rock. This classification is slightly more conservative than criteria provided by the NDEP (1990) that considers samples in which NP exceeds AP by 20% (NPR>1.2) to be non-acid generating.

Table 6-2: Criteria Used in the Determination of Acid Generation Potential

Net Neutralizing Potential (NNP) eq. kg CaCO ₃ /ton	NPR	Material Acid Generation Potential
> 20	>3	Acid neutralizing
< 20 and > -20	>1.2 <3	Uncertain or low acid generating potential
< -20	< 1.2	Acid generating

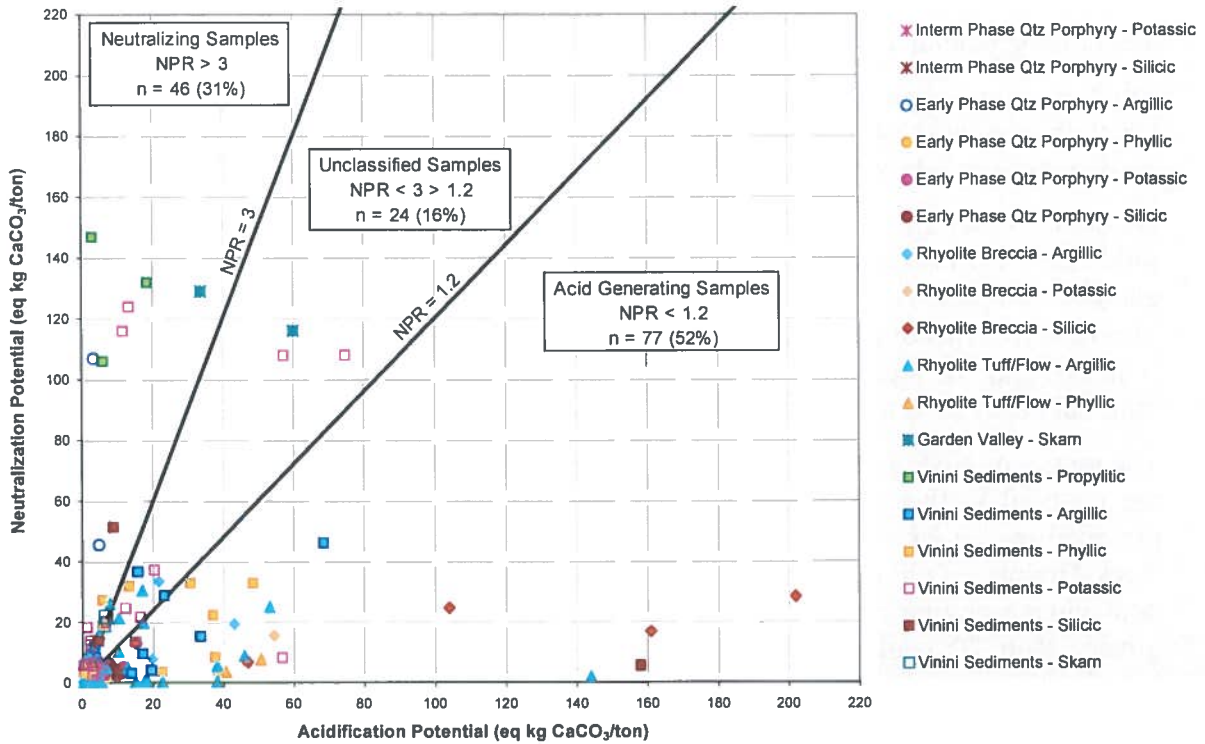
Criteria from NDEP (1990) and BLM (1996).

The criteria shown in Table 6-2 were used to assess the acid generating potential of both core and pulp samples of Mount Hope waste rock. The results of the ABA testing for the core samples and pulp samples are summarized in the following sections and the complete ABA dataset is provided in Appendix F and H, respectively.

6.4.1 ABA Results for Core Samples

ABA testing was conducted on 89 historic core samples and 48 recent core samples for a total of 137 samples. For quality assurance, 10 duplicate samples were also submitted for ABA testing. The ABA results for the core samples are summarized in Appendix F and the acid neutralizing and acid generating potential for each sample are plotted on Figure 6-4 according to rock type and alteration. Additional plots of the ABA results are provided in Appendix F and present the median and upper and lower quartiles as well as the full range of results by material type.

Figure 6-4: Neutralization Potential vs. Acidification Potential



As shown in Figure 6-4, about 50 percent of the samples fall within either the neutralizing zone or within the zone of low or undefined reactivity. The remaining 50 percent fall within the zone of potential acid generation. However, only 25 percent of these samples have AP values greater than 20 eq. kg CaCO₃/ton. Furthermore, Figure 6-4 shows there is very little buffering potential in the host rocks and the system as a whole can be considered “carbonate-poor”. For the majority of the samples, there is a limited amount of both acid neutralizing minerals and acid generating minerals and about 75 percent of the samples contain NP and AP values less than 20 eq. kg CaCO₃/ton. This reflects the low reactivity of materials associated with the Mount Hope deposit due to the lower carbonate and lower sulfide content.

The dominant sulfur species in the rock assemblage of the Mount Hope Project is sulfide and there is an overall deficit in sulfate regardless of material type (Figure 6-5). Consequently, total sulfur can be used to define the acid generating capacity of a material. The main exception to this is the Argillic Rhyolite Tuff that contains sulfate sulfur in excess of sulfide for some of the samples.

Figure 6-5: Sulfide vs. Total Sulfur

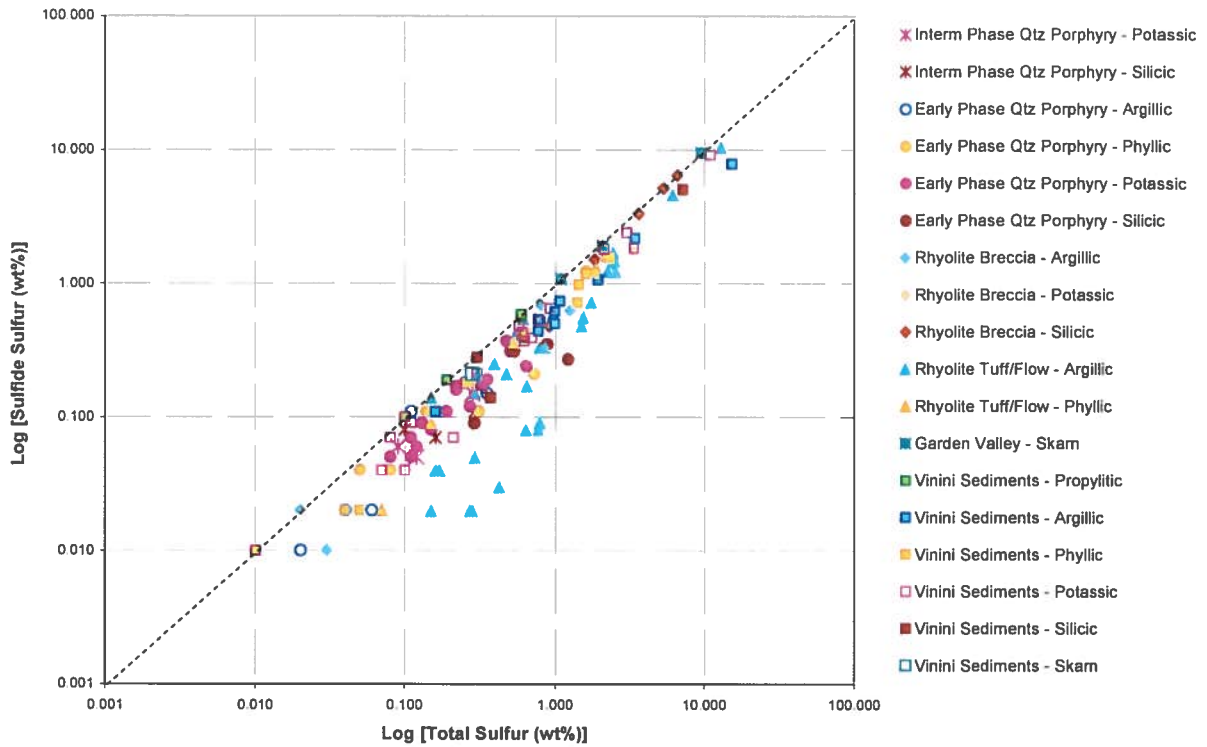
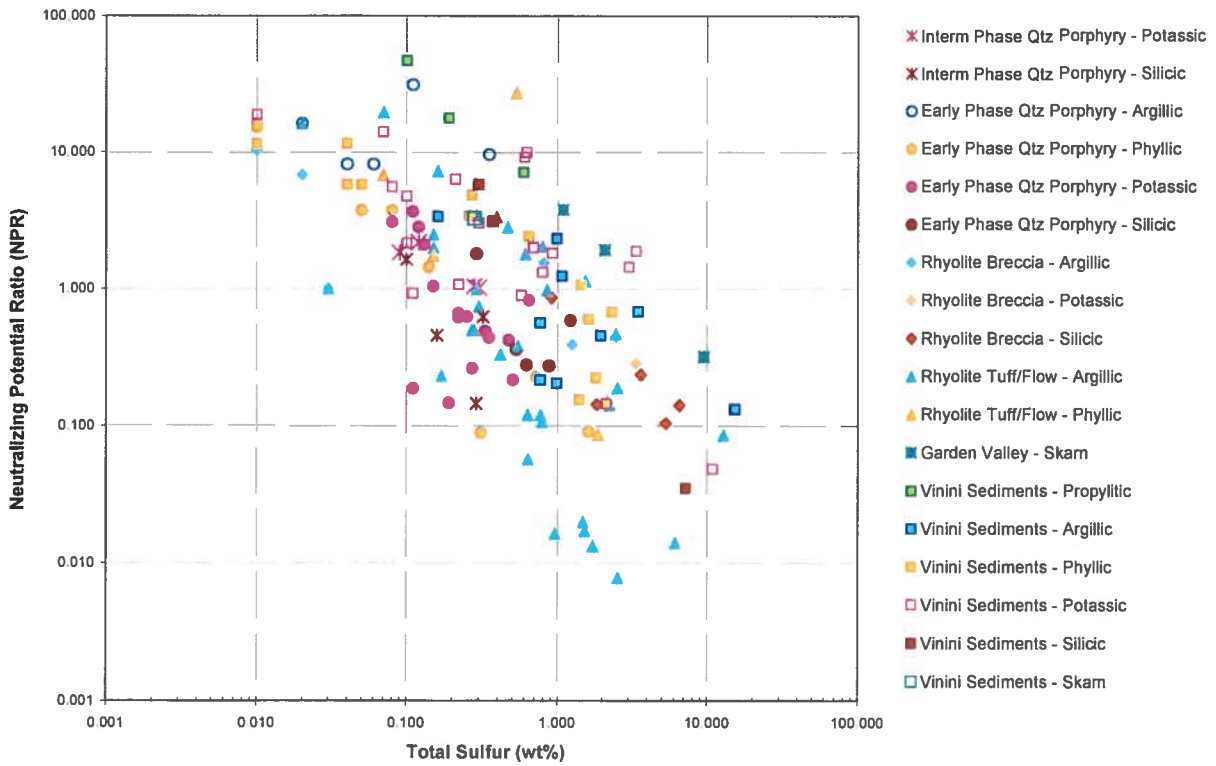
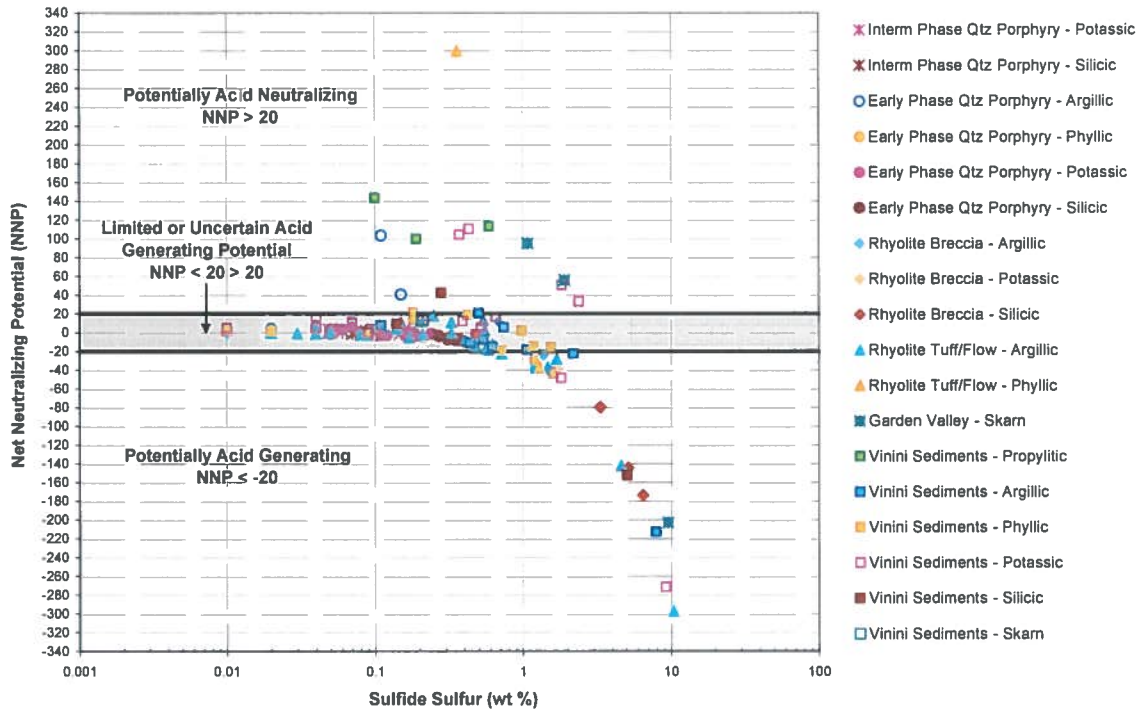


Figure 6-6: NPR vs. Total Sulfur



In Figure 6-7, samples with sulfide sulfur above 1 weight percent demonstrate a greater potential to be net acid generating with NNP values less than -20 eq. kg CaCO₃/ton. A few samples demonstrate some neutralizing capacity (i.e., propylitic Vinini, Garden Valley Skarn, and Potassic Vinini) with NNP values greater than 20 eq. kg CaCO₃/ton. However, in general, there is a limited amount of both acid neutralizing minerals and acid generating minerals. This reflects the low reactivity of materials associated with the Mount Hope deposit.

Figure 6-7: NNP vs. Sulfide



Because there is a relative lack of carbonate in the rock assemblage at Mount Hope and a resulting deficit of neutralizing capacity in the system, the potential for acid generation is primarily controlled by the amount of sulfide in the rock. In general, there is a poor correlation between the various rock/alteration types (i.e., material types) and sulfide content and with a few exceptions, most of the material types have both potentially acid forming and non-acid forming rocks. However, some of the general trends that can be observed include:

- The Early and Intermediate Phase Quartz Porphyry (Tqp and Tqpa) material types have relatively less sulfide and thus, an overall lower potential to generate acid. Both of these material types are tightly clustered within the zone of limited or undefined acid generating potential, with the exception of the Argillic Early Phase Quartz Porphyry which demonstrates some acid neutralizing capacity;
- The Rhyolite Breccia was collected along the margin of the deposit near the skarn deposit and is host to pyrite and chalcopyrite that has undergone limited oxidation. As a result, this material type is generally acid generating, with the exception of a few

samples of Argillic Rhyolite Breccia that demonstrate some minor neutralizing capacity. Rhyolite Breccia that has undergone silicic alteration has the greatest potential to generate acid, with AP values consistently greater than 100 eq. kg CaCO₃/ton;

- Rhyolite Tuff and Flow that have undergone argillic or phyllic alteration typically contain relatively higher sulfide content and demonstrate potential to generate acid, with the exception of one sample of Phyllic Rhyolite Tuff with an NP value greater than 300 eq. kg CaCO₃/ton that can be attributed to calcite-bearing fractures associated with this sample;
- Vinini Sediments that have undergone argillic, potassic, or phyllic alteration have an overall higher sulfide content and demonstrate a greater potential to generate acid. However, the majority of the samples from these rock types fall within the undefined zone and several samples of Potassic Vinini Sediments demonstrate neutralization capacity with NP values greater than 100 eq. kg CaCO₃/ton. Silicic Vinini Sediments demonstrate a similar wide range of results with samples classified as both potentially acid generating and acid neutralizing;
- Vinini Sediments that have undergone propylitic alteration contain carbonate, chlorite and sulfide. The pyrite is coarse grained and less reactive and significant buffering capacity is provided by the carbonate minerals. As a result, these samples demonstrate the greatest acid neutralizing potential; and
- Garden Valley Skarn shows a bimodal distribution with samples classified as both acid generating and acid neutralizing.

6.4.2 ABA Results for Pulp Samples

Total sulfur and total carbon results for the historic pulps provide a comprehensive overview of the acid generating potential for the drilled portions of the Mount Hope Project. Samples with molybdenum values greater than 0.034 percent were not included in this evaluation as this material will be mined and processed as ore. This produced a dataset consisting of 1,546 samples that can be directly related to the existing mine model and used to estimate volumes of the different types of waste rock to be mined.

In Figure 6-8, the acid neutralizing and acid generating potential are plotted for each material type. The distribution of pulp ABA results appear similar to the core ABA results (Figure 6-4) where 80 percent of the 1,546 pulp samples have AP values less than 20 eq. kg CaCO₃/ton and 60 percent of the pulp samples have NP values less than 20 eq. kg CaCO₃/ton, further demonstrating the low reactivity of the Mount Hope system. A notable difference is the significant acid neutralization potential demonstrated by the Argillic Rhyolite Tuff in the pulp database that was not captured by the core samples. The NNP for the pulp samples is plotted against total sulfur in Figure 6-9 and is similar to ABA results for the core samples (Figure 6-7) for which a significant portion of the samples fall within the limited or uncertain zone of acid generation (i.e., between -20 and 20 eq. kg CaCO₃/ton). However, in comparison to the core database, a greater number of samples in the pulp database demonstrate acid neutralizing potential with NNP values greater than 20 eq. kg CaCO₃/ton.

Figure 6-8: AP vs. NP for Pulp Samples

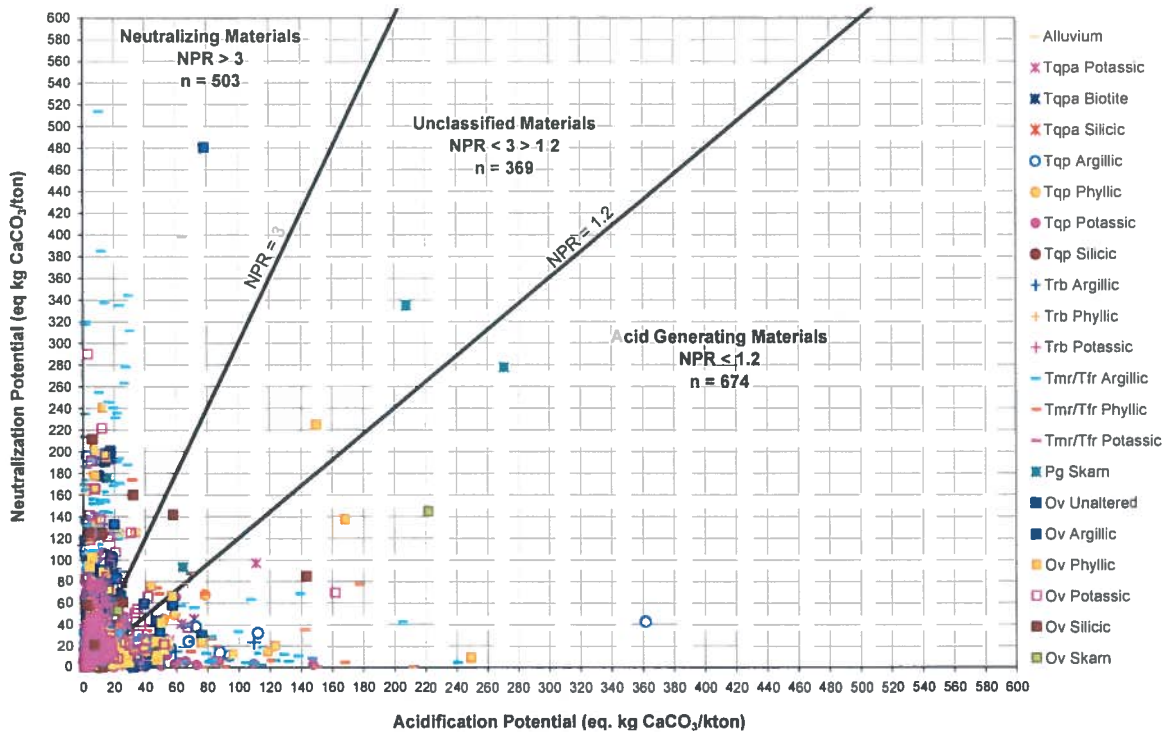
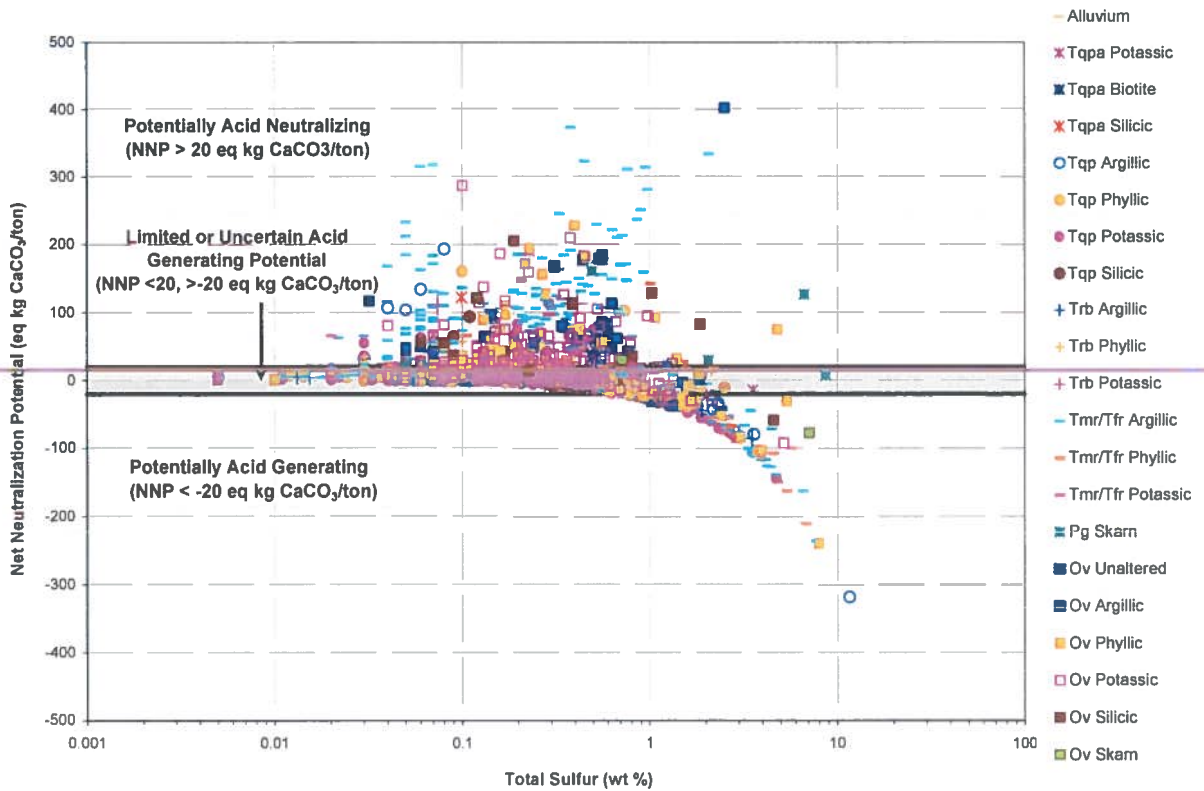


Figure 6-9: NNP vs. Total Sulfur for Pulp Samples



The total carbon and total sulfur results are summarized in Table 6-3 for each of the different material types. The results indicate that less than 35 percent of the pulp samples are potentially acid generating with NPR less than 1.2, about ten percent have limited or uncertain acid generating potential ($1.2 < \text{NPR} < 3$) and more than half the pulp samples are non-acid generating with NPR greater than 3.

Table 6-3: Acid Base Accounting Results for Pulp Samples

Rock Type	Primary Alteration	Material Type	n	Total Carbon			Total Sulfur			NPR		
				Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alluvium (Qal)	NA	1	5	0.07	1.25	0.32	0.04	0.20	0.10	1.87	16.67	5.96
Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	2	21	0.05	2.37	0.37	0.03	3.55	0.66	0.46	31.62	4.62
	Biotite	3	7	0.09	0.27	0.17	0.18	0.64	0.41	0.67	1.68	1.22
	Silicic	4	46	0.02	1.50	0.15	0.07	1.38	0.52	0.12	40.40	2.04
Early Phase Quartz Porphyry (Tqp)	Argillic	5	44	0.04	2.35	0.31	0.01	11.56	1.05	0.12	86.67	12.16
	Phyllic	6	95	0.01	1.97	0.20	0.01	33.00	0.66	0.01	52.27	5.18
	Potassic	7	257	0.01	1.47	0.14	0.01	4.72	0.29	0.02	59.56	3.57
	Silicic	8	24	0.01	1.16	0.27	0.07	1.45	0.35	0.04	28.12	5.80
Rhyolite Breccia (Trb)	Argillic	9	24	0.05	0.71	0.17	0.01	3.50	0.44	0.12	12.73	2.99
	Phyllic	10	8	0.10	0.94	0.40	0.03	2.14	0.37	1.02	38.22	13.01
	Potassic	11	9	0.19	1.51	0.68	0.07	1.54	0.72	0.60	49.09	8.87
	Silicic	12	--	--	--	--	--	--	--	--	--	--
Rhyolite Tuff/Flow (Tmr/Tfr)	Argillic	13	382	0.01	6.17	0.73	0.01	7.70	0.54	0.02	168.89	12.44
	Phyllic	14	80	0.01	2.09	0.33	0.03	6.79	1.01	0.00	20.98	3.53
	Potassic	15	24	0.01	2.28	0.40	0.02	0.56	0.11	0.38	105.33	12.81
Garden Valley (Pg)	Skarn	16	8	0.20	4.02	1.51	0.05	8.67	2.32	1.02	14.03	6.74
Vinini Sediments (Ov)	Unaltered	17	15	0.61	2.41	1.36	0.03	0.77	0.50	2.80	117.42	14.80
	Propylitic	18	--	--	--	--	--	--	--	--	--	--
	Argillic	19	53	0.01	5.77	0.41	0.04	2.51	0.47	0.01	31.47	4.40
	Phyllic	20	142	0.01	2.89	0.39	0.01	7.98	0.58	0.04	27.94	4.17
	Potassic	21	290	0.01	3.48	0.36	0.01	5.18	0.32	0.17	92.53	5.01
	Silicic	22	10	0.25	2.54	1.25	0.06	4.59	0.94	0.59	35.51	14.57
	Skarn	23	2	0.64	1.74	1.19	0.72	7.10	3.91	0.65	2.36	1.50

A histogram showing the distribution of total sulfur data for the entire dataset is provided in Figure 6-10 and shows that the greatest population of total sulfur concentration falls between zero and 0.3 weight percent. This equates to greater than 60 percent of the samples containing less than 0.3 weight percent total sulfur. A histogram showing the distribution of total carbon data is provided in Figure 6-11. This graph shows a similar trend of decreasing frequency with increasing total carbon content and indicates a deficiency of carbonate minerals (i.e., neutralization potential) in the system. The distribution of total carbon data reveals that approximately 56 percent of the pulps have a carbonate content less than 0.3 weight percent.

These data are consistent with the fact that the Mount Hope mineralizing system is a low sulfide, low carbonate system. As such, there is limited potential for either acid generating or acid buffering processes within the waste rock and pit walls. One exception to this generalization is the skarn, which has higher concentrations of both carbonate and sulfide and has the potential to be net acid generating.

Figure 6-10: Total Sulfur Histogram

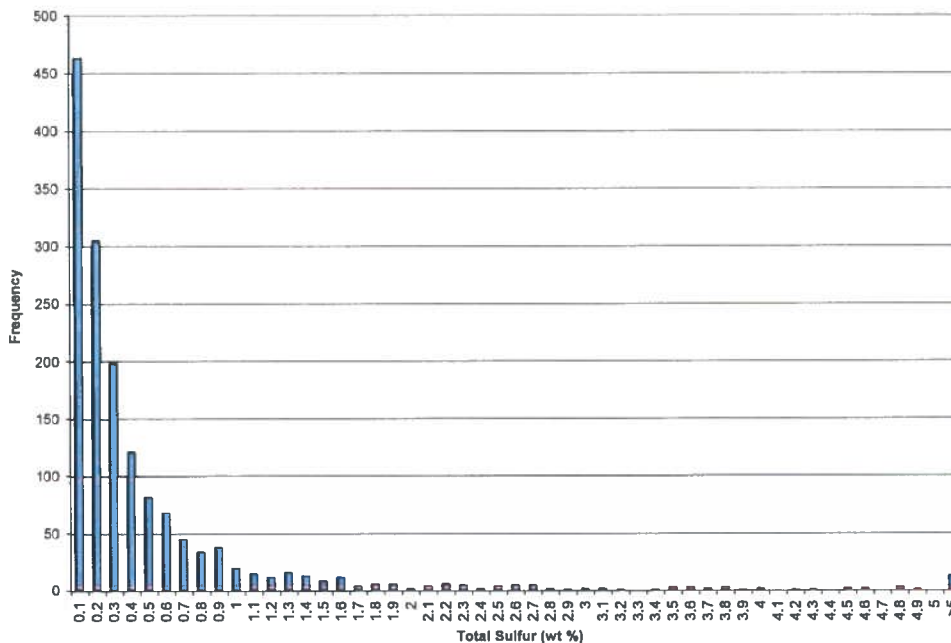
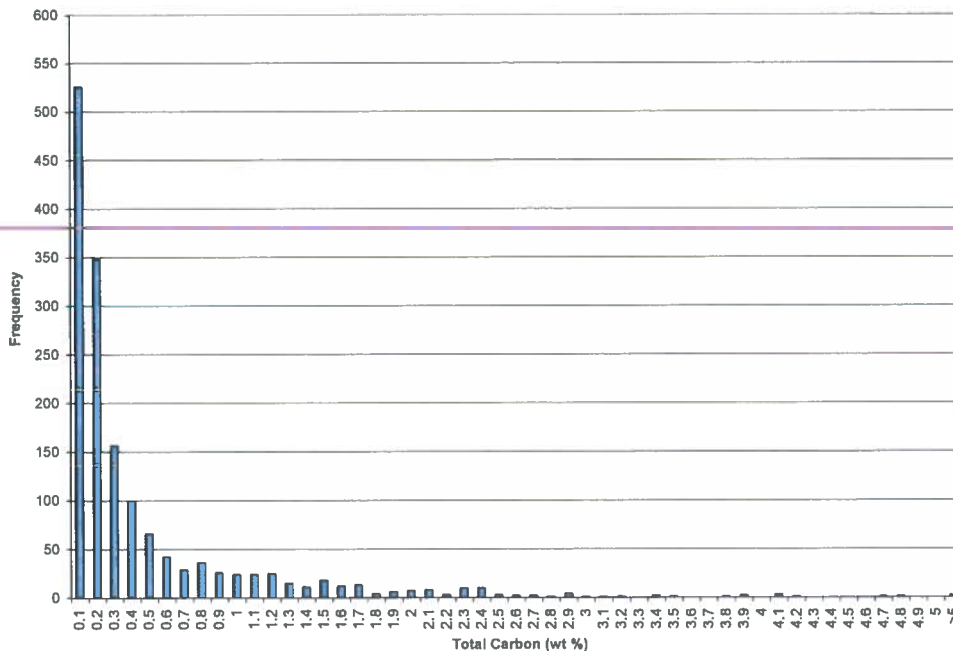


Figure 6-11: Total Carbon Histogram



6.5 Net Acid Generation Test Results

For this study, net acid potential was determined using the NAG test method of Miller et al. (1997). This test is a modification of the hydrogen peroxide method of Sobek et al. (1978), which involves the laboratory oxidation of sulfides in a weak hydrogen peroxide solution (a very aggressive oxidant). This reaction releases the acid produced by sulfide oxidation, oxidation of ferrous to ferric iron, and the oxidation of any other metals. Because the reaction takes place in water, the dissolution of secondary salts also contributes to the acid potential. Any acid that is released will react with any buffering materials (e.g., carbonate minerals) that are present, yielding a net pH indicative of overall acid generation potential.

NAG testing was conducted to determine the final NAG pH (s.u.) following H_2O_2 digestion and the NAG value (expressed in kg H_2SO_4 /ton) following NaOH titration to raise the pH of each sample to 6 s.u. and 7 s.u., respectively. The NAG test provides a direct assessment of the potential for a material to produce acid after a period of exposure and weathering (i.e., sample reactivity). NAG values were not determined for samples with a NAG pH value greater than 4 s.u. and for these samples the NAG value is reported as 0 eq. kg H_2SO_4 /ton).

This test differs from the ABA test in that it oxidizes sulfides present through a two-stage hydrogen peroxide digest, and then establishes acid generation potential through a one-step titration rather than through back titration as is done in the Sobek test. The benefit of using the NAG test is that it does not differentiate between the different sulfur forms and therefore provides a direct empirical estimate of the overall sample reactivity, including semi-soluble acid-generating sulfate minerals (e.g., jarosite) as well as other acid-generating sulfide minerals. As such, NAG testing is often a better estimate of the "reactive" or "field" acid generation than the more widely used ABA method, which defines acid potential based solely on sulfide content.

The guidelines used for assessing the acid generation potential based on NAG results are summarized in Table 6-4. NAG results greater than one kg H_2SO_4 /ton indicate the sample will generate some acidity in excess of available alkalinity. However, by convention, any NAG value below 10 equivalent kg H_2SO_4 per ton of material has a limited potential for acid generation and the results are considered inconclusive. This is because a blank hydrogen peroxide solution (the reagent in the NAG test) can generate a NAG artifact value up to 10 kg H_2SO_4 /ton. When dealing with low sulfide material, the NAG final pH becomes more important as it can be used to identify samples that are likely to generate acid empirically, under steady state conditions.

NAG testing was conducted on 89 historic core samples and 48 recent core samples for a total of 137 samples. For quality assurance, ten duplicate samples were also submitted for NAG testing. Results of the NAG testing are reported as equivalent kg H_2SO_4 per ton of material and are summarized in Table 6-5. In Figure 6-12, NAG values are plotted against NAG pH values according to material type. The complete set of results is provided in Appendix F.

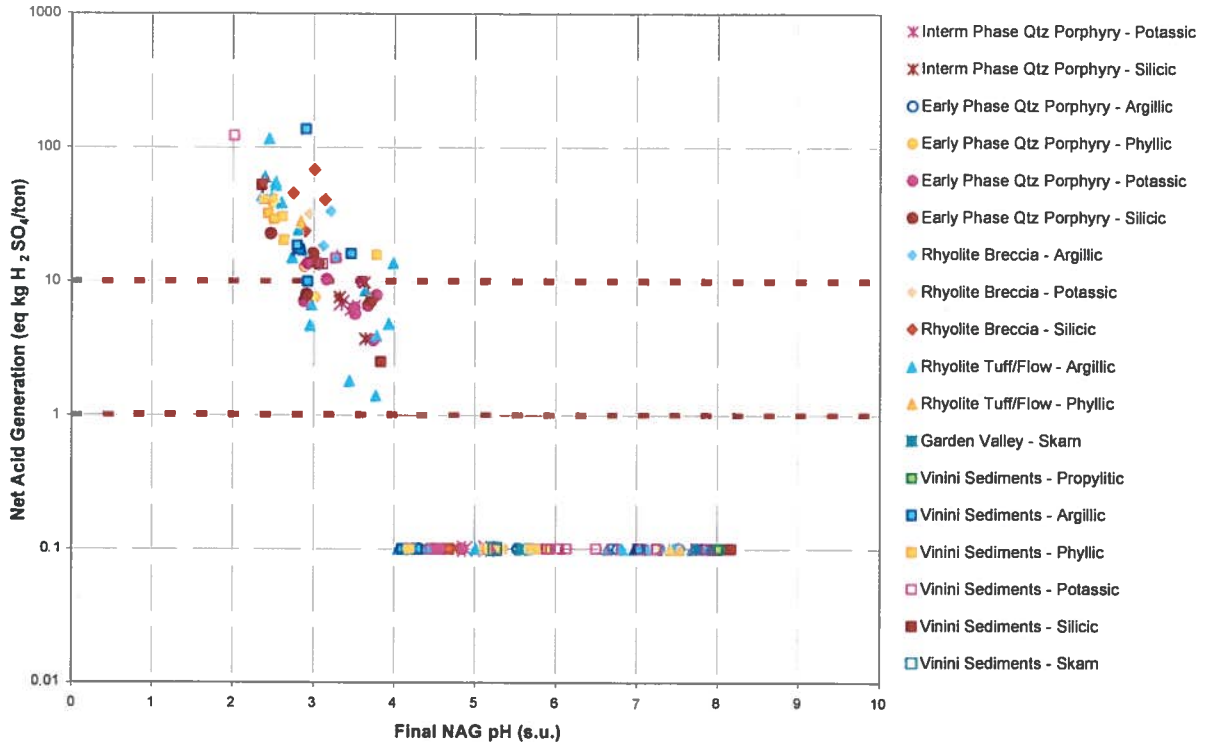
Table 6-4: Acid Generation Criteria for NAG Results

Acid Generation Capacity		Final NAG pH (s.u.)	Static NAG (kg H ₂ SO ₄ /ton)
Potentially Acid Forming	Higher Capacity	< 4	>10
	Lower Capacity	< 4	≤10, >1
Non-Acid Forming		≥ 4	<1

Table 6-5: Summary of NAG Results

Rock Type	Primary Alteration	Material Type	n	NAG pH (s.u.)			NAG pH 7 (kgH ₂ SO ₄ /ton)		
				min	max	mean	min	max	mean
Alluvium (Qal)	NA	1	--	--	--	--	--	--	--
Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	2	4	3.34	5.14	4.21	<1	6.90	3.31
	Biotite	3	--	--	--	--	--	--	--
	Silicic	4	4	3.32	4.73	3.83	<1	9.80	5.28
Early Phase Quartz Porphyry (Tqp)	Argillic	5	5	5.53	7.53	6.23	<1	<1	<1
	Phyllic	6	8	2.50	7.23	4.53	<1	38.80	6.60
	Potassic	7	17	2.88	4.84	3.91	<1	13.70	3.83
	Silicic	8	5	2.47	3.71	3.03	7.10	22.70	13.48
Rhyolite Breccia (Trb)	Argillic	9	6	3.12	7.46	5.61	<1	33.30	8.63
	Phyllic	10	--	--	--	--	--	--	--
	Potassic	11	1	2.95	2.95	--	32.00	32.00	--
	Silicic	12	5	2.75	4.70	3.30	<1	68.40	35.82
Rhyolite Tuff/Flow (Tmr/Tfr)	Argillic	13	35	2.36	8.05	4.36	0.01	117.00	15.16
	Phyllic	14	7	2.51	7.78	5.59	0.01	43.10	10.13
	Potassic	15	--	--	--	--	--	--	--
Garden Valley (Pg)	Skarn	16	3	4.23	7.75	5.85	<1	<1	<1
Vinini Sediments (Ov)	Unaltered	17	--	--	--	--	--	--	--
	Propylitic	18	3	7.85	8.15	8.00	<1	<1	<1
	Argillic	19	9	2.79	7.85	4.24	<1	138.00	25.01
	Phyllic	20	12	2.38	5.84	4.06	<1	41.20	14.13
	Potassic	21	19	2.02	7.92	5.65	<1	123.00	8.50
	Silicic	22	3	2.36	8.17	4.79	<1	52.80	18.44
	Skarn	23	1	5.25	5.25	--	<1	<1	--

Figure 6-12: Final NAG pH vs. NAG



As can be seen in Figure 6-12, a majority of the samples have NAG values less than 10 eq. kg H₂SO₄/ton and are predicted to have a low acid generating potential or are non-acid forming with NAG pH values greater than 4 s.u. The NAG results are consistent with the conclusion of the ABA testing of the same samples and allow the following conclusions to be drawn:

- Early and Intermediate Phase Quartz Porphyry material types have relatively less sulfide and thus, an overall lower potential to generate acid. Both of these material types demonstrate low reactivity with NAG values typically between one and 10 eq. kg H₂SO₄/ton regardless of alteration type. The exception to this is the silicic Early Phase Quartz Porphyry that shows a greater potential for acid generation with some NAG values greater than 10 eq. kg H₂SO₄/ton. All samples of Argillic Early Phase Quartz Porphyry are predicted to be non-acid generating with NAG pH values greater than 4 s.u.
- Rhyolite Breccia samples were collected near the zinc deposit and contain a significant amount of unoxidized pyrite and chalcopyrite. The sulfides in this location are generally unoxidized which is reflected by NAG results for the majority of the samples that demonstrate acid generating potential. Similar to the ABA results Rhyolite Breccia that has undergone silicic alteration has the greatest potential to generate acid, with NAG values greater than 10 eq. kg H₂SO₄/ton for three out of the five samples.
- Rhyolite Tuff and Flow that have undergone argillic or phyllic alteration typically contain relatively higher sulfide content and the majority of the samples demonstrate

a low to high capacity for acid generation with NAG values between one and 100 eq. kg H₂SO₄/ton and NAG pH values below 4 s.u. However, some samples representing these material types are predicted to be non-acid generating, with pH values greater than 4 s.u.

- Vinini Sediments that have undergone argillic, potassic, or phyllic alteration have an overall higher sulfide content and demonstrate a greater potential to generate acid. NAG results for the majority of the samples are around 10 eq. kg H₂SO₄/ton and NAG pH values below 4 s.u. However, some samples from these material types demonstrate a low capacity for acid generation with pH values greater than 4 s.u. Silicic Vinini Sediments demonstrate a similar wide range of results with samples classified as both acid generating and non-acid generating.
- Vinini Sediments that have undergone propylitic alteration contain carbonate minerals that provide significant buffering capacity. This coupled with the coarse grained habit of the pyrite, results in a less reactive material, as demonstrated by neutral NAG pH values.
- Based on the NAG data, Garden Valley Skarn is potentially acid generating with pH values less than 4 s.u. and NAG values generally greater than 10 eq. kg H₂SO₄/ton. This reflects the high sulfide content of this material.

In summary, the NAG results are generally consistent with the ABA assessment and indicate the total sulfur percent can be used to predict acid generation capacity. This is demonstrated by Figure 6-13 and Figure 6-14, where sulfide sulfur and total sulfur are plotted against NAG values. In Figure 6-13 (sulfide sulfur versus NAG), those samples with sulfide sulfur content above 0.3 weight percent are predicted by the NAG assessment to be acid generating with NAG values greater than 10 eq. kg H₂SO₄/ton. Those samples with sulfide sulfur content less than 0.3 weight percent are predicted to either have a low capacity for acid generation or are non-acid generating with NAG values less than 10 H₂SO₄/ton. NAG values for some samples were not measured (i.e., NAG = <1). A small percentage of these samples (e.g., Vinini Skarn and Propylitic Vinini Sediments) contain greater than 0.5 wt% sulfide sulfur but are classified as non-acid generating due to the neutralization capacity attributed to these material types.

In Figure 6-14 (total sulfur versus NAG) the threshold is slightly greater than shown in Figure 6-13 and samples with total sulfur content less than 0.5 weight percent are predicted by the NAG assessment to be limited (NAG values between 1 and 10 H₂SO₄/ton) or non-acid generating (NAG values less than 1 kg H₂SO₄/ton). Samples with total sulfur content greater than 0.5 wt% are generally predicted by the NAG assessment to be acid generating (NAG values greater 10 H₂SO₄/ton).

From the NAG assessment, it can be concluded that samples with total sulfur content less than 0.5 wt% have limited acid generation potential or are non-acid generating and samples with total sulfur content greater than 0.5 wt% are potentially acid generating.

Figure 6-13: Sulfide Sulfur vs. NAG

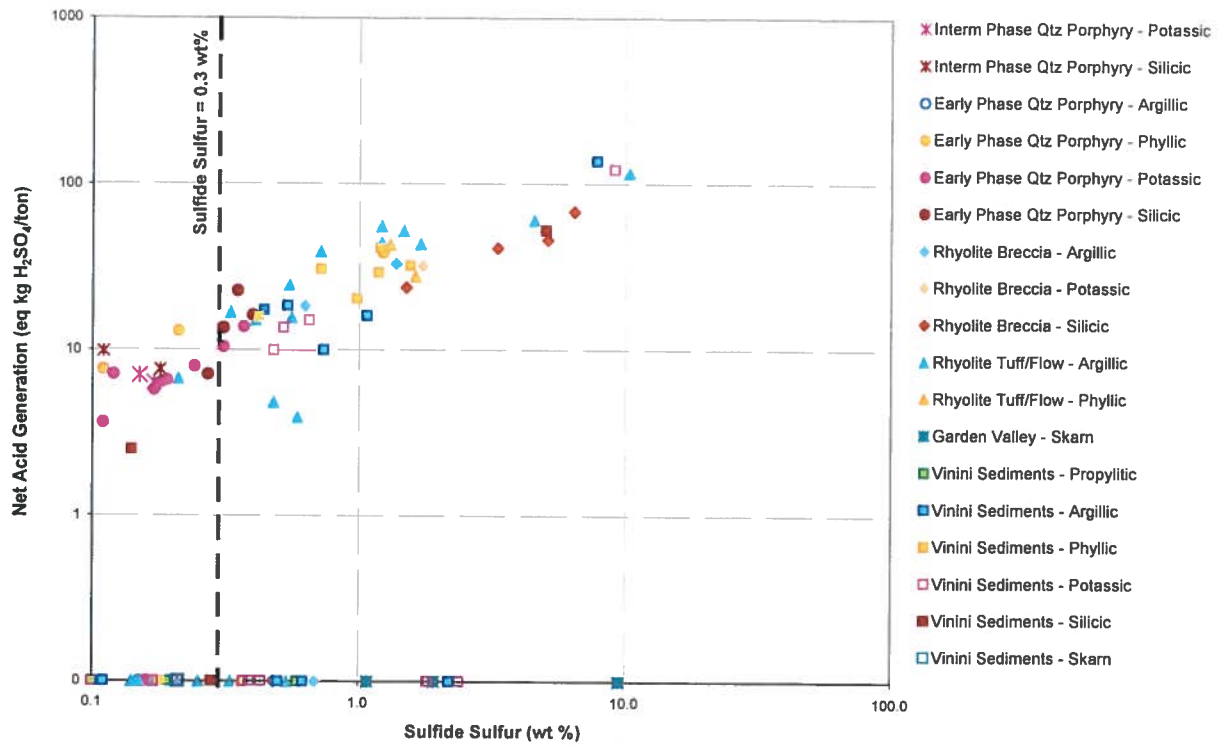
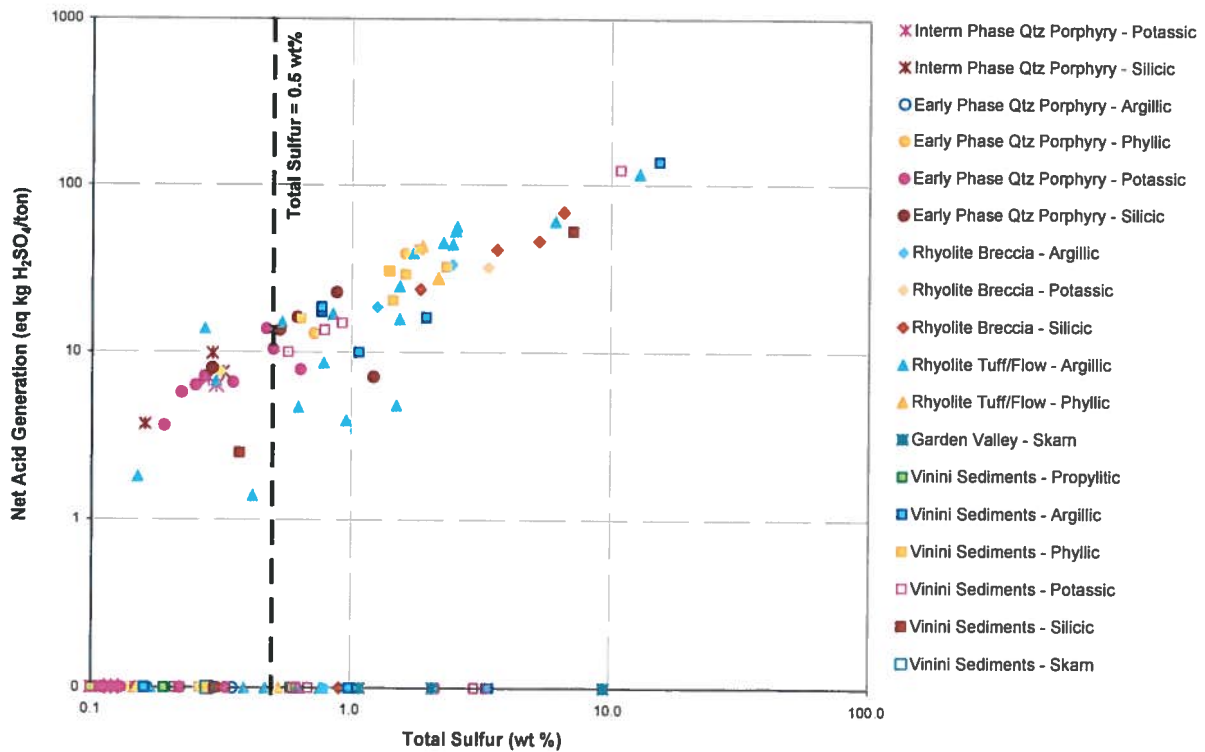


Figure 6-14 Total Sulfur vs. NAG



6.6 Comparison of Mount Hope Data to Other Mineral Deposit Types

The static test results indicate that the Mount Hope mineralizing system is a low sulfide, low carbonate system. In general, base metal sulfides are volumetrically lower in the Mount Hope deposit and as a result, this system is characterized by a lower overall potential for acid generation. This is supported by a comparison of the static test results for the Mount Hope deposit to other mineral deposit types throughout Nevada. As shown in Figures 6-15 and 6-16, the Mount Hope deposit is characterized by a lower overall reactivity and potential for acid generation. The majority of the Mount Hope samples fall within the same range of NAG and NNP values as the low sulfidation and Carlin type deposits. A few samples in the Mount Hope database overlap the range of data reported for copper porphyry type deposits. However, the Mount Hope samples generally have higher paste pH values (i.e., generally greater than 5 s.u.) than the high sulfidation and copper porphyry samples with comparable NNP values, reflecting the overall lower reactivity of the Mount Hope lithotypes and the difficulty in predicting acid generating potential from ABA results for low sulfide-low carbonate systems. Figure 6-16 further demonstrates the lower overall reactivity of the Mount Hope system, with a significant percentage of the Mount Hope samples with NAG values less than 10 eq. kg H₂SO₄. By comparison, NAG values for the high sulfidation and copper porphyry systems are generally greater than 10 eq. kg H₂SO₄ and show much higher range of NAG values.

Figure 6-15: Comparison of ABA Data for Mineral Deposit Types

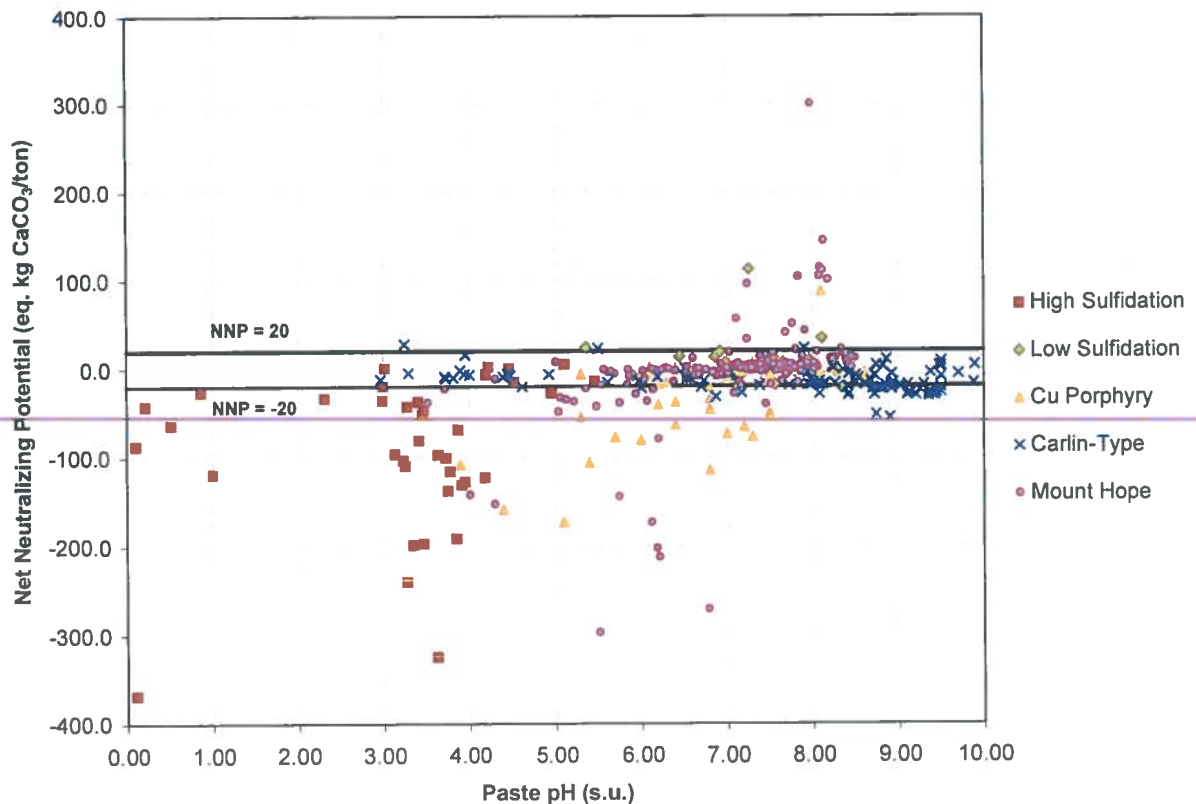
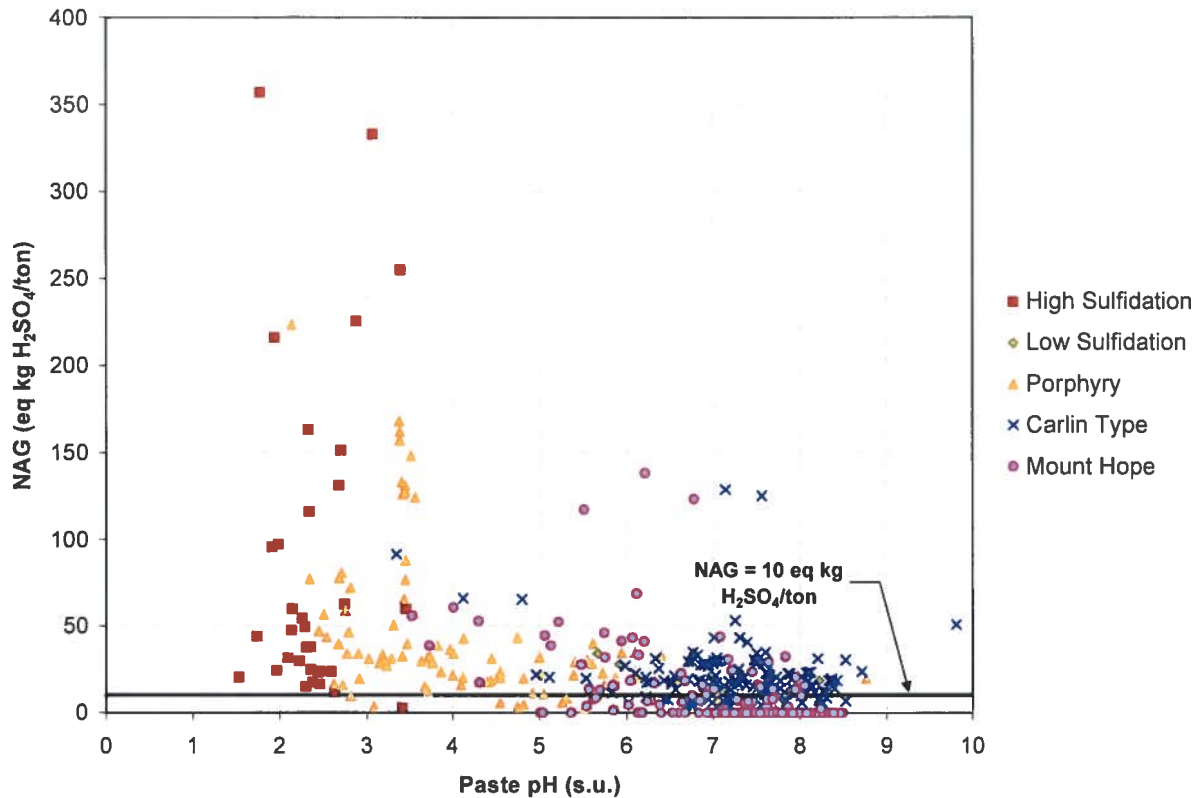


Figure 6-16: Comparison of NAG Data for Mineral Deposit Types



6.7 Comparison of Historic and Recent Core

Static test results from historic core and recent core were compared to assess the extent of oxidation and the impacts this may have on the testing program. For this comparison, samples of similar lithology were compared to limit the natural variation that is expected in geologic material. Material types with both historic and recent core include: Argillic Vinini Sediments, Potassic Vinini Sediments, Silicic Vinini Sediments, Argillic Rhyolite Tuff, Phyllic Rhyolite Tuff, and Potassic Early Phase Quartz Porphyry.

The comparison of the ABA and NAG data from the recent core shows that it has a range of values that is similar to the historic core. However, the Vinini Sediments that have undergone argillic and potassic alteration appear to have a greater potential for acid generation from the recent core. A graph of sulfide sulfur versus sulfate sulfur, Figure 6-17, indicates the sulfide content of the samples is consistently greater than the sulfate content, regardless of the age of the core. This indicates there has been little or no degradation of the core in storage. A plot of pH versus TDS, Figure 6-18, shows that higher reactivity is observed for the more recent core in comparison to the historic core for individual material types. This is particularly true for Argillic Rhyolite Tuff, Argillic Vinini Sediments, and Silicic Vinini Sediments and to a lesser extent for the Quartz Porphyry material types (Tqp and Tqpa) This is opposite of what would be expected if the archived cores had degraded over time. Consequently, it can be concluded that the observed difference is due to greater representation of the full range of geochemical behavior for those material types that

demonstrate a broader range in values when the more recent samples are included, rather than being related to the age of the core. Those material types that do not show a wide range in geochemical behavior do not show any measurable difference in metal release as a function of age (Figure 6-19).

Figure 6-17: Sulfide Sulfur vs. Sulfate Sulfur for Historic and Recent Core

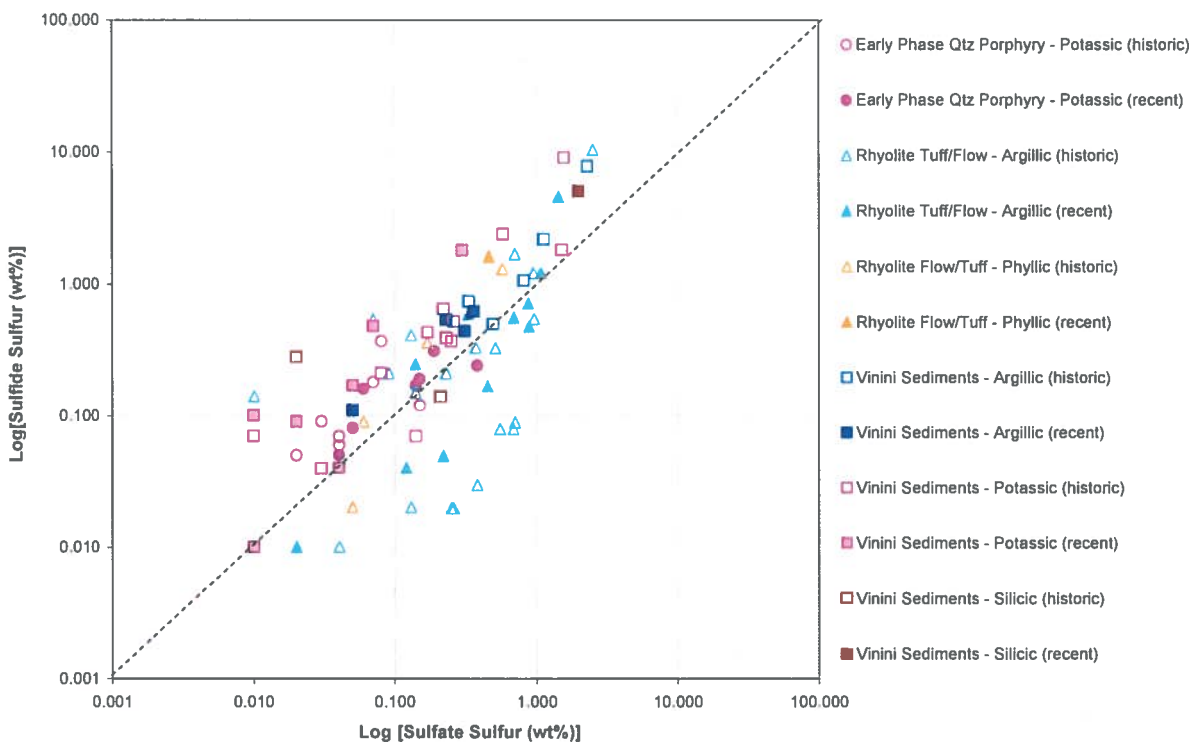


Figure 6-18: pH vs. TDS for Historic and Recent Core

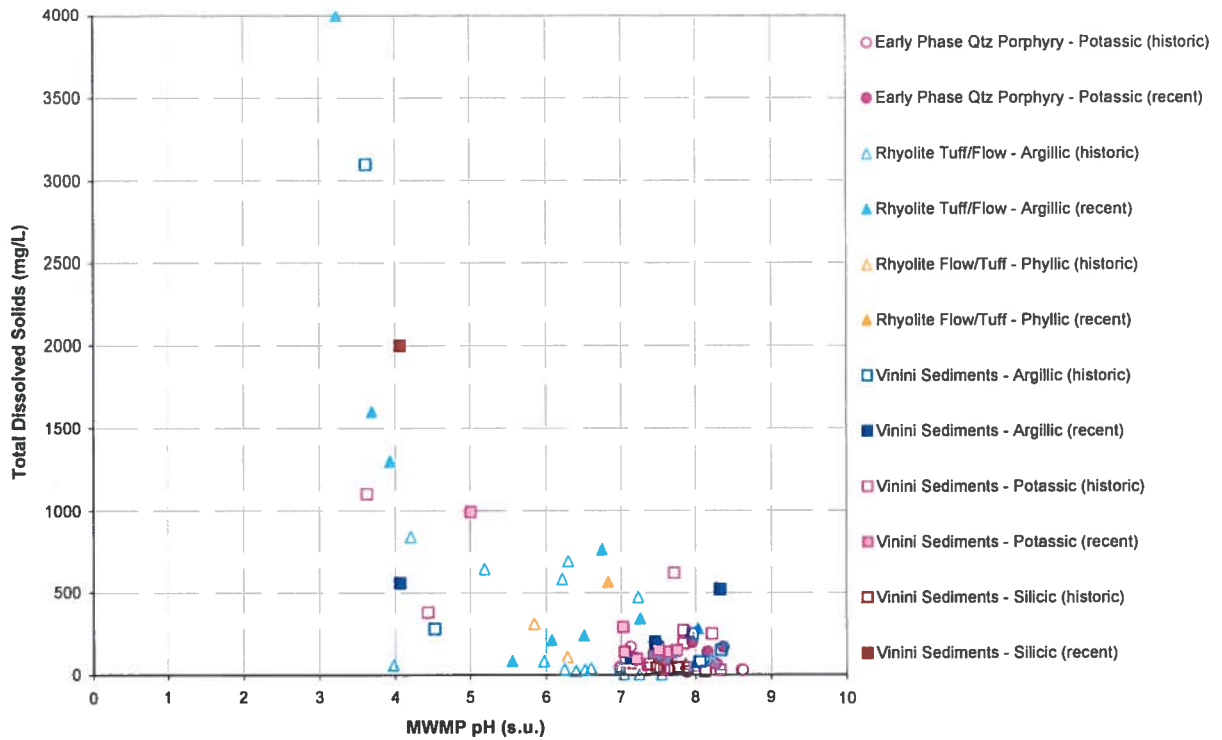
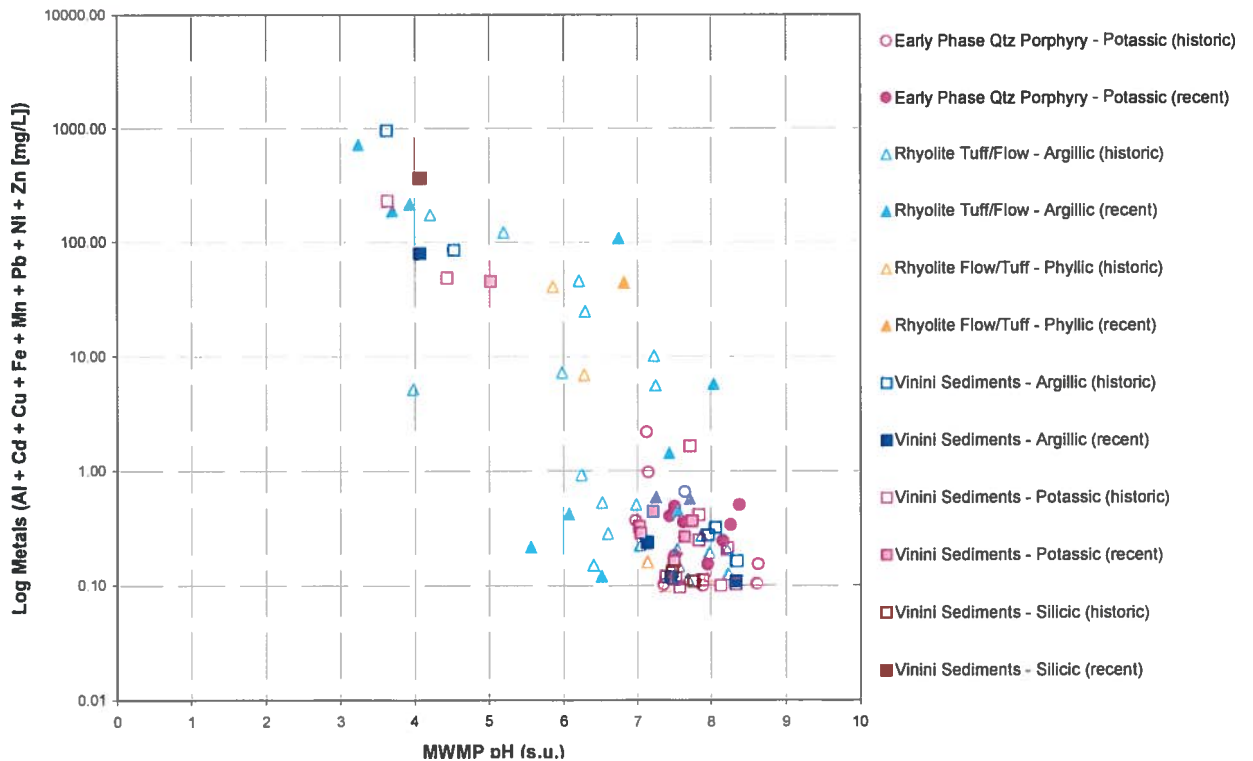


Figure 6-19: Ficklin Metals for Historic and Recent Core



7 KINETIC TEST RESULTS

7.1 Overview

- Nine humidity cell tests were initially conducted for waste rock characterization. Samples were selected for this first phase of testing to represent the main waste rock material types. Two of the nine humidity cells were conducted for 55 weeks and the remaining seven were terminated after Week 69, once steady state chemistry was attained;
- Twenty additional samples were selected for kinetic testing, based on the static evaluation, to augment the first phase of kinetic tests. These cells are currently in progress and the laboratory results are reported herein through Week 30, and leachate analyses for Nevada Profile II constituents are available through Week 25;
- The humidity cell results for the Phase 1 HCTs generally confirm the initial prediction of acid generation from ABA results. The exception to this is Cell 9, which is predicted to have very low reactivity in NAG and HCT test results although ABA tests predict that the material will become acidic;
- MWMP test results and the HCT results are generally consistent with respect to the constituents that are liberated at concentrations above NDEP comparative values;
- Based on the HCT results, the Argillic Quartz Porphyry demonstrates net neutralizing behavior and the Potassic Quartz Porphyry is predicted to be potentially acid generating. Variable acid generation potential is predicted for the Argillic Rhyolite Tuff and Flow material types. One HCT of Argillic Vinini Sediments indicates net neutralizing behavior and HCT results for Potassic Vinini Sediments indicate variable acid generation potential;
- The results of the termination tests have demonstrated that the majority of metals have been mobilized during the test, and as a result it can be assumed that weathering reactions have occurred in the kinetic tests and that the Phase 1 HCT program has provided a complete characterization of the reaction rates;
- A comparison of static test data and the corresponding HCT data reveals that total sulfur is a sensitive indicator of metal leaching and acid generation potential and is a reliable diagnostic parameter in determining the geochemical characteristics of waste rock for the Mount Hope system;
- The HCT results are generally in agreement with the ABA results and confirm that the NPR criteria of 1.2 is an appropriate threshold in determining if a material has the potential to be acid generating; and
- There is a strong correlation between HCT results and the prediction of acid generation from NAG results. This correlation confirms that the threshold of 10 eq. kg H₂SO₄ is effective in discriminating between acid generating and non-acid generating samples.

7.2 Introduction

Kinetic testing was conducted in two phases. In conjunction with the initiation of static test program, nine humidity cell tests were initiated (Phase 1). An additional 20 samples were selected for a second phase of kinetic testing based on the ABA evaluation (Phase 2). The testing methods are discussed in Section 4 and a summary of the number of kinetic tests that were run for each material type is summarized in Table 7-1.

Table 7-1: Sample Frequency for Kinetic Testing

Material Type	Humidity Cell Number	HCT Phase	Age of Core	HCT Duration
Intermediate Phase Qtz Porphyry – Potassic (Tqpa – Po)	Cell 23	2	Historic	In progress
Intermediate Phase Qtz Porphyry – Silicic (Tqpa – Si)	Cell 13	2	Historic	In progress
	Cell 22	2	Historic	In progress
Early Phase Qtz Porphyry – Argillic (Tqp – Ar)	Cell 2	1	Historic	69 weeks
	Cell 17	2	Historic	In progress
Early Phase Qtz Porphyry – Phyllic (Tqp – Ph)	Cell 14	2	Historic	In progress
	Cell 16	2	Historic	In progress
Early Phase Qtz Porphyry – Potassic (Tqp – Pot)	Cell 7	1	Historic	69 weeks
	Cell 29	2	Recent	In progress
	Cell 30	2	Recent	In progress
Early Phase Qtz Porphyry – Silicic (Tqp – Si)	Cell 15	2	Historic	In progress
	Cell 26	2	Historic	In progress
Rhyolite Flow/Tuff – Argillic (Tmr – Ar)	Cell 8	1	Historic	69 weeks
	Cell 1	1	Historic	69 weeks
	Cell 3	1	Historic	55 weeks
	Cell 4	1	Historic	55 weeks
	Cell 27	2	Recent	In progress
Rhyolite Flow/Tuff – Phyllic (Tmr – Ph)	Cell 28	2	Recent	In progress
	Cell 25	2	Historic	In progress
Vinini Sediments – Propylitic (Ov – Pr)	Cell 20	2	Historic	In progress
	Cell 21	2	Historic	In progress
Vinini Sediments – Argillic (Ov – Ar)	Cell 9	1	Historic	69 weeks
	Cell 18	2	Historic	In progress
	Cell 31	2	Recent	In progress
Vinini Sediments – Phyllic (Ov – Ph)	Cell 19	2	Historic	In progress
	Cell 24	2	Historic	In progress
Vinini Sediments – Potassic (Ov – Po)	Cell 5	1	Historic	69 weeks
	Cell 6	1	Historic	69 weeks
Vinini Sediments – Silicic (Ov – Si)	Cell 12	2	Historic	In progress

The HCT provides an estimate of the time-dependent rate of constituent release from a material when it is exposed to alternate cycles of wetting and drying. The length of time required to achieve steady conditions in this type of test varies substantially depending upon mineralogy and rock texture and can be prolonged where weakly acidic systems oxidize in the presence of little to no buffering potential. For this reason, the Phase 1 Mount Hope waste rock cells required 69 weeks of leach testing to reach steady state chemistry, with the exception of Cells 3 and 4 which reached a steady state effluent chemistry in 55 weeks. Phase 2 humidity cells are in Week 35 (as of November 2007) and have not yet reached a steady state.

The information gathered during the HCT provides an understanding of how materials respond to weathering during the wetting and drying cycles that occur in the field. Although the test was originally designed to target sulfide oxidation, results are used to estimate and compare reaction rates of major constituents. The changes in these reaction rates through the course of the test can be used to estimate whether the sample will be net acid generating or net acid neutralizing, and therefore refine predictions based on static test data. Leach tests also indicate what constituents will be mobilized from the material under long-term weathering conditions. However, the test results are not directly comparable to water quality standards due to the increase in surface area by crushing and the artificial control on weathering through a seven-day wet-dry cycle rinsing of the samples. The rate of water application relative to the surface area/mass ratio of rock vastly exceeds the actual precipitation rate that would be expected at Mount Hope, and the laboratory temperature conditions do not represent normal field variations. These variables accelerate the weathering process and therefore provide a conservative view of field scale leaching conditions.

HCT results can be interpreted as early, middle, and late stage responses. The early stage response is dominated by the chemistry of the first flush of readily soluble minerals that are stored in the sample prior to weathering in the column, which can be easily dissolved and rinsed from the sample. This flush includes secondary minerals that are highly soluble, such as halides and some metal sulfate minerals, as well as desorption of weakly-held species on mineral surfaces.

The middle stage response is characterized by a gradual stabilization of chemistry, driven by stable dissolution reaction rates of primary mineral phases in response to the conditions imposed by the weathering cycles of the test. For samples with equal acid producing and neutralizing reaction rates, this middle response can be prolonged. However, for strongly basic or acidic samples, the middle stage response is usually brief, and the late stage response tends to be the same as the middle stage response. A sample with a strongly acidic middle stage response will commonly show late stage acid generation, and strongly neutralizing samples will commonly indicate an alkaline late stage. For intermediate samples, the late phase response is characterized by the depletion of available acidic or neutralizing phases, resulting in stabilization of the effluent at either acidic or alkaline pH.

The late stage response may occur at any time in the kinetic test cycle and reflects long-term sulfide oxidation, flushing of constituents, and attainment of steady state chemistry with little fluctuation in the release rates. At this point, the cells have characterized the release rate of the material, and the tests can be terminated.

The analysis of the HCT results includes a review of the trends in physical chemistry (e.g., pH) and trends in macrochemistry. The macrochemistry of humidity cell effluent is generally controlled by dissolution or precipitation of common minerals, such as calcite or gypsum. Their relative solubility can be evaluated using a thermodynamic speciation code like PHREEQC to calculate a saturation index (SI). Another method for gaining insight on important mineral controls in the humidity cells is to examine the ratio of key components (e.g., calcium and magnesium to sulfate, as an indication of gypsum solubility). Calcium-magnesium sulfate phases have a stoichiometric ratio of 1:1 Ca+Mg: sulfate. A molar ratio of cations to sulfate that is greater than one (i.e. above gypsum saturation) indicates there is a surplus of sulfate in solution by comparison to calcium and magnesium. This provides evidence of sulfide oxidation, because the amounts of sulfate exceed the calcium and magnesium. Conversely, a molar ratio of less than one is interpreted to reflect release of magnesium and calcium cations from carbonate, sulfate and silicate minerals as they undergo chemical weathering and ion exchange reactions.

Neutralization potential (NP) was calculated for each cell on a weekly basis from sulfate and alkalinity concentrations measured in the HCT leachate. The NP consumption in each cell was determined by subtracting the NP measured in the cell from the initial NP of the solids as determined by titration in the ABA testwork. Trends in NP consumption were plotted for the duration of the HCT in order to monitor the rate of NP depletion in each cell.

HCT leachate chemistry was compared to comparative values listed in NDEP Form 0090 - Profile II to identify relevant constituents that are leached at concentrations that are above these values. However, the test results are not directly comparable to water quality standards due to the increase in surface area by crushing and the artificial control on weathering through a seven-day wet-dry cycle rinsing of the samples. This comparison provides a semi-quantitative evaluation of elements released in the HCT at concentrations above comparative values. These are the elements that would typically be addressed during the assessment of potential risks.

Weekly and cumulative summaries of pH, sulfate, acidity and alkalinity produced in each humidity cell are presented as tables and graphs in Appendix I (Phase 1) and Appendix K (Phase 2) along with graphs of key constituents from Profile II testing.

Following completion of the Phase 1 HCT tests, the material remaining in the column was submitted for termination tests including selective extraction, ABA, and whole rock analysis. These results are provided in Appendix J.

The detailed leachate chemistry results for the Phase 2 humidity test cell results are provided up to Week 25 and up to Week 30 for weekly data. These results will be updated as testing progresses. Termination tests will be conducted after the cells have reached a steady state. Upon completion of the remaining HCT data collection and evaluation, the results will be summarized and submitted as an addendum to this report.

7.3 Sample Selection and Pre-HCT Material Characterization

7.3.1 Phase 1 HCT Program

The initial nine samples were selected for kinetic testing based solely on field reactivity because static tests were in progress and could not be used as a basis for sample selection. The main objective of the first phase of kinetic testing was to study samples that represent the main material types for the Mount Hope deposit including Argillic and Potassic Early Phase Quartz Porphyry, Argillic Rhyolite Tuff and Argillic and Potassic Vinini Sediments.

The ABA characteristics of the Phase I HCT samples are summarized in Table 7-2 along with the range in AP and NP values for each material type from the static test database. The Phase 1 samples were selected to represent the range of reactivity observed from the screening level results (i.e., contact pH and EC) for each of the main material types. Static test results were not available at the time the samples were selected. As a result, the full range of reactivity as determined from the ABA testing is not captured by the Phase 1 testing for some of the material types (e.g., Argillic Rhyolite Tuff).

Table 7-2: Pre-HCT ABA Results for Phase I HCT Samples

Material Type	AP Range	NP Range	HCT Cell	Sulfide Sulfur (wt %)	AP (eq. kg CaCO ₃ /ton)	NP (eq. kg CaCO ₃ /ton)	NNP (eq. kg CaCO ₃ /ton)	NPR
Tqp - Ar	0.3-4.7	4.9-107	Cell 2	0.01	0.31	4.9	4.60	16.33
Tqp - Po	1.6-11.6	0.5-8.1	Cell 7	0.37	11.6	4.9	-6.70	0.42
Tmr/Tfr - Ar	0.3-325	1.5-30.4	Cell 1	0.14	4.4	8.8	4.40	2.00
Tmr/Tfr - Ar			Cell 3	1.22	38.1	5.4	-32.70	0.14
Tmr/Tfr - Ar			Cell 4	1.47	45.9	8.8	-37.10	0.19
Tmr/Tfr - Ar			Cell 8	0.01	0.31	4.9	4.60	16.33
Ov - Ar	3.4-245	3-46.1	Cell 9	2.19	68.4	46.1	-22.30	0.67
Ov - Po	1.3-285	2.6-124	Cell 5	0.21	6.6	20.1	13.50	3.05
Ov - Po			Cell 6	9.12	285	13.7	-271.30	0.05

The mineralogy of the nine Phase 1 humidity cells is shown in Table 7-3. Molybdenite occurs in all cells except Cell 4 and Cell 9, although only Cell 5 and Cell 8 can be classified as ore. Although sulfides are present in all cells, they occur at concentrations of sulfide sulfur content equal or less than 2 weight percent in all cells except Cell 6, which represents base metal mineralization in a hornfels skarn and contains 9.12 weight percent sulfide mainly as pyrite and sphalerite with lesser arsenopyrite, bornite, chalcocite, chalcopyrite, galena and tetrahedrite.

Table 7-3: Mineralogy Results for Phase I HCT Samples

Mineral	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	Cell 7	Cell 8	Cell 9
	Tmr -Ar	Tqp-Ar	Tmr-Ar	Tmr-Po	Ov-Po	Ov-Po	Tqp-Po	Tmr-Ar	Ov-Ar
anhydrite			*			*			
ankerite		*	*		**	*		*	*
apatite		*					*		
arsenopyrite						*	*		
barite					*				**
biotite		*			*	*	**		*
bornite							*		
brochantite									
calcite			*						
cassiterite	*	*			**				**
chalcopyrite							*		
chalcocite			*			*	*		*
chlorite			*						*
creedite			**		**	*			
epidote			*			*	*		
K-feldspar					**				
Na-feldspar	**	**	*	*	**	***	***	*	*
ferromagnesio-anthophyllite	*	*		**	**	*	**	**	**
ferrimolybdate					*		*		
fluorite							*		
galena	**	***	**	*	*	*	*	*	**
gearsutite			*			**			
goethite			**	*	*		*		**
hawleyite		*	*			*			*
Illite			*						
ilsemanite	***	***	***	**	**	*	**	**	**
jarosite	*	**			*	*	*	*	
jurbanite			*	*		*	*		
kaolinite			*		*				*
molybdenite	***	***	***	**	*	*	*	**	***
monazite	*	*	*		*	*	*	*	
muscovite		*			*		*		
pyrite	*	*	*	*	**	*	**	*	*
quartz		*	**	**		**	*		*
scheelite	***	***	***	***	***	***	***	***	***
schrol (tourmaline)		*					*		*
siderite					*		*	*	**
smithsonite	*		*						
sphalerite	*	*	*		*		*		*
tetrahedrite			**	*		**			*
Topaz			*			*			
wolfram							*		

*** major mineral > 10% of sample
 ** minor mineral 1 to 10% of sample
 * trace mineral < 1 % of sample

7.3.2 Phase 2 HCT Program

For the second phase of HCT testing, 20 additional core samples were selected for kinetic testing (Table 7-4). Phase 2 HCT samples were selected based on the results of the static testing including mineralogy, ABA, NAG and MWMP testing. For material types with a broad range of static test results, multiple samples were chosen to represent the upper and lower ranges for key parameters including NPR and MWMP constituents such as arsenic, cadmium, iron, manganese, molybdenum, pH and sulfate.

Table 7-4: ABA Test Results for Phase 2 HCT Samples

Rock Type	AP Range	NP Range	HCT Cell	Age of Core	Sulfide Sulfur (weight percent)	AP (eq. kg CaCO ₃ /ton)	NP (eq. kg CaCO ₃ /ton)	NPR
Tqpa - Po	1.6-5.3	3.5-5.4	23	historic	0.05	1.6	3.5	2.19
Tqpa - Si	2.2-5.6	0.5-4.1	13	historic	0.11	3.4	0.5	0.15
Tqpa - Si			22	historic	0.08	2.5	4.1	1.64
Tqp - Ar	0.3-4.7	4.9-107	17	historic	0.15	4.7	45.5	9.68
Tqp - Ph	0.3-38.4	0.3-4.9	14	historic	0.21	6.6	1.5	0.23
Tqp - Ph			16	historic	<0.01	0.3	4.6	15.33
Tqp - Po	1.6-11.6	0.5-8.1	29	new	0.31	9.7	2.1	0.22
Tqp - Po			30	new	0.08	2.5	2.6	1.04
Tqp - Si	2.8-12.5	3-5.1	15	historic	0.35	10.9	3.0	0.28
Tqp - Si			26	historic	0.27	8.4	4.9	0.58
Tmr/Tfr - Ar	0.3-325	1.5-30.4	27	new	1.22	38.1	<0.3	0.01
Tmr/Tfr - Ph	0.3-50.6	3.5-311	25	historic	0.09	2.8	4.9	1.75
Tmr/Tfr - Ph			28	new	1.62	50.6	7.7	0.15
Ov - Pr	3.1-18.4	106-147	20	historic	0.59	18.4	132.0	7.17
Ov - Pr			21	historic	0.10	3.1	147.0	47.42
Ov - Ar	3.4-245	3-46.1	18	historic	0.50	15.6	36.7	2.35
Ov - Ar			31	new	0.54	16.9	9.5	0.56
Ov - Ph	0.3-48.4	3.5-32.9	24	historic	1.20	37.5	8.4	0.22
Ov - Ph			19	historic	0.98	30.6	32.9	1.08
Ov - Si	4.4-158	5.5-51.4	12	historic	0.14	4.4	13.7	3.11

Table 7-4 summarizes the ABA results for the selected HCT samples and shows that the majority of the static tests fall within the zone of uncertain acid generation, with NPR values less than 3 but greater than 1.2. Exceptions to this are samples of Propylitic Vinini Sediments and Silicic Vinini Sediments, for which NPR values are greater than three. This is also the case for one of two samples of the Phyllic and the Argillic Early Phase Quartz Porphyry samples.

The quartz porphyry lithologies (Tqpa and Tqp) are generally depleted in sulfide, with concentrations consistently less than 0.5 weight percent. In contrast, the sulfide content of the Vinini Sediments samples is more variable and ranges from 0.1 to 1.2 weight percent. Two out of three samples of Rhyolite Tuff have sulfide values greater than one percent.

7.4 Humidity Test Cell Average Release Rates

Constituent loads were calculated for key constituents by multiplying the concentration (mg/L) by the leachate volume recovered (L) and dividing by the weight of the sample (kg). This results in load units of mg/kg/week. The constituent loads were averaged over the length of the test to derive the average loading rates for Phase 1 HCT samples as summarized in Table 7-5. Weekly concentrations are provided in Appendix I. Average release rates will be calculated for Phase 2 HCTs upon completion of the test.

Table 7-5: Phase 1 HCT Average Release Rates for Key Constituents

Rock Type	Quartz Porphyry Argillic (Tqp Ar)	Quartz Porphyry Potassic (Tqp Po)	Rhyolite Tuff/Flow Argillic (Tmr/Tfr Ar)				Vinini Sediments Argillic (Ov-Ar)	Vinini Sediments Potassic (Ov-Po)	
	Cell 2	Cell 7	Cell 1	Cell 3	Cell 4	Cell 8	Cell 9	Cell 5	Cell 6
Bicarbonate	3.6203	1.5336	4.3723	0.9468	1.5501	4.3816	3.3754	12.0643	0.8861
Acidity	1.1884	18.1481	1.4838	45.9036	32.1164	1.6691	48.2655	0.0000	271.5831
Arsenic	0.0064	0.0100	0.0055	0.0017	0.0009	0.0042	0.0005	0.0060	0.0986
Aluminum	0.0322	1.5204	0.0129	2.2493	1.6119	0.0347	0.6130	0.0021	1.6058
Antimony	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0025
Cadmium	0.0009	0.0206	0.0004	0.1044	0.0250	0.0006	0.0090	0.0002	0.0052
Copper	0.0035	0.3703	0.0000	0.0877	0.0212	0.0000	0.0774	0.0000	2.0897
Iron	0.0043	0.1269	0.0024	0.5270	0.2944	0.0547	23.3382	0.0003	77.3506
Fluoride	1.3535	4.2814	1.7316	4.6969	3.7911	0.2838	0.1052	0.4718	0.5660
Manganese	0.0078	0.2313	0.0332	14.1370	10.9590	0.0178	60.4933	0.0280	1.7425
Molybdenum	0.0467	0.0018	0.0078	0.0000	0.0000	0.0129	0.0000	0.2022	0.0005
Sulfate	0.5373	30.3701	10.8152	141.4546	90.6827	7.6650	383.6041	16.0835	600.1728
Thallium	0.0000	0.0001	0.0000	0.0004	0.0002	0.0000	0.0019	0.0000	0.0054
Zinc	0.0033	1.2318	0.0454	17.4118	8.7671	0.0179	22.2094	0.0240	0.6090

Average release rates reported as mg/kg/week.
Non-detect values were set to zero for the load calculations.

As shown in Table 7-5, the greatest average release of acidity is from Cell 6, one of the two Potassic Vinini Sediments samples. This cell also shows significantly elevated release rates for aluminum, copper, iron, manganese, and sulfate in comparison to the other cells. Moderate acidity release (average release around 40 mg/kg/week) is observed from the sample of Argillic Vinini Sediments (Cell 9) and two out of four of the Argillic Rhyolite Tuff samples (Cell 3 and Cell 4). These cells also had higher overall release of iron, manganese and zinc than the other cells.

Average release rates for the sample of Argillic Early Phase Quartz Porphyry indicate low acid generation and a correspondingly low rate of metal release. Potassic Early Phase Quartz Porphyry shows a somewhat higher potential for acidity release relative to the Argillic Early Phase Quartz Porphyry, along with higher concentrations of arsenic, aluminum, cadmium, copper, fluoride, sulfate and zinc. The greatest alkalinity release was observed in Cell 5, one

of the two Potassic Vinini Sediments samples. Average metal release rates for this sample are relatively low.

7.5 Summary of Humidity Cell Chemistry Trends

7.5.1 Intermediate Phase Quartz Porphyry

No samples of Intermediate Phase Quartz Porphyry were selected for Phase 1 HCTs. Three samples of Intermediate Phase Quartz Porphyry were included in the Phase 2 HCT program; two with silicic alteration (Cell 13 and Cell 22) and one with potassic alteration (Cell 23). The results for the Intermediate Phase Quartz Porphyry HCTs are summarized in Figure 7-1 and discussed according to alteration type below.

7.5.1.1 Potassic Alteration

The sample of Potassic Intermediate Phase Quartz Porphyry shows very little variation in pH throughout the HCT, ranging from 5 to 6 s.u. This sample demonstrates active buffering capacity and a slow rate of available alkalinity consumption. At Week 30, more than 90 percent of the initial neutralization potential is still remaining. Under these conditions, metals release is consistently low with the exception of molybdenum. During the first few weeks, molybdenum demonstrates a release related to rinsing of secondary salts.

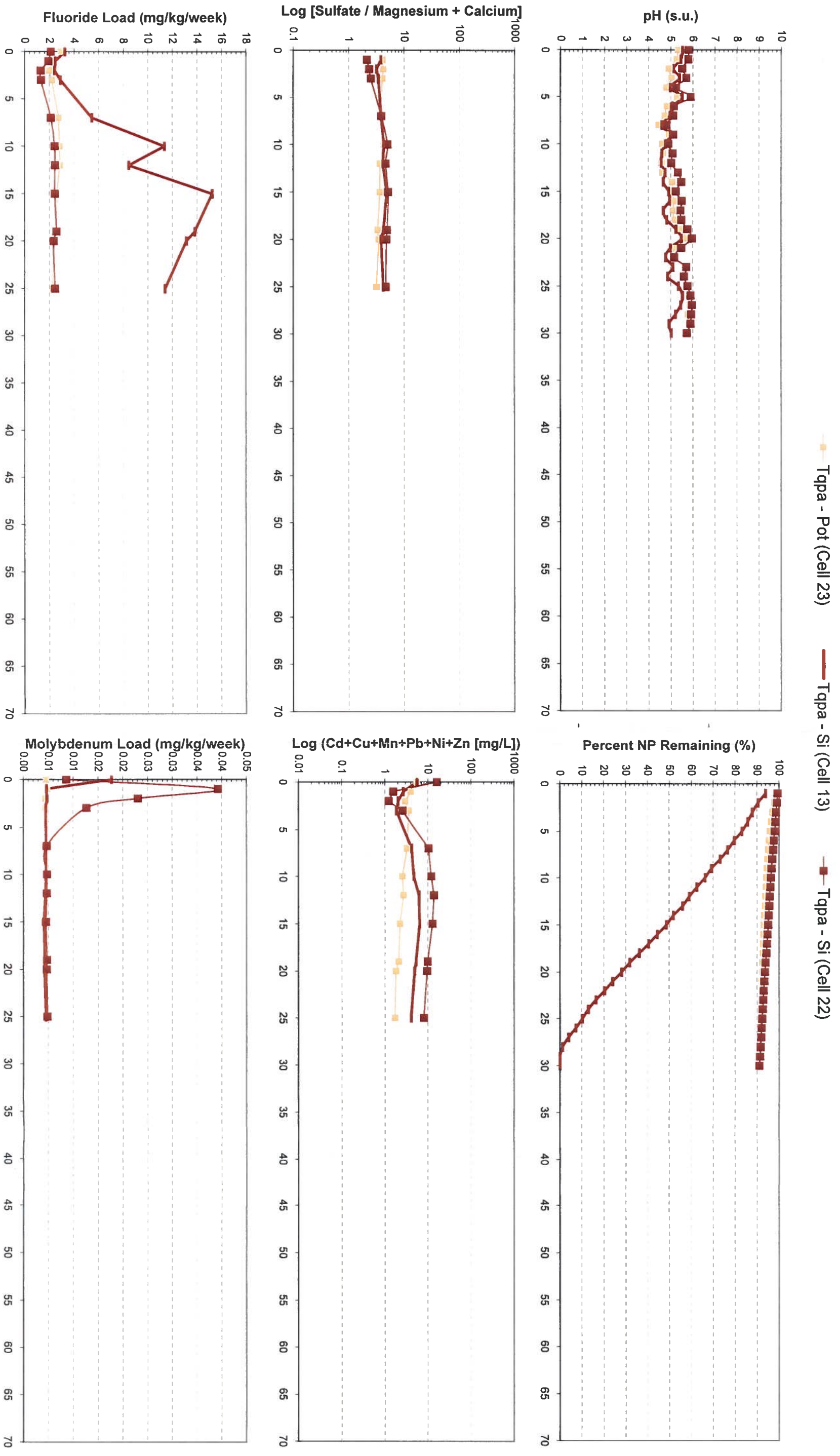
The molar ratio of cations to sulfate for this cell is consistently greater than one (i.e. above gypsum saturation), indicating a surplus of sulfate in solution by comparison to calcium and magnesium. However, there is no significant increase or decrease in the molar ratio over time, further demonstrating the low reactivity of this sample.

7.5.1.2 Silicic Alteration

Both samples of Silicic Intermediate Phase Quartz Porphyry show similar trends. For both cells pH shows very little variation ranging from 4 to 5 s.u, with the lowest values demonstrated by Cell 13. For this cell, the small amount of neutralization potential that was in the sample has been completely consumed by Week 30 indicating very little buffering capacity. This is consistent with the trends in pH and acidity loads for this sample. By contrast, Cell 22 demonstrates active buffering capacity and for this sample there is a trend of slow consumption of available alkalinity.

The trends in the molar ratio of cations to sulfate for both silicically altered samples are consistently greater than one (i.e. above gypsum saturation) throughout the 30 weeks of the HCT, indicating a surplus of sulfate in solution by comparison to calcium and magnesium. However, there is not a significant increase in the molar ratio over time, reflecting the low reactivity of these samples. The release of metals for both cells is moderate (i.e., the sum of metals ranges from 1 to 10 mg/L) and shows a slight increase during the test period. During the first few weeks, molybdenum demonstrates a release related to rinsing of secondary salts for both cells. Thereafter, molybdenum concentrations have been below detection.

Figure 7-1: Intermediate Phase Quartz Porphyry – HCT Trends



7.5.2 Early Phase Quartz Porphyry

Two samples of Early Phase Quartz Porphyry were initially included in the Phase 1 HCT program; one with argillic alteration (Cell 2) and one with potassic alteration (Cell 7). Seven additional samples were included in the Phase 2 HCT program; one with argillic alteration (Cell 17), two with phyllic alteration (Cell 14 and 16), two with potassic alteration (Cell 29 and 30) and two with silicic alteration (Cell 15 and 26). The results for the Early Phase Quartz Porphyry HCTs are summarized in Figure 7-2 and discussed according to alteration type below.

7.5.2.1 Argillic Alteration

Leachate pH for the two samples of Argillic Early Phase Quartz Porphyry is initially mildly neutral and gradually decreases over time. The two argillically altered samples show a slow consumption of neutralization potential and at Week 30 still have greater than 90 percent of the initial NP remaining, indicating active buffering of solution in the cells is occurring. The trends in metals load is low for both argillically altered samples (i.e., the sum of metals is less than 1 mg/L throughout the test). Furthermore, the molar ratio of cations (Mg+Ca) to sulfate are generally below one and decrease over the length of the test, most likely due to weathering of calcite, release of sulfate and silicate minerals and ion exchange reactions attenuating calcium and magnesium in place of sodium in silicate minerals.

7.5.2.2 Phyllic Alteration

Two samples of Phyllic Early Phase Quartz Porphyry show distinctly different trends. The pH for the cell with a greater NP value and non-detectable sulfide (Cell 16) is buffered around 7 s.u. and for Cell 14 is less than 4 s.u. and declines to around 3 s.u. at Week 30. This cell contained significant sulfide minerals and very little buffering content. Consequently, by Week 30, this cell is acidic and all of the initial neutralization potential has been consumed. This is consistent with the trends in low pH, high acidity, and increasing metals loads observed for this sample.

For Cell 16, there is a gradual decline in the amount of available neutralizing potential and at Week 30 about 90 percent of the initial NP is remaining. This cell also demonstrates a very low metals release (less than 1 mg/L) throughout the HCT and the molar ratio of cations to sulfate is less than one and continues to decrease indicating the release of calcium and magnesium from chemical weathering and ion exchange reactions. By comparison, the molar ratio of cations to sulfate for Cell 14 is greater than 10 and continues to increase indicating active sulfide oxidization is occurring.

7.5.2.3 Potassic Alteration

Both Cell 29 and Cell 7 of Potassic Early Phase Quartz Porphyry show similar trends. Leachate pH values for these two samples are initially neutral and gradually decline to less than 5 s.u., with the greatest decline demonstrated by Cell 29. Overall, the pH of Cell 29 is about 1 pH value lower than Cell 7 due to greater sulfide content (0.31 weight percent). This cell also shows the most significant consumption of neutralization potential in comparison to the other two cells and based on the current trend, complete consumption of the initial neutralization potential is predicted to occur at some point in the test. Leachate for Cell 30 is declining but conditions are still neutral with pH values above 5 s.u. At Week 30, this cell

has greater than 80% of the initial neutralization potential remaining and at this stage in the test it is uncertain if conditions in this cell will become acidic.

All three samples show a rapid increase in metals load over the first 25 weeks of the test and then stabilize. For the Phase 1 sample (Cell 7), a spike in metals load is observed toward the end of the test that corresponds to an increase in the molar ratio of cations to sulfate, indicating a late stage pulse of sulfide oxidization. In this cell, increased sulfate concentration, though modest, was associated with increased iron and arsenic concentrations as a result of pyrite and arsenopyrite oxidation. A similar increase in zinc, cadmium and thallium for Cell 7 is attributed to the oxidation of sphalerite (Appendix I).

These oxidation reactions in Cell 7 correspond to an increase in acidity and lowering of pH. Increased acidic conditions would lead to the dissolution of soluble base cation minerals such as gearsutite $[\text{CaAl}(\text{OH},\text{F})_5\cdot\text{H}_2\text{O}]$ and creedite $[\text{Ca}_3\text{Al}_2(\text{SO}_4)(\text{OH})_2\text{F}_8\cdot 2\text{H}_2\text{O}]$, as indicated by released fluoride and aluminum that increases over time and is correlated with a decrease in pH values and an increase in sulfate. Further support for this mechanism comes from numerical modeling, which predicted a change in the SI in solution of creedite from initially saturated to undersaturated throughout the period of column testing.

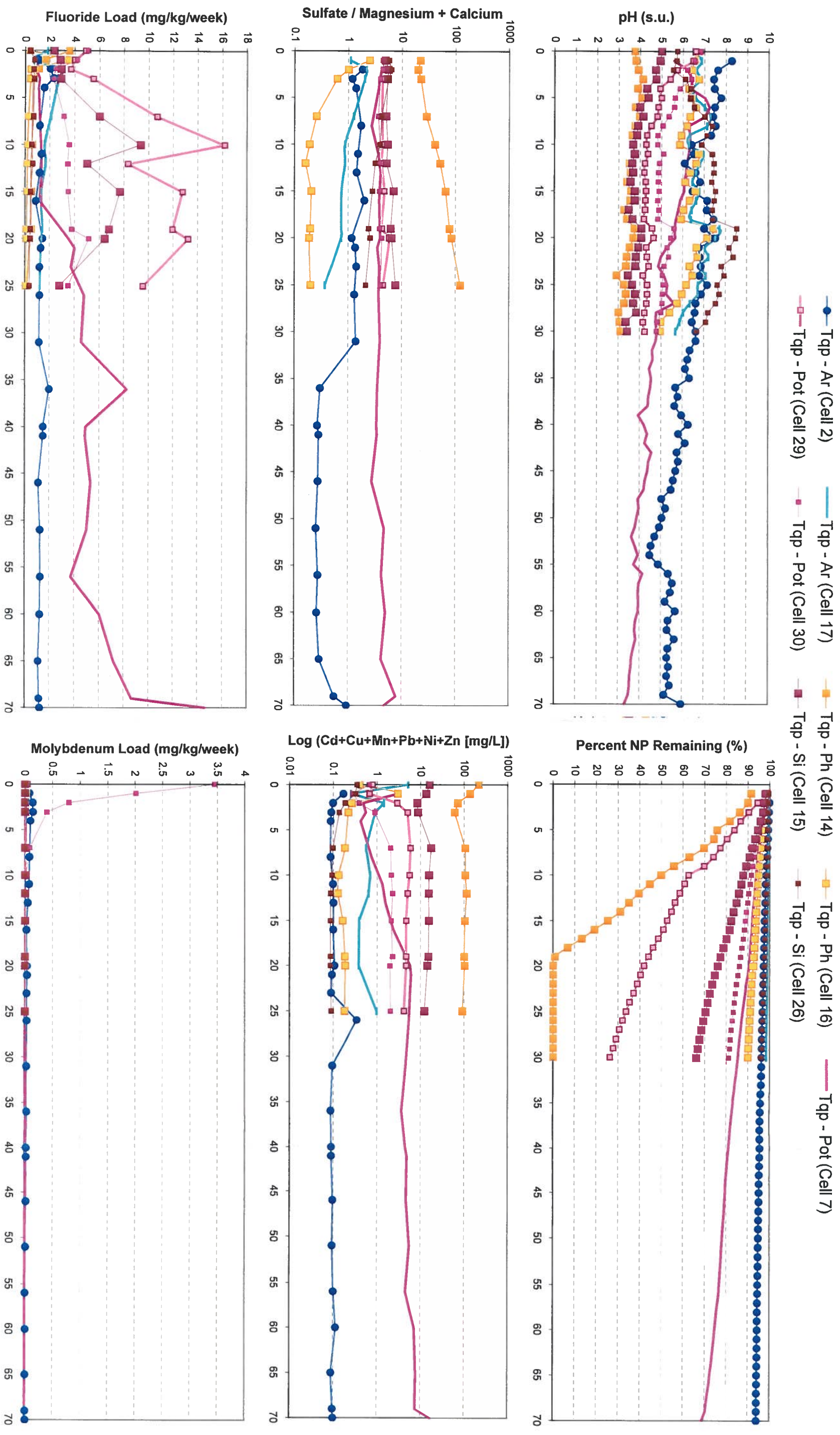
7.5.2.4 Silicic Alteration

Despite having very similar ABA characteristics, the two samples of Silicic Early Phase Quartz Porphyry show different trends in the HCT. The pH for Cell 26 is buffered between 7 s.u. to 8 s.u. and the leachate pH for Cell 15 is initially neutral and gradually declines to below 4 s.u. after Week 8, along with an increase in acidity. Both cells show a gradual decline in the amount of available alkalinity; however, alkalinity is consumed more rapidly in Cell 15 and at Week 30 less than 70 percent of the initial neutralization potential is remaining. The consumption of alkalinity in Cell 26 has been minor (< five percent) to this point in the test.

The molar ratio of cations to sulfate is slightly greater than 1 for Cell 26 but the ratio does not significantly increase or decrease with time, reflecting the overall low reactivity (either acid neutralizing or acid generating) of this sample.

The molar ratio for Cell 15 is greater than 1 and increased over the duration of the test indicating oxidation of sulfide minerals. The oxidation reactions in Cell 15 correspond to an increase in acidity, lowering of pH, moderate levels of sulfate and elevated concentrations of iron, manganese and zinc. Metals load (mainly attributed to manganese) for Cell 15 is significantly greater than that observed for Cell 26 and is generally increasing over time.

Figure 7-2: Early Phase Quartz Porphyry – HCT Trends



7.5.3 Rhyolite Tuff and Flow

Four of the Phase 1 humidity cells contained samples of Rhyolite Tuff and Flow (Cell 1, Cell 3, Cell 4 and Cell 8). All four of these samples contained samples of argillically altered rhyolite. Three additional samples of Rhyolite Tuff were included in the Phase 2 HCT program; one with argillic alteration (Cell 27) and two with phyllic alteration (Cell 25 and 28). The results for the Rhyolite Tuff and Flow HCTs are summarized in Figure 7-3 and discussed according to alteration type below.

7.5.3.1 Argillic Alteration

The results for the Argillic Rhyolite Tuff/Flow can be grouped into three categories; low, moderate and high reactivity.

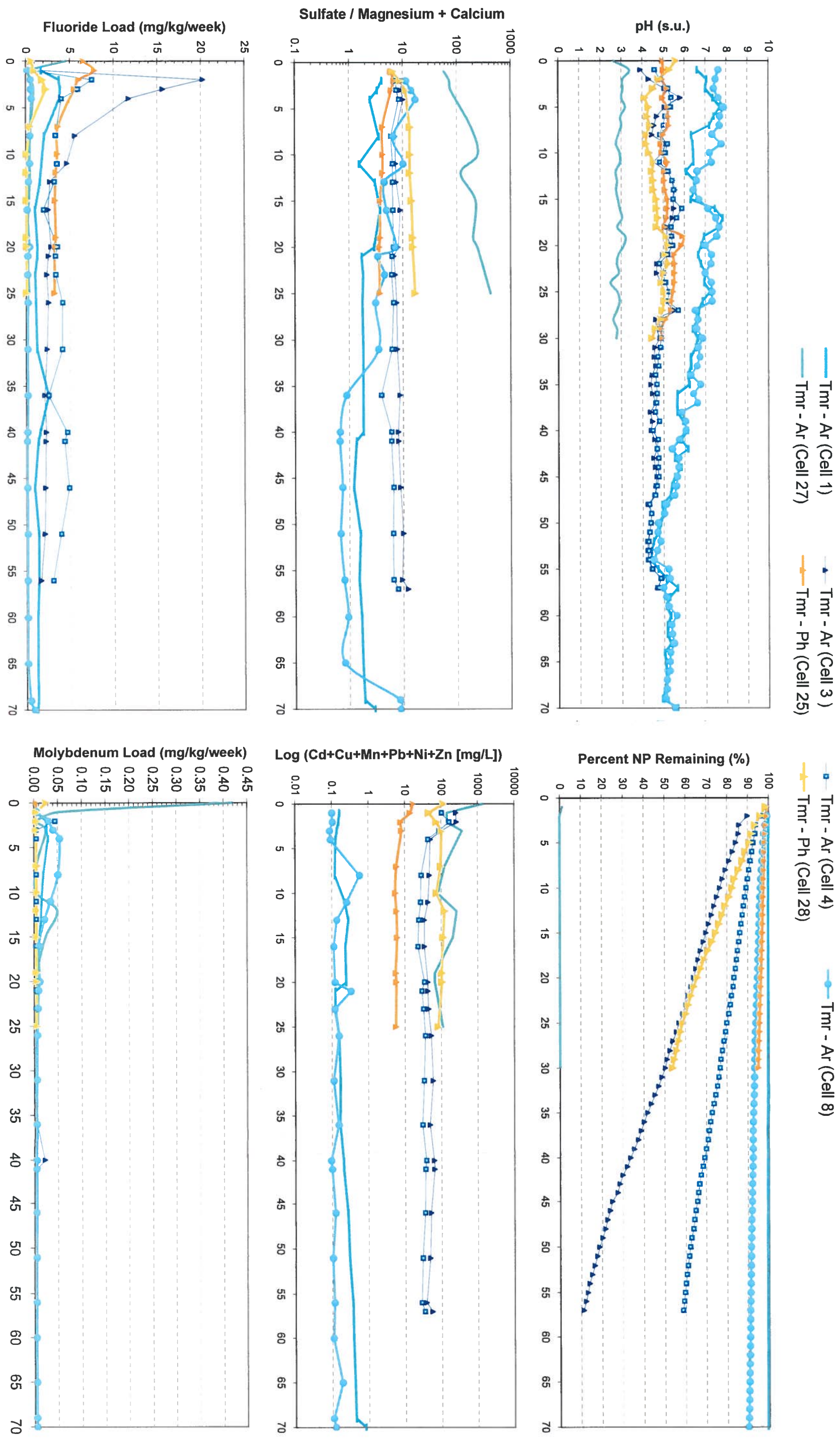
Cells 1 and 8 show nearly identical trends and demonstrate an overall low reactivity during the HCT. Leachate pH values for these cells start high (above 7 s.u.) and show a gradual decline over time finally stabilizing at a pH around 5 s.u. after Week 45. Metals release for these two cells are low with the sum of metals consistently less than 1 mg/L despite the declining pH conditions. The molar ratio of cations to sulfate is initially greater than 1 for both cells, but decreases with time, most likely reflecting release of magnesium and calcium from calcite and silicate minerals undergoing chemical weathering and ion exchange reactions.

Cell 3 and Cell 4 demonstrate moderate reactivity during the HCT with fairly consistent pH values that quickly stabilized between a pH of 4 and 5 s.u. Both of these samples contain between one and 1.5 weight percent sulfide from static tests. During the first few weeks of the test, both samples show an initial flush of metals after which metals release is consistently elevated for the remainder of the test. Metals including cadmium and zinc were high in the leachate and associated with rinsing of alkalinity in the samples during the first couple weeks, presumably due to dissolution of smithsonite with trace concentrations of cadmium in the mineral. No evidence of cadmium carbonate, otavite, was observed in the mineralogy. The molar ratio of cations to sulfate is greater than 1 for both cell and increases slightly during the test, indicating the oxidation of sulfide is occurring, however at a slow rate.

Cell 27 demonstrates significant reactivity and during the HCT, conditions are consistently acidic with pH values around 3 s.u. and elevated acidity loads. This behavior agrees with the ABA characteristics of the pre-HCT solids, which indicated moderate sulfide content (1.2 weight percent) and non-detectable neutralization potential. For this sample, no buffering content was initially available (i.e., non-detect NP). Consequently, the neutralization potential balance in this cell has been zero since the beginning of the test. Furthermore, the molar ratio of cations to sulfate is greater than 100 and continues to increase over time indicating substantial sulfide oxidation is occurring in the absence of any buffering capacity. This is consistent with the low pH and high acidity loads observed for this sample. This sample also demonstrates significant metal release with the sum of metals consistently greater than 100 mg/L.



Figure 7-3: Rhyolite Tuff and Flow – HCT Trends



7.5.3.2 Phyllic Alteration

The two samples of Phyllic Rhyolite Tuff show different trends in the HCT. However, the pH trends are similar with slightly acidic pH values that have been fairly consistent during the 30 weeks of the test and range from 4 to 5 s.u with the lowest pH values demonstrated by the sample with greater sulfide content (Cell 28).

Cell 28 shows a more significant depletion of available alkalinity over time due to greater sulfide content even though the initial neutralization potential for Cell 28 is slightly greater than that observed for Cell 25. At Week 30, less than 60 percent of the neutralization potential is remaining for Cell 28, compared with 95 percent for Cell 25. This trend in neutralization potential consumption indicates active sulfide oxidation is occurring in Cell 28. This is further supported by the molar ratio of cations to sulfate that is greater than 1 and is gradually increasing over time.

Higher pH values and greater buffering capacity is observed for Cell 25 that also shows low very low sulfate, TDS, and metal release throughout the HCT. The difference in chemistry between the two samples of Phyllic Rhyolite Tuff reflect a difference between the reaction rates of the buffering minerals and greater sulfide content observed for Cell 28.

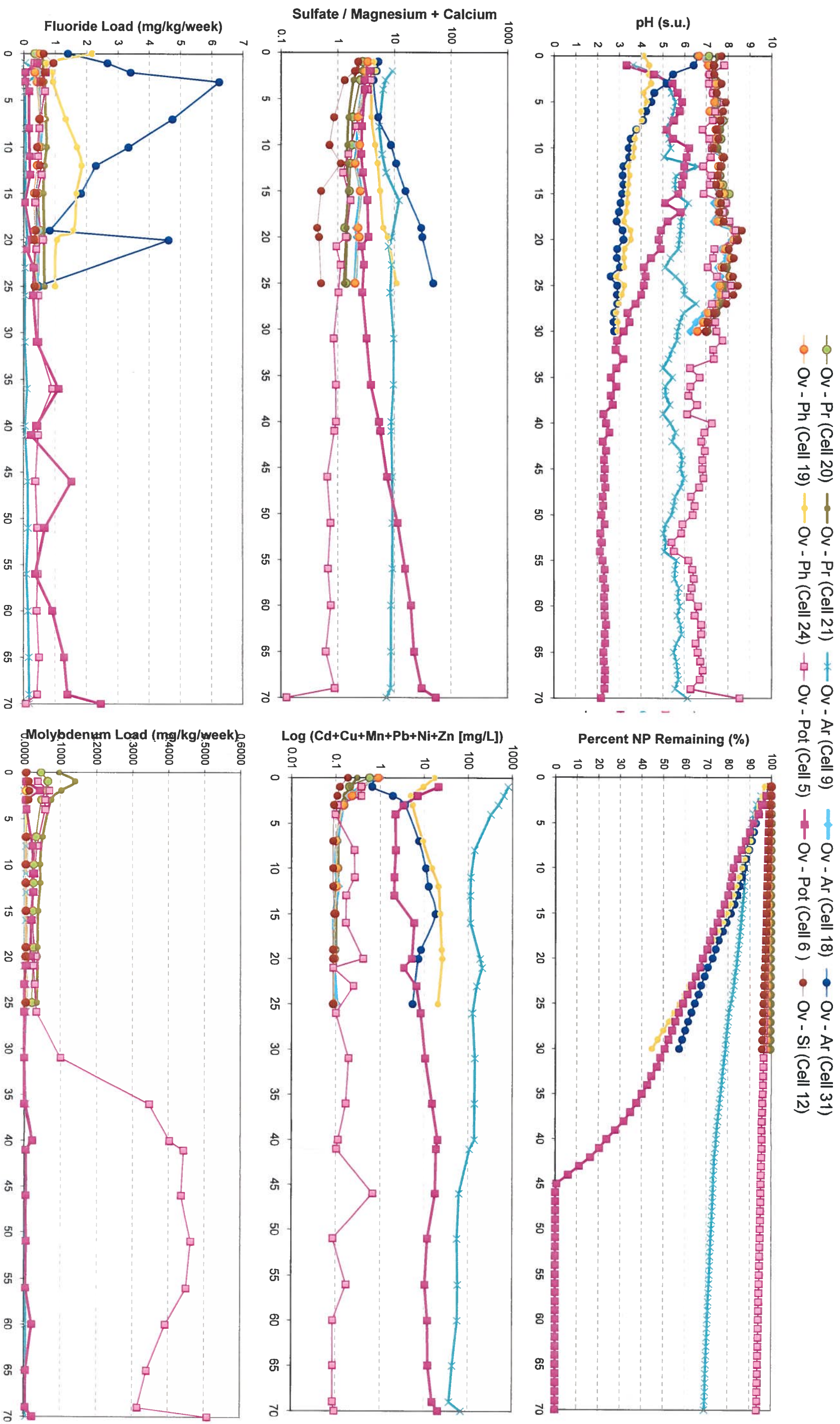
7.5.4 Vinini Sediments

Three samples of Vinini Sediments were included in the Phase 1 HCT program; two of them have undergone potassic alteration (Cell 5 and Cell 6), and the third sample was argillically altered (Cell 9). Seven additional samples of Vinini Sediments were included in the Phase 2 HCT program; two with propylitic alteration (Cell 20 and 21), two with argillic alteration (Cell 18 and 31), two with phyllic alteration (19 and 24), and one with silicic alteration (Cell 12). The results for the Vinini Sediments HCTs are summarized in Figure 7-4 and discussed according to alteration type below.

7.5.4.1 Propylitic Alteration

In the two samples of Propylitic Vinini Sediments (Cell 20 and 21), the pH is buffered around 7 and 8 s.u., and alkalinity loads have remained consistently high. In Week 25, pH values show a slight downward trend, but remained above 7 s.u. This is consistent with ABA tests of the pre-HCT solids which indicate that these samples have NPR values greater than three and NP values greater than 100 eq. kg CaCO₃/ton. For both cells, the trends in the molar ratio of cations to sulfate indicate the ratio is greater than one (i.e. above gypsum saturation) and has gradually decreased throughout the 30 weeks of the HCT, reflecting the low reactivity of these samples. TDS concentrations and sulfate release are also low, although moderate concentrations of arsenic and manganese are mobile under the high pH conditions.

Figure 7-4: Viniini Sediments – HCT Trends



7.5.4.2 Argillic Alteration

The three samples of Argillic Vinini Sediments each show distinctly different trends during the HCT.

Cell 9 shows little variation in pH throughout the period of testing, with pH buffered by calcite and clay minerals after the initial flushing of iron sulfate salts which were formed through oxidation of pyrite. The one percent calcite content and abundant goethite in this sample buffer pH in the range of 5 to 6 s.u. Cell 18 is buffered higher around 7 and 8 s.u., and alkalinity has remained consistently high.

Both Cell 18 and Cell 9 demonstrate active buffering capacity throughout the HCT and greater than 70 percent of the initial neutralization potential remains for Cell 9 and greater than 90 percent remains for Cell 18 at Week 30. This reflects the relatively high carbonate content of these samples, which contain calcite, ankerite, and siderite and minor sulfide content. Although the ratio of cations to sulfate is greater than one for both samples, there is a general decrease in the ratio over time, reflecting a release of magnesium and calcium from calcite and silicate minerals undergoing chemical weathering and ion exchange reactions.

By contrast, leachate pH values for Cell 31 decrease rapidly to less than 3 s.u during the first 20 weeks of testing along with an increase in the release of acidity and metal release throughout the test. The molar ratio of cations to sulfate is greater than 1 and rapidly increase throughout the HCT indicating active oxidation of sulfide is occurring. This is further supported by a rapid decrease in the amount of available alkalinity. By Week 30 less than 60 percent of the initial neutralization potential is remaining. The ABA results for Cell 31 predict potential acid generation with NPR values less than 1.2.

The initial flush of soluble salts was absent for Cell 31, and metal constituents have increased over time in response to active sulfide oxidation. The low pH conditions of the cell have attenuated those constituents that are mobile under high pH conditions (e.g., oxyanions such as arsenic and antimony). However, a small, short-lived release of oxyanions was observed during the first two weeks of the HCT before pH conditions dropped below 5 s.u.

7.5.4.3 Phyllic Alteration

The two samples of Phyllic Vinini Sediments (Cell 24 and Cell 19) show distinctly different trends primarily due to differences in sulfide content.

Trends for Cell 19 are similar to those observed for the Propylitic Vinini Sediments, with pH buffered around 7 to 8 s.u., high alkalinity load and low metals release. At Week 30, greater than 90 percent of the initial neutralization potential is remaining for this cell.

The ABA results for Cell 24 indicate potential acid generation with NPR values less than 1.2 and sulfide content of 1.2 weight percent. The HCT results are consistent with the ABA prediction and indicate sulfide oxidation is occurring in Cell 24 under acidic conditions. This is supported by leachate pH values for Cell 24 that decrease rapidly and are less than 3 s.u. at Week 30. This sample shows a significant release of acidity and metals including aluminum, copper, iron, manganese, and zinc. These constituents are increasing over time in

response to active sulfide oxidation. Based on the current trend of neutralization potential depletion, complete consumption of the initial neutralization potential is likely to occur.

7.5.4.4 Potassic Alteration

The two Potassic Vinini Sediments samples (Cell 5 and 6) showed two distinctly different trends.

The pH for Cell 6 shows a steady decline and stabilizes at Week 60, around an acidic pH value less than 3 s.u. The higher sulfide content (i.e., 9.3 weight percent) measured in this sample resulted in a rapid depletion of alkalinity, so that there is a zero neutralization potential balance by Week 46. Cell 6 showed an initial flushing of iron sulfate salts that formed through the oxidation of pyrite, followed by a brief period of stabilization and then a gradual climb toward the end of the test indicating mid- to late- stage oxidation of sulfides under acidic conditions. Coincident with an increase of sulfate and acidity was an increase in the leachate concentration of arsenic, antimony, cadmium, copper, iron, nickel, lead, and thallium. As in other cells, the widespread presence of creedite and gearsutite results in aluminum and fluoride release in response to increased acidity from sulfide oxidation.

By contrast, Cell 5 remains buffered above 6 s.u. for the majority of the test and shows an overall low reactivity with a very low level of metals release throughout the test. The active buffering capacity is further demonstrated by the very slow decrease in available neutralization potential. At the end of the test, greater than 90 percent of the initial neutralization potential is remaining. This reflects the relatively high carbonate content of this sample, which contains calcite, ankerite, and siderite. Sulfide content is low in this sample, despite the fact that the sample hosted near ore grade molybdenum concentrations indicating the main sulfide present in the sample is molybdenite. This is confirmed by mineralogy.

7.5.4.5 Silicic Alteration

The trends for the one sample of Silicic Vinini Sediments (Cell 12) are similar to those observed for the Propylitic Vinini Sediments, with pH buffered around 7 to 8 s.u., high alkalinity load and low metals release. This cell demonstrates active buffering capacity throughout the HCT and greater than 90 percent of the initial neutralization potential remains at Week 30. This is consistent with ABA tests of the pre-HCT solids which indicate this sample is acid neutralizing with an NPR value greater than three.

Furthermore, the molar ratio of cations to sulfate in Cell 12 started out above one and rapidly decreased to below one, indicating an increase in magnesium and calcium concentration, most likely due to weathering of calcite and silicate minerals undergoing chemical weathering and ion exchange reactions.

7.6 Comparison of Static Test Results to HCT Results

By comparing the static test results to the corresponding HCT results, the effectiveness of the simpler static tests in predicting longer term behavior can be assessed (Table 7-6). This comparison can also clarify the behavior of materials that are indicted by the more conservative static tests to fall within the zone of uncertain behavior, or materials with a wide range of static test results.

Acid Base Accounting provides a conservative measure of the maximum potential acid generation for a given material, at the point in time the test is run. By comparison, kinetic testing provides an estimate of reactivity for materials exposed to oxidation and leaching stress over time. Minerals assumed to be reactive in an Acid Base Accounting test may not react at all in a leach test, due to a variety of factors that affect reaction rates. Despite this, the results of the HCT tests to date are reasonably consistent with the prediction of acid generation based on ABA and NAG results as shown in Table 7-6 with the following exceptions:

- For Cell 19 and Cell 26, the HCT results are in disagreement with both the NAG and ABA results. However, MWMP test seems to be a good indicator that these samples will not leach significant metals as confirmed by the HCT results; and
- For Cell 9 and Cell 30, HCT results agree with the NAG results that predict non-acid generation; the ABA results, however, predict these samples will become acidic.

Of these, only Cell 9 was part of Phase 1 testing for which testing is complete. The other cells are at Week 30 and the kinetic testing is still in progress. Samples that were predicted to be acid generating from ABA results, which are not currently acid generating (Cell 19, Cell 26 and Cell 30), could become acidic as the test progresses and additional neutralization potential is consumed. However, both Cell 19 and Cell 26 showed significant buffering potential and high pH values in Week 30 and the potential for these cells to become acidic is low. Cell 30 has a greater chance of becoming acidic, which is consistent with the geochemical properties of the material type (Potassic Early Phase Quartz Porphyry).

The MWMP is intended to predict potential leachate chemistry from a mine waste when it is flushed with meteoric water simulating typical Great Basin rain storm conditions (NDEP, 1990). This differs from humidity cell tests, which are designed to predict constituent release from weathered rock over a prolonged period of leaching, rather than in a single, extreme storm event. The MWMP test dissolves available mineral salts, while the HCT promotes actual salt formation through ongoing oxidation, dissolution, and desorption reactions. Comparison of the MWMP test results and the HCT results shows a generally consistent set of constituents that are liberated at concentrations above the NDEP comparative values (Table 7-6). However, the HCT tests released more constituents at higher concentrations than the MWMP tests (Figure 7.16). This reflects the impact of prolonged weathering of the mineral assemblage in the kinetic tests.

Table 7-6: Results of Humidity Cell Testing and Static Tests

Cell #	Material Type	Acid Generation Prediction from ABA ¹	Net Acid Generation Test Prediction ²	Acid Generation Prediction from HCT	MWMP Constituents Above NDEP Values	HCT Constituents Above NDEP Values
1	Tmr – Ar	uncertain	NAG	NAG	None Elevated	pH
2	Tqp – Ar	NAG	NAG	NAG	None Elevated	None Elevated
3	Tmr – Ar	PAG	PAG	PAG	Al, Cd, Cu, F, Fe, Pb, Mn, Ni, pH, SO ₄ , Ti, Zn	Al, As, Cd, F, Mn, Ni, pH, SO ₄ , Ti, Zn
4	Tmr – Ar	PAG	PAG	PAG	Mn, pH, Zn	pH, Al, Mn, Zn
5	Ov – Pot	NAG	NAG	NAG	None Elevated	None Elevated
6	Ov – Pot	PAG	PAG	PAG	Al, As, Cd, Cu, Fe, Pb, Mn, Ni, pH, SO ₄ , Ti, Zn	Al, As, Sb, Cd, Cu, Fe, Mn, Ni, pH, SO ₄ , Ti, Zn
7	Tqp - Pot	PAG	PAG	PAG	Mn	Al, As, Cd, Cu, Fe, pH,
8	Tfr – Ar	NAG	NAG	NAG	None Elevated	pH
9	Ov – Ar	PAG	NAG	NAG	Al, Cd, Cu, Fe, Pb, Mn, Ni, pH, SO ₄ , Ti, Zn	Al, As, Cd, F, Mn, Ni, pH, SO ₄ , Zn
12	Ov – Si	NAG	uncertain	NAG	None Elevated	As
13	Tqpa - Si	PAG	PAG	PAG	Al, Cd, F, Mn	Al, Cd, F, Mn, pH
14	Tqp – Ph	PAG	PAG	PAG	Al, Cd, Cu, Fe, Pb, Mn, Ni, Ti, Zn	Al, Cd, Cu, F, Fe, Pb, Mn, Ni, pH, Sulfate, Ti, TDS, Zn
15	Tqp – Si	PAG	PAG	PAG	None Elevated	Al, As, Cd, Cu, F, Fe, Pb, Mn, pH, Zn
16	Tqp – Ph	NAG	NAG	NAG	None Elevated	Cd, F, Mn
17	Tqp – Ar	NAG	NAG	NAG	F, Mn	F, Mn
18	Ov – Ar	uncertain	NAG	NAG	Mn	Mn
19	Ov – Ph	PAG	PAG	NAG	None Elevated	Mn
20	Ov – Pr	NAG	NAG	NAG	None Elevated	As, Mn
21	Ov - Pr	NAG	NAG	NAG	Mn	As, Mn
22	Tqpa - Si	uncertain	NAG	NAG	None Elevated	Al, Cd, F, Mn, Zn
23	Tqpa - Pot	uncertain	NAG	NAG	None Elevated	Al, F, Fe, Mn, pH
24	Ov - Ph	PAG	PAG	PAG	Al, Be, Cd, Fe, Pb, Mn, Ni, Sulfate	Al, Be, Cd, Cu, Fe, Pb, Mn, Ni, pH, Sulfate, TDS, Zn
25	Tmr - Ph	uncertain	NAG	NAG	Al, F, Mn	Al, F, Mn, pH, Ti, Zn
26	Tqp - Si	PAG	uncertain	NAG	None Elevated	Mn
27	Tmr - Ar	PAG	PAG	PAG	Al, Sb, Be, Cd, Cu, F, Pb, Mn, Ni, Se, Sulfate, Ti, TDS, Zn	Al, As, Be, Cd, Cu, F, Fe, Pb, Mn, Ni, pH, Se, Sulfate, Ti, TDS, Zn
28	Tmr - Ph	PAG	PAG	PAG	Cd, Mn, Ni, Ti, Zn	Al, Cd, Pb, Mn, Ni, pH, Sulfate, Ti, TDS, Zn
29	Tqp - Pot	PAG	PAG	PAG	F, Mn	Al, Cd, F, Pb, Mn, pH
30	Tqp - Pot	PAG	NAG	NAG	Al, F, Mn	Al, F, Mn, pH
31	Ov - Ar	PAG	PAG	PAG	Cd	Al, Be, Cd, Cu, F, Fe, Pb, Mn, Ni, pH, Ti

NAG = non-acid generating

PAG = potentially acid generating

¹ Criteria used for this assessment is provided in Table 6-2.

² Criteria used for this assessment is provided in Table 6-4.

A graphical comparison of static test data and the corresponding HCT data reveals that total sulfur is a sensitive indicator of metal leaching and acid generation potential and is a reliable diagnostic parameter in determining the geochemical characteristics of waste rock for the Mount Hope system. This relationship is demonstrated by Figure 7-5 where total sulfur is plotted versus the average HCT pH value. Samples with an average HCT pH greater than or equal to 5 s.u. are considered non-acid generating, since the equilibrium pH for feldspar and goethite minerals with water is 5 s.u. Figure 7-5 shows that samples containing less than 0.3 weight percent total sulfur consistently demonstrate non-acid behavior in the HCTs with an average pH value greater than 5 s.u., and the samples containing greater than 0.5 weight percent have the lowest corresponding average HCT pH values (i.e., less than 4 s.u.). These graphs confirm static test results that indicate total sulfur can be used to discriminate between acid generating and non-acid generating waste. This is confirmed by Figure 7-6 and 7-7, where total sulfur is plotted against average HCT acidity load and percent neutralization potential remaining at the end of the HCT, respectively.

For samples containing less than 0.3 weight percent total sulfur, the average acidity load in the HCT is low (i.e., generally less than 10 mg/kg/week) and at the end of the HCT, greater than 80 percent of the initial neutralizing potential is remaining for these cells. For samples with total sulfur greater than 0.5 weight percent, the average acidity load generally increases with increasing total sulfur content. There are some exceptions to this for samples that contain some neutralizing potential (Figure 7-6).

Figure 7-5: Total Sulfur vs. Average HCT pH

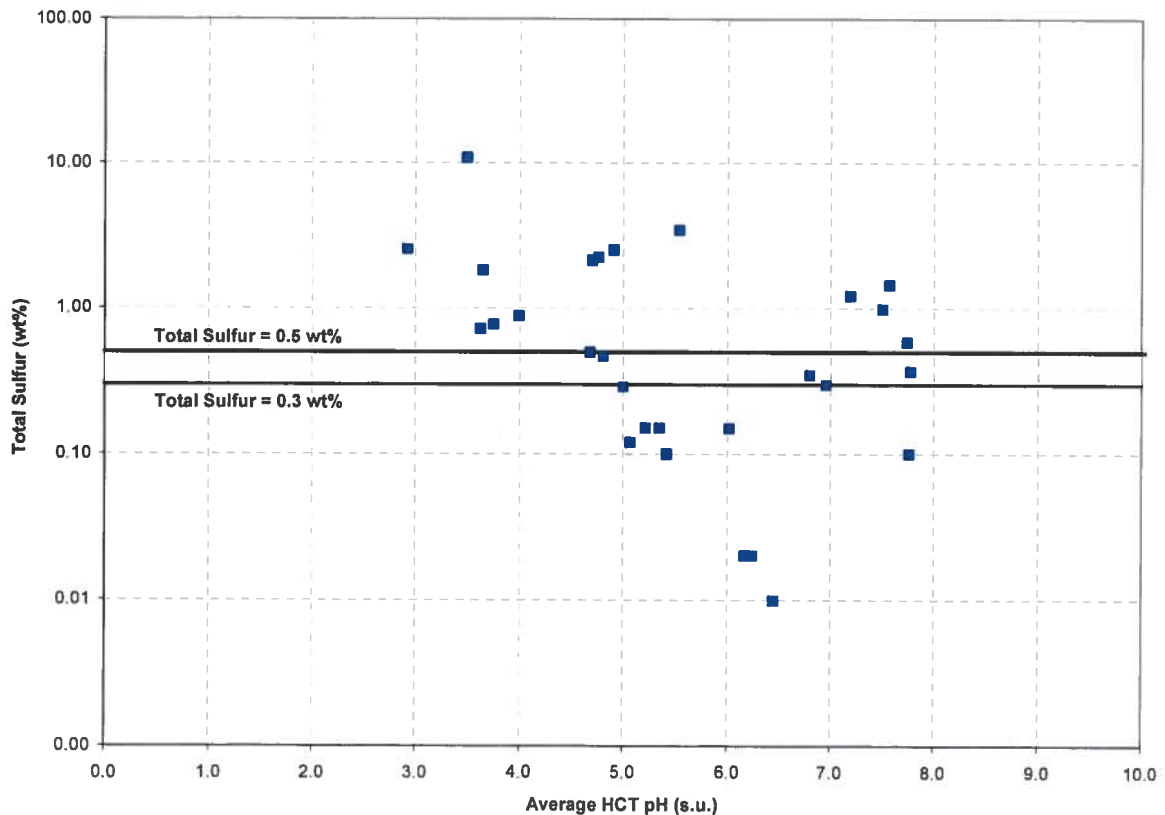


Figure 7-6: Total Sulfur vs. Average Acidity Load

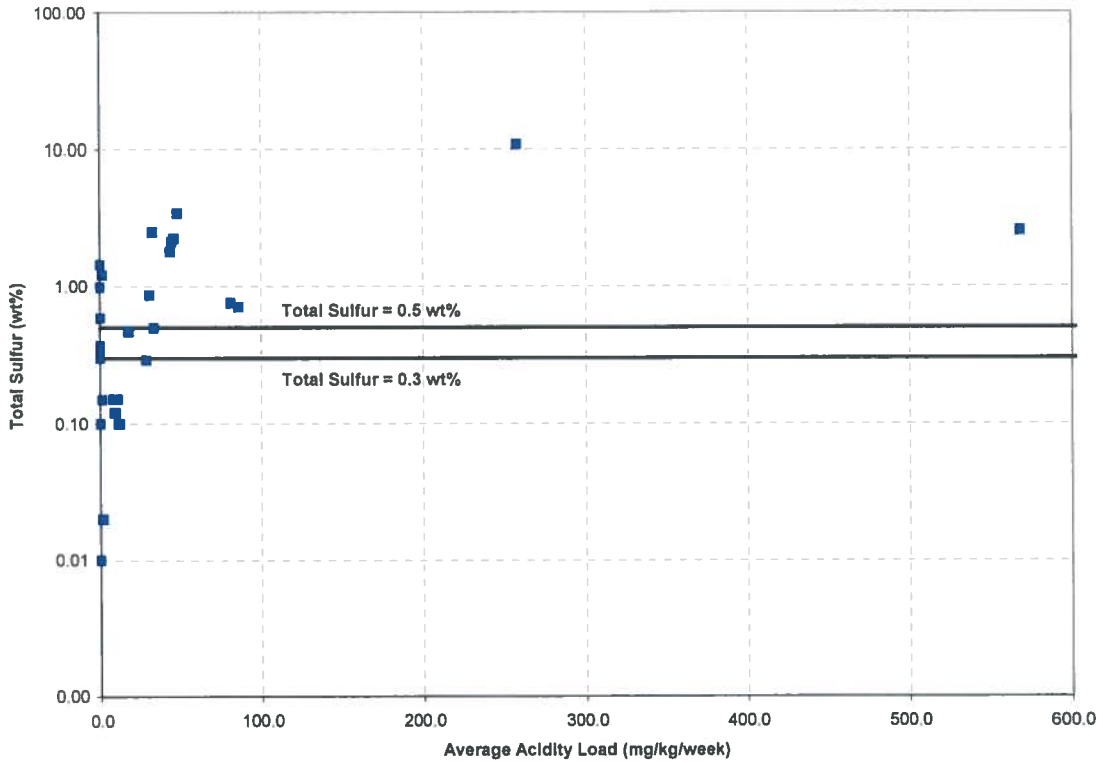
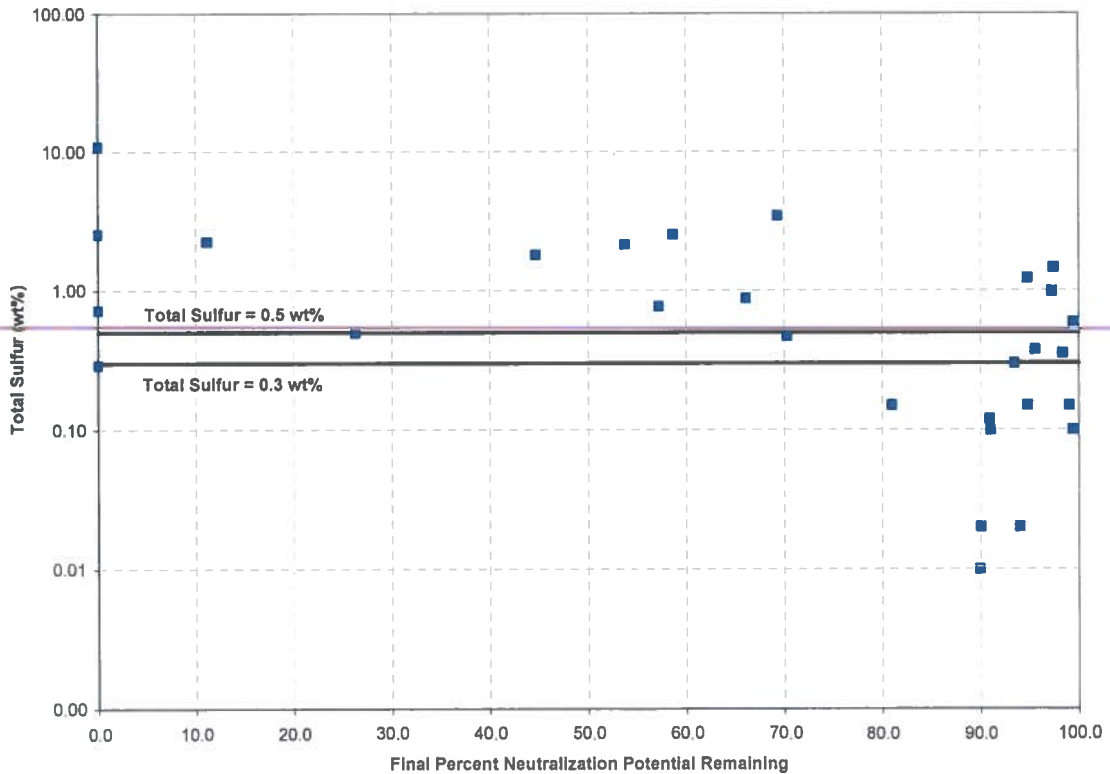


Figure 7-7: Total Sulfur vs. Final Percent NP Remaining



The data also indicates the NPR value is a useful indicator of acid generation, which takes into account the presence of both acid generating and acid neutralizing minerals. In Figure 7-8, the NPR ratio is compared to the average pH value from the HCTs. From this comparison, it can be observed that all of the samples with NPR values greater than 1.2 have average pH values greater than 5 s.u. (i.e., non-acid). These results confirm that the NPR criteria of 1.2 is an appropriate threshold in determining if a material has the potential to be acid generating. However, the difficulty in using ABA to predict acid generating potential for low-sulfide-low carbonate systems is illustrated by four samples for which the ABA results predict acid generation (i.e., NPR less than 1.2) and the HCT results predict net neutralizing conditions (i.e., pH greater than 5 s.u.). A similar relationship is observed in Figure 7-9, where the NPR values are plotted against the final neutralization potential remaining at the end of the HCT. As shown in Figure 7-9, all samples with NPR values greater than 1.2 demonstrate significant neutralization potential and at the end of the HCT still have greater than 90% of the initial neutralization potential remaining.

Figure 7-8 NPR vs. Average HCT pH

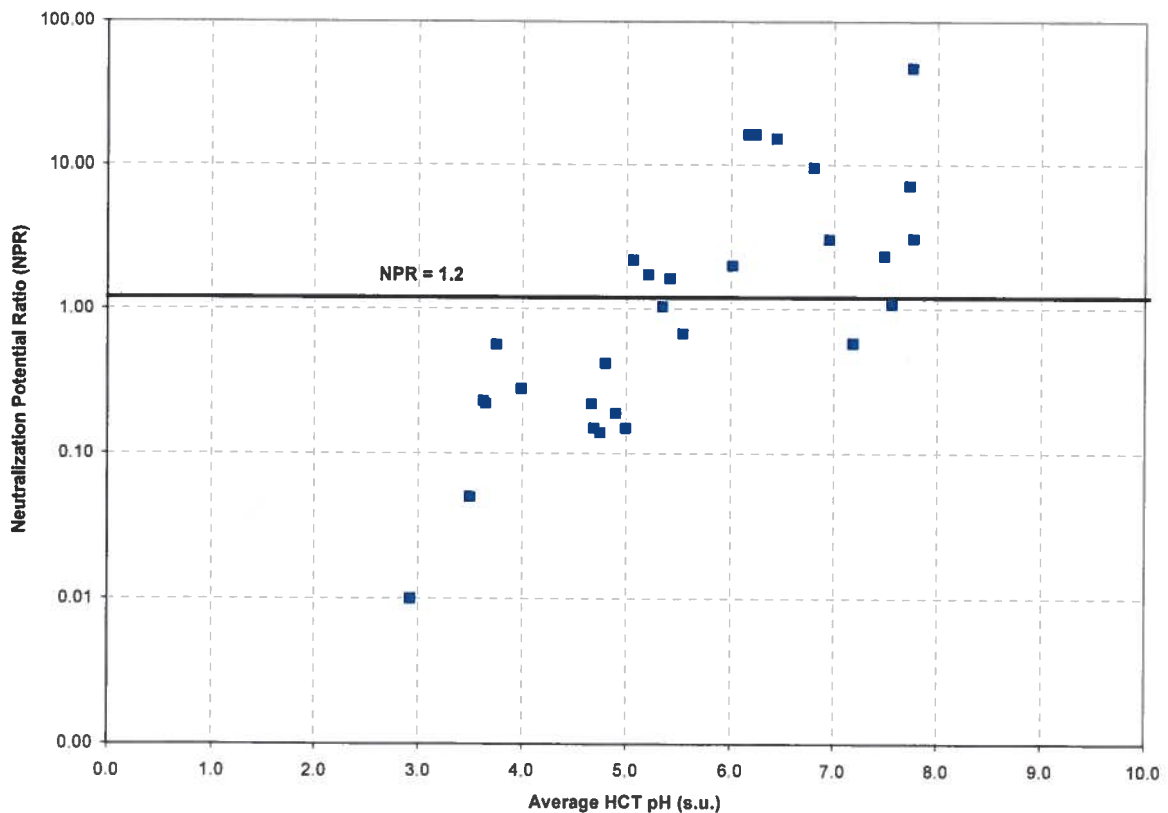
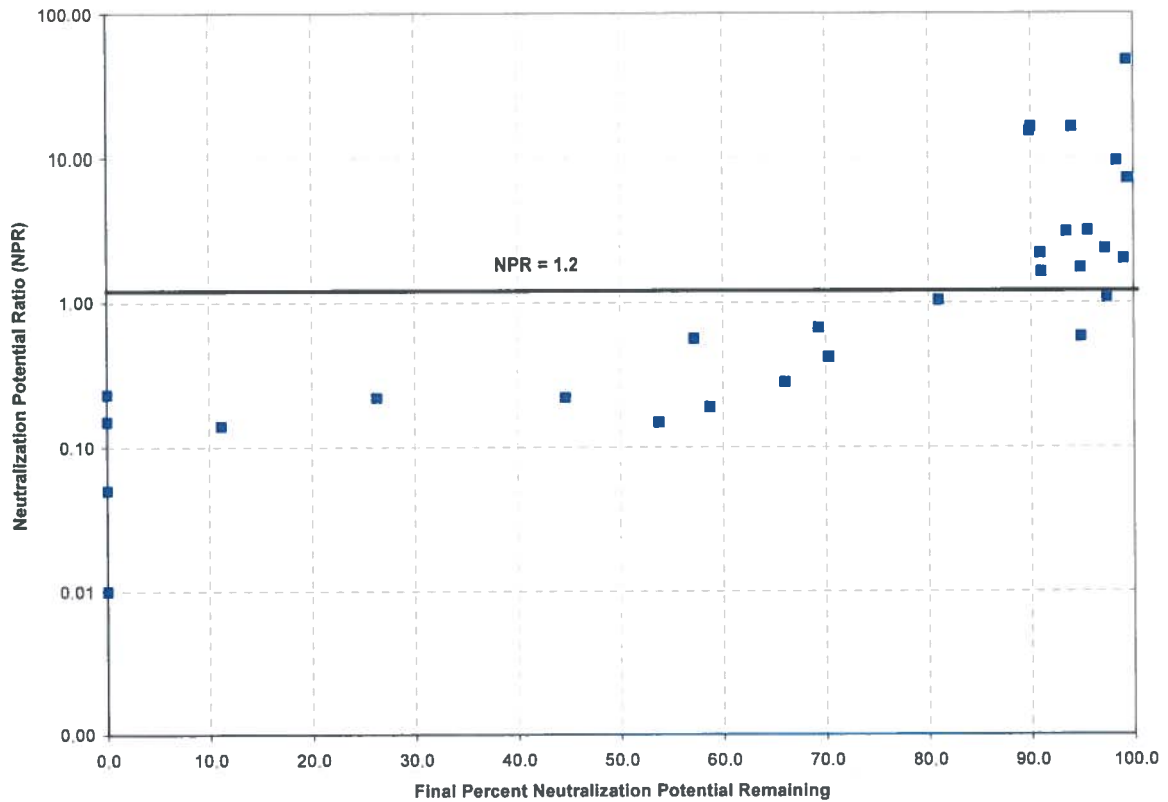


Figure 7-9: NPR vs. Final Percent NP Remaining



Figures 7-10 and 7-11 demonstrate the effectiveness of using NAG to determine the acid generating potential of waste material. Figure 7-10 shows NAG values plotted versus the average HCT pH values and Figure 7-11 shows NAG values plotted versus the percent neutralization potential remaining at the end of the HCT. In Figures 7-10 and 7-11, there is a clear distinction in the acid generating potential of samples based on a NAG criteria of 10 eq. kg H₂SO₄/ton. Samples containing greater than 10 eq. kg H₂SO₄/ton, correspond to average HCT pH values less than 5 s.u. By contrast, pH values for all samples containing less than 10 eq. kg H₂SO₄/ton are greater than 5 s.u. and at the end of the HCT, these samples still contain a significant percentage of the initial neutralization potential (i.e., typically greater than 80%).

Figure 7-10: NAG vs. Average HCT pH

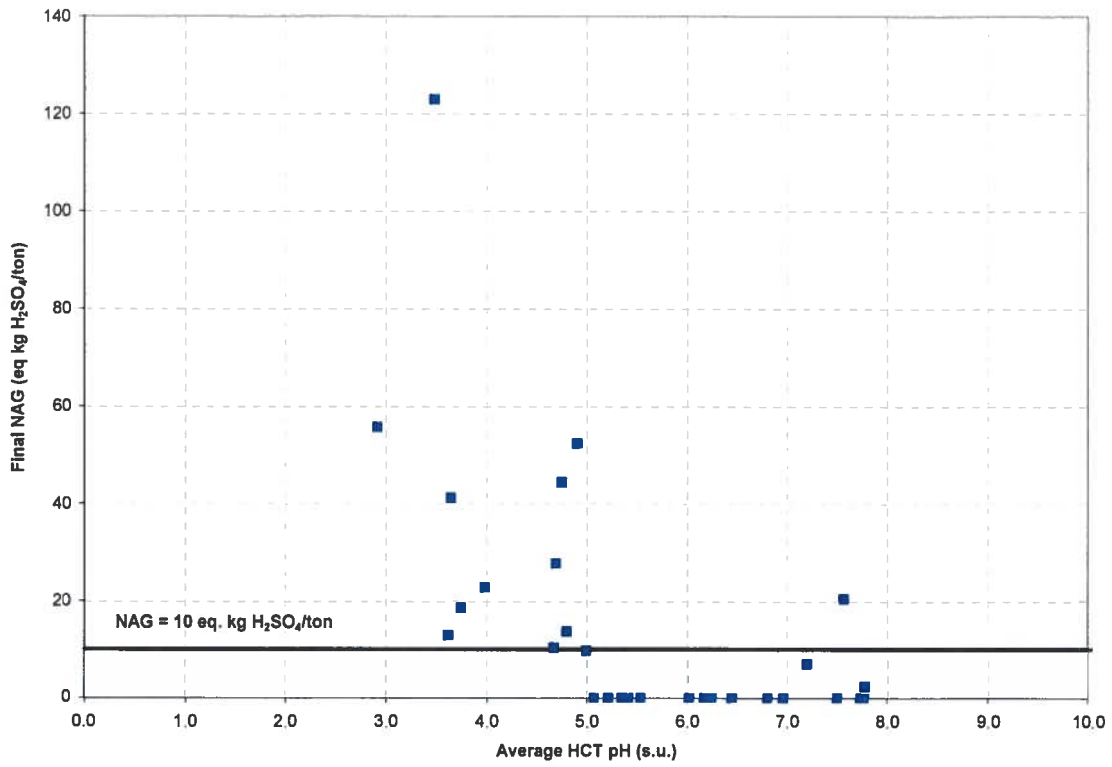
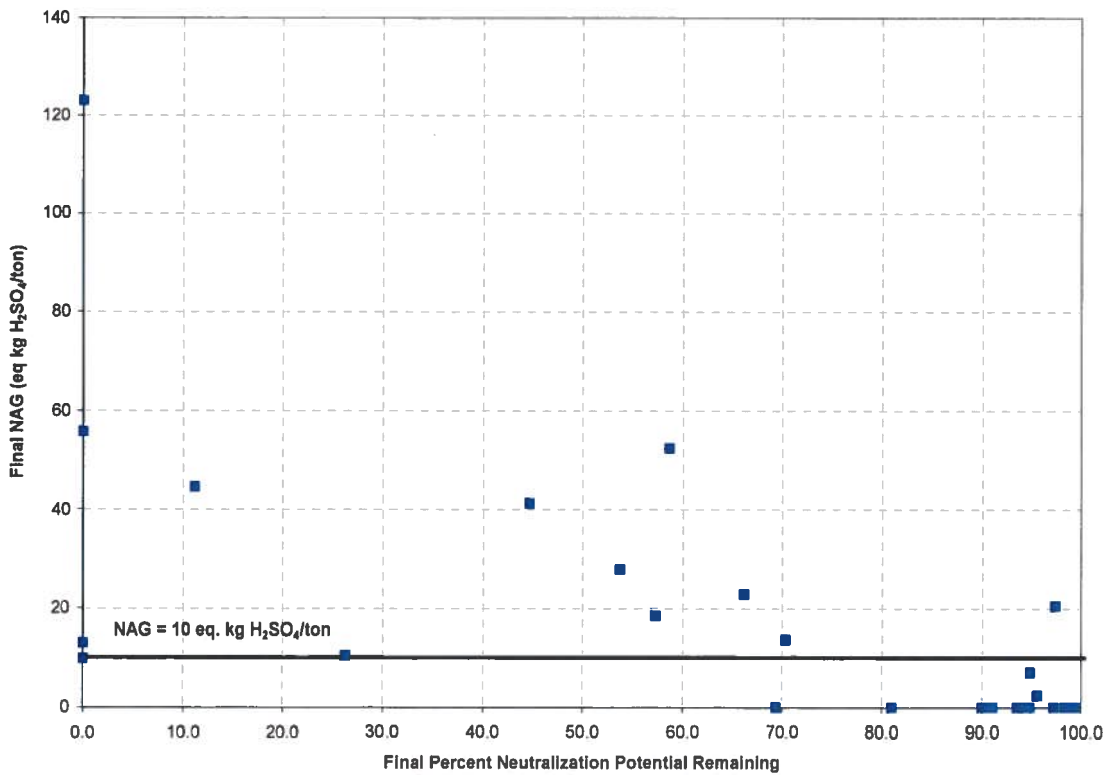


Figure 7-11: NAG vs. Final Percent Neutralization Potential Remaining



7.7 Phase 1 HCT Termination Test Results

The intent of a humidity cell test is to predict the rate of sulfide oxidation and leaching of constituents from a mine waste. The test should be continued until all likely mineral reactions that can be predicted from mineralogy or static testing have been observed, and steady state chemistries are measured in effluent.

Termination test results for Phase 1 humidity cells are provided in Appendix J and summarized below. After 55 or 69 weeks, the data indicated that steady-state conditions had been attained and the cells were terminated following approval from the BLM.

In order to determine the level of reactivity in the cells during the test, a series of termination tests were completed on the HCT residue material to measure changes in mineralogy, mass of key elements, and acid generation potential. As part of this testing, mineral speciation of remaining metals, metalloids and sulfur was identified using mineralogical assessment and a selective extraction procedure (modified from Tessier and others 1979; Bowell, 1994; and Hall, 1999).

Following the final rinse, the columns were dismantled and the test residues were homogenized and split into sub-samples. These HCT residue samples were submitted for the following tests:

- Mineralogy by SEM and XRD analysis;
- Selective extraction according to the method described in Section 4.2.3.1;
- ABA including sulfur speciation by LECO analysis; and
- Whole rock analysis by a four-acid digest (i.e., Chemex ME-MS61).

7.7.1 Mineralogy of HCT Residues

7.7.1.1 Early Phase Quartz Porphyry

The mineralogical analysis of the HCT residues for Early Phase Quartz Porphyry showed very little changes in the macro-mineralogy of the leached rock. The only observed difference by XRD was the loss of carbonate minerals in the cells and the added presence of anhydrite, goethite and gypsum. In polished section exposed pyrite and sphalerite showed partial dissolution and replacement of sulfide by secondary minerals, mainly goethite.

7.7.1.2 Rhyolite Tuff and Flow

In the Rhyolite Tuff HCT cell residues, the only mineralogical difference observed in XRD traces was increased gypsum. Due to the dominance of quartz, it is difficult to determine any other mineralogical changes in HCT residue.

7.7.1.3 Vinini Sediments

The samples of Vinini Sediments show a loss of carbonate minerals and increased illite and gypsum content in the residues relative to the initial analysis of the sample material. In polished section, material from Cell 6 showed no free sulfide. Pyrite, sphalerite and galena are present in the samples of Vinini Sediments but are typically encapsulated in quartz.

7.7.2 Sequential Extraction Assessment

A sequential extraction sequence test was used to assess the mineralogical hosts for the metals of interest in the HCT residues. The mineral hosts for the elements of concern occur in small amounts (less than one percent of the total mass), making it very difficult to measure changes by XRD. Of the total mass of regulated constituents in the HCT samples, only a small portion is mobile. At such low concentrations, it is difficult to speciate minerals through instrumental analysis, and if they are very fine grained, they may be missed in mineralogical studies. Sequential extraction offers a useful alternative under these circumstances. The sequential extraction method is described in Section 4.2.3.1. The extraction steps target specific mineral species, as described below:

- **Water soluble fraction** is released by leaching with de-ionized water. This fraction should include any secondary halide or soluble sulfate phases;
- **Exchangeable fraction** is extracted by leaching with magnesium chloride. This fraction should release any adsorbed constituents from mineral species;
- **Strongly adsorbed fraction** is released using sodium pyrophosphate. This fraction should release any elements still held in adsorption bonds with iron-manganese oxyhydroxides or clays;
- **Carbonate mineral fraction** is extracted using a weak hydrochloric acid solution. This fraction also includes manganese oxides and some amorphous iron oxyhydroxides;
- **Amorphous iron oxyhydroxides** are released by leaching with ammonium oxalate. This dissolves any remaining poorly crystallized secondary minerals, such as ferrihydrite, jarosite, and schwertmannite;
- **Crystalline iron-aluminum oxides** are released by stronger citrate-bicarbonate solution. This extraction proceeds extremely slowly, due to the stability of these minerals under ambient conditions;
- **Sulfides** are released by dissolution with strong nitric acid solution. This should dissolve any organic matter (although this fraction is negligible at Mound Hope) and any sulfide minerals or partially weathered pyrite in the sample; and
- **Residual portion** is the difference between the sum of the above and the total whole rock concentration.

In Appendix J, the results of the sequential extraction test are shown as a percentage of the total constituent present (based on the original whole rock analysis). The potentially mobile components will be held in the water soluble, exchangeable, strongly adsorbed, carbonate and amorphous ferric oxyhydroxides mineral fractions and possibly the sulfide mineral fraction. However, based on humidity cell tests this last fraction appears to take a lot longer to be released than more reactive mineral species in the humidity cells. These species are either immediately soluble or react readily with mildly acidic to alkaline, oxidizing fluids through dissolution or desorption reactions. The results of the sequential extraction are discussed in the following sections for each of the main lithotypes.

7.7.2.1 Early Phase Quartz Porphyry

In Cell 2, more than 80 percent of the elements are held in the residual component that is unlikely to be leached. For aluminum, barium, iron, and zinc, more than 90 percent of the total mass is held in the residual fraction. The sulfide-bound portion is important for arsenic, cadmium, vanadium, and zinc. Aluminum is also present in the sulfide fraction and is released as dissolved inclusions of creedite and gearsutite. Of the mobile fractions, cadmium and nickel are the only ones that are mobile in concentrations that represent a substantial portion of the total content.

Cell 7 displays the impacts of more intense leaching than Cell 2 with most elements only occurring in the residual fraction except for nickel, which also shows a substantial portion in the ion-bound fraction.

7.7.2.2 Rhyolite Tuff and Flow

In Cell 1, the residual portion hosts most of the elements of interest. Exceptions to this are again cadmium and nickel, which are hosted in both the sulfide and ion-bound fraction and molybdenum, which is present in the sulfide fraction. This indicates these elements could still be released over time.

Despite the acidic conditions developed in Cell 3 and Cell 4 there is apparently only limited mobility of arsenic, nickel, and molybdenum in these cells as reflected in a high portion of these elements in potentially reactive mineral species at the termination of the testwork. This might reflect a premature termination of these two cells tests, which were perceived to be finished after 55 weeks and discontinued, while the remaining seven test were continued for 69 weeks. In contrast, Cell 8 (completed in 69 weeks) shows less of the bulk trace element content in reactive fractions, except for cadmium.

7.7.2.3 Vinini Sediments

In the acid generating Cell 6, despite 69 weeks of reactivity, nickel concentrations remain high in reactive fractions, including ion-bound species. The sulfide fraction is also important for nickel in Cell 6. The cadmium concentration is significant in both the sulfide and the residual fraction. Iron is present in the crystalline iron oxide and residual fractions. The final acidic pH of the rock tested in Cell 6 supports high copper, iron, nickel and manganese in the water-soluble fraction.

In the two neutral cells (Cell 5 and Cell 9), cadmium also shows wide distribution over the different fractions, with elevated concentrations in the sulfide and ion-bound fractions. The latter fraction is also important for arsenic and nickel. As with other cells, the residual portion generally dominates for all elements, indicating the refractory nature of this reservoir. The sulfide fraction is also important for arsenic, nickel, molybdenum and zinc.

7.7.3 Summary of Termination Tests

The termination tests on the Mount Hope humidity cells demonstrate that the majority of constituents that have the potential to be leached, have been leached during the Phase 1 HCT test. However, a small residuum does remain in the test residues, particularly for cadmium, that is considered to be inert.

The main factor in the stabilization of metals in the Mount Hope rocks appears to be encapsulation of metal bearing sulfides by primary silicate minerals. Silicate minerals weather at an extremely low rate by comparison to sulfides or carbonate minerals (Sverdrup, 1990). Consequently, any mineral encapsulated within the primary silicates is considered inert, and may only be available once the silicate host is weathered. The termination tests have demonstrated that the majority of metals have been mobilized during the HCT, and as a result it can be assumed that weathering reactions have occurred in the kinetic tests and that the Phase 1 HCT program has provided a complete characterization of the reaction rates.

8 PREDICTED GEOCHEMICAL BEHAVIOR

8.1 Overview

- The results of the geochemical testing program have been evaluated to define the geochemical behavior of the various waste rock material types associated with the Mount Hope deposit and classify their potential reactivity based on both acid generating and metal leaching properties;
- A waste management classification system has been developed based on site-specific data that indicates the primary control on metal leaching and acid generation for the Mount Hope material types is the concentration of sulfide minerals, which can be quantified by the measurement of total sulfur. This parameter is also the most sensitive of the geochemical characteristics and provides a valid prediction of geochemical behavior. The NPR is another appropriate threshold in determining the acid generating potential of waste rock; and
- The materials at Mount Hope can be segregated into two waste classes: Non-Acid Generating (NAG), and Potentially Acid Generating (PAG). Materials that have greater than 0.5 weight percent total sulfur are considered potentially acid generating (PAG) and materials that have less than 0.3 weight percent total sulfur are considered non-acid generating (NAG). Materials with total sulfur values between 0.3 weight percent and 0.5 weight percent are classified based on the NPR value, where materials with an NPR greater than 1.2 are considered non-acid generating and materials with an NPR less than 1.2 are considered potentially acid generating.

8.2 Waste Rock Geochemistry

The geochemical characteristics of the lithologies and altered equivalents at Mount Hope have been described in this report. A summary of these characteristics are provided in Table 8-1 below and discussed in the following sections.

In Table 8-1, the acid generation prediction for each material type is based primarily on HCT data. However, for those material types where HCT data are not available, the prediction of acid generation is based on the static testing only. The MWMP constituents listed in Table 8-1 for each material type are those constituents that are commonly elevated in the MWMP extracts as determined from the data evaluation graphs in Appendix G. As a result, the full suite of constituents may not be captured for material types that demonstrate a wide range in MWMP results.

Table 8-1: Summary of Predicted Waste Rock Geochemistry

Rock Type	Primary Alteration	Material Type	Acid Generation Prediction	Constituents Commonly Elevated in MWMP Extracts ¹
Alluvium (Qal)	NA	1	NAG	No data available
Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	2	NAG	No elevated constituents
	Biotite	3	PAG	No data available
	Silicic	4	Variable	Cd, Mn
Early Phase Quartz Porphyry (Tqp)	Argillic	5	NAG	F, Mn
	Phyllic	6	Variable	Al, Cd, Cu, Fe, Mn, Pb, Tl, Zn, pH <6.5
	Potassic	7	Variable	F, Mn
	Silicic	8	Variable	Mn
Rhyolite Breccia (Trb)	Argillic	9	Variable	Mn
	Phyllic	10	Variable	No data available
	Potassic	11	PAG	Cd, Mn, Zn
	Silicic ²	12	PAG	Mn, Ni, Tl
Rhyolite Tuff/Flow (Tmr/Tfr)	Argillic	13	Variable	Al, Cd, Fe, Mn, pH <6.5
	Phyllic	14	Variable	Al, Cd, Mn, Zn
	Potassic	15	PAG	No data available
Garden Valley (Pg)	Skarn ²	16	Variable	Cd, Mn, Tl, Zn
Vinini Sediments (Ov)	Unaltered ²	17	NAG	No data available
	Propylitic	18	NAG	pH (>8.5)
	Argillic	19	Variable	Al, As, Cd, Cu, F, Fe, Mn, Ni, Pb, pH <6.5
	Phyllic	20	Variable	Al, Mn, Ni, pH >8.5
	Potassic	21	Variable	Al, F, Mn
	Silicic	22	NAG	Al, Cd, Cu, Fe, Mn, Ni, Pb, Tl, Zn, SO ₄ , TDS, pH <6.5
	Skarn ²	23	Variable	pH >8.5

¹ The material is considered to leach significant concentrations of the element if the 3rd quartile line from the data evaluation graphs in Appendix G is at or above the respective NDEP comparative value.

² Material type that does not occur within the proposed pit boundary and will not be mined but was included in the geochemical characterization program for completeness.

8.2.1 Intermediate Phase Quartz Porphyry

This lithology occurs in the lower part of the deposit and partially overprints the Early Phase Quartz Porphyry (Tqp). The unit displays three alteration types: potassic, biotite, and silicic.

8.2.1.1 Potassic Intermediate Phase Quartz Porphyry

The potassic alteration of the Intermediate Phase Quartz Porphyry typically shows neutral pH in MWMP tests (greater than 6 s.u.), low TDS concentrations, and no constituent release at concentrations elevated above NDEP comparative values in MWMP tests. The low sulfide content associated with this alteration type indicates low acid generation potential (NAG). This is confirmed by HCT results, which indicate that this material type does not have potential for significant acid generation.

8.2.1.2 Biotite Intermediate Phase Quartz Porphyry

Biotite alteration of the Intermediate Phase Quartz Porphyry occurs within the deepest portions of the deposit, where there is limited access to samples. As a result, this material type was not included in the static test program. The acid base prediction from the pulp test program indicates potential for acid generation (PAG) with NPR values generally less than 1.2. HCT results are not available for this material type.

8.2.1.3 Silicic Intermediate Phase Quartz Porphyry

As with the silicic alteration of the Early Phase Quartz Porphyry, most minerals with neutralization potential are absent and the majority of the unit is comprised of silica. MWMP test results for this unit generally show neutral pH, and TDS concentrations are relatively low (<100 mg/L). However, due to the presence of sulfides, and the absence of buffering minerals, acid generating behavior is predicted for this unit by static tests. In MWMP testwork, only cadmium and manganese concentrations are elevated above NDEP comparative values. HCT results for one out of two samples confirm the initial prediction of acid generation based on ABA results with several constituents elevated above NDEP comparative values including aluminum, cadmium, fluoride, manganese and zinc.

8.2.2 Early Phase Quartz Porphyry

This lithology is significant in the deposit and displays four alteration types; argillic, phyllic, potassic and silicic.

8.2.2.1 Argillic Early Phase Quartz Porphyry

This unit is net neutralizing and due to high calcite content (approximately two percent) has a high potential to buffer acidity. In MWMP and HCT tests, the only constituents that were elevated above NDEP comparative values were fluoride and manganese. Phase 1 and Phase 2 HCT results confirm the ABA assessment that this material type is non-acid generating.

8.2.2.2 Phyllic Early Phase Quartz Porphyry

The majority of samples from this unit are predicted to be non-acid generating with minimal constituents elevated above NDEP comparative values in the MWMP testwork results. However, in the lower eastern part of the deposit, this unit can host appreciable pyrite content (approximately one percent), sphalerite, and ore grade molybdenum. In these zones, pH is acidic and several constituents are elevated above NDEP comparative values in

MWMP and HCT effluents, including aluminum, cadmium, copper, fluoride, iron, lead, manganese, nickel, sulfate, thallium, TDS, and zinc. In this portion of the deposit, ABA results predict acid generation. Variable acid generating potential for this material type is confirmed by preliminary Phase 2 HCT results, which indicate that one sample is acid generating and one sample is non-acid generating.

8.2.2.3 Potassic Early Phase Quartz Porphyry

This unit is host to a substantial portion of the ore and the sulfide shell associated with the ore zone. Despite the overall high sulfide content, the lithology does not show significant geochemical reactivity as reflected in the contact and MWMP pH results that are typically above pH 6 s.u. The acid generating potential of this material type is variable based on static test results. Fluoride and manganese are the only constituents that commonly occur at concentrations above NDEP comparative values in the MWMP extracts. By contrast, the humidity cells show pH below pH 6 s.u., higher concentrations of molybdenum (0.1 mg/L) and greater metals release in the leachates. Two out of three of the HCTs demonstrate acid generation, with a several constituents released at concentrations above NDEP comparative values including aluminum, arsenic, cadmium, copper, fluoride, iron, lead, and manganese. The difference in geochemical reactivity between the MWMP and HCT leachate predictions reflect the importance of time related sequential leaching in generating acidic conditions with this rock type.

8.2.2.4 Silicic Early Phase Quartz Porphyry

By definition, silicic alteration is characterized by complete replacement of all silicates with quartz. Consequently, this alteration type typically demonstrates a relatively low buffering capacity due to a lack of base cations or carbonate mineralization. The sulfide content is also generally low in this unit. Consequently, MWMP results for this unit indicate neutral pH values (above 6 s.u.), low TDS concentrations and the only constituent elevated above NDEP comparative values is manganese. However, the ABA prediction generally indicates acid generation potential with NPR ratios below 1.2. One out of two of the preliminary Phase 2 HCTs confirm the ABA prediction for acid generation with low pH values and several constituents elevated above NDEP comparative values including aluminum, arsenic, cadmium, copper, fluoride, iron, lead, manganese, and zinc.

8.2.3 Rhyolite

The rhyolite lithology can be subdivided into breccia, flows and tuffs. All three show similar geochemical behavior. As such, the rhyolite lithologies are grouped together and described below for each of the alteration types. Rhyolite is a major component of the waste rock at Mount Hope but hosts only a small component of molybdenum mineralization.

8.2.3.1 Argillic Rhyolite

Argillic alteration overprints earlier mineralization and as such sulfides present in the argillic alteration show a variable degree of oxidation. This is particularly noticeable closer to the massive zinc orebody to the east, where less oxidation has occurred. For argillic alteration in this area, the acid generating potential of this rock type is proportional to the degree of oxidation. As such, near the zinc orebody the material is predicted to have a greater potential for acid generation. However, based on the mineralogy studies, the sulfides

are largely encapsulated in silica and as a result NAG results and MWMP extracts show that the majority of the argillically altered rhyolite is inert. Consequently, this unit has a complex behavior based on the exposure of contained sulfides.

Several constituents are elevated above NDEP comparative values in acidic MWMP extracts, including aluminum, arsenic, beryllium, cadmium, copper, fluoride, iron, lead, manganese, nickel, sulfate, thallium, zinc, sulfate, and TDS. Sulfide mineralization is more developed in the tuff unit so that this material shows the greatest magnitude of metal release of all Mount Hope waste rock and virtually all of this material type is classified as potentially acid generating. However, two out of five of the humidity cell tests of this material type were non-acid generating after 69 weeks of testing. The ABA prediction of acid generation was consistent with the results of the HCT. This result indicates that the ABA results can be used to predict the long term acid generation potential.

8.2.3.2 Phyllic Rhyolite

As discussed above, where the phyllic alteration is associated with little or no sulfide, it is neutral in contact tests, predicted to be net neutralizing based on static tests and has no metal concentrations in MWMP leachates above NDEP comparative values. However, in the rhyolite units at depth and to the eastern and southern portions of the pit, the phyllic alteration in the Rhyolite Tuff overprints potassic alteration that is associated with mineralization. In this region, this rock is generally acid generating, with low MWMP pH values and concentrations of aluminum, arsenic, beryllium, cadmium, fluoride, lead, manganese, nickel, thallium, and zinc above NDEP comparative values. Preliminary HCT results suggest that one out of two samples demonstrates acid generation, confirming the assessment that the acid generating potential of this material is variable.

8.2.3.3 Potassic Rhyolite

In the rhyolite lithologies, the potassic alteration zone is typically associated with the Rhyolite Breccia zone, where it is dominated by biotite rather than K-feldspar and typically contains more sulfides. As a result, this material type is generally predicted to be acid generating based on NPR values below 1.2 and low pH leachated from the one MWMP sample. Constituents that are elevated above NDEP comparative values in the MWMP leachate include cadmium, manganese and zinc. Because this material type represents a small portion of the material that will be excavated from the pit, no HCTs were conducted.

8.2.3.4 Silicic Rhyolite

As with the potassic alteration zone, the silicic alteration zone for the rhyolite lithologies is associated with the Rhyolite Breccia that contains more sulfides and a limited amount of buffering minerals. Consequently, all silicically altered rhyolite samples are predicted to be acid generating and the contact tests reveal acidic to neutral pH solutions with elevated TDS. The MWMP test work leachates indicate manganese, nickel, and thallium concentrations are commonly elevated above the NDEP comparative values. No HCTs were conducted for this material type.

8.2.4 Garden Valley Formation

8.2.4.1 Garden Valley Skarn

This zone is comprised of Ca-Mg-Fe carbonates, Ca-Mg silicates, quartz and sulfides. The geochemical reactivity of the unit is directly influenced by the transformation of carbonates to silicates and the precipitation of sulfides during alteration. Consequently, in the weakly mineralized zones, the material has neutral to alkaline pH and metal concentrations below NDEP comparative values concentrations in MWMP extracts. These findings agree with predictions of net neutralizing behavior based on static test results. As the sulfide content increases and these sulfides are oxidized to various degrees, the material shows greater reactivity in contact tests, with lower pH and higher TDS. The results of static test for skarn material indicates potential for acid generation for this subset of the skarn samples, with a few exceedences in MWMP leachates for cadmium, manganese, thallium, zinc and sulfate.

8.2.5 Vinini Sediments

These Paleozoic sedimentary units have undergone contact metasomatism during porphyry emplacement. Subsequent hydrothermal mineralization has resulted in alteration styles similar to those observed in the rhyolite and porphyry rocks.

8.2.5.1 Propylitic Vinini

Samples of Propylitic Vinini Sediments consistently show net neutralizing behavior, neutral to alkaline pH and variable TDS in MWMP tests. Manganese was the only constituent elevated above NDEP comparative values for one out of three MWMP samples. Preliminary HCT results for two cells confirm the ABA prediction of non-acid generation for this material type. From the HCT, TDS concentrations and sulfate release are low, although moderate concentrations of arsenic and manganese are mobile under the high pH conditions.

8.2.5.2 Argillic Vinini Sediments

Due to the presence of partially oxidized and unoxidized sulfides in this unit, the MWMP tests demonstrate generally acidic to neutral pH and elevated TDS. The ABA results indicate acid generation for this material type is variable. Several constituents are commonly elevated above NDEP comparative values in MWMP extracts including aluminum, arsenic, cadmium, copper, fluoride, iron, lead, manganese, nickel, and thallium and to a lesser extent zinc, sulfate, and TDS. HCT results also indicate variable acid generating potential that is dependent upon the balance of acid neutralizing and acid generating components. Comparison of two cells with similar sulfide content but varying neutralization potential shows that the cell with additional neutralization potential has not become acidic at Week 30 and only manganese is elevated above NDEP comparative values.

8.2.5.3 Phyllic Vinini Sediments

The Phyllic Vinini Sediments have an alkaline pH and low TDS concentrations in contact and MWMP tests. Acid generation tests indicate that the acid generating potential of this material is variable. As sulfide content increases, and these sulfides are oxidized to various degrees, the material shows greater reactivity in MWMP tests, resulting in lower pH and

higher TDS, with aluminum, antimony, barium, cadmium, iron, lead, manganese, nickel, and sulfate elevated above NDEP comparative values.

Preliminary HCT results from two samples of Phyllic Vinini Sediments confirm the acid generating potential is variable and dependent upon the balance of acid neutralizing and acid generating components. Comparison of two cells that contain similar sulfide content but varying neutralization potential, the cell with additional neutralization potential has not become acidic at Week 30 and only manganese is elevated above NDEP comparative values.

8.2.5.4 Potassic Vinini Sediments

This unit is also referred to as “hornfels” and is a major waste rock and ore host on site. As with argillic alteration, the presence of partially oxidized and unoxidized sulfides in this unit yields acidic to neutral pH and relatively elevated TDS in contact tests. The ABA results indicate acid generation for this material type is variable. Several constituents are elevated above NDEP comparative values in acidic MWMP leachates including; aluminum, antimony, arsenic, barium, cadmium, coppery, fluoride, iron, lead, manganese, nickel, selenium, thallium, zinc, sulfate, and TDS. From HCT results, one out of two samples demonstrates acid generation, confirming the assessment that the acid generating potential of this material is variable.

8.2.5.5 Silicic Vinini Sediments

The silicic alteration of the Vinini Sediments is volumetrically small but is similar in geochemical reactivity to the more abundant potassic alteration. As described above, this zone typically has acidic to neutral pH and elevated TDS in contact and MWMP tests. Acid Base Accounting indicates the acid generating potential of this material type is variable. Several constituents are commonly elevated above NDEP comparative values in MWMP leachates including; aluminum, cadmium, copper, iron, lead, manganese, nickel, thallium, zinc, sulfate, and TDS. Preliminary HCT results from one sample of Silicic Vinini Sediments containing a minor amount of sulfide indicate net neutralizing behavior through Week 30. Samples of this material type containing a greater concentration of sulfide are predicted to be acid generating in the absence of significant neutralizing potential. However, no HCT data is available to confirm this.

8.2.5.6 Vinini Skarn Sediments

The Vinini Skarn, like the Garden Valley Skarn, is predicted to have limited acid generation potential due to the presence of sulfides when using a carbonate based NNP or NPR assessment. From the mineralogy of this unit it can be observed that the high content of calcium-magnesium silicate minerals present would artificially increase NP assessment in the titration relative to actual field conditions.

Based on two samples from the historic pulp database, the Vinini Skarn is potentially acid generating. Static test results from one sample of this unit indicates this material type is non-acid generating with pH values greater than 8.5 s.u. and no constituents elevated above NDEP comparative values in the MWMP leachate. This sample is likely from portions of the skarn that are more peripheral to the sulfide mineralization. Due to its limited occurrence, this material type was not included in either of the HCT programs.

8.3 Waste Rock Management Classification System

In the *characterization* of waste rock geochemistry, the material is segregated according to a series of detailed chemical characteristics that are diagnostic of metal leaching and acid generation potential. The criteria used in the *classification* of materials for use in waste rock management need to be sufficiently sensitive to the indicators of metal leaching and acid generation that are defined by the characterization program, but simple enough for operational waste management. This geochemical characterization study has confirmed that the primary control on metal leaching and acid generation for the Mount Hope material types is the concentration of sulfide minerals, which can be quantified by the measurement of total sulfur. This parameter is also the most sensitive of the geochemical characteristics. Consequently, this parameter can be used as the main diagnostic indicator of metal leaching and acid generation potential. A secondary indicator is the NPR value, which takes into account the presence of both acid generating and acid neutralizing minerals.

Based on the static and kinetic testwork, the materials at Mount Hope can be segregated into the following two waste rock management *classes*:

- Non-Acid Generating (NAG); and
- Potentially Acid Generating (PAG).

Waste rock materials are grouped into one of these two classes based on the two main criteria; total sulfur and NPR value. Materials that have greater than 0.5 weight percent total sulfur are considered potentially acid generating (PAG) and materials that have less than 0.3 weight percent total sulfur are considered non-acid generating (NAG) regardless of the NPR value. However, materials with total sulfur values between 0.3 weight percent and 0.5 weight percent are classified based on the NPR value, where materials with an NPR greater than 1.2 are considered non-acid generating and materials with an NPR less than 1.2 are considered potentially acid generating.

Based on an evaluation of the ABA, NAG, MWMP and kinetic test results from this site, the NDEP NPR criteria of 1.2 (NDEP, 1990) is an appropriate threshold in determining if a material has the potential to be acid generating. Furthermore, these data demonstrate that samples containing less than 0.3 weight percent total sulfur are not predicted to generate acid or leach significant metals. Materials that have greater than 0.5 weight percent total sulfur have a greater potential to generate acid and leach significant metals and are therefore classified as PAG. These observations are consistent with published results from other geochemical studies that have drawn similar conclusions when evaluating low sulfide and low carbonate systems similar to the Mount Hope deposit. A summary of these studies is presented in Price (1997) and Jambor et al. (2000).

9 GEOLOGIC AND GEOCHEMICAL MODELING

9.1 Overview

- Based on geochemical modeling, approximately 26 percent of the waste rock from the Mount Hope Project is predicted to be PAG and 74 percent of the waste rock is predicted to be non-acid generating or have limited acid generating potential (i.e., NAG);
- The most significant waste rock material types, in terms of volume, are the Argillic Rhyolite Tuff, Potassic Vinini Sediments, and Potassic Early Phase Quartz Porphyry;
- The results of the waste rock characterization reveals that, at the end of mine life, the lithologies exposed at the base of the pit will be dominated by a combination of inert and potentially acid generating residual ore. There is limited buffering material available in the base of the pit;
- Mass balanced humidity cell results were used to develop a source term for the waste rock storage areas. The resulting source term is a prediction of the concentrations of constituents that will likely be released from the waste rock storage areas in response to meteoric rinsing by infiltration;
- The source term chemistry indicates that for waste rock storage areas comprised of PAG waste rock, aluminum, cadmium, iron, manganese, zinc, and to a lesser extent fluoride and nickel, will be elevated in dump seepage with pH buffered in the range of 5 to 6 s.u. The overall low sulfide content of the system is reflected in the relatively low predicted sulfate and TDS concentrations for the PAG dump material; and
- The source term chemistry for waste rock storage areas comprised of NAG waste rock indicates seepage with neutral pH (around 7 s.u.) and low predicted metals concentrations with the exception of manganese and aluminum. The source term modeling predicts that manganese will be elevated above the NDEP comparative values at concentrations comparable to those observed in background groundwater wells for the Mount Hope Project (i.e., in the range of 1 mg/L). Aluminum is also predicted to be elevated above NDEP comparative values in NAG dump seepage.

9.2 Geologic Modeling and Estimated Pit Wall Geology

A three-dimensional geological model was created for the Mount Hope ore, waste rock, and pit walls using Mintec's MineSight[®] mining software. The model is based on exploration holes drilled by Exxon that define a smaller pit than the one currently being proposed by GMI. Data from the Exxon drill holes were used by Call and Nicholas Incorporated (CNI) to generate a series of geological solids that describe the rock type (lithology) and alteration of the deposit. The set of solids developed to describe lithology are laterally and vertically extensive and extend beyond the proposed pit boundary. However, alteration was interpreted only to the expected Exxon pit boundary based on data from Westra and Riedell (1996) and the set of solids developed to describe alteration do not extend to the proposed pit boundary. Consequently, the alteration types had to be extrapolated from the drill hole data to the edge of the proposed final pit wall using standard geologic interpretation methods that take into account a variety of geologic parameters including trends in regional and local scale structures that influence the movement of mineralizing fluids, trends in the main lithologic contacts and the mineralogical controls of the various host rocks on the resulting alteration assemblages.

A series of snapshots from the model are provided in Appendix L that illustrate the various geological solids. These graphs also show the approach taken to extrapolate the alteration solids to the final proposed pit wall. Initially, a 100m x 100m grid was established for the full plan-view area of the final proposed pit. This grid was extended downward in depth creating sectional planes, which formed sectional traces when they intersected the final pit wall. Alteration boundaries were then re-interpreted in cross section using three sets of data:

1. 3D drill holes coded with logged alteration;
2. Existing CNI solid surface interpretations; and
3. Original Exxon geologic cross sections.

Using these data, new intercept points for each alteration type were interpreted along the section traces. The intercept points were then connected into 3D polylines that define the contacts between the alteration types along the final pit wall.

Due to the conical shape of the pit and the cylindrical shape of the interpreted ore body, the shallow alteration types (e.g., argillic and potassic alteration) required the most extrapolation. Similarly, there were some distal occurrences of phyllic alteration in drill holes that had not previously been captured. These phyllic intercepts were projected to the pit wall during the exercise. Deeper alteration types (e.g., silicic and biotite alteration) were largely unedited as they already extend out to and fully intersect the bottom of the cone. Figure 9-1 and Figure 9-2 show the geologic interpretation (i.e., lithology and alteration, respectively) for the final pit walls in plan view.

As shown in Figure 9-1 and Figure 9-2, Potassic Vinini Sediments will be exposed along the southern and eastern portion of the final pit and becomes progressively less altered (i.e., hornfels) to the south and east. Argillic Rhyolite Tuff will comprise a significant portion of the north and east pit walls. Potassic and Silicic Early Phase Quartz Porphyry will be exposed within the center of the pit in an exposure elongated east-west. Silicic Intermediate Phase Quartz Porphyry occurs within the deeper portion of the deposit and will be exposed

at the bottom of the pit. Exposure of biotite-altered Intermediate Phase Quartz Porphyry is limited to a small area at the deepest point within the pit.

The results of the waste rock characterization reveals that, at the end of mine life, the lithologies exposed at the base of the pit will be dominated by a combination of inert and potentially acid generating residual ore. There is limited buffering material available in the base of the pit. As the pit eventually floods, most of the sulfide bearing rock will be covered by water and as a result, the potential for acid generation will be less. The majority of sulfide bearing rocks exposed in the central portion of the pit walls will continue to contribute acidity, metals, and salt to the pit lake until the area is covered by water. More neutralizing lithologies, exposed higher in the pit wall, will buffer the pH of the pit lake water. These materials will exert a greater control on the pit lake water quality once hydrologic equilibrium is reached.

Figure 9-1: Final Pit Wall Lithologies

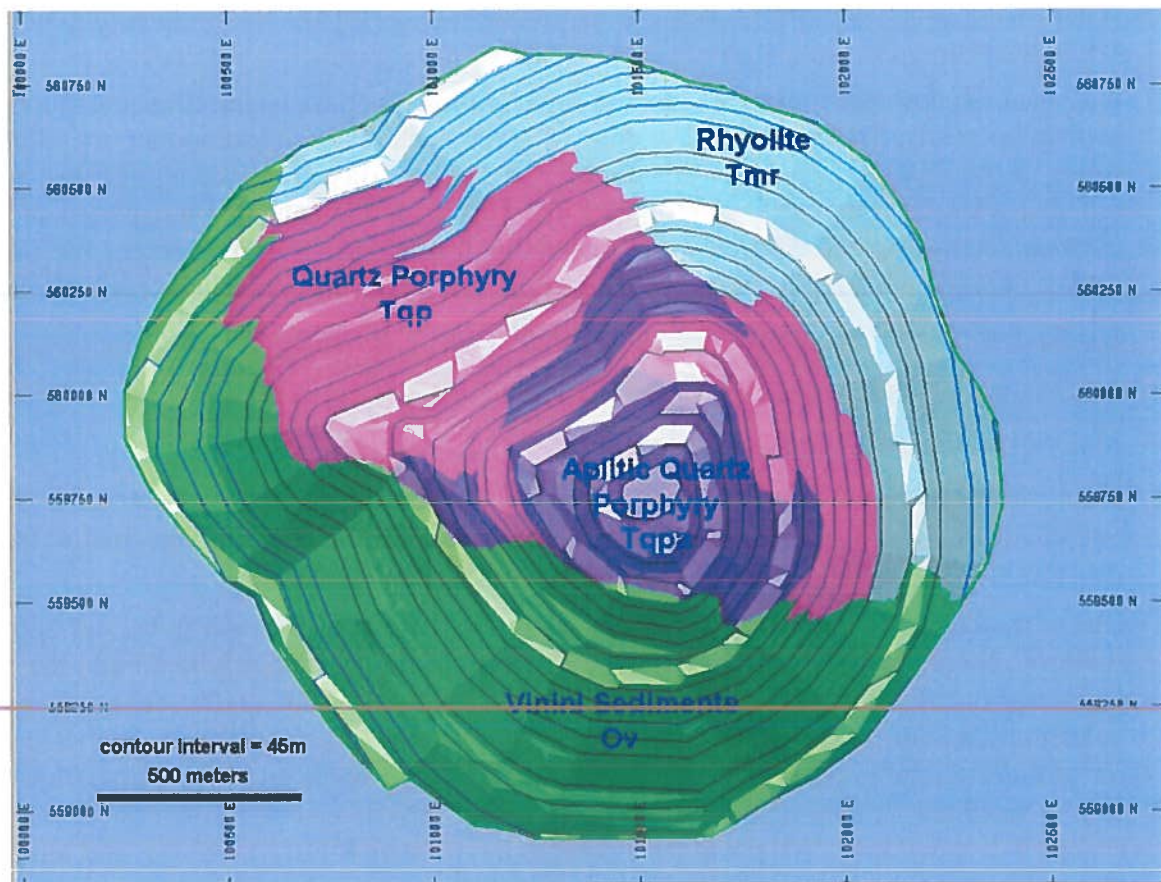
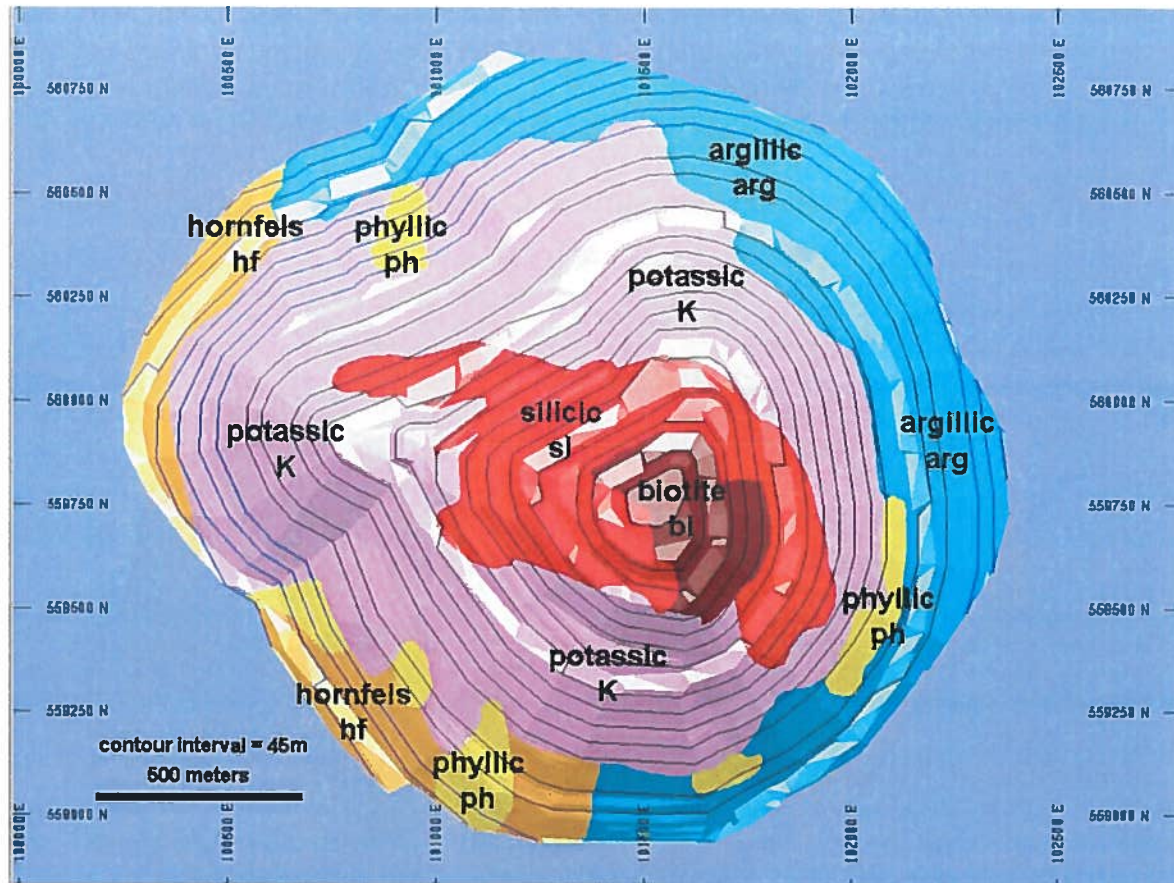


Figure 9-2: Final Pit Alteration Assemblages



9.3 Waste Rock Geochemical Modeling

As discussed in Section 6.2.2, total sulfur and total carbon results for the historic pulps provide a comprehensive dataset of the acid generating potential for the majority of the deposit that has been drilled for the Mount Hope Project. These pulp test data were entered into the three-dimensional MineSite[®] software geological block model program to produce an ARD block model for the deposit. The mine block model and geochemical parameters (i.e., total sulfur and NPR values) were used to generate a three-dimensional shape that defines the distribution of potential acid generating (PAG) material throughout the deposit and in the final pit walls.

From the block model and three-dimensional PAG shape, the volumes of acid generating and acid neutralizing material within the deposit were estimated. However, because this PAG shape is based on data from historic assay pulps from the Exxon drill holes, approximately 30% of the pit material is undefined with respect to acid generating potential. For these undefined areas, the PAG shape had to be extrapolated to the edge of the final proposed pit.

The steps taken to extrapolate the PAG shape are depicted in a series of oblique images of the model and cross-sections in Appendix L. During extrapolation, if the outermost drill location was defined as PAG, then the three-dimensional shape defining the PAG material

Table 9-1: Final Pit Wall Material Type Percentages

Predicted Geochemical Behavior	Rock Type	Alteration Type	Material Type Code	Total Pit Surface Area (acres)	Percent Surface Area
NAG	Intermediate Phase Quartz Porphyry (Tqpa)	Potassic	Tqpa Po	26	2.4
		Biotite	Tqpa Bi	33	3.1
		Silicic	Tqpa Si	77	7.2
	Early Phase Quartz Porphyry (Tqp)	Argillic	Tqp Ar	1	0.1
		Phyllic	Tqp Ph	7	0.7
		Potassic	Tqp Po	203	19
		Silicic	Tqp Si	54	5.1
	Rhyolite (Tmr/Tfr/Trb)	Argillic	Tmr Ar	98	9.2
		Phyllic	Tmr Ph	5	0.5
		Potassic	Tmr Po	43	4
	Vinini Sediments (Ov)	Argillic	Ov Ar	53	4.9
		Phyllic	Ov Ph	33	3.1
		Potassic	Ov Po	263	24.6
Silicic		Ov Si	9	0.8	
PAG	Early Phase Quartz Porphyry (Tqp)	(various)	Tqp PAG	9	0.9
	Rhyolite (Tmr/Tfr/Trb)	(various)	Tmr PAG	102	9.5
	Vinini Sediments (Ov)	(various)	Ov PAG	53	5
Total				1,070	100

The estimated percentage of NAG and PAG waste rock for each of the different material types is summarized in Table 9-2. The most significant waste rock material types, in terms of volume, include Argillic Rhyolite Tuff, Potassic Vinini Sediments, and Potassic Early Phase Quartz Porphyry. However, for reasons discussed above, the alteration type is undefined for a large percentage of the three main rock types (Early Phase Quartz Porphyry, Vinini Sediments and Rhyolite Tuff). These undefined materials account for approximately 37 percent of the total waste rock that is scheduled for mining.

Material types that were included in the characterization but are not included in the volume of waste rock to be mined include Alluvium, Garden Valley Skarn, Propylitic Vinini, Vinini Skarn, Unaltered Vinini Sediments, and Silicic Rhyolite Breccia. The Propylitic Vinini Sediments will be mined, however the volume of this material type cannot be estimated from the mine model because propylitic alteration was not recognized or documented in past exploration drill logs and as a result cannot be defined as a distinct alteration type in the current mine model. Alluvium comprises an insignificant amount of the total waste rock and was not included in the estimate of waste rock volumes.

Also summarized in Table 9-2 are the constituents that were elevated above NDEP comparative values (Form 0090 for Profile II constituents) in MWMP tests on drill core samples for each of the main material types.

Table 9-2: Predicted Tonnage of Waste Rock

Rock Type	Primary Alteration	% of Total Waste Based on Mine Model	Percentage of Waste Rock Based on Mine Model		Constituents Commonly Elevated in MWMP Extracts ¹
			% NAG	% PAG	
Undefined	Undefined	0.6	73	27	No data available
Intermediate Phase Quartz Porphyry (Tqpa)	Undefined	0.6	98	2	No data available
	Potassic	1.1	84	16	None
	Biotite	0.1	100	0	No data available
	Silicic	1.1	75	25	Cd, Mn
Early Phase Quartz Porphyry (Tqp)	Undefined	6	94	6	No data available
	Argillic	2.3	82	18	F, Mn
	Phyllic	0.1	10	90	Al, Cd, Cu, Fe, Mn, Pb, Ti, Zn, pH (<6.5)
	Potassic	12.7	91	9	F, Mn
	Silicic	1.2	98	2	Mn
Rhyolite Tuff and Flow (Tmr/Tfr)	Undefined	10	60	40	No data available
	Argillic	22.9	53	47	Al, Cd, Fe, Mn, pH (<6.5)
	Phyllic	0.6	30	70	Al, Cd, Mn, Zn
	Potassic	3.5	79	21	No data available
Vinini Sediments (Ov)	Undefined	20.5	80	20	No data available
	Argillic	2.9	56	44	Al, As, Cd, Cu, F, Fe, Mn, Ni, Pb, pH (<6.5)
	Phyllic	1.6	66	34	Al, Mn, Ni, pH (>8.5)
	Potassic	12.1	89	11	Al, F, Mn
	Silicic	0.1	100	0	Al, Cd, Cu, Fe, Mn, Ni, Pb, Ti, Zn, SO ₄ , TDS, pH (<6.5)
Totals		100	74	26	

¹ The material is considered to leach significant concentrations of the element if the 3rd quartile line from the data evaluation graphs in Appendix G is at or above the respective NDEP comparative value.

9.4 Waste Rock Source Term Modeling

9.4.1 Modeling Approach

Mass balanced HCT results were used to develop a source term for the waste rock associated with the Mount Hope Project. The resulting source term is a prediction of the concentrations of constituents that will likely be released from the waste rock in response to meteoric rinsing by infiltration. It was assumed that the waste rock material will be segregated into separate waste rock storage areas according to the geochemical properties of the material (i.e., NAG versus PAG).

The geochemical prediction calculations were made using the USGS-developed software PHREEQC (release version 2.13.2, 2007). For this evaluation, the chemistry of an average solution based on HCT data has been mass balanced to the predicted composition of the waste rock storage areas and allowed to form a chemical equilibrium with rainwater and atmospheric oxygen. Rainwater chemistry was taken from the default values provided in PHREEQC manual. The input data for these calculations were the average concentrations obtained from the humidity cell testwork program and the predicted material type distribution for the PAG and NAG waste rock storage areas was obtained from the current mine plan (Table 9-2). The resulting chemistry is the predicted overall source term or seepage chemistry that is predicted, assuming all meteoric water infiltrating the waste rock storage areas is fully mixed. Sensitivity analysis has been completed on key parameters to support the use of averaged values in the modeling (SRK 2008b). The results of this evaluation are summarized in Table 9-3.

9.4.2 Source Term Modeling Results

For waste rock storage areas comprised of PAG waste rock, aluminum, cadmium, iron, manganese, zinc, and to a lesser extent fluoride and nickel, are predicted to be elevated in seepage, and pH is buffered in the range of 5 to 6 s.u. (Table 9-3). However, the overall low sulfide content of the system is reflected in the relatively low predicted sulfate and TDS concentrations for the PAG dump material. In comparison, the source term chemistry for waste rock storage areas comprised of NAG waste rock is predicted to have seepage with neutral pH (around 7 s.u.) and low metals concentrations, with the exception of manganese and aluminum. The source term modeling predicts that manganese will be elevated above the NDEP comparative values in the seepage at concentrations comparable to those observed in background groundwater wells for the Mount Hope Project (i.e., in the range of 1 mg/L). Aluminum is also predicted to be elevated above NDEP comparative values in NAG dump seepage.

Table 9-3: Source Term Predictions

Parameter	NDEP Comparative Values	PAG Waste Rock	NAG Waste Rock
Aluminum	0.05-0.2	8.84	0.87
Antimony	0.146	0.001	0.001
Arsenic	0.05	0.007	<0.002
Barium	2	0.011	0.004
Beryllium	0.004	0.000003	<0.002
Cadmium	0.005	0.142	0.002
Chloride	250-400	2.47	31.73
Chromium	0.1	<0.002	<0.002
Copper	1.3	0.746	0.080
Fluoride	2.0-4.0	5.59	3.60
Iron	0.3-0.6	28.98	0.001
Lead	0.015	0.001	<0.002
Magnesium	125-150	7.90	3.20
Manganese	0.05-0.1	22.95	1.47
Mercury	0.002	<0.0005	<0.0005
Nickel	0.1	0.123	0.029
pH (s.u.)	6.5-8.5	5.86	6.85
Selenium	0.10	0.007	0.001
Silver	0.1	0.002	<0.002
Sulfate	250-500	341	49
Thallium	0.002	0.002	0.0002
TDS	500-1,000	353	100
Zinc	5	22.92	0.56

All values reported in mg/L unless otherwise noted.
Bold and shaded values exceed the NDEP comparative values.

10 CONCLUSIONS

The following conclusions can be drawn from the waste rock and pit wall rock geochemical characterization program:

1. The relative lack of carbonate in the rock assemblage at Mount Hope results in a deficit of neutralization capacity in the system, so the potential for acid generation is primarily controlled by the amount of sulfide in the rock;
2. There is a poor correlation between the various rock types and alteration types and sulfide content and despite some exceptions almost every material type has both potentially acid forming and non-acid forming rocks. Some of the general observations useful for waste rock management include:
 - The geochemical and mineralogical data indicate the Early and Intermediate Phase Quartz Porphyry rock units (Tqp and Tqpa) have relatively less base metal sulfide than the Vinini Sediments and rhyolite units and thus have an overall lower potential to generate acid. The leachable concentrations of metals and metalloids are thus lower from these rock types, as supported by the MWMP test results; and
 - The geochemical data indicate the rhyolite units that have undergone argillic or phyllic alteration, and the Vinini Sediments that have undergone argillic, potassic, or phyllic alteration, have relatively higher sulfide content and demonstrate the greatest potential to generate acid or leach metals and metalloids at concentrations above NDEP comparative values.
3. Overall the waste rock characterization indicates that the majority of material types to be exposed or extracted from the Mount Hope molybdenum deposit are inert in terms of geochemical reactivity, with only a small proportion being classified as acid generating. This feature reflects the low sulfide and negligible buffering content of the rocks;
4. Those materials predicted to be potentially acid generating from static test results have low pH in MWMP and HCT leachates and release several constituents at concentrations above NDEP comparative values. Constituents that are commonly elevated include aluminum, arsenic, cadmium, fluoride, iron, lead, manganese, nickel, sulfate, thallium and zinc;
5. For the material types predicted to have a low potential for acid generation from static test results, the humidity cells indicate that although there is little or no neutralization potential in the cells, the pH is buffered by iron oxyhydroxides and thus limits metal release. Buffering of the solutions maintains pH in the range 5 to 6 s.u. The limited exposure of sulfide minerals in these material types limits the reservoir of available metals that can be leached;
6. There is a strong correlation between HCT results and the prediction of acid generation from NAG results. This correlation confirms that the threshold of 10 eq. kg H₂SO₄ is effective in discriminating between acid generating and non-acid generating samples; and

7. The humidity test cell results confirm the predictions of acid generating potential from static testing (ABA and NAG) and support the conclusion that total sulfur is a sensitive indicator of metal leaching and acid generation potential for the Mount Hope system.

The results of the geochemical characterization indicate that the waste rock material types can be divided into two categories for use in the management of waste rock during operations and at closure. These include:

1. Potentially acid generating material (PAG); sulfide content greater than 0.5 weight percent that result in release of metals at concentrations above NDEP comparative values in a low pH and high sulfate solution; and
2. Non-acid generating material (NAG); sulfide content less than 0.3 weight percent for which there is no acid generation or significant metal release in humidity cells indicating that over time any rock leachate will not impact the receiving environment.

For material types with sulfide content between 0.3 weight percent and 0.5 weight percent (as measured by total sulfur) the acid generation prediction is based on the balance of acid generating components and acid neutralizing components (i.e., NPR value), where materials with an NPR greater than 1.2 are considered non-acid generating (NAG) and materials with an NPR value less than 1.2 are considered potentially acid generating (PAG).

11 REFERENCES

- ASTM, 1996 (reapproved 2001). Standard test method for accelerated weathering of solid materials using a modified humidity cell: American Society for Testing and Materials. West Conshohocken, PA, (www.astm.org), D 5744-96(2001), p. 13.
- Biscaye, G., 1964. X-ray identification of clays, *in* Brown, G., editor, X-ray Identification and Crystal Structure of Clays: London, Mineralogical Society.
- Bowell, R.J., Rees, S.B., and Parshley, J.V., 2000. Geochemical predictions of metal leaching and acid generation: geologic controls and baseline assessment: Geology and Ore Deposits 2000, *in* The Great Basin and Beyond Proceedings, Volume II: Geological Society of Nevada, Reno, p. 799-823.
- Bureau of Land Management (BLM), 1996. Instruction Memorandum No. 96-79, Subject: Acid Rock Drainage Policy for Activities Authorized under 43 CFR 3802/3809, April 2, 1996.
- Environmental Geochemistry International (EGi), 2002. Net acid generation (NAG) test procedures. Unpublished report for BHP Billiton, February 2002, p. 6.
- Ficklin, W.H., Plumlee, G.S., Smith, K.S., and McHugh, J.B., 1992. Geochemical classification of mine drainages and natural drainages in mineralized areas: Proceedings, 7th International Symposium on Water-Rock Interactions, Park City, Utah, p. 381-384.
- IGMI, 2005. *Mount Hope Feasibility Study Part 2*. Unpublished. June 2005.
- Hall, G.E.M., 1999. A review of selective extraction procedures: *Journal of Geochemical Exploration*, v. 67, p. 1-18.
- Hem, John D., 1985. Study and Interpretation of the Chemical Characteristics of Natural Water, U.S. Geological Survey Water-Supply Paper 2254.
- Jambor, J.L., D.W. Blowes, and C.J. Ptacek, 2000. Mineralogy of mine wastes and strategies for remediation. *EMU Notes in Mineralogy*, Vol. 2, Chapter 7. p. 260
- Lappakko, K.A., and White, III, W.W., 2000. Modification of the ASTM 5744-96 kinetic test: ICARD 2000, p. 631-639.
- Mabey, D.R., 1996. Regional Gravity and Magnetic Anomalies in Part of Eureka County, Nevada. *Min. Geophys.*, v. 1, p. 77-84.
- Mills, C. 1998 Interpretation of Acid Base Accounting. Infomine website article. <http://technology.infomine.com/enviromine/ard/Acid-BaseAccounting>.

- Miller, S., Robertson, A., and Donohue, T., 1997. Advances in acid drainage prediction using NAG test: ICARD '97, Vancouver, Mine Environmental Neutral Drainage Program, Ottawa, Canada, p. 535-549.
- Nevada Division of Environmental Protection (NDEP), 1990. *Waste Rock and Overburden Evaluation*, September 14, 1990.
- The Pacific Northwest Cooperative Agricultural Weather Network, (2007). Retrieved November 7, 2007, from http://news.ninemsn.com.au/health/story_13178.asp.
- Price, W.A., 1997. Draft guidelines and recommended methods for the prediction of metal leaching and acid rock drainage at minesites in British Columbia: British Columbia Ministry of Employment and Investment, Energy and Minerals Division, Smithers, BC, April 1997, p. 143.
- Riedell, K.B., 1996. The Mount Hope Porphyry Molybdenum Deposit, Eureka County, Nevada. Published in: *Geology and Ore Deposits of the American Cordillera, Field Trip Guidebook Compendium*, Editors: S.M. Green and E. Struhsacker. Geological Society of Nevada, Reno, Nevada.
- Roberts, R.J., Montgomery, K.M., and Lehner, R.E., 1967. *Geology and Mineral Resources of Eureka County, Nevada*. Nevada Bureau of Mines Geology Bulletin 64, p. 152.
- Shawe, D.R., Poole, F.G., and Heyl, A.V., 1978. Geologic Framework of the Cordilleran Regional Traversed by Field Excursion C-1 in Eastern Nevada and Western Utah. Published in: *Guidebook to Mineral Deposits of the Central Great Basin*. Nevada Bureau of Mines Geology Report 32, p. 3-9.
- Sobek, A.A, Schuller, W.A., Freeman, J.R., and Smith, R.M., 1978. Field and laboratory methods applicable to overburden and minesoils: EPA 600/2-78-054, 203 pp.
-
- SRK Consulting (U.S.) Inc. (SRK), 2006. *Mount Hope Project, Plan of Operations, and Reclamation Permit Application*. Submitted June 2006, revised September 2006.
- SRK Consulting (U.S.) Inc. (SRK), 2007a. *Mount Hope Hydrogeologic Investigation and Zinc Exploration Drilling Report*. January 2007.
- SRK Consulting (U.S.) Inc. (SRK), 2007b. *Mount Hope Project, Waste Rock Management Plan*. October 2007.
- SRK Consulting (U.S.), Inc. (SRK), 2007c. *Mount Hope Project Tailings Characterization Report*. November 2007.

- SRK Consulting (U.S.), Inc. (SRK), 2008a *Mount Hope Project Baseline Surface Water and Ground Water Report*, January 2008.
- SRK Consulting (U.S.), Inc. (SRK), 2008b. *Mount Hope Project, Future Pit Lake Geochemical Prediction Report*. Unpublished.
- Stewart, J.H., Moore, W.J., and Zietz, I., 1977. East-west Patterns of Cenozoic Igneous Rocks, Aeromagnetic Anomalies, and Mineral Deposits, Nevada and Utah. *Geological Society of America Bulletin*, v. 88, p. 67-77.
- Sverdrup, H.U., 1990. *The kinetics of base cation release due to chemical weathering*: Lund University Press, Lund.
- Tessier, A., Campbell, P, and Bisson, M., 1979. Sequential extraction for the speciation of particulate trace metals: *Analytical Chemistry*, v. 51.
- Westec, Inc. 1995. *Mount Hope Environmental Due Diligence Study Phase I* (Unpublished). Prepared for Kennecott Corporation.
- Westra G. and K.B. Riedell, 1996. Geology of the Mount Hope Stockwork Molybdenum Deposit, Eureka County, Nevada. Published in: *Geology and Ore Deposits of the American Cordillera, Symposium Proceedings*, Editors: A.R. Coyner and P.L. Fahey. Geological Society of Nevada, Reno, Nevada.
- White, III, W.W., and Lapakko, K.A., 2000. Preliminary indications of repeatability and reproducibility of the ASTM 5744-96 kinetic test for drainage pH and sulfate release rate: *ICARD 2000*, p. 621-630.

