Appendix D

Geochemical Analysis

D-1

Phase 1 Eagle Project Geochemistry Study

REPORT ON

PHASE I EAGLE PROJECT ACID ROCK DRAINAGE STUDY - MARQUETTE COUNTY, MICHIGAN

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EXECUTIVE SUMMARY

Background and Basis for Study

The Eagle Project, located on the Yellow Dog plains in Michigamme Township of Marquette County, Michigan, U.S.A., is a small Ni-Cu sulfide deposit hosted in intrusive igneous rocks, called peridotite, composed chiefly of the silicate minerals pyroxene and olivine. The principal sulfide minerals are pyrrhotite [$Fe_{1-x}S$], chalcopyrite [$CuFeS_2$], and pentlandite [$(Ni,Fe)_9S_8$]. If exposed to atmospheric oxygen and water, sulfides can oxidize and dissolve, releasing sulfate and metals into solution and generating acidity. The peridotites intrude siltstones and sandstones, referred to as the country rock. Both silicate and carbonate minerals in the intrusive and in country rock can react with acidity to neutralize effluents and reduce concentrations of certain trace metals potentially mobilized in runoff or effluent.

Kennecott Minerals Company (Kennecott Minerals) would develop the Ni-Cu ores of the Eagle Project as an underground mine, with direct shipment of ore with or without on-site processing. The economically valuable minerals lie in the massive and semi-massive ore zones, and underground mining allows quite precise extraction of ore. After mining, there would be essentially no massive sulfide mineralization remaining underground. Essentially all the rock that will be moved to and temporarily stored on the ground surface will be "development" country rocks. The evolving mine plans call for the development rock to be backfilled into the mine voids during the latter parts and after mining. After mining, the backfilled workings will re-flood, controlling and limiting the availability of oxygen needed to initiate sulfide oxidation.

Kennecott Minerals has initiated a geochemical testing program to evaluate the risks of acid rock drainage (ARD), metals leaching, and other geochemical concerns associated with mining of the Eagle deposit. The program is intended to be modular, building geochemical data sets as the project progresses. The objective of the Phase I testing program is an initial evaluation of the spatial distribution of the geochemical characteristics of the Eagle deposit that could cause ARD and metals leaching. Geochemical testing includes whole-rock chemistry, acid-base accounting (ABA), short-term metal leaching, long-term kinetic column testing and mineralogical analysis. The Phase I program analyzes whole-rock chemistry and ABA characteristics of 42 samples, short-term leaching of 10 samples, and the detailed mineralogy of 15 samples. Long-term kinetic leach tests are ongoing on five Phase I samples to simulate weathering under surface conditions, to determine reaction rates, and to evaluate the leachability of trace metals and other constituents of potential environmental concern.

Data-quality objectives for the Project guide all test work. Qualified geologists selected the samples, and qualified analytical laboratories, operating under quality assurance/quality control (QA/QC) programs consistent with U.S. Environmental Protection Agency guidance, conducted all geochemical tests and analyses.

Results

Sulfide-bearing peridotite contains concentrations of Cd, Co, Cu, Fe, Pb, Ni, Se, Ag, S, and Zn that are elevated with respect to common crustal rocks. The metals are not bio-available in the rock, which must be oxidized and acidified before the metals would be released and mobilized.

Mineralogical analysis and ABA testing show that sulfides are pervasive in all rock types, and the ultimate acid generation potential of all rock types generally exceeds their neutralization potential (NP). Olivine, lizardite, calcite and dolomite contribute to NP. Electron microprobe analyses show that the calcite and dolomite contain almost no iron or manganese and therefore would provide readily available acid-neutralizing capacity. Kinetic tests show that olivine and lizardite weather at a rate fast enough to be effective, too, as acid-neutralizing minerals.

Kinetic tests conducted to date indicate that metal-leaching rates are low for siltstone and peridotite because neither of these rock types has developed acidic conditions over the period of testing. Kinetic tests to date show very low-level leaching of As, Co, Cu, Ni, Sb, Se, and V, and these trends will be evaluated further in Phase II. Massive and semi-massive sulfide samples do generate metals, but these rocks will not be stored at surface.

The QA/QC assessment of analytical data indicates good analytical accuracy and precision. The data are adequate for the current evaluation.

Conclusions

Because the rocks contain sulfide minerals and elevated concentrations of some trace metals, static testing results indicate a need for active management of all rock types.

Phase I kinetic tests, except for the Massive and Semi-Massive Sulfide Unit, have not generated acidic effluent or high concentrations of dissolved metals. Sulfide oxidation and NP depletion rates indicate that development rock could be stored at surface for extended periods, probably on the order of decades, without becoming acid-generating.

Recommendations for Phase II

Phase II activities will expand the geochemical and mineralogical data set to be representative of the full, three-dimensional range of all lithologies that will be involved in the waste rock management program. Kinetic testing of existing samples will continue, and additional samples will be included in the kinetic testing program to confirm ABA results and to expand data on metal-leaching rates. To assess potential impacts to water quality, metal-leaching rates will be integrated with both the engineering designs of waste rock management and site hydrological conditions to quantify water-quality impacts. To ensure high-quality data, Phase II testing will continue to implement appropriate QA/QC protocols.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Project Description 1
1.2 Geologic Description 1
1.3 Previous Geochemical Characterization 2

2.0 PHASE I CHARACTERIZATION PROGRAM 3
2.1 Overview 3
2.2 Sample Selection 3
2.3 Geochemical Characterization Program 4
2.3.1 Static Testing 4
2.3.1.1 Whole Rock Chemistry 4
2.3.1.2 Acid-Base Accounting 5
2.3.1.3 Short-Term Leach Testing 6
2.3.2 Kinetic Testing 7
2.3.2.1 Column Leach Testing 7
2.3.3 Mineralogical Analysis 8
2.4 Quality Assurance/Quality Control 8

3.0 PHASE I TESTING RESULTS 10
3.1 Mineralogy 10
3.1.1 Sulfide Mineralogy 10
3.1.2 Minerals with Neutralization Potential 11
3.1.3 Host Mineralogy 12
3.2 Rock Chemistry 13
3.3 Acid-base accounting 14
3.4 Column Leach Testing 16
3.4.1 ARD and Metal Leaching Rates 19
3.5 Short-Term Leach Testing 20

4.0 ENVIRONMENTAL ASSESSMENT 23

5.0 RECOMMENDATIONS – PHASE II PROGRAM 25
5.1 Task 1 - Coordination with Mine Planning and Geology 25
5.2 Task 2 - Expand Database for Static Geochemical Testing 26
5.3 Task 3 - Kinetic Testing 27
5.4 Task 4 - Mineralogy 28
5.5 Task 5 - Coordination with Baseline Water Quality and Hydrology 28
5.6 Task 6 - Quality Assurance 29

6.0 REFERENCES 30

LIST OF TABLES

Table 2-1 State and Federal Freshwater and Drinking Water Criteria
Table 2-2 Phase I Sample and Analytical List

Table 3-1 Whole Rock Analysis Results
Table 3-2 Elemental Analysis Results
Table 3-3 Acid-Base Accounting Results
Table 3-4 Kinetic Testing Results - Acid Generation and Neutralization Depletion Rates
Table 3-5 Kinetic Testing Results - Metal Leaching Rates
Table 3-6 Short-Term Leach Testing Results

LIST OF FIGURES

Figure 1-1 Site Map
Figure 1-2 Schematic of Typical Eagle Stratigraphic Column

Figure 2-1 Eagle Drill Plan and Long Section
Figure 2-2 Eagle Sample Locations – Longitudinal
Figure 2-3 Eagle Sample Locations – Transverse

Figure 3-1 Whole Rock Analysis – Aluminum
Figure 3-2 Whole Rock Analysis - Calcium
Figure 3-3 Whole Rock Analysis - Iron
Figure 3-4 Whole Rock Analysis - Magnesium
Figure 3-5 Whole Rock Analysis – Silicon
Figure 3-6 Elemental Analysis – Antimony
Figure 3-7 Elemental Analysis - Arsenic
Figure 3-8 Elemental Analysis - Cadmium
Figure 3-9 Elemental Analysis - Chromium
Figure 3-10 Elemental Analysis - Cobalt
Figure 3-11 Elemental Analysis - Copper
Figure 3-12 Elemental Analysis - Lead
Figure 3-13 Elemental Analysis - Nickel
Figure 3-14 Elemental Analysis - Selenium
Figure 3-15 Elemental Analysis - Silver
Figure 3-16 Elemental Analysis - Titanium
Figure 3-17 Elemental Analysis - Mercury
Figure 3-18 Elemental Analysis - Uranium
Figure 3-19 Elemental Analysis – Zinc
Figure 3-20 Static Testing Results – S(T) versus Cobalt
Figure 3-21 Static Testing Results – S(T) versus Cadmium
Figure 3-22 Static Testing Results – S(T) versus Selenium
Figure 3-23 Static Testing Results – S(T) versus Silver
Figure 3-24 Static Testing Results – S(T) versus Lead
Figure 3-25 ABA Results – S(T) versus Paste pH

Figure 3-26 Eagle Deposit Sediment Total Sulfur
Figure 3-27 ABA Results – S(T) versus $S(SO_4)$
Figure 3-28 ABA Results – Acid Potential
Figure 3-29 ABA Results – Neutralization Potential
Figure 3-30 ABA Results – Total Inorganic Carbon
Figure 3-31 Eagle Deposit Sediment Total Inorganic Carbon
Figure 3-32 ABA Results – TIC versus NP
Figure 3-33 ABA Results – AP versus NP
Figure 3-34 ABA Results – S(T) versus NNP
Figure 3-35 Kinetic Test Samples AP and NP
Figure 3-36 SPLP Results – pH vs. Paste pH
Figure 3-37 SPLP Results – pH vs. NP
Figure 3-38 SPLP Results – pH vs. Calcium
Figure 3-39 SPLP Results – pH vs. Magnesium
Figure 3-40 SPLP Results – pH vs. Copper
Figure 3-41 SPLP Results – pH vs. Nickel
Figure 3-42 SPLP Results – S(T) vs. Nickel and Copper
Figure 3-43 SPLP Results – pH vs. Cobalt
Figure 3-44 SPLP Results – pH vs. Arsenic
Figure 3-45 SPLP Results – pH vs. Selenium
Figure 3-46 SPLP Results – pH vs. Antimony
Figure 3-47 SPLP Results – pH vs. Lead
Figure 3-48 SPLP Results – pH vs. Chromium
Figure 3-49 SPLP Results – pH vs. Vanadium
Figure 3-50 SPLP Results – pH vs. Aluminum
Figure 3-51 SPLP Results – pH vs. Iron

LIST OF APPENDICES

Appendix A Kinetic Testing Graphs
Appendix B Quality Assurance/Quality Control Report
Appendix C Canadian Environmental Metallurgical Inc. Static Testing Report
Appendix D Canadian Environmental Metallurgical Inc. Kinetic Testing Report
Appendix E Leslie Investments Inc. Research and Consulting Mineralogy Reports (Part I and II)

1.0 INTRODUCTION

1.1 Project Description

This report presents the results of the Eagle Project Phase I Acid Rock Drainage (ARD) characterization study conducted by Geochimica, Inc. (Geochimica) and Golder Associates, Inc. (GAI) in co-ordination with Kennecott Exploration Company (KEX). The project, a nickel-mineralized peridotite occurrence, is located on the Yellow Dog plains in the Michigamme Township of Marquette County in the Upper Peninsula, Michigan, U.S.A..

The Eagle deposit is a magmatic sulfide deposit hosted in ultramafic rocks. Previous characterization has identified the following principal sulfide minerals: pyrrhotite [$Fe_{1-x}S$], chalcopyrite [$CuFeS_2$], and pentlandite [$(Ni,Fe)_9S_8$]. If exposed to atmospheric oxygen and modest fluxes of water, these sulfides will oxidize and dissolve, releasing sulfate and metals into solution and generating acidity. Unless there is adequate, readily-available neutralization potential in the rocks, the net effluent from surficial weathering could become acidic. Under low-pH conditions, most metals (e.g., Fe, Cu and Ni) and metalloids (e.g., As) are soluble, and so subject to leaching and transport as dissolved species. Thus, the acidity generated by oxidation of primary sulfides also may leach metals and metalloids from non-sulfide phases, including potentially from ferromagnesian silicates or even under extreme conditions from primary oxides.

The objective of the Phase I study was to provide an initial "order-of-magnitude" evaluation of the risks of acid generation, metals leaching, and other geochemical concerns associated with mining of the Eagle deposit. The Phase I testing program was designed to evaluate the spatial distribution (x, y, z), by lithology, of the geochemical characteristics of the Eagle deposit that could affect the reactive geochemistry of waste materials during surficial weathering.

1.2 Geologic Description

The geology of the deposit is described in *Report on the Geology of the Eagle Nickel-Copper Deposit* (Rossell and Coombes, 2004). The deposit is hosted by two peridotite intrusions. Peridotites are intrusive, ultramafic igneous rocks composed chiefly of pyroxene and olivine; during intrusion, interactions with shallow meteoric waters typically alter some of the primary silicate minerals to hydrated secondary minerals called serpentine, and iron and other metals may be converted to oxides. Chemically, peridotites are low in silica and alumina, but elevated in ferrous iron and, particularly magnesia. Some ultramafic rocks develop immiscible iron, nickel and copper sulfides that can concentrate locally near the margins of the intrusions. The eastern and western intrusions are referred to as the **East Eagle** and **Eagle** deposits, respectively (Figure 1-1). Drilling at East Eagle to date has not identified economic grades of nickel and copper.

Three distinct types of sulfide mineralization occur in the Eagle deposit: massive, semi-massive (or net-textured) and disseminated. There are two sulfide zones in the Eagle deposit, referred to as the Upper Sulfide and Lower Sulfide zones. The peridotites intrude siltstones and sandstones. Hornfels alteration occurs in the siltstone or sandstone near the hanging wall contact of the Eagle peridotite. Olivine alteration to lizardite occurs locally in the peridotites.

A typical stratigraphic column is presented as Figure 1-2. This figure describes the three types of mineralization and where they occur. The main rock types and their location relative to the mineralized zones are shown.

1.3 Previous Geochemical Characterization

In Summer 2003, KEX submitted twelve drill core samples to ALS Chemex (Chemex) of North Vancouver, British Columbia (BC) for geochemical characterization (i.e., acid-base accounting (ABA) and trace metal analysis). The results of this testing, referred to in this report as the "Phase 0" testing, were considered in the current evaluation. Testing procedures and results are discussed in Sections 2 and 3.

2.0 PHASE I CHARACTERIZATION PROGRAM

2.1 Overview

The Phase I program focused on characterization of the deposit with the greatest economic potential (i.e., the Eagle deposit) (Figure 1-1). Although the characterization encompassed all material types, greater emphasis was placed on geochemical testing of the sediments (i.e., sandstones and siltstones) and hornfels, the materials most likely to be stored temporarily as waste on the surface.

The testing program included both static (short-term) and kinetic (long-term) testing. The objective of static testing is to describe the bulk chemical characteristics of a waste material. These tests are designed to evaluate the potential of a particular rock type to leach metals or generate acid. Static testing is typically the first phase of geochemical characterization, and usually is a precursor to kinetic testing. Although the results of static testing may indicate a potential for acid rock drainage and/or metal leaching (ARD/ML), kinetic testing is required to verify whether the various ARD/ML potentials identified will indeed be realized over time.

Data collected as part of the Phase I study may ultimately be used in evaluations, the results of which may be compared to regulatory or risk-based limits. Determination of the analyte suite and required reporting limits therefore considered all applicable and relevant state and federal water quality regulations. Relevant state (Michigan Department of Environmental Quality – MDEQ) and federal (Environmental Protection Agency – EPA) freshwater and drinking water criteria are summarized in Table 2-1. Analytical methods were selected to achieve (whenever technically possible) reporting limits below applicable state and federal water quality criteria.

This chapter describes the rationale for sample selection and the components of the static and kinetic testing programs.

2.2 Sample Selection

Rock samples for static and kinetic testing were selected from 2003 drill core by Steven Coombes, a KEX project geologist intimately familiar with the deposit. The Eagle drill plan is shown in Figure 2-1. Figures 2-2 and 2-3 show the spatial distribution of the thirty samples selected for testing. These figures also show the locations of the twelve samples previously characterized by KEX. A complete sample listing (i.e., Phase I and KEX Phase 0 samples) is shown in Table 2-2.

Sample selection considered the following criteria:

- **Lithology** – Individual samples selected for testing were representative of a single lithology.

- **Spatial Representation (x, y, z)** – Samples were selected to ensure good spatial representation (vertical and horizontal) of the area to be mined, focusing on the Eagle deposit (western deposit). Sample representation included both the Upper and Lower Sulfide Zones of the Eagle deposit. Samples were selected from both the hanging wall and foot wall. ("Hanging wall" and "foot wall" refer to the locations of the sediment samples collected from above and below the intrusive, respectively.)

- **Compositional Representation** – Sample selection included all major material types including: massive sulfide (MSU), semi-massive sulfide (SMSU), peridotite (PER),

sediments (siltstone (SLST) and sandstone (SDST)) and hornfels (HFL). Although slates/shales occur in the foot-wall sedimentary units, these material types were not characterized as part of the Phase I program because there is no plan for mining to intersect these rock types. Sample selection was biased toward characterization of the host rock, which is expected to provide the overwhelming majority of waste rock stockpiled at surface for the Eagle Project. For the sulfide samples from the MSU and SMSU, representation of a range of copper contents was also considered.

By ensuring good spatial representation, it was expected that compositional variability within distinct lithologies would be captured (e.g., carbonate veining observed in peridotite core).

The forty-two, Phases 0 and I samples are divided lithologically as follows (number of samples provided in parentheses): massive sulfide (5), semi-massive sulfide (6), peridotite (9), pyroxenite (2), siltstone (14), sandstone (3) and hornfels (3).

2.3 Geochemical Characterization Program

The testing program included the following components: whole-rock chemistry, acid-base accounting (ABA), short-term metal leaching, long-term column testing and mineralogical analysis. A description of each of these components follows.

The primary laboratory for this study was Canadian Environmental Metallurgical Inc. (CEMI) of Vancouver, BC. CEMI contracted portions of the analytical testing to Chemex and ALS Environmental (ALS), as identified below. Analytical methods and procedures are (or are technically consistent with) those of the U.S. Environmental Protection Agency and other standard compilations of methods for analytical chemistry, as documented in Geochimica (2004). The analytical laboratories hold standard certifications from provincial and federal agencies in Canada, using approaches that are consistent with those of equivalent agencies in the United States.

2.3.1 Static Testing

CEMI's static testing report, which includes descriptions of the analytical methods applied, analytical results, and QA/QC reporting, is provided as Appendix C.

2.3.1.1 Whole-Rock Chemistry

The chemical composition of the thirty Phase I rock samples was characterized by Chemex. Whole-rock chemical analysis was by X-Ray fluorescence spectroscopy (XRF) following decomposition in lithium tetraborate (Chemex method MEXRF-06). Results were presented as the total elemental weight percent composition of the sample as oxides for the major rock forming elements (i.e., Al_2O_3, BaO, CaO, Cr_2O_3, Fe_2O_3, MgO, MnO, P_2O_5, K_2O, SiO_2, Na_2O, SrO and TiO_2). The reporting limit for all elements was 0.01 wt. %.

The concentration of fifty elements was determined by inductively coupled plasma mass spectrometry (ICP-MS) or inductively coupled plasma atomic emission spectroscopy (ICP-AES) following an Aqua Regia digestion (Chemex method ME-MS41). Chemex's description of this method, including the digestion step, is presented in Appendix C.

The 12 Phase 0 samples were also submitted to Chemex for chemical characterization; however, different analytical methods were applied. The concentrations of seven major rock forming elements (i.e., Al_2O_3, CaO, Fe_2O_3, MgO, MnO, SiO_2, and TiO_2) and eight trace metals (i.e., As, Co, Cr, Cu, Ni, Pb, S and Zn) were determined by ICP-AES following sodium peroxide fusion (Chemex method ME-ICP81). Precious metals analysis (i.e., Au, Pt and Pd) was also performed by ICP-AES following fire assay fusion (Chemex method PGM-ICP23 and PGM-1CP24). At the level of this study, the differences in analytical methods between Phase 0 and Phase I are not considered significant in evaluating the likely environmental behavior of rocks that may be handled at the Eagle Project.

2.3.1.2 Acid-Base Accounting

Acid-base accounting was performed on 42 samples (i.e., 12 Phase 0 and 30 Phase I samples). ABA testing is conducted to predict the acid neutralizing potential (NP) and acid generation potential (AP) of a material. ABA analysis included determination of the following (method descriptions provided in Appendix C):

- Bulk neutralization potential (NP) by modified Sobek;
- Carbonate neutralization potential (CaNP) by total inorganic carbon (TIC) analysis;
- Paste pH; and,
- Acid potential (AP) by sulfur determination (total sulfur (S_T) and sulfate sulfur (S_{SO4})).

Brief descriptions of each analysis are provided below; details and citations are included in Appendix C.

The bulk NP of a material is determined by treating the sample with a known excess of hydrochloric acid, and back-titrating the amount of unconsumed acid with sodium hydroxide. The principal neutralizing minerals in most geologic materials are calcium and magnesium carbonates. Additional neutralizing minerals accounted for in the determination of bulk NP include basic silicates such as calcic feldspars, lizardite, olivine, amphiboles, and biotite. However, due to their generally slower dissolution rates, the contribution to the overall NP of most of these minerals is generally considered to be small under ambient conditions. However, as will be discussed in Section 3.1.2, olivine and lizardite are important sources of available NP in the Eagle rocks. Felsic silicates, such as sodic and potassic feldspars, muscovite, most clay minerals, and quartz, do not contribute significantly to the NP. The NP is expressed in conventional units of tonnes of calcium carbonate equivalent per 1,000 tonnes of material (t $CaCO_3$/ 1,000 t), representing the capacity of the solids to neutralize acid, but not necessarily implying that calcite ($CaCO_3$) is present.

The carbonate neutralization potential (CaNP) of a sample is determined from its total inorganic carbon content (TIC). TIC is determined by measuring the amount of carbon dioxide (CO_2) evolved from an acidified sample. CaNP is a measure of the neutralization capacity of a sample afforded by carbonate minerals only, while assuming all carbonates react like calcite. As noted earlier, only calcium and magnesium carbonates are the principal neutralizing minerals in most geologic materials. Iron and manganese carbonates (e.g., siderite [$FeCO_3$], ankerite [$CaFe(CO_3)_2$], and rhodochrosite [$MnCO_3$]) do not contribute buffering capacity since subsequent hydrolysis of the Fe and Mn tends to generate acidity. Therefore, if iron and manganese carbonates are present, CaNP will overestimate the neutralizing capacity of a material. The potential for overestimation can be addressed explicitly through careful mineralogical evaluations (see Section 3.1, below).

Paste pH is a qualitative corollary of the NP, and provides additional information on the neutralizing capabilities of a material. It is determined by mixing the solid with a fixed amount of distilled water, and measuring the pH of the resulting slurry.

The AP of a material is derived from a sulfur determination. For the current study, total sulfur and sulfate sulfur were determined using Leco furnace and a hydrochloric acid (HCl) extraction, respectively. The most environmentally conservative approach to calculate AP is to make the assumption that all sulfur in a sample is potentially reactive and therefore capable of generating acid. However, this ignores the fact that not all sulfur will contribute acidity (e.g., sulfur in gypsum, barite, or chalcocite). For this study, AP was calculated using sulfide sulfur, and assuming that sulfide sulfur was equal to the difference between total sulfur and sulfate sulfur. As for NP, the AP is expressed as (t $CaCO_3$/ 1000 t). By convention in ABA studies, one assumes that the sulfide sulfur is present entirely as pyrite (FeS_2), and the stoichiometry of pyrite oxidation is used to calculate a theoretical amount of sulfuric acid that could be generated, then requiring neutralization by hypothetical $CaCO_3$.

For the current study, samples were submitted to CEMI who performed the paste pH and NP analyses in-house. Chemex was subcontracted to perform the sulfur speciation and TIC analyses. ABA testing on the twelve Phase 0 samples was conducted entirely by Chemex.

2.3.1.3 Short-Term Leach Testing

Ten of the thirty Phase I samples were selected for short-term metal leach testing following the Environmental Protection Agency's Synthetic Precipitation Leaching Procedure (SPLP) (EPA Method 1312). Leach test samples were selected following review of ABA, whole-rock and trace-metal analysis results. Sample selection considered the following:

1. Representation of all lithologies;

2. Representation of a range of total sulfur contents; and,

3. Spatial representation (i.e., mineralized and non-mineralized zones, hanging-wall and foot-wall).

SPLP tests were conducted on the minus-9.5 mm fraction for 22 hours at a solid to solution ratio of 1 to 20 by weight. A pH 4.2 lixiviant (60% sulfuric/40% nitric acid solution), which is considered representative of "acid rain" generated in industrialized areas, was applied.

The short-term nature of the SPLP test provides a snapshot in time of a material's environmental stability. Test results depend entirely on the present disposition of the sample (e.g., unoxidized vs. oxidized; oxidation products absent vs. present, etc.). For reactive rocks, the mechanisms that lead to changes in solution chemistry during water-rock interactions often develop over periods of time that are much greater than can be represented in a 22-hour extraction test. For this reason, kinetic testing is conducted to address chemical changes in the waste initiated by long-term microbiological and abiotic chemical processes. One of the advantages of short-term leach testing is the ability to rapidly test many samples at a modest unit cost. The results of short-term leach testing may be considered in the selection of samples for long-term kinetic testing.

2.3.2 Kinetic Testing

2.3.2.1 Column Leach Testing

Kinetic testing is conducted to verify whether the various ARD/ML potentials identified through static testing will be realized. These tests are also used to determine reaction rates and evaluate the leachability of trace metals.

Five long-term leach tests are currently being conducted by CEMI. Kinetic testing samples were selected from the Phase 0 samples (sample locations identified in Figure 2-2). To provide the maximum information possible during the Phase I schedule, kinetic testing was initiated in advance of the Phase I static testing using the Phase 0 samples that already had preliminary static characterization. Sample breakdown by lithology is as follows: massive sulfide (1), semi-massive sulfide (1), peridotite (1) and siltstone (2). Kinetic testing was initiated on February 20, 2004. This report presents testing results for weeks 1 through 7. Testing will continue to at least 20 weeks, and Kennecott Minerals Company (Kennecott Minerals) expects that some or all of these samples will be tested for even longer periods. CEMI's interim kinetic testing report, which includes a description of testing protocols and analytical results to date, is included as Appendix D to this report. A brief description of the testing design follows.

Testing columns were charged with approximately 2 to 4 kg of rock, crushed to minus $^{3}/_{8}$ inch with a jaw crusher. Prior to charging, a sieve analysis was conducted on each sample to allow for calculation of sample surface area, to be used in the determination of weathering rates. The pore volume of each column was determined by filling the column with lab-grade distilled water. Columns were drained and the leachate volume measured and analyzed (Week 0).

The column leach tests simulate weathering under surface conditions by subjecting each sample to alternate periods of moist and dry air. Once every week, the column is flushed with 500 mL of lab grade distilled water, and the solution is analyzed. The liquid to solid ratio used for this study varies from approximately 1:8 by weight for the semi-massive sulfide sample to 1:3 for one of the siltstone samples. The difference in ratios derives from both differences in the specific mass in the columns and also from the much higher grain density of the sulfides compared to the alumino-silicates that dominate the siltstones.

Leachates from each weekly cycle are analyzed for ARD indicator parameters including pH, redox, conductivity, alkalinity, acidity, calcium, magnesium, iron and sulfate. Leachate pH, acidity, iron and sulfate are used to assess the degree and rate of sulfide oxidation. Leachate alkalinity, calcium and magnesium provide information on the neutralization capacity of the rock and the mineral phases (e.g., calcite or dolomite) responsible for neutralization.

Leachate from Weeks 0, 1, 3, 5, 10, 15 and 20 are scheduled for more comprehensive analysis including major ions, trace metals, metalloids and nutrients. With the exception of pH, redox, alkalinity, acidity and sulfate, chemical analyses are performed by ALS.

Kinetic testing is scheduled to be conducted for a minimum period of 20 weeks. Kinetic testing is generally performed until stabilization of sulfate generation and metal leaching rates. This sometimes requires extending the testing beyond the standard 20-week period. Stabilization is defined as a 5-week period of approximately constant rates (Price, 1997).

The results of kinetic testing may be applied to evaluate the following:

- The oxidation rate of sulfides from waste materials;
- The relative rates of acid generation and acid neutralization to assess the likelihood for acid generation from waste materials;
- The timing of the onset of acid generation; and,
- The composition of waste rock runoff and seepage (i.e., metal leaching under variable pH conditions).

2.3.3 Mineralogical Analysis

Mineralogical analysis was performed by Dr. John Jambor of Leslie Investments Inc. Research and Consulting (LRC), Tsawwassen, BC. Preliminary mineralogical analysis of the five kinetic testing samples was performed first. This set of initial samples was supplemented with the 10 additional samples for which SPLP tests were conducted in the Phase I program. For simplicity, these will be called "SPLP samples" to distinguish the ten additional samples. Because the initial five samples are undergoing kinetic tests, they will be called "kinetic-testing samples" in some places below. Mineralogical analysis was conducted to confirm aspects of the current understanding of the mineralogy of the ore body, with particular reference to some of the possible environmental behavior of minerals during weathering. Analysis of the siltstone and peridotite samples was intended to provide additional characterization of the country-rock mineralogy, including identification of mineral phases with neutralization potential. In addition, Dr. Jambor was asked to identify specific serpentine minerals and asbestiform characteristics, if present.

Mineralogical analysis included the following: optical microscopy, x-ray diffractometry (XRD), quantitative XRD using the Rietveld method and reconnaissance scanning electron microscopy with qualitative energy-dispersive analysis (SEM-EDS).

2.4 Quality Assurance/Quality Control

A primary data quality objective (DQO) of the ARD characterization program is to provide analytical data that are of known and defensible quality. To ensure a defensible data set, the following protocols have been adhered to:

1. Careful selection of analytical laboratories following compilation and review of relevant information (e.g., laboratory QA/QC protocols, achievable reporting limits, analytical accreditation and colleague feedback).
2. Selection of appropriate analytical methods (e.g., selenium analysis by hydride vapour atomic absorption spectrometry (HVAAS) in addition to ICP-MS).
3. Inclusion of quality control samples in sample delivery groups (i.e., duplicate and equipment blank samples).
4. Data validation of analytical packages following guidelines presented in *USEPA Contract Laboratory Program Functional Guidelines for Inorganic Data Review* (EPA, 2002).

5. Data reduction on an ongoing basis to identify data anomalies (i.e., calculation of charge balance errors, plotting of kinetic testing results as received to identify anomalous concentration trends).

The results of data validation and data reduction pertaining to assessment of the quality of the analytical data generated in this study are provided in a separate QA/QC report (Appendix B).

3.0 PHASE I TESTING RESULTS

This section presents the results of each component of the Phase I testing program. An overall assessment of the ARD/ML potential of waste materials based on the collective interpretation of all test results is provided in Section 4.0.

3.1 Mineralogy

Dr. Jambor's mineralogy reports are provided as Appendix E to this report (Jambor, 2004a and 2004b). Parts 1 and 2, issued in April 2004 and May 2004, present the results of mineralogical analysis of the five kinetic-testing samples and ten SPLP samples, respectively. This section summarizes the findings of the mineralogical investigation. Mineralogical results of the five Part 1, kinetic-testing, samples are discussed in detail, to provide a basis for the interpretation of the kinetic testing results presented in Section 3.4. Supplemental information from the Part 2 analyses (SPLP samples) also are discussed where the additional information adds qualitatively to the conclusions form the initial samples. For detailed discussions of the fifteen samples for Phase I, the reader should consult the two mineralogy reports in Appendix E.

3.1.1 Sulfide Mineralogy

Sulfide mineralogy is of paramount environmental significance for a sulfide-ore body such as Eagle because after mining the sulfide minerals are subject to oxidation and dissolution, with potential for subsequent generation of acidity and leaching of metals. The potential for oxidation and release of metals depends on the specific sulfide minerals present in each rock type that may be mined. Because the Ni-Cu ore that is the economic target at Eagle is present in an intrusive rock, it is important to evaluate sulfide mineralogy in not only the ore zone, but also in the peridotite country rock and in the sedimentary host rocks into which the peridotite intruded.

Sulfide ore zones in mafic to ultramafic rocks represent the accumulation of immiscible sulfide liquids that, because their density was so much greater than that of the general silicate magma, migrated under gravity during the intrusion and fractional crystallization of the rocks in which they are found now (Naldrett, 1989; Foose *et al.*, 1995). Well-known examples in North America include the Duluth Complex (MN) and the Stillwater Complex (MT). The currently observed sulfide mineralogy in such deposits reflects a complex, solid-state recrystallization history, and the specific locations within the ultramafic rock where the sulfides accumulate are a function of the individual physical conditions that occurred in each intrusive body where these are found. Because of fundamental, physico-chemical controls having to do with chemical bonding of the transition elements, the immiscible sulfide liquids concentrate some important trace metals, including Ni, Cu, and Co (Pauling, 1960; Burns, 1970; Cotton and Wilkinson, 1988). Iron (Fe) is less strongly partitioned to the sulfide phase, but because it is present in such high proportion in the original magma, Fe is typically the most important metal (by mass) in the immiscible fluid. During the crystallization (and subsequent recrystallization) process, these transition metals precipitate as sulfide minerals. Iron occurs in pyrrhotite [$Fe_{1-x}S$], often with substitution by Co and Ni that are preferentially partitioned to the sulfide liquids, as well as the pentlandite [$(Fe,Ni)_9S_8$] and chalcopyrite [$CuFeS_2$] that are the principal reservoirs of Ni and Cu, respectively. These magmatic sulfide minerals also may contain other trace metals and metalloids.

Four massive/semi-massive samples were submitted for mineralogical analysis. In the Eagle deposit, the primary sulfide phases of the massive and semi-massive units identified by Dr. Jambor's

mineralogical analysis (listed in order of typical abundance) were pyrrhotite [$Fe_{1-x}S$], chalcopyrite [$CuFeS_2$] and pentlandite [$(Fe,Ni)_9S_8$], in good accord with expectations for a massive sulfide of this sort. All three of the dominant sulfides have metal:sulfur ratios near 1:1. Pyrrhotite accounted for approximately half the total sulfide content of the kinetic-testing massive sulfide sample, for which the reported total sulfur content was 36.1 wt. %. Intergrowths of pentlandite and chalcopyrite were observed in pyrrhotite, but only in small amounts. The pyrrhotite in the kinetic-testing massive sulfide sample was described as smooth and uniform; whereas, in the kinetic-testing semi-massive sample, the pyrrhotite grains were fractured. Only pentlandite (not chalcopyrite) intergrowths in pyrrhotite were observed in the kinetic-testing semi-massive sample; however, such intergrowths were not common. Because of the simple dominant mineralogy, the massive and semi-massive units are highly elevated in transition metals compared to average crustal rocks and the surrounding, older country rocks, primarily in Fe, Ni, Cu and Co.

The total sulfur contents of the hanging-wall and foot-wall siltstone samples undergoing Phase I kinetic testing were similar at 1.23 wt. % (foot-wall) and 1.06 wt. % (hanging-wall), respectively. Most of the sulfide grains in siltstones were described as sub-millimetric, disseminated, and encapsulated by silicate or oxide minerals. The occurrence of fracture-controlled sulfides was inconclusive in the initial samples. Pyrrhotite was identified as the primary sulfide phase in both samples. Pyrite [FeS_2] was also identified in both samples. The pyrite content of the hanging-wall sample returned by Rietveld analysis (3.9 wt. %) was noted by Jambor to be high based on optical review of polished thin sections. For reference, the pyrrhotite content of this sample was 3.0 wt. %. Pyrite was below quantifiable limits in the foot-wall sample. Small amounts of chalcopyrite and sphalerite [(Zn,Fe)S] were also identified in the hanging wall sample. Textures of chalcopyrite in the siltstone were very distinct from those in the sulfide ores, and pentlandite was not identified.

The total sulfur contents of the hanging-wall and foot-wall siltstone SPLP samples examined were 0.77 and 1.39 wt. %, respectively. The major mineral assemblages of these siltstone samples were similar to the kinetic testing samples with regard to their environmental mineralogy. Pyrite and pyrrhotite were identified as the primary sulfides in the hanging-wall and foot-wall samples, respectively.

The total sulfur content of the peridotite kinetic-testing sample examined was relatively low (0.2 wt. %). Sulfides were not visible megascopically; however, microscopic evaluation identified pyrrhotite as the primary sulfide, accounting for 90% of the total sulfide content. Pentlandite and chalcopyrite, listed in order of relative abundance, were also observed.

A single SPLP pyroxenite sample was examined. Pyrrhotite in this sample was converted to marcasite [FeS_2], making marcasite the most abundant sulfide (marcasite > chalcopyrite > pentlandite > pyrite > pyrrhotite). Trace cubanite [$CuFe_2S_3$] was also identified.

The two SPLP hornfels samples examined yielded total sulfur contents of 0.67 and 2.72 wt. %. Pyrite, pyrrhotite and chalcopyrite were present in both samples. Trace sphalerite was present in the higher-sulfur sample.

3.1.2 Minerals with Neutralization Potential

As with the sulfides, the mineralogical controls of neutralization potential must be considered with respect to the specific lithologies and their genetic and intrusive relationships in the area of the Eagle deposit.

The presence of phases with neutralization potential in the kinetic-testing massive sulfide sample is negligible because there is very little silicate or other gangue in these materials. Although the measured NP of the kinetic-testing semi-massive sulfide sample was 41 t $CaCO_3$/1,000 t, mineralogical analysis initially suggested that this value was anomalously high. Carbonates, if present, occurred in only trace amounts. Therefore, all NP was attributed to olivine and lizardite which, while neutralizing minerals, may react at rates slower than those for carbonate minerals. Although slower to react than carbonates, olivine and fine-grained, high-surface-area, Mg-rich lizardite are among the fastest reacting silicate minerals (Jambor, 2004a). Jambor's report (Part 2, Appendix E) presents results from other published studies for NP determinations on pure mineral phases using the Sobek method. The range of reported NP values (in t $CaCO_3$/ 1,000 t) for olivine (i.e., forsterite) and lizardite is as follows: 23.9 to 40.2 (olivine) and 16.1 to 22.5 (lizardite). NP determinations using the modified Sobek method (the method used in this study) yielded higher values for both olivine and lizardite. These experimental data are consistent for the Eagle samples with (a) the identification of Mg-rich olivine and (b) the observed kinetic behavior of samples during column testing. The neutralization potential of olivine and lizardite will be explored further in subsequent mineralogical analyses as part of Phase II.

The peridotite sample undergoing kinetic testing contained small amounts of calcite [$CaCO_3$], with the bulk of the NP attributed to olivine and lizardite. Calcite typically occurred as minute, polycrystalline aggregates. Mineralogical analysis of the SPLP samples also showed low carbonate contents for the peridotite and pyroxenite. Most of the measured NP was attributed to the presence of olivine and serpentine.

Calcite and dolomite [$CaMg(CO_3)_2$] were both identified in the siltstone samples undergoing kinetic testing. The iron and manganese contents of both carbonates were determined to be very low, so it seems likely that calculated values of CaNP can be taken as effective. Carbonate phases occurred as fill in fractures or in association with spotted alteration. Zones of spotted alteration, interpreted to be a thermal metamorphic effect, were the loci of deposition of carbonate phases, in addition to other minerals (i.e., chlorite, quartz and K-feldspar). Chlorite [most commonly $(MgFe)_5Al(Si_3Al)O_{10}(OH)_8$] also contributed to the NP of the siltstones.

Part 2 of the mineralogical evaluation confirmed that carbonate (in secondary veins) is common in the country rocks near the intrusive. Fracture-fill carbonates, both calcite and dolomite, were identified in the siltstone and hornfels SPLP samples. The iron and manganese contents of the calcite and dolomite were low, which means that the carbonate NP determinations indeed represent available NP. The presence of siderite [$FeCO_3$] was restricted to the SPLP massive sulfide sample.

3.1.3 Host Mineralogy

Olivine [Mg_2SiO_4], clinopyroxene [$(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$], and plagioclase [$NaAlSi_3O_8$ – $CaAl_2Si_2O_8$ solid solution] were the principal silicate minerals in the peridotite. They are primary minerals formed during crystallization of the silicate portion of the magma. As this ultramafic rock intruded into the shallow crust, it interacted with local waters, producing a so-called "deuteric" alteration in which both mafic and felsic minerals react with water to form secondary mineral phases. The role of water in the deuteric alteration can be identified mineralogically by the presence of low-temperature minerals containing hydroxyl (OH-) radicals, such as lizardite, talc, and chlorite.

Much of the olivine was altered to non-fibrous lizardite serpentine [$Mg_3Si_2O_5(OH)_4$]. The kinetic-testing semi-massive sample examined showed more alteration of olivine to lizardite than observed in

the kinetic-testing peridotite sample. Whether this is a general feature, perhaps related to the smaller relative volume of silicate gangue in the net-textured rock, or is a specific feature of the individual sample cannot yet be determined. In one of the Part 2 peridotite samples, partial alteration of olivine to lizardite was observed, and the lizardite identification was confirmed by X-ray diffraction. No asbestiform serpentine was observed either macroscopically or microscopically, or identified by X-ray diffraction in any sample of the Phase I study. Because the high-sulfide zones are relatively close to the margins of the Eagle peridotite, it seems plausible that there was more convective circulation of meteoric water into the intrusion than in more interior parts of the peridotite, leading to greater deuteric alteration and hence a higher proportion of lizardite. The kinetic-testing peridotite sample also contained abundant chlorite (20.6 wt. %) and talc [$Mg_3Si_4O_{10}(OH)_2$] (10.8 wt. %), with the talc occurring at the periphery of the altered olivine. These phases were not present in quantifiable amounts in the kinetic-testing semi-massive sulfide sample.

During deuteric alteration, it is common for a portion of the Fe and Ti content of the pyroxene to report to secondary iron oxides such as magnetite or ilmenite. Magnetite [Fe_2O_4] (~5 wt. %) was the fourth-important non-sulfide mineral phase identified in the kinetic-testing massive sulfide sample. The magnetite contents of the kinetic-testing semi-massive and peridotite samples were quantified by XRD as 12 wt. % and 8.4 wt. %, respectively. The magnetite content of the peridotite sample was interpreted as high. Megascopic identification indicated ilmenite [$FeTiO_3$] as the more abundant iron oxide phase in the kinetic-testing peridotite sample.

Quantitative mineralogical analysis of the kinetic-testing siltstone samples yielded similar abundances between samples for the non-sulfide mineral phases as follows: quartz [SiO_2] (~28 wt. %), muscovite [$KAl_2AlSi_3O_{10}(OH)_2$] (~40 wt. %), chlorite (~19 wt. %), plagioclase (albite) [$NaAlSi_3O_8$] (~12 wt. %) and kaolinite [$Al_2Si_2O_5(OH)_4$](~ 2 t. %).

3.2 Rock Chemistry

Whole-rock and trace-metal results are presented in Tables 3-1 and 3-2, respectively. These tables include data from the Phase 0 testing. For each lithology, summary statistics[1] (i.e., minimum, maximum, average and standard deviation) are provided. The twelve sets of results Phase 0 samples were combined with those of the thirty Phase I samples to provide a larger dataset from which to generate statistics.

Average concentrations by rock type for the major elements (i.e., Al, Ca, Fe, Mg and Si) are shown in Figures 3-1 through 3-5. The observed concentration trends are consistent with our understanding of the ore and host rock mineralogy. For reference, these figures also show the average abundance of these elements in the earth's crust, argillites/sandstones (representing the siltstones/sandstones) and ultramafic rock.

The trace-metal content of each rock type was evaluated to identify potential metals of concern, although it should be understood that a high concentration of a particular element does not necessary imply that this element will indeed be mobilized in concentrations that may lead to environmental impacts. Average concentrations by rock type for the following elements are shown in Figures 3-6 though 3-19: antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), nickel (Ni), selenium (Se), silver (Ag), titanium (Ti), mercury (Hg), uranium (U) and zinc

[1] Concentrations reported as below detectable limits are assumed to be equal to the detection limit in statistical calculations.

(Zn). For reference, these figures also show the average abundance of these elements in the earth's crust, argillites (which were taken to be equivalent to the siltstones/sandstones at the Eagle site by KEX) and ultramafic rock.

In addition to copper and nickel, the following elements show enrichment in the Eagle samples relative to the reference materials for one or more rock type: cadmium, arsenic, cobalt, selenium, silver and lead.

Cobalt has been demonstrated to occur at elevated levels in the Eagle pyrrhotite (Jago, 2002). This is supported by the good correlation observed between total sulfur and cobalt as shown in Figure 3-20. Cadmium, selenium, silver and lead (although to a lesser extent) also show a correlation with total sulfur (Figures 3-21 through 3-24). Figure 3-24 shows higher lead concentrations in the foot-wall siltstones than the hanging-wall samples.

3.3 Acid-base accounting

ABA results from the Phase 0 and Phase I studies are shown in Table 3-3. Summary statistics by lithology are provided.

The massive sulfide samples were the only samples to report acidic paste pH values, ranging from 3.7 to 6.4. All other rock types reported paste pH values from neutral to distinctly alkaline (i.e., 7.6 to 9.7) (Figure 3-25).

The total sulfur content of the massive sulfide samples is relatively uniform, ranging from 32 to 38 wt. % (Figure 3-25). The semi-massive sulfide samples typically report a narrow range of total sulfur contents (approximately 12 to 15 wt. %). A one-percent total sulfur cutoff appears to distinguish the peridotite samples identified as mineralized versus non-mineralized. The four mineralized peridotite samples reported total sulfur values of a few percent (2.4 to 3.7 wt. %). Most (i.e., 4 out of 5) of the non-mineralized peridotite samples had low total sulfur contents (i.e., 0.3 wt. % or below).

The total sulfur content of the sediment samples (i.e., siltstones and sandstones) ranged from 0.2 to 1.4 wt. %. There is some mobilization of the sulfide mineralization into the country rock in the form of veins near the peridotite intrusive. The sedimentary rocks outside of the zone of influence of the mineralization contain relatively low concentrations of iron sulfides. The three sandstone samples reported total sulfur contents at the low end of the sediment sample range (0.2 to 0.5 wt. %). Figure 3-26 shows the spatial distribution of total sulfur for the sediment samples. Lower total sulfur in the sandstone samples would be expected given their relatively distal location to the sulfide zones. The siltstone samples that yielded the lowest total sulfur contents were not the most distal samples. For example, the shallowest siltstone samples from drill holes 03EA030 and 03EA032 reported greater than 1 wt. % total sulfur. An obvious correlation between total sulfur content and proximity to the ore body is therefore not apparent from the current data set.

The sulfate contribution to total sulfur for all samples was small (Figure 3-27). The massive sulfide samples reported the highest sulfate contents.

Average AP by lithology is shown in Figure 3-28. The average values for AP of the peridotite, pyroxenite, siltstone and hornfels data sets are similar, ranging from 32 to 49 t $CaCO_3$/1,000 t. Because the traditional AP calculation assumes that potential acidity is present as pyrite, AP

calculations are likely conservative for the current study (i.e., biased high). Oxidation of pyrrhotite, the primary sulfide mineral in the Eagle deposit, produces about 20% less acidity per mole than would oxidation of pyrite.

Average neutralization potential (NP) by lithology is shown in Figure 3-29. The average NP values for the semi-massive sulfide, peridotite and pyroxenite data sets are similar, ranging from 34 to 44 t $CaCO_3$/1,000 t. The siltstone and sandstone data sets show the greatest variability in measured NP. A histogram of sediment (i.e., siltstone and sandstone) NP values (inset to Figure 3-29) shows a bi-modal distribution. This bi-modal distribution is likely attributable to carbonate veining in the 3 sedimentary rock samples with elevated NP.

Average total inorganic carbon (TIC) by lithology is shown in Figure 3-30. The sedimentary rocks report the highest average TIC values. A bi-modal distribution is once again observed for TIC (inset to Figure 3-30). The spatial distribution of carbonate veining in the sedimentary units has not been well defined; however, it has been suggested that carbonate veining may be strongest proximal to the peridotite intrusions (S. Coombes, personal communication). The spatial distribution of TIC for sedimentary samples characterized to date is shown in Figure 3-31. These data show low TIC values (<0.05 wt. %) for the shallowest sedimentary samples.

Neutralization potential versus TIC is shown in Figure 3-32. As expected, a good correlation is observed between NP and TIC for the sedimentary samples. High NP values (> 60 t $CaCO_3$/1,000 t) are also reported for some peridotite and semi-massive sulfide samples with low TIC.

A number of criteria have been proposed for assigning an ARD potential to a material using ABA results. The most common approaches are those based on use of the neutralization potential ratio (NPR = AP/NP) and the net neutralization potential (NNP = AP - NP). For several reasons, no single ratio or NNP value has been identified to have universal applicability in terms of predicting acid generation. The actual threshold values for a particular solid are material-specific, and depend on many factors, including the amounts and types of acid generating and neutralizing minerals, their morphology, their grain size, their crystallinity, their chemical composition, their paragenesis, the material's texture, and the site-specific exposure conditions.

NPR guidelines presented by Price (1997) are summarized below:

Potential for ARD	Criteria	Comments
Likely	NPR <1	Likely acid generating, unless sulfide minerals are non-reactive.
Possible (uncertain)	1< NPR <2	Possibly acid generating if NP is insufficiently reactive or is depleted at a rate faster than sulfides.
Low	2< NPR <4	Not potentially acid generating unless significant preferential exposure of sulfides along fractures planes, or extremely reactive sulfides in combination with insufficiently reactive NP.
None	NPR >4	

AP versus NP is shown in Figure 3-33. Price's threshold NPR criteria of 1, 2 and 4 are superimposed on this figure. Most samples report NPR values less than one, and are therefore classified as likely acid generating. Most un-mineralized peridotite samples report NPR values greater than 4 and therefore are very unlikely to become acid generating. Because the TIC content of the peridotite samples is low, the bulk of the NP is likely attributable to olivine and lizardite. The sediment samples with high NP values, attributed to the presence of carbonates, also report NPR values greater than four. These samples, too, are classified as having no ARD potential.

NNP was also evaluated for each sample. A negative NNP indicates a general potential to generate acidic drainage whereas a positive NNP represents a propensity to neutralize any acid generated by the rock or mining waste. The samples that report NPR values greater than 4 also report positive NNP values (Figure 3-34).

3.4 Column Leach Testing

Kinetic leach testing is used in ARD investigations for two major purposes. Firstly, it confirms predictions of static ABA tests. Secondly, it produces experimental data on rates of sulfide oxidation, acid neutralization, and metals leaching from samples undergoing oxidation and infiltration in a variably saturated environment that can be related to ambient weathering conditions at a real field site. Column tests are well suited to evaluations of waste rock because the sample can be tested without having to crush it to size fractions that are not representative of materials that would be exposed in the field. However, bench-scale tests never can be perfect, one-to-one analogues of field-scale processes because of experimental conditions. The absolute leachate concentrations from laboratory kinetic tests do not necessarily represent the absolute concentrations that would be expected at a mine site during leaching of bulk mine wastes under ambient conditions. The specific constituent concentrations of testing leachates are a function not only of the underlying geochemistry of the samples, but also of the details of the experimental procedure. In general, the expected water-quality of a field-scale effluent would be different from that of the columns. Experimental data from this program and its Phase II extensions will be applied to develop estimates for weathering rates.

Kinetic testing leachate results are typically represented graphically in plots that show actual (and sometimes cumulative) concentrations versus time. The early stages of leaching are generally characterized by release of sulfate, metals, and acidity from readily-soluble components such as

sulfide oxidation products (e.g., sulfate salts, gypsum) that formed on the surfaces of samples before testing. Sulfate concentrations in leachates from later weeks are generally thought to be indicative of oxidation of sulfides (e.g., pyrrhotite, pentlandite, chalcopyrite and pyrite, in the case of the Eagle deposit).

Kinetic testing results for selected parameters are shown in Figures A-1 through A-32 (Appendix A). Because reporting limits differ between columns and over time, for easy identification, "non-detect" concentrations are shown as open symbols. Metal detection limits for ICP-OES are generally higher than those for ICP-MS, the analytical method applied for comprehensive analyses.

When available, solid phase data corresponding to the kinetic test sample are shown on the figures. For those elements not quantified in the Phase 0 testing, the average concentrations based on the full data set are shown.

For those parameters for which State or Federal regulatory limits are set, Figures A-1 through A-32 also plot the minimum regulatory limit that might be applicable were such waters to be present in the general environment. These values are shown entirely as a general reference for the reader. As discussed above, absolute leachate concentrations from laboratory kinetic tests do not necessarily represent the absolute concentrations that would be expected at a mine site during leaching of bulk mine wastes under ambient conditions.

Observations of kinetic testing results by lithology, based on week 0 through 8 data, are provided below. To date, acidic conditions have been established in only the massive sulfide column. Leachate pH values for the other columns have remained above 7. The AP and NP of the kinetic testing samples versus the average values calculated for all samples of a particular rock type are shown in Figure 3-35. The semi-massive sulfide sample selected for kinetic testing is representative of average AP and NP conditions. The NP of the siltstone and massive sulfide samples is below average. The NP of the peridotite is representative of average conditions; however, the AP is below average. The peridotite sample selected for testing is an un-mineralized sample.

Since week 4, leachate pHs in all five columns have been relatively stable (Figure A-1). Leachate pHs for weeks 4 though 8 for each of the columns are summarized below (listed in order of highest to lowest pH);

- Peridotite - 7.8 to 8.0;
- Semi-Massive Sulfide – 7.6 to 7.9;
- Siltstones – 7.2 to 7.7; and,
- Massive Sulfide – 3.6 to 4.0.

Siltstone

Good agreement is generally observed between test results for the two siltstone columns. The conductivity and total dissolved solids (TDS) concentrations of the siltstone leachates are low, reporting levels below those of the other three columns. Calcium, magnesium and sulfate concentrations currently show an increasing trend.

Arsenic and antimony are detectible at low concentrations in the siltstone leachates. Arsenic concentrations are relatively stable at 0.02 to 0.03 mg/L. Antimony concentrations are currently trending downward. Low levels (i.e., ppb level and below) of copper, lead and selenium are present in the leachates. Similar to antimony, copper and lead are currently trending downward.

Massive Sulfide

Acidic conditions were established immediately in the massive sulfide column. Sulfate and iron leachate concentrations are currently relatively stable at approximately 1,000 mg/L and 200 mg/L, respectively. Calcium and magnesium concentrations are trending downward.

The acidic conditions in the massive sulfide cell result in elevated metals concentrations. Nickel concentrations are high, ranging from approximately 300 to 400 mg/L. Copper, cobalt, manganese and zinc are also elevated in the leachate, reporting peak levels on the order of 1 to 10 mg/L.

Selenium and arsenic are both leached from the massive sulfide sample (10s of ppb). Cadmium and lead are reported at the 10s to 100s ppb level. Mercury has been detected at low levels (< 1 ppb).

Semi-Massive Sulfide

Sulfate concentrations in leachate from the semi-massive sample are approximately 10 times lower than those measured in the massive sulfide leachate. Selenium and arsenic concentrations are also typically an order of magnitude lower.

The identification of olivine and lizardite as the primary mineral phases with neutralization potential (Jambor, 2004a) is consistent with the occurrence of magnesium in column leachate (currently stable at approximately 40 mg/L). Calcium concentrations are stable at approximately 20 mg/L.

Nickel (0.1 mg/L), copper (0.02 mg/L), cobalt (0.002 mg/L) and manganese (0.02 mg/L) concentrations are currently relatively stable. Nickel and manganese concentrations are approximately 3 orders of magnitude lower than in the massive sulfide leachate.

The semi-massive sulfide column shows some mercury leaching. Mercury levels in weeks 1 through 5 leachates range from 0.05 µg/L (the reporting limit for mercury) to 0.17 µg/L.

Peridotite

Peridotite leachate conductivity and TDS are intermediate to those of the siltstone and semi-massive sulfide leachates. The peridotite column reports the lowest sulfate concentrations, currently stable at approximately 4 mg/L.

Leachate pH and alkalinity concentrations are highest in peridotite leachate. Calcium and magnesium are currently relatively stable at approximately 10 and 14 mg/L, respectively. Mineralogical analysis identified small amounts of calcite [CaCO3]; however, the bulk of the NP was attributed to olivine and serpentine (Jambor, 2004a).

Nickel, cobalt, arsenic, copper and lead concentrations in peridotite column leachate are low (ppb levels or below). Zinc is present at the 10s of ppb level.

3.4.1 ARD and Metal Leaching Rates

At the time of preparation of this report, seven complete weeks of kinetic testing data were available. As shown in the plots of leachate concentration versus time, sulfide oxidation and metal leaching rates have not stabilized. Although it is standard practice to calculate sulfide oxidation, neutralization depletion and metal leaching rates following stabilization, preliminary calculations were performed to provide an early indication of ARD and metal leaching rates.

Acid generation and neutralization depletion rates are shown in Table 3-4 for each of the five kinetic test columns. As expected from the very high sulfide-mineral contents and negligible NP, acidic conditions were developed immediately in the massive sulfide column. The siltstone, semi- massive sulfide and peridotite samples are predicted to eventually establish acidic conditions as the NP of these columns will be depleted prior to exhaustion of acid-generating minerals.

Preliminary estimates of metal leaching rates for selected metals and metalloids (i.e., Ni, Cu, Fe, Co, Pb, Se, Zn and As) are shown in Table 3-5. The mobility of many trace metals is pH dependant. Although there are exceptions, most metals exhibit greater mobility as pH decreases (acidic conditions). It is therefore expected that the massive sulfide would yield much higher metal leaching rates than the other columns whose leachates report circum-neutral pH values.

For the eight elements evaluated, the order (highest to lowest) of metal leaching rates for the massive sulfide sample is as follows: $Ni > Fe > Co > Cu > Zn > Pb = Se = As$. Relative rates of metal leaching for all columns are tabulated below. Estimated metal leaching rates for the siltstones and the peridotite are generally similar. The rate of arsenic leaching in the siltstones is, however, most similar to that of the massive sulfide. Nickel, copper and cobalt leach approximately 10 times faster in the semi-massive sulfide sample than in siltstones and peridotite.

	Kinetic Testing Metal Leaching Rates (mass/m²/wk)						
	10s mg	1 mg	100s µg	10s µg	1 µg	0.1 µg	< 0.1 µg
Ni	MSU			SMSU		PER / SLST	
Fe	MSU				SMSU / PER / SLST		
Co		MSU				SMSU	PER / SLST
Cu			MSU		SMSU	PER / SLST	
As					MSU / SLST	SMSU / PER	
Zn				MSU	SMSU / PER / SLST	SLST	
Pb					MSU		SMSU / PER / SLST
Se					MSU	SMSU / SLST	PER

3.5 Short-Term Leach Testing

Short-term leach testing was conducted on ten samples as follows (number of samples provided in parentheses): siltstone (2), sandstone (1), hornfels (2), pyroxenite (1), peridotite (2), massive sulfide (1) and semi-massive sulfide (1). These tests were conducted to provide additional information on the metal leaching potential of each rock type.

The results of the short-term leach testing are shown in Table 3-6. The results of short-term leach testing were generally consistent with the results of kinetic testing conducted to date with respect to the metals or metalloids identified as having leaching potential (e.g., Ni, Cu, Co and As). Concentration trends between lithologies were also generally consistent with kinetic testing results; however, variability was observed in the magnitude of leachate concentrations. This is to be expected given the differences in the testing methodologies (e.g., solid to solution ratio, nature of the lixiviant, grain size reduction). For example, short-term leach testing was conducted on finer material and at a lower solid to solution ratio (by weight) (i.e., 1:20) than kinetic testing (ranging from approximately 3:1 to 8:1). This section includes a comparison of the short-term results to the kinetic testing results presented in Section 3.4.

Figures 3-36 through 3-51 show the results of short-term leach testing for selected parameters. Constituent concentrations are plotted versus leachate pH. As discussed earlier, the mobility of many trace metals is pH dependant. Although there are exceptions, most metals exhibit greater mobility as pH decreases (acidic conditions). For comparison, the results of the week 5 kinetic testing (the final week of comprehensive analysis available to date) are plotted as dashed lines[2].

With the exception of the massive sulfide sample, all SPLP leachates were neutral to alkaline (pH values ranging from 7.6 to 9.4). SPLP leachate pH versus paste pH is shown in Figure 3-36. SPLP pH values were generally equal to or lower than the paste pH values for the same samples. This difference may be attributed to differences in grain size. Paste pH is determined on a more finely-ground sample than that of the short-term leach test. Pulverization of the paste pH sample may result in preferential exposure and/or greater reactivity of the neutralizing minerals than in the SPLP test. All SPLP leachate pH values were higher than the pH of their respective kinetic test column.

[2] Average week 5 results for the two siltstone columns are plotted.

SPLP pH versus neutralization potential is shown in Figure 3-37. The total inorganic carbon content of each sample is also indicated on this figure. As would be expected, a positive correlation is observed between pH and NP. Speciation modeling with PHREEQC shows near equilibrium with respect to calcite and dolomite for one peridotite and siltstone sample (identified in Figure 3-37), suggesting neutralization by dissolution of a carbonate phase. Dissolution of carbonate is supported by the relatively high (in comparison to other samples) calcium concentrations in SPLP leachates for these two samples (Figure 3-38). Neutralization potential from olivine or lizardite is supported by the presence of magnesium in SPLP leachates (Figure 3-39). Magnesium concentrations in SPLP leachates were highest for the pyroxenite, peridotite and semi-massive sulfide samples.

Consistent with the kinetic testing results, copper leaching is observed for all rock types (Figure 3-40)[3]. Nickel was detected in all but two of the sediment samples (Figure 3-41). For both metals, SPLP leachate concentrations generally increase as the total sulfur content increases (Figure 3-42). Cobalt, which occurs in association with the pyrrhotite, was detected in most SPLP leachates (Figure 3-43).

SPLP leachates showed higher arsenic leaching for the sedimentary and hornfels samples than the peridotite, pyroxenite and ore samples (Figure 3-44). Selenium leaching is highest from the massive sulfide sample (Figure 3-45). Kinetic testing has shown the same behavior for arsenic and selenium.

Antimony concentrations were low in SPLP leachates (ppb level). Peak concentrations were reported for siltstone and hornfels samples (Figure 3-46). Kinetic testing has shown higher antimony leaching from the siltstones than the other rock types.

Lead was detected in all SPLP leachates at low levels (ppb and below) (Figure 3-47). These levels are comparable to lead concentrations in the initial weeks of kinetic testing.

Chromium has been below detectable limits in all kinetic testing leachates since week 1; therefore, the chromium leaching potential of Eagle rocks has not been quantified. Chromium in SPLP leachates ranged from below detectable limits (<0.0005 mg/L) to 10s of ppb (Figure 3-48). The peridotite and pyroxenite reported the highest chromium concentrations in leachate.

Vanadium has been consistently below detectable limits in the peridotite, massive sulfide and semi-massive sulfide kinetic testing leachates. Vanadium concentrations in SPLP leachates ranged from below detectable limits (<0.001 mg/L) to 10s of ppb (Figure 3-49). Similar to chromium, the peridotite and pyroxenite reported the highest vanadium concentrations.

Aluminum and iron concentrations in SPLP leachates were higher than would be expected under neutral to alkaline pH conditions (Figures 3-50 and 3-51). Because the leachates that contained the highest aluminum and iron concentrations also reported a positive charge imbalance (see Appendix B), total (i.e. particulate) iron and aluminum may have been present in solution. The presence of colloidal-sized particles in 0.45 μm filtered samples is documented in the literature (Langmiur, 1997).

The following parameters were below detectable limits in all SPLP leachates: beryllium (<0.0005 mg/L), bismuth (<0.0005 mg/L), lithium (<0.005 mg/L), mercury (<0.00005 mg/L) and

[3] As identified in Table 3-6, some SPLP results have been qualified as estimated high (J+) due to detections in the blank sample (see Appendix B).

thallium (<0.0001 mg/L). Kinetic testing also indicates a low potential for beryllium, bismuth and thallium leaching. Lithium leaching has been observed from the siltstone kinetic tests.

4.0 ENVIRONMENTAL ASSESSMENT

The objective of the Phase I study was to provide an initial "order-of-magnitude" evaluation of the risks of acid generation, metals leaching, and other geochemical concerns associated with mining of the Eagle deposit. To this end, a standard geochemical approach was applied, with testing conducted in phases. Static testing was initiated first on samples of all rock types to assess ARD/ML potential by lithology. Detailed mineralogical analysis and kinetic testing followed to confirm the ARD/ML potentials identified. The testing program is intended to be modular, building the data set as the project progresses.

The Ni-Cu ores of the Eagle Project would be developed in an underground mine, with direct shipment of ores without on-site processing. Essentially all the rock that will be moved to and temporarily stored on the ground surface will be "development" rock, bulk-mined country rocks that lie along access routes between surface access points and the limited zones of massive and semi-massive Ni-Cu sulfide concentrations. Because the metal values lie in the massive and semi-massive ore zones and because underground mining allows quite precise extraction of ores, there will be essentially no massive-sulfide mineralization remaining underground while mining occurs and during the re-flooding after mining. The evolving mine plans call for the development rock to be backfilled, with the addition of alkaline amendment to help buffer pH, into the mine voids during the latter parts and after mining. After mining, the backfilled workings will re-flood, controlling the availability of oxygen needed to initiate sulfide oxidation.

Based on these conceptual mine plans, the Phase I program focused on characterization of the sediments (i.e., sandstones and siltstones, including the hornfelsic varieties) and ultramafic rocks from outside ore zones, the materials most likely to be placed temporarily on the surface and exposed in the walls of underground access routes and stopes. Testing of some massive sulfide and semi-massive sulfide samples was conducted for completeness only, as the current mine plans do not include a provision for storage of these materials at surface or to leave them underground where exposure to oxygen would result in ARD and subsequent metal leaching. Kinetic testing has confirmed the high reactivity and metal leaching potential of the massive sulfide.

The static testing results indicate a need for active management of all rock types. ABA testing shows that sulfides are pervasive in all rock types, with ultimate acid generation potential generally exceeding neutralization potential. Mineralogical analysis identified olivine, lizardite and to a lesser extent carbonates (i.e., calcite and dolomite), as the mineral phases contributing to NP. The results of kinetic testing conducted on low-CaNP samples to date show that olivine and lizardite, at least initially, weather at a rate fast enough to be effective as neutralizing minerals. To date, acidic conditions have not been established for the sediment columns. Preliminary sulfide oxidation and NP depletion rates suggest that county rock could be stored at surface for extended periods, probably on the order of decades based on current analyses of kinetic tests (Table 3-4), without becoming acid-generating. This is much longer than the expected life of the mine, so the lag period indicates that generation of acid drainage is very unlikely.

Results of kinetic testing conducted to date indicate that, apart from the massive and semi-massive sulfide samples, metal-leaching rates appear to be generally low. These low rates are largely attributed to the fact that acidic conditions have not been developed in the siltstone and peridotite columns. Estimates of metal-leaching rates will continue to be revised as kinetic testing proceeds and additional data become available. To assess potential impacts to water quality, metal-leaching rates

will need to be integrated with both the engineering designs of waste-rock stockpiles and site hydrological conditions.

Kinetic testing shows that low concentrations of arsenic (As) may leach from the siltstone samples under circum-neutral pH conditions. Low-level leaching of nickel and cobalt (which occurs in association with the pyrrhotite) also merits further attention. Following release, the mobility of these metals is expected to be high due to the absence of effective secondary mineral controls. Short-term leach testing has also shown some potential for chromium and vanadium leaching, particularly from the peridotite/pyroxenite. As discussed above, the laboratory results need to be extrapolated to field conditions.

The ARD program will continue to give mercury special consideration due to (a) its intrinsic toxicity and (b) regional background concentrations that already approach levels that are considered problematical to ecological receptors and food-web considerations. Kinetic testing shows low levels of mercury leaching in columns of the massive sulfide and semi-massive sulfide ores, but not from the country rocks. Again, readers should note that neither massive sulfide nor semi-massive sulfide ores would be stored at the surface as part of the Eagle Project.

The quality assurance/quality control assessment (Appendix B) of analytical data indicates good analytical accuracy and precision. The data are adequate for the current evaluation. QA/QC protocols established in Phase I should be continued.

A phased testing approach will continue to be followed in the Phase II study (see Section 5) whereby results of each phase of testing are evaluated to define issues of concern and identify a path forward to address these issues. Phase II will expand the geochemical data set as the project progresses.

5.0 RECOMMENDATIONS – PHASE II PROGRAM

The Phase I results provide an initial mineralogical and geochemical basis for considering that a short-lived underground mine, with direct shipment of ore, would pose relatively little risk of adverse water-quality impacts. However, the Phase I database of samples is limited, and there are some technical issues that require further examination in order to support a quantitative evaluation of water-quality impacts. Therefore, the principal goal of the Phase II study will be to expand the scale of testing, with respect to (a) numbers of samples and their spatial distribution around the mined rock and (b) duration of kinetic testing, to a level that would meet current Rio Tinto guidance for ARD evaluations appropriate for a pre-feasibility study. In addition, the Phase II program should (i) address some specific, technical issues that have been identified in Phase I and (ii) coordinate closely with the Project's baseline water-quality and background hydrogeologic investigations to ensure that the geochemical behavior of the mined rock can be related properly to the larger-scale local and regional water-resource systems.

Specific objectives of the Phase II program include:

- Coordinating the geochemical database with the evolving geologic models and mine plans for the Eagle project.
- Increasing the total database of static geochemical testing to about 100 samples (from the current 42), selected to be representative of the full three-dimensional range of all lithologies that will be involved in the waste-management program.
- Continuing kinetic testing of the five samples that were started in Phase I. The tests will be extended to at least 20 weeks, and probably longer for some or all of the five.
- Increasing the program of kinetic testing to include approximately 10 additional samples of important lithologies and to increase the time period of testing for all samples under leach.
- Evaluating mineralogical controls on trace metals that can be identified in kinetic-test effluents.
- Establishing geological controls on distribution of carbonates in the rock types.
- Determining the potential, if any, for asbestiform minerals in and adjacent to the ultramafic rocks.
- Developing initial conceptual models of waste-management units that are coupled to engineering plans and site hydrology in ways that allow initial quantification of water-quality impacts.
- Advancing, and hopefully resolving, residual QA/QC issues, including quantification of sulfate concentrations, refining detection limits for some regulated parameters (e.g., chromium and vanadium), and coordinating with the baseline program on low-level quantification of mercury.

5.1 Task 1 - Coordination with Mine Planning and Geology

The first task of Phase II will be to meet with Eagle's Mine Planning group to establish current plans (and alternatives) for development of the underground mine. Virtually all of the rock stored at

surface during mining will be development rock, and it is the geochemistry of this material that will define the magnitude of ARD and metal-leaching hazard that would need to be managed by surface engineering. Additionally, the rock that is moved from underground will be intimately related to rock left in the shell of the excavations, and the geochemical effects of the damaged rock zone around mine opening also needs to be considered with respect to operational water-management and post-mining groundwater quality. Because of the shape of the Eagle peridotite, the surface-water regime, and Kennecott's land position, there are several possible routes for driving access ramps to the ore zones, some of which would intersect significant amounts of siltstone and related sediments, but others of which would be driven largely through unmineralized peridotite. Based on the Phase I geochemical results, it appears that unmineralized peridotite would pose fewer risks of ARD and metal leaching than might the sediments, but there are many other characteristics (e.g., distance from portal to ore zone; rock quality and hardness; surface access; connection with high permeability groundwater flow zones and surface water) that also need to be considered. To develop a cost-effective sampling and testing strategy, it is imperative that the geochemical team and the mine-planning group work together to ensure that samples selected for testing represent rocks most likely to be mined. The samples must be selected and documented so that the geochemical data can be coordinated quantitatively with evolving geological block models and mine planning. The testing for Phase II should be weighted in terms of the likely proportions of lithologies that will be mined and also of the sequencing of those lithologies. Sample selection and allocation across static testing methods will be based on explicit interactions with Eagle Geology and Mine Planning groups to ensure that the data set is representative of rock that may be mined over the life of the project.

For example, if a portal were collared at East Eagle and the access driven overwhelmingly through peridotite, then most of the samples to be tested should be peridotite. Furthermore, because the rocks closest to the portal would be mined first, they will report to the surface first and probably be exposed for the longest period of time before backfilling into the underground workings. It would be appropriate to consider phased testing to focus first on these rocks. At the same time, there is a general expectation, based on knowledge of the mechanism of sulfide segregation and experience at other such magmatic sulfide ore deposits, that peridotite close to the ore zones likely would have a higher sulfide content than would ultramafic rocks farther away from the ore. This expectation needs to be tested, and the geochemical characteristics of the whole deposit characterized so that the history of mining can be adequately described. As exploratory in-fill drilling continues, it will be important for the geochemical team to be aware of results, especially if concentrations of sub-economic sulfide concentrations are discovered, or if the drilling results change mine plans.

5.2 Task 2 - Expand Database for Static Geochemical Testing

Based on the discussions with and guidance from Eagles' Mine Planning and Geology teams, we recommend increasing the number of samples subjected to static testing from the current 42 to approximately 100 samples. Because the purpose of the geochemical program is to evaluate the environmental risks from waste management, the sampling should focus very strongly on the country rocks. [In addition, static tests are properly understood as screening tools, and there is little need to develop additional data that show that the acid-base account for Massive Sulfide and Semi-Massive Sulfide ores indicates that they are potentially acid generating.] The specific balance of samples needs to be based on mine plans, but the goal would be to have tested at least 10 samples of each country-rock lithology by the end of this Phase II work:

Lithology	Currently Tested	Minimum Phase II Number	Additional Samples
Massive Sulfide	5	None	
Semi-Massive Sulfide	6	None	
Peridotite and Pyroxenite	11	14	
Sandstone	3	7	
Siltstone	14	11	
Hornfels	3	7	
Balance for Phase II			20

Both the proposed minimum number of samples and the 20-sample remainder of the nominal 100-sample set would be divided between the country-rock units on the basis of mine-planning and geologic considerations. Issues to be addressed specifically in sample selection include extent of sulfide mineralization within the ultramafic and hornfelsic rocks, nature and extent of carbonate veining in the sedimentary rocks, and the locations of available core samples to the proposed orientation and sequencing of the underground workings. It is possible that one or more additional samples of semi-massive sulfide ore will be selected in order to further evaluate the lizardite in those units for comparison with lizardite in the unmineralized peridotite. Static testing would include acid-base accounting for all additional samples. A subset of the additional samples (approximately 50%) would be analyzed for whole-rock chemistry (major and trace elements) and also subjected to the Net Acid Generation (NAG) test to begin to establish the usefulness of the NAG procedures in conjunction with standard North American acid-base methods. Approximately half of those samples (i.e., 25% of the Phase II samples) would be tested for static leachability using the SPLP procedure. Mineralogical analyses are described in a separate task below.

5.3 Task 3 - Kinetic Testing

Based on the static test results from Phase I and Phase II, we will nominate up to 10 additional samples, beyond the five samples under leach as part of Phase I, for kinetic testing. We expect that 5 samples would be selected early in Phase II, based on the static testing and mineralogy from Phase I, and that an additional 5 samples would be selected from the Phase II static-test work. By phasing the additional kinetic test samples in this manner, it will be possible to maximize the amount of kinetic test data available in a timely manner for Kennecott Minerals' planning.

The Phase I program anticipated kinetic testing of its five (5) samples for not less than 20 weeks. During Phase II we will continue to report the results of the Phase I kinetic tests and make recommendations for continuing some or all of them beyond the original 20 weeks. There are significant advantages to the Eagle Project if the kinetic tests are extended to longer periods. In particular, the longer the kinetic tests proceed, the shorter is the extrapolation in time from laboratory phase to the periods over which development rock may actually be stored on site. In addition, because the Phase I results show that there is a significant lag period associated with available neutralization potential of the samples currently under leach, extending the kinetic tests would demonstrate to outside reviewers that Kennecott Minerals' has no intention of terminating tests before trends are apparent. Finally, by extending the earliest tests, it will be possible to use their long-term results to justify decisions on length of leaching needed to interpret subsequent tests.

5.4 Task 4 - Mineralogy

As part of Phase II, we recommend that the mineralogy be extended to further concentrate on these two issues:

- **The nature and extent of trace metal concentrations in country rocks.** Phase I kinetic tests show that As and some other trace metals are leachable (at low rates) from some of the country rock lithologies that contain sulfide minerals. In addition, the mineralogy and acid-base accounting data suggest that olivine and lizardite in peridotite samples may be providing neutralization potential; olivines and serpentines are known to be the locus of some trace metals (e.g., Co, Ni and Zn) in some ultramafic rocks. Additionally, further data on the Fe and Mn concentrations in carbonate minerals are needed in order to understand the extent to which carbonate minerals can provide long-term neutralization potential during weathering. This activity would use semi-quantitative (e.g., electron microscopy) and quantitative (electron microprobe) methods to identify and quantitate concentrations of trace metals in sulfide and non-sulfide minerals. These data would allow the Eagle Project to show that it has a comprehensive understanding of the geochemical hazards and natural mitigation present in development rock and underground openings.
- **Expanding the database on nature and extent of serpentine minerals, especially their potential for description as "asbestiform".** Dr. Jambor would conduct this work on samples, primarily from the peridotite samples selected for Phase II evaluations. During discussions with Eagle Geology staff, we also can pursue the potential, if any, for generation of veins containing asbestiform minerals in the country rocks surrounding the peridotite. If such veins have been identified in core logging, then sampling and mineralogical analysis could be extended to these rocks also.

At this time, we anticipate that the Phase II mineralogy would be performed on about 10 additional samples, to be selected in very close consultation with Eagle Geology to ensure that the samples are appropriate for representation of the problems that are selected for final analysis.

5.5 Task 5 - Coordination with Baseline Water Quality and Hydrology

The final technical product required by the Eagle Project is a quantitative evaluation of risks to water resources. This requires that the data generated by the geochemical investigations be coordinated with the ambient water quality and hydrology of the site. The ambient conditions at the site need to

be evaluated in the context of the proposed plans for engineering management of development rock and other mine disturbances. For example, runoff and infiltration over a stockpile of development rock depends not only on the reactive geochemistry of the rock, but also the construction details (e.g., surface area and steps to minimize infiltration). The impacts of runoff and infiltration depend on both quantity and quality of the flows, and also on water-management methods and other active management steps (including water treatment if that is determined to be necessary) that will be taken for the Eagle Project.

In order to develop initial estimates of water-quality impacts, suitable for a formal Environmental Report, the Phase II investigations will be coordinated with the baseline studies and the evolving engineering plans. The work product will be conceptual models for waste management that produce initial, quantitative estimates of effluent chemistry and flow and the impacts of those effluents on other water resources to be identified to us by the Eagle Project.

5.6 Task 6 - Quality Assurance

The Phase II geochemical studies will maintain the high level of quality assurance and quality control established for the Phase I project. Growing out of the Phase I work there are five specific issues that will be evaluate further:

- Reproducibility of sulfate concentrations and the impacts of that step on ion balances;
- Detection limits for trace metals and metalloids, including chromium and mercury;
- Apparently elevated Fe and Al concentrations in SPLP results;
- Importance for environmental evaluations of detection limits that exceed minimum regulatory limits; and,
- Potential for low level zinc contamination in kinetic testing leachates and low level metals contamination in SPLP testing.

If additional data-quality issues arise during Phase II, they, too, will be evaluated and reported to Kennecott Minerals.

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TABLES

TABLE 2-1

State and Federal Freshwater and Drinking Water Criteria

Parameter	State Regulations						Federal Regulations			
	HNV Drink mg/L	HNV Non-drink mg/L	WV mg/L	FCV mg/L	AMV mg/L	FAV mg/L	MCL mg/L	Secondary MCL mg/L	CMC mg/L	CCC mg/L
Alkalinity										**20**
Aluminum								**0.05** to 2	0.750 (c)	0.087 (c)
Ammonia									(e)	(e)
Ammonia (unionized coldwater)	ID*	ID*		**0.029**	0.16	0.32				
Ammonia (unionized warmwater)	ID*	ID*		**0.053**	0.21	0.42				
Antimony	**0.0017**	0.13		0.24	1.1	2.3	0.006			
Arsenic	0.05	0.28		0.15	0.34	0.68	**0.01**		0.34	0.15
Barium	1.9	160		**0.1**	0.286	0.572	2			
Beryllium	0.16	1.2		**0.00007**	0.0006	0.0013	0.004		NA	NA
Boron	**1.9**	160		**1.9**	16	31				
Cadmium	0.0025	0.13		0.002	0.02	0.02	0.005		0.00052	**0.00009**
Chloride								250	860	**230**
Chromium	0.12	9.4		**0.036**	0.036	0.072	0.1			
Chromium (III)									0.183	**0.024**
Chromium (VI)	0.12	9.4		**0.011**	0.016	0.032			0.016	**0.011**
Cobalt	ID*	ID*		**0.1**	0.37	0.74				
Copper	0.79	64		**0.003**	0.004	0.007	1.3 (a)	1	0.004	**0.003**
Fluoride							4	**2**		
Hydrogen sulfide	NLS	NLS		**0.000088**	0.0008	0.0016				0.002
Iron								**0.3**		1
Lead	0.014	0.19		**0.002**	0.02	0.02	0 (a)		0.014	**0.0005**
Lithium	0.78	63		**0.096**	0.87	1.7				
Manganese	3.6	59		0.571	1.2	2.5		**0.05**		
Mercury	0.0000018	0.0000018	**0.0000013**	0.00077	0.0014	0.0028	0.002 (b)		0.0014	0.00077
Molybdenum	**0.12**	10		0.8	7.2	14				
Nickel	2.6	210		**0.016**	0.145	0.290			0.145	**0.016**
Nitrate (as N)	**10**	NLS		NLS	NLS	NLS	**10**			
Nitrite (as N)							**1**			
pH								6.5 to 8.5		6.5 to 9.0
Selenium & inorganic salts	0.12	2.7		**0.005**	0.062	0.12	0.05		0.024 (d)	**0.005** (c)
Silver	0.13	11		**0.00006**	0.00054	0.0011		0.1	0.0003	
Strontium	ID*	ID*		**8.3**	75	150				
Sulfate								**250**		
TDS								**500**		
Thallium	**0.0012**	0.0037		0.01	0.078	0.16	0.002			
Titanium	NLS	NLS		ID	ID	ID				
Uranium							**0.03**			
Vanadium	0.22	2.2		**0.012**	0.11	0.22				
Zinc	4.5	22		**0.036**	**0.036**	0.072		5	**0.036**	**0.036**

All concentrations presented in mg/L with the exception of pH (in standard units).
For each parameter, bold type identifies lowest criterion.

State Criteria
HNV - Human non-cancer value
HCV - Human cancer value (calculated only for carcinogens)
WV - Wildlife Value - calculated only for bioaccumulative chemicals of concern.
FCV - Final chronic value
AMV - Aquatic maximum value
FAV - Final acute value

Federal Criteria
MCL - Drinking water maximum contaminant level
Secondary MCL - Drinking water secondary MCL
CMC - Acute freshwater
CCC - Chronic freshwater

Notes:
ID - Insufficient data to derive value.
* - The lowest HNV, WV, HCV or FCV given for this chemical will adequately protect the uses.
NLS - No literature search has been conducted.
Red text identifies values expressed as the dissolved fraction.
Shaded yellow cell identifies criteria that are hardness dependant. Values shown for hardness = 25 mg/L (as $CaCO_3$).
TDS - Total dissolved solids
(a) MCLG - Maximum contaminant level goal (non-enforceable public health goal).
(b) Inorganic mercury
(c) Expressed as total recoverable concentration
(d) Criterion dependent on selenium speciation. Value presented assumes 50% selenate and 50% selenite.
(e) Criterion is pH, temperature and life-stage dependent

TABLE 2-2

Phase I Sample and Analytical List

Sample ID (Figure 2-2)	Sample	Rock Type	Drill Hole	Interval			Notes	Phase 0	Phase I	ABA	Whole Rock / Trace Metals	Short-Term Leach Testing	Kinetic Testing
				From (m)	To (m)	Length (m)							
1	VR71109A	HFL	03EA032	288.82	290.32	1.5			x	x	x	x	
3	VR91306A	HFL	03EA041	184	185.5	1.5	weakly mineralized		x	x	x	x	
2	VR91579A	HFL	03EA043	122.3	123.8	1.5			x	x	x		
36	VR71062A	MSU	03EA030	329.75	331.25	1.5		x		x	x		
4	VR71120A	MSU	03EA032	299.64	301.14	1.5		x		x	x		x
41	VR71388A	MSU	03EA034	238.6	240.1	1.5		x		x	x		
5	VR71450A	MSU	03EA034	309.2	310.7	1.5			x	x	x		
6	VR90181A	MSU	03EA037	253.8	255.3	1.5	high Cu		x	x	x	x	
39	VR71348A	PER	03EA034	193.9	195.4	1.5	mineralized	x		x	x		
11	VR71373A	PER	03EA034	220.7	222.2	1.5	mineralized		x	x	x	x	
40	VR71375A	PER	03EA034	222.2	223.4	1.2	mineralized	x		x	x		
12	VR71821A	PER	03EA036	129.4	130.9	1.5	mineralized		x	x	x		
38	VR71192A	PER	03EA034	15	16.5	1.5		x		x	x		
7	VR71213A	PER	03EA034	39	40.5	1.5		x		x	x		x
8	VR71314A	PER	03EA034	159	160.5	1.5			x	x	x		
10	VR91267A	PER	03EA041	139.16	140.66	1.5			x	x	x	x	
9	VR91624A	PER	03EA035	409	411	2			x	x	x		
13	VR71275A	PRX	03EA034	113	114.5	1.5	feldspathic		x	x	x	x	
14	VR71938A	PRX	03EA036	263.67	265.17	1.5	weakly mineralized		x	x	x		
17	VR90257A	SDST	03EA038	75.33	76.83	1.5	Hanging Wall		x	x	x		
15	VR91620A	SDST	03EA032	160	162	2	Hanging Wall		x	x	x	x	
16	VR91621A	SDST	03EA032	200	202	2	Hanging Wall		x	x	x		
18	VR71087A	SLST	03EA030	359.73	361.23	1.5	Foot Wall		x	x	x		
19	VR71161A	SLST	03EA032	345.44	346.94	1.5	Foot Wall		x	x	x		
21	VR71499A	SLST	03EA034	366.6	368.1	1.5	Foot Wall	x		x	x		x
23	VR91482A	SLST	03EA042	130.13	131.63	1.5	Foot Wall		x	x	x		
20	VR91623A	SLST	03EA032	375	377	2	Foot Wall		x	x	x		
22	VR91625A	SLST	03EA036	310	312	2	Foot Wall		x	x	x	x	
24	VR91627A	SLST	03EA043	150	152	2	Foot Wall		x	x	x		
26	VR71043A	SLST	03EA030	305.75	307.25	1.5	Hanging Wall		x	x	x		
29	VR71100A	SLST	03EA032	276.82	278.32	1.5	Hanging Wall	x		x	x		x
31	VR90425A	SLST	03EA039	148.4	149.9	1.5	Hanging Wall		x	x	x	x	
25	VR91618A	SLST	03EA030	100	102	2	Hanging Wall		x	x	x		
27	VR91619A	SLST	03EA032	100	102	2	Hanging Wall		x	x	x		
28	VR91622A	SLST	03EA032	260	262	2	Hanging Wall		x	x	x		
30	VR91626A	SLST	03EA039	30	32	2	Hanging Wall		x	x	x		
37	VR71134A	SMSU	03EA032	315.31	316.81	1.5		x		x	x		
32	VR71325A	SMSU	03EA034	173	174.5	1.5		x		x	x		x
42	VR71418A	SMSU	03EA034	271.7	273.2	1.5		x		x	x		
33	VR90125A	SMSU	03EA037	189.3	190.8	1.5			x	x	x	x	
34	VR90457A	SMSU	03EA039	198.8	200.3	1.5			x	x	x		
35	VR91542A	SMSU	03EA043	81.3	82.8	1.5			x	x	x		
							Total	12	30	42	42	10	5

TABLE 3-1

Whole Rock Analysis Results

Sample	Rock Type	Al_2O_3 %	BaO %	CaO %	Cr_2O_3 %	Fe_2O_3 %	K_2O %	MgO %	MnO %	Na_2O %	P_2O_5 %	SiO_2 %	SrO %	TiO_2 %	Total %	LOI %
VR71109A	HFL	17.41	0.07	0.92	0.02	8.26	4.43	3.71	0.06	0.79	0.13	57.72	0.01	0.88	98.76	4.33
VR91306A	HFL	12.28	0.03	0.43	0.03	12.68	2.16	4.3	0.06	1.48	0.08	56.91	0.01	0.71	95.77	4.62
VR91579A	HFL	17.45	0.07	0.2	0.02	9.43	3.94	3.63	0.04	0.78	0.13	57.73	0.01	0.92	99.08	4.73
VR71062A	MSU													0.02		
VR71120A	MSU													0.05		
VR71388A	MSU													0.03		
VR71450A	MSU	0.51	<0.01	0.08	0.02	73.62	0.11	0.28	0.07	<0.01	<0.01	1.24	0.02	0.11	86.87	10.8
VR90181A	MSU	0.13	0.01	0.02	<0.01	73.77	0.04	0.2	0.04	<0.01	0.01	0.61	<0.01	0.05	86.68	11.8
VR71348A	PER													0.86		
VR71373A	PER	5.74	0.02	4.6	0.16	19.17	0.26	21.11	0.18	0.63	0.09	39.95	<0.01	1.16	98.4	5.33
VR71375A	PER													0.88		
VR71821A	PER	4.63	0.01	3.38	0.33	21.42	0.18	20.85	0.21	0.45	0.06	40.36	0.01	0.96	99.17	6.33
VR71192A	PER													0.74		
VR71213A	PER													0.8		
VR71314A	PER	6.26	0.03	4.78	0.15	16.73	0.34	22.05	0.2	0.91	0.1	42.75	0.01	1.3	99.86	4.26
VR91267A	PER	8.39	0.03	6.39	0.2	15.87	0.5	15.41	0.18	1.07	0.12	46.37	0.02	1.48	99.36	3.34
VR91624A	PER	5.09	0.02	4.56	0.32	16.09	0.24	25.8	0.2	0.76	0.07	40.75	0.02	0.94	99.76	4.9
VR71275A	PRX	5.05	0.02	6.17	0.37	14.5	0.19	19.5	0.2	0.49	0.07	46.42	<0.01	1.11	99.86	5.76
VR71938A	PRX	7.45	0.03	7.46	0.15	18.85	0.39	12.89	0.19	0.73	0.21	43.72	0.02	2.33	98.13	3.7
VR90257A	SDST	11.1	0.03	0.28	0.04	4.59	1.55	1.78	0.02	2.81	0.09	75.05	0.04	0.5	99.62	1.74
VR91620A	SDST	12.81	0.03	0.25	0.02	5.5	1.5	1.73	0.01	2.77	0.1	71.19	0.01	0.55	98.92	2.44
VR91621A	SDST	12.05	0.03	3.14	0.03	6.02	2	3.89	0.1	1.89	0.09	62.81	0.01	0.61	98.39	5.71
VR71087A	SLST	17.23	0.07	0.24	0.03	9.21	3.97	3.19	0.04	1.02	0.13	57.86	0.01	0.89	98.1	4.21
VR71161A	SLST	17.64	0.07	0.28	0.03	9.18	3.45	2.77	0.02	1.59	0.11	58.63	0.01	0.89	99.51	4.84
VR71499A	SLST													0.77		
VR91482A	SLST	17.29	0.06	0.28	0.03	8.83	3.39	3.56	0.03	1.2	0.12	58.69	0.01	0.92	98.92	4.52
VR91623A	SLST	13.24	0.03	3.84	0.09	5.95	1.73	1.93	0.06	2.47	0.09	64.52	0.04	0.62	98.41	3.8
VR91625A	SLST	17.39	0.06	0.58	0.02	9.42	3.38	3.12	0.03	1.53	0.12	57.7	0.01	0.9	99.42	5.15
VR91627A	SLST	17.49	0.07	0.25	0.03	9.5	3.73	3.43	0.03	1.19	0.13	57.5	0.01	0.91	99.12	4.85
VR71043A	SLST	10.44	0.04	4.85	0.03	4.11	1.24	1.22	0.06	2.45	0.09	69.34	0.04	0.48	98.44	4.04
VR71100A	SLST													0.85		
VR90425A	SLST	17.81	0.07	0.23	0.03	8.95	4.59	4.02	0.04	0.63	0.11	57.54	0.01	0.92	99.21	4.27
VR91618A	SLST	18.05	0.07	0.19	0.02	8.83	4.06	3.38	0.03	0.85	0.11	57.85	0.01	0.9	99.12	4.77
VR91619A	SLST	17.48	0.06	0.21	0.03	8.88	3.72	3.28	0.04	1.13	0.13	58.65	<0.01	0.91	99.11	4.58
VR91622A	SLST	17.33	0.07	0.52	0.02	9.29	3.56	3.11	0.03	1.43	0.13	57.76	0.01	0.92	98.48	4.31
VR91626A	SLST	17.6	0.06	0.26	0.02	8.94	4.36	3.97	0.04	0.29	0.12	57.35	0.01	0.88	98.81	4.9
VR71134A	SMSU													0.68		
VR71325A	SMSU													0.37		
VR71418A	SMSU													0.22		
VR90125A	SMSU	3.4	<0.01	4.07	0.37	28.57	0.2	18.24	0.18	0.25	0.05	34.36	0.02	0.69	96.48	6.08
VR90457A	SMSU	1.37	0.01	0.84	0.18	44.96	0.14	16.23	0.14	<0.01	0.04	19.52	0.01	0.36	94.76	10.95
VR91542A	SMSU	1.12	0.01	0.75	0.09	38.67	0.1	18.4	0.16	<0.01	0.03	21.38	0.01	0.35	93.77	12.7

TABLE 3-1

Whole Rock Analysis Results

Rock Type		STATISTICS BY LITHOLOGY														
		Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SrO	TiO_2	Total	LOI
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
MSU	MIN	0.13	0.01	0.02	0.01	73.62	0.04	0.20	0.04	0.01	0.01	0.61	0.01	0.02	86.68	10.80
	MAX	0.51	0.01	0.08	0.02	73.77	0.11	0.28	0.07	0.01	0.01	1.24	0.02	0.11	86.87	11.80
	COUNT	2	2	2	2	2	2	2	2	2	2	2	2	5	2	2
	AVERAGE	0.32	0.01	0.05	0.02	73.70	0.08	0.24	0.06	0.01	0.01	0.93	0.02	0.05	86.78	11.30
	STDEV	0.27	0.00	0.04	0.01	0.11	0.05	0.06	0.02	0.00	0.00	0.45	0.01	0.03	0.13	0.71
SMSU	MIN	1.12	0.01	0.75	0.09	28.57	0.10	16.23	0.14	0.01	0.03	19.52	0.01	0.22	93.77	6.08
	MAX	3.40	0.01	4.07	0.37	44.96	0.20	18.40	0.18	0.25	0.05	34.36	0.02	0.69	96.48	12.70
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	6	3	3
	AVERAGE	1.96	0.01	1.89	0.21	37.40	0.15	17.62	0.16	0.09	0.04	25.09	0.01	0.45	95.00	9.91
	STDEV	1.25	0.00	1.89	0.14	8.27	0.05	1.21	0.02	0.14	0.01	8.08	0.01	0.19	1.37	3.43
PER	MIN	4.63	0.01	3.38	0.15	15.87	0.18	15.41	0.18	0.45	0.06	39.95	0.01	0.74	98.40	3.34
	MAX	8.39	0.03	6.39	0.33	21.42	0.50	25.80	0.21	1.07	0.12	46.37	0.02	1.48	99.86	6.33
	COUNT	5	5	5	5	5	5	5	5	5	5	5	5	9	5	5
	AVERAGE	6.02	0.02	4.74	0.23	17.86	0.30	21.04	0.19	0.76	0.09	42.04	0.01	1.01	99.31	4.83
	STDEV	1.46	0.01	1.08	0.09	2.39	0.12	3.72	0.01	0.24	0.02	2.65	0.01	0.25	0.58	1.12
PRX	MIN	5.05	0.02	6.17	0.15	14.50	0.19	12.89	0.19	0.49	0.07	43.72	0.01	1.11	98.13	3.70
	MAX	7.45	0.03	7.46	0.37	18.85	0.39	19.50	0.20	0.73	0.21	46.42	0.02	2.33	99.86	5.76
	COUNT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AVERAGE	6.25	0.03	6.82	0.26	16.68	0.29	16.20	0.20	0.61	0.14	45.07	0.02	1.72	99.00	4.73
	STDEV	1.70	0.01	0.91	0.16	3.08	0.14	4.67	0.01	0.17	0.10	1.91	0.01	0.86	1.22	1.46
SLST	MIN	10.44	0.03	0.19	0.02	4.11	1.24	1.22	0.02	0.29	0.09	57.35	0.01	0.48	98.10	3.80
	MAX	18.05	0.07	4.85	0.09	9.50	4.59	4.02	0.06	2.47	0.13	69.34	0.04	0.92	99.51	5.15
	COUNT	12	12	12	12	12	12	12	12	12	12	12	12	14	12	12
	AVERAGE	16.58	0.06	0.98	0.03	8.42	3.43	3.08	0.04	1.32	0.12	59.45	0.02	0.84	98.89	4.52
	STDEV	2.31	0.01	1.59	0.02	1.65	0.99	0.80	0.01	0.65	0.01	3.67	0.01	0.13	0.44	0.40
SDST	MIN	11.10	0.03	0.25	0.02	4.59	1.50	1.73	0.01	1.89	0.09	62.81	0.01	0.50	98.39	1.74
	MAX	12.81	0.03	3.14	0.04	6.02	2.00	3.89	0.10	2.81	0.10	75.05	0.04	0.61	99.62	5.71
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	11.99	0.03	1.22	0.03	5.37	1.68	2.47	0.04	2.49	0.09	69.68	0.02	0.55	98.98	3.30
	STDEV	0.86	0.00	1.66	0.01	0.72	0.28	1.23	0.05	0.52	0.01	6.26	0.02	0.06	0.62	2.12
HFL	MIN	12.28	0.03	0.20	0.02	8.26	2.16	3.63	0.04	0.78	0.08	56.91	0.01	0.71	95.77	4.33
	MAX	17.45	0.07	0.92	0.03	12.68	4.43	4.30	0.06	1.48	0.13	57.73	0.01	0.92	99.08	4.73
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	15.71	0.06	0.52	0.02	10.12	3.51	3.88	0.05	1.02	0.11	57.45	0.01	0.84	97.87	4.56
	STDEV	2.97	0.02	0.37	0.01	2.29	1.19	0.37	0.01	0.40	0.03	0.47	0.00	0.11	1.83	0.21

Notes:
LOI = loss on ignition

TABLE 3-2

Elemental Analysis Results

Sample	Rock Type	Ag	Al	As	Ba	Be	Bi	B	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn
		ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm
VR71109A	HFL	0.1	2.76	12.5	40	0.88	0.26	10	0.63	0.25	68.5	20.2	124	1.81	70.1	5.22	8.58	0.12	1.07	0.2	0.019	0.36	34.8	82.4	1.84	451
VR91306A	HFL	4.06	2.9	38.6	10	0.59	1.13	10	0.27	1.21	42	93.7	189	0.53	15000	8	10.8	0.23	0.77	0.17	0.116	0.13	19.6	59	2.66	491
VR91579A	HFL	0.13	3.17	11.9	50	0.77	0.33	10	0.12	0.06	60.9	23.7	110	1.6	79.5	6.23	8.73	0.12	0.96	0.08	0.027	0.37	29.8	69.1	2.03	320
VR71062A	MSU											1830	200		40600											
VR71120A	MSU											1910	100		45100											
VR71388A	MSU											1870	100		26400											
VR71450A	MSU	12.35	0.24	6.4	10	0.06	4.24	<10	0.03	4.19	1.74	1340	61	0.46	47600	>15	1.24	2.02	0.06	0.12	0.406	0.08	0.8	5.7	0.09	465
VR90181A	MSU	27.7	0.02	5.9	<10	<0.05	5.73	<10	<0.01	9.93	0.48	1110	<1	0.05	56200	>15	1.03	1.99	0.02	0.25	0.653	0.01	0.2	1.1	0.04	286
VR71348A	PER											260	1100		6610											
VR71373A	PER	1.3	1.61	1.4	30	0.16	0.79	50	0.59	0.54	10.2	187.5	305	2.02	3720	9.24	5.87	0.33	0.14	0.02	0.051	0.16	4.7	12.2	7.91	507
VR71375A	PER											230	2300		4340											
VR71821A	PER	2.51	1.5	1.5	30	0.13	1.02	50	0.6	1.29	8.41	217	971	1.4	5250	10.55	5.52	0.36	0.15	0.04	0.087	0.12	3.9	18.8	6.32	689
VR71192A	PER											140	2600		320											
VR71213A	PER											140	2400		330											
VR71314A	PER	0.21	1.53	0.8	40	0.23	0.09	70	0.63	0.15	12.7	86.6	242	1.17	479	7.04	5.89	0.18	0.16	0.01	0.02	0.2	5.9	13.9	7.68	618
VR91267A	PER	0.47	2.2	0.7	40	0.18	0.19	20	0.81	0.23	12.9	76.8	557	5.52	1090	5.98	8.22	0.18	0.17	0.01	0.03	0.29	5.7	20.9	3.61	378
VR91624A	PER	0.09	1.46	0.2	30	0.16	0.03	10	0.74	0.09	10.4	101.5	677	0.49	214	7.51	5.16	0.21	0.11	0.02	0.015	0.15	4.8	5	10.1	860
VR71275A	PRX	0.51	1.91	0.7	20	0.16	0.23	30	0.56	0.26	8.87	88.3	976	1.5	1135	5.42	6.93	0.2	0.14	0.03	0.03	0.1	4.1	30.7	5.24	423
VR71938A	PRX	4.36	2.09	1.5	30	0.33	1.58	10	1.52	1.7	20.3	113	298	3.75	5760	7.91	10.6	0.27	0.48	0.12	0.1	0.21	8.8	16.8	3.35	486
VR90257A	SDST	0.13	1.45	9.2	20	0.19	0.07	10	0.09	0.05	35.8	13.6	295	0.57	230	2.99	6.5	0.09	0.62	0.02	0.014	0.12	16	33.5	1.06	236
VR91620A	SDST	0.17	1.68	13.6	30	0.25	0.12	<10	0.14	0.11	35.6	13.8	166	0.44	78.5	3.52	5.32	0.07	0.61	0.08	0.009	0.15	16.8	33.6	0.91	190
VR91621A	SDST	0.11	1.86	13.8	30	0.38	0.14	10	2.21	0.13	41.2	14.4	142	0.42	36.7	3.74	5.46	0.09	0.57	0.07	0.01	0.2	20.4	34.2	2.15	782
VR71087A	SLST	5.32	2.35	19.4	50	0.7	0.82	10	0.12	1.43	59.8	23.4	104	2.46	4340	5.66	6.88	0.13	1.24	0.15	0.043	0.39	32.5	51.6	1.36	285
VR71161A	SLST	0.11	2.39	13.8	50	0.51	0.41	10	0.17	0.9	61.4	24.8	108	0.65	80.1	5.51	7.45	0.11	1.02	0.12	0.031	0.29	31.7	38.5	1.22	219
VR71499A	SLST											20	100		90											
VR91482A	SLST	0.13	2.6	15.5	40	0.8	0.33	10	0.17	0.47	55.9	23.5	104	1.14	98	5.39	7.46	0.13	1	0.14	0.029	0.3	27.6	58.1	1.68	266
VR91623A	SLST	0.1	1.8	15.1	30	0.28	0.17	<10	2.62	0.1	45.5	13.7	152	0.46	38.2	3.58	5.36	0.09	0.4	0.1	0.012	0.17	21.7	27.5	0.96	497
VR91625A	SLST	0.31	2.26	30.8	40	0.37	0.47	<10	0.4	0.92	60.4	25.9	80	0.57	112	5.79	6.41	0.12	0.53	0.22	0.036	0.21	31.4	42	1.48	277
VR91627A	SLST	0.25	2.54	14.4	40	0.42	0.57	<10	0.17	0.88	59.8	25.3	85	0.49	192	5.72	6.73	0.12	0.86	0.19	0.049	0.27	29.4	45.8	1.62	269
VR71043A	SLST	0.06	1.24	13	20	0.19	0.12	<10	3.43	0.1	36.4	10.6	150	0.38	23.4	2.54	3.8	0.08	0.39	0.04	0.009	0.11	18.4	18.2	0.63	541
VR71100A	SLST											30	400		70											
VR90425A	SLST	0.09	3.09	15.8	40	0.94	0.2	10	0.13	0.06	63.8	23.8	132	2.25	48	5.59	9.85	0.13	1.15	0.04	0.024	0.48	30.9	105	2.05	303
VR91618A	SLST	0.13	2.27	19.4	30	0.33	0.34	10	0.11	0.4	57.2	22.9	72	0.74	59.2	4.97	7.1	0.12	0.68	0.13	0.02	0.18	29.7	46.5	1.37	233
VR91619A	SLST	0.13	2.53	14.9	40	0.38	0.29	10	0.14	0.6	61.6	24.2	96	0.51	78.4	5.42	7.23	0.12	0.77	0.15	0.023	0.23	31.4	50.3	1.46	269
VR91622A	SLST	0.13	2.48	15.3	50	0.38	0.26	<10	0.36	0.26	60.8	23.9	96	0.55	69.2	5.88	7.29	0.13	0.67	0.16	0.015	0.3	31.7	45.5	1.45	279
VR91626A	SLST	0.23	2.86	16.4	50	0.75	0.33	20	0.17	0.8	57.6	22.4	92	1.2	315	5.39	7.62	0.13	0.8	0.23	0.02	0.41	28.3	70.2	1.94	310
VR71134A	SMSU											660	1400		36600											
VR71325A	SMSU											740	900		10900											
VR71418A	SMSU											750	1900		10700											
VR90125A	SMSU	4.56	0.6	1.2	20	0.1	1.33	70	0.24	1.46	5.86	392	494	1.37	9810	14.85	2.43	0.58	0.13	0.04	0.1	0.11	2.6	7.9	6.29	532
VR90457A	SMSU	5.13	0.4	2.9	10	0.07	1.41	<10	0.14	2.01	2.92	651	379	0.18	17800	>15	1.62	1.09	0.11	0.06	0.171	0.07	1.4	2.4	8.84	811
VR91542A	SMSU	6.54	0.45	2.6	10	0.09	1.63	140	0.39	2.16	4.38	585	202	0.42	22600	>15	1.71	1	0.11	0.08	0.198	0.05	2	7.3	10	795

TABLE 3-2

Elemental Analysis Results

Rock Type		STATISTICS BY LITHOLOGY																								
		Ag	Al	As	Ba	Be	Bi	B	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn
		ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm
MSU	MIN	12.4	0.0	5.9	10	0.1	4.2	10	0.01	4.19	0.5	1110	1	0.1	26400	15.00	1.03	1.99	0.02	0.12	0.406	0.01	0.2	1.1	0.04	286
	MAX	27.7	0.2	6.4	10	0.1	5.7	10	0.03	9.93	1.7	1910	200	0.5	56200	15.00	1.24	2.02	0.06	0.25	0.653	0.08	0.8	5.7	0.09	465
	COUNT	2	2	2	2	2	2	2	2	2	2	5	5	2	5	2	2	2	2	2	2	2	2	2	2	2
	AVERAGE	20.0	0.1	6.2	10	0.1	5.0	10	0.02	7.06	1.1	1612	92	0.3	43180	15.00	1.14	2.01	0.04	0.19	0.530	0.05	0.5	3.4	0.07	376
	STDEV	10.9	0.2	0.4	0	0.0	1.1	0	0.01	4.06	0.9	364	73	0.3	10965	0.00	0.15	0.02	0.03	0.09	0.175	0.05	0.4	3.3	0.04	127
SMSU	MIN	4.6	0.4	1.2	10	0.1	1.3	10	0.14	1.46	2.9	392	202	0.2	9810	14.85	1.62	0.58	0.11	0.04	0.100	0.05	1.4	2.4	6.29	532
	MAX	6.5	0.6	2.9	20	0.1	1.6	140	0.39	2.16	5.9	750	1900	1.4	36600	15.00	2.43	1.09	0.13	0.08	0.198	0.11	2.6	7.9	10.00	811
	COUNT	3	3	3	3	3	3	3	3	3	3	6	6	3	6	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	5.4	0.5	2.2	13	0.1	1.5	73	0.26	1.88	4.4	630	879	0.7	18068	14.95	1.92	0.89	0.12	0.06	0.156	0.08	2.0	5.9	8.38	713
	STDEV	1.0	0.1	0.9	6	0.0	0.2	65	0.13	0.37	1.5	132	659	0.6	10372	0.09	0.44	0.27	0.01	0.02	0.051	0.03	0.6	3.0	1.90	157
PER	MIN	0.1	1.5	0.2	30	0.1	0.0	10	0.59	0.09	8.4	77	242	0.5	214	5.98	5.16	0.18	0.11	0.01	0.015	0.12	3.9	5.0	3.61	378
	MAX	2.5	2.2	1.5	40	0.2	1.0	70	0.81	1.29	12.9	260	2600	5.5	6610	10.55	8.22	0.36	0.17	0.04	0.087	0.29	5.9	20.9	10.10	860
	COUNT	5	5	5	5	5	5	5	5	5	5	9	9	5	9	5	5	5	5	5	5	5	5	5	5	5
	AVERAGE	0.9	1.7	0.9	34	0.2	0.4	40	0.67	0.46	10.9	160	1239	2.1	2484	8.06	6.13	0.25	0.15	0.02	0.041	0.18	5.0	14.2	7.12	610
	STDEV	1.0	0.3	0.5	5	0.0	0.5	24	0.10	0.50	1.9	67	940	2.0	2502	1.82	1.20	0.09	0.02	0.01	0.029	0.07	0.8	6.2	2.39	183
PRX	MIN	0.5	1.9	0.7	20	0.2	0.2	10	0.56	0.26	8.9	88	298	1.5	1135	5.42	6.93	0.20	0.14	0.03	0.030	0.10	4.1	16.8	3.35	423
	MAX	4.4	2.1	1.5	30	0.3	1.6	30	1.52	1.70	20.3	113	976	3.8	5760	7.91	10.60	0.27	0.48	0.12	0.100	0.21	8.8	30.7	5.24	486
	COUNT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AVERAGE	2.4	2.0	1.1	25	0.2	0.9	20	1.04	0.98	14.6	101	637	2.6	3448	6.67	8.77	0.24	0.31	0.08	0.065	0.16	6.5	23.8	4.30	455
	STDEV	2.7	0.1	0.6	7	0.1	1.0	14	0.68	1.02	8.1	17	479	1.6	3270	1.76	2.60	0.05	0.24	0.06	0.049	0.08	3.3	9.8	1.34	45
SLST	MIN	0.1	1.2	13.0	20	0.2	0.1	10	0.11	0.06	36.4	11	72	0.4	23	2.54	3.80	0.08	0.39	0.04	0.009	0.11	18.4	18.2	0.63	219
	MAX	5.3	3.1	30.8	50	0.9	0.8	20	3.43	1.43	63.8	30	400	2.5	4340	5.88	9.85	0.13	1.24	0.23	0.049	0.48	32.5	105.0	2.05	541
	COUNT	12	12	12	12	12	12	12	12	12	12	14	14	12	14	12	12	12	12	12	12	12	12	12	12	12
	AVERAGE	0.6	2.4	17.0	40	0.5	0.4	11	0.67	0.58	56.7	22	127	1.0	401	5.12	6.93	0.12	0.79	0.14	0.026	0.28	28.7	49.9	1.44	312
	STDEV	1.5	0.5	4.8	10	0.2	0.2	3	1.12	0.42	7.9	5	82	0.7	1136	1.02	1.43	0.02	0.28	0.06	0.012	0.11	4.4	21.9	0.39	100
SDST	MIN	0.1	1.5	9.2	20	0.2	0.1	10	0.09	0.05	35.6	14	142	0.4	37	2.99	5.32	0.07	0.57	0.02	0.009	0.12	16.0	33.5	0.91	190
	MAX	0.2	1.9	13.8	30	0.4	0.1	10	2.21	0.13	41.2	14	295	0.6	230	3.74	6.50	0.09	0.62	0.08	0.014	0.20	20.4	34.2	2.15	782
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	0.1	1.7	12.2	27	0.3	0.1	10	0.81	0.10	37.5	14	201	0.5	115	3.42	5.76	0.08	0.60	0.06	0.011	0.16	17.7	33.8	1.37	403
	STDEV	0.0	0.2	2.6	6	0.1	0.0	0	1.21	0.04	3.2	0	82	0.1	102	0.39	0.64	0.01	0.03	0.03	0.003	0.04	2.3	0.4	0.68	329
HFL	MIN	0.1	2.8	11.9	10	0.6	0.3	10	0.12	0.06	42.0	20	110	0.5	70	5.22	8.58	0.12	0.77	0.08	0.019	0.13	19.6	59.0	1.84	320
	MAX	4.1	3.2	38.6	50	0.9	1.1	10	0.63	1.21	68.5	94	189	1.8	15000	8.00	10.80	0.23	1.07	0.20	0.116	0.37	34.8	82.4	2.66	491
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	1.4	2.9	21.0	33	0.7	0.6	10	0.34	0.51	57.1	46	141	1.3	5050	6.48	9.37	0.16	0.93	0.15	0.054	0.29	28.1	70.2	2.18	421
	STDEV	2.3	0.2	15.2	21	0.1	0.5	0	0.26	0.62	13.6	41	42	0.7	8617	1.41	1.24	0.06	0.15	0.06	0.054	0.14	7.7	11.7	0.43	89

TABLE 3-2

Elemental Analysis Results

Sample	Rock Type	Mo	Na	Nb	Ni	Pb	P	Rb	Re	Sb	Sc	Se	Sn	Sr	S	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
VR71109A	HFL	4.12	0.02	<0.05	94.2	5.5	480	20.3	0.003	0.75	6.2	0.6	0.7	19.8	0.67	<0.01	0.02	7.3	0.017	0.23	3.03	74	0.12	15.1	83	41.4
VR91306A	HFL	2.58	0.04	0.05	2970	10.5	370	4.2	0.003	3.16	9.1	6.9	2.9	19.6	2.89	<0.01	0.39	5.3	0.009	0.36	1.49	77	0.13	7.48	158	26.8
VR91579A	HFL	4.46	0.02	<0.05	115.5	16	490	17.8	0.003	0.98	7.6	0.8	1.3	18.8	1.51	0.01	0.04	6.3	0.007	0.19	2.87	69	0.07	12.45	49	41.6
VR71062A	MSU				60700										36.9										200	
VR71120A	MSU				69200										37.8										200	
VR71388A	MSU				64300										36										200	
VR71450A	MSU	3.59	<0.01	0.36	>10000	69.6	10	4.9	0.064	0.38	1.1	84.2	4.5	2.4	6.79	<0.01	6.78	0.3	0.025	0.74	0.11	33	0.1	0.54	123	2.9
VR90181A	MSU	3.19	<0.01	0.39	>10000	64.4	<10	0.3	0.058	0.46	1	83.9	12.2	1.4	6.89	<0.01	11.6	<0.2	0.009	0.7	<0.05	62	0.21	0.11	186	0.9
VR71348A	PER				9430										3.8										200	
VR71373A	PER	1.14	0.12	0.06	5870	5.4	380	10.5	0.012	0.14	5.5	5.9	0.8	32.8	2.26	<0.01	0.54	1	0.108	0.31	0.21	62	0.05	6.87	70	5.6
VR71375A	PER				6850										3.11										100	
VR71821A	PER	1.1	0.13	0.06	6230	12.5	300	6.9	0.015	0.1	9	9.7	1	48.6	3.58	<0.01	1.02	0.7	0.111	0.16	0.18	82	0.07	5.25	67	5.4
VR71192A	PER				1470										0.23										100	
VR71213A	PER				1430										0.21										100	
VR71314A	PER	1.02	0.14	0.06	1080	3.1	450	10.2	0.001	<0.05	4.7	0.9	0.4	30.9	0.3	<0.01	0.07	1.2	0.12	0.1	0.29	69	0.11	6.89	87	7
VR91267A	PER	1.09	0.22	<0.05	1395	3.7	480	21.7	0.005	<0.05	6.6	2.1	0.5	59.6	0.89	<0.01	0.13	1.2	0.174	0.34	0.26	124	0.05	7.06	39	6.3
VR91624A	PER	0.77	0.18	0.07	1325	2.3	350	6.5	0.001	<0.05	6.7	0.5	0.3	50.3	0.17	<0.01	0.03	0.8	0.105	0.05	0.22	57	0.06	5.2	85	4.7
VR71275A	PRX	0.68	0.09	<0.05	1590	4.1	300	7.5	0.005	0.06	12.3	2.3	0.3	47.1	1.02	<0.01	0.17	0.8	0.102	0.15	0.19	88	<0.05	5.74	58	5.1
VR71938A	PRX	1.33	0.12	0.05	3390	18.2	930	16.2	0.004	0.08	7.5	6.2	1.4	66.9	1.58	<0.01	1.66	1.2	0.222	0.34	0.23	133	0.06	12.6	66	15.7
VR90257A	SDST	3.96	0.05	<0.05	197.5	2.8	320	4.9	0.001	0.4	5.6	0.4	0.8	13	0.2	<0.01	0.02	5.4	0.007	0.05	1.36	46	0.12	7.98	30	21.5
VR91620A	SDST	2.6	0.01	<0.05	57.4	8.1	450	8.3	<0.001	0.38	3.1	0.3	0.3	11.4	0.3	<0.01	0.01	4.7	<0.005	0.08	1.22	24	0.08	6.45	77	23
VR91621A	SDST	2.8	0.02	<0.05	57.3	10.6	430	9.5	<0.001	0.6	3.8	0.5	0.2	18.7	0.51	<0.01	0.01	4.6	<0.005	0.1	1.14	25	0.19	10.75	92	22
VR71087A	SLST	5.48	0.01	0.05	168	43.8	490	31.5	0.004	0.87	5.1	0.9	0.9	12	1.39	<0.01	0.05	7.5	0.023	0.45	3.61	60	0.09	14.3	155	49.2
VR71161A	SLST	8.03	<0.01	<0.05	109	25.4	500	15.6	0.007	0.56	4.2	0.9	0.3	14.9	0.83	<0.01	0.05	6.8	0.006	0.13	3.3	36	0.07	13.1	231	38.4
VR71499A	SLST				90										1.17										200	
VR91482A	SLST	8.36	0.01	<0.05	113	34.1	540	15.7	0.004	1.52	5.7	0.6	0.6	16.4	1.06	<0.01	0.04	5.6	0.009	0.2	2.75	54	0.07	11.35	140	40.3
VR91623A	SLST	2.64	0.02	<0.05	62.5	15.8	430	8.6	<0.001	0.63	3.8	0.4	0.3	178	0.37	<0.01	0.02	4.3	0.005	0.09	0.85	26	0.06	6.44	78	14.7
VR91625A	SLST	11.45	0.01	<0.05	147.5	23.5	530	10.2	0.007	1.54	3.4	0.8	0.2	25.2	1.36	<0.01	0.07	5.5	0.006	0.11	2.05	34	0.1	7.87	222	18.9
VR91627A	SLST	7.23	0.01	<0.05	219	32.6	580	12.8	0.003	1.71	3.8	0.8	0.3	15.4	1.41	<0.01	0.06	6.5	0.005	0.16	2.34	32	0.07	9.97	210	34.6
VR71043A	SLST	2.23	0.01	<0.05	39.4	10.6	370	6.1	<0.001	0.57	2.5	0.3	0.2	217	0.16	<0.01	0.02	4.4	<0.005	0.07	0.91	18	0.15	7.7	69	14.1
VR71100A	SLST				80										1.05										200	
VR90425A	SLST	2.06	0.02	0.07	104	6.8	470	30.9	0.002	0.54	7.8	0.4	0.6	17.7	0.76	<0.01	0.03	7.3	0.038	0.31	2.74	80	0.1	12.5	61	46.2
VR91618A	SLST	2.4	<0.01	<0.05	89.4	18.6	470	9.2	0.002	1.52	3.1	0.6	0.6	14.6	1	<0.01	0.03	6.7	0.005	0.14	1.94	27	0.05	8.18	166	25.2
VR91619A	SLST	3.77	<0.01	<0.05	100	17.8	570	11.5	0.003	1.68	3.4	0.5	0.2	17.5	1.09	<0.01	0.03	6.8	0.005	0.16	1.98	32	0.13	9.1	188	29.8
VR91622A	SLST	5.95	0.01	<0.05	106.5	17.9	560	15.4	0.002	2.52	3.9	0.7	0.3	21.1	1.47	<0.01	0.02	6.5	0.006	0.19	1.84	32	0.05	9.14	138	26.7
VR91626A	SLST	3.65	<0.01	<0.05	269	22.1	510	19.6	0.005	1.27	4.9	0.8	0.5	26	1.04	<0.01	0.06	5.1	0.017	0.28	1.99	50	0.08	9.72	128	29.6
VR71134A	SMSU				23300										14.6										300	
VR71325A	SMSU				26300										12.2										200	
VR71418A	SMSU				27000										14.35										300	
VR90125A	SMSU	1.3	0.04	0.09	>10000	20.8	190	6.9	0.054	0.09	4.3	17.1	0.9	13	4.7	<0.01	1.46	0.6	0.074	0.24	0.13	44	0.05	2.85	59	4
VR90457A	SMSU	1.94	0.04	0.18	>10000	21.2	100	3.7	0.04	0.12	4.7	34.1	1.3	9.3	6.51	<0.01	2.03	0.3	0.078	0.18	0.12	46	0.07	1.53	108	4.9
VR91542A	SMSU	1.63	0.03	0.15	>10000	20.7	110	2.4	0.031	3.9	4.8	35.2	2	18.2	6.94	<0.01	2	0.4	0.05	0.19	0.1	38	0.05	2.69	108	4.7

TABLE 3-2

Elemental Analysis Results

Rock Type		STATISTICS BY LITHOLOGY																							
		Mo	Na	Nb	Ni	Pb	P	Rb	Re	Sb	Sc	Se	Sn	Sr	S	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
MSU	MIN	3.19	0.01	0.36	60700	64.4	10	0.3	0.058	0.38	1.0	83.9	4.5	1.4	6.8	0.01	6.78	0.2	0.009	0.70	0.05	33	0.10	0.11	123	0.9
	MAX	3.59	0.01	0.39	69200	69.6	10	4.9	0.064	0.46	1.1	84.2	12.2	2.4	37.8	0.01	11.60	0.3	0.025	0.74	0.11	62	0.21	0.54	200	2.9
	COUNT	2	2	2	3	2	2	2	2	2	2	2	2	2	5	2	2	2	2	2	2	2	2	2	5	2
	AVERAGE	3.39	0.01	0.38	64733	67.0	10	2.6	0.061	0.42	1.1	84.1	8.4	1.9	24.9	0.01	9.19	0.3	0.017	0.72	0.08	48	0.16	0.33	182	1.9
	STDEV	0.28	0.00	0.02	4267	3.7	0	3.3	0.004	0.06	0.1	0.2	5.4	0.7	16.5	0.00	3.41	0.1	0.011	0.03	0.04	21	0.08	0.30	33	1.4
SMSU	MIN	1.30	0.03	0.09	23300	20.7	100	2.4	0.031	0.09	4.3	17.1	0.9	9.3	4.7	0.01	1.46	0.3	0.050	0.18	0.10	38	0.05	1.53	59	4.0
	MAX	1.94	0.04	0.18	27000	21.2	190	6.9	0.054	3.90	4.8	35.2	2.0	18.2	14.6	0.01	2.03	0.6	0.078	0.24	0.13	46	0.07	2.85	300	4.9
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	6	3	3	3	3	3	3	3	3	3	6	3
	AVERAGE	1.62	0.04	0.14	25533	20.9	133	4.3	0.042	1.37	4.6	28.8	1.4	13.5	9.9	0.01	1.83	0.4	0.067	0.20	0.12	43	0.06	2.36	179	4.5
	STDEV	0.32	0.01	0.05	1966	0.3	49	2.3	0.012	2.19	0.3	10.1	0.6	4.5	4.3	0.00	0.32	0.2	0.015	0.03	0.02	4	0.01	0.72	104	0.5
PER	MIN	0.77	0.12	0.05	1080	2.3	300	6.5	0.001	0.05	4.7	0.5	0.3	30.9	0.2	0.01	0.03	0.7	0.105	0.05	0.18	57	0.05	5.20	39	4.7
	MAX	1.14	0.22	0.07	9430	12.5	480	21.7	0.015	0.14	9.0	9.7	1.0	59.6	3.8	0.01	1.02	1.2	0.174	0.34	0.29	124	0.11	7.06	200	7.0
	COUNT	5	5	5	9	5	5	5	5	5	5	5	5	5	9	5	5	5	5	5	5	5	5	5	9	5
	AVERAGE	1.02	0.16	0.06	3898	5.4	392	11.2	0.007	0.08	6.5	3.8	0.6	44.4	1.6	0.01	0.36	1.0	0.124	0.19	0.23	79	0.07	6.25	94	5.8
	STDEV	0.15	0.04	0.01	3191	4.1	73	6.2	0.006	0.04	1.6	3.9	0.3	12.3	1.6	0.00	0.42	0.2	0.029	0.13	0.04	27	0.02	0.94	44	0.9
PRX	MIN	0.68	0.09	0.05	1590	4.1	300	7.5	0.004	0.06	7.5	2.3	0.3	47.1	1.0	0.01	0.17	0.8	0.102	0.15	0.19	88	0.05	5.74	58	5.1
	MAX	1.33	0.12	0.05	3390	18.2	930	16.2	0.005	0.08	12.3	6.2	1.4	66.9	1.6	0.01	1.66	1.2	0.222	0.34	0.23	133	0.06	12.60	66	15.7
	COUNT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AVERAGE	1.01	0.11	0.05	2490	11.2	615	11.9	0.005	0.07	9.9	4.3	0.9	57.0	1.3	0.01	0.92	1.0	0.162	0.25	0.21	111	0.06	9.17	62	10.4
	STDEV	0.46	0.02	0.00	1273	10.0	445	6.2	0.001	0.01	3.4	2.8	0.8	14.0	0.4	0.00	1.05	0.3	0.085	0.13	0.03	32	0.01	4.85	6	7.5
SLST	MIN	2.06	0.01	0.05	39	6.8	370	6.1	0.001	0.54	2.5	0.3	0.2	12.0	0.2	0.01	0.02	4.3	0.005	0.07	0.85	18	0.05	6.44	61	14.1
	MAX	11.45	0.02	0.07	269	43.8	580	31.5	0.007	2.52	7.8	0.9	0.9	217.0	1.5	0.01	0.07	7.5	0.038	0.45	3.61	80	0.15	14.30	231	49.2
	COUNT	12	12	12	14	12	12	12	12	12	12	12	12	12	14	12	12	12	12	12	12	12	12	12	14	12
	AVERAGE	5.27	0.01	0.05	121	22.4	502	15.6	0.003	1.24	4.3	0.6	0.4	48.0	1.0	0.01	0.04	6.1	0.011	0.19	2.19	40	0.09	9.95	156	30.6
	STDEV	3.00	0.00	0.01	62	10.4	61	8.2	0.002	0.62	1.4	0.2	0.2	70.5	0.4	0.00	0.02	1.1	0.010	0.11	0.83	18	0.03	2.40	57	11.6
SDST	MIN	2.60	0.01	0.05	57	2.8	320	4.9	0.001	0.38	3.1	0.3	0.2	11.4	0.2	0.01	0.01	4.6	0.005	0.05	1.14	24	0.08	6.45	30	21.5
	MAX	3.96	0.05	0.05	198	10.6	450	9.5	0.001	0.60	5.6	0.5	0.8	18.7	0.5	0.01	0.02	5.4	0.007	0.10	1.36	46	0.19	10.75	92	23.0
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	3.12	0.03	0.05	104	7.2	400	7.6	0.001	0.46	4.2	0.4	0.4	14.4	0.3	0.01	0.01	4.9	0.006	0.08	1.24	32	0.13	8.39	66	22.2
	STDEV	0.73	0.02	0.00	81	4.0	70	2.4	0.000	0.12	1.3	0.1	0.3	3.8	0.2	0.00	0.01	0.4	0.001	0.03	0.11	12	0.06	2.18	32	0.8
HFL	MIN	2.58	0.02	0.05	94	5.5	370	4.2	0.003	0.75	6.2	0.6	0.7	18.8	0.7	0.01	0.02	5.3	0.007	0.19	1.49	69	0.07	7.48	49	26.8
	MAX	4.46	0.04	0.05	2970	16.0	490	20.3	0.003	3.16	9.1	6.9	2.9	19.8	2.9	0.01	0.39	7.3	0.017	0.36	3.03	77	0.13	15.10	158	41.6
	COUNT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	AVERAGE	3.72	0.03	0.05	1060	10.7	447	14.1	0.003	1.63	7.6	2.8	1.6	19.4	1.7	0.01	0.15	6.3	0.011	0.26	2.46	73	0.11	11.68	97	36.6
	STDEV	1.00	0.01	0.00	1654	5.3	67	8.7	0.000	1.33	1.5	3.6	1.1	0.5	1.1	0.00	0.21	1.0	0.005	0.09	0.85	4	0.03	3.87	56	8.5

TABLE 3-3

Acid-Base Accounting Results

Sample	Rock Type	Paste pH	S(T)	$S(SO_4)$	TIC	AP	NP	NNP	NPR
		s.u.	wt. %	wt. %	wt. %	t $CaCO_3$/1000 t			
VR71109A	HFL	9.19	0.67	0.02	0.25	20.3	25.3	4.9	1.24
VR91306A	HFL	8.84	2.72	0.02	0.11	84.4	20.6	-63.8	0.24
VR91579A	HFL	8.69	1.38	0.02	<0.05	42.5	8.1	-34.4	0.19
VR71062A	MSU	5.3	37.3	0.28	0.15	1156.9	-2.0	-1158.9	<0.01
VR71120A	MSU	3.7	36.1	0.16	0.06	1123.1	-4.0	-1127.1	<0.01
VR71388A	MSU	6.4	37.5	<0.01	0.11	1171.9	3.0	-1168.9	<0.01
VR71450A	MSU	6.1	35	0.08	<0.05	1091.3	2.8	-1088.4	<0.1
VR90181A	MSU	4.64	32.4	<0.01	<0.05	1012.5	0.9	-1011.6	<0.1
VR71348A	PER	9	3.67	0.02	0.09	114.1	38.0	-76.1	0.33
VR71373A	PER	9.58	2.44	0.02	0.06	75.6	34.4	-41.3	0.45
VR71375A	PER	9.1	2.94	0.01	0.12	91.6	38.0	-53.6	0.42
VR71821A	PER	9.48	3.37	0.01	0.11	105.0	39.0	-66.0	0.37
VR71192A	PER	8.8	0.18	0.01	0.09	5.3	76.0	70.7	14.31
VR71213A	PER	8.8	0.2	0.01	0.09	5.9	42.0	36.1	7.07
VR71314A	PER	9.57	0.3	0.03	0.05	8.4	41.4	32.9	4.90
VR91267A	PER	9.69	0.89	0.02	0.05	27.2	22.2	-5.0	0.82
VR91624A	PER	9.05	0.16	0.03	0.09	4.1	64.9	60.8	15.97
VR71275A	PRX	9.35	0.99	0.01	<0.05	30.6	24.6	-6.0	0.80
VR71938A	PRX	9.68	1.6	0.01	0.31	49.7	43.4	-6.3	0.87
VR90257A	SDST	9.13	0.19	0.01	<0.05	5.6	5.6	0.0	1.00
VR91620A	SDST	9	0.31	0.01	<0.05	9.4	5.6	-3.8	0.59
VR91621A	SDST	9.05	0.49	0.02	1.25	14.7	103.6	88.9	7.06
VR71087A	SLST	8.98	1.42	0.01	<0.05	44.1	6.6	-37.5	0.15
VR71161A	SLST	9.13	0.83	0.01	<0.05	25.6	7.4	-18.3	0.29
VR71499A	SLST	8.8	1.23	0.03	0.07	37.5	11.0	-26.5	0.29
VR91482A	SLST	9.03	1.09	0.01	<0.05	33.8	8.6	-25.2	0.25
VR91623A	SLST	9.44	0.35	0.01	0.83	10.6	71.9	61.3	6.76
VR91625A	SLST	9.17	1.39	0.01	0.11	43.1	12.3	-30.9	0.28
VR91627A	SLST	9.07	1.4	0.03	<0.05	42.8	8.6	-34.2	0.20
VR71043A	SLST	9.22	0.16	<0.01	1.08	5	90.0	85.0	18.00
VR71100A	SLST	8.6	1.06	0.01	0.06	32.8	14.0	-18.8	0.43
VR90425A	SLST	9.15	0.77	0.01	<0.05	23.8	8.8	-15.0	0.37
VR91618A	SLST	7.63	1.09	0.01	<0.05	33.8	4.9	-28.9	0.14
VR91619A	SLST	8.74	1.09	0.01	<0.05	33.8	4.6	-29.1	0.14
VR91622A	SLST	9.02	1.44	0.02	0.09	44.4	11.8	-32.6	0.27
VR91626A	SLST	8.19	1.08	0.02	<0.05	33.1	8.8	-24.3	0.27
VR71134A	SMSU	8.3	15.2	0.03	0.12	474.1	34.0	-440.1	0.07
VR71325A	SMSU	8.9	12.85	0.02	0.07	400.9	41.0	-359.9	0.10
VR71418A	SMSU	8.6	15.3	0.03	0.1	477.2	33.0	-444.2	0.07
VR90125A	SMSU	9.26	8.13	0.02	0.05	253.4	23.9	-229.6	0.09
VR90457A	SMSU	8.88	15.45	0.01	0.06	482.5	44.0	-438.5	0.09
VR91542A	SMSU	9.07	13.65	0.04	0.23	425.3	67.2	-358.1	0.16

TABLE 3-3

Acid-Base Accounting Results

STATISTICS BY LITHOLOGY									
Rock Type		Paste pH	S(T)	$S(SO_4)$	TIC	AP	NP	NNP	NPR
		s.u.	wt. %	wt. %	wt. %	t $CaCO_3$/1000 t			
MSU	MIN	3.70	32.40	0.01	0.05	1013	-4	-1169	0.01
	MAX	6.40	37.50	0.28	0.15	1172	3	-1012	0.10
	COUNT	5	5	5	5	5	5	5	5
	AVERAGE	5.23	35.66	0.11	0.08	1111	0	-1111	0.05
	STDEV	1.10	2.08	0.11	0.04	63	3	64	0.05
SMSU	MIN	8.30	8.13	0.01	0.05	253	24	-444	0.07
	MAX	9.26	15.45	0.04	0.23	483	67	-230	0.16
	COUNT	6.00	6.00	6.00	6.00	6	6	6	6.00
	AVERAGE	8.84	13.43	0.03	0.11	419	41	-378	0.10
	STDEV	0.34	2.80	0.01	0.07	87	15	83	0.03
PER	MIN	8.80	0.16	0.01	0.05	4	22	-76	0.33
	MAX	9.69	3.67	0.03	0.12	114	76	71	15.97
	COUNT	9	9	9	9	9	9	9	9
	AVERAGE	9.23	1.57	0.02	0.08	49	44	-5	4.96
	STDEV	0.35	1.51	0.01	0.03	47	16	57	6.26
PRX	MIN	9.35	0.99	0.01	0.05	31	25	-6	0.80
	MAX	9.68	1.60	0.01	0.31	50	43	-6	0.87
	COUNT	2	2	2	2	2	2	2	2
	AVERAGE	9.52	1.30	0.01	0.18	40	34	-6	0.84
	STDEV	0.23	0.43	0.00	0.18	13	13	0	0.05
SLST	MIN	7.63	0.16	0.01	0.05	5	5	-38	0.14
	MAX	9.44	1.44	0.03	1.08	44	90	85	18.00
	COUNT	14	14	14	14	14	14	14	14
	AVERAGE	8.87	1.03	0.01	0.19	32	19	-12	1.99
	STDEV	0.47	0.39	0.01	0.33	12	27	37	4.92
SDST	MIN	9.00	0.19	0.01	0.05	6	6	-4	0.59
	MAX	9.13	0.49	0.02	1.25	15	104	89	7.06
	COUNT	3	3	3	3	3	3	3	3
	AVERAGE	9.06	0.33	0.01	0.45	10	38	28	2.88
	STDEV	0.07	0.15	0.01	0.69	5	57	52	3.62
HFL	MIN	8.69	0.67	0.02	0.05	20	8	-64	0.19
	MAX	9.19	2.72	0.02	0.25	84	25	5	1.24
	COUNT	3	3	3	3	3	3	3	3
	AVERAGE	8.91	1.59	0.02	0.14	49	18	-31	0.56
	STDEV	0.26	1.04	0.00	0.10	33	9	34	0.59

Kinetic Testing Results - Acid Generation and Neutralization Depletion Rates

Column	Rock Type	Sulfide Sulfur	NP	Acid Generation Rate	Neutralization Potential Consumption Rate	Time to Sulfide Depletion	Time to NP Exhaustion	Acid Generating
		wt. %	t $CaCO_3$/1000 t	mg $SO4/m^2/wk$	mg $CaCO_3$/kg/wk	years	years	AP>NP
1	Siltstone	1.1	14	8	13	90	20	Yes
5	Siltstone	1.2	11	4	11	126	18	Yes
3	Peridotite	0.19	42	1	13	128	63	Yes
4	Semi-Massive Sulfide	13	41	16	18	597	44	Yes
2	Massive Sulfide	36	-4	221	168	127	negligible	Yes

TABLE 3-5

Kinetic Testing Results - Metal Leaching Rates

Column	Rock Type	Leach Rates ($mg/m^2/week$)							
		Ni	Cu	Fe	Co	Pb	Se	Zn	As
1	Siltstone	0.0002	0.0005	0.009	0.00005	0.00008	0.0002	0.003	0.009
5	Siltstone	0.0001	0.0002	0.002	0.00001	0.00002	0.0002	0.0007	0.003
3	Peridotite	0.0006	0.0002	0.003	0.00002	0.00002	0.00006	0.001	0.0003
4	Semi-Massive Sulfide	0.01	0.002	0.002	0.0003	0.00003	0.0003	0.001	0.0002
2	Massive Sulfide	67	0.1	45	1.3	0.008	0.009	0.04	0.002

TABLE 3-6

Short-Term Leach Testing Results

Sample		VR90425A	VR91625A	VR91620A	VR71109A	VR91306A	VR71275A	VR91267A	VR71373A	VR90181A	VR90125A	Blank	Detection Limits
Rock Type		SLST	SLST	SDST	HFL	HFL	PRX	PER	PER	MSU	SMSU		
Water Volume	mL	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
Sample Mass	g	100	100	100	100	100	100	100	100	100	100	100	
CEMI Analyses													
pH		7.69	9.09	7.85	8.72	7.80	9.29	9.27	9.35	5.17	7.61	4.48	
Redox	mV	185	222	231	179	214	201	197	180	133	104	278	
Conductivity	uS/cm	32	38	36	59	33	72	44	66	117	97	10	
Alkalinity	mg $CaCO_3$/L	19.5	26.0	24.0	31.0	20.0	35.0	27.5	26.0	2.0	17.0	0.0	
Acidity (pH 4.5)	mg $CaCO_3$/L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Acidity (pH 8.3)	mg $CaCO_3$/L	8.0	0.0	1.5	0.0	1.5	0.0	0.0	0.0	33.5	2.0	5.5	
Sulfate	mg/L	8	<3	<3	<3	<3	10	7	<3	48	<3	<3	3
ALS Analyses													
Dissolved Metals													
Aluminum	mg/L	2.24	0.553	0.495	1.3	0.623	1.9	0.917	0.0261	**0.0061** *	0.0358	**0.0026**	0.001
Antimony (ICP-MS)	mg/L	**0.00084**	**0.00324**	**0.00067**	**0.00067**	**0.00522**	<0.00010	<0.00010	**0.00015**	<0.00050 *	**0.0004**	**0.00106**	0.0001
Antimony (HVAAS)		**0.0008**	**0.0032**	**0.00078**	**0.00072**	**0.0054**	<0.00020	<0.00020	<0.00020	<0.00020	**0.00048**	**0.00102**	0.0002
Arsenic (ICP-MS)	mg/L	0.00858	0.00843	0.0065	0.00741	0.0103	**0.00057**	**0.00033**	**0.00029**	<0.00050 *	**0.00044**	**0.00065**	0.0001
Arsenic (HVAAS)		0.00823	0.00838	**0.00671**	0.00707	0.0108	**0.00061**	**0.00033**	**0.00035**	<0.00020	**0.00063**	**0.00068**	0.0002
Barium	mg/L	0.0114	**0.000981**	**0.00107**	0.00687	**0.00107**	0.0015	0.00223	0.00247	0.00359 *	**0.00132**	**0.000137**	0.00005
Beryllium	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0025 *	<0.00050	<0.00050	0.0005
Bismuth	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0025 *	<0.00050	<0.00050	0.0005
Boron	mg/L	0.023	0.026	0.012	0.02	0.015	0.164	0.052	0.044	<0.050 *	0.103	<0.010	0.01
Cadmium	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.00403 *	<0.000050	<0.000050	0.00005
Calcium	mg/L	0.811	4.9	3.05	3.92	1.29	1.46	1.5	4.28	0.662	1.88	<0.050	0.05
Chromium	mg/L	0.00431	<0.00050	<0.00050	0.002	0.00071	0.0923	0.0307	<0.00050	<0.0025 *	0.00103	<0.00050	0.0005
Cobalt	mg/L	0.00101	<0.00010	<0.00010	0.00026	0.00092	0.00497	0.00412	<0.00010	0.222 *	0.00024	<0.00010	0.0001
Copper	mg/L	**0.00376**	**0.00059**	**0.00088**	**0.00251**	**0.0384**	**0.0158**	**0.0144**	**0.00104**	**0.0426** *	**0.00331**	**0.0121**	0.0001
Iron	mg/L	2.04	0.053	0.081	0.527	0.802	6.26	2.93	<0.030	12.8	0.069	<0.030	0.03
Lead	mg/L	**0.00121**	**0.000179**	**0.000134**	**0.000283**	**0.000928**	**0.000527**	**0.00076**	<0.000050	**0.00136** *	**0.000082**	**0.000246**	0.00005
Lithium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.025 *	<0.0050	<0.0050	0.005
Magnesium	mg/L	1.19	0.32	0.46	0.81	1.37	8.96	3.78	2.43	0.73	4.14	<0.10	0.1
Manganese	mg/L	0.0108	**0.000476**	0.000918	0.00901	0.00515	0.0541	0.0234	**0.000202**	0.131 *	0.00103	**0.000051**	0.00005
Mercury	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.00005
Molybdenum	mg/L	0.00131	0.00615	0.0015	0.00216	0.00115	0.000078	0.000065	<0.000050	<0.00025 *	0.000086	<0.000050	0.00005
Nickel	mg/L	0.0048	<0.00050	<0.00050	0.00113	0.0222	0.0703	0.0785	0.00543	15.6 *	0.0147	<0.00050	0.0005
Phosphorous	mg/L	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.3
Potassium	mg/L	4.8	2.1	2.5	2.2	2.3	<2.0	4.3	<2.0	<2.0	<2.0	<2.0	2
Selenium (ICP-MS)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050 *	<0.0010	<0.0010	0.001
Selenium (HVAAS)		<0.00050	<0.00050	<0.00050	<0.00050	0.00065	0.00086	0.00059	<0.00050	0.00187	<0.00050	<0.00050	0.0005
Silicon	mg/L	10.8	3.76	3.88	6.15	3.01	13.4	8.68	4.08	0.67	3.97	<0.050	0.05
Silver	mg/L	<0.000010	<0.000010	0.00001	<0.000010	0.000023	0.000037	0.000028	<0.000010	<0.000050 *	<0.000010	<0.000010	0.00001
Sodium	mg/L	7.3	3.7	4.8	7.4	5.6	14.2	8.1	2.2	<2.0	2	<2.0	2
Strontium	mg/L	0.0125	0.0141	0.0108	0.0342	0.0265	0.0261	0.0234	0.0261	0.0127 *	0.00892	<0.00010	0.0001
Thallium	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00050 *	<0.00010	<0.00010	0.0001
Tin	mg/L	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	0.00012	0.00025	<0.00010	<0.00050 *	<0.00010	<0.00010	0.0001
Titanium	mg/L	0.067	<0.010	<0.010	0.02	<0.010	0.046	0.037	<0.010	<0.010	<0.010	<0.010	0.01
Uranium	mg/L	0.00014	0.000088	0.000051	0.000119	0.000019	0.000011	<0.000010	<0.000010	<0.000050 *	<0.000010	<0.000010	0.00001
Vanadium	mg/L	0.0077	0.0046	0.0026	0.0045	<0.0010	0.0242	0.0136	0.0017	<0.0050 *	<0.0010	<0.0010	0.001
Zinc	mg/L	**0.0029**	<0.0010	<0.0010	**0.0013**	**0.0016**	**0.0053**	**0.0021**	<0.0010	0.0417 *	<0.0010	**0.0018**	0.001
Dissolved Anions													
Chloride	mg/L	1.86	1.07	1	0.66	1.78	2.46	2.58	3.98	2.87	12.2	<0.50	0.5
Fluoride	mg/L	0.048	0.046	0.043	0.032	0.144	<0.020	0.027	0.062	0.037	0.074	<0.020	0.02
Nutrients													
Ammonia	mg/L-N	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	
Nitrite/Nitrate	mg/L-N	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	
Total Dissolved Solids	mg/L	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	

Notes:
IP - In progress.
* Detection limit increased by a factor of five.
Shaded cells identify results qualified as estimated high (J+) due to detection in blank sample.

FIGURES

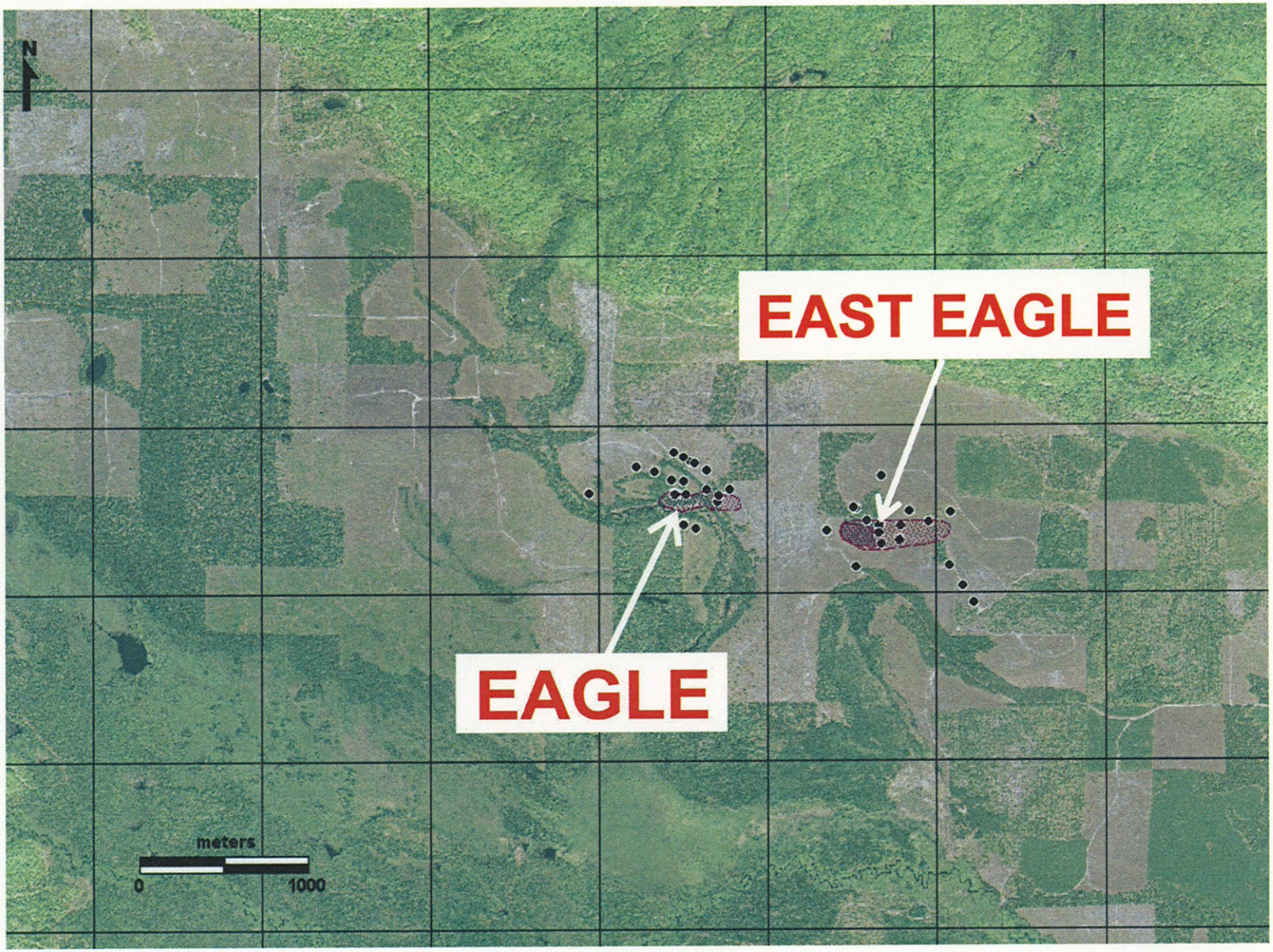
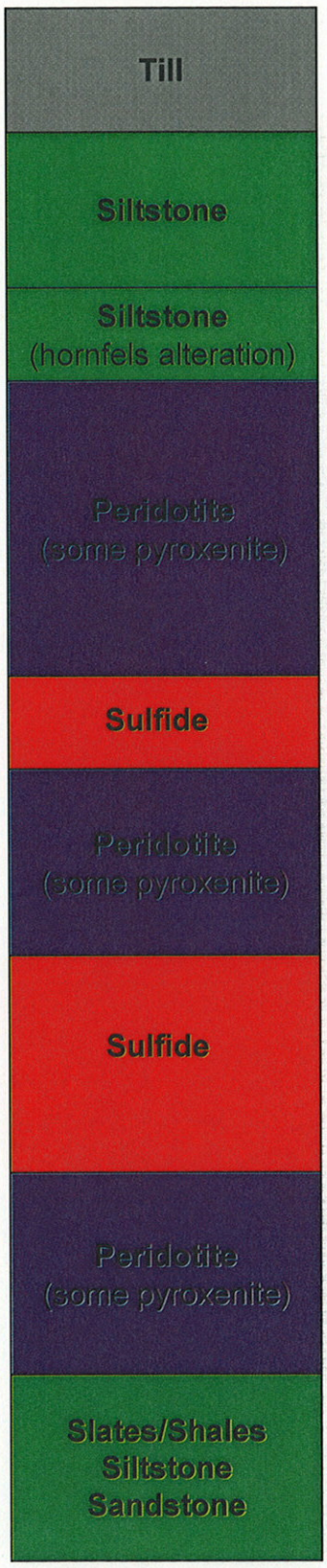


Figure 1-1
Site Map



Not drawn to scale.

Glacial Till

- Thickness (0 to >60 metres)

Sedimentary Rock (Upper)

- ***Siltstone***
  - minor fine grained greywacke sandstone interbeds
  - hornfels alteration at intrusive contact (hanging wall)

Intrusion

- ***Peridotite*** (most common)
  - medium to coarse grained
  - 30 to 60% olivine
  - 25 to 45% pyroxene
  - local olivine alteration to lizardite
- ***Pyroxenite*** (occurs at mineralized contacts)
  - fine grained
  - pyroxene is primary mineral phase
  - 3 to 10% olivine

Mineralization

- ***Disseminated Sulfide***
  - occurs along margins of intrusions above and below Upper Sulfide Zone and above Lower Sulfide Zone and in fine-grained pyroxenites
  - pyrrhotite and lesser chalcopyrite and pentlandite
- ***Semi-Massive Sulfide (SMSU)***
  - similar to disseminated sulfides
  - occurs in both Upper and Lower Sulfide Zones
  - abrupt transition between disseminated sulfide and SMSU
- ***Massive Sulfide (MSU)***
  - significant portion of Lower Sulfide Zone and part of Upper Sulfide Zone
  - pyrrhotite is dominant sulfide, also chalcopyrite and pentlandite

Sedimentary Rock (Lower)

- ***Slates/Shales, Sulphide laminae, thin bedded Siltstone and fine grained Sandstone***

Figure 1-2
Schematic of Typical Eagle Stratigraphic Column

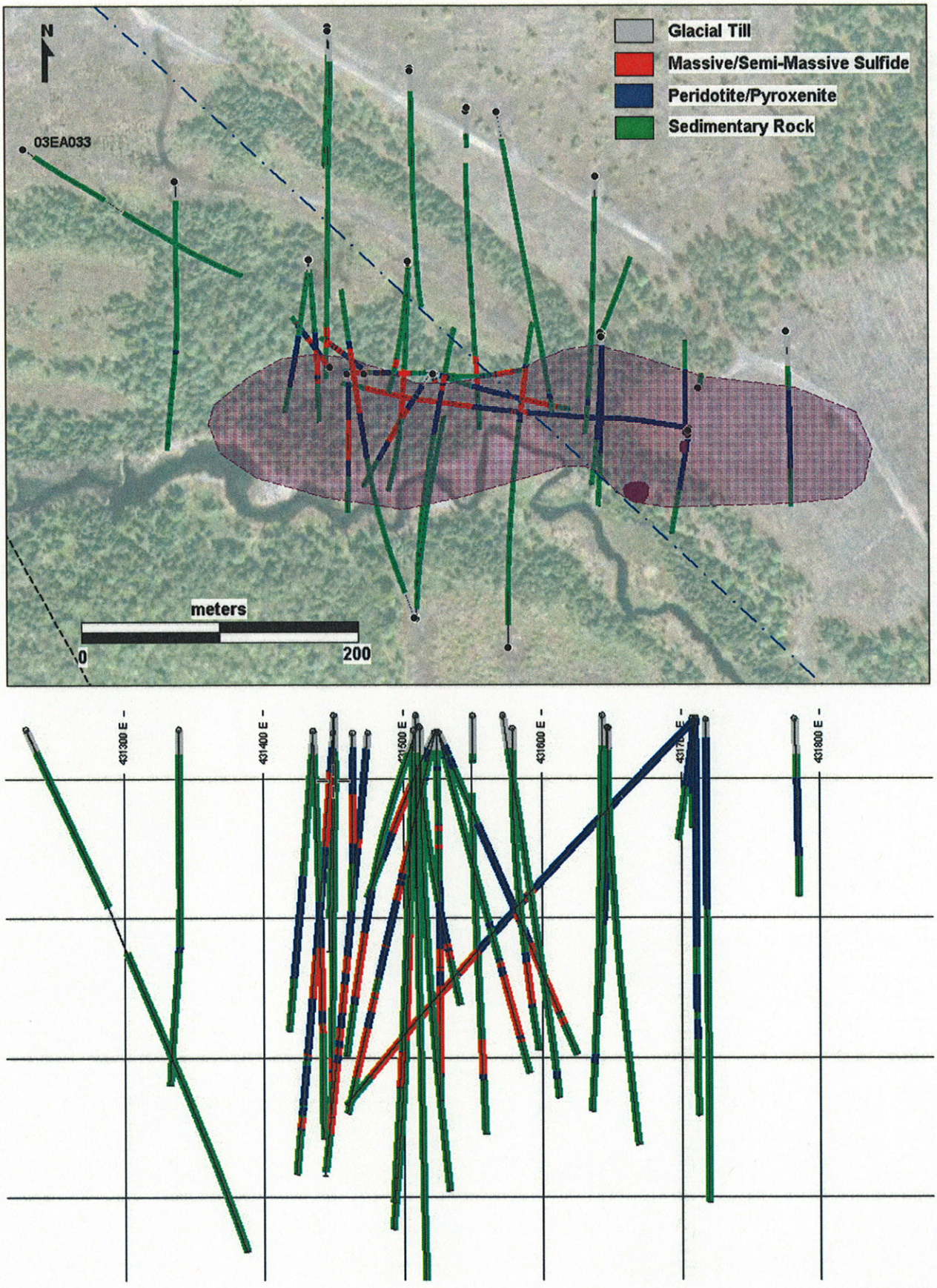
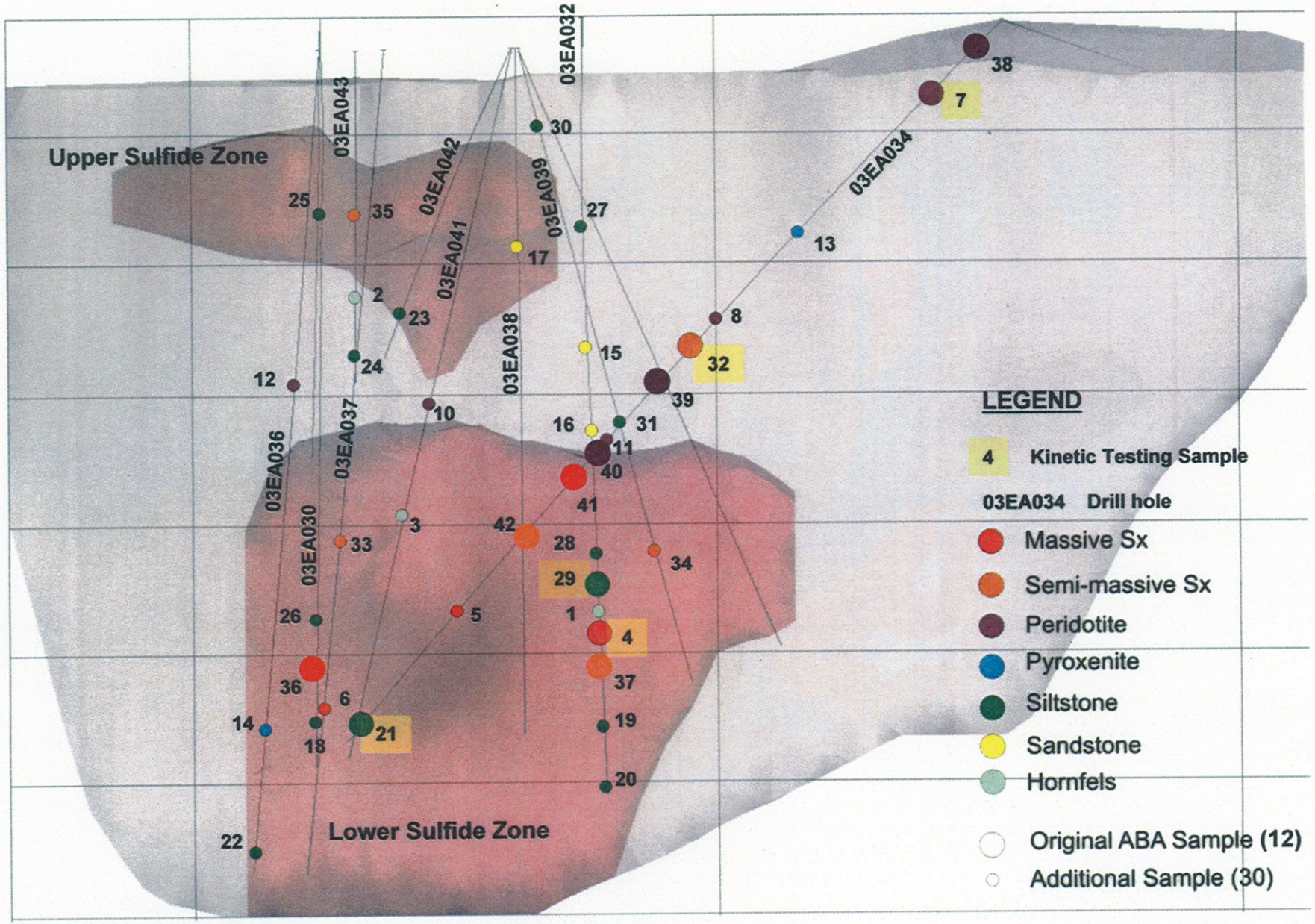
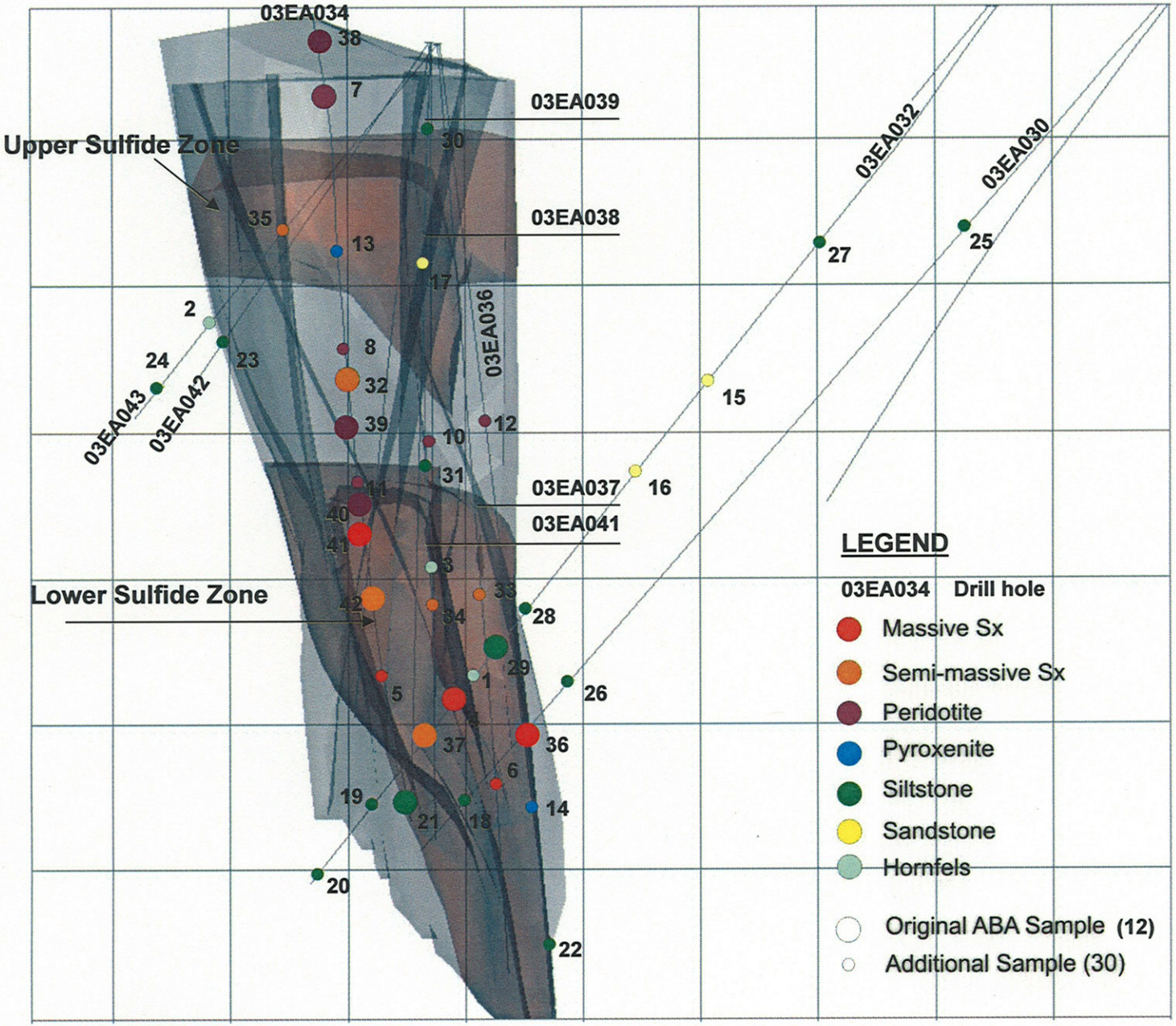


Figure 2-1
Eagle Drill Plan and Long Section



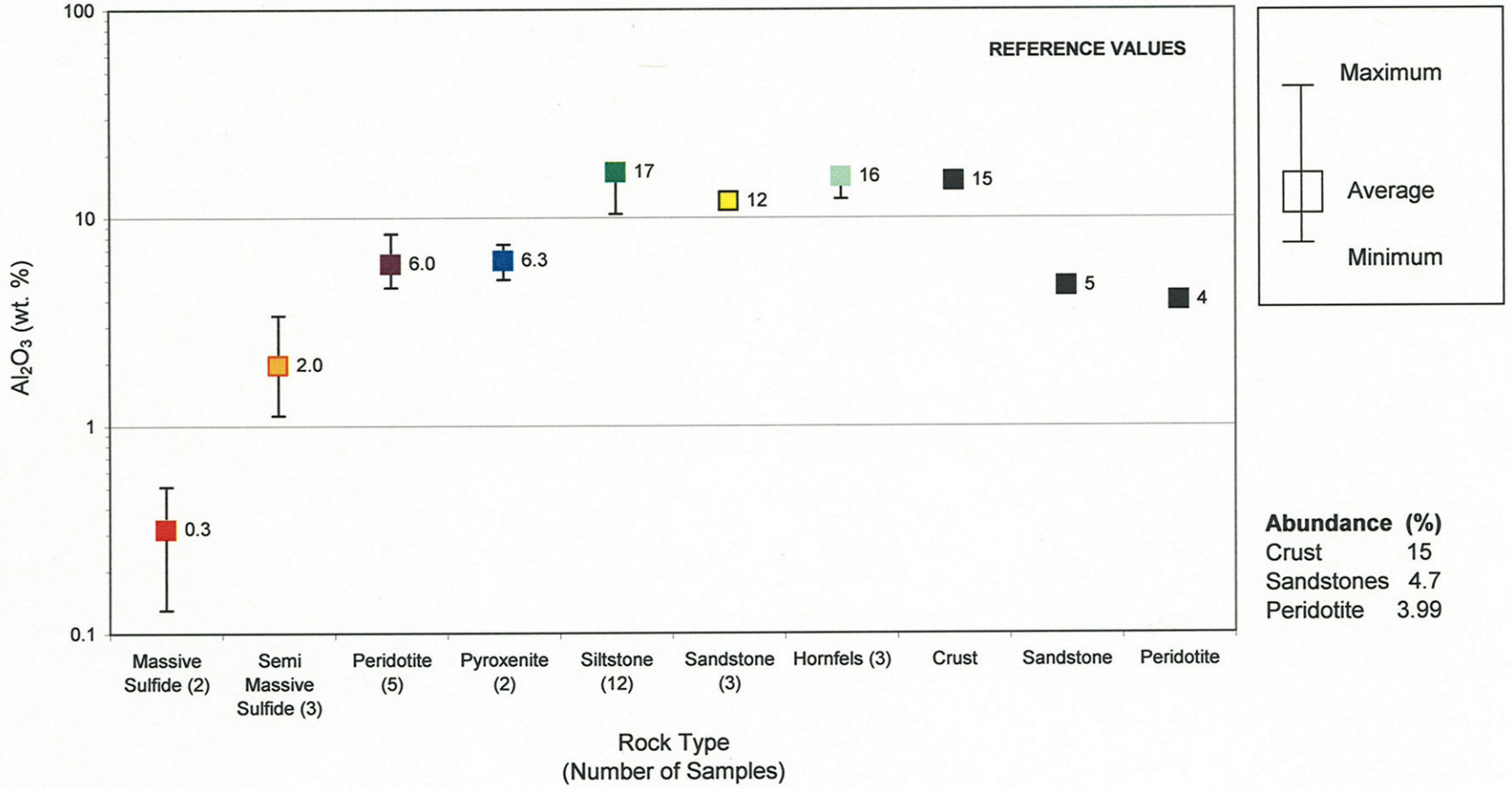
Notes: Single Eastern Eagle sample (# 9) location not shown
Sample numbers correspond to ID numbers shown in Table 2-2.

Figure 2-2
Eagle Sample Locations – Longitudinal



Notes: Single Eastern Eagle (#9) sample location not shown.
Sample numbers correspond to ID numbers shown in Table 2-2.

Figure 2-3
Eagle Sample Locations – Transverse



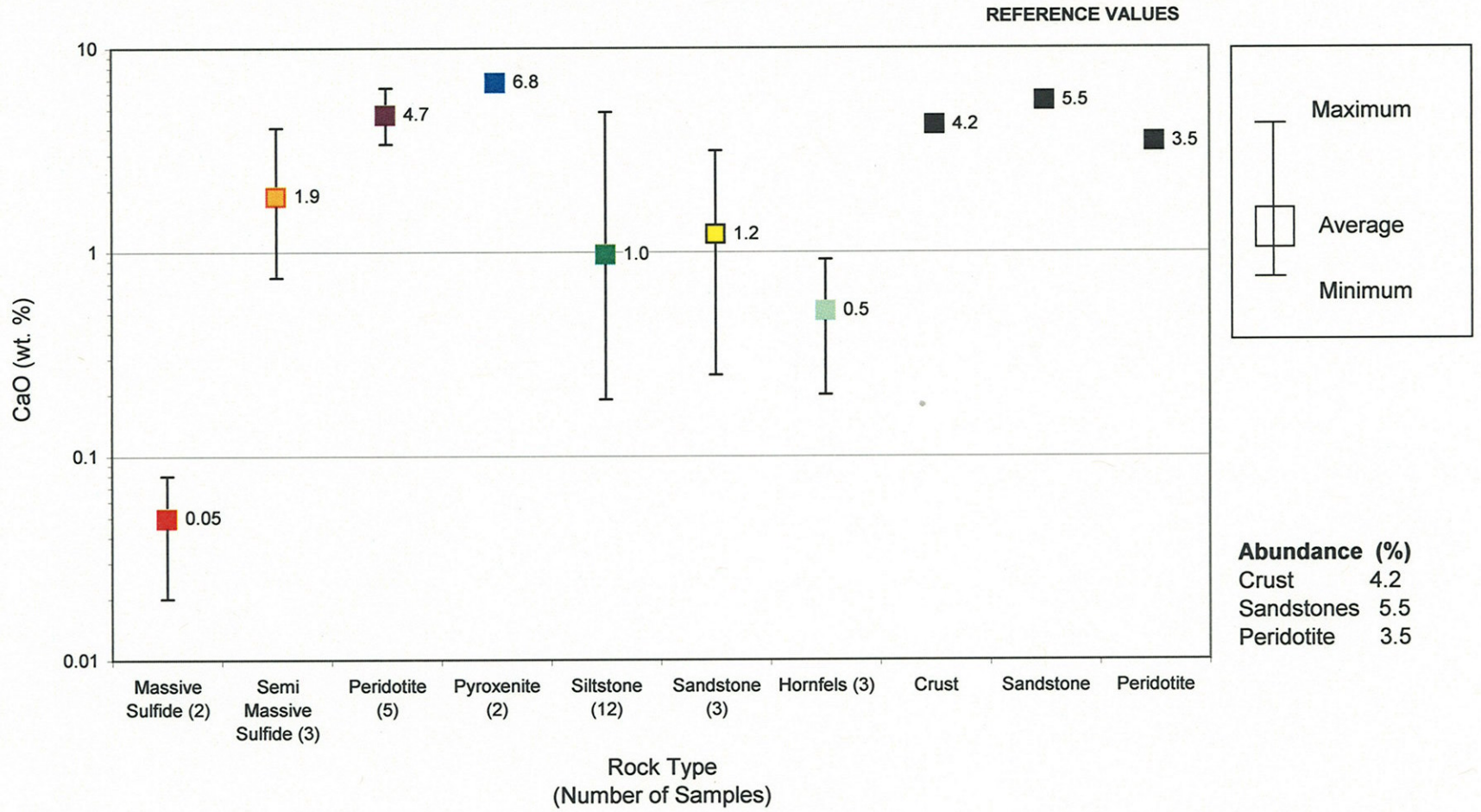
Abundance (%)

Crust	15
Sandstones	4.7
Peridotite	3.99

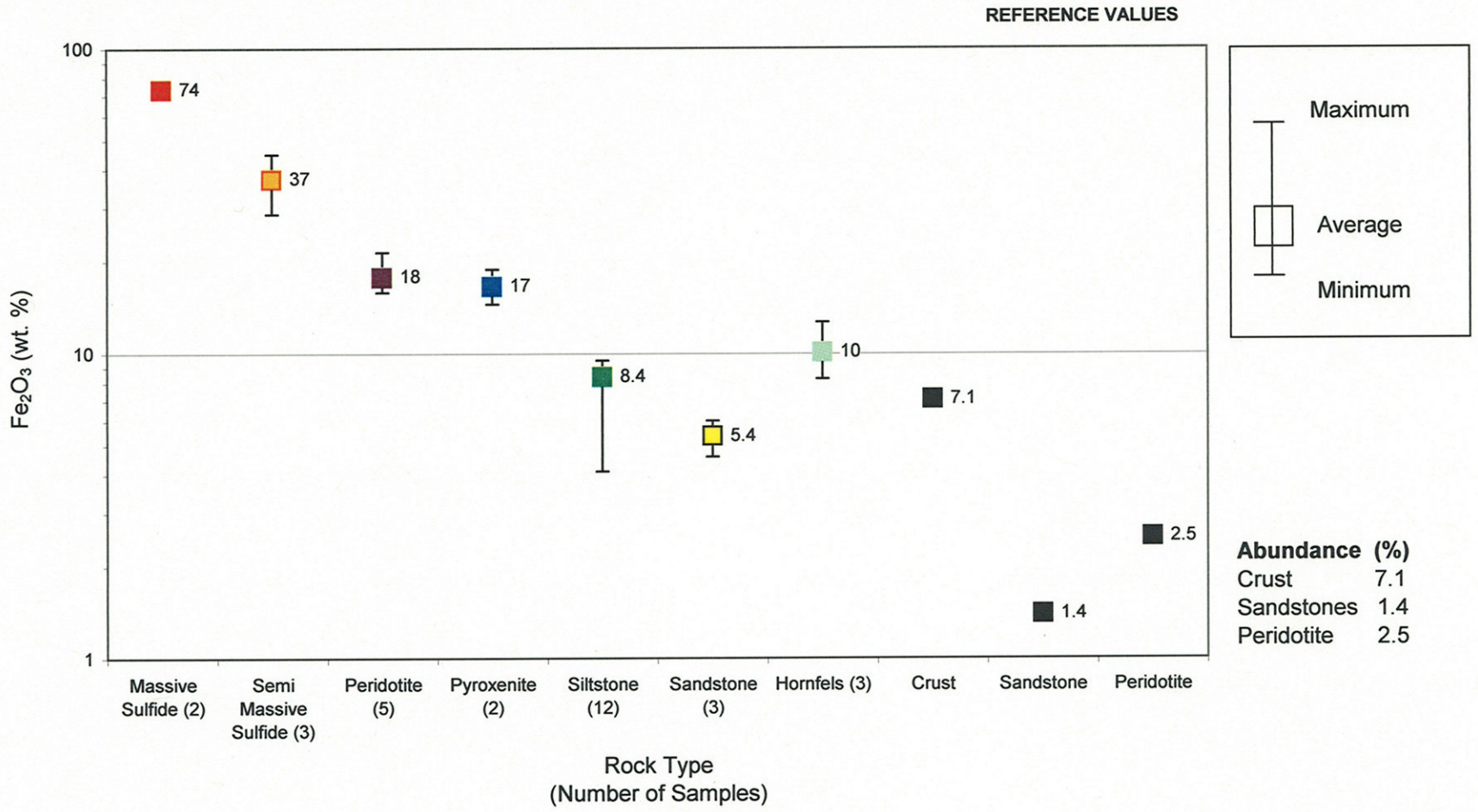
Eagle Mine
Phase I Static Testing

TITLE: **Whole Rock Analysis - Aluminum**

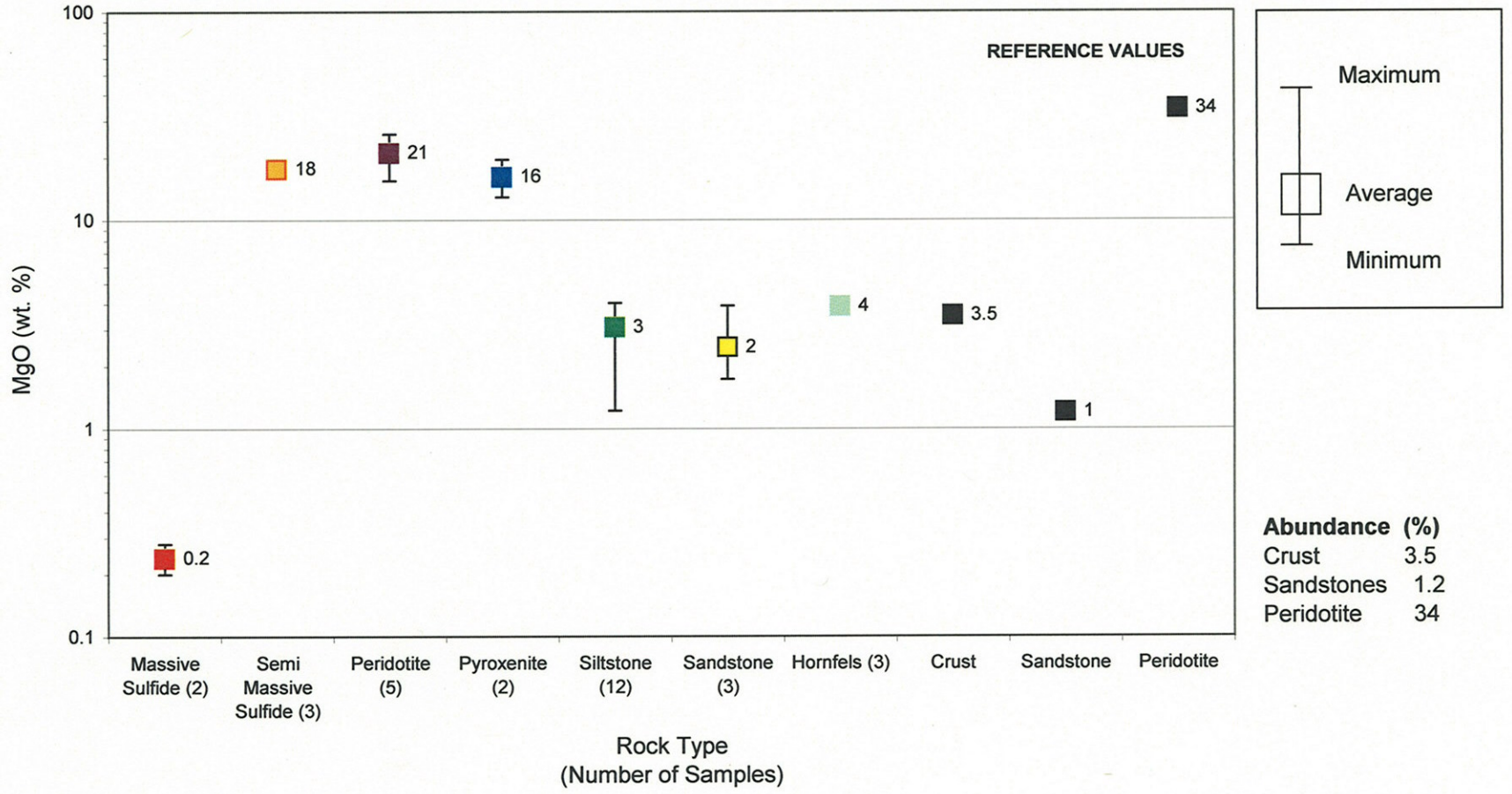
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-1



Eagle Mine **Phase I Static Testing**	TITLE	**Whole Rock Analysis - Calcium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-2	



Eagle Mine **Phase I Static Testing**	TITLE	**Whole Rock Analysis - Iron**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-3**	



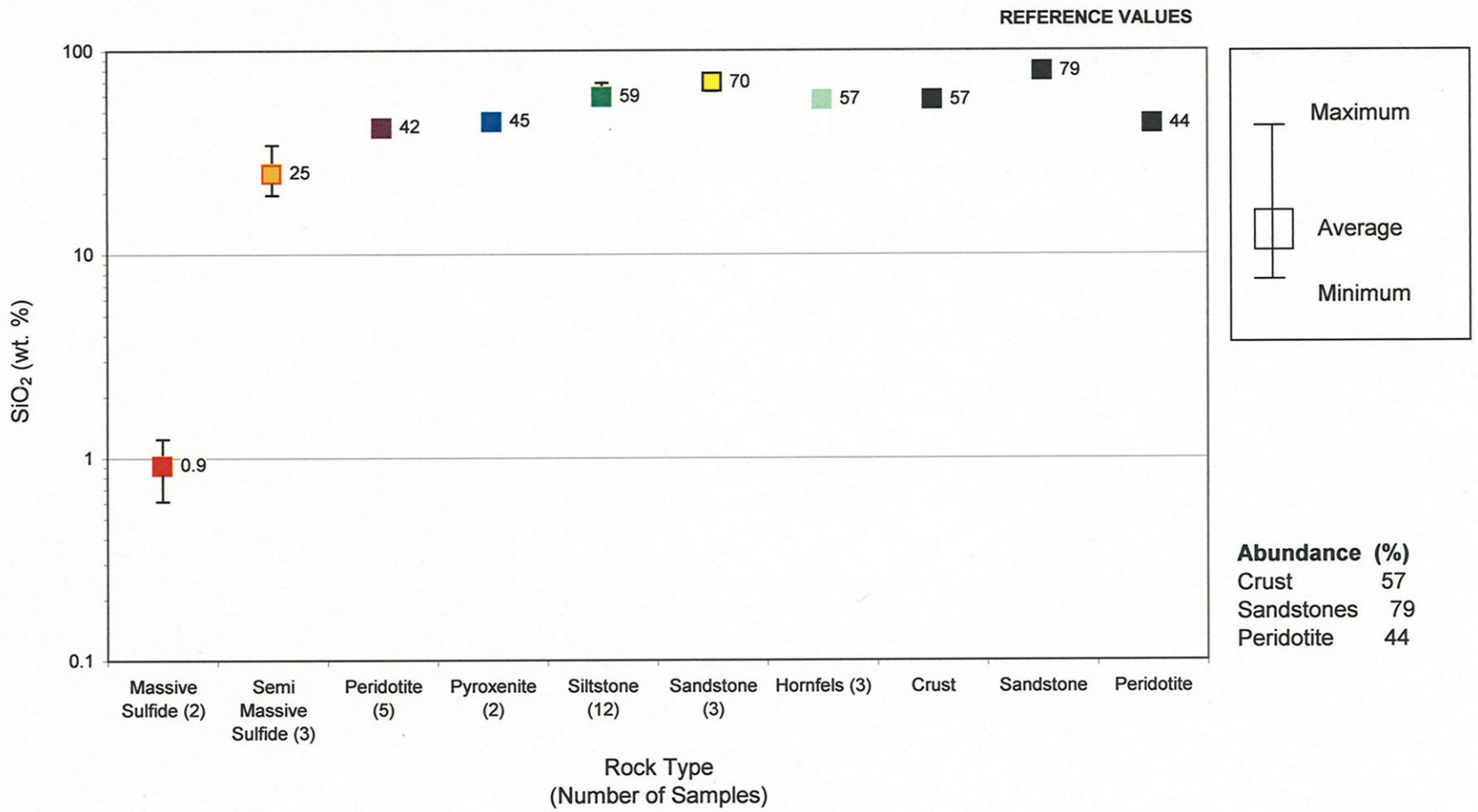
Abundance (%)

Crust	3.5
Sandstones	1.2
Peridotite	34

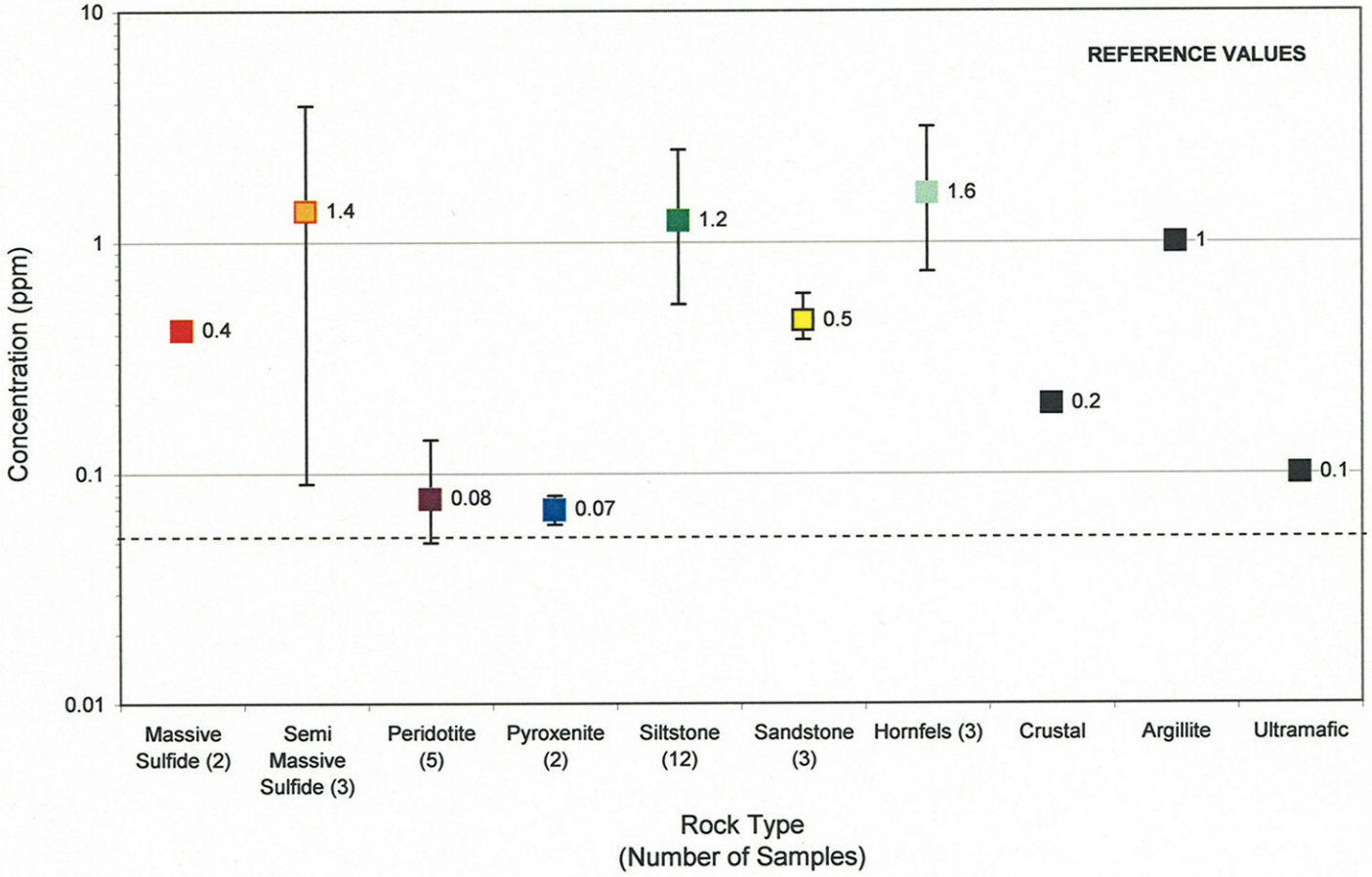
Eagle Mine
Phase I Static Testing

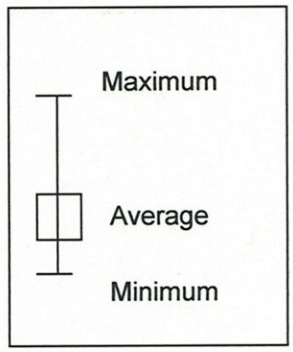
TITLE: **Whole Rock Analysis - Magnesium**

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-4



Eagle Mine **Phase I Static Testing**	TITLE	**Whole Rock Analysis - Silicon**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-5	





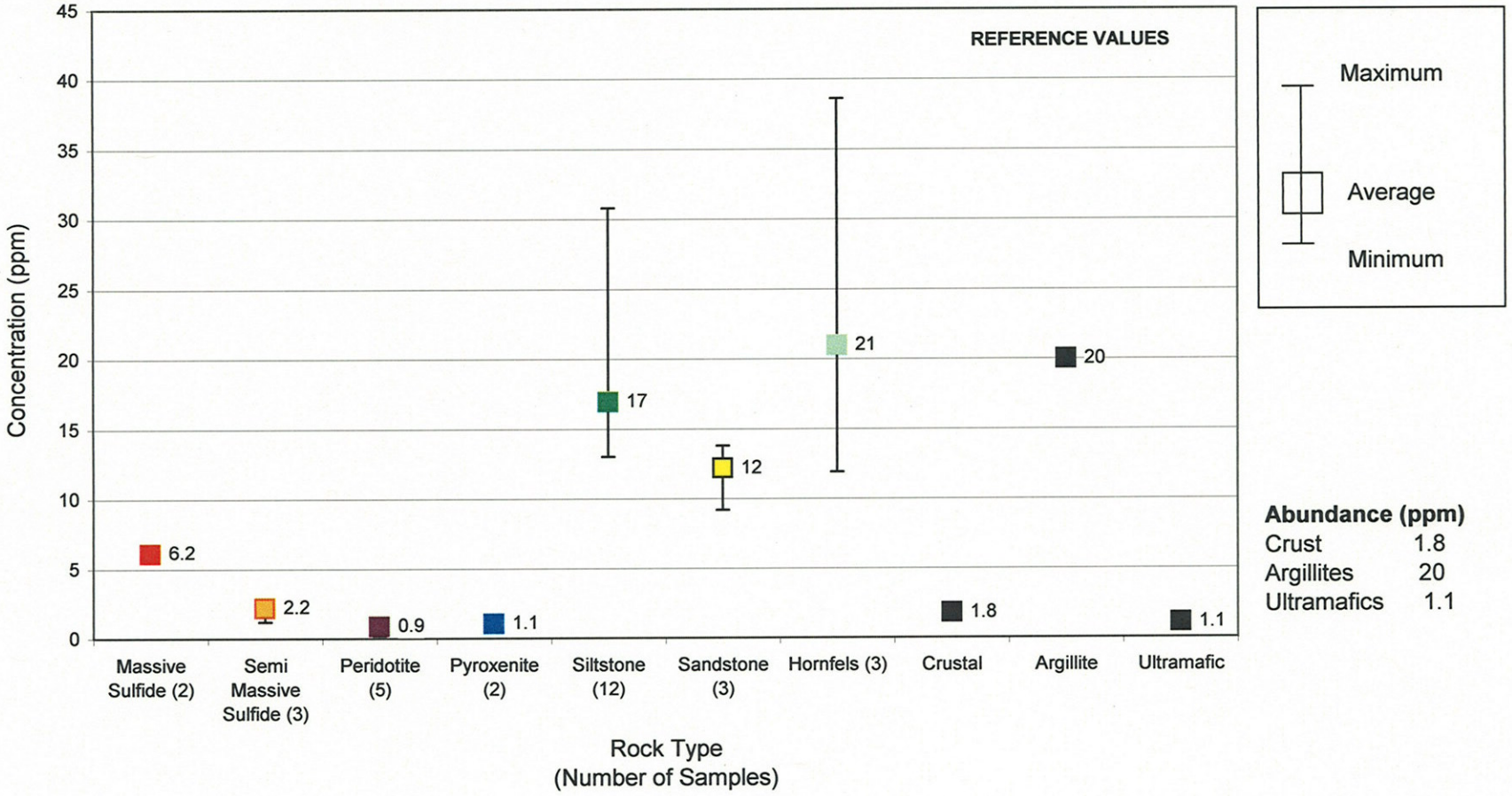
Notes:
Non-detect concentrations assumed equal to the detection limit (DL). DL = 0.05 ppm (shown as dashed line).

Abundance	**(ppm)**
Crust	0.2
Argillites	1
Ultramafics	0.1

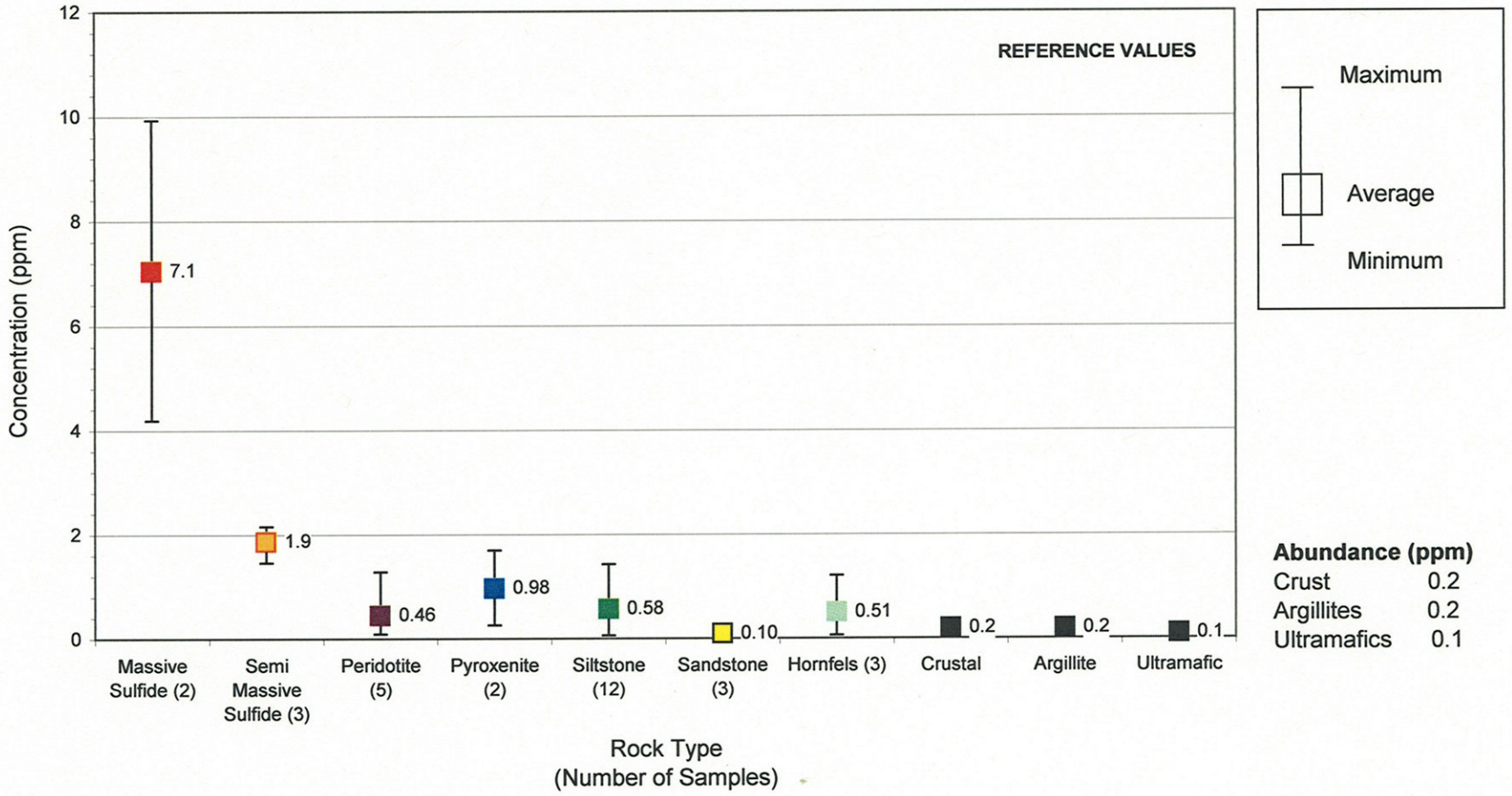
Eagle Mine
Phase I Static Testing

TITLE: **Elemental Analysis - Antimony**

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-6



Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Arsenic**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-7	

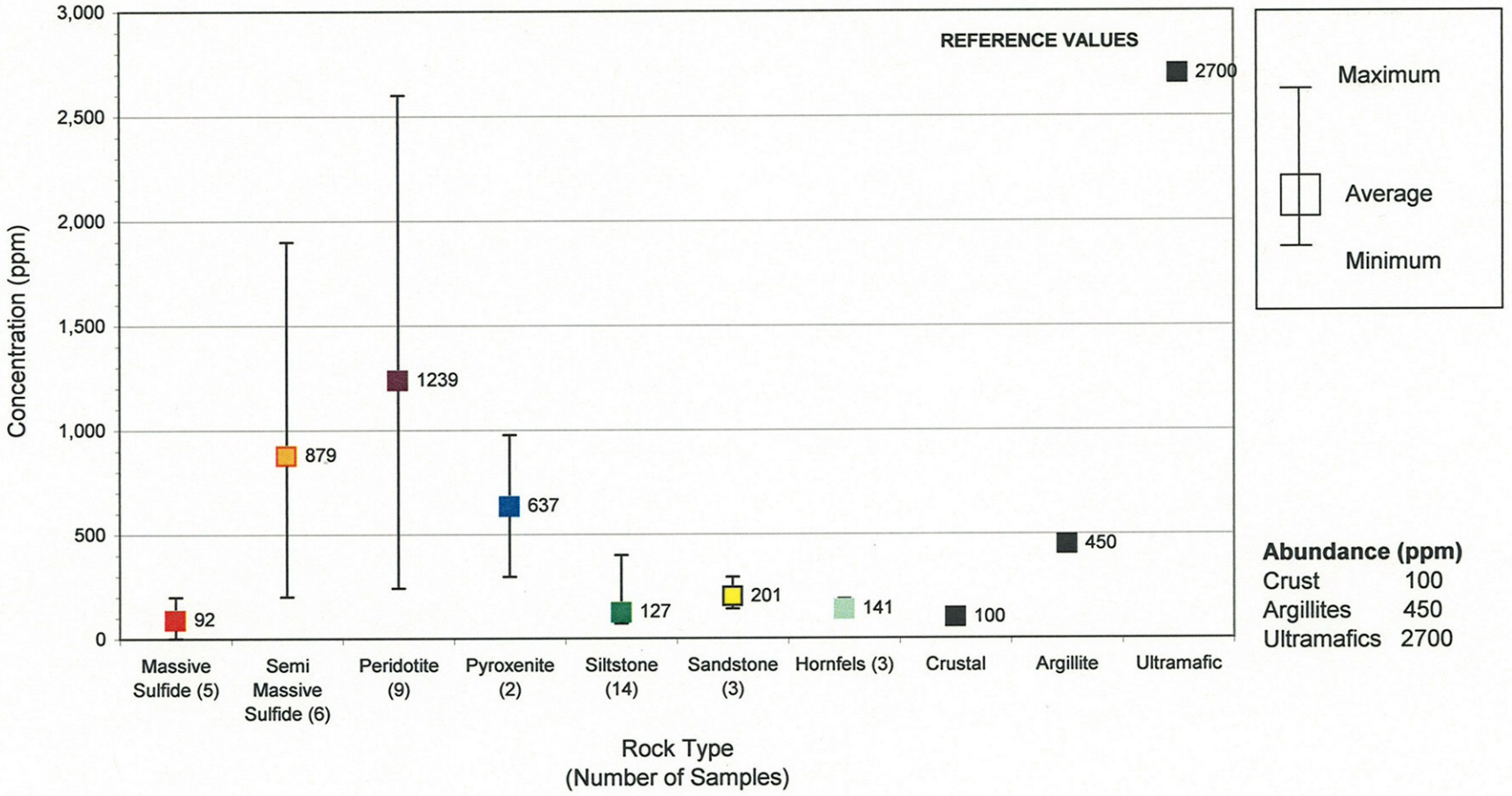


Eagle Mine
Phase I Static Testing

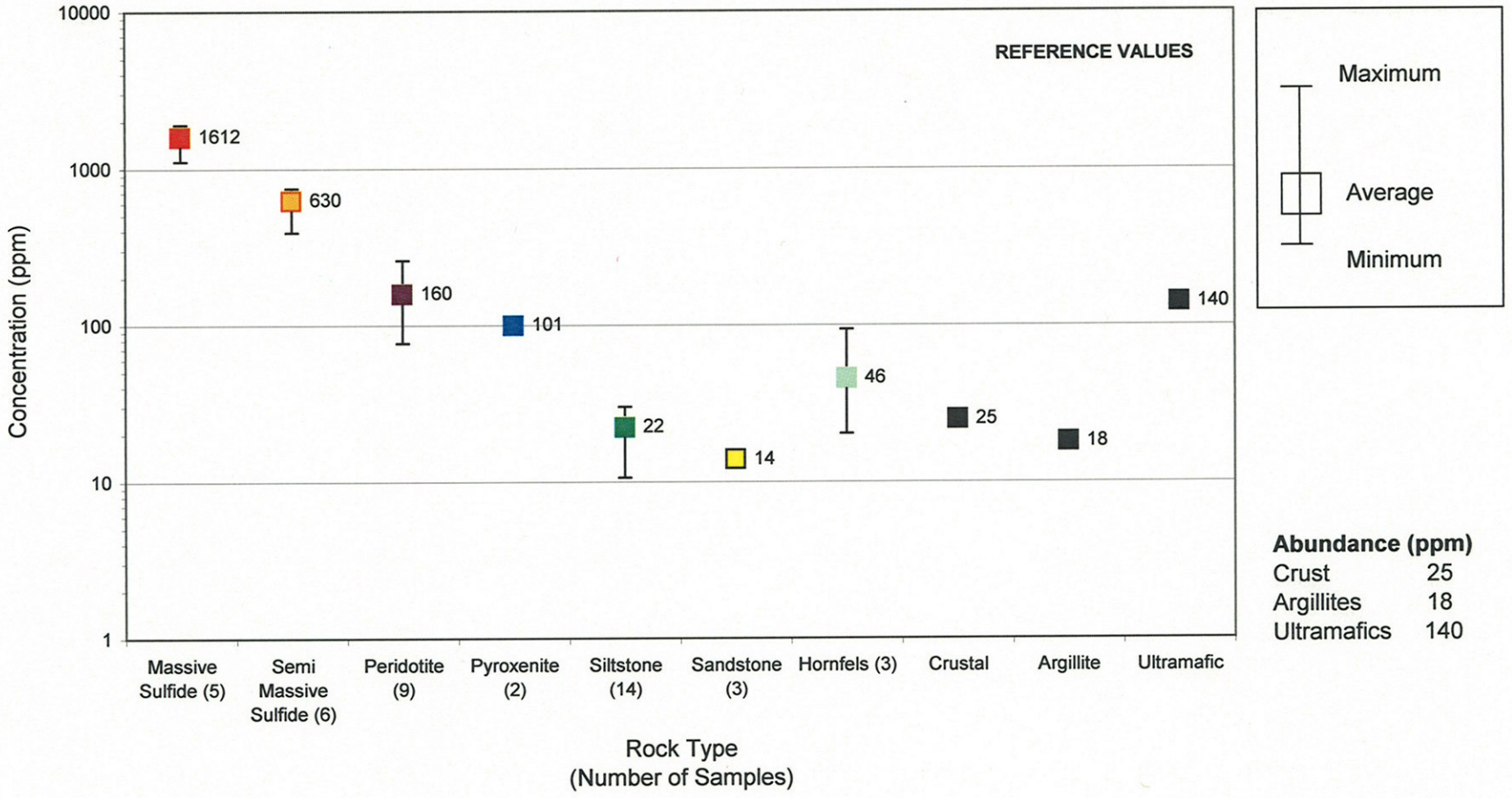
TITLE

Elemental Analysis - Cadmium

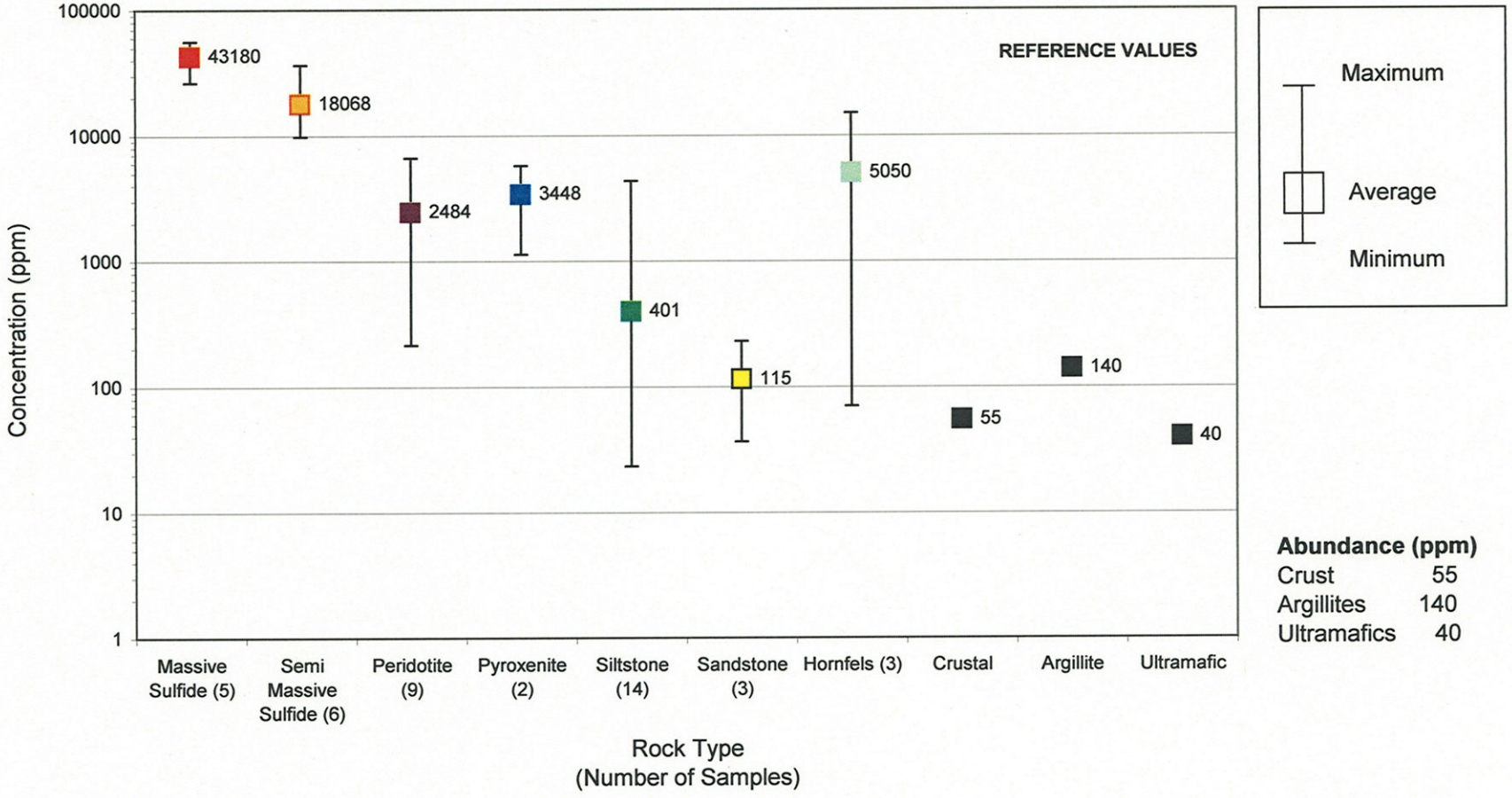
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-8



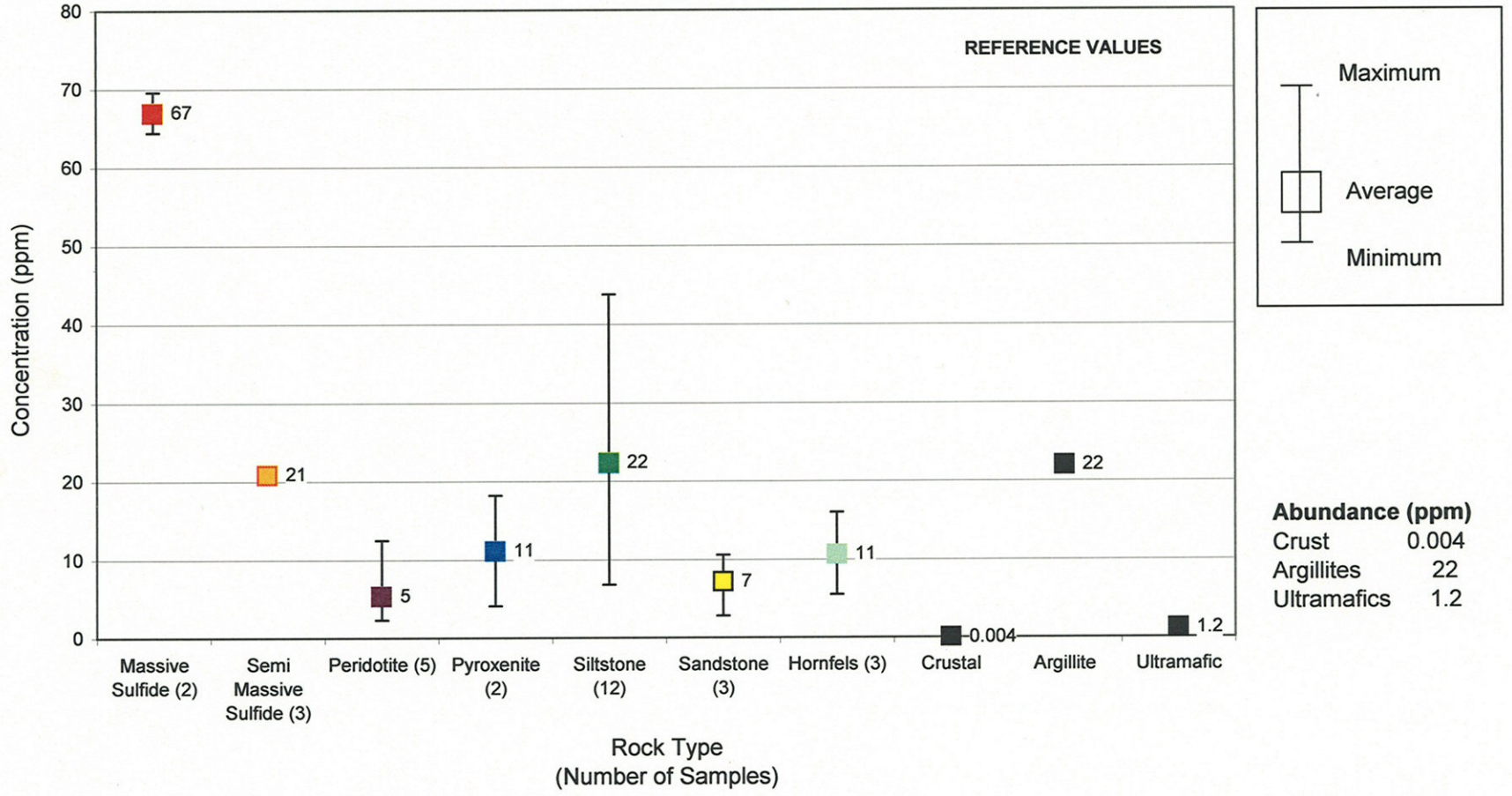
Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Chromium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-9	



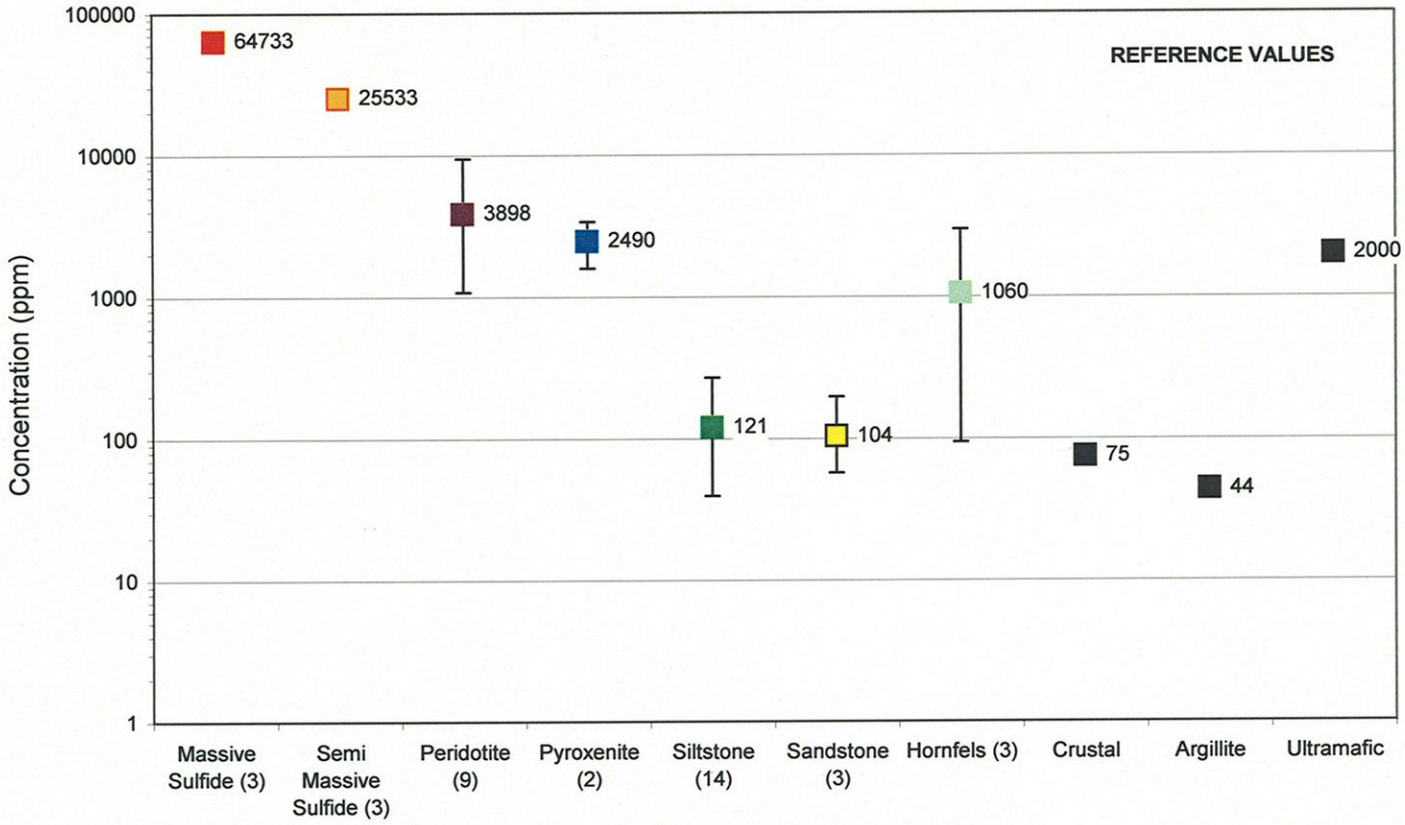
Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Cobalt**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-10**	

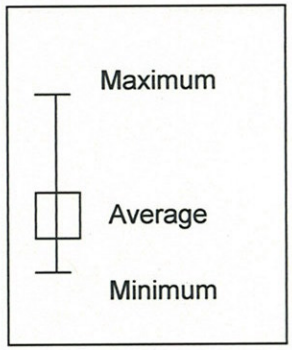


Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Copper**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-11**	



Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Lead**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-12**	





Note:
Over limit samples (>10,000) not included in evaluation.

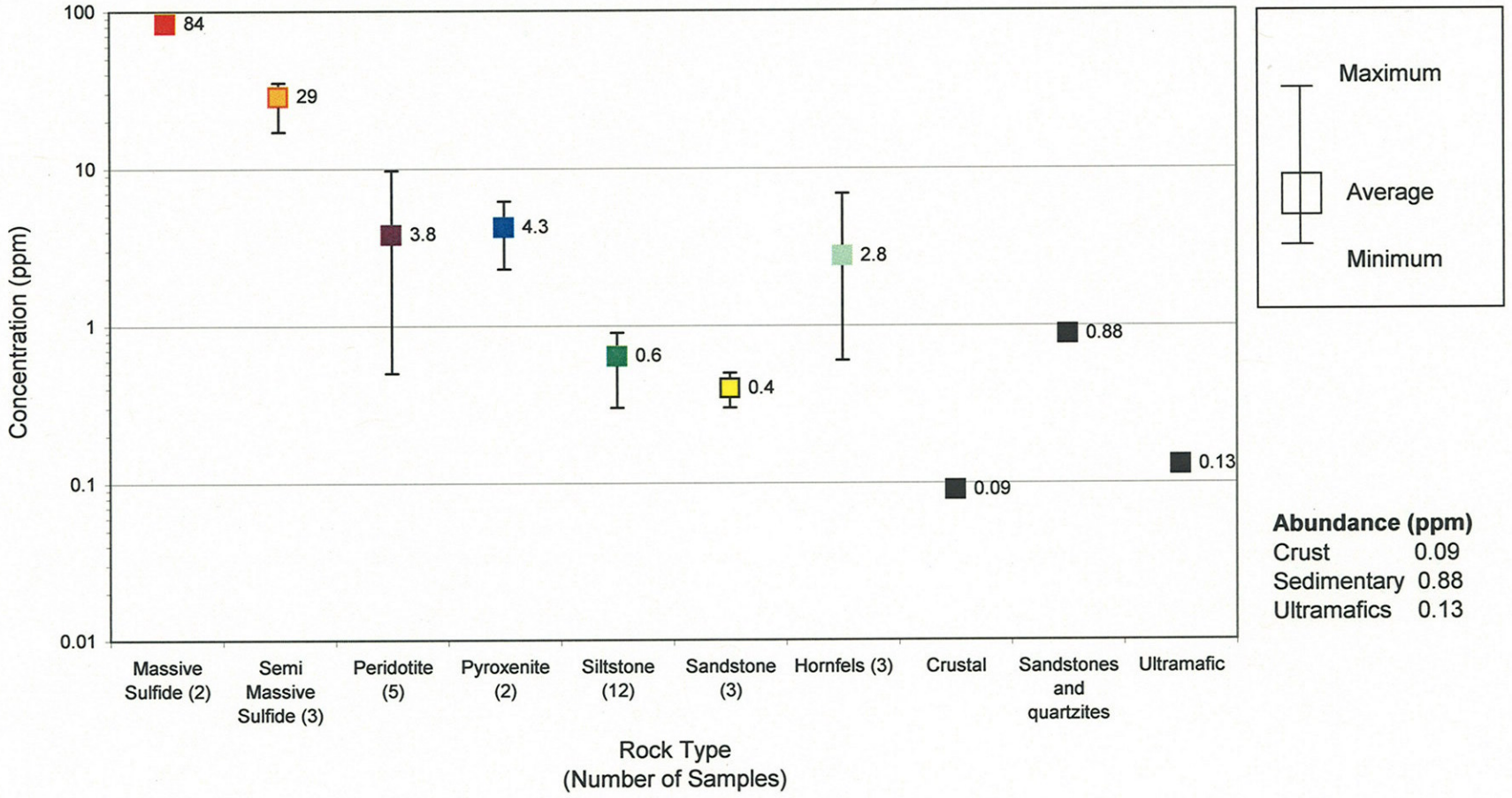
Abundance (ppm)

Crust	75
Argillites	44
Ultramafics	2000

Eagle Mine
Phase I Static Testing

TITLE: **Elemental Analysis - Nickel**

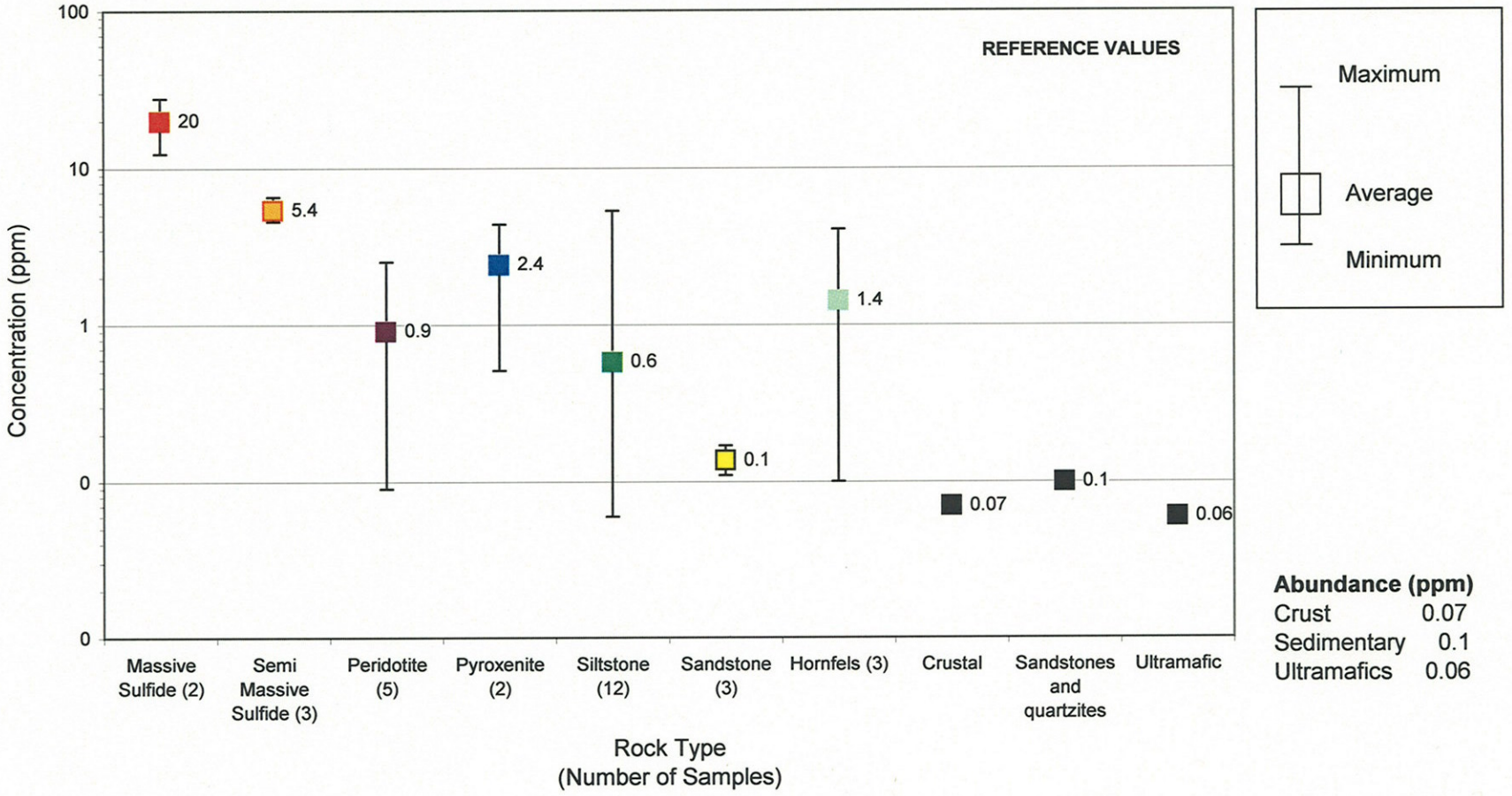
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-13



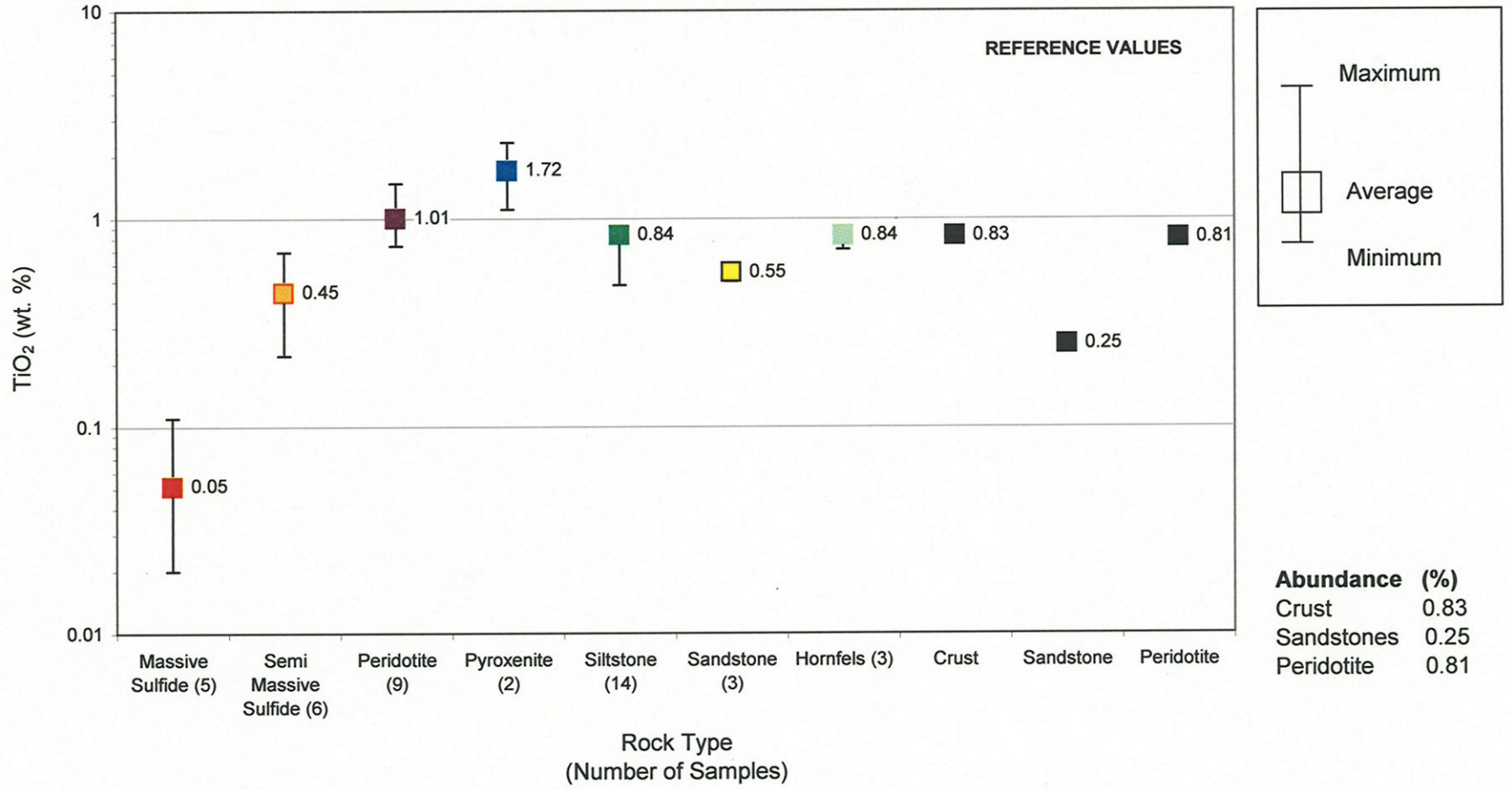
Eagle Mine
Phase I Static Testing

TITLE: **Elemental Analysis - Selenium**

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-14



Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Silver**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-15**	

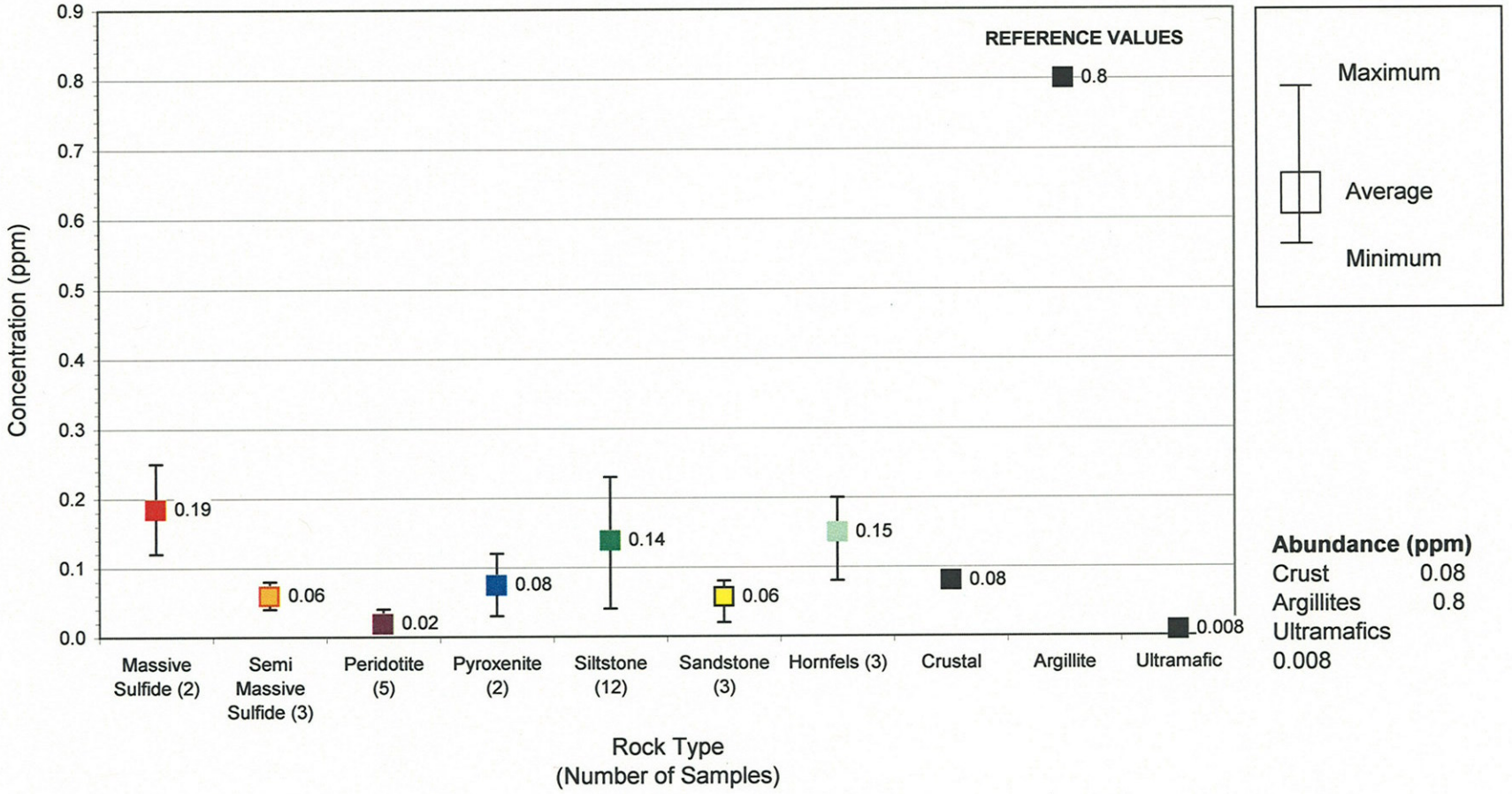


Abundance	(%)
Crust	0.83
Sandstones	0.25
Peridotite	0.81

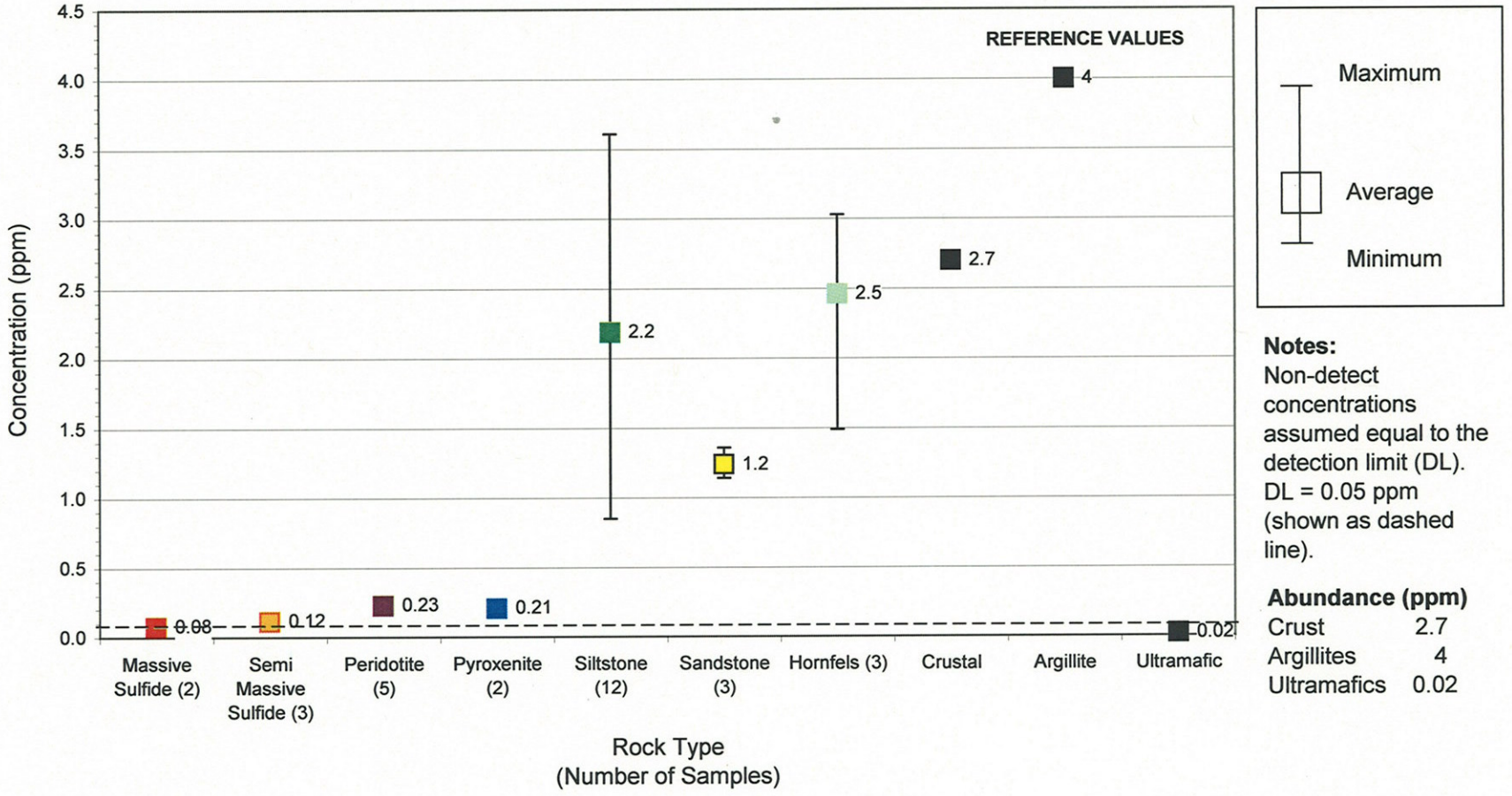
Eagle Mine
Phase I Static Testing

TITLE: **Elemental Analysis - Titanium**

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-16



Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Mercury**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-17**	



Notes:
Non-detect concentrations assumed equal to the detection limit (DL). DL = 0.05 ppm (shown as dashed line).

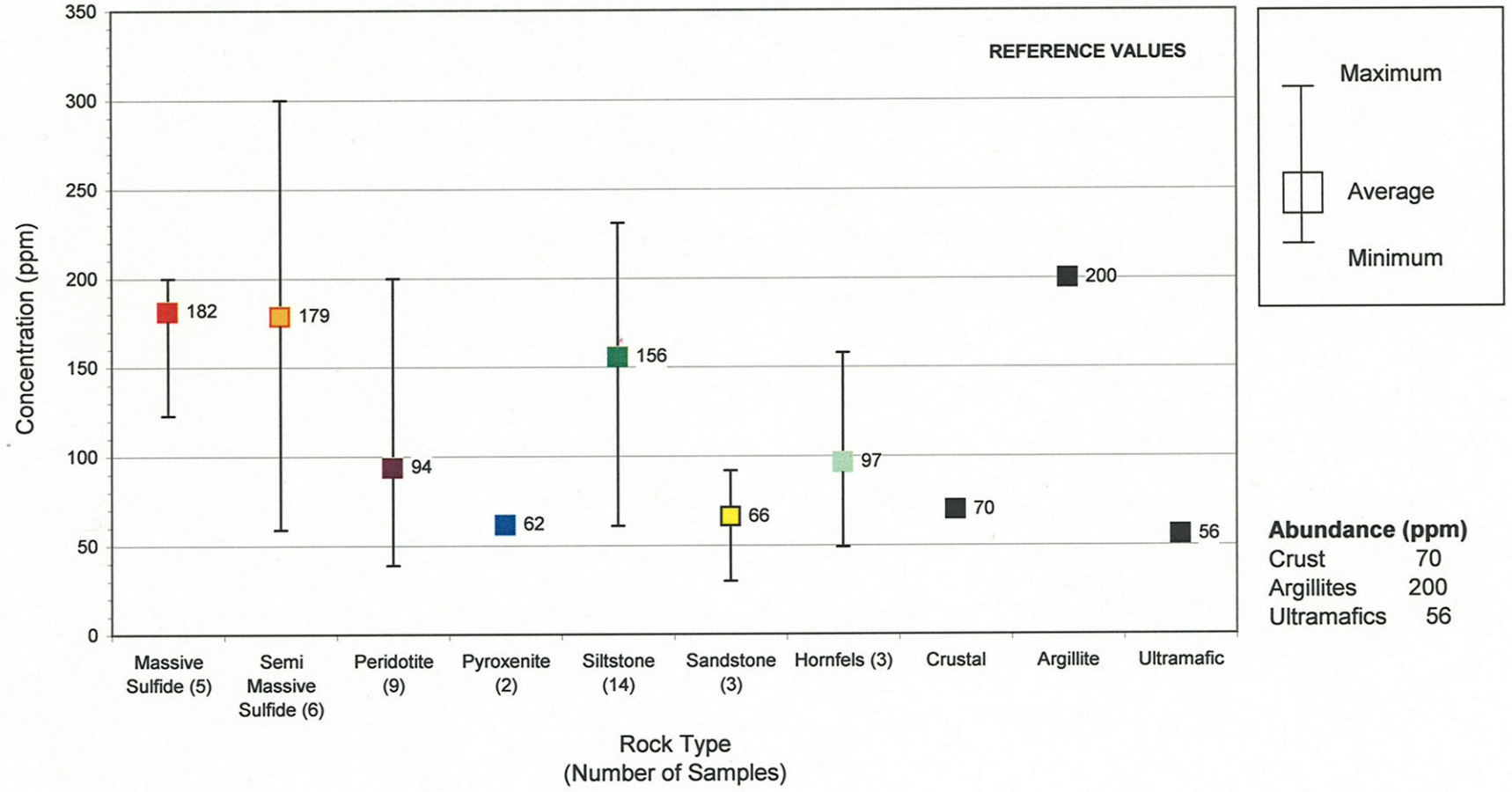
Abundance (ppm)

Crust	2.7
Argillites	4
Ultramafics	0.02

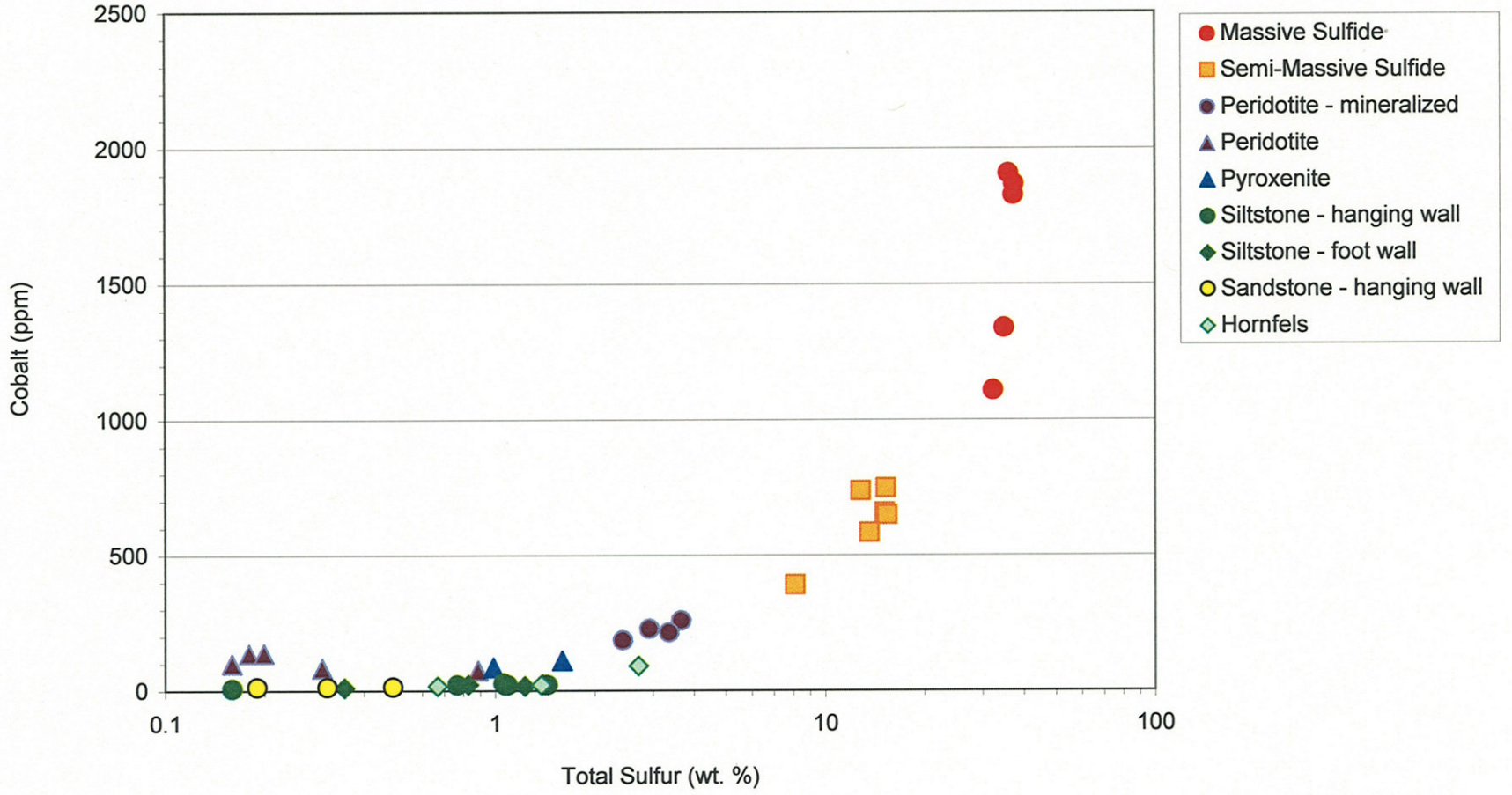
Eagle Mine
Phase I Static Testing

TITLE: **Elemental Analysis - Uranium**

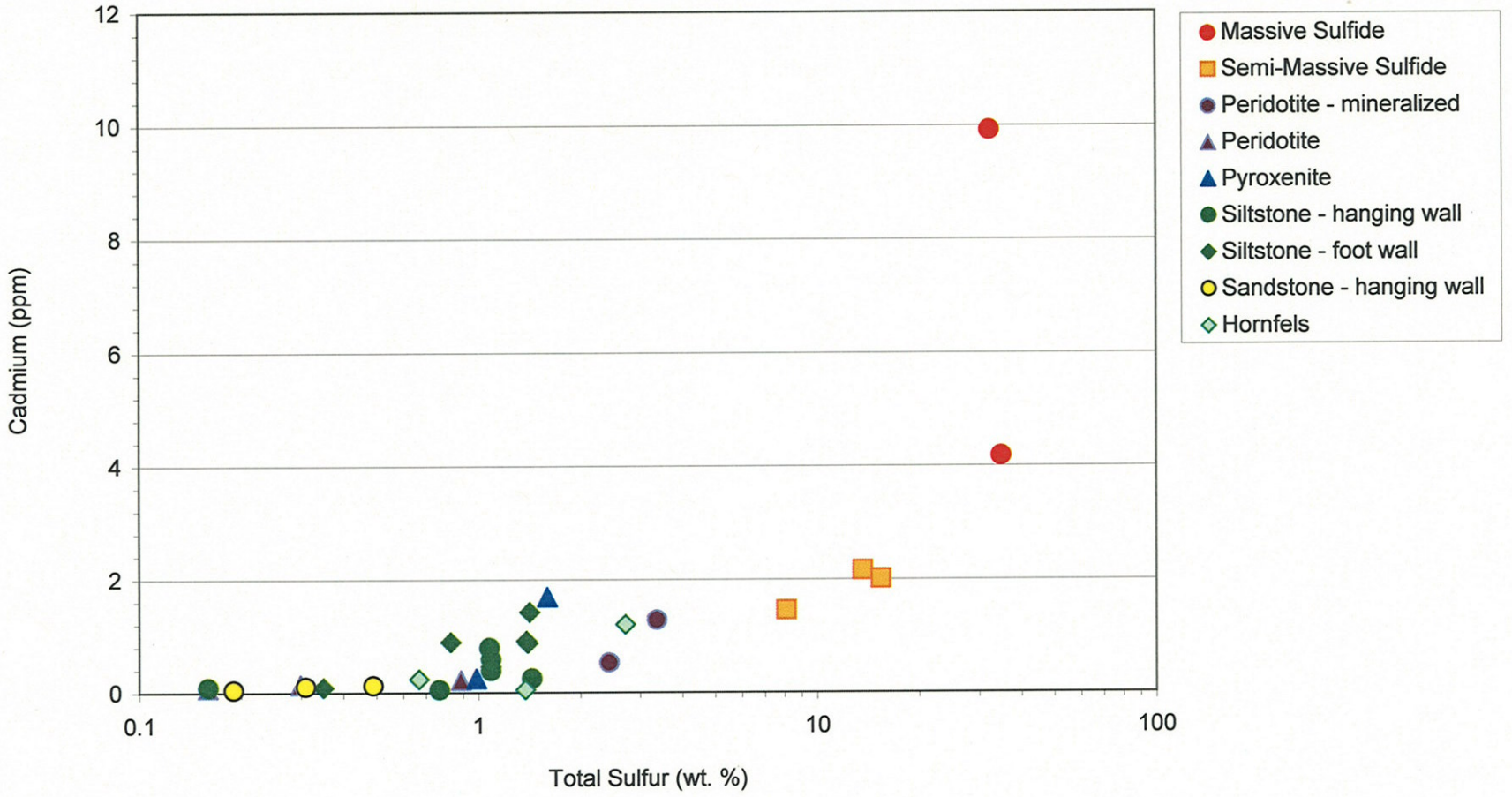
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-18



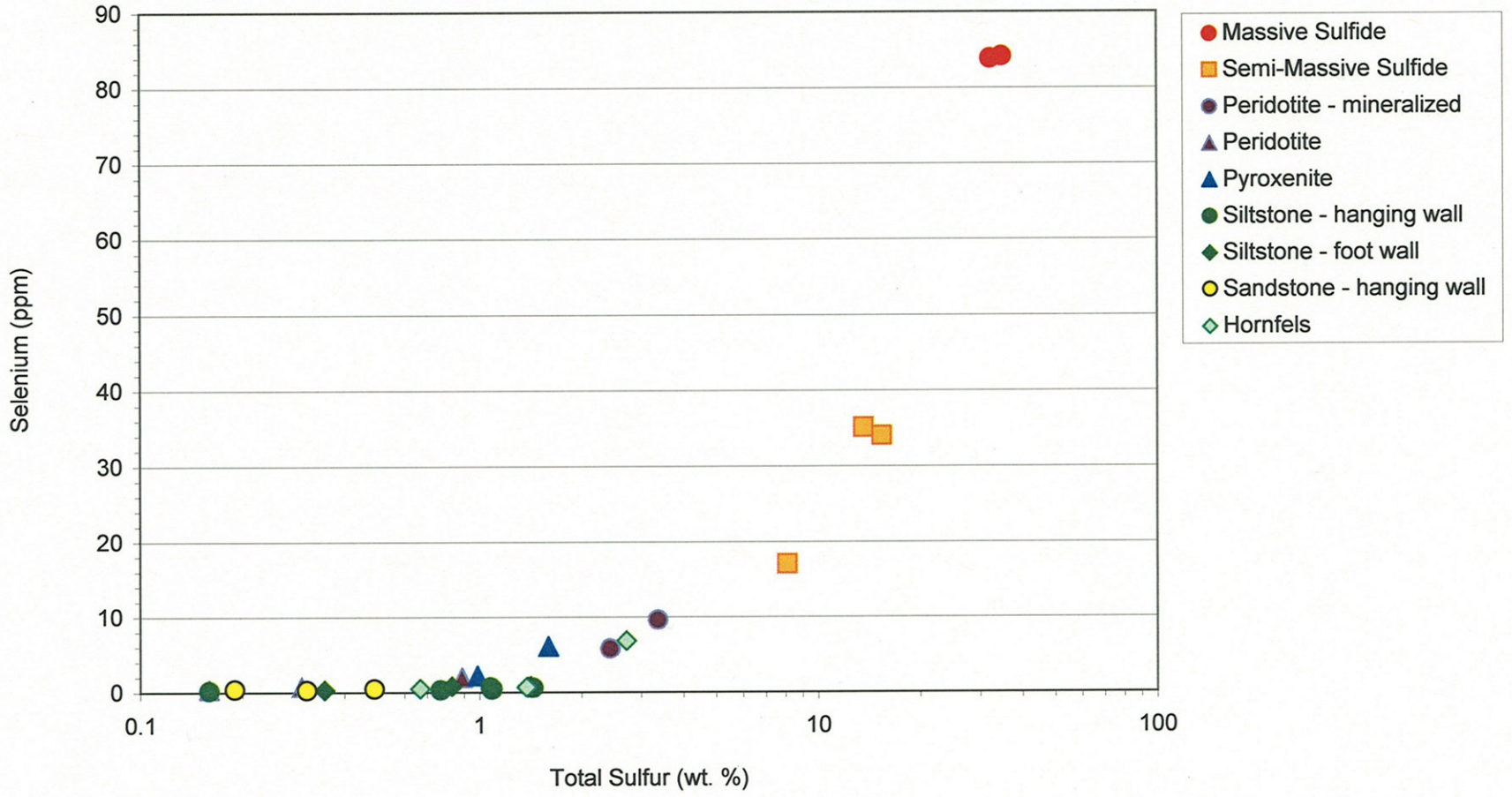
Eagle Mine **Phase I Static Testing**	TITLE	**Elemental Analysis - Zinc**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-19**	



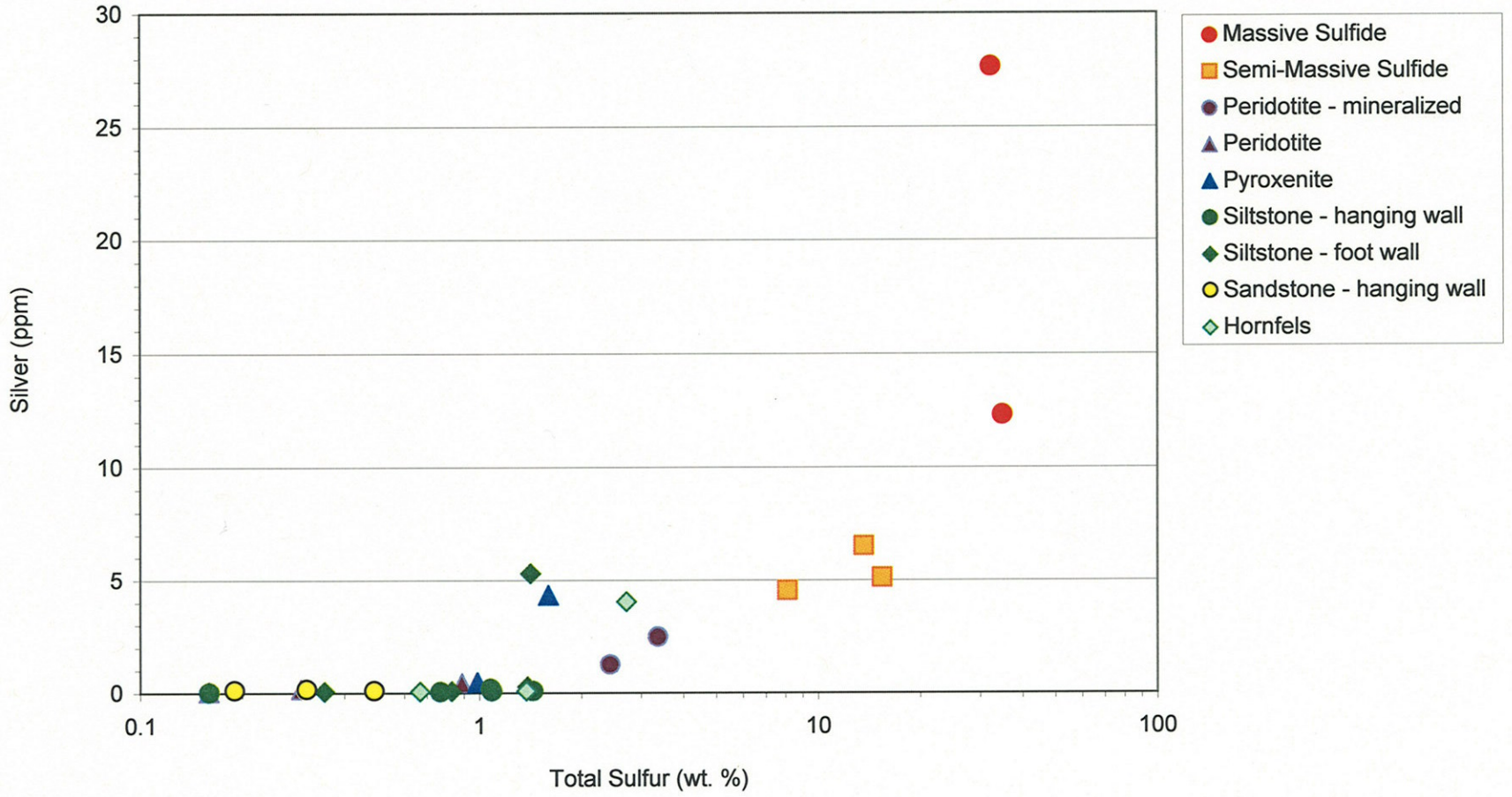
Eagle Mine **Phase I Static Testing**	TITLE	**Static Testing Results - S(T) vs. Cobalt**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-20**	



Eagle Mine **Phase I Static Testing**	TITLE	**Static Testing Results - S(T) vs. Cadmium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-21	



Eagle Mine **Phase I Static Testing**	TITLE	**Static Testing Results - S(T) vs. Selenium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-22**	

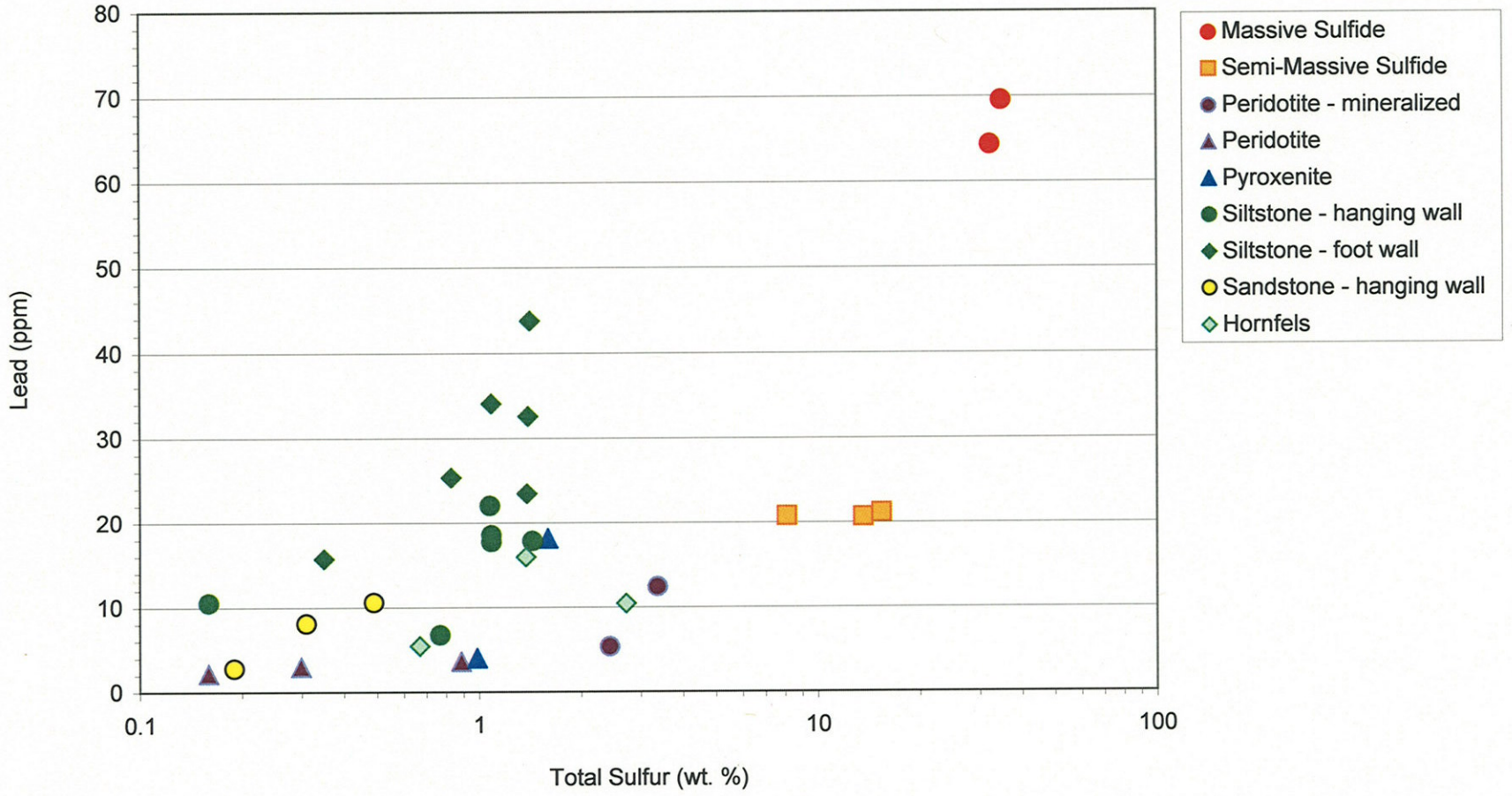


Eagle Mine
Phase I Static Testing

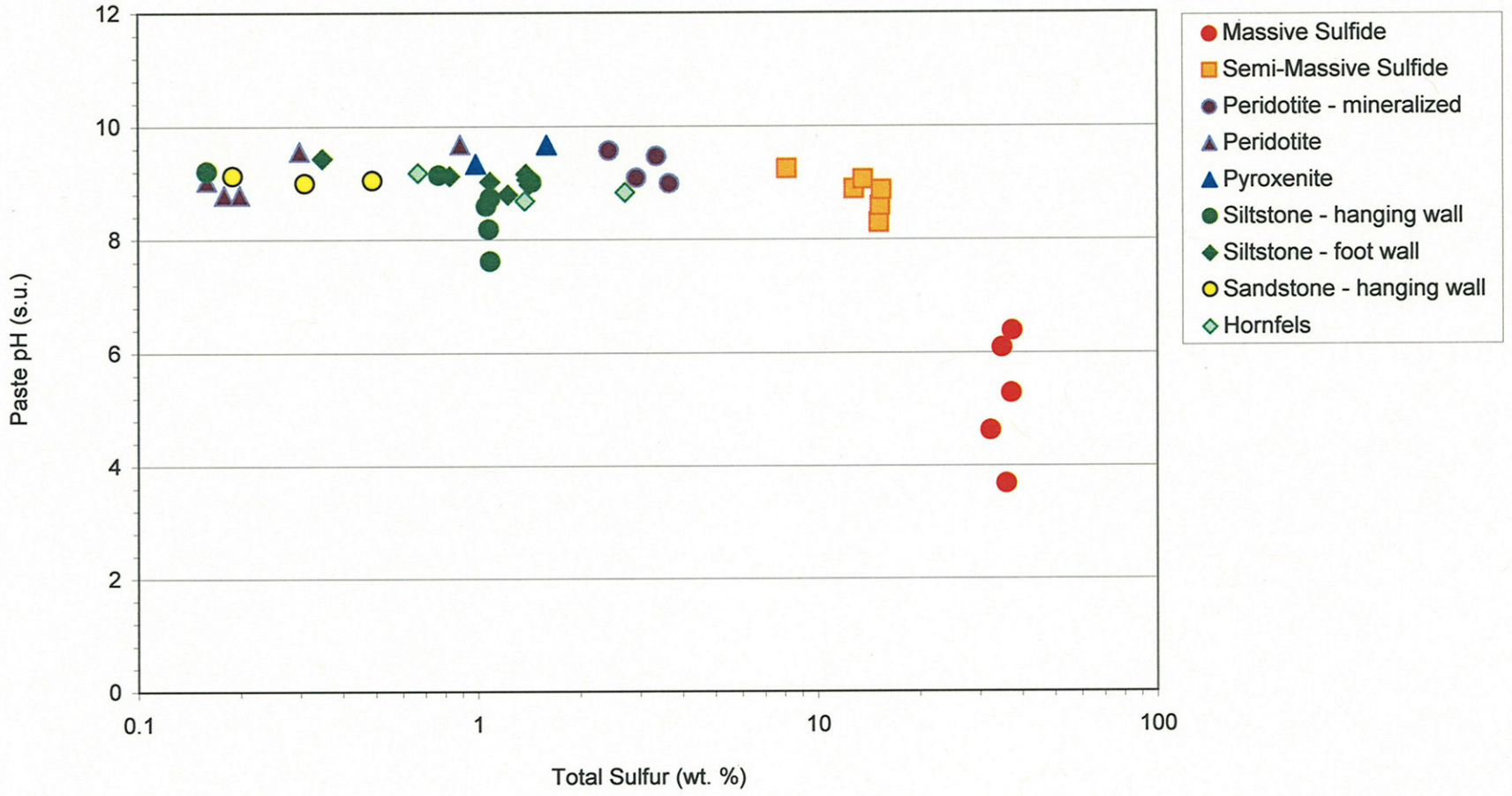
TITLE

Static Testing Results - S(T) vs. Silver

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-23



Eagle Mine **Phase I Static Testing**	TITLE	**Static Testing Results - S(T) vs. Lead**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-24**	



Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - S(T) vs. Paste pH**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing.xls	FIGURE NO. **3-25**	

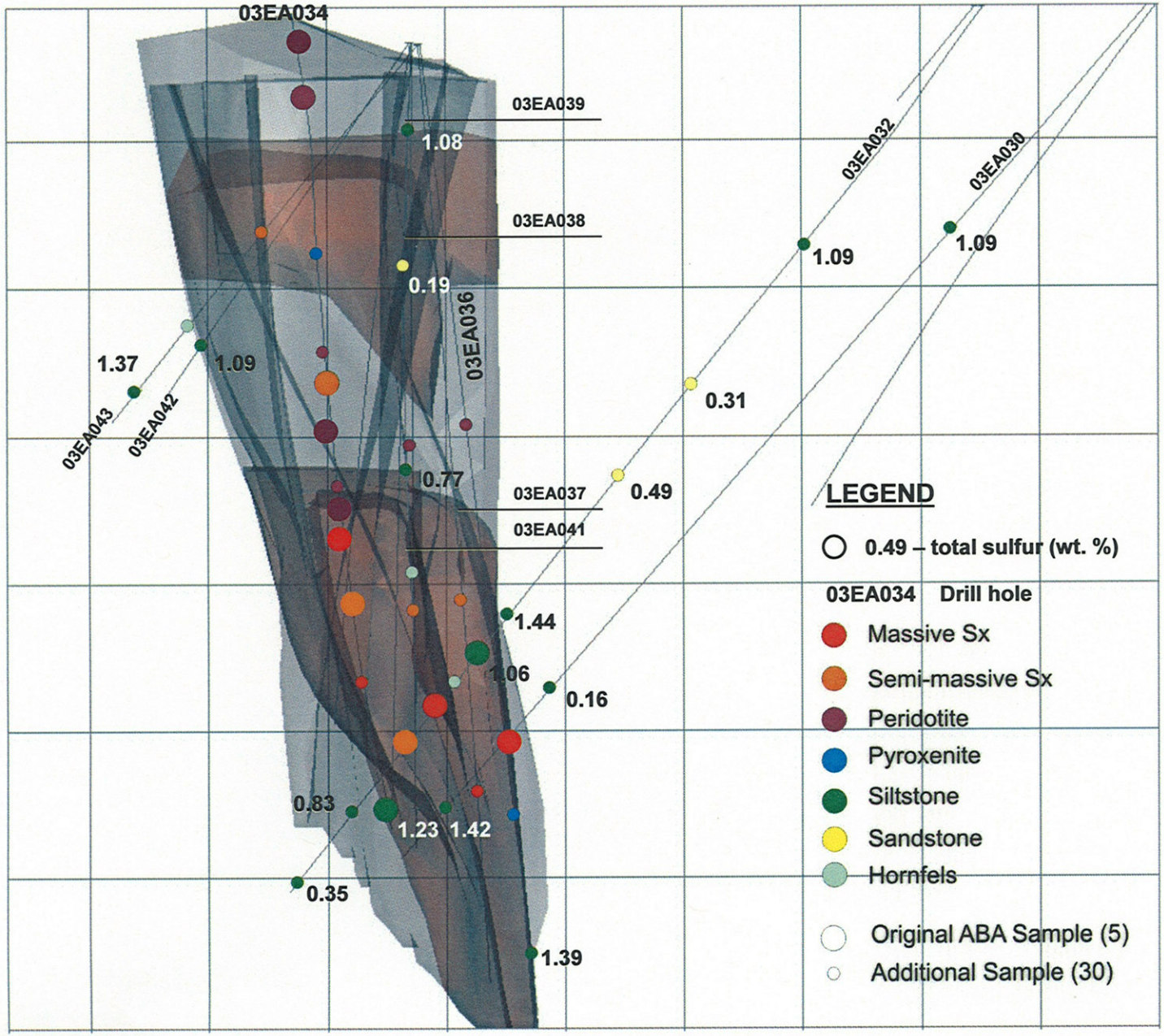
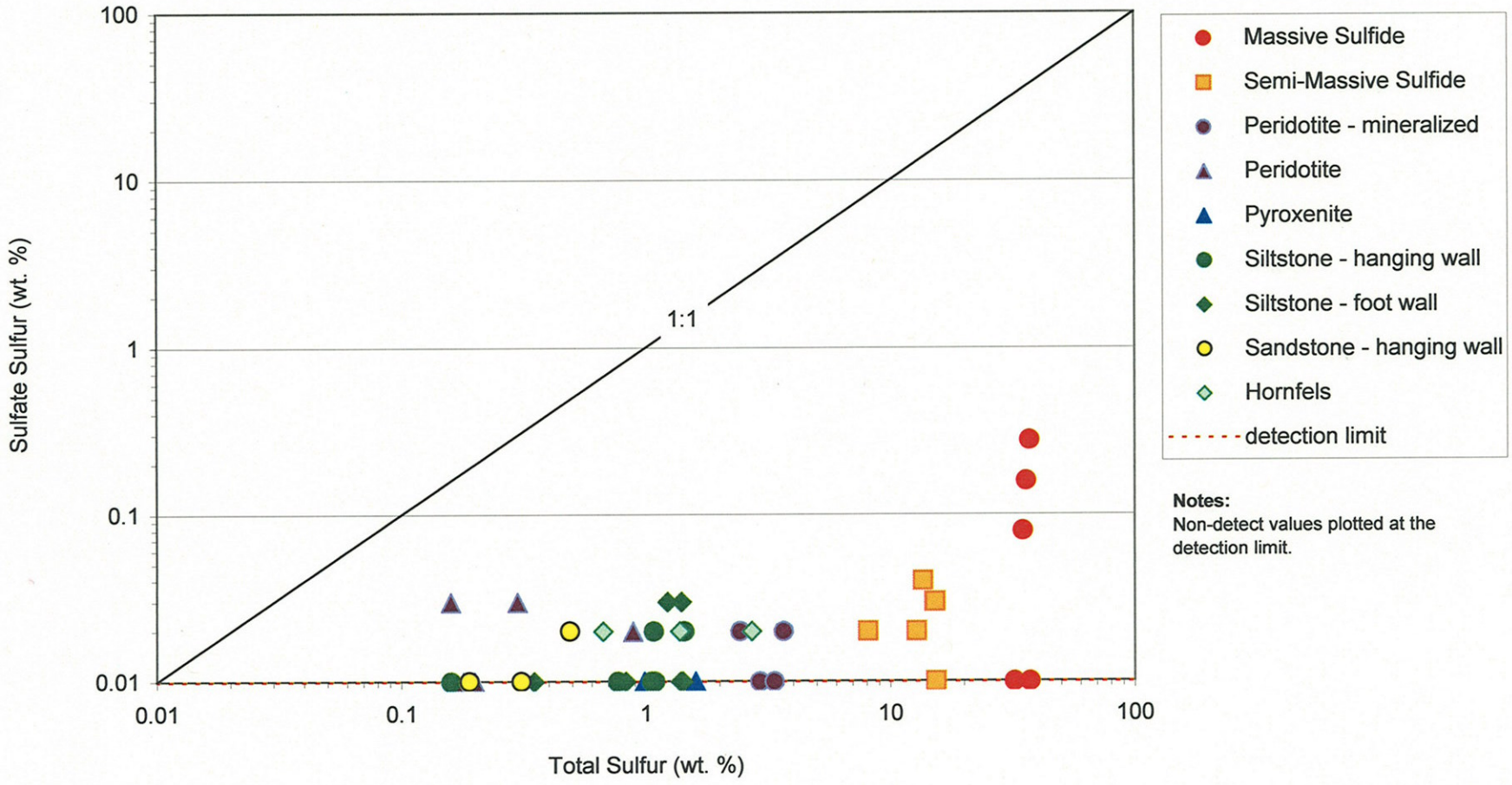
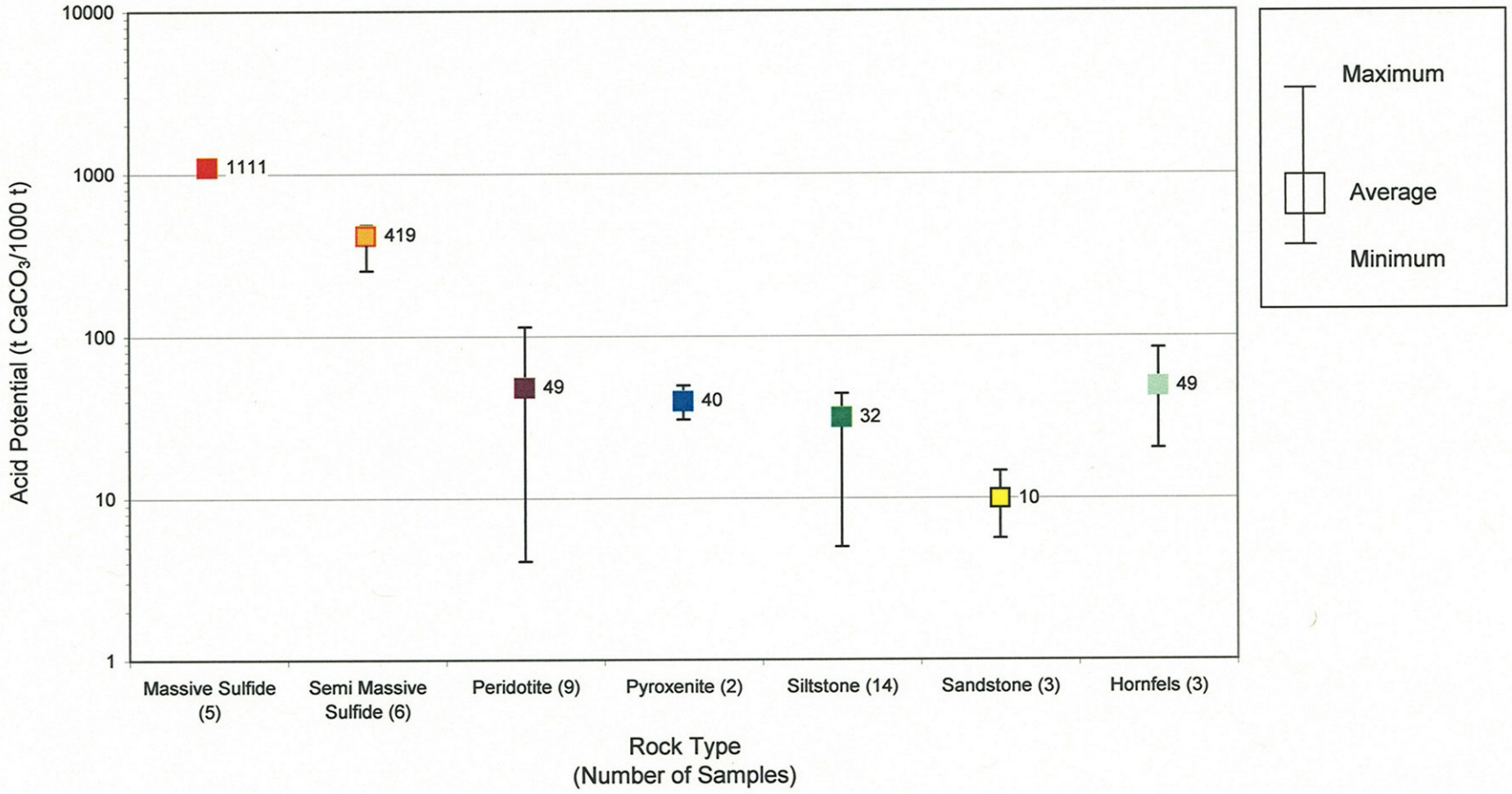


Figure 3-26
Eagle Deposit Sediment Total Sulfur



Notes:
Non-detect values plotted at the detection limit.

Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - S(T) vs. S(SO4)**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing.xls	FIGURE NO. 3-27	

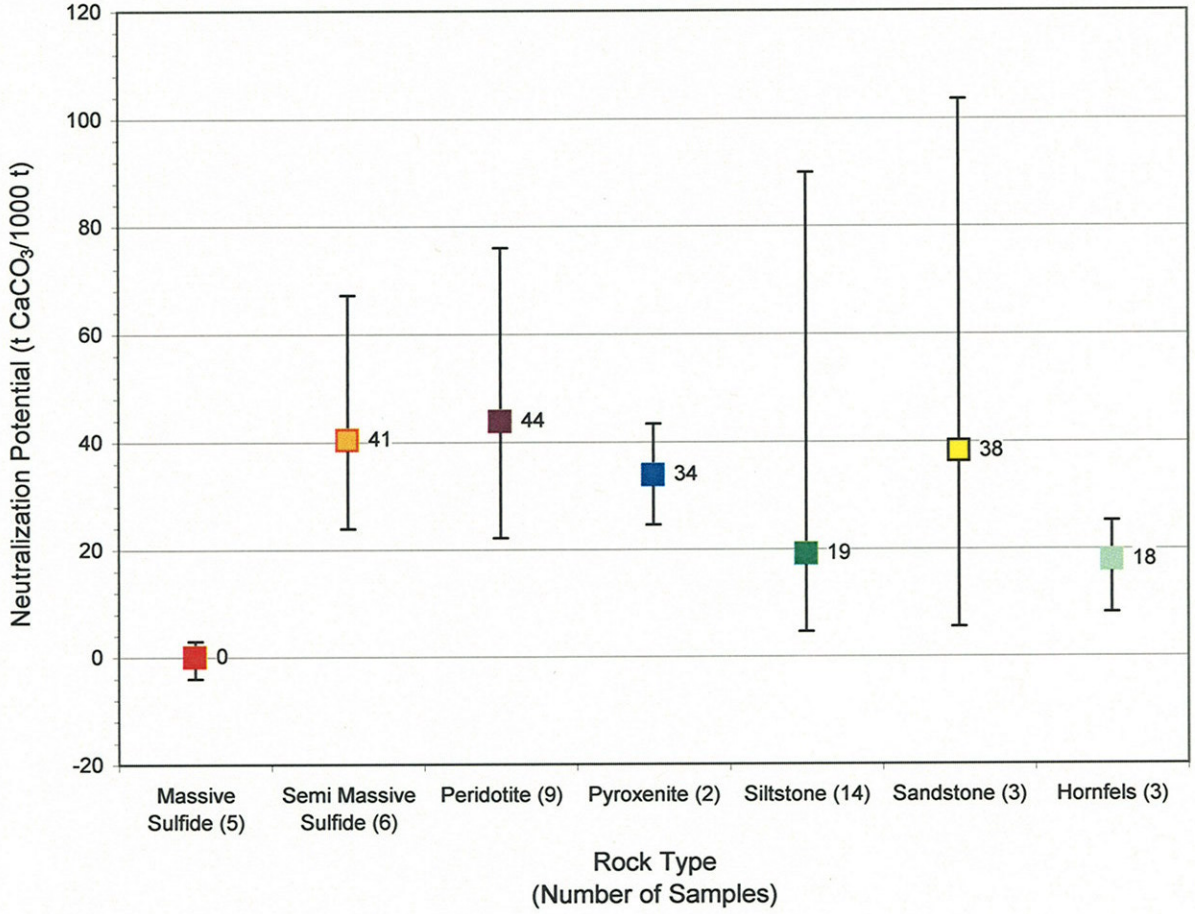


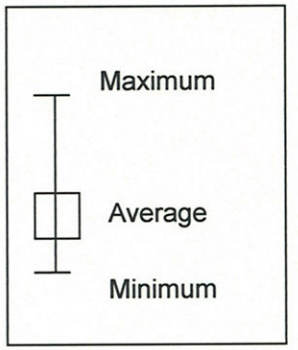
Eagle Mine
Phase I Static Testing

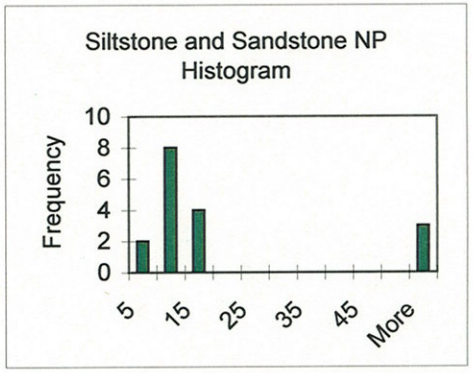
TITLE

ABA Results - Acid Potential

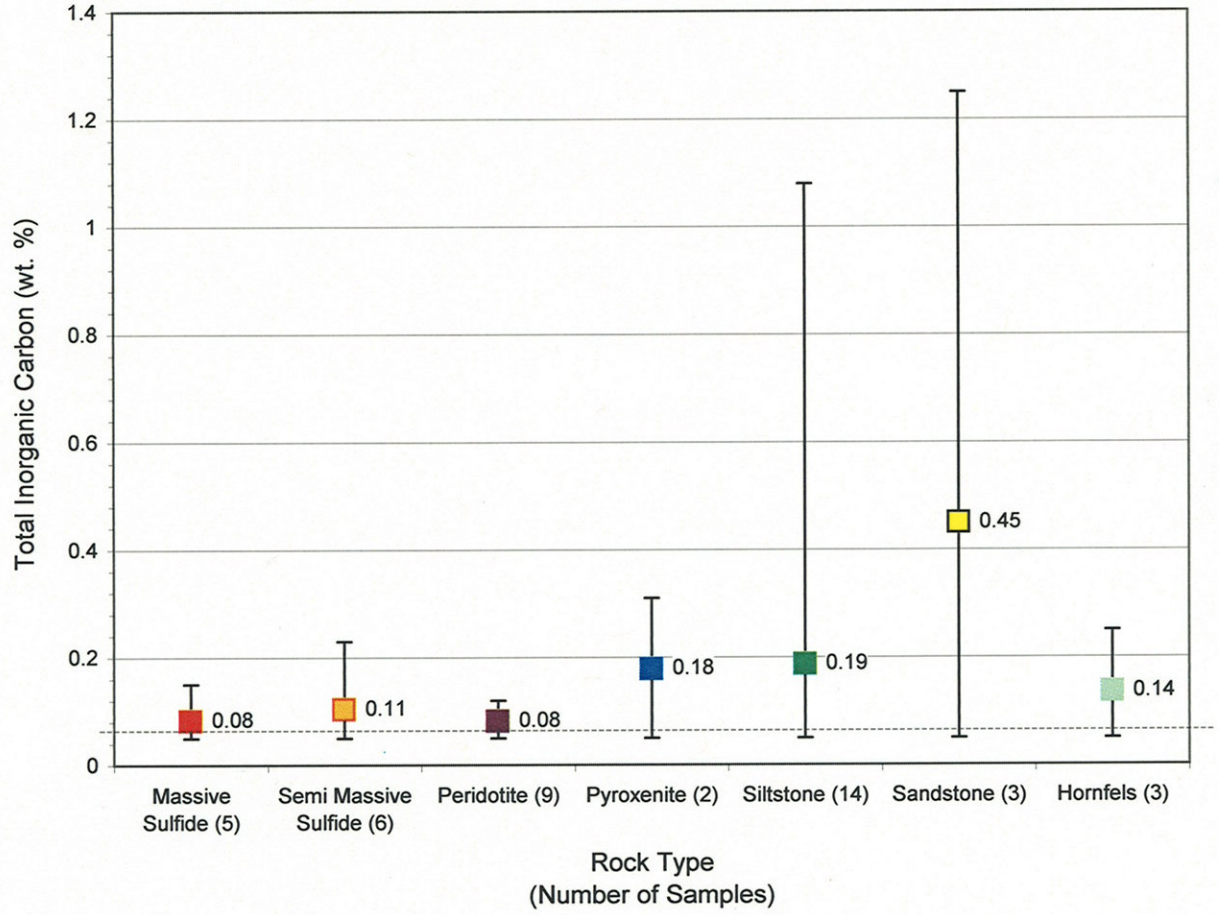
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing - Jun04.xls	FIGURE NO.	3-28

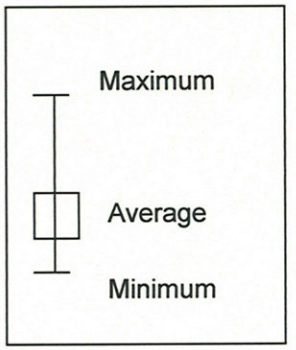




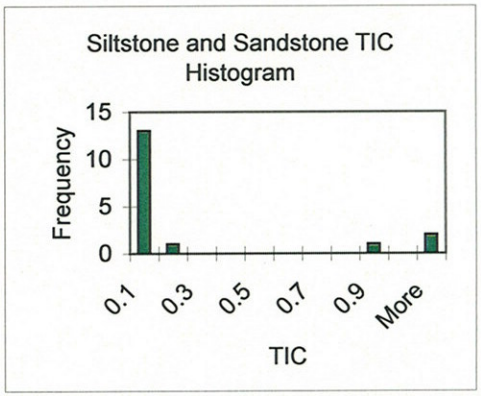


Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - Neutralization Potential**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-29**	





Notes:
Non-detect concentrations assumed equal to the detection limit.
TIC detection limit - 0.05 wt. %
(shown as red dashed line)



Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - Total Inorganic Carbon**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. **3-30**	

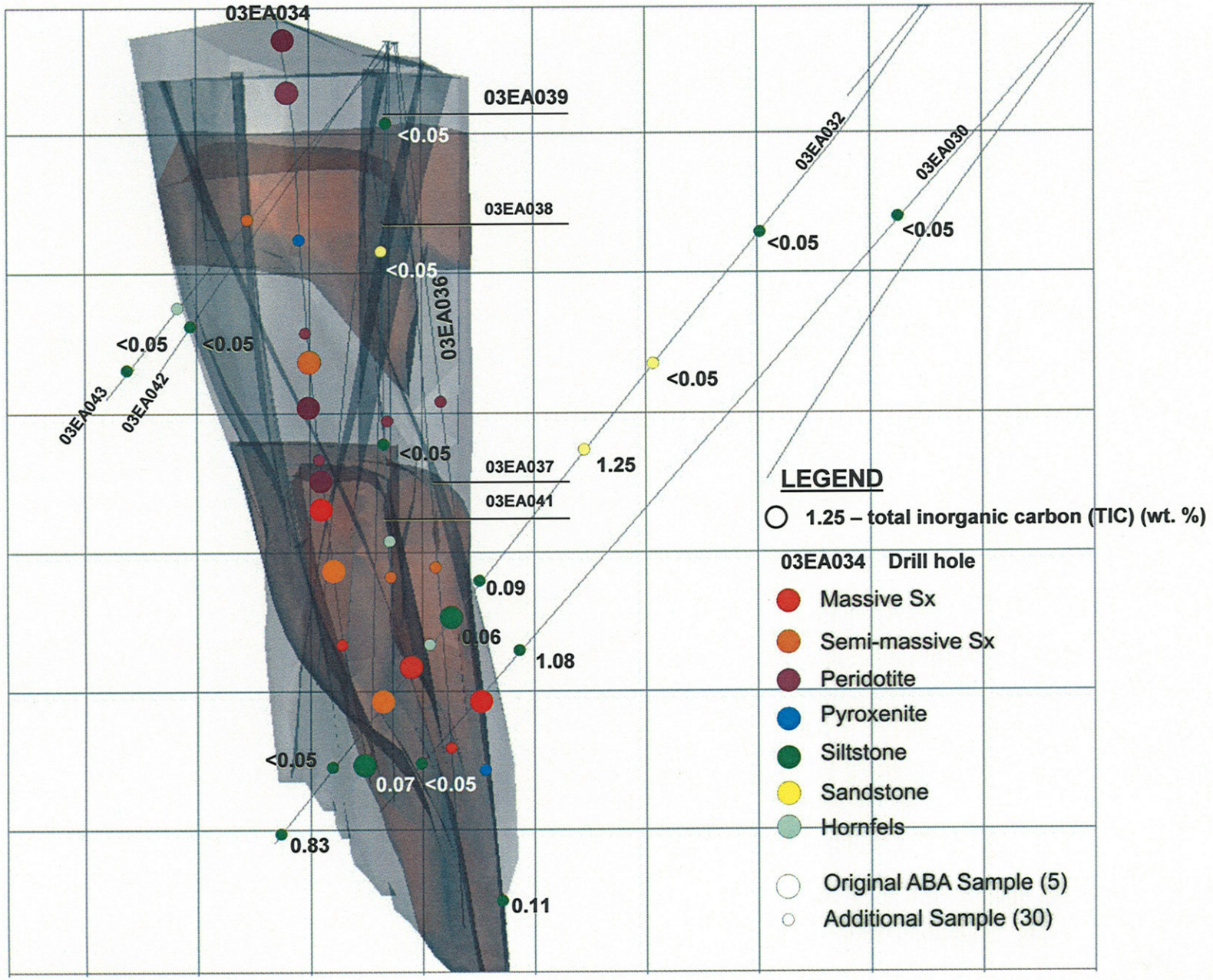
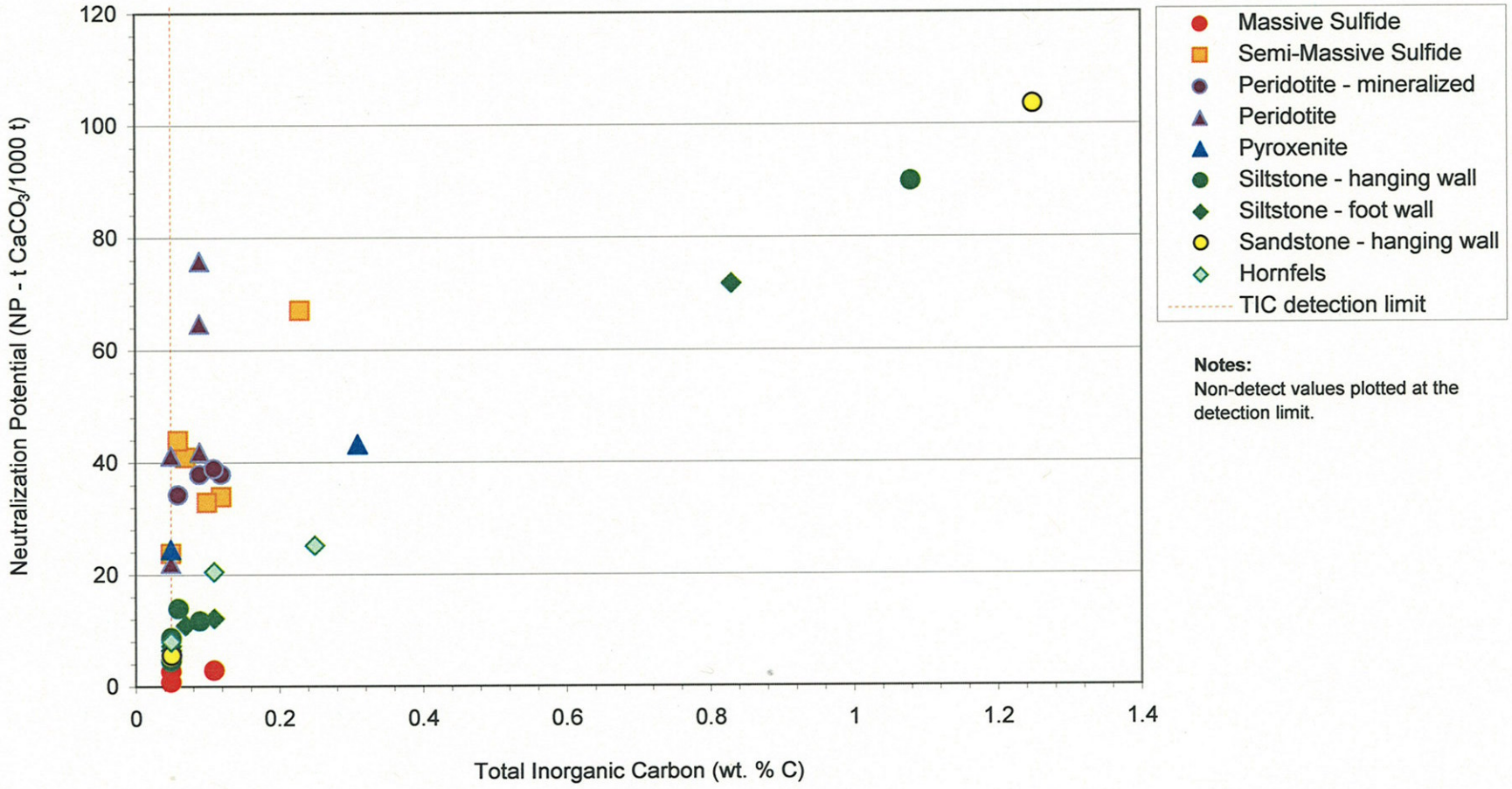
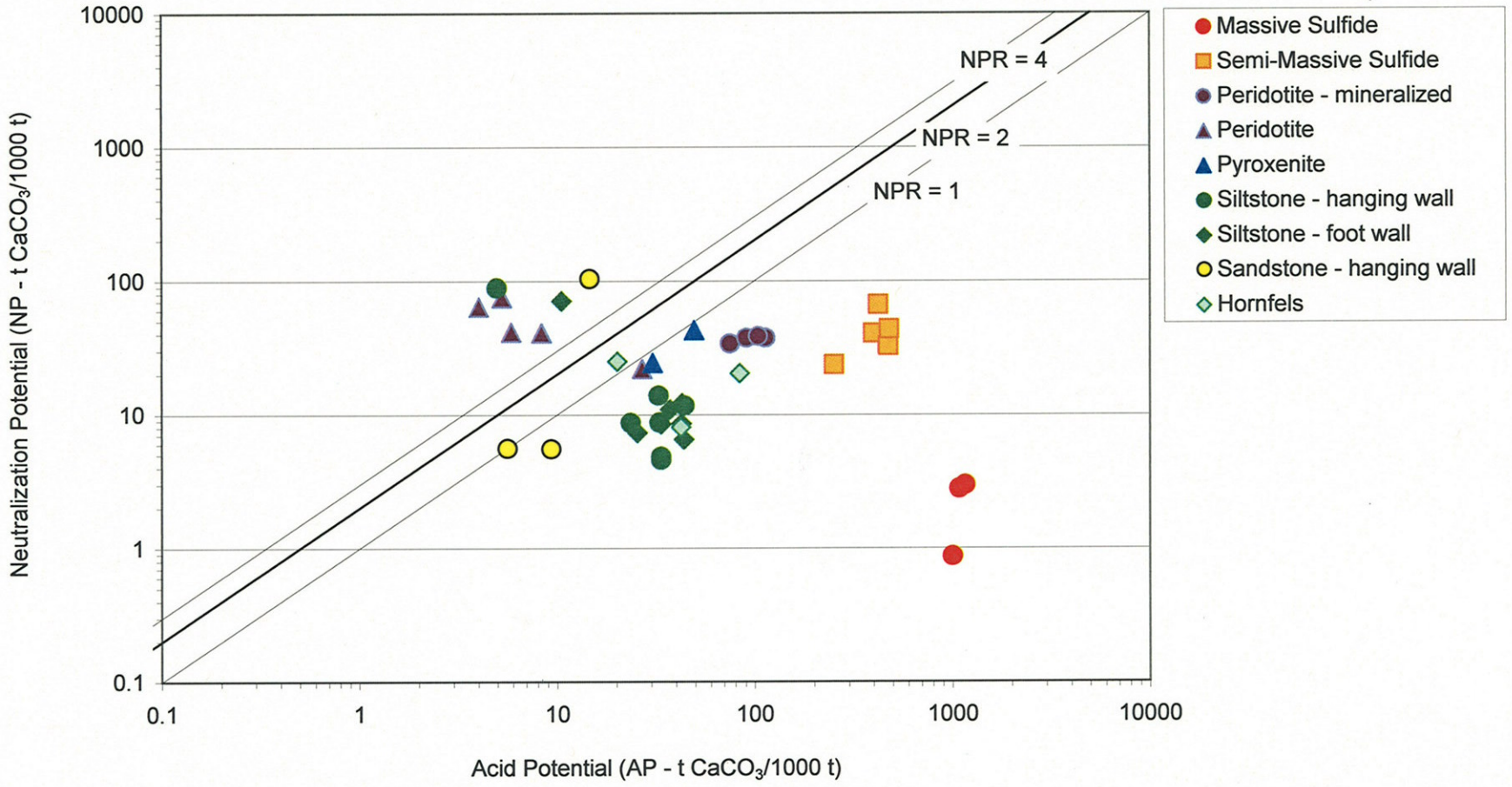


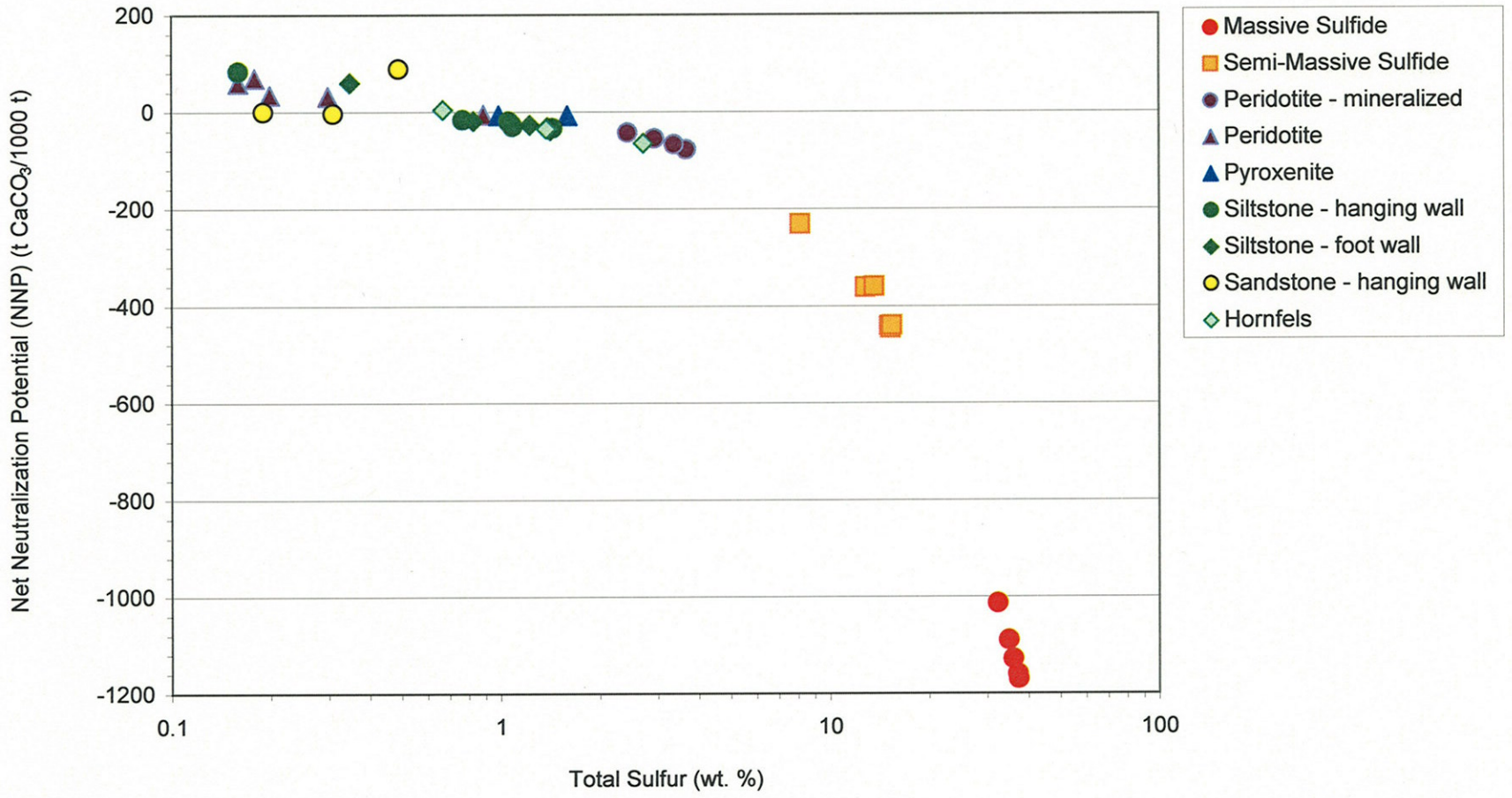
Figure 3-31
Eagle Deposit Sediment Total Inorganic Carbon



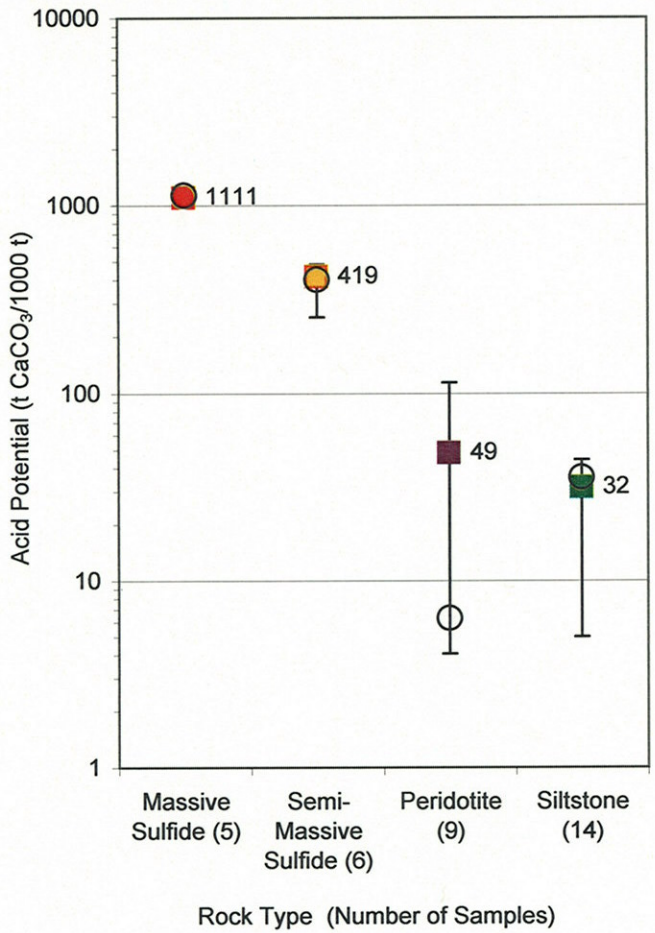
Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - TIC vs. NP**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing.xls	FIGURE NO. **3-32**	

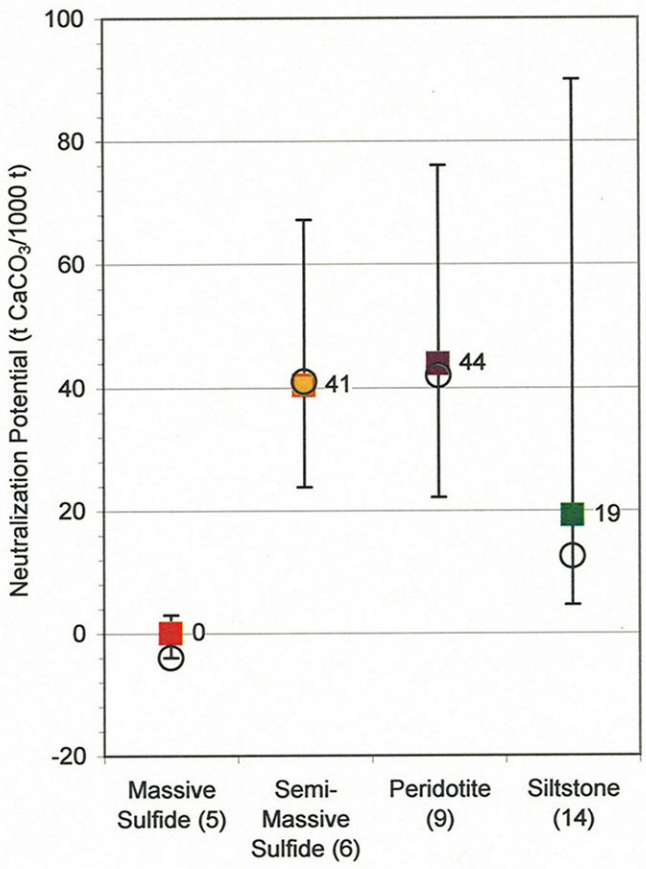


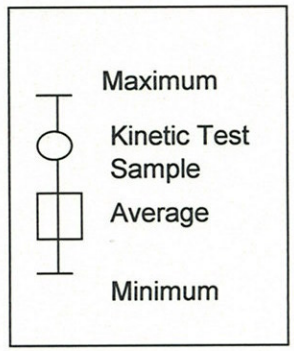
Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - AP vs. NP**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing.xls	FIGURE NO. 3-33	



Eagle Mine **Phase I Static Testing**	TITLE	**ABA Results - S(T) vs. NNP**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing.xls	FIGURE NO. **3-34**	

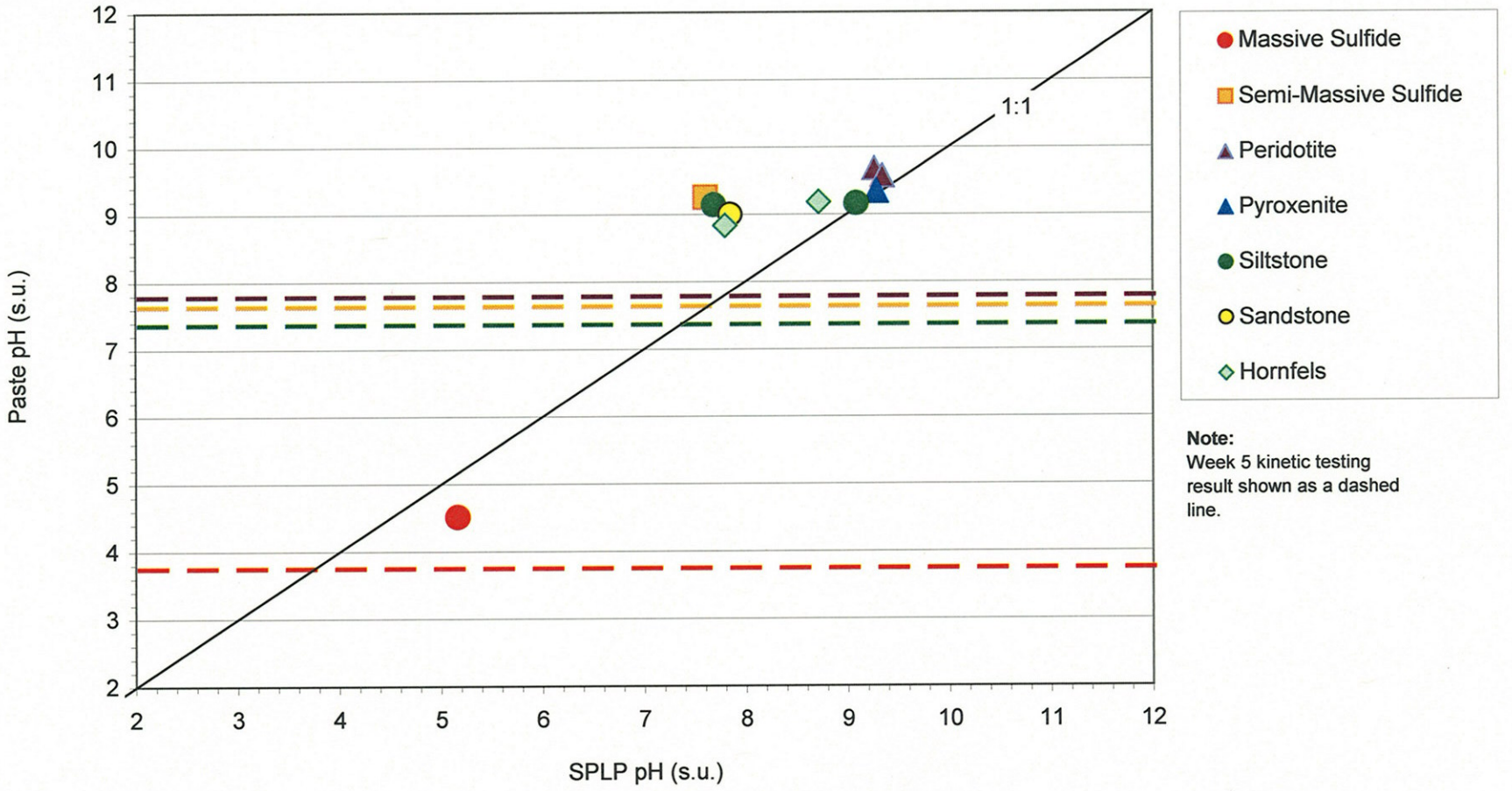




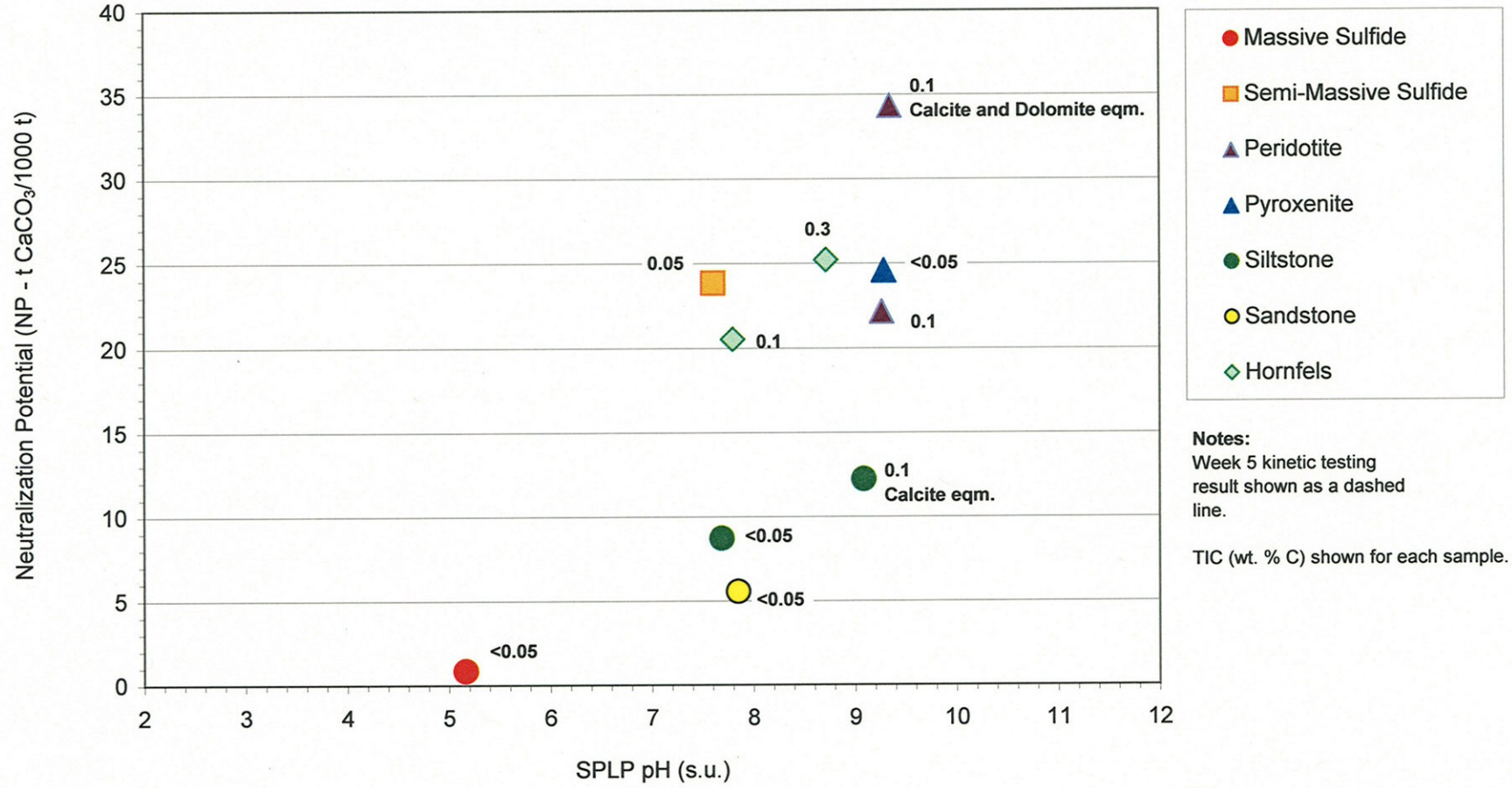


Note:
Kinetic testing samples shown as open circles. Average AP and NP of the two siltstone samples plotted.

Eagle Mine **Phase I Static Testing**	TITLE	**Kinetic Test Samples AP and NP**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing - Jun04.xls	FIGURE NO. 3-35	



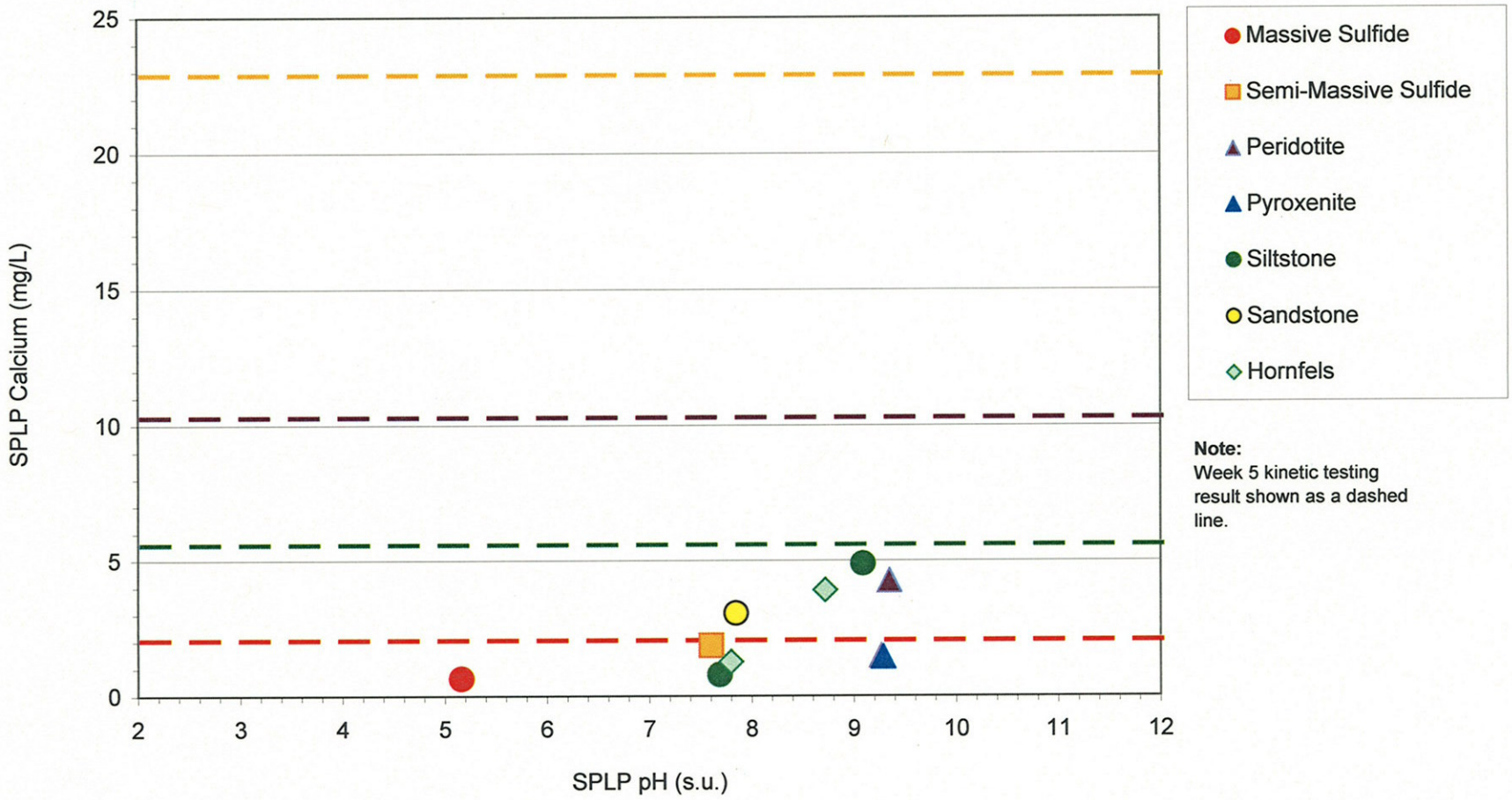
Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Paste pH**		
	DRAWN	CR	DATE June 2004	JOB NO. 043-1055
	CHECKED	RV	SCALE na	DWG. NO.
	REVIEWED	ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-36**



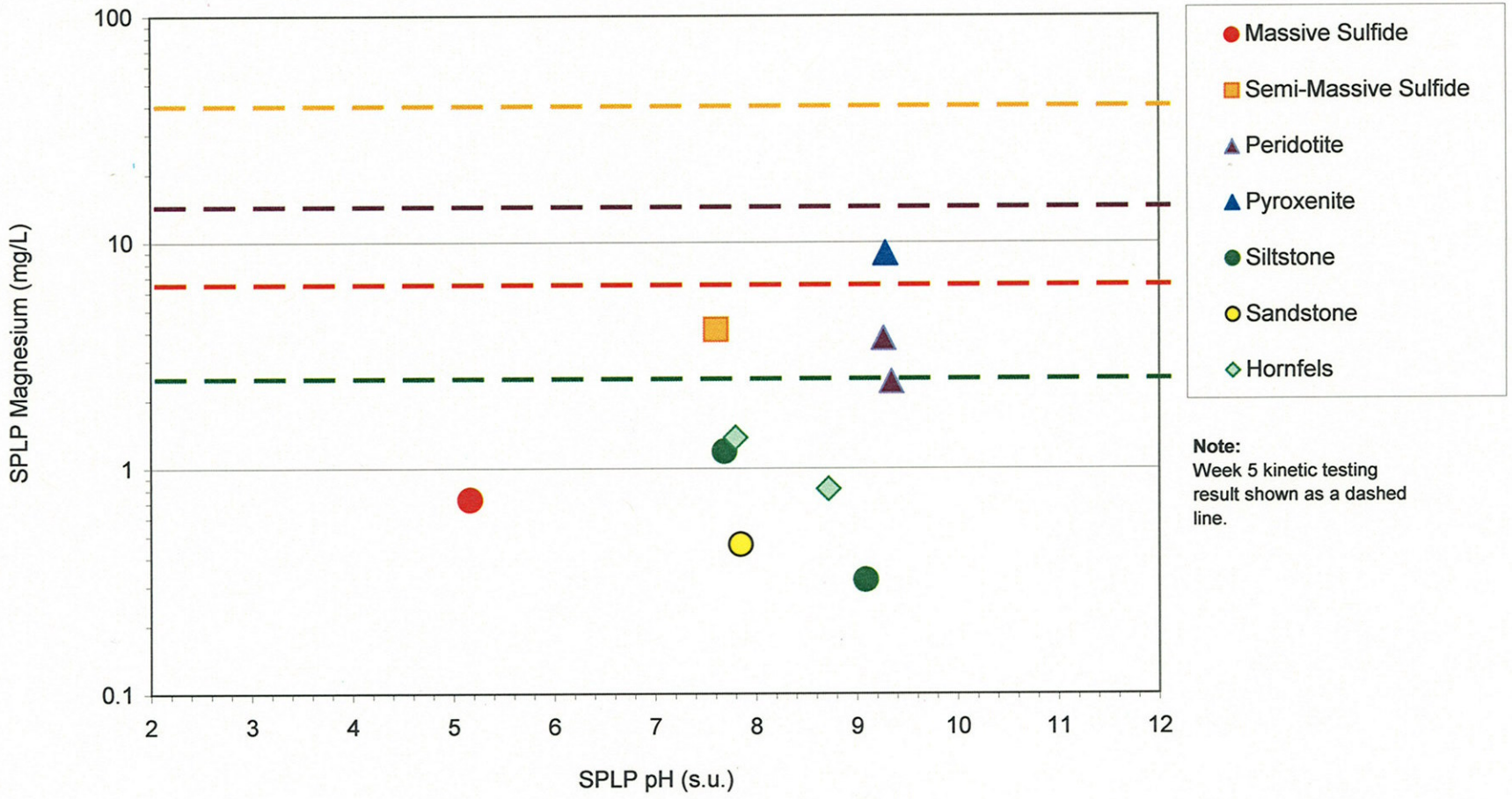
Notes:
Week 5 kinetic testing result shown as a dashed line.

TIC (wt. % C) shown for each sample.

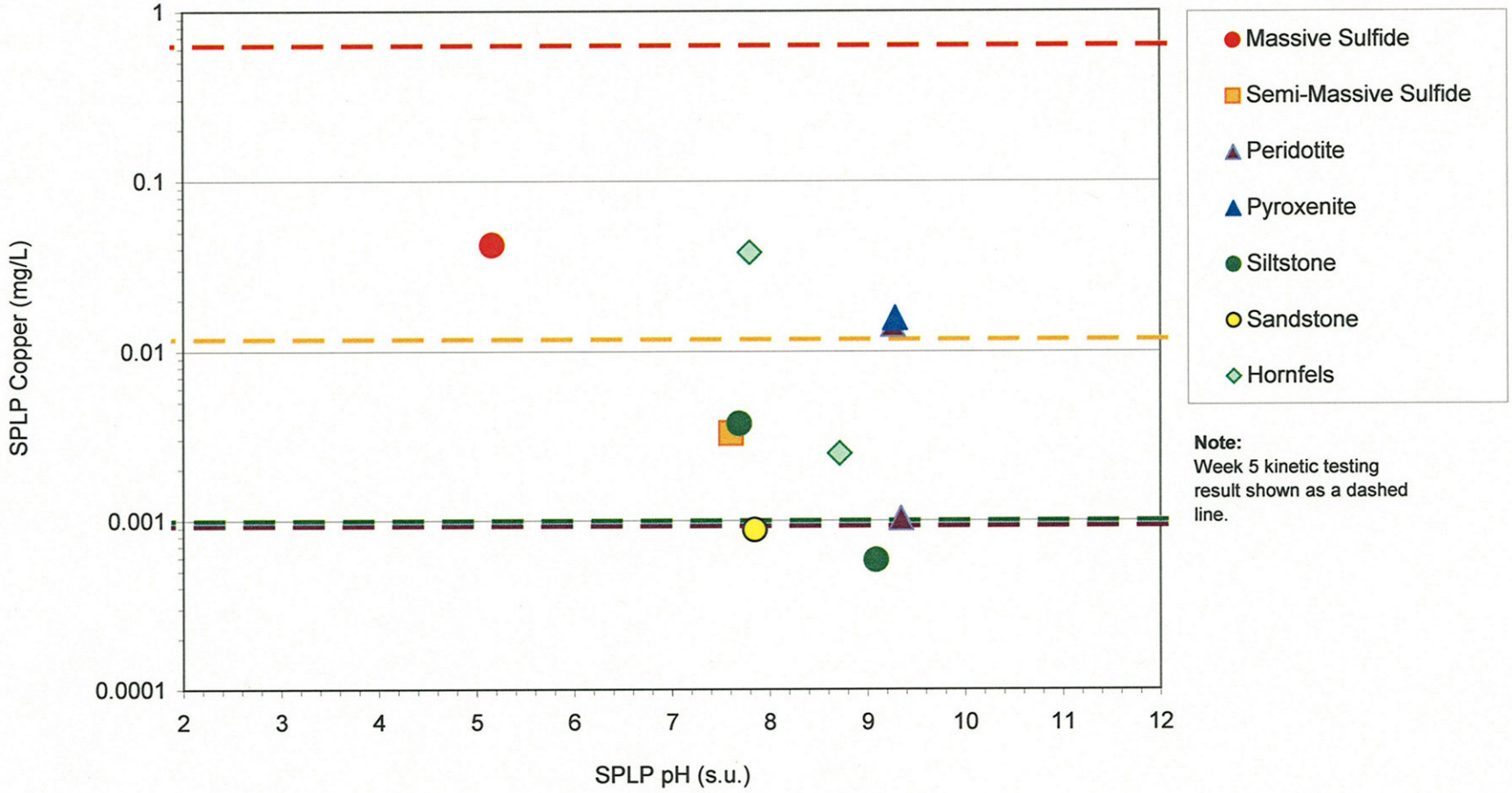
Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. NP**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. 3-37	



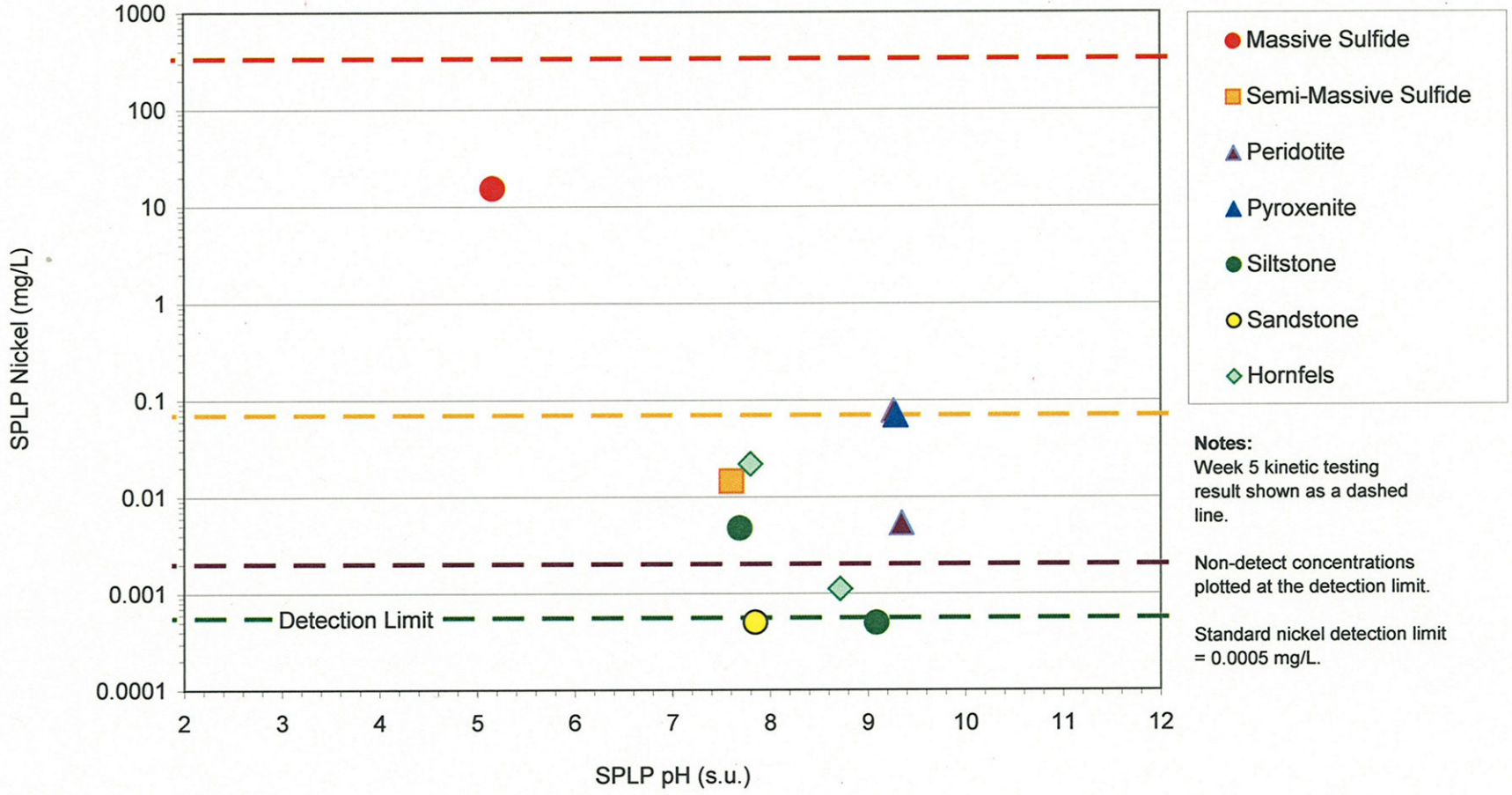
Eagle Mine Phase I Static Testing	TITLE	**SPLP Results - pH vs. Calcium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-38**	



Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Magnesium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. 3-39	



Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Copper**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-40**	



Notes:
Week 5 kinetic testing result shown as a dashed line.

Non-detect concentrations plotted at the detection limit.

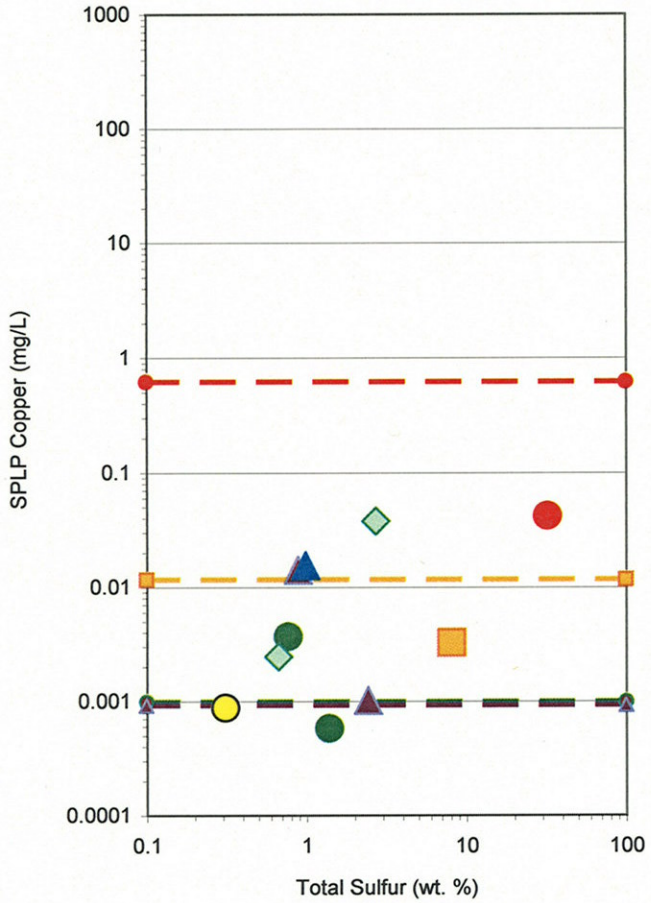
Standard nickel detection limit = 0.0005 mg/L.

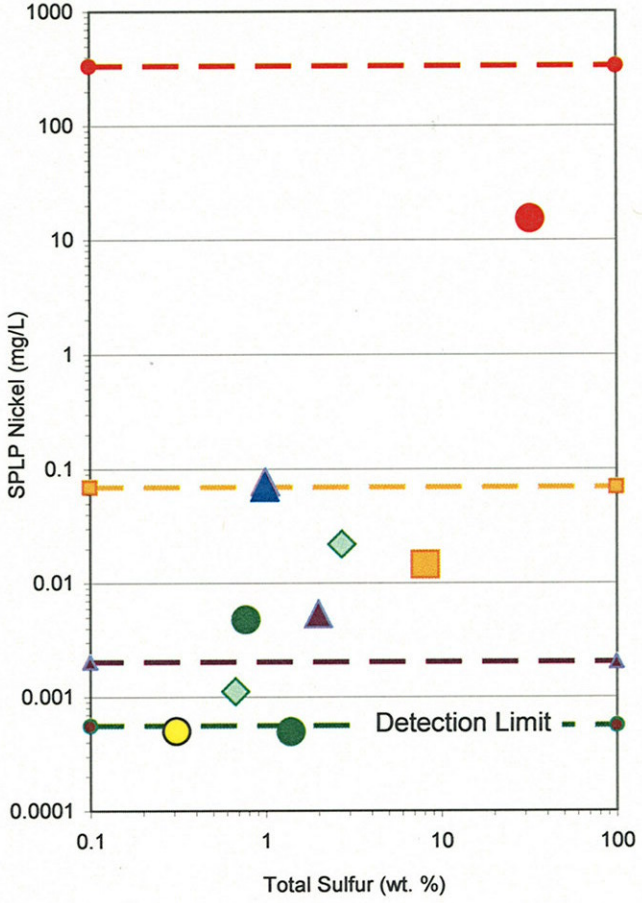
Eagle Mine
Phase I Static Testing

TITLE

SPLP Results - pH vs. Nickel

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing SPLP - Jun04.xls	FIGURE NO.	3-41







Notes:
Week 5 kinetic testing result shown as a dashed line.

Non-detect concentrations plotted at the detection limit.

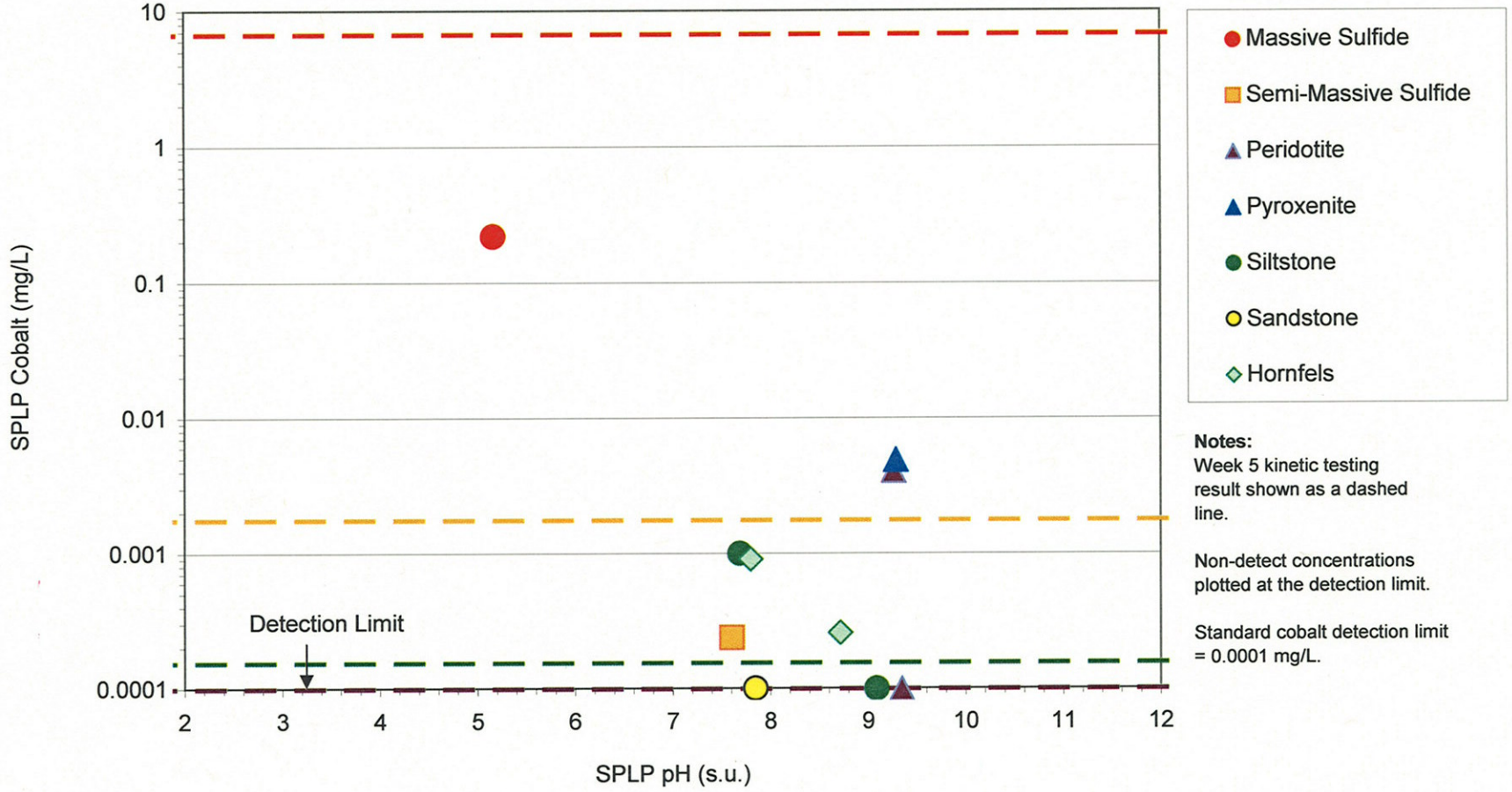
Standard nickel detection limit = 0.0005 mg/L.

Eagle Mine
Phase I Static Testing

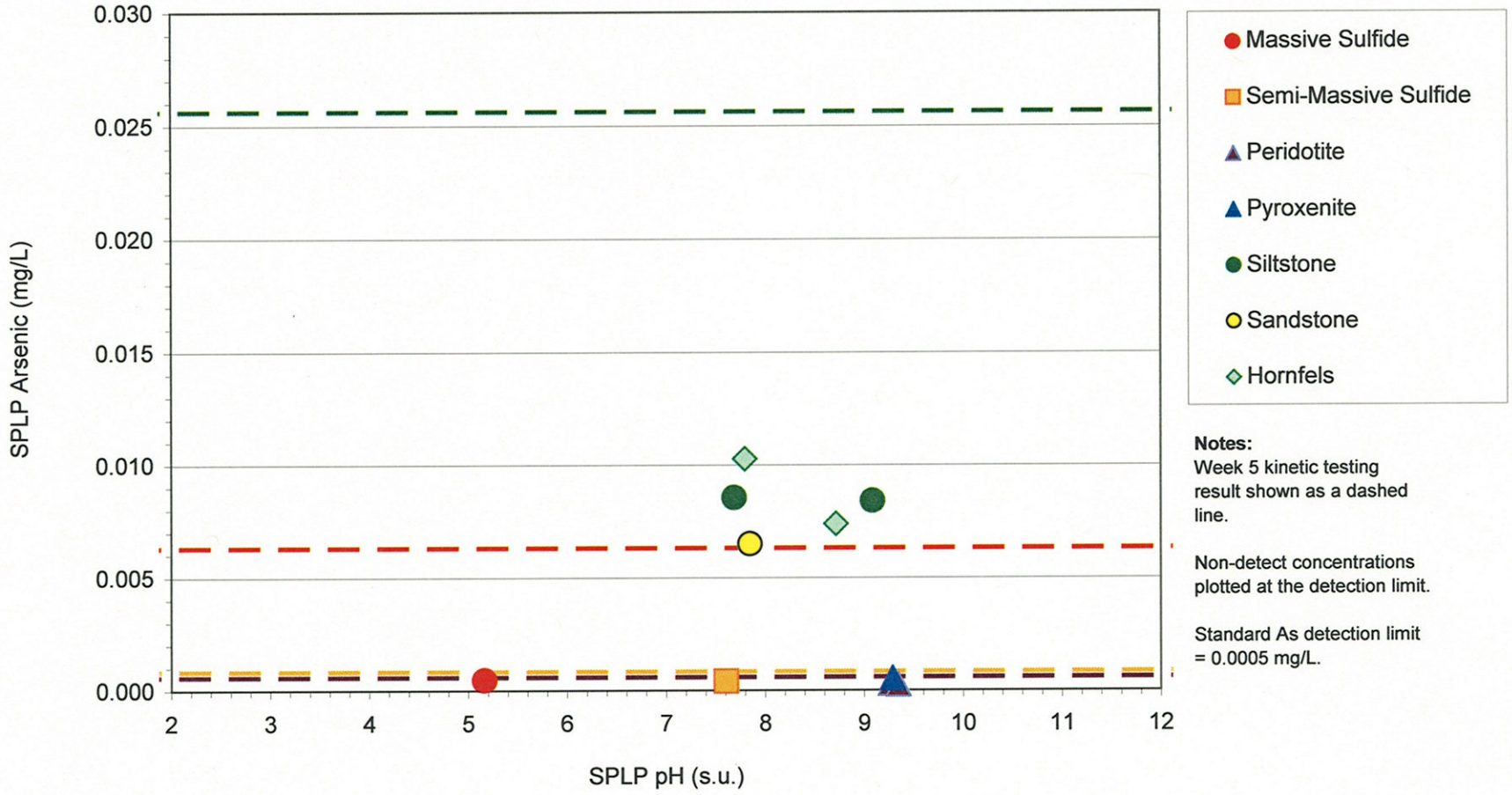
TITLE

SPLP Results - S(T) vs. Nickel and Copper

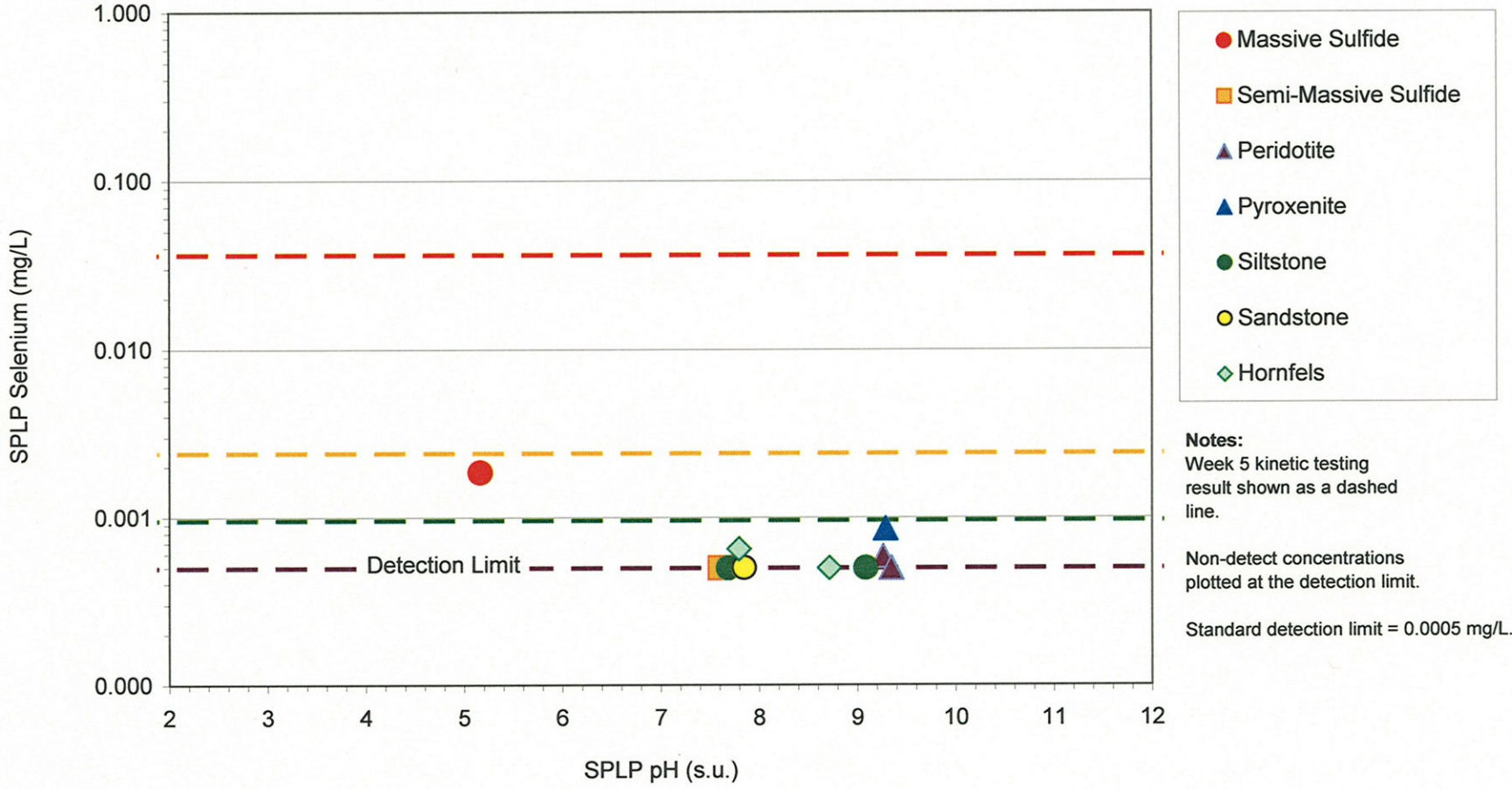
DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing SPLP - Jun04.xls	FIGURE NO.	3-42



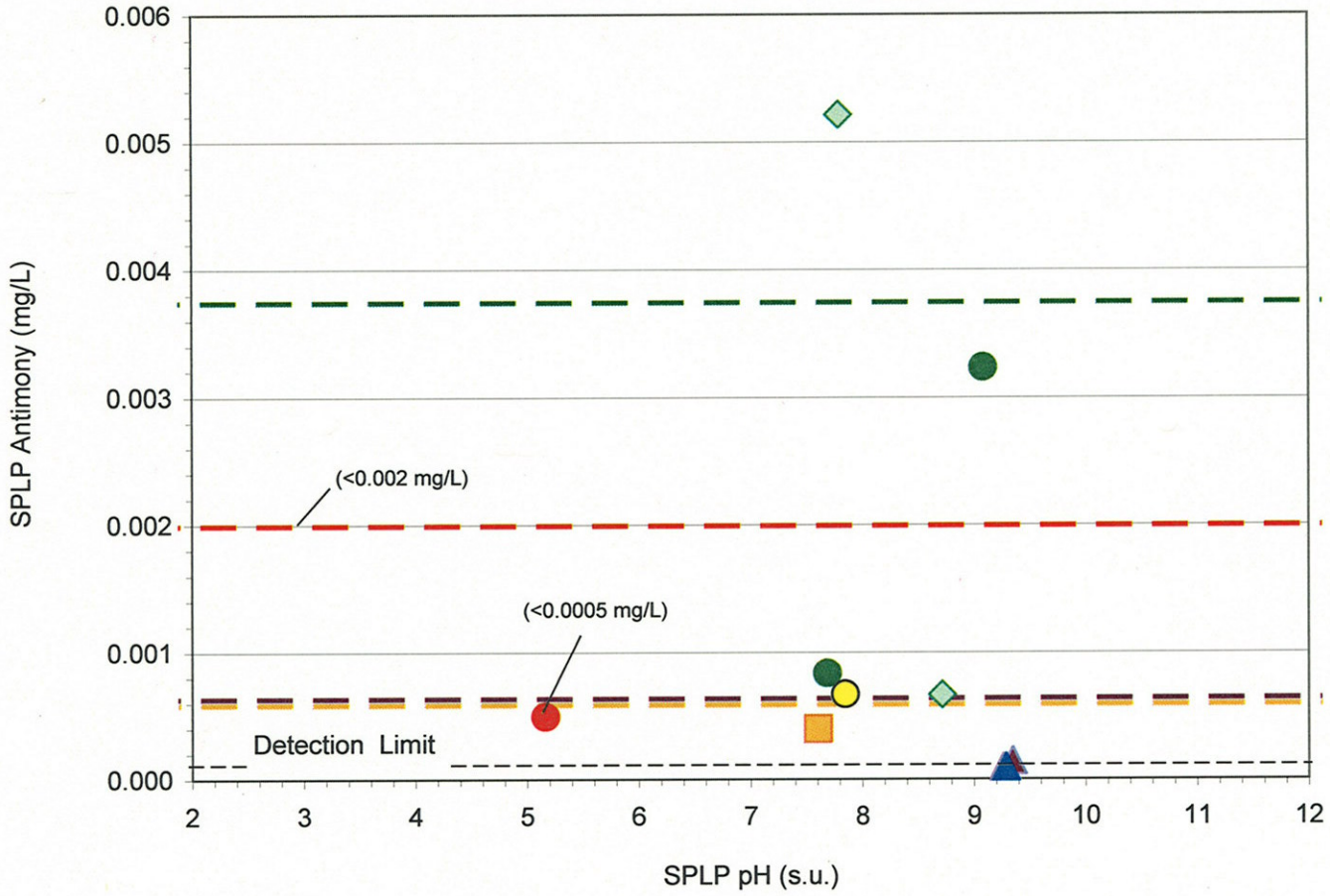
Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Cobalt**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. 3-43	



Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Arsenic**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-44**	



Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Selenium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-45**	



Notes:
Week 5 kinetic testing result shown as a dashed line.

Non-detect concentrations plotted at the detection limit.

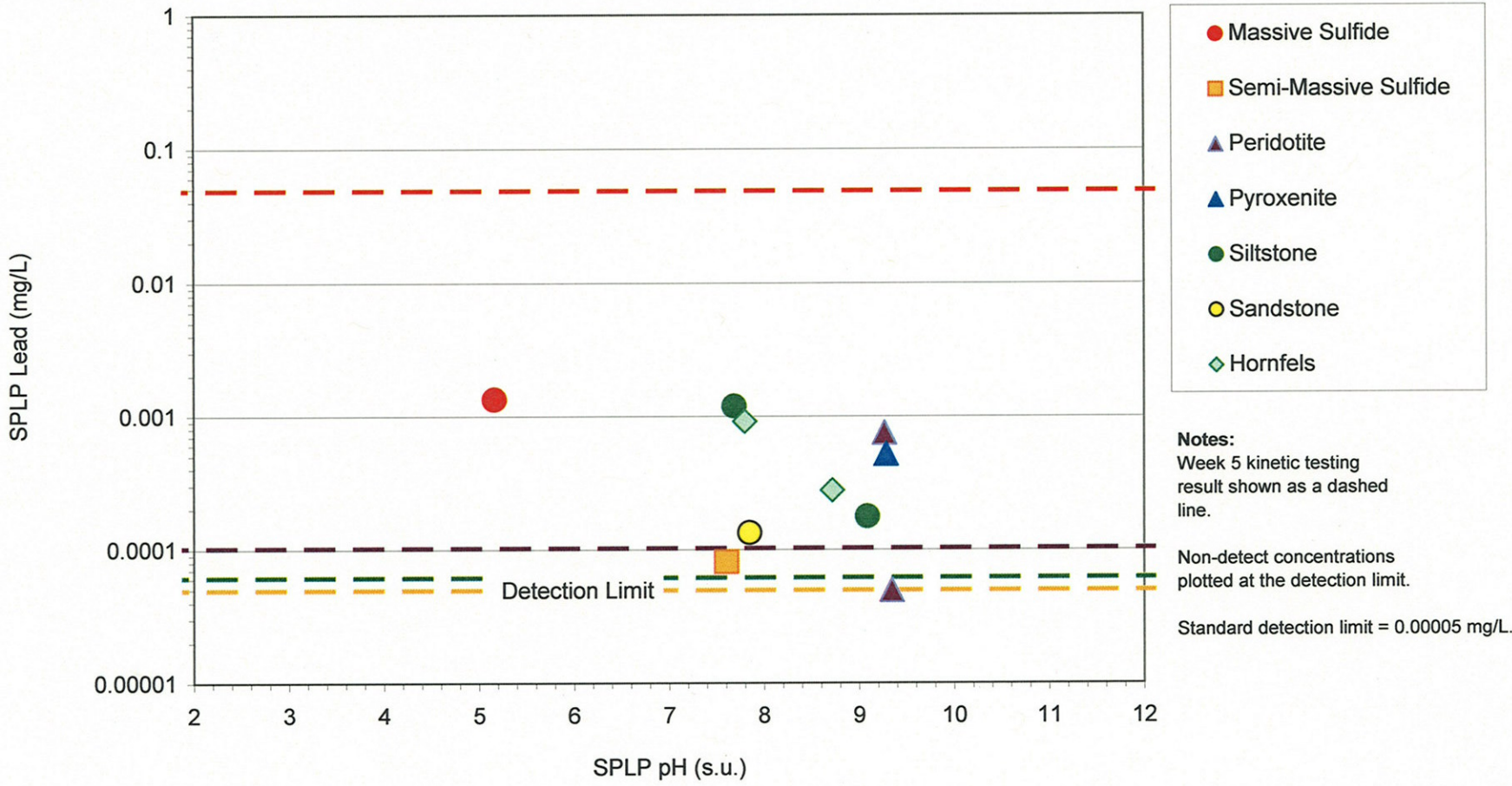
Standard detection limit = 0.0001 mg/L.

Eagle Mine
Phase I Static Testing

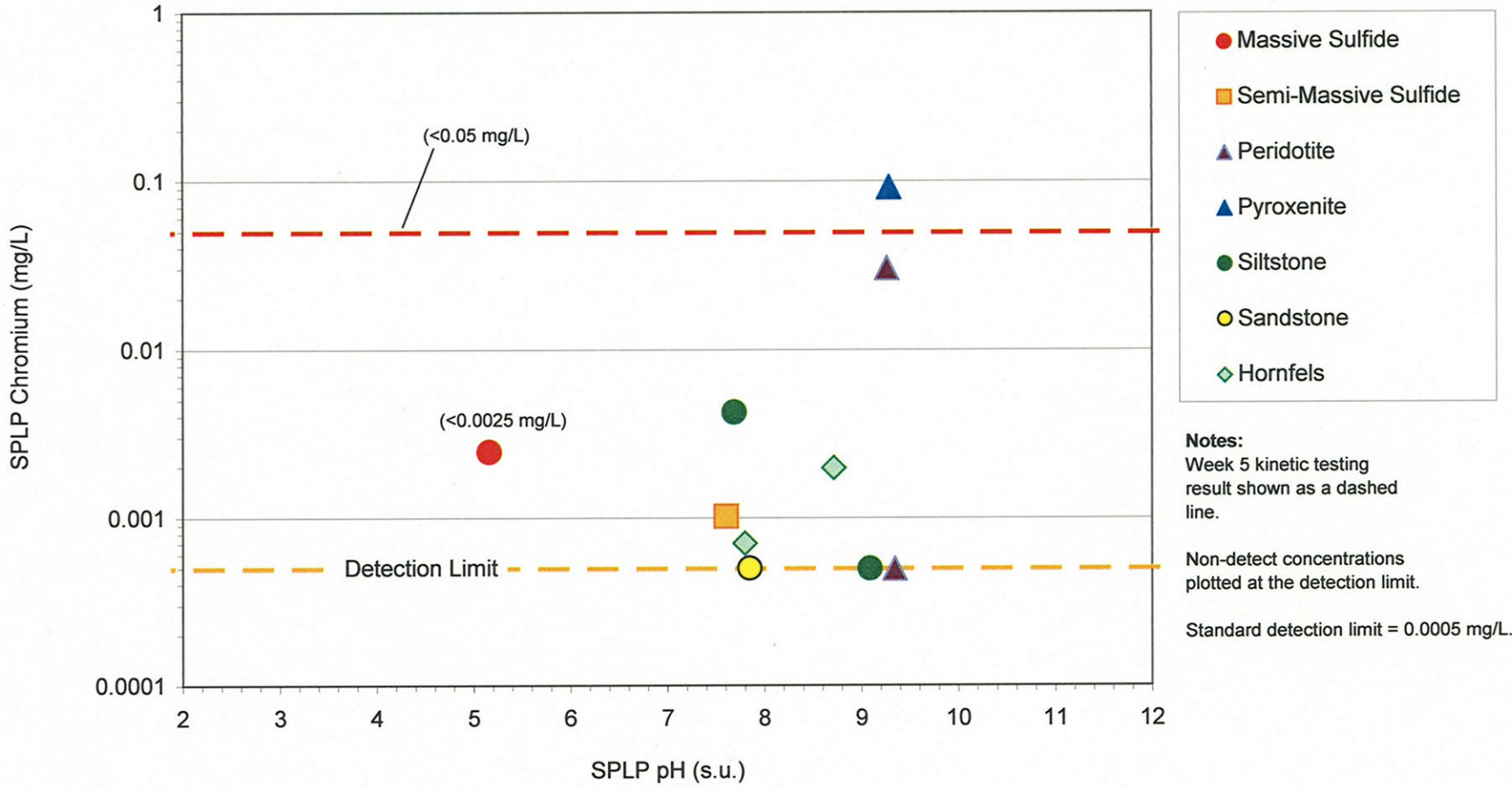
TITLE

SPLP Results - pH vs. Antimony

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing SPLP - Jun04.xls	FIGURE NO.	3-46



Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Lead**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-47**	



Notes:
Week 5 kinetic testing result shown as a dashed line.

Non-detect concentrations plotted at the detection limit.

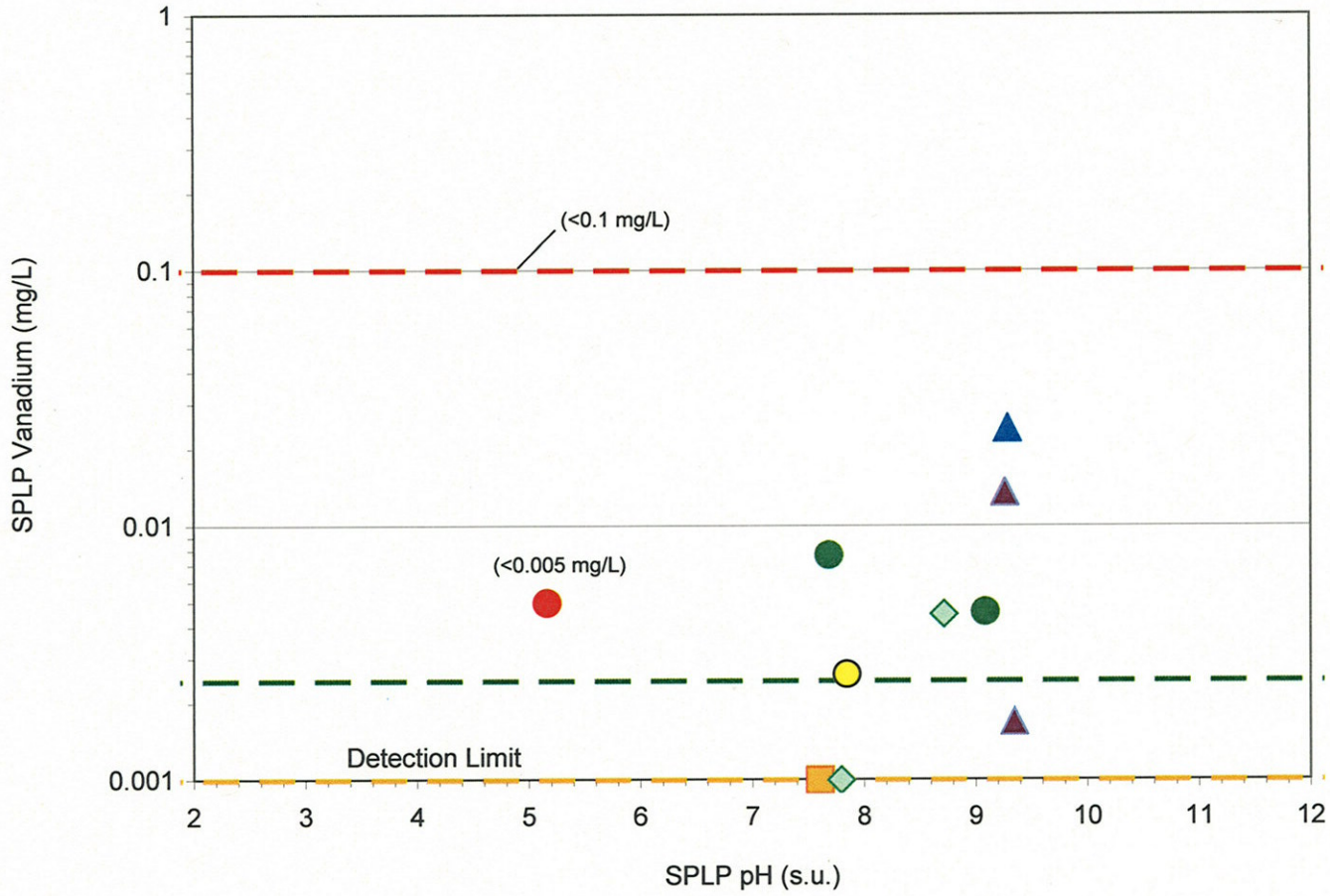
Standard detection limit = 0.0005 mg/L.

Eagle Mine
Phase I Static Testing

TITLE

SPLP Results - pH vs. Chromium

DRAWN	CR	DATE	June 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I Static Testing SPLP - Jun04.xls	FIGURE NO.	3-48

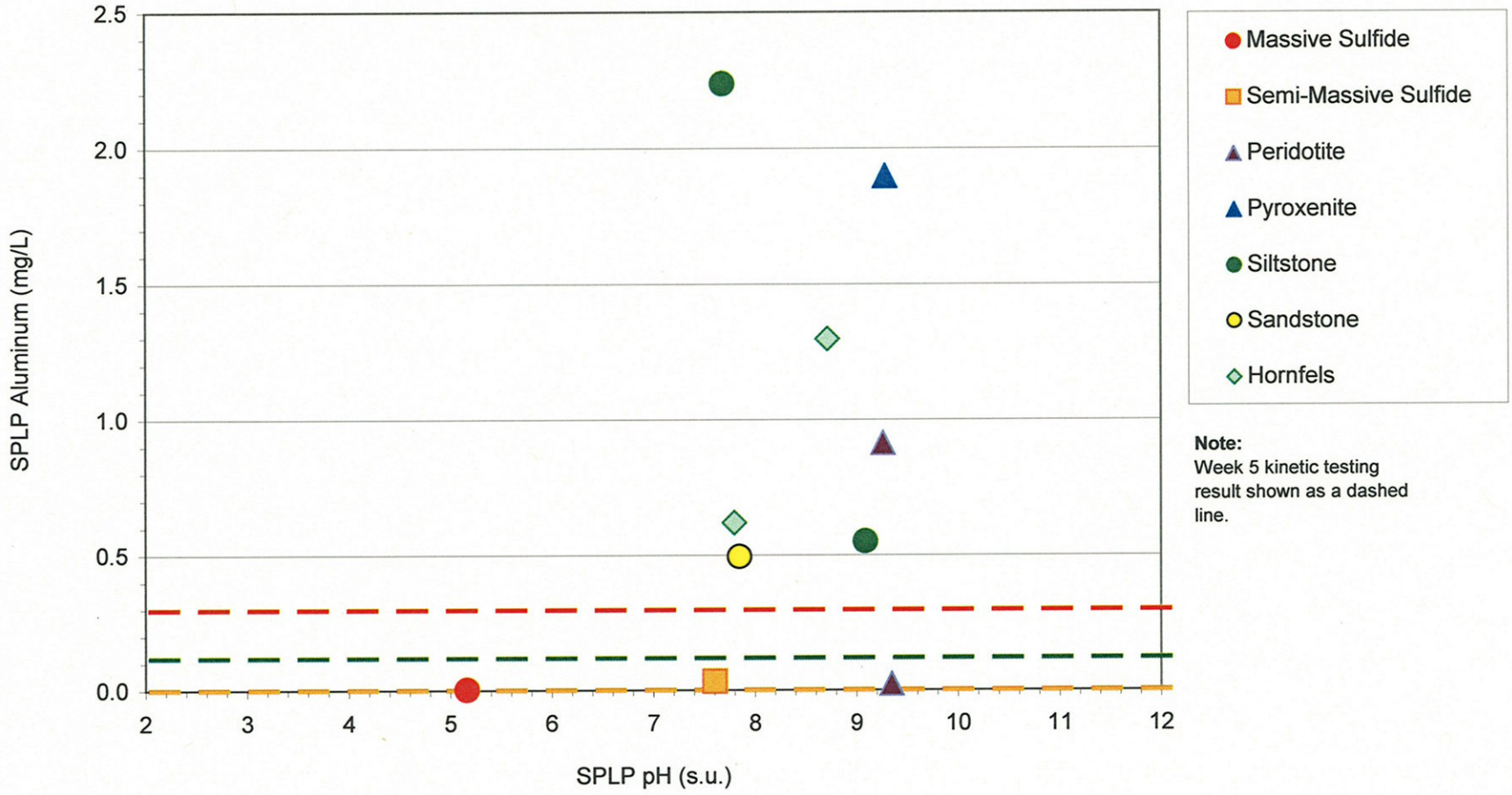


Notes:
Week 5 kinetic testing result shown as a dashed line.

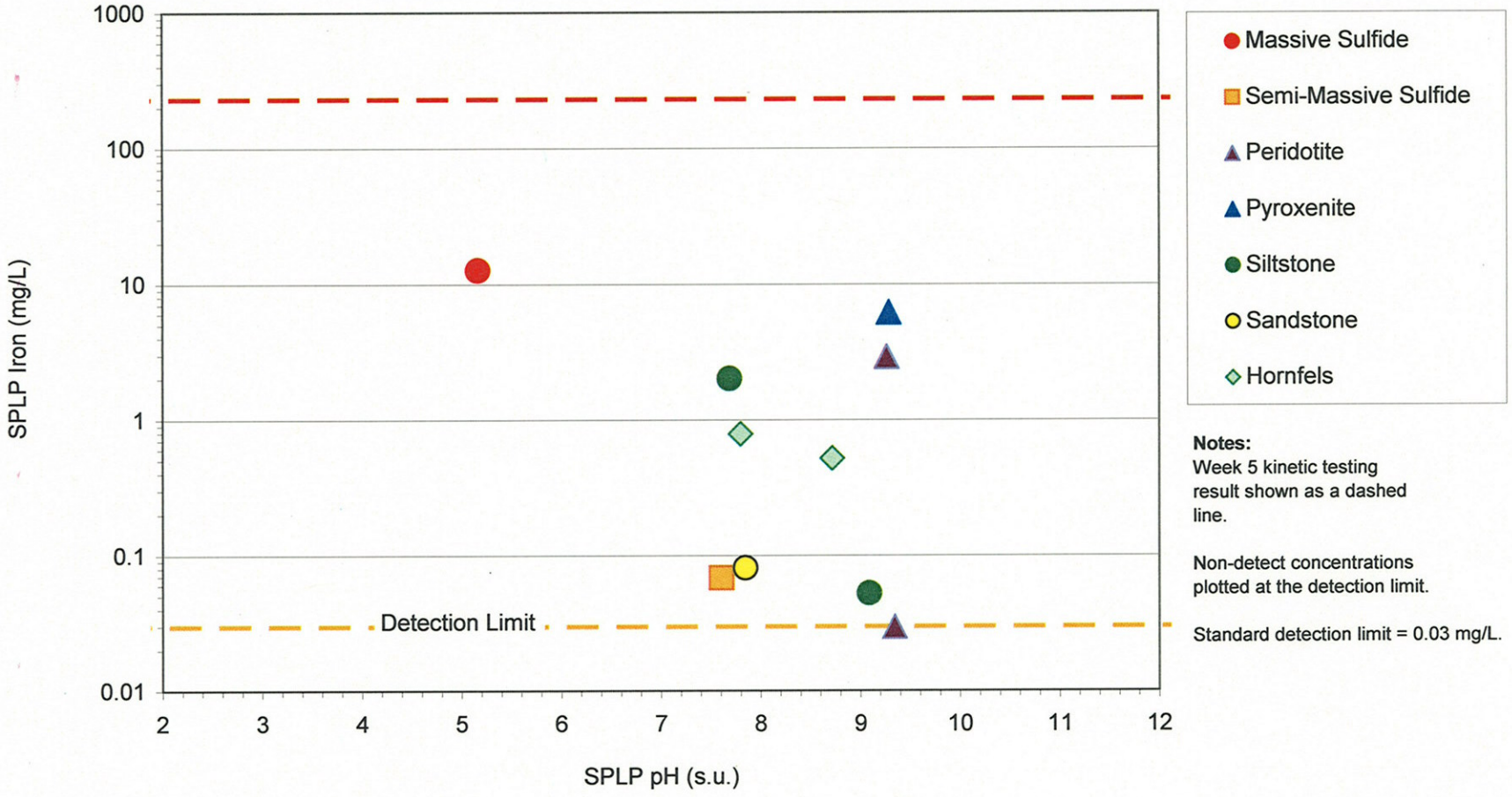
Non-detect concentrations plotted at the detection limit.

Standard detection limit = 0.001 mg/L.

Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Vanadium**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-49**	



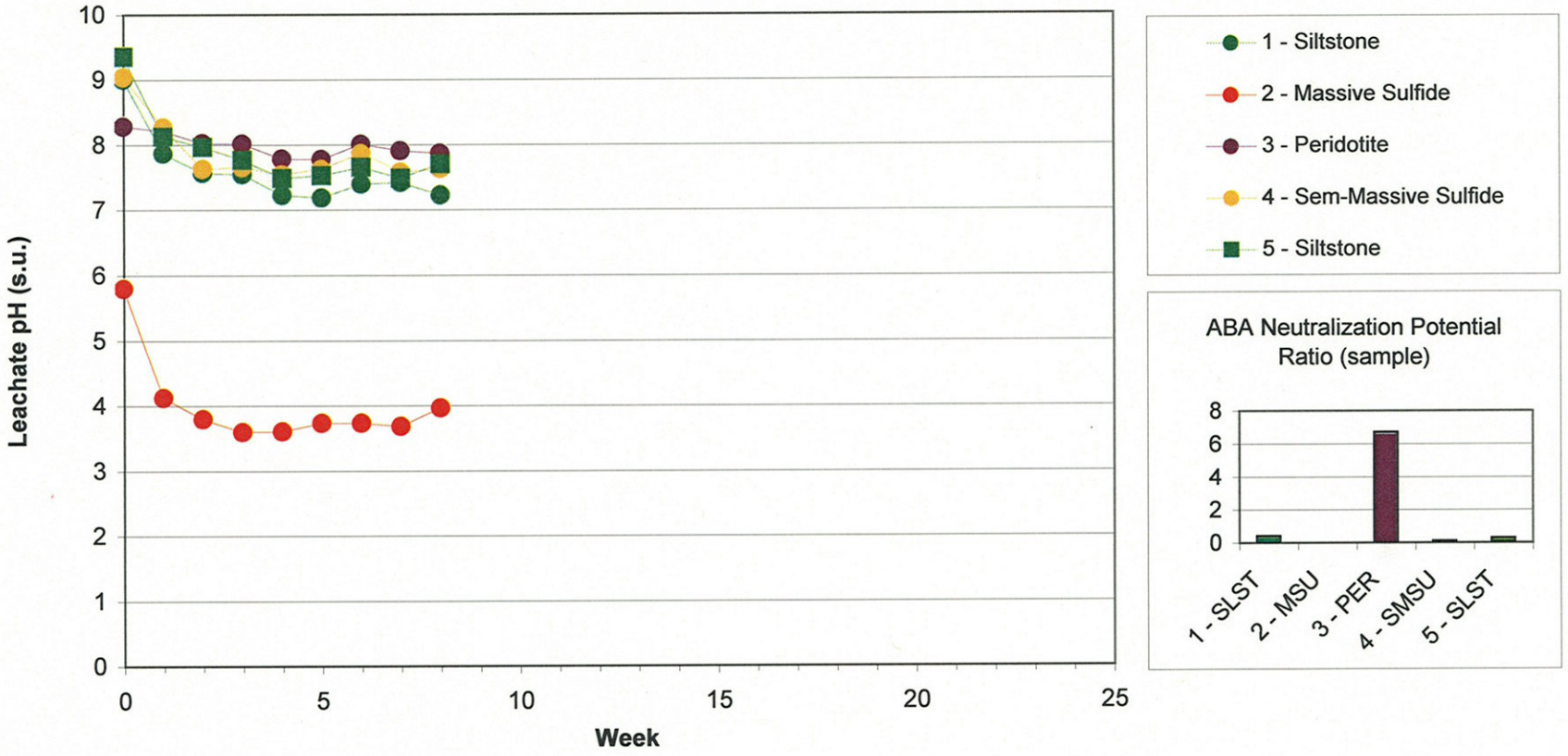
Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Aluminum**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. **3-50**	



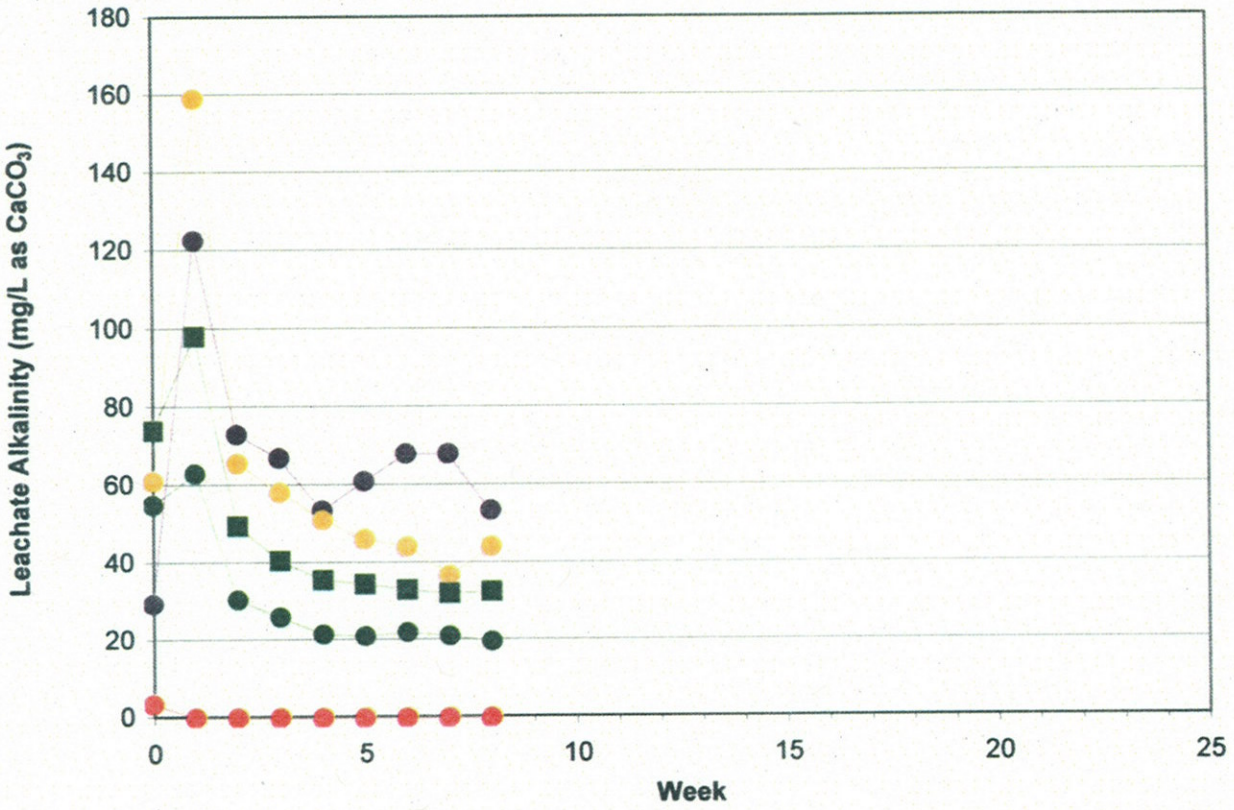
Eagle Mine **Phase I Static Testing**	TITLE	**SPLP Results - pH vs. Iron**		
	DRAWN CR	DATE June 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I Static Testing SPLP - Jun04.xls	FIGURE NO. 3-51	

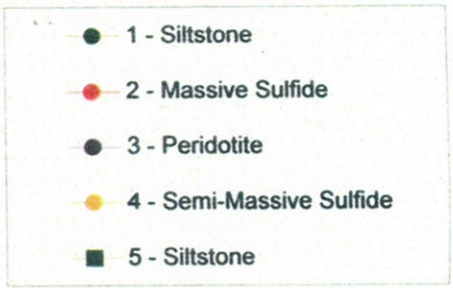
APPENDIX A

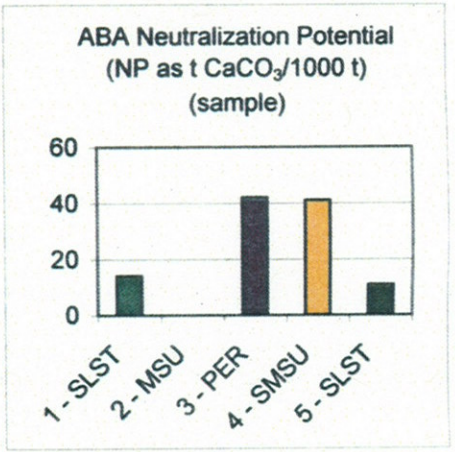
KINETIC TESTING GRAPHS



Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - pH**		
	DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
	CHECKED	RV	SCALE	na	DWG. NO.	
	REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	A-1



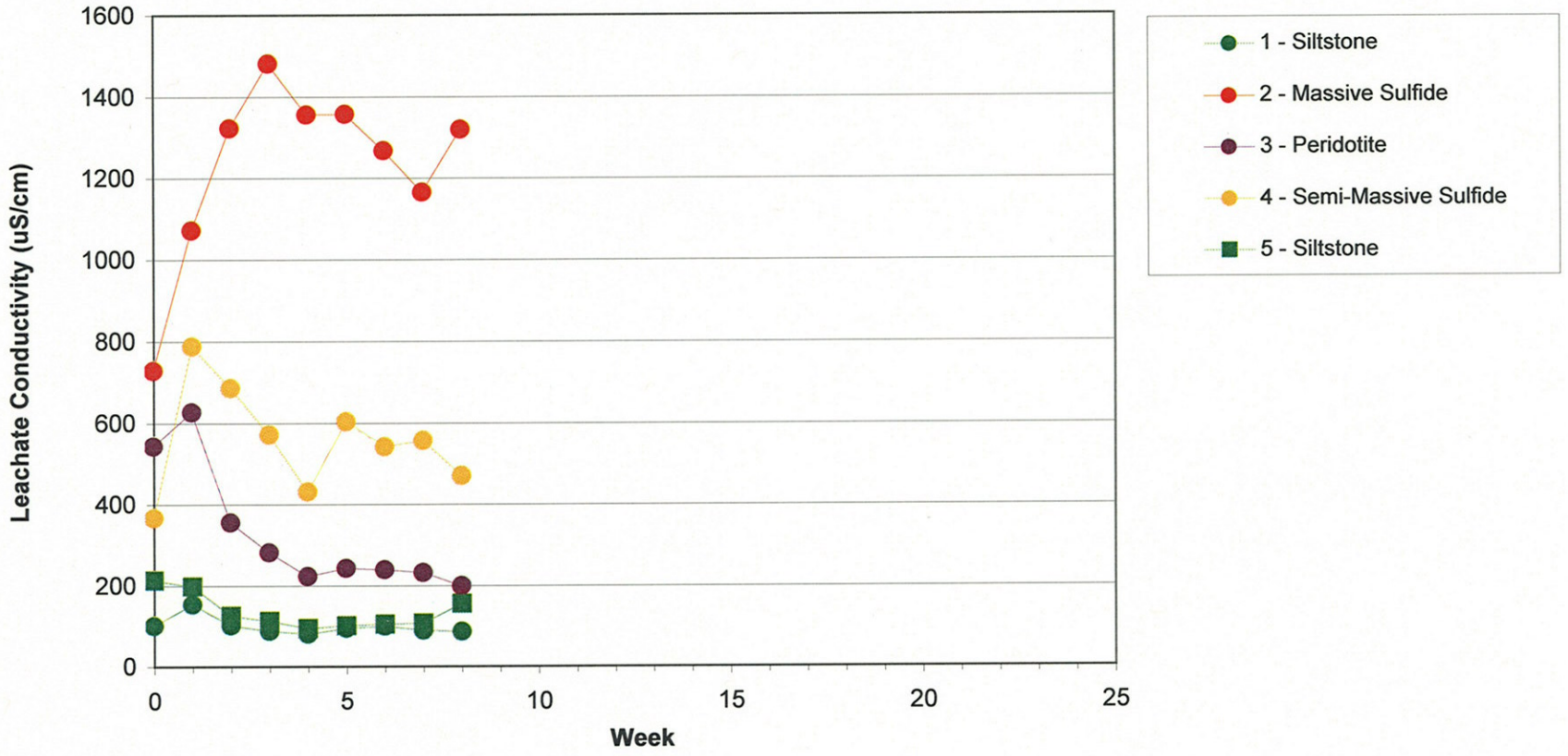




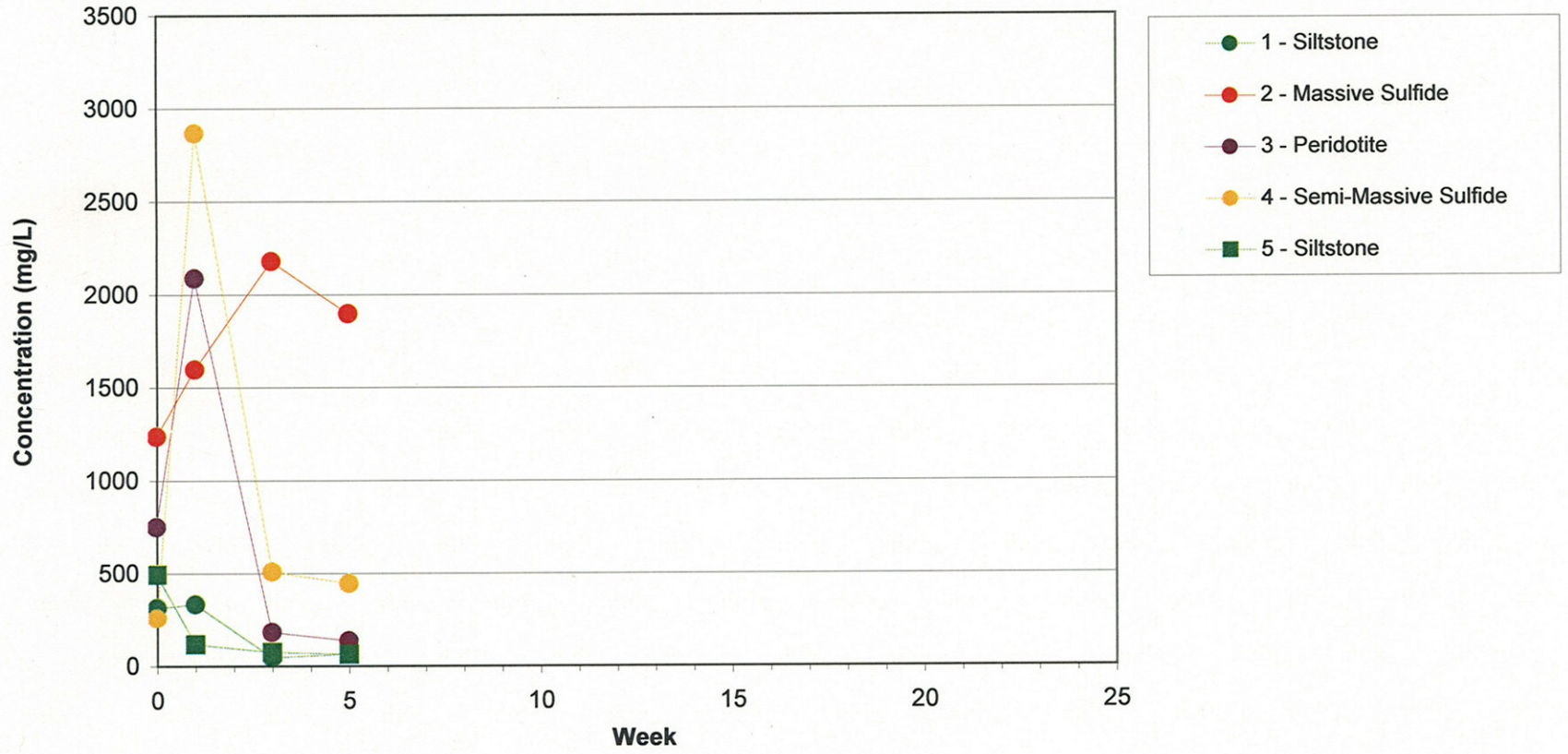
Eagle Mine
Phase I Kinetic Testing

TITLE: **Kinetic Testing Results - Alkalinity**

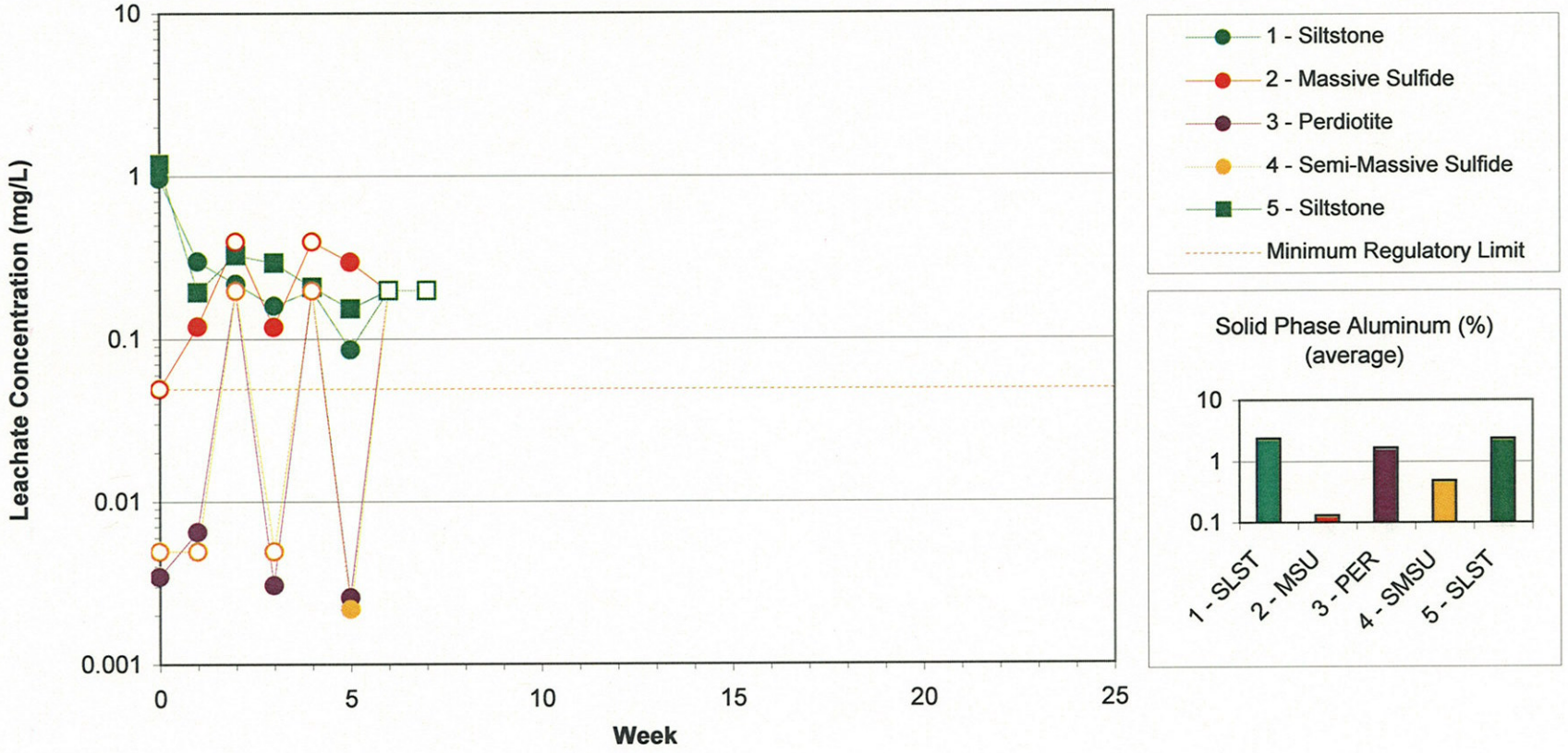
DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
CHECKED	RV	SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	A-2



Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Conductivity**		
	DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
	CHECKED	RV	SCALE	na	DWG. NO.	
	REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	A-3

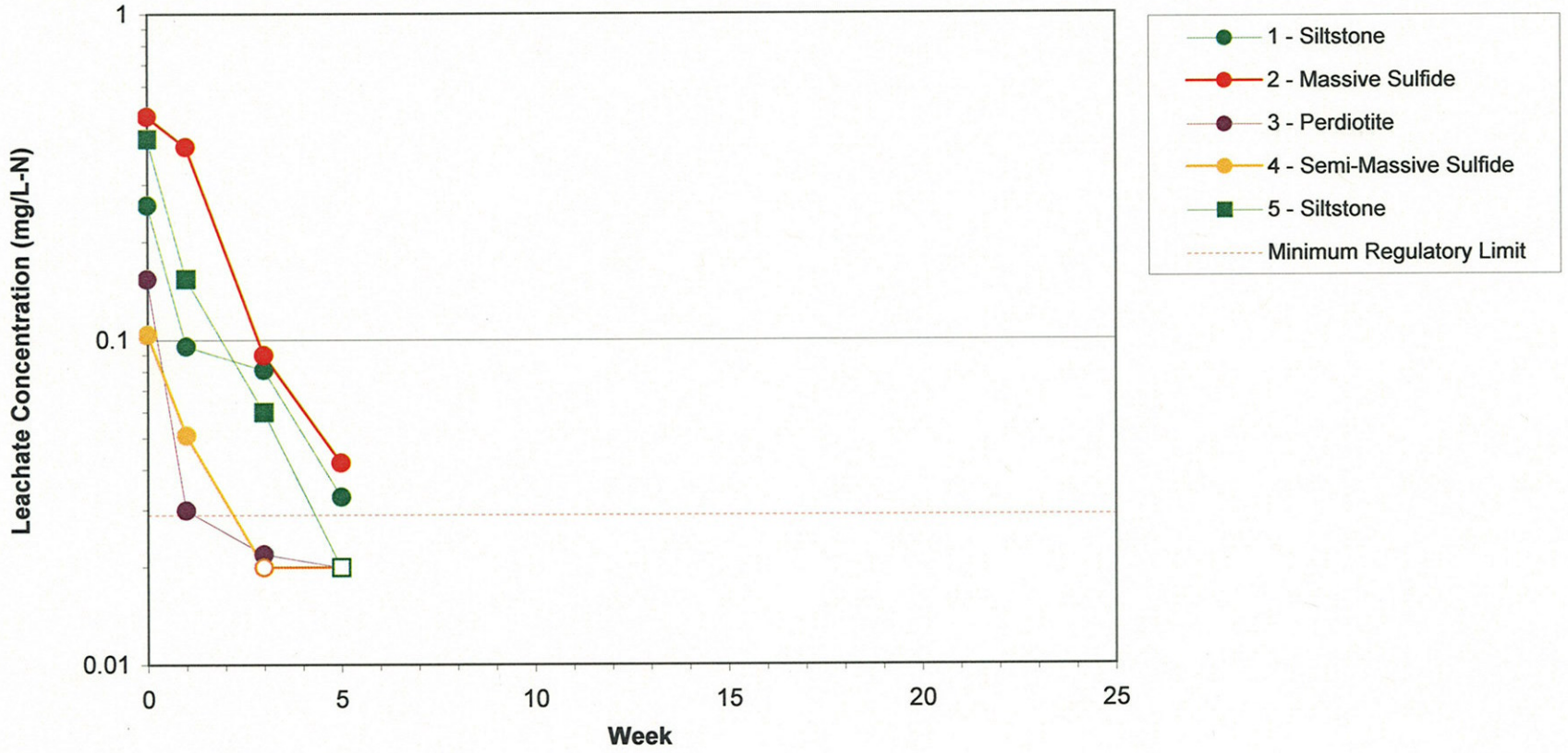


Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Total Dissolved Solids**		
	DRAWN	CR	DATE May 2004	JOB NO. 043-1055
	CHECKED	RV	SCALE na	DWG. NO.
	REVIEWED	ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. A-4



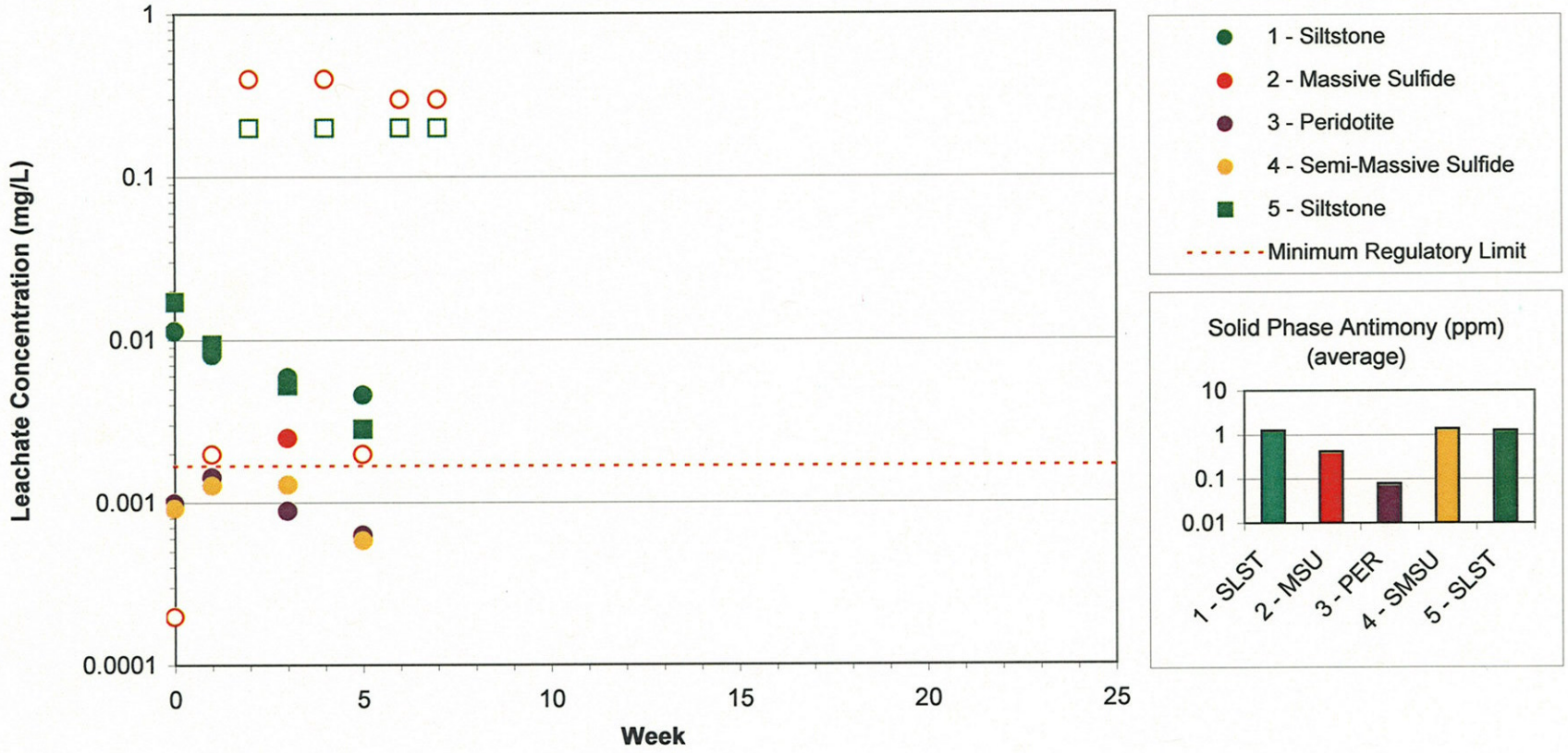
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Aluminum**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-5**	



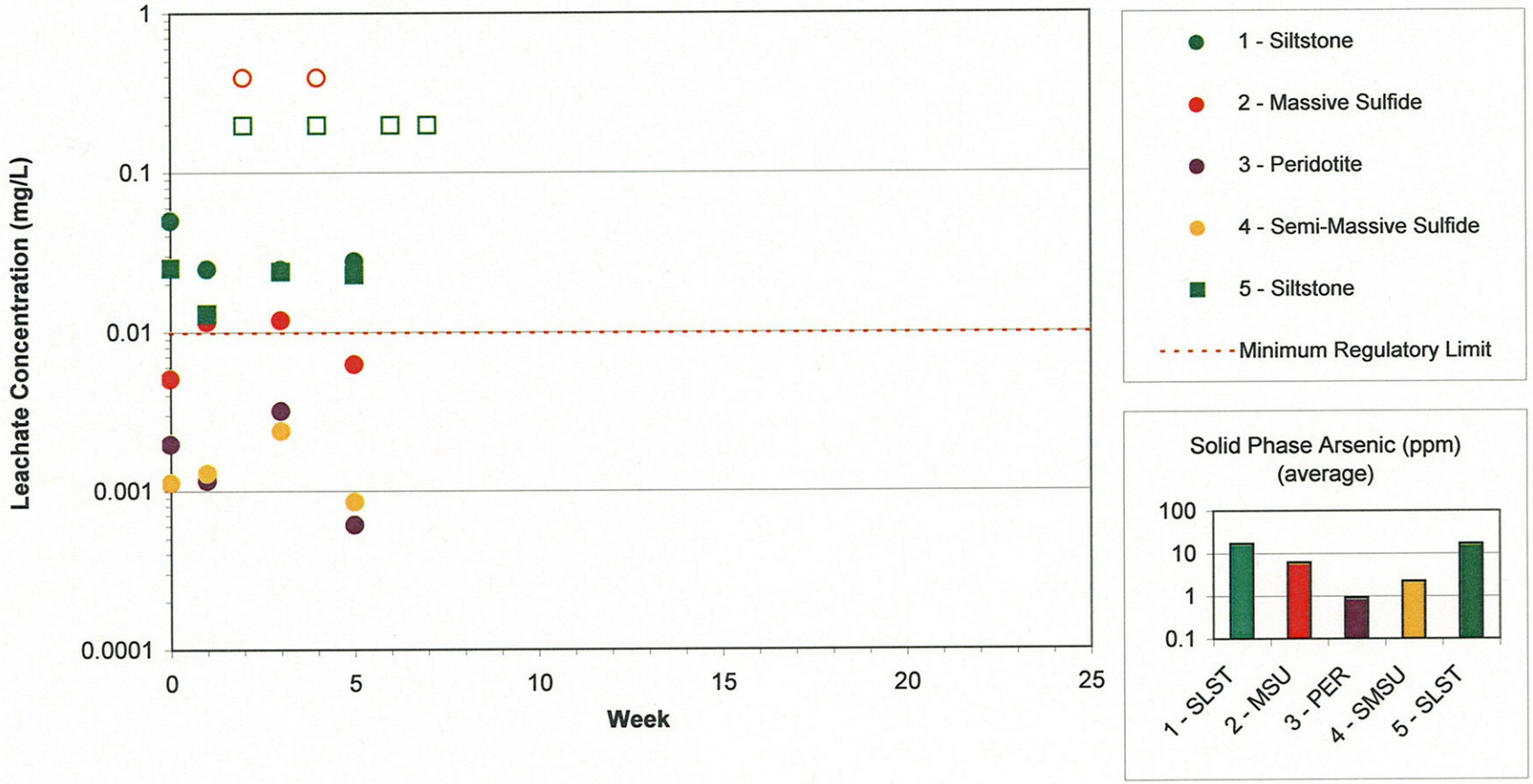
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Ammonia**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-6**	



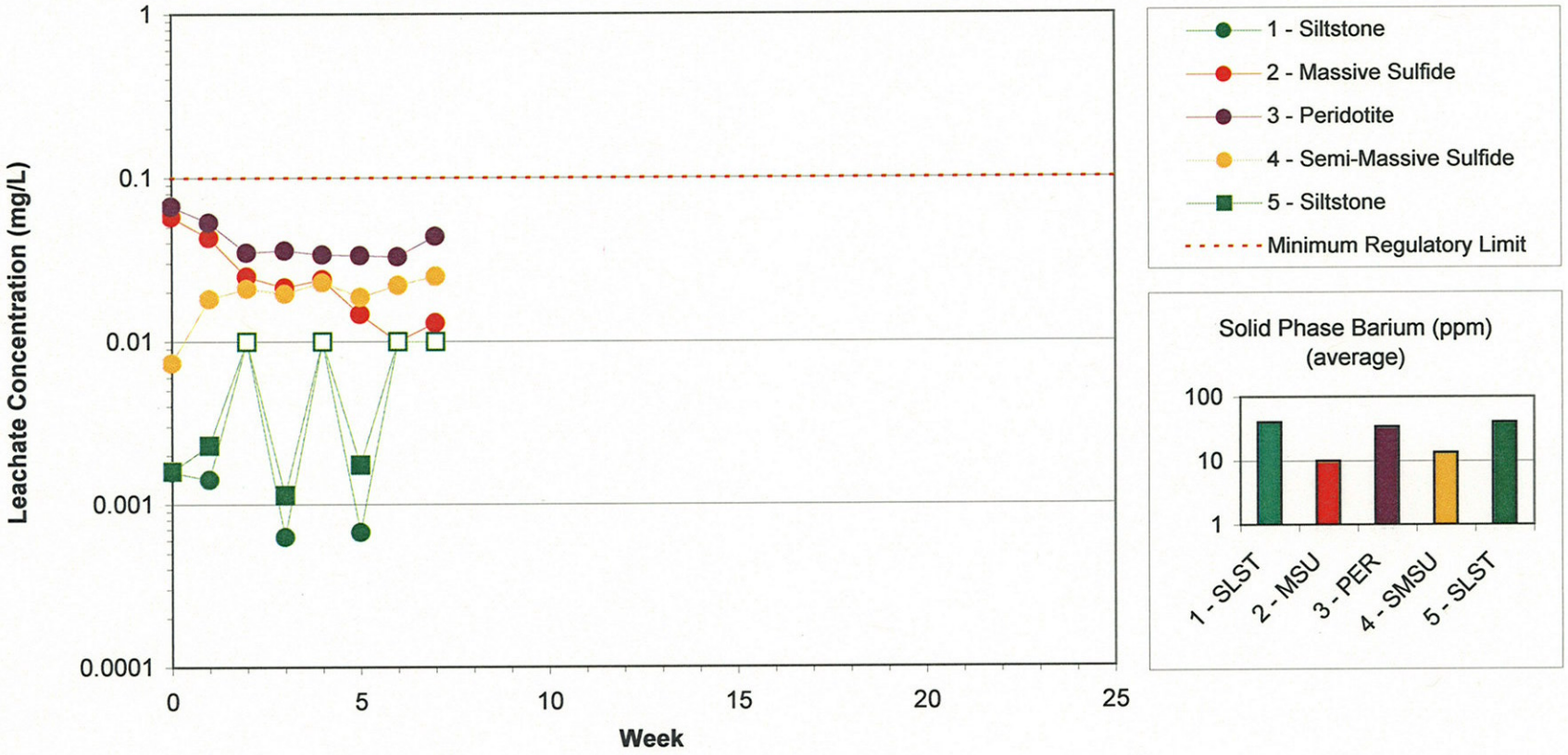
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Antimony**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. A-7	



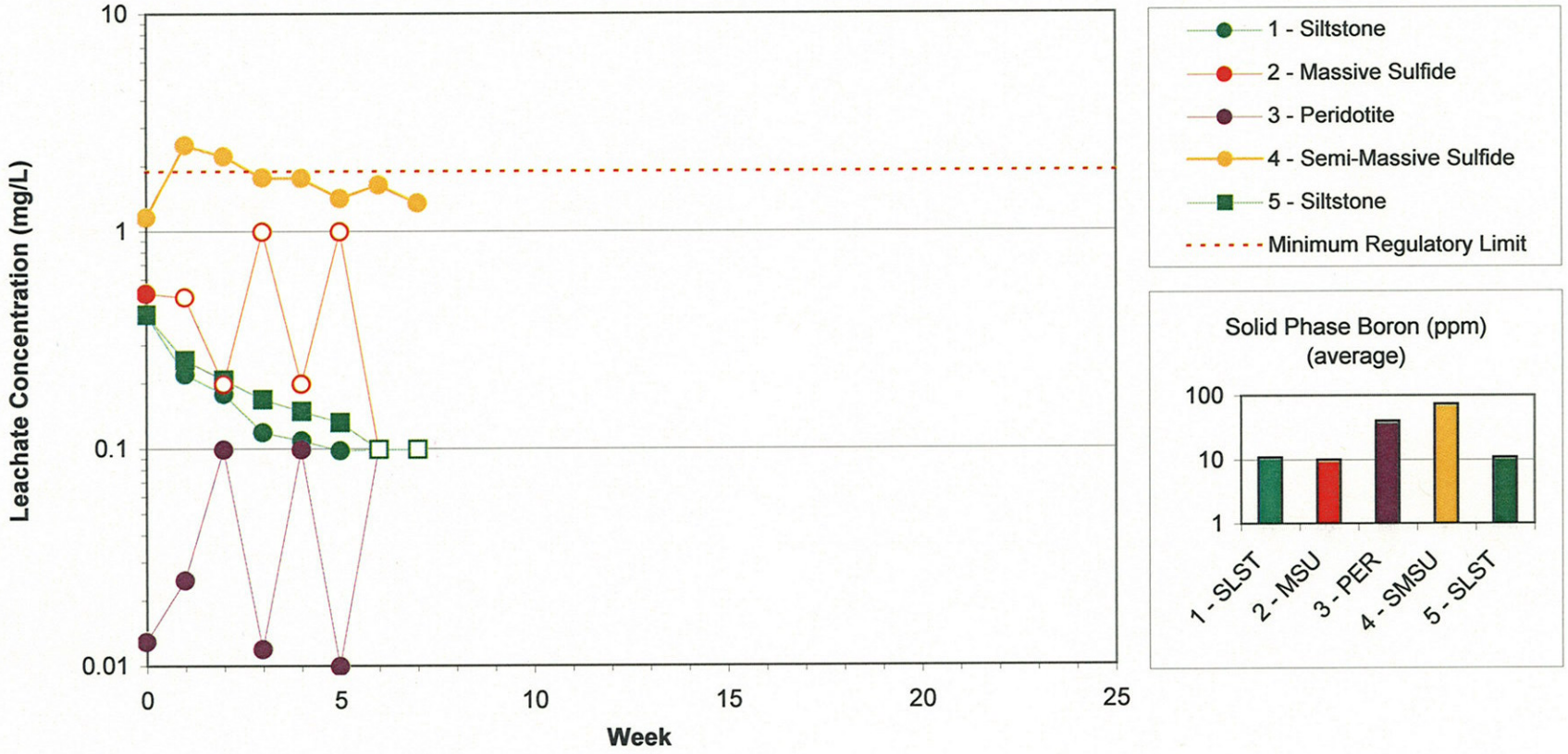
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Arsenic**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-8**	



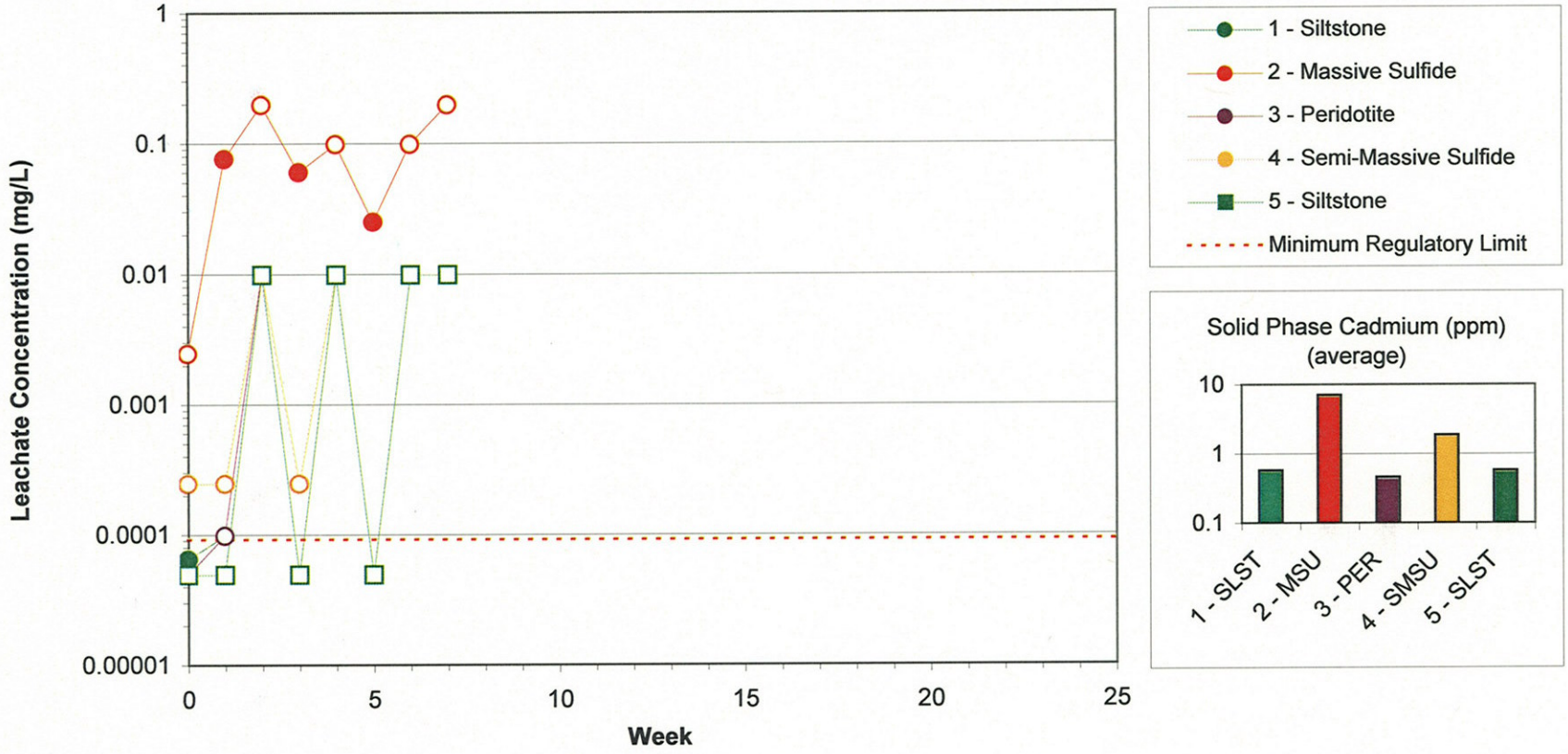
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Barium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. A-9	



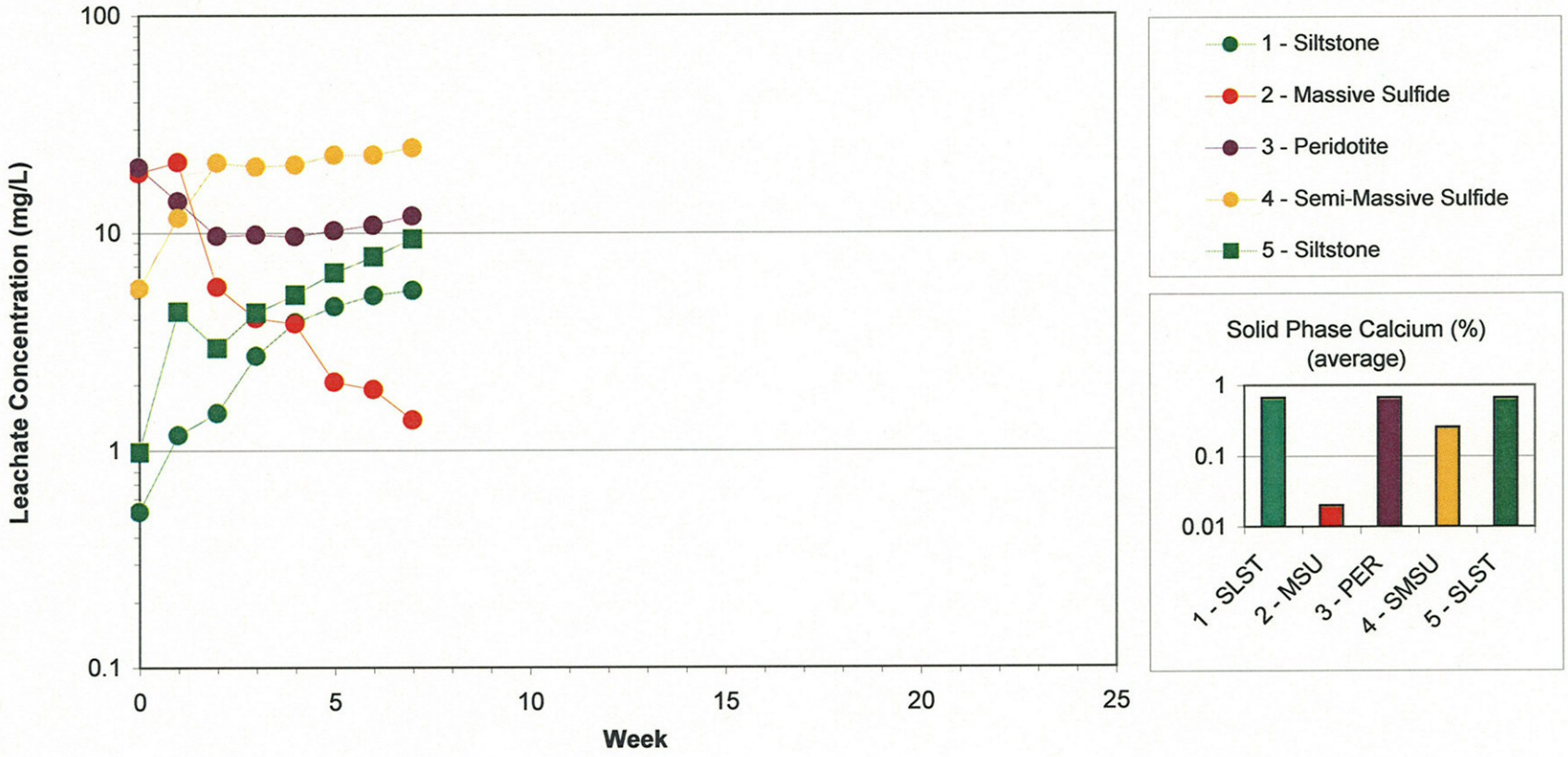
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Boron**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-10**	



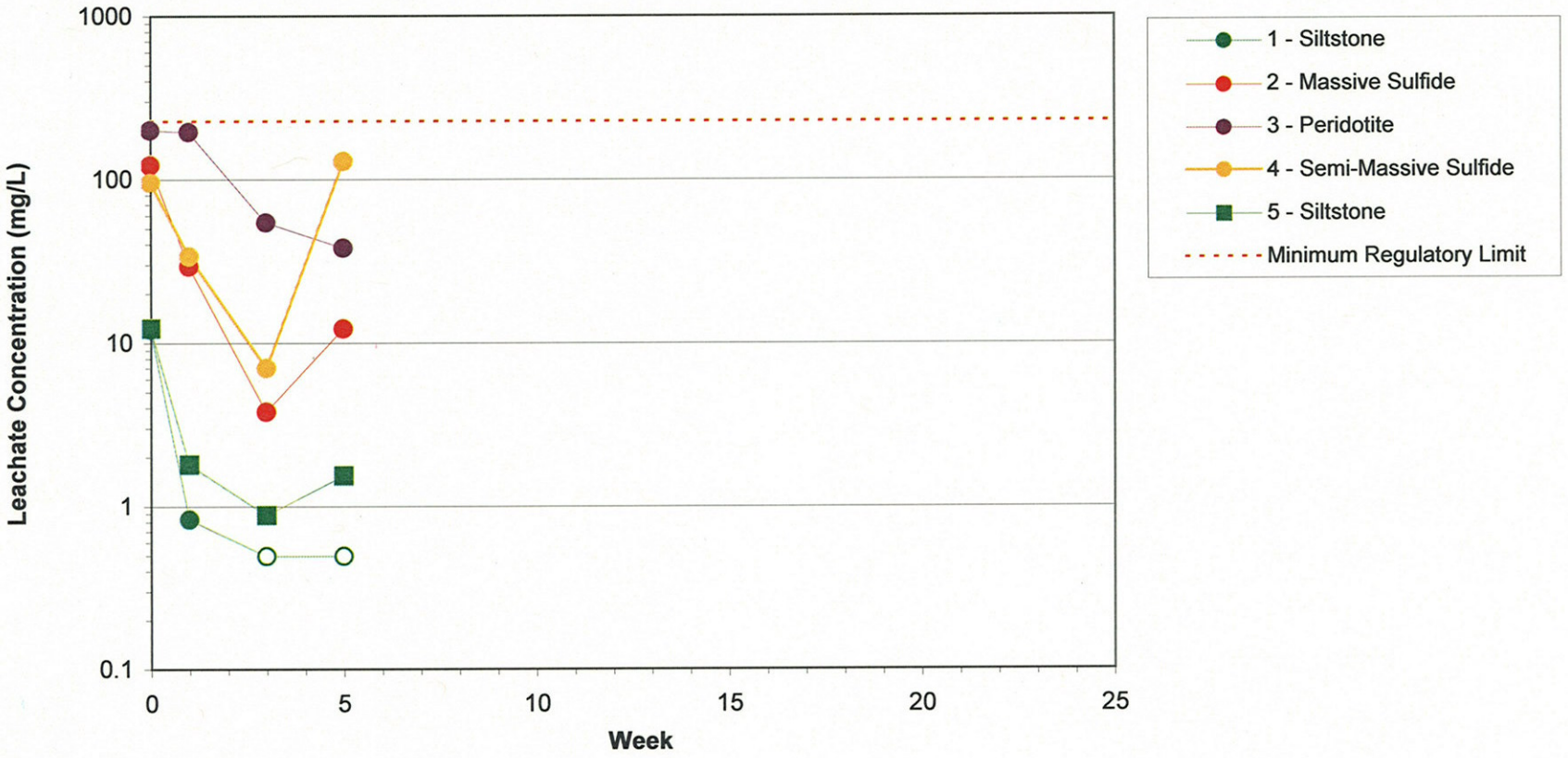
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Cadmium**		
	DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
	CHECKED	RV	SCALE	na	DWG. NO.	
	REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	A-11



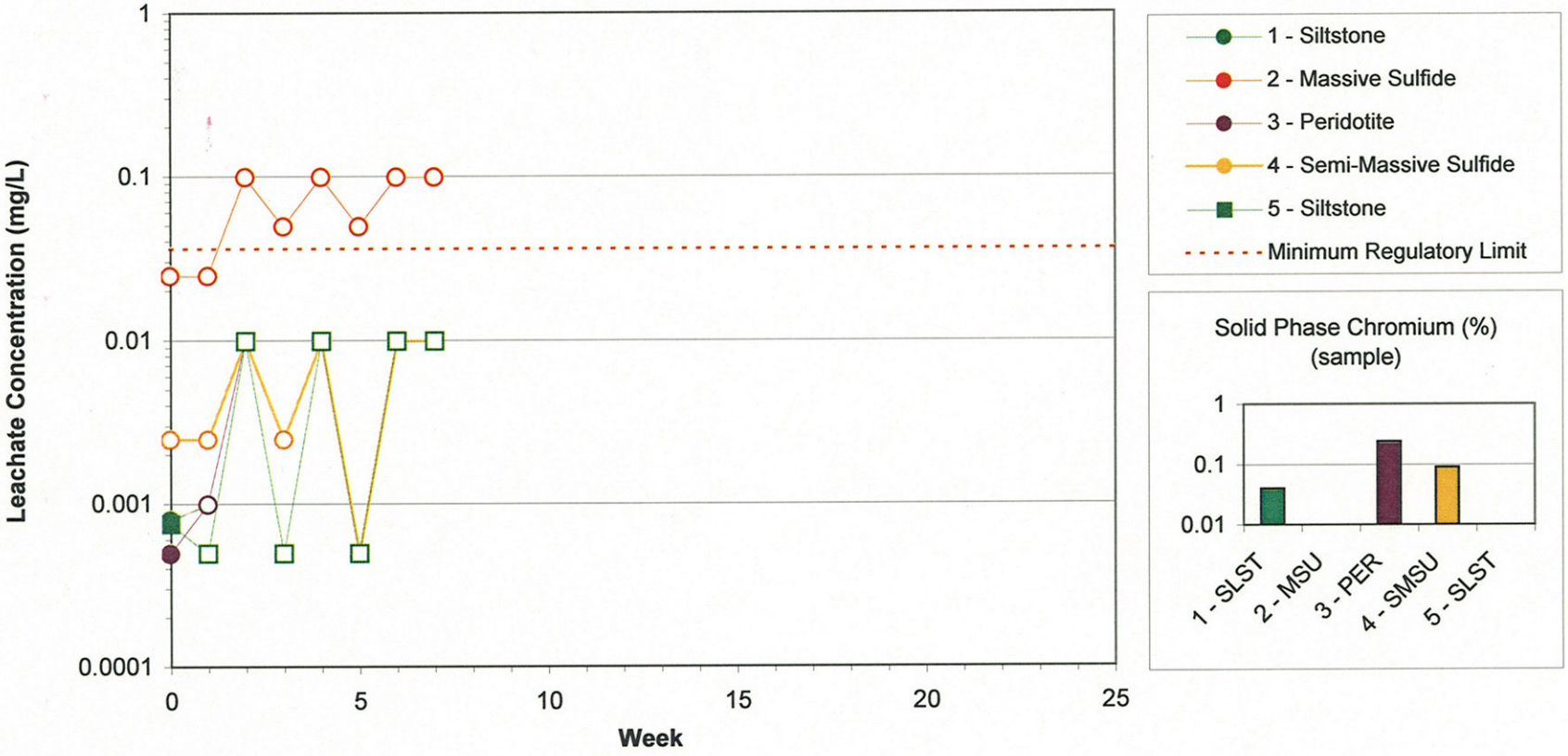
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Calcium**		
	DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
	CHECKED	RV	SCALE	na	DWG. NO.	
	REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	A-12



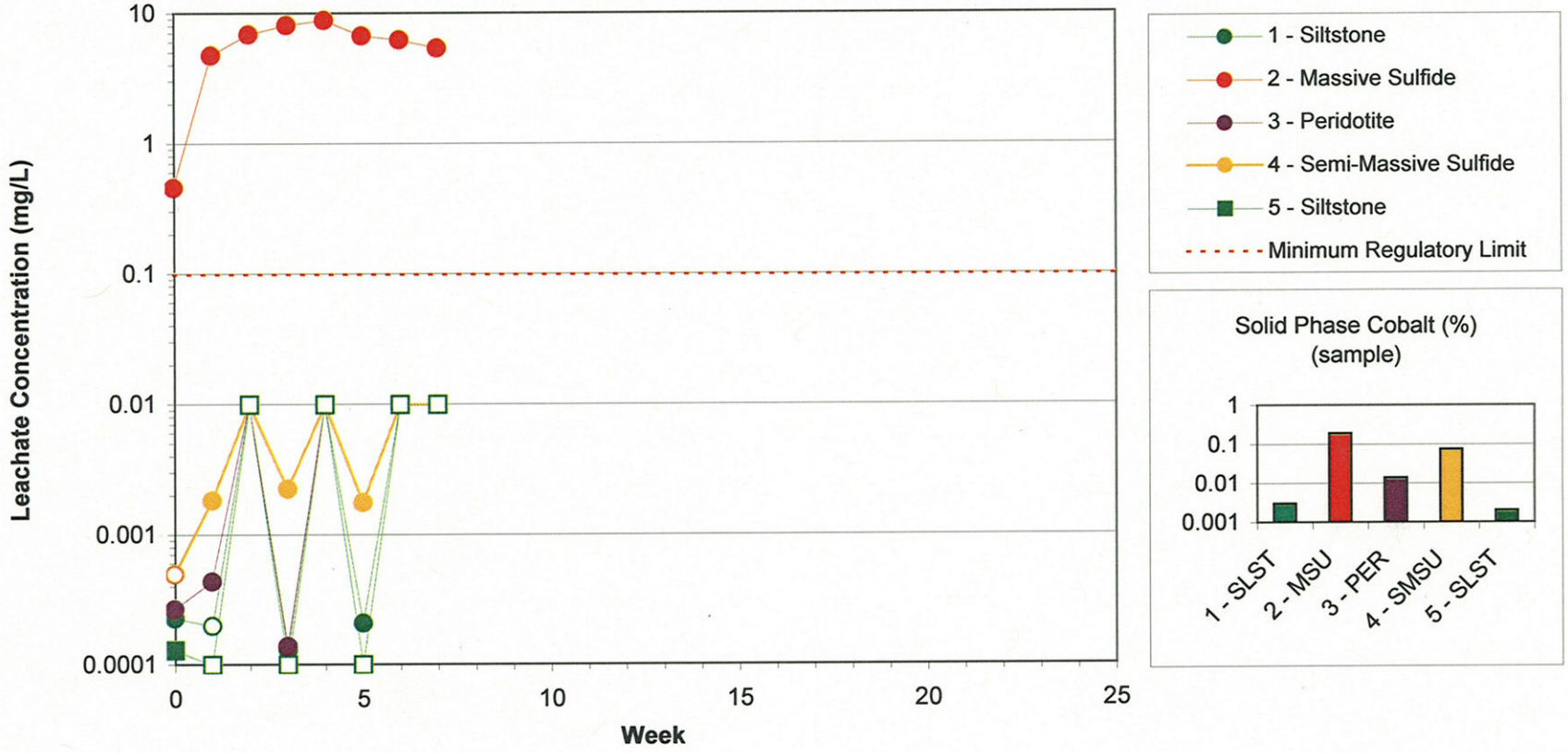
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Chloride**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-13**	



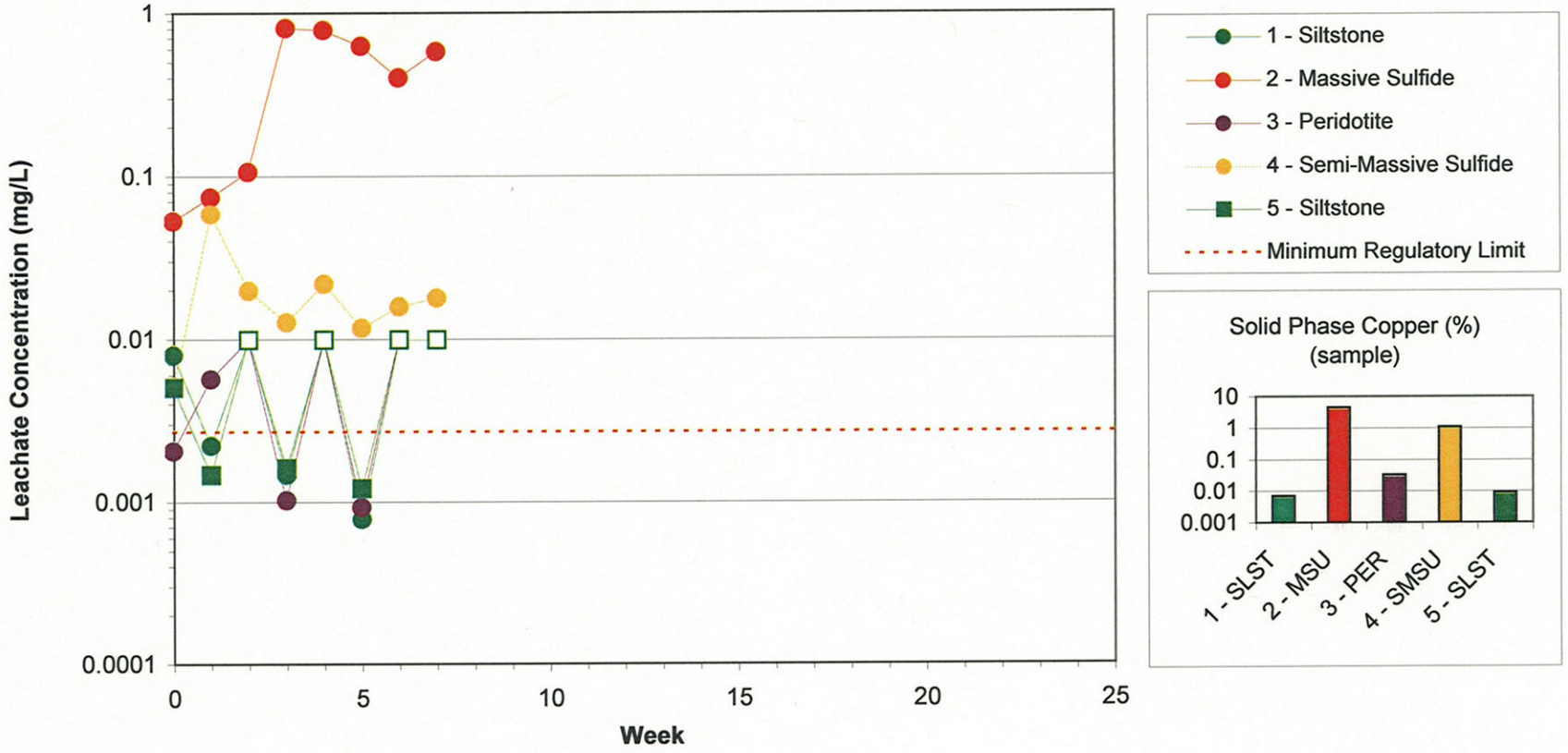
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Chromium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-14**	



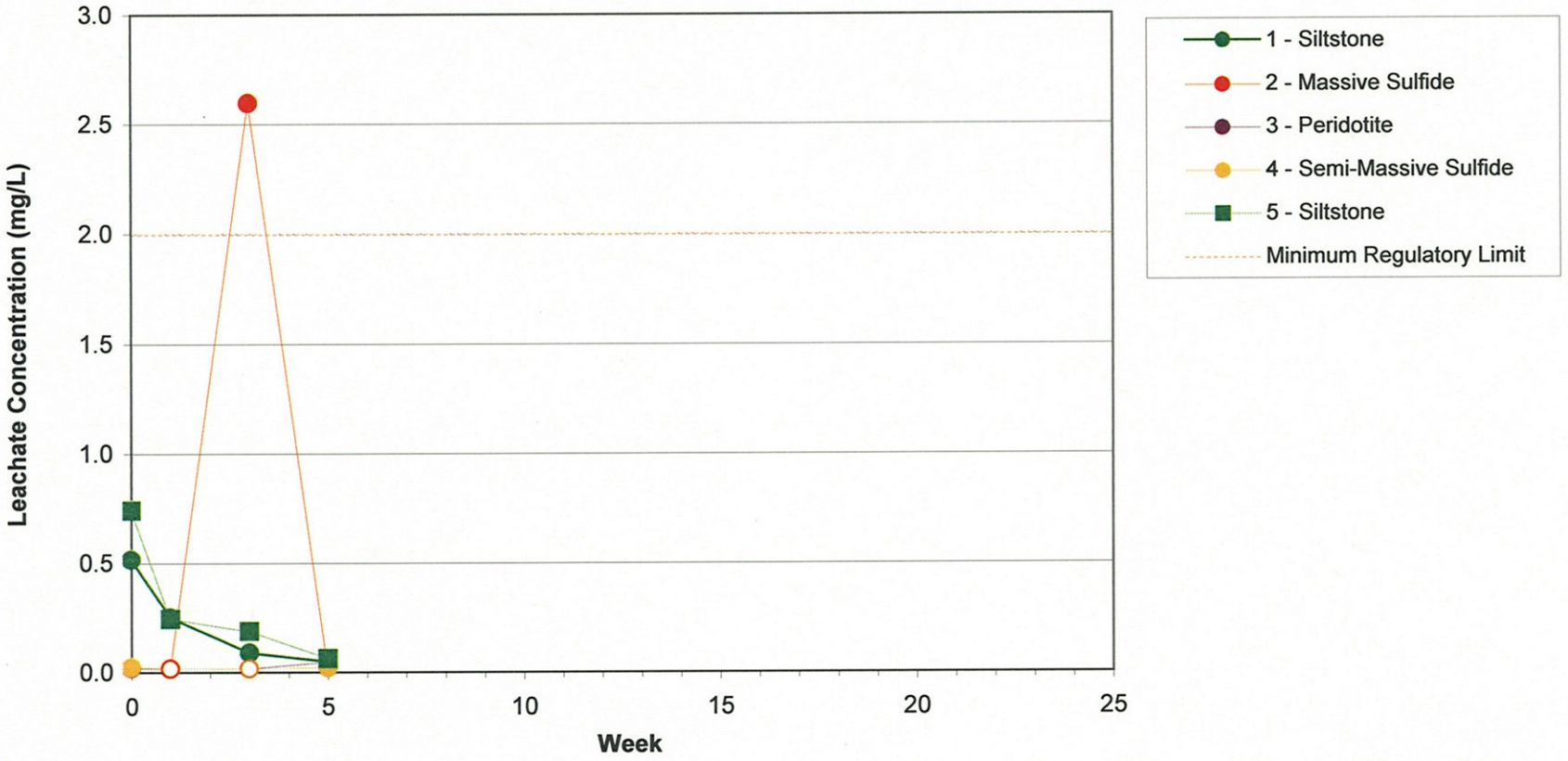
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Cobalt**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. A-15	



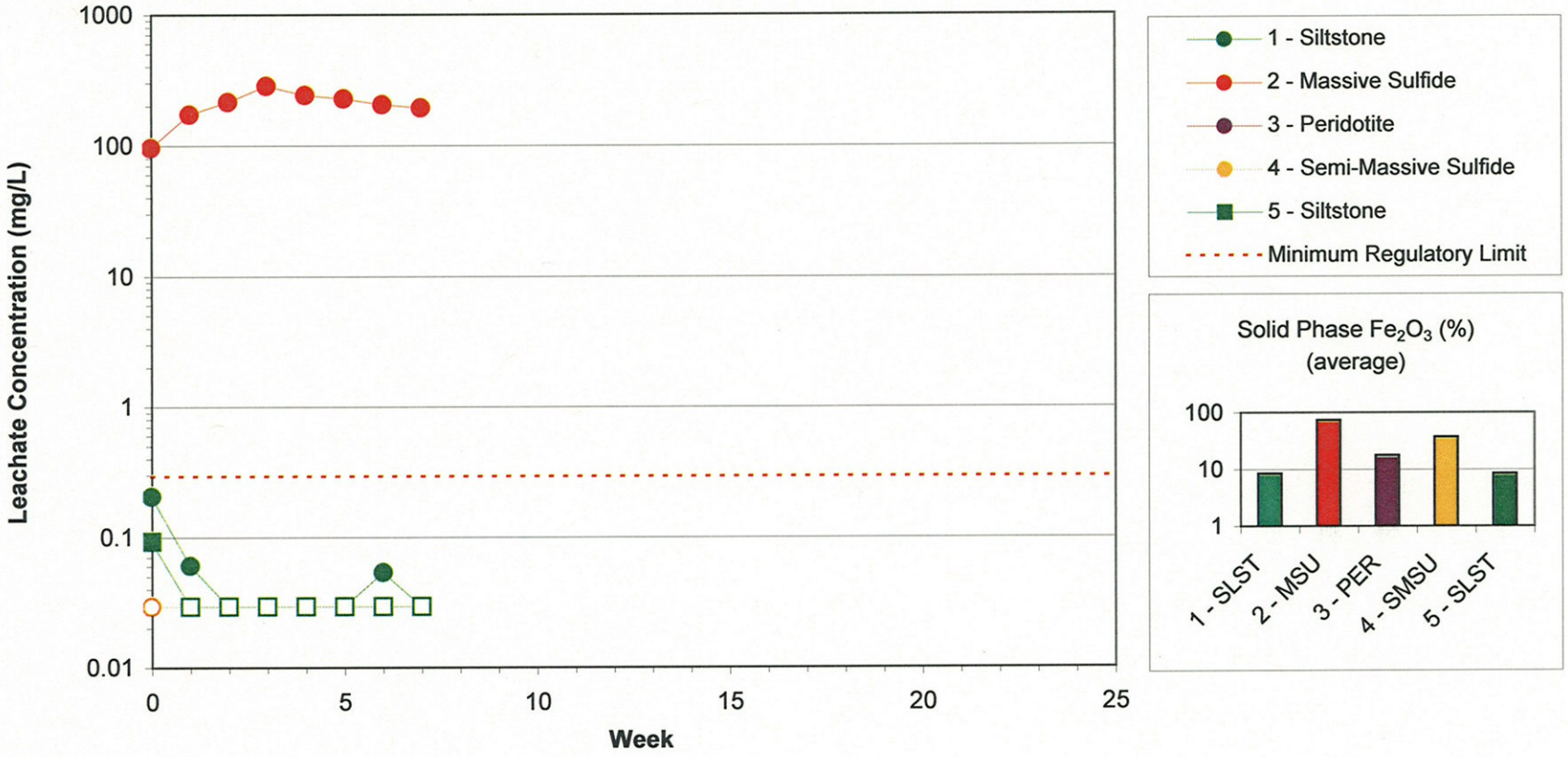
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Copper**		
	DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
	CHECKED	RV	SCALE	na	DWG. NO.	
	REVIEWED	ML	FILE NO.	Phase I - Kinetic Testing Cells.xls	FIGURE NO.	**A-16**



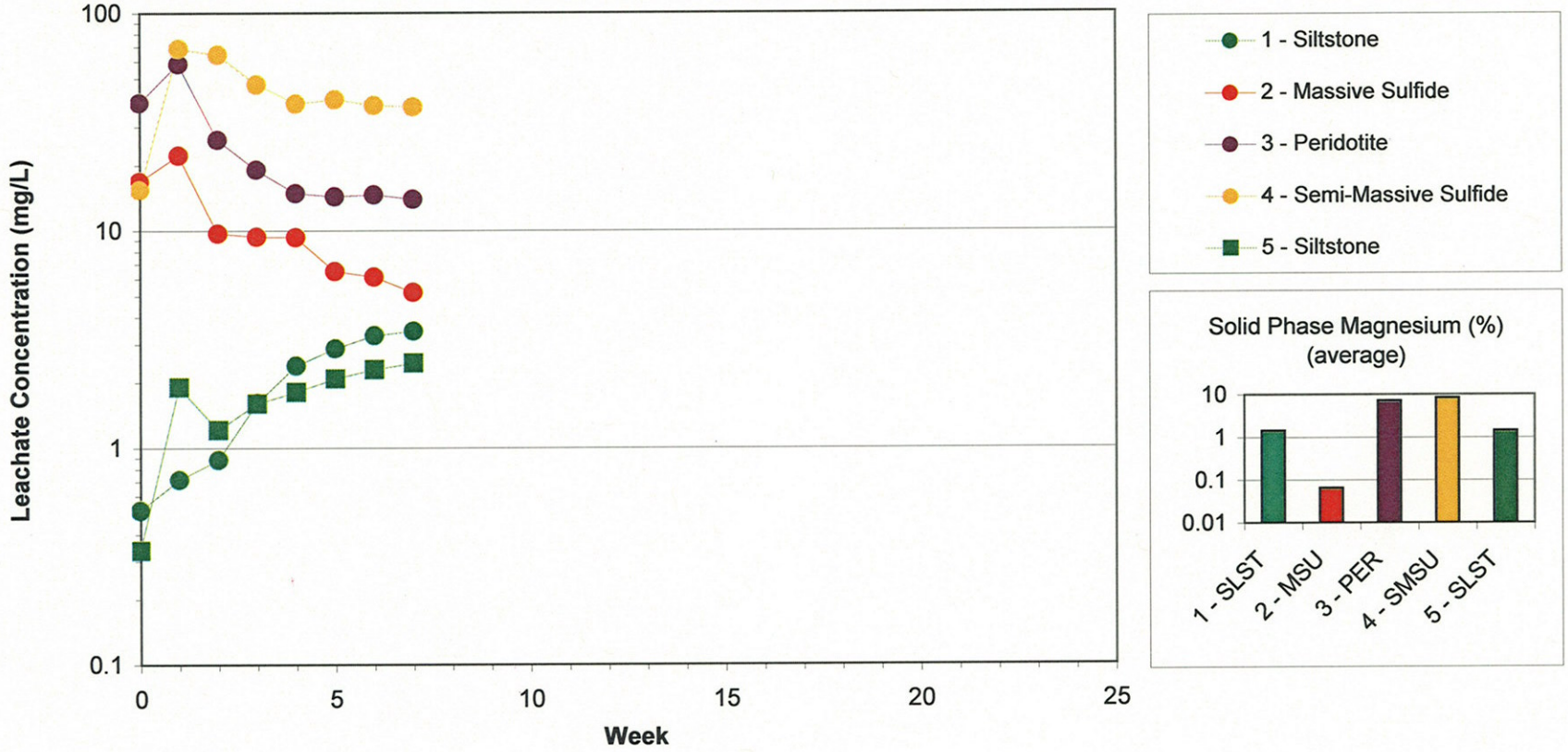
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Fluoride**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-17**	



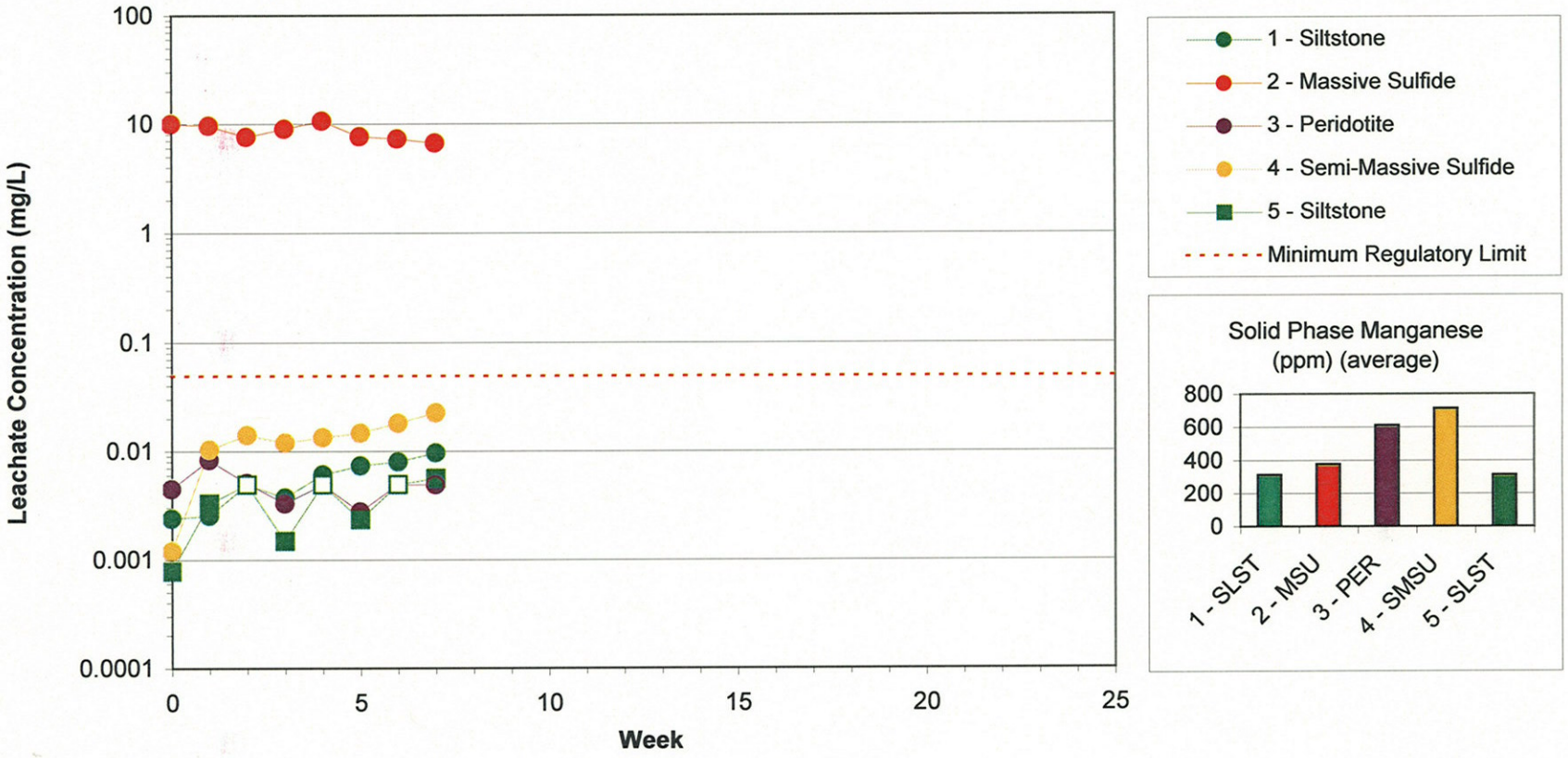
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Iron**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-18**	



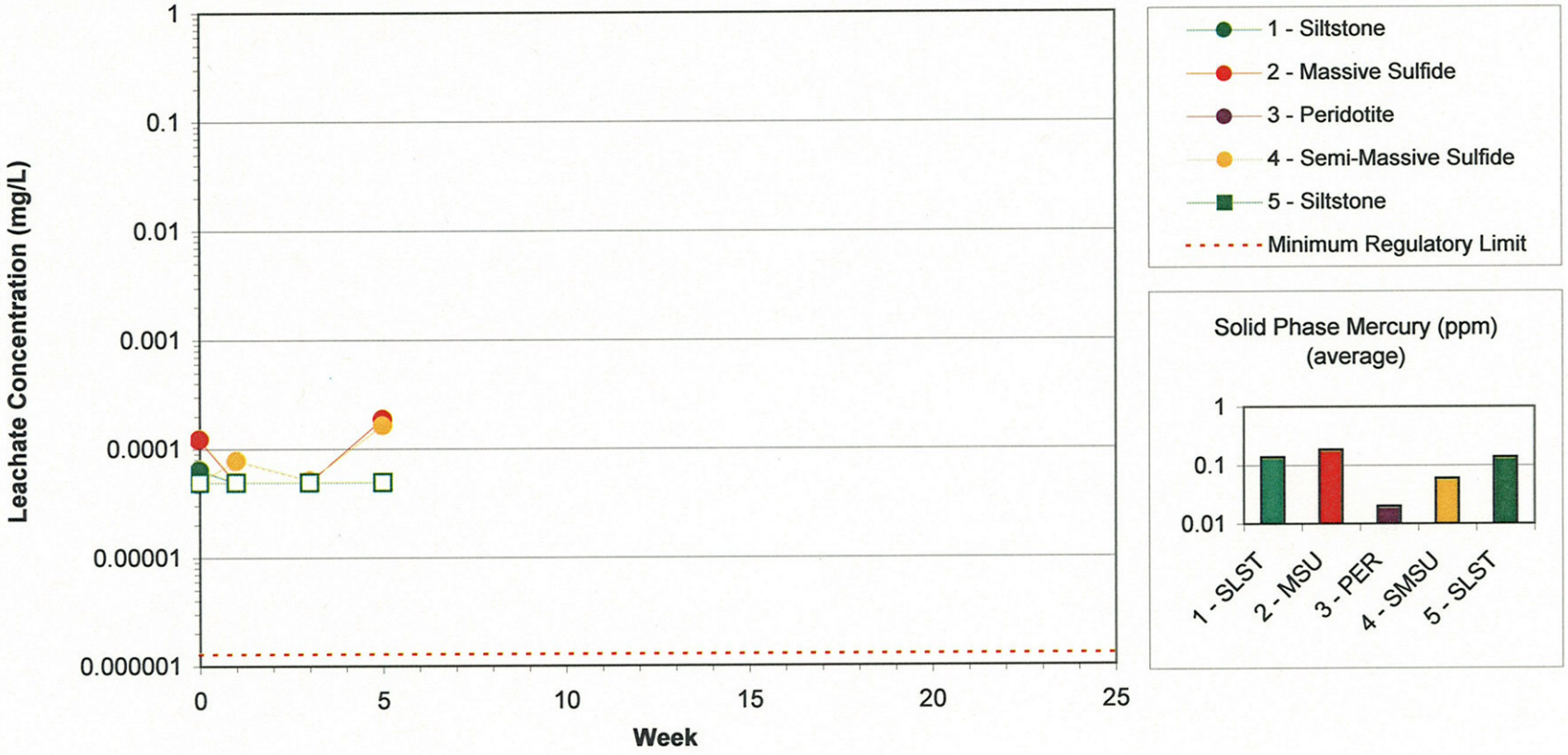
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Magnesium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-19**	



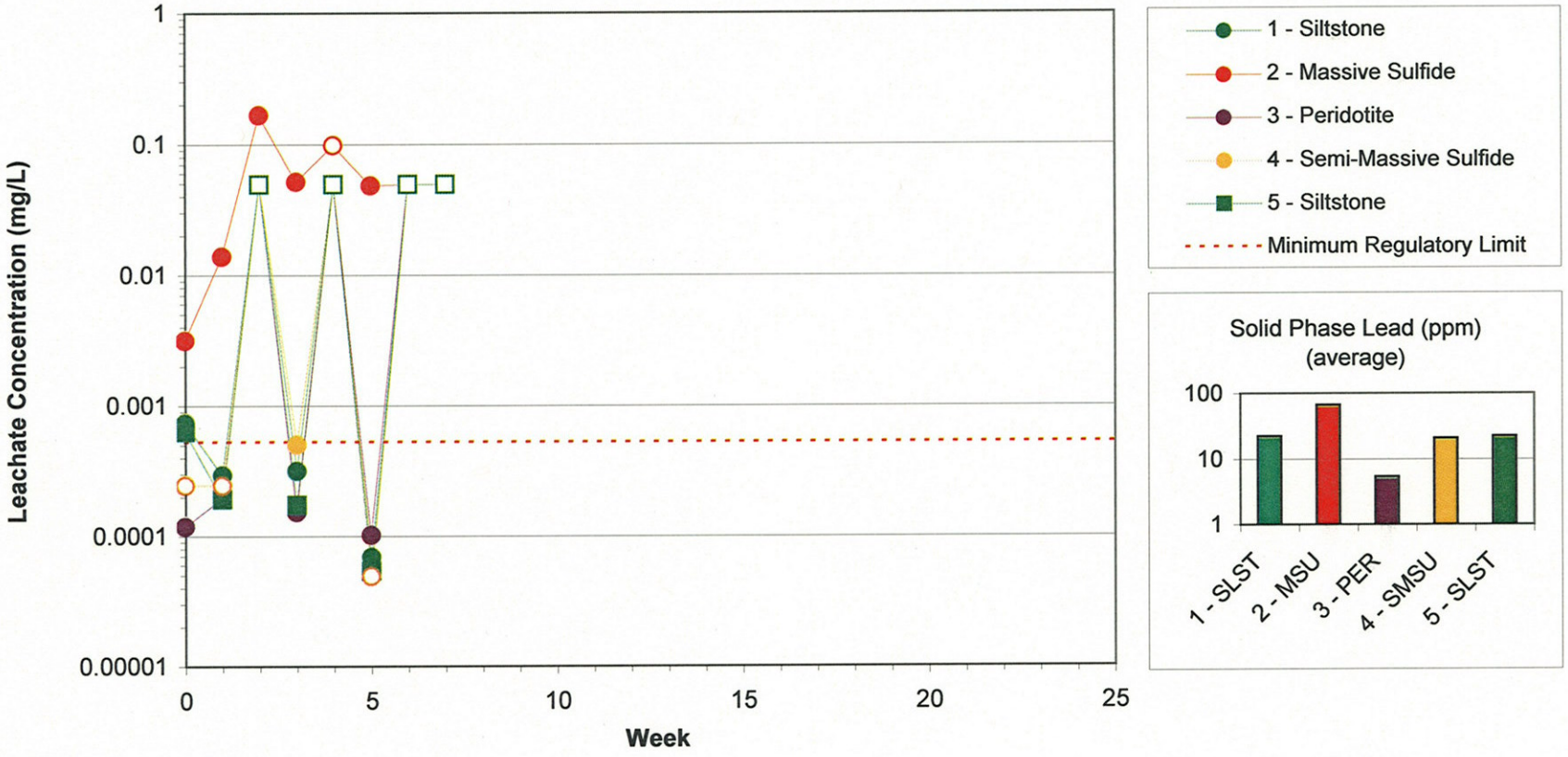
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Manganese**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-20**	



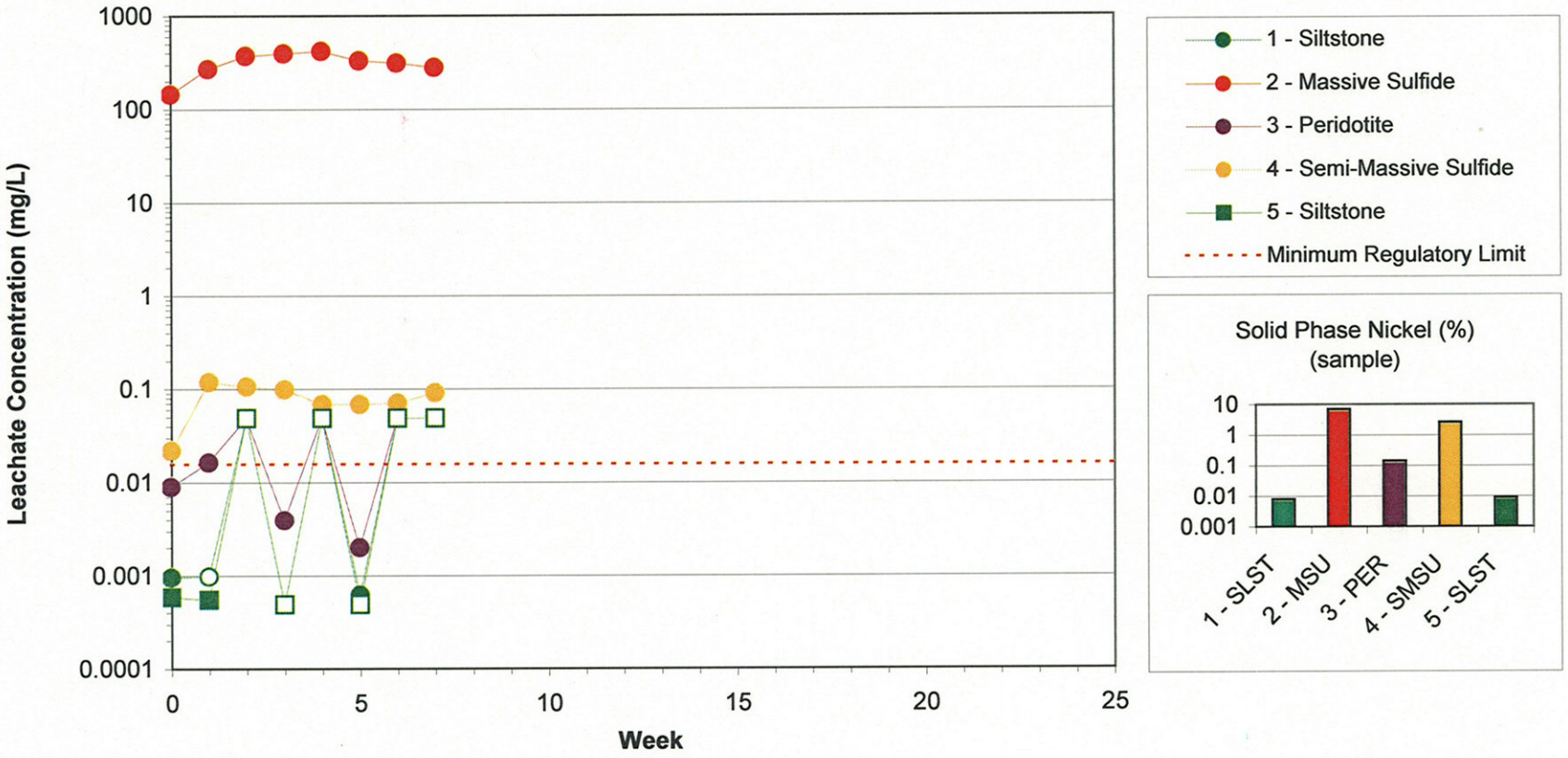
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Mercury**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-21**	



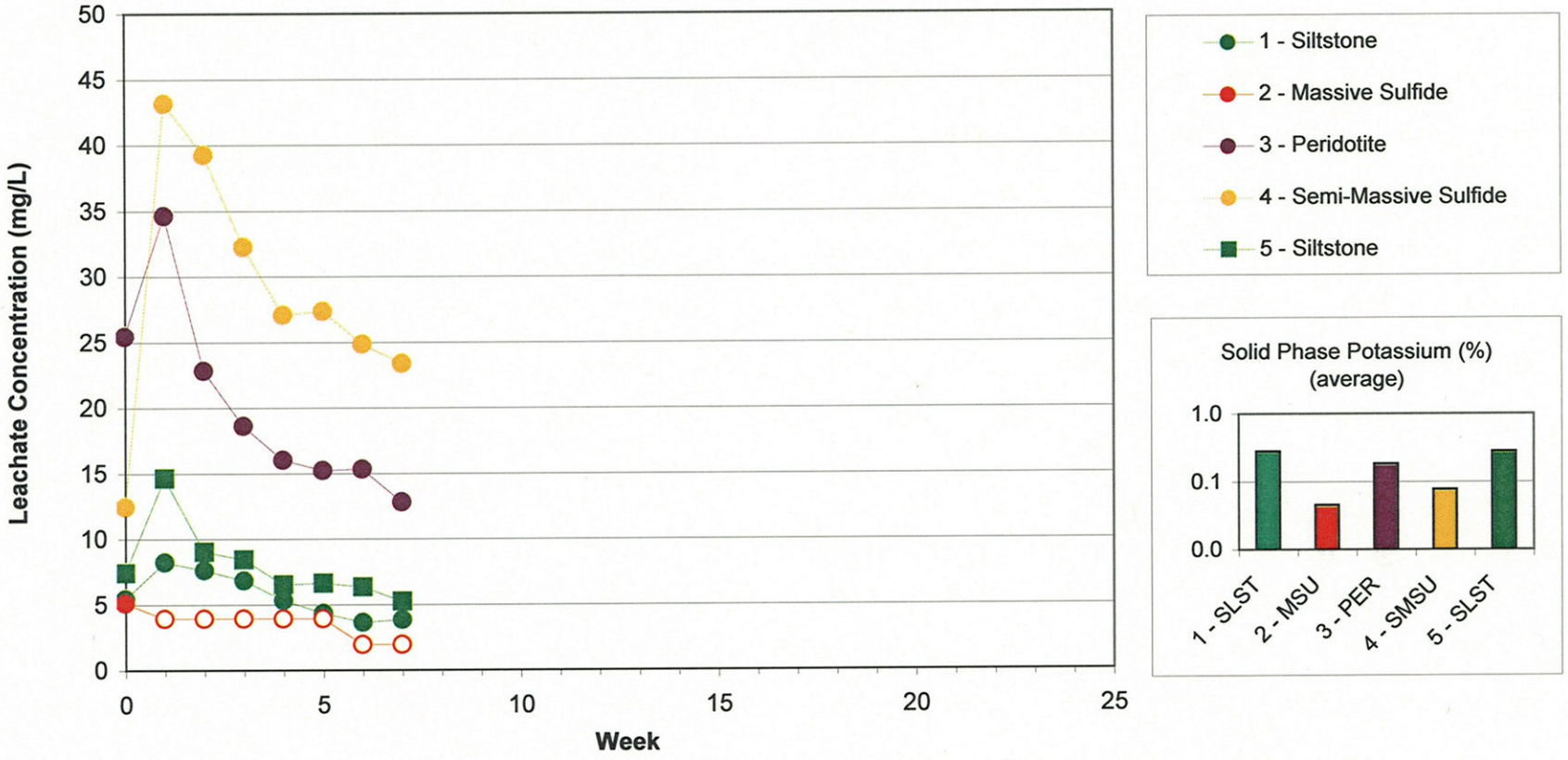
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Lead**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-22**	



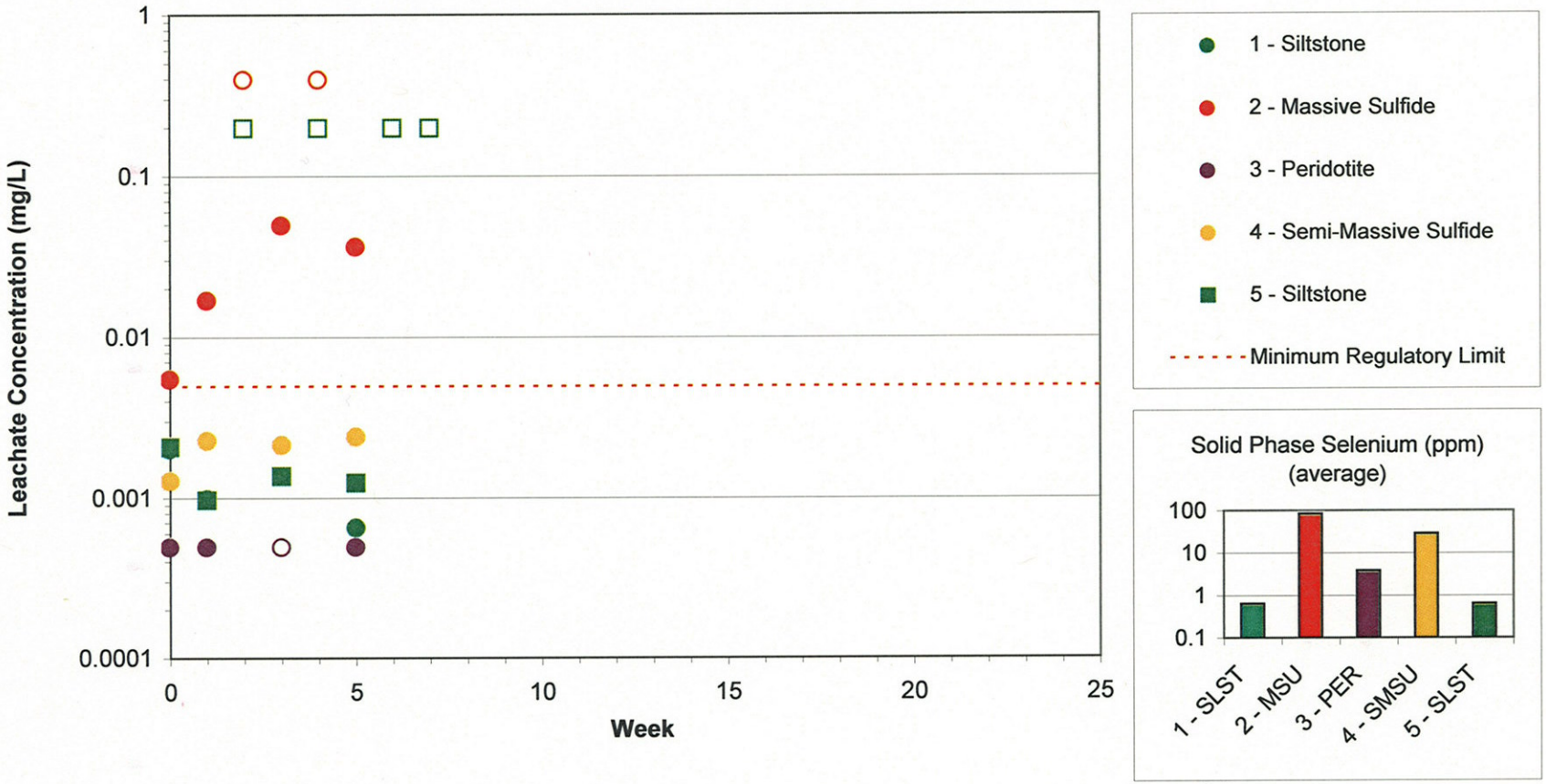
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Nickel**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-23**	



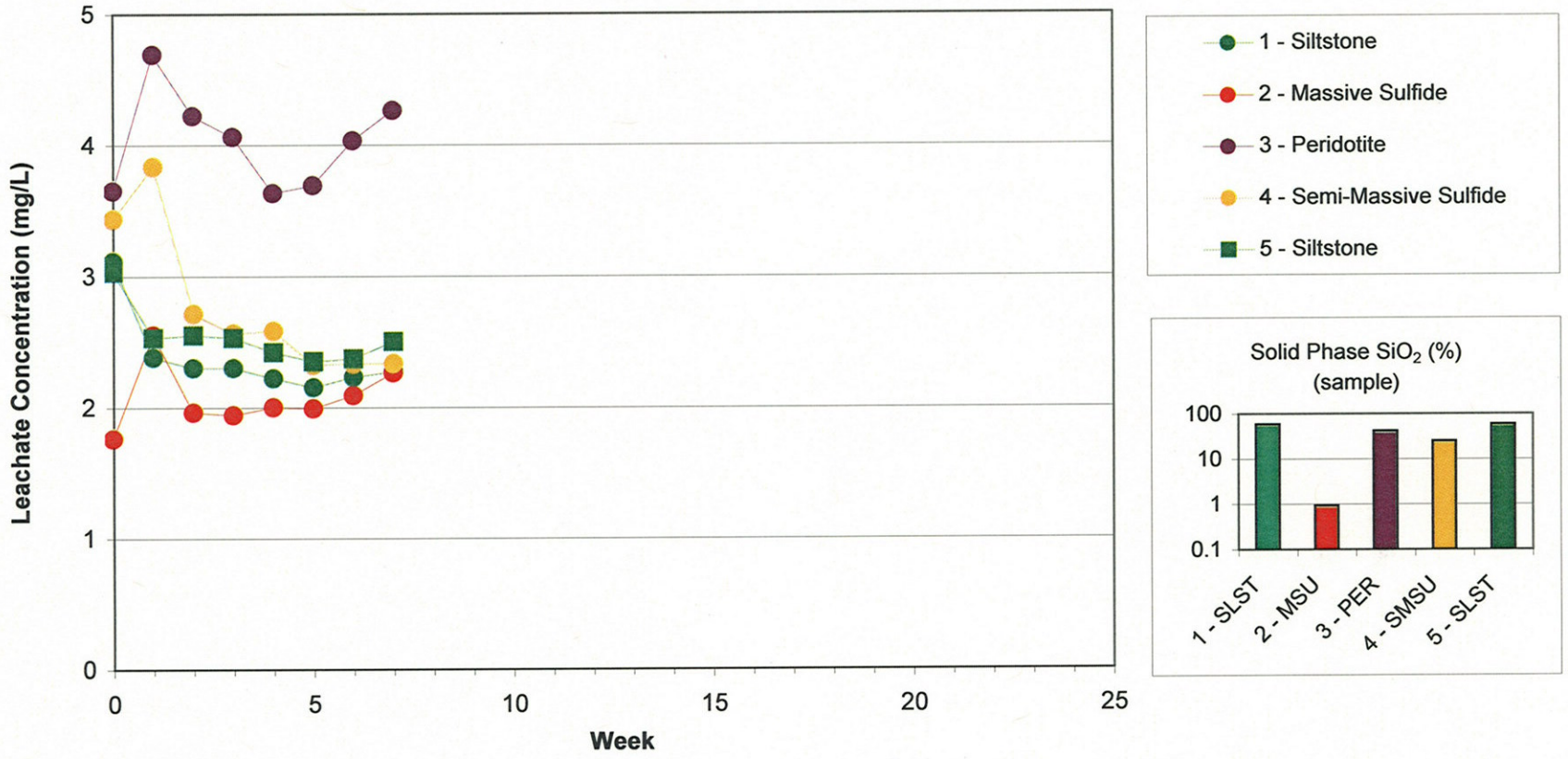
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Potassium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-24**	



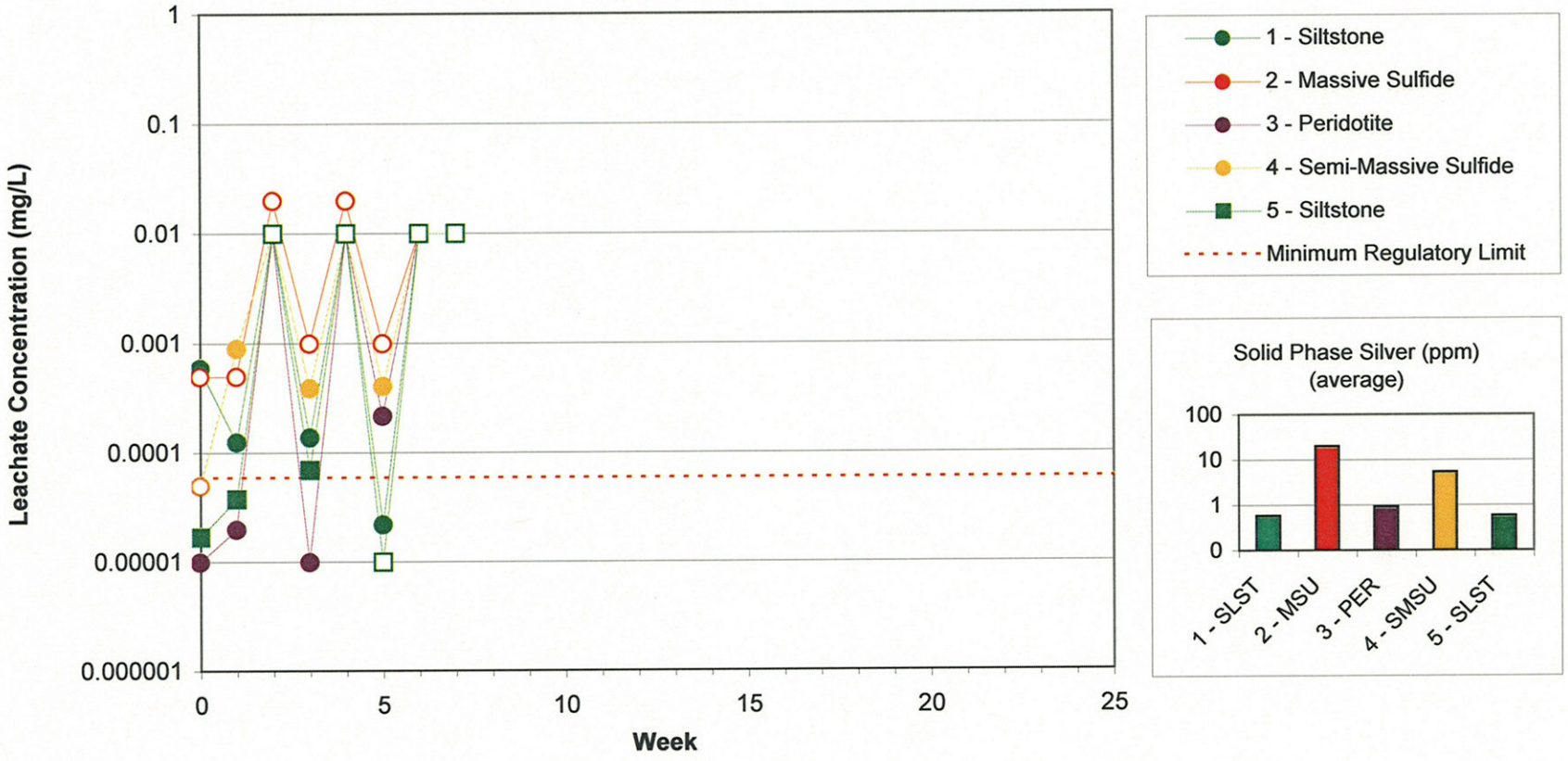
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Selenium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-25**	



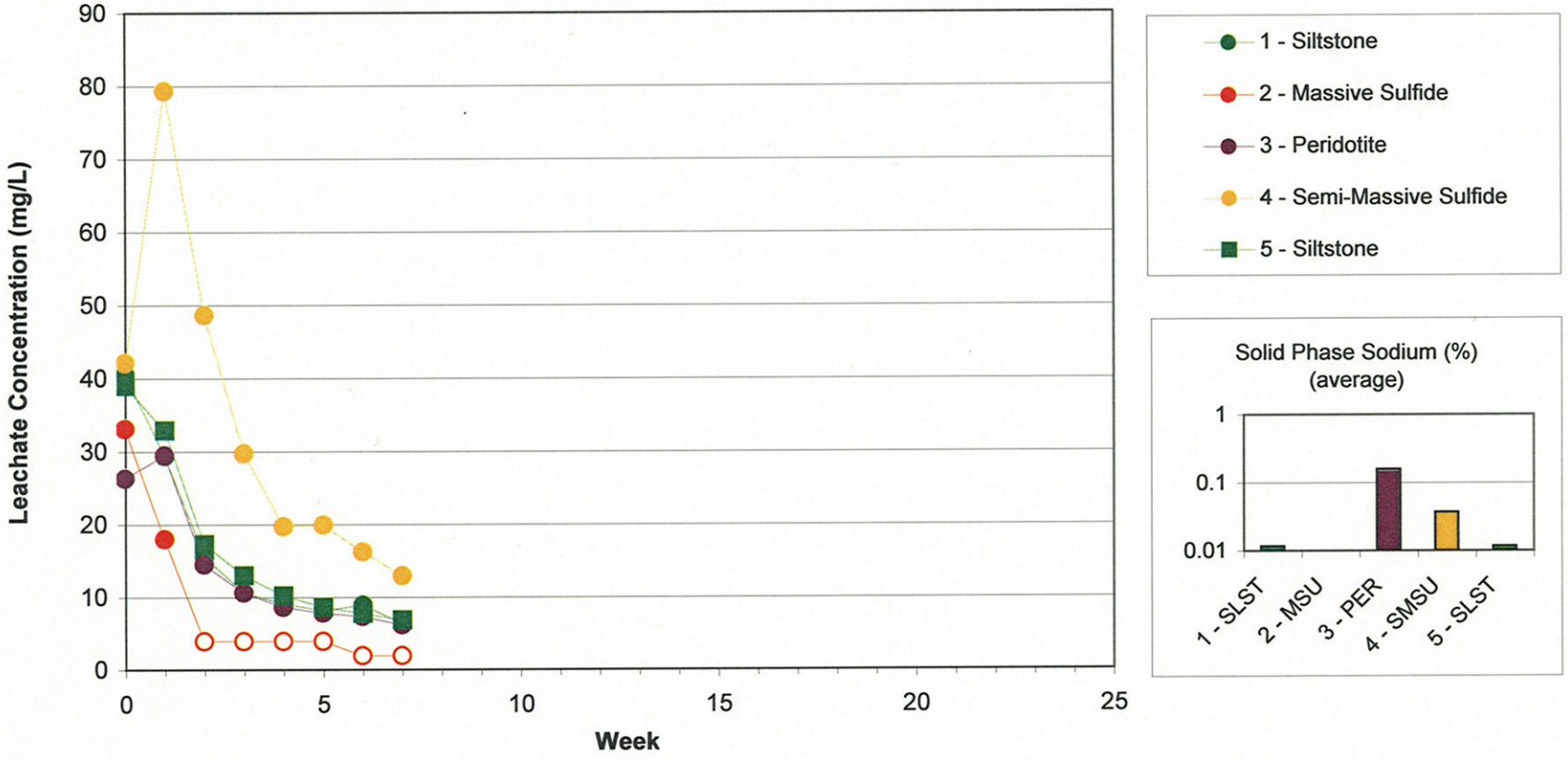
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Silicon**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-26**	



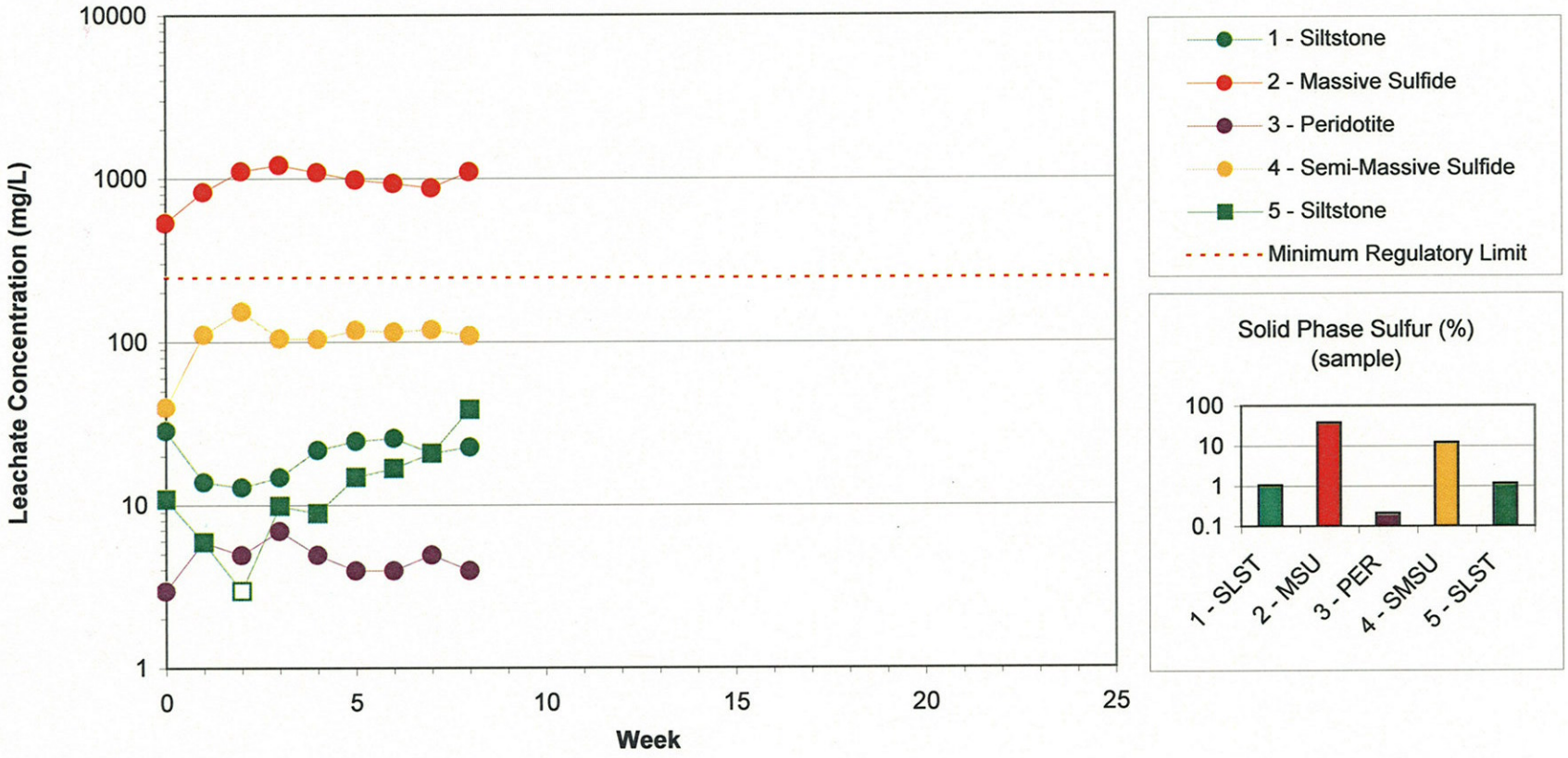
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Silver**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. A-27	



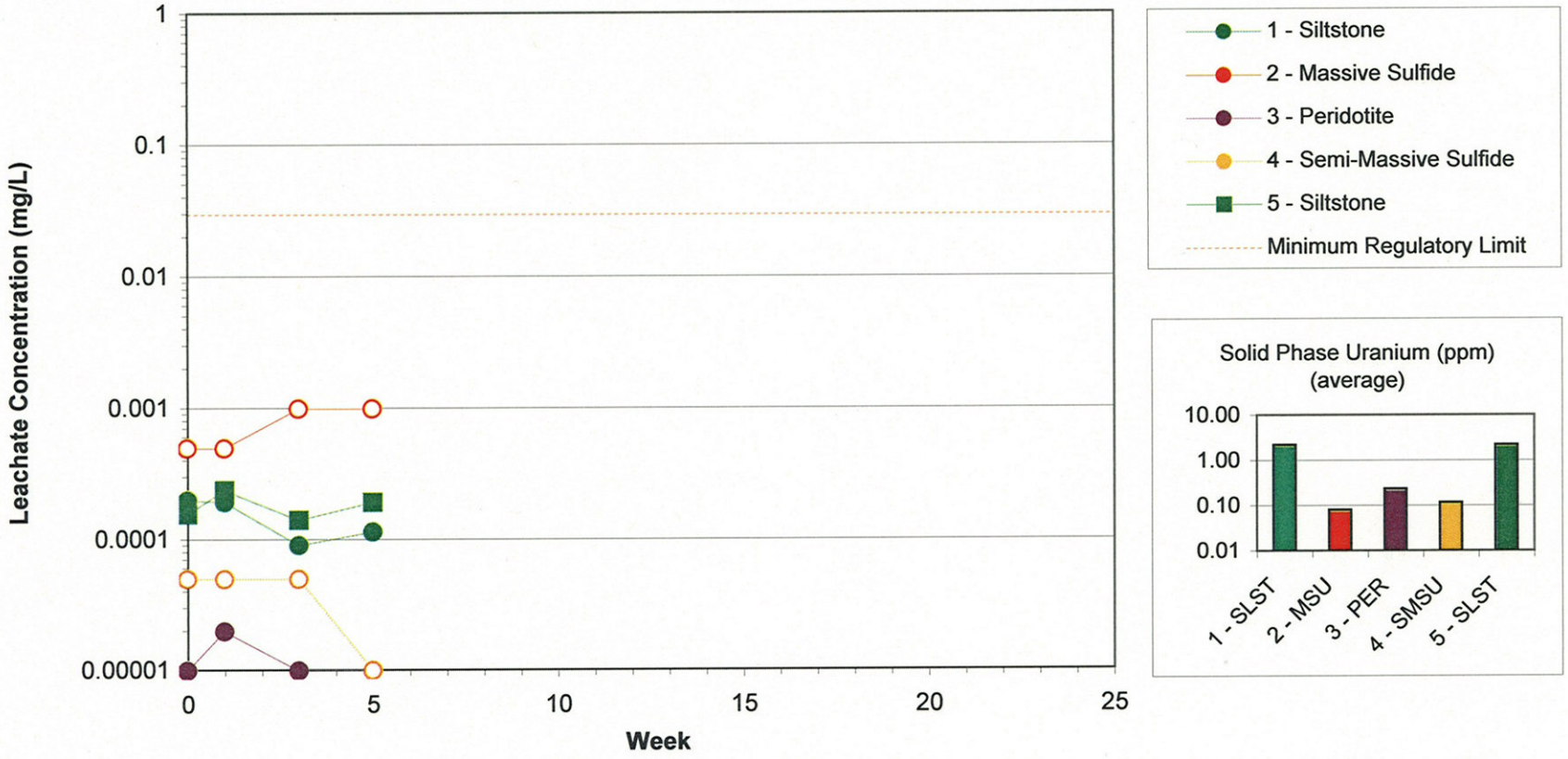
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Sodium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-28**	



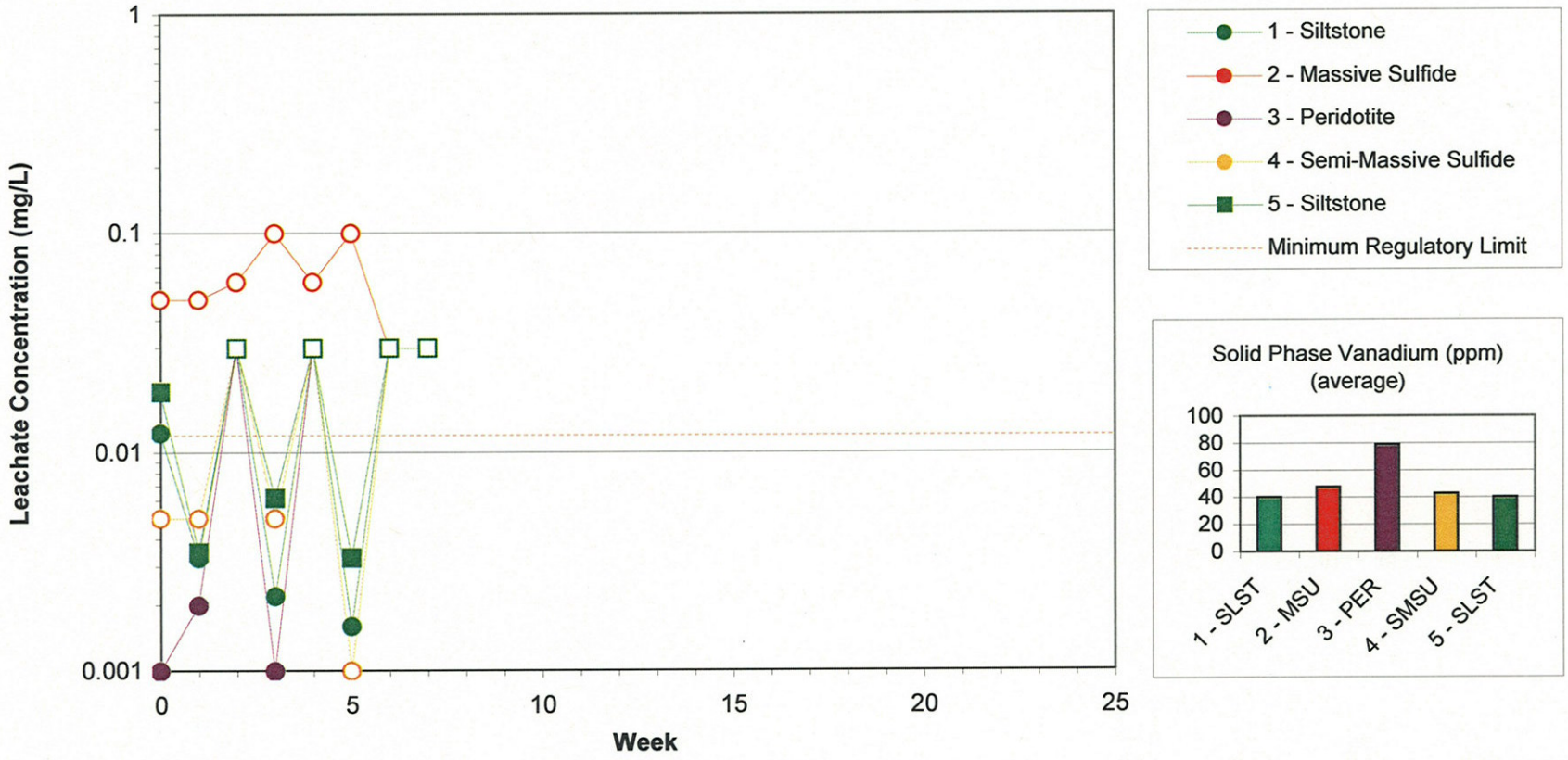
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Sulfate**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-29**	



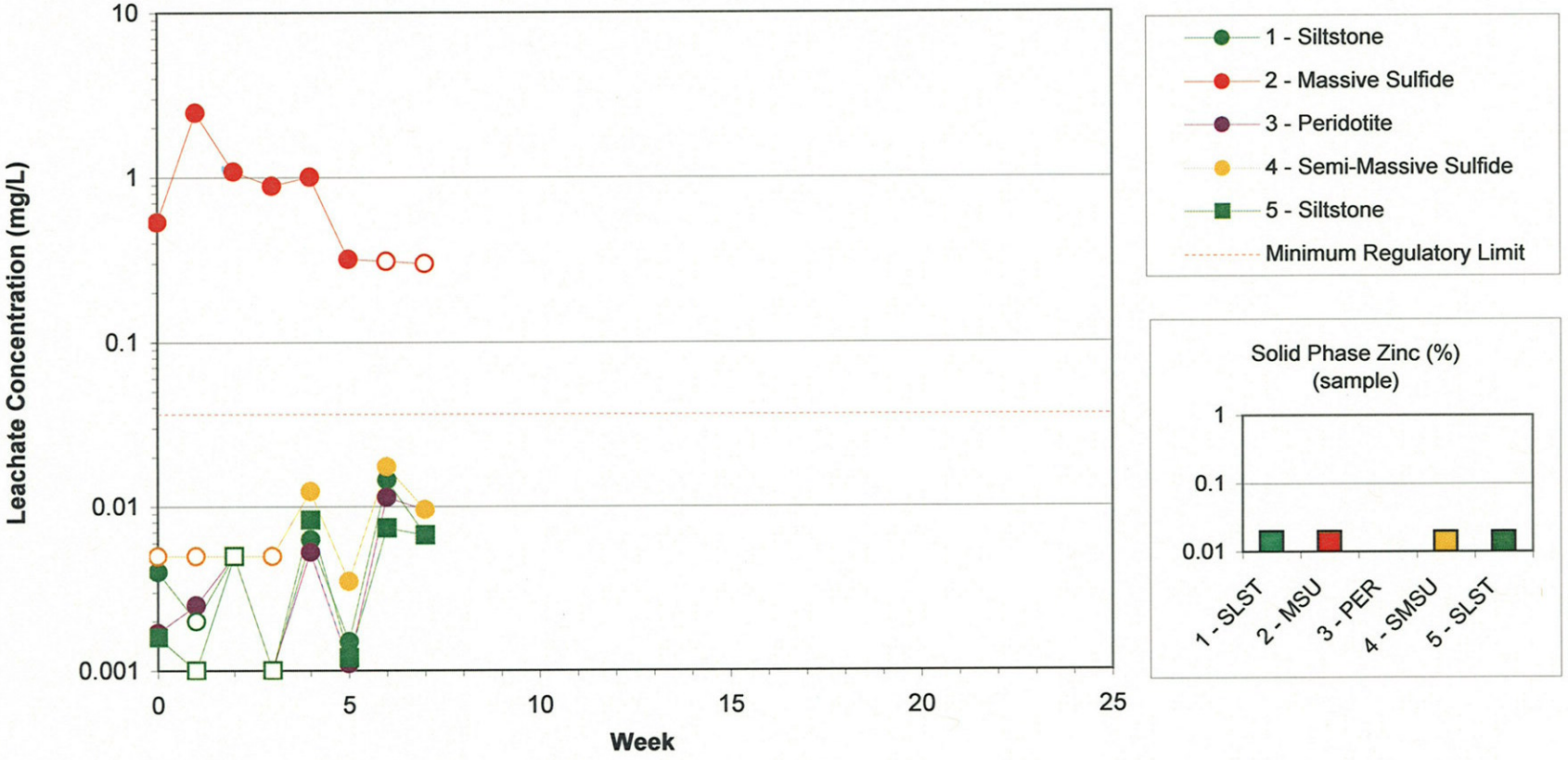
Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Uranium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-30**	



Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Vanadium**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-31**	



Non-detect concentrations plotted at the detection limit (shown as open symbols).

Eagle Mine **Phase I Kinetic Testing**	TITLE	**Kinetic Testing Results - Zinc**		
	DRAWN CR	DATE May 2004	JOB NO. 043-1055	
	CHECKED RV	SCALE na	DWG. NO.	
	REVIEWED ML	FILE NO. Phase I - Kinetic Testing Cells.xls	FIGURE NO. **A-32**	

APPENDIX B

QUALITY ASSURANCE/QUALITY CONTROL REPORT

APPENDIX B
QUALITY ASSURANCE/QUALITY CONTROL REPORT

PHASE I EAGLE PROJECT ACID ROCK DRAINAGE STUDY - MARQUETTE COUNTY, MICHIGAN

May 7, 2004

043-1055.1005

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 KINETIC TESTING DATA EVALUATION 2
2.1 Equipment Blank 2
2.2 Charge Balance Errors 3
2.3 Duplicate Analyses 3
2.4 Analytical Method Comparison – HVAAS versus ICP-MS 4
2.5 Inter-Laboratory Comparison –Sulfate Analysis 5
2.6 ALS Supporting QAQC Documentation 5
2.6.1 Precision 5
2.6.2 Accuracy 6
2.7 Trend Analysis 6

3.0 STATIC TESTING DATA EVALUATION 8
3.1 Acid Base Accounting and Whole Rock Analysis 8
3.1.1 Duplicate Analysis 8
3.1.2 Chemex Supporting QAQC Documentation 8
3.1.2.1 Precision 8
3.1.2.2 Accuracy 9
3.2 SLPL Testing 9
3.2.1 Blank Analysis 9
3.2.2 Charge Balance Errors 9
3.2.3 Duplicate Analysis 10
3.2.4 Analytical Method Comparison – HVAAS versus ICP-MS 10
3.2.5 ALS Supporting QAQC Documentation 10
3.2.5.1 Precision 10
3.2.5.2 Accuracy 10

4.0 REFERENCES 11

LIST OF TABLES

Table B2-1 Kinetic Testing – Charge Balance Errors
Table B2-2 Summary of Kinetic Testing Duplicate Analysis Results
Table B2-3 Summary of Kinetic Testing Laboratory Replicate Analysis Results
Table B2-4 Summary of Kinetic Testing Laboratory Reference Analysis Results
Table B3-1 Summary of Static Testing Duplicate Analysis Results
Table B3-2 Short-Term Leach Testing - Charge Balance Errors

LIST OF FIGURES

Figure B2-1 Kinetic Testing Zinc Results

LIST OF APPENDICES

Appendix B-1 Kinetic Testing – Data Validation Reports and Supporting Documentation
Appendix B-2 Arsenic, Antimony and Selenium – HVAAS versus ICP-MS Analysis
Appendix B-3 Static Testing (ABA and Whole Rock Analysis) - Data Validation Reports and Supporting Documentation
Appendix B-4 Short-Term Leach Testing – Data Validation Reports and Supporting Documentation

1.0 INTRODUCTION

A primary data quality objective (DQO) of the Eagle Project Phase I Acid Rock Drainage (ARD) characterization study is to provide analytical data that are of know and defensible quality. Project protocols and procedures to ensure generation of a defensible data set were outlined in *Sampling and Analysis Plan Eagle Project Acid Rock Drainage Study – Marquette County, Michigan* (Geochimica Inc., 2004). This report presents the results of the evaluations performed on the analytical data generated as part of the Phase I study.

2.0 KINETIC TESTING DATA EVALUATION

Kinetic testing is being conducted by Canadian Environmental Metallurgical Inc. (CEMI) of Vancouver, BC. CEMI constructed and charged five columns for testing following the protocols outlined in the Sampling and Analysis Plan (SAP) (Geochimica Inc., 2004). Column leachate is collected and analyzed on a weekly basis.

CEMI performs the following analyses in house: pH, conductivity, alkalinity, acidity and sulfate. Leachates are forwarded to ALS Environmental (ALS) for the analysis of metals, nutrients, major cations and anions. Metals analysis is by inductively coupled plasma optical emission spectrometry (ICP-OES) (weeks 2, 4, 6-9, 11-14 and 16-19) or inductively coupled plasma mass spectrometry (ICP-MS) (weeks 0, 1, 3, 5, 10 and 15). Selenium (Se), antimony (Sb) and arsenic (As) analysis may also be performed by hydride vapor atomic absorption spectrometry (HVAAS).

2.1 Equipment Blank

Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures. Prior to charging the kinetic testing columns, an equipment blank was collected for each column. Conductivity and pH were measured on the blank leachates from all five columns. One of the five equipment blanks was submitted to ALS for chemical analysis.

With the following exceptions, all analytes were below detectable limits in the equipment blank:

- Chloride - 0.55 mg/L
- Nitrate/nitrite - 0.0075 mg/L
- Arsenic - 0.00108 mg/L
- Barium - 0.00007 mg/L
- Copper - 0.00013 mg/L
- Zinc - 0.0059 mg/L

In general, the concentrations detected in the blank sample were considered insignificant. Reported chloride and nitrate/nitrite concentrations are only marginally above the reporting limits for these analytes of 0.5 mg/L and 0.005 mg/L, respectively. Trace metal detections were at the part per billion (ppb) level or below.

CEMI was contacted regarding the presence of zinc in the equipment blank. CEMI noted that they have observed low levels of zinc in blank samples for other studies. CEMI speculates that the most likely sources of zinc contamination are the acrylic tubing, nylon mesh or tygon tubing. Specifically, the molds used in the manufacturing of the tubing may be the source of the zinc. Mr. Basra of CEMI noted that in his experience, zinc contamination is only observed in the initial flushes. This hypothesis was supported by the week 0 and 1 leachate analyses. Four out of five columns reported zinc concentrations lower than the equipment blank in these leachates. Zinc concentrations in leachates from the Massive Sulfide column were orders of magnitude higher than the equipment blank (greater than 0.5 mg/L), but this is expected given the acidic conditions. Consideration was given to analysis of the blank samples from the other columns (retained by CEMI pending review of the first equipment blank results); however, it was decided that additional testing was not required because of the low values and the decline in zinc over time in all columns except the acidified Massive Sulfide test.

2.2 Charge Balance Errors

Calculation of a charge balance error is a standard practice in assessing the accuracy of a water analyses. Solution electroneutrality means that the sum of cations in solution (expressed in meq/L) should be equal to the sum of anions. A charge balance error of less than 5 % is generally regarded as indicative of a good analysis (Hounslow, 1995).

Charge balance calculations were performed on all comprehensive water quality analyses (i.e., solutions for which all major cations and anions have been determined). Therefore, this calculation was performed for comprehensive kinetic testing leachates (Weeks 0, 1, 3 and 5 to date).

Charge balance errors were calculated as follows:

$$Error(\%) = \frac{(\sum cation - |\sum anion|)}{(\sum cation + |\sum anion|)} \qquad \text{(Equation 1)}$$

Charge balance errors were calculated for speciated solutions using PHRREQC Version 2.7, an equilibrium speciation and mass-transfer code developed by the United States Geological Survey (USGS) (Parkhurst and Appelo, 1999). Constituents reported below detectable limits were assumed equal to the detection limit. The following parameters, which are not included in the model's database, were excluded from the analysis: molybdenum (Mo), bismuth (Bi), tin (Sn) and titanium (Ti). Because the charge balance of a solution is generally dictated by the major ions, exclusion of these trace metals has a negligible impact on the error calculated. Solutions were speciated assuming oxidizing conditions (i.e., a redox value of 600 mV).

Charge balance errors for weeks 0, 1, 3 and 5 for the five kinetic testing leachates are shown in Table B2-1. Acceptable charge balance errors are consistently achieved for columns 1, 2 (with the exception of week 0), 3 and 5. The Semi-Massive Sulfide column (column 4) however consistently reports a poor charge balance. Poor charge balance errors may be indicative of an inaccurate analysis or omission of an analyte in testing. Because the evaluation was done using a very large suite of analytes, we think it unlikely that the issue arises from failing to consider an analyte that could account for the differences in column 4.

Inaccurate or at least inconsistent sulfate analysis may be the source of the observed errors. Sulfate and alkalinity are analyzed at CEMI, whereas the cations and chloride are analyzed at ALS. To evaluate possible issues in the sulfate analyses, we developed an inter-laboratory comparison. The results of an inter- laboratory evaluation of sulfate analysis by CEMI and ALS are presented in Section 2-5.

2.3 Duplicate Analyses

Duplicate leachate samples were submitted to ALS at a frequency of 10% to assess laboratory precision. For the five kinetic testing cells, this is equivalent to one duplicate sample every two weeks.

The USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 2002) provides no "required" review criteria for determining the comparability of "field" duplicate analyses. For laboratory duplicate analyses, a control limit of 20 % for the Relative Percent Difference (RPD) is applied to original and duplicate samples values that are greater then or

equal to five times the Contract Required Quantitation Limit (CRQL)[1] (commonly referred to as the method detection limit (MDL)). If either the original or duplicate sample is less than five times the CRQL (MDL), a control limit of one times the CRQL is applied. Exceedance of a control limit results in qualification of all related results as estimates. If both samples are non-detect, no RPD is calculated. These criteria were applied to assess duplicate results.

The RPD of all duplicate samples less than five times the CRQL was calculated as follows:

$$RPD(\%) = \frac{|original - duplicate|}{(orginal + duplicate)/2} x100 \qquad \text{(Equation 2)}$$

A summary of the results of duplicate evaluation are shown in Table B2-2. Duplicate analyses showed excellent agreement, with no parameters reporting any exceedances of the RPD criteria (documentation of RPD analyses is provided in Appendix B-1).

2.4 Analytical Method Comparison – HVAAS versus ICP-MS

The SAP stipulated that during the initial stages of kinetic testing, arsenic (As), antimony (Sb) and selenium (Se) analysis would be performed by both ICP-MS and HVAAS. It was anticipated that better reporting limits would be achievable using HVAAS due to anticipated matrix interferences in ICP-MS analysis. A determination regarding the continuation of HVAAS analysis beyond week 3 was to be made based on the results of weeks 0, 1 and 3 analyses.

The Project Team provided a recommendation to Council regarding the continuation of HVAAS analysis beyond week 3. The Technical Memorandum, which discusses the results of weeks 0 though 3 testing, is provided in Appendix B-2. Based on discussions following review of this memorandum, the following decision regarding the continuation of HVAAS analysis was communicated to CEMI on April 1, 2004 (effective for weeks 7 through 20).

- Selenium analysis by HVAAS (in addition to ICP-MS) will be continued for all columns;
- For the Massive Sulfide Column (Column 2), HVAAS analysis will be continued for As, Sb and Se; and,
- For any additional columns for which it is necessary to dilute the sample by 10 times or more, HVAAS analysis will be conducted for As, Sb and Se.

A comparison of duplicate analyses for As, Sb and Se for weeks 0 through 5 is provided in Appendix B-2. Week 5 results, not available when the Technical Memorandum cited above was drafted, are included. The week 5 results are generally consistent with earlier conclusions regarding HVAAS and ICP-MS analysis as follows:

- Good agreement is observed for Sb and Se analysis by ICP-MS and HVAAS.
- Poor agreement is observed for As analysis by ICP-MS and HVAAS for approximately 30 % of samples tested to date. In week 5, three of out five samples failed to meet EPA guidelines for acceptable duplicate analysis. The ALS week 5 analytical report noted unusual matrix

[1] Criteria for inorganic analysis by ICP-MS.

interferences in samples run by HVAAS (see remarks section of full analytical report provided in Appendix D).

- Selenium analysis by HVAAS consistently achieves lower reporting limits than analysis by ICP-MS.

- For some samples, dilution results in an increase in the reporting limits of As and Sb to be equivalent to or above the lowest regulatory limit.

2.5 Inter-Laboratory Comparison –Sulfate Analysis

As mentioned in Section 2.2, poor charge-balance errors have been reported for some kinetic testing leachates (Table B2-1). Sulfate is typically the major anion in ARD leachates. Due to the inherent difficulties in sulfate analysis - and potential differences between analytical methods (APHA *et al.*, 1989), this analyte was identified as a potential cause of the charge imbalances.

An inter-laboratory comparison of sulfate analysis by CEMI and ALS for week 6 leachates was conducted. Poor reproducibility was observed for two of the five leachates (supporting documentation provided in Appendix B-1). Because agreement was satisfactory for some samples but not for others, a simple two-laboratory design is not adequate to resolve all questions. The reproducibility of sulfate analyses will continue to be addressed in the Phase II program, and we also will evaluate the alkalinity measurements in samples.

2.6 ALS Supporting QAQC Documentation

The QA/QC documentation provided by ALS with each analytical package was evaluated to assess laboratory precision and accuracy. ALS QA/QC reports were transmitted as portable document format (pdf) files. To conduct an independent review of replicate RPD and reference sample percentage recovery calculations, these reports were scanned by text recognition software and then imported into Excel. Although the accuracy of the text recognition software is good, errors may occur. It should be noted that an independent check (on a value by value basis) of all imported data was beyond the scope of this review.

Data validation forms were completed for each analytical package to document the QA/QC assessment (validation forms provided in Appendix B-1). This section provides an overall summary of the accuracy and precision of aqueous analyses.

2.6.1 Precision

Precision is defined as the degree of agreement among repeated measurements of the same characteristic. It is assessed through calculation of the RPD (Equation 2). The DQO for duplicate water analyses by ALS is typically 20 %. This DQO is consistent with the EPA acceptability criteria for duplicate metals analysis by ICP-MS (USEPA, 2002). ALS applies the following DQO for results "near" the detection limit. ALS defines "near" as within five times the reporting limit (RL) (Leanne Harris, personal communication).

$$DQO = (RDP\% * Mean) + (\sqrt{2} x RL) \qquad \text{(Equation 3)}$$

This criterion is less stringent than the EPA guidelines that stipulates, as described in Section 2.3, if either the original or duplicate sample is less than five times the CRQL (or RL), a control limit of one times the CRQL is applied.

For the current study, ALS replicate analyses were first assessed against the EPA criteria. If the analytical results failed to meet the EPA criteria, the results were assessed against the ALS criteria.

The results of the laboratory replicate analysis assessment are provided in Table B2-3 (supporting documentation provided in Appendix B-1). Due to insufficient sample volumes, a replicate analysis was not conducted during all weeks (as identified in Table B2-3). Insufficient sample volume also precluded replicate analysis of all constituents in some weeks.

Based on the results of this assessment, laboratory precision is deemed to be acceptable.

2.6.2 Accuracy

Accuracy is a measure of how close the results are to a "true" or expected value. Accuracy is assessed through calculation of the percent difference from the true value or certified target for reference materials. This difference is referred to as the percent recovery (%R), calculated as follows:

$$\%R = \frac{Found(value)}{True(value)} x100 \qquad \text{(Equation 4)}$$

The EPA acceptability criterion for percent recovery for metals by ICP-MS is 80 % to 120 % (USEPA, 2002). ALS defines their DQO for accuracy as follows:

- Trace metals – 75 % to 125 % recovery;
- Nutrients – 85 % to 115 % recovery;
- Dissolved anions – 85 % to 115 % recovery; and,
- Physical tests (TDS) – 85 % to 115 % recovery.

ALS applies the following DQO for results are near the reporting limit (RL).

$$DQO = (DQO\%R * TrueValue) + (RL) \qquad \text{(Equation 5)}$$

The results of reference analyses provided by ALS were first assessed against the EPA criteria. Samples which failed this criterion were then assessed against the ALS criteria.

A summary of the results of the reference analysis assessments for all weeks is provided in Table B2-4 (supporting documentation provided in Appendix B-1). With the exception of aluminum, all parameters met ALS's DQO for accuracy. CEMI has been contacted regarding failure of aluminum analysis for certain weeks.

2.7 Trend Analysis

Kinetic testing data were plotted as received. Concentration trends were evaluated to identify anomalous results. The following anomalies were identified:

- The original total dissolved solids (TDS) concentration reported for column 5 week 1 leachate of 4,190 mg/L was anomalously high. ALS subsequently corrected this result to 120 mg/L.
- The fluoride concentration reported for column 3 week 3 leachate appears to be high. CEMI was asked to follow-up with ALS regarding this result. ALS confirmed the original result.

Zinc has been reported in the Siltstone, Peridotite and Semi-Massive Sulfide kinetic testing leachates at low levels (10s of ppb and below). Comparison of zinc results among columns has identified systematic trends (Figure B2-1), suggesting possible zinc contamination.

CEMI was contacted regarding these trends. CEMI indicated that the grade of acid used to preserve samples for metals analysis by ICP-MS and ICP-OES differs. Samples analyzed by ICP-OES consistently yield higher zinc concentrations. In future, CEMI will acidify all samples with the ultra trace metal grade acid (i.e., the acid currently used for samples submitted for ICP-MS analysis). Zinc results will continue to be scrutinized with regards to potential evidence of zinc contamination.

3.0 STATIC TESTING DATA EVALUATION

3.1 Acid Base Accounting and Whole Rock Analysis

Static testing samples were submitted to CEMI for acid-base accounting (ABA), whole rock and elemental analysis. CEMI performed the following components of ABA analysis in house: paste pH and neutralization potential (NP). Samples were submitted to ALS Chemex (Chemex) for sulfur speciation and total inorganic carbon analysis (TIC). Chemex also performed whole rock (Method MEXRF-06) and elemental analysis (Method ME-MS41).

3.1.1 Duplicate Analysis

Duplicate samples were submitted to Chemex at a frequency of 10 % (3 out of 30) to assess laboratory precision. CEMI performed replicate analysis of paste pH and TIC on 10 % of samples.

As for the aqueous analyses, the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA, 2002) criteria for laboratory duplicate analysis were applied. These guidelines note that laboratory variability arising from sub-sampling of non-homogeneous soil samples is a common occurrence. Therefore, DQOs may allow the use of less restrictive criteria in the assessment of duplicate soil samples (i.e., 35 % RPD and 2x the CRQL). These criteria were applied in the current data evaluation.

A summary of the results of duplicate solids analysis are shown in Table B3-1. Duplicate analyses showed good agreement. All ABA analyses met the project defined acceptability criteria. A few parameters (as identified in Table B3-1) failed to meet the defined criteria in a single sample. Because failure of no single parameter was shown in more than one of the three analyses, qualification of results as estimates was not warranted. Documentation of RPD analysis is provided in Appendix B-3).

3.1.2 Chemex Supporting QAQC Documentation

3.1.2.1 Precision

Chemex's DQO for duplicate analyses are as follows: 10 % for trace metal analysis (method ME-MS41), 5 % for whole rock analysis (method ME-XRF06) and 7 % for ABA analyses. If a duplicate sample does not meet these criteria, the quality control data are reviewed by the laboratory manager, and if deemed necessary, samples are re-analyzed.

Chemex runs at least one duplicate for every forty samples. Two duplicate samples were reported for trace metal analysis. One duplicate was reported for whole rock and ABA analysis. For each duplicate analysis, Chemex provides the acceptable target range for the analysis. Duplicate results were assessed against these target ranges.

All ABA and whole rock duplicate analyses were within acceptable limits. Of the 100 trace metal duplicate determinations, two duplicates failed to meet Chemex's acceptability criterion as follows: copper (1) and zinc (1). This results in a 2 % failure rate. Chemex was contacted regarding these results. Because the second copper and zinc duplicate samples were within acceptable limits, no further action was deemed necessary by the Chemex analyst.

3.1.2.2 Accuracy

Chemex uses reference materials to assess accuracy. Chemex's DQOs for accuracy are as follows: 10 % for trace metal analysis (method ME-MS41), 5 % for whole rock analysis (method ME-XRF06) and 5 % for ABA analyses. If a standard sample does not meet these criteria, the quality control data are reviewed by the laboratory manager, and if deemed necessary, samples are re-analyzed.

Chemex runs at least one reference material for every twenty unknown samples. Four reference samples were reported for trace metal analysis. Two reference samples were reported for whole rock and ABA analysis. For each reference analysis, Chemex provides the acceptable target range for the analysis. Chemex has been contacted regarding some target ranges which appear to be greater than the prescribed acceptable limits. While awaiting a response from Chemex, duplicate results were assessed against the identified target ranges.

All ABA and whole rock reference material results were within the defined target limits.

For the following trace metals, one (or more where indicated) reference sample result fell outside the target range: Hg, La, Li, Mo, Ni, Pb, Rb, Sb, Sr, Ti (2 samples), Tl, U and W. Therefore, of the 200 reference sample determinations, fourteen (7 %) reference analysis results failed to meet acceptable criteria. Chemex was contacted regarding these analyses. Because only one of four reference samples failed to meet acceptable criteria, no further action was warranted.

3.2 SLPL Testing

Short-term leach testing was conducted on ten of the thirty static testing samples following the Environmental Protection Agency's Synthetic Precipitation Leaching Procedure (SPLP) (EPA Method 1312). The following analyses were conducted in house by CEMI: pH, redox, alkalinity, acidity, specific conductance and sulfate. Leachates were forwarded to ALS for the analysis of metals, nutrients, major cations and anions. Nutrient analyses are pending, but are expected to be very low, probably at or below detection limits.

3.2.1 Blank Analysis

The SPLP blank sample reported detections for the following trace metals: aluminum, antimony, arsenic, barium, copper lead, manganese and zinc. As per the EPA guidelines (USEPA, 2002) for preparation blank samples, all samples reporting values less than ten times the reporting limit for any constituent detected in the blank sample were qualified as estimated high (J+). These results were identified as such in Table 3-6.

3.2.2 Charge Balance Errors

Charge balance errors were calculated for speciated SPLP solutions using PHRREQC. Nutrient results (i.e., ammonia and nitrate/nitrite) are pending and therefore were not included in charge balance error calculations. For these calculations, constituents reported below detectable limits were assumed equal to the detection limit.

Charge balance errors are shown in Table B3-2. Only two out of ten leachates reported acceptable charge balance errors (i.e., less than 5%). For those samples reporting sulfate below detectable limits, charge balance errors were re-calculated assuming sulfate equal to zero. This improved the error reported for four of the samples reporting cation deficiency, resulting in an acceptable charge

imbalance for two additional samples. Determining an acceptable charge balance when all major-ion parameters are close to detection limits is very difficult.

As shown at the bottom of Table B3-2, the samples reporting the highest positive charge balance errors also report high aluminum and iron. The presence of elevated iron and aluminum at neutral to alkaline pH conditions in SPLP leachates was unexpected. Under these pH conditions, in an oxidized environment, solubility controls will generally result in low dissolved iron and aluminum. It is hypothesized that the presence of total iron and aluminum in leachate samples may be the cause of the positive charge imbalances. On a preliminary basis we consider that the issue may be due to formation of ephemeral, colloidal aluminum-hydroxide solids some of which pass the 0.45 μm filters.

3.2.3 Duplicate Analysis

One duplicate SPLP leachate sample was submitted for chemical analysis. Results of this duplicate analysis are pending.

3.2.4 Analytical Method Comparison – HVAAS versus ICP-MS

Arsenic, antimony and selenium were analyzed in SPLP leachates using both ICP-MS and HVAAS. Good agreement was observed for all samples (supporting documentation provided in Appendix B-2).

3.2.5 ALS Supporting QAQC Documentation

The QA/QC documentation provided by ALS with the SPLP analytical package was evaluated to assess laboratory precision and accuracy. The results of this evaluation are documented on the data validation form provided in Appendix B-4.

3.2.5.1 Precision

The results of the laboratory replicate analysis were reviewed and deemed to be acceptable (supporting documentation of RPD assessment provided in Appendix B-4).

3.2.5.2 Accuracy

The results of reference analysis were reviewed and deemed to be acceptable (supporting documentation provided of percentage recoveries provided in Appendix B-4).

4.0 REFERENCES

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Parkhurst, D.L., and C.A.J. Appelo, 1999. User's Guide to PHREEQC (Version 2) - A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations. U.S. Geological Survey Water-Resources Investigations Report 99-4259, Denver, CO.

American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1989. *Standard Methods for the Examination of Water and Wastewater, 17th Edition.* Washington, DC: American Public Health Association.

Kinetic Testing - Charge Balance Errors

Column	Rock Type	Charge Balance Error (%)						
		Week 0	Week 1	Week 3	Week 5	Week 10	Week 15	Week 20
1	SLST	0.3	2	4	-0.8	TBD	TBD	TBD
2	MSU	**-16**	5	3	2	TBD	TBD	TBD
3	PER	-3	-3	-0.4	0.8	TBD	TBD	TBD
4	SMSU	**-13**	**27**	**35**	-8	TBD	TBD	TBD
5	SLST	0.5	2	5	0.6	TBD	TBD	TBD

Notes:

Charge balance error computed by Phreeqc speciation simulation.

TBD - Testing ongoing. To be determined at a later date.

Assumptions:

Non-detect values equal to the detection limit.

Temperature = 22 °C.

Redos (pe = 10.2)

The following analytes were excluded from the calculation as these analytes are not included in the Mineqa2 database: Mo, Bi, Sn and Ti.

Summary of Kinetic Testing Duplicate Analysis Results

Week	Column	RPD Assessment	
		% Failure	Parameters
2	1	0%	-
3	2	0%	-
6	3	0%	-

Notes:
RPD - relative percent difference.
Shaded cells identify weeks for comprehensive analysis.
Supporting documentation provided in Appendix B-1.

TABLE B2-3
Summary of Kinetic Testing Laboratory Replicate Analysis Results

Week	Laboratory Replicate Reported	Column	RPD Assessment		Notes
			% Failure	Parameters	
0					Insufficient sample volume
1	x	3	0%	-	TDS omitted from replicate analysis.
2	x	3	0%	-	
3	x	3	3%	Al	NO_3/NO_2, TDS and HVAAS (As, Se and Sb) omitted from replicate analysis.
4	x	4	0%	-	
5					Insufficient sample volume assumed (have requested lab confirmation)
6					Insufficient sample volume assumed (have requested lab confirmation)
7	x	3	0%	-	

Notes:
Shaded cells identify weeks for comprehensive analysis.
RPD - relative percent difference.
Supporting documentation provided in Appendix B-1.

TABLE B2-4
Summary of Kinetic Testing Laboratory Reference Analysis Results

Week	EPA % Recovery Criteria		ALS % Recovery Criteria	
	% Failure	Parameters	% Failure	Parameters
EB	3%	Al, B	1%	Al
0	2%	Al, B	1%	Al
1	4%	Al, B, Ni, Tl	1%	Al
2	2%	B	0%	-
3	2%	Al, B	1%	Al
4	4%	B, Ni	0%	-
5	4%	Al, B, Sb	0%	-
6	3%	B	0%	
7	2%	B	0%	-

Notes:
EB - Equipment Blank
Shaded cells identify weeks for comprehensive analysis.
Supporting documentation provided in Appendix B-1.

Summary of Static Testing Duplicate Analysis Results

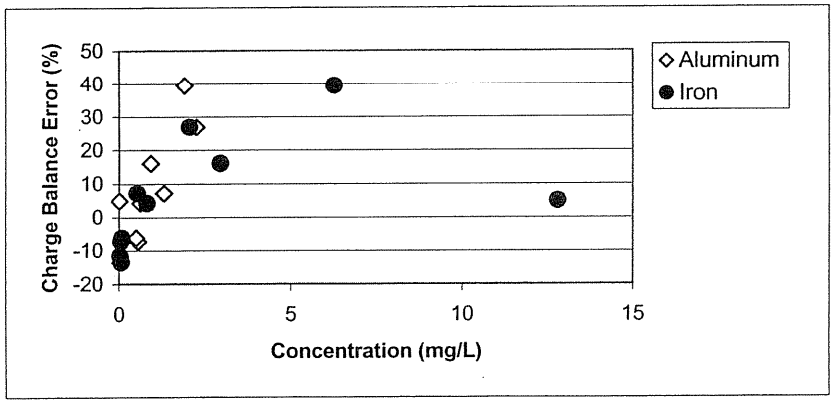
Analysis	No. Samples	No. Duplicates	% Duplicates	Duplicate Sample ID	% Failure	Failed Parameters
Trace Metal	30	3	10%	VR91623A	0%	-
				VR90181A	2%	Li
				VR91627A	4%	Cu, Ni
Whole Rock	30	3	10%	VR91623A	7%	Cr_2O_3
				VR90181A	0%	-
				VR91627A	0%	-
Acid Base Accounting	30	3	10%	VR91623A	0%	-
				VR90181A	0%	-
				VR91627A	0%	-

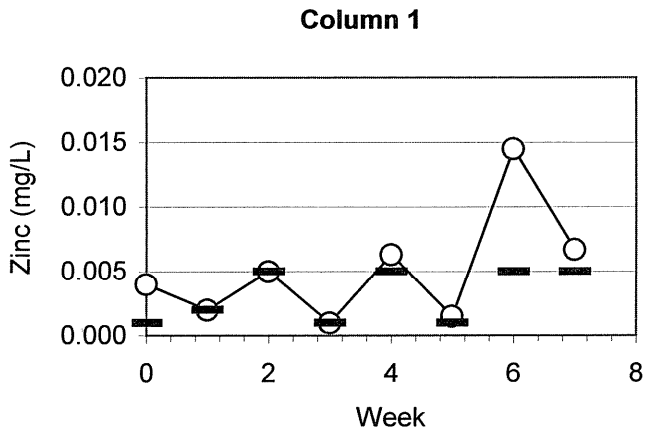
TABLE B3-2
Short-Term Leach Testing Charge Balance Errors

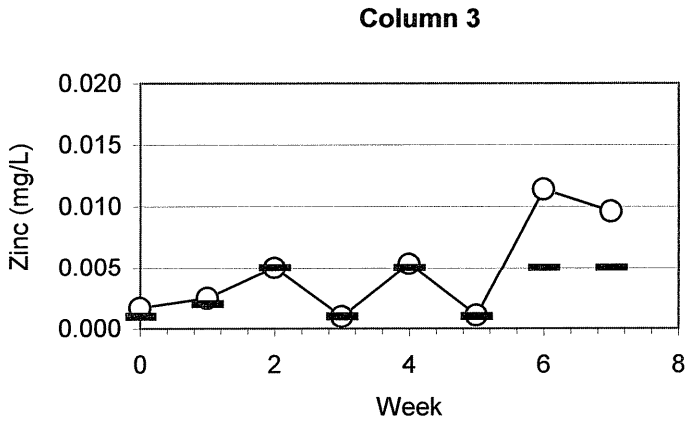
Sample	Rock Type	pH	Sulfate	Aluminum	Iron	Charge Balance Error (%)	
		s.u.	mg/L	mg/L	mg/L	non-detect SO_4 equal to detection limit	non-detect SO_4 equal to zero
VR90425A	SLST	7.69	8	2.24	2.04	**27**	
VR91625A	SLST	9.09	<3	0.553	0.053	**-7**	-1
VR91620A	SDST	7.85	<3	0.495	0.081	**-6**	0
VR71109A	HFL	8.72	<3	1.3	0.527	**7**	**13**
VR91306A	HFL	7.8	<3	0.623	0.802	4	**12**
VR71275A	PRX	9.29	10	1.9	6.26	**39**	
VR91267A	PER	9.27	7	0.917	2.93	**16**	
VR71373A	PER	9.35	<3	0.0261	<0.03	**-12**	**-7**
VR90181A	MSU	5.17	48	0.0061	12.8	5	
VR90125A	SMSU	7.61	<3	0.0358	0.069	**-14**	**-9**

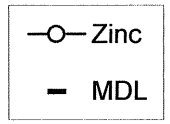
Notes:
Charge balance error computed by Phreeqc speciation simulation.

Assumptions:
Non-detect values equal to the detection limit unless noted otherwise.
Temperature = 22 °C.
The following analytes were excluded from the calculation as these analytes are not included in the Mineqa2 database: Mo, Bi, Sn and Ti.



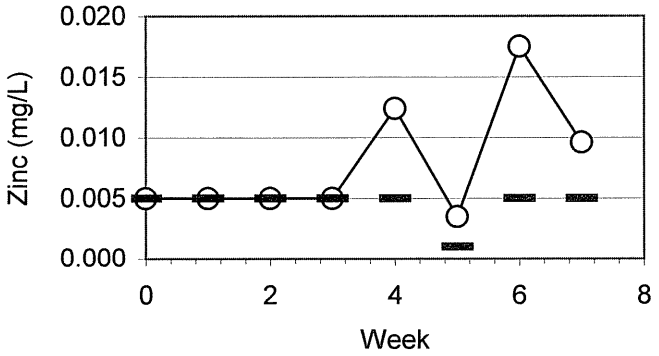


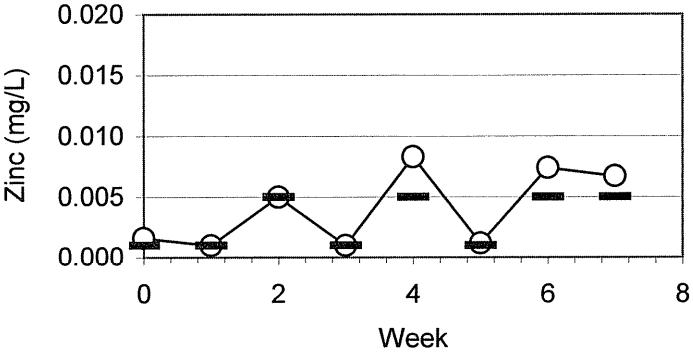




Notes:
ICP-MS analysis conducted in weeks 0, 1, 3 and 5.

ICP-OES analysis conducted in weeks 2, 4, 6 and 7.





Eagle Mine
Phase I Kinetic Testing

TITLE

Kinetic Testing Zinc Results

DRAWN	CR	DATE	May 2004	JOB NO.	043-1055
CHECKED		SCALE	na	DWG. NO.	
REVIEWED	ML	FILE NO.	Zinc Check.xls	FIGURE NO.	B2-1

APPENDIX B-1

KINETIC TESTING -
DATA VALIDATION REPORTS AND SUPPORTING DOCUMENTATION

Inorganic Data Validation Summary

1. PROJECT INFORMATION

Project	Eagle Mine - Kennecott	**Project No.**	043-1055
Date	March 14, 2004		
Laboratory	ALS Environmental		
SDG	ALS File No. T9844		
Description of Analysis	Phase I Kinetic Testing – Equipment Blank		
Report Date	March 3, 2004		
Validator	Cheryl Ross		

2. CHAIN OF CUSTODY

No. of Samples: __1___
No. of Duplicates: __0___

☐ Sample preservation documented on COC.

☐ Samples preserved correctly. ☐ Not Applicable.

☐ Sample temperature documented on COC.

☐ Samples maintained at 4 °C.

Comments:

- Have requested a copy of COC.

3. SUMMARY OF ANALYSES

Check all analyses included in SDG.

ANALYSIS		NOTES
Metals by ICP-OES		
Metals by ICP-MS	x	
Metals by HVASS		As Sb Se
TDS	x	
Chloride (APHA 4500)	x	
Fluoride (APHA 4500)	x	
Ammonia (APHA 4500)	x	
Nitrate/Nitrite (APHA 4500)	x	
Mercury (EPA 7470A/7471/245.7)	x	

☒ All requested analyses conducted.

Comments:

4. LABORATORY REMARKS

☐ Detection limits increased due to matrix interferences.

Comments:

5. HOLDING TIME EVALUATION

ANALYSIS	HOLDING TIME (Days)	APPLICABLE	HT EXCEEDED	NOTES
Metals by ICP-OES	6 months			
Metals by ICP-MS	6 months	x		
Metals by HVASS	6 months			
TDS	7	x		
Chloride	28	x		
Fluoride	28	x		
Ammonia	28	x		
Nitrate/Nitrite	2	x		
Mercury	28	x		

☐ All analyses conducted within acceptable holding times.

Comments/Qualified Results:

- Need COC to check TDS and nitrate/nitrite.

6. FIELD DUPLICATE SAMPLE RESULTS

☐ Duplicate sample submitted. ☒ No duplicate sample.

☐ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☐ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

7. BATCH QC RESULTS – BLANK SAMPLE

☒ Blank analysis results reported.

☒ All constituents non-detect in the blank sample.

☒ Reporting limits equivalent to project reporting limits.

Constituents detected in blank sample:

Comments/Qualified Results:

8. BATCH QC RESULTS – LABORATORY REPLICATE SAMPLES

☐ Replicate analysis results reported.

☐ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☐ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

- No replicate analyses provided.

- **BATCH QC RESULTS – REFRENCE SAMPLES**

☒ Reference sample analysis results reported.

☐ All % Recovery meet EPA criteria (between 80 and 120%).

☐ All % Recovery meet lab criteria.

Comments/Qualified Results:

- One total aluminum sample by ICP-MS failed to meet EPA and ALS criteria. The dissolved ICP-MS reference sample reported an acceptable % recovery.
- Three out of four total boron analyses by ICP-MS failed to meet only EPA criteria. The IPC-MS boron reference sample % recovery was acceptable.

9. LABORATORY FOLLOW-UP

- Have requested COC from CEMI (email dated March 12, 2004).
- Inquire about absence of laboratory replicate sample.
- Inquire about aluminum reference sample % recovery.

10. ADDITIONAL COMMENTS

- Supporting documentation provided in *Phase I Kinetic Testing - QAQC.xls.*

C. Ross
Validator

03/14/04
Date

LABORATORY REFERENCE SAMPLES
Analysis Kinetic Testing - Equipment Blank

QA/QC Report

Analyte		Result	Target	Units	DL	ALSQC#	Method	% Recovery
Bismuth	T-Bi	1.02	1	mg/L	0.1	376877	ICP-OES	102%
Bismuth	T-Bi	1.01	1	mg/L	0.1	377155	ICP-OES	101%
Bismuth	T-Bi	1.02	1	mg/L	0.05	377260	ICP-MS	102%
Lithium	T-Li	0.203	0.2	mg/L	0.01	376877	ICP-OES	102%
Lithium	T-Li	0.206	0.2	mg/L	0.01	377155	ICP-OES	103%
Lithium	T-Li	*0.5*	*0.5*	mg/L	0.5	377260	ICP-MS	100%
Phosphorus	T-P	1.97	2	mg/L	0.3	376877	ICP-OES	99%
Phosphorus	T-P	2.02	2	mg/L	0.3	377155	ICP-OES	101%
Silicon	T-Si	1	1	mg/L	0.05	376877	ICP-OES	100%
Silicon	T-Si	1.02	1	mg/L	0.05	377155	ICP-OES	102%
Tin	T-Sn	1.03	1	mg/L	0.03	376877	ICP-OES	103%
Tin	T-Sn	1.04	1	mg/L	0.03	377155	ICP-OES	104%
Tin	T-Sn	1.01	1	mg/L	0.01	377260	ICP-MS	101%
Titanium	T-Ti	0.2	0.2	mg/L	0.01	376877	ICP-OES	100%
Titanium	T-Ti	0.201	0.2	mg/L	0.01	377155	ICP-OES	101%
Aluminum	D-Al	0.0574	0.054	mg/L	0.001	377259	ICP-MS	106%
Antimony	D-Sb	0.00026	0.00023	mg/L	0.00005	377259	ICP-MS	113%
Arsenic	D-As	0.00075	0.00068	mg/L	0.0001	377259	ICP-MS	110%
Barium	D-Ba	0.0135	0.0122	mg/L	0.00005	377259	ICP-MS	111%
Beryllium	D-Be	*0.0005*	*0.0005*	mg/L	0.0005	377259	ICP-MS	100%
Cadmium	D-Cd	*0.00005*	*0.00005*	mg/L	0.00005	377259	ICP-MS	100%
Calcium	D-Ca	5.86	6.2	mg/L	0.02	377259	ICP-MS	95%
Chromium	D-Cr	*0.0005*	*0.0005*	mg/L	0.0005	377259	ICP-MS	100%
Cobalt	D-Co	*0.0001*	*0.0001*	mg/L	0.0001	377259	ICP-MS	100%
Copper	D-Cu	0.00188	0.00181	mg/L	0.0001	377259	ICP-MS	104%
Lead	D-Pb	0.000082	0.000086	mg/L	0.00005	377259	ICP-MS	95%
Magnesium D-Mg	D-Mg	1.89	1.6	mg/L	0.005	377259	ICP-MS	118%
Manganese D-Mn	D-Mn	0.00332	0.00337	mg/L	0.00005	377259	ICP-MS	99%
Molybdenum D-Mo	D-Mo	0.000223	0.00021	mg/L	0.00005	377259	ICP-MS	106%
Nickel	D-Ni	0.00075	0.00067	mg/L	0.0001	377259	ICP-MS	112%
Potassium	D-K	0.678	0.68	mg/L	0.01	377259	ICP-MS	100%
Strontium	D-Sr	0.0283	0.0263	mg/L	0.0001	377259	ICP-MS	108%
Uranium	D-U	0.000049	0.00005	mg/L	0.00001	377259	ICP-MS	98%
Vanadium	D-V	*0.001*	*0.001*	mg/L	0.001	377259	ICP-MS	100%
Zinc	D-Zn	0.0011	*0.001*	mg/L	0.001	377259	ICP-MS	110%
Aluminum	T-Al	0.197	0.152	mg/L	0.01	377261	ICP-MS	**130%**
Antimony	T-Sb	0.271	0.262	mg/L	0.001	377261	ICP-MS	103%
Arsenic	T-As	0.146	0.152	mg/L	0.001	377261	ICP-MS	96%
Barium	T-Ba	0.438	0.438	mg/L	0.0005	377261	ICP-MS	100%
Beryllium	T-Be	0.0374	0.0367	mg/L	0.005	377261	ICP-MS	102%
Boron	T-B	0.12	0.1	mg/L	0.1	377261	ICP-MS	120%
Cadmium	T-Cd	0.074	0.0767	mg/L	0.0005	377261	ICP-MS	96%
Chromium	T-Cr	0.122	0.125	mg/L	0.005	377261	ICP-MS	98%
Cobalt	T-Co	0.215	0.225	mg/L	0.001	377261	ICP-MS	96%
Copper	T-Cu	0.297	0.309	mg/L	0.001	377261	ICP-MS	96%
Lead	T-Pb	0.386	0.402	mg/L	0.0005	377261	ICP-MS	96%
Manganese	T-Mn	0.324	0.339	mg/L	0.0005	377261	ICP-MS	96%
Molybdenum	T-Mo	0.0972	0.095	mg/L	0.0005	377261	ICP-MS	102%
Nickel	T-Ni	0.204	0.203	mg/L	0.005	377261	ICP-MS	100%
Selenium	T-Se	0.0368	0.0365	mg/L	0.005	377261	ICP-MS	101%
Silver	T-Ag	0.0705	0.0733	mg/L	0.0001	377261	ICP-MS	96%
Strontium	T-Sr	0.344	0.354	mg/L	0.001	377261	ICP-MS	97%
Thallium	T-Tl	0.107	0.111	mg7[	0.001	377261	ICP-MS	96%
Vanadium	T-V	0.193	0.194	mg/L	0.01	377261	ICP-MS	99%
Zinc	T-Zn	0.145	0.151	mg/L	0.01	377261	ICP-MS	96%
Aluminum	T-Al	0.99	1.00	mg/L	0.2	376878	ICP-OES	99%
Aluminum	T-Al	1	1.00	mg/L	0.2	377156	ICP-OES	100%
Antimony	T-Sb	0.28	0.28	mg/L	0.2	376878	ICP-OES	100%
Antimony	T-Sb	0.28	0.28	mg/L	0.2	377156	ICP-OES	100%

Analyte		Result	Target	Units	DL	ALSQC#	Method	% Recovery
Arsenic	T-As	0.49	0.49	mg/L	0.2	376878	ICP-OES	100%
Arsenic	T-As	0.49	0.49	mg/L	0.2	377156	ICP-OES	100%
Barium	T-Ba	0.526	0.525	mg/L	0.01	376878	ICP-OES	100%
Barium	T-Ba	0.525	0.525	mg/L	0.01	377156	ICP-OES	100%
Beryllium	T-Be	0.4	0.397	mg/L	0.005	376878	ICP-OES	101%
Beryllium	T-Be	0.389	0.397	mg/L	0.005	377156	ICP-OES	98%
Boron	T-B	0.35	0.28	mg/L	0.1	376878	ICP-OES	125%
Boron	T-B	0.35	0.28	mg/L	0.1	377156	ICP-OES	125%
Cadmium	T-Cd	0.354	0.353	mg/L	0.01	376878	ICP-OES	100%
Cadmium	T-Cd	0.352	0.353	mg/L	0.01	377156	ICP-OES	100%
Chromium	T-Cr	0.168	0.167	mg/L	0.01	376878	ICP-OES	101%
Chromium	T-Cr	0.169	0.167	mg/L	0.01	377156	ICP-OES	101%
Cobalt	T-Co	0.241	0.24	mg/L	0.01	376878	ICP-OES	100%
Cobalt	T-Co	0.245	0.24	mg/L	0.01	377156	ICP-OES	102%
Copper	T-Cu	0.396	0.391	mg/L	0.01	376878	ICP-OES	101%
Copper	T-Cu	0.402	0.391	mg/L	0.01	377156	ICP-OES	103%
Iron	T-Fe	1	1.01	mg/L	0.03	376878	ICP-OES	99%
Iron	T-Fe	0.994	1.01	mg/L	0.03	377156	ICP-OES	98%
Lead	T-Pb	0.844	0.857	mg/L	0.05	376878	ICP-OES	98%
Lead	T-Pb	0.837	0.857	mg/L	0.05	377156	ICP-OES	98%
Manganese	T-Mn	2.25	2.26	mg/L	0.005	376878	ICP-OES	100%
Manganese	T-Mn	2.27	2.26	mg/L	0.005	377156	ICP-OES	100%
Molybdenum	T-Mo	0.097	0.097	mg/L	0.03	376878	ICP-OES	100%
Molybdenum	T-Mo	0.098	0.097	mg/L	0.03	377156	ICP-OES	101%
Nickel	T-Ni	0.627	0.611	mg/L	0.05	376878	ICP-OES	103%
Nickel	T-Ni	0.625	0.611	mg/L	0.05	377156	ICP-OES	102%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	376878	ICP-OES	100%
Selenium	T-Se	0.21	*0.2*	mg/L	0.2	377156	ICP-OES	105%
Silver	T-Ag	0.21	0.21	mg/L	0.01	376878	ICP-OES	100%
Silver	T-Ag	0.21	0.21	mg/L	0.01	377156	ICP-OES	100%
Strontium	T-Sr	0.104	0.104	mg/L	0.005	376878	ICP-OES	100%
Strontium	T-Sr	0.104	0.104	mg/L	0.005	377156	ICP-OES	100%
Thallium	T-Tl	0.35	0.38	mg/L	0.2	376878	ICP-OES	92%
Thallium	T-Tl	0.33	0.38	mg/L	0.2	377156	ICP-OES	87%
Titanium	T-Ti	0.192	0.192	mg/L	0.01	376878	ICP-OES	100%
Titanium	T-Ti	0.187	0.192	mg/L	0.01	377156	ICP-OES	97%
Vanadium	T-V	1.51	1.5	mg/L	0.03	376878	ICP-OES	101%
Vanadium	T-V	1.5	1.5	mg/L	0.03	377156	ICP-OES	100%
Zinc	T-Zn	0.12	0.121	mg/L	0.005	376878	ICP-OES	99%
Zinc	T-Zn	0.121	0.121	mg/L	0.005	377156	ICP-OES	100%
Mercury	T-Hg	0.00988	0.01	mg/L	0.00001	376622	CVAFS	99%
Fluoride	F	1.03	1.02	mg/L	0.02	377041	Electrode	101%
Calcium	T-Ca	15.6	15.6	mg/L	0.05	376876	ICP-OES	100%
Calcium	T-Ca	15.4	15.6	mg/L	0.05	377154	ICP-OES	99%
Calcium	T-Ca	15	15.6	mg/L	0.04	377258	ICP-MS	96%
Magnesium T -Mg	T-Mg	5.59	5.85	mg/L	0.1	376876	ICP-OES	96%
Magnesium T -Mg	T-Mg	5.62	5.85	mg/L	0.1	377154	ICP-OES	96%
Magnesium T -Mg	T-Mg	6.42	5.85	mg/L	0.01	377258	ICP-MS	110%
Potassium	T-K	34	33.1	mg/L	2	376876	ICP-OES	103%
Potassium	T-K	33.9	33.1	mg/L	2	377154	ICP-OES	102%
Potassium	T-K	33.3	33.1	mg/L	0.1	377258	ICP-MS	101%
Sodium	T-Na	40.2	39.1	mg/L	2	376876	ICP-OES	103%
Sodium	T-Na	41.8	39.1	mg/L	2	377154	ICP-OES	107%
Sodium	T-Na	38.7	39.1	mg/L	0.02	377258	ICP-MS	99%
Ammonia Nitrogen	N	11.2	11.4	mg/L	0.02	376955	Electrode	98%
Nitrite/Nitrate Nitrogen	N	18.8	17.1	mg/L	0.005	377632	Colourimetry	110%
Aluminum	T-Al	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Aluminum	T-Al	*0.2*	*0.2*	mg/L	0.2	377153	ICP-OES	100%
Antimony	T-Sb	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Antimony	T-Sb	*0.2*	*0.2*	mg/L	0.2	377153	ICP-OES	100%
Arsenic	T-As	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Arsenic	T-As	*0.2*	*0.2*	mg/L	0.2	377153	ICP-OES	100%
Barium	T-Ba	0.338	0.338	mg/L	0.01	376875	ICP-OES	100%

Analyte		Result	Target	Units	DL	ALSQC#	Method	% Recovery
Barium	T-Ba	0.344	0.338	mg/L	0.01	377153	ICP-OES	102%
Beryllium	T-Be	0.0776	0.0751	mg/L	0.005	376875	ICP-OES	103%
Beryllium	T-Be	0.0773	0.0751	mg/L	0.005	377153	ICP-OES	103%
Boron	T-B	0.2	0.23	mg/L	0.1	376875	ICP-OES	87%
Boron	T-B	0.18	0.23	mg/L	0.1	377153	ICP-OES	**78%**
Cadmium	T-Cd	0.094	0.088	mg/L	0.01	376875	ICP-OES	107%
Cadmium	T-Cd	0.092	0.088	mg/L	0.01	377153	ICP-OES	105%
Chromium	T-Cr	0.222	0.218	mg/L	0.01	376875	ICP-OES	102%
Chromium	T-Cr	0.224	0.218	mg/L	0.01	377153	ICP-OES	103%
Cobalt	T-Co	0.291	0.28	mg/L	0.01	376875	ICP-OES	104%
Cobalt	T-Co	0.296	0.28	mg/L	0.01	377153	ICP-OES	106%
Copper	T-Cu	0.295	0.287	mg/L	0.01	376875	ICP-OES	103%
Copper	T-Cu	0.3	0.287	mg/L	0.01	377153	ICP-OES	105%
Iron	T-Fe	0.387	0.368	mg/L	0.03	376875	ICP-OES	105%
Iron	T-Fe	0.385	0.368	mg/L	0.03	377153	ICP-OES	105%
Lead	T-Pb	0.251	0.264	mg/L	0.05	376875	ICP-OES	95%
Lead	T-Pb	0.253	0.264	mg/L	0.05	377153	ICP-OES	96%
Manganese	T-Mn	0.485	0.479	mg/L	0.005	376875	ICP-OES	101%
Manganese	T-Mn	0.495	0.479	mg/L	0.005	377153	ICP-OES	103%
Molybdenum	T-Mo	0.148	0.149	mg/L	0.03	376875	ICP-OES	99%
Molybdenum	T-Mo	0.153	0.149	mg/L	0.03	377153	ICP-OES	103%
Nickel	T-Ni	0.076	0.078	mg/L	0.05	376875	ICP-OES	97%
Nickel	T-Ni	0.081	0.078	mg/L	0.05	377153	ICP-OES	104%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	377153	ICP-OES	100%
Silver	T-Ag	0.059	0.063	mg/L	0.01	376875	ICP-OES	94%
Silver	T-Ag	0.061	0.063	mg/L	0.01	377153	ICP-OES	97%
Strontium	T-Sr	0.373	0.367	mg/L	0.005	376875	ICP-OES	102%
Strontium	T-Sr	0.377	0.367	mg/L	0.005	377153	ICP-OES	103%
Thallium	T-Tl	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Thallium	T-Tl	*0.2*	*0.2*	mg/L	0.2	377153	ICP-OES	100%
Tin	T-Sn	0.902	0.89	mg/L	0.03	376875	ICP-OES	101%
Tin	T-Sn	0.905	0.89	mg/L	0.03	377153	ICP-OES	102%
Titanium	T-Ti	0.099	0.093	mg/L	0.01	376875	ICP-OES	106%
Titanium	T-Ti	0.096	0.093	mg/L	0.01	377153	ICP-OES	103%
Vanadium	T-V	0.101	0.097	mg/L	0.03	376875	ICP-OES	104%
Vanadium	T-V	0.1	0.097	mg/L	0.03	377153	ICP-OES	103%
Zinc	T-Zn	0.151	0.148	mg/L	0.005	376875	ICP-OES	102%
Zinc	T-Zn	0.153	0.148	mg/L	0.005	377153	ICP-OES	103%
Total Dissolved Solids		225	236	mg/L	10	376813	Gravimetry	95%
Chloride	Cl	79.3	77.9	mg/L	0.5	376681	Colourimetry	102%
Chloride	Cl	7.74	7.79	mg/L	0.5	376682	Colourimetry	99%
Chloride	Cl	160	156	mg/L	0.5	376683	Colourimetry	103%

Number of Parameters Failing EPA Criteria	4
%	3%

Number of Parameters Failing ALS Criteria	1
%	1%

Inorganic Data Validation Summary

1. PROJECT INFORMATION

Project	Eagle Mine - Kennecott	**Project No.**	043-1055
Date	March 14, 2004		
Laboratory	ALS Environmental		
SDG	ALS File No. T9845		
Description of Analysis	Phase I Kinetic Testing – Week 0 Results (Comprehensive)		
Report Date	March 8, 2004		
Validator	Cheryl Ross		

2. CHAIN OF CUSTODY

No. of Samples: __5__
No. of Duplicates: __0__

☐ Sample preservation documented on COC.

☐ Samples preserved correctly. ☐ Not Applicable.

☐ Sample temperature documented on COC.

☐ Samples maintained at 4 °C.

Comments:

- Have requested a copy of the COC.

3. SUMMARY OF ANALYSES

Check all analyses included in SDG.

ANALYSIS		NOTES
Metals by ICP-OES		
Metals by ICP-MS	x	
Metals by HVASS	x	As x Sb x Se x
TDS	x	
Chloride (APHA 4500)	x	
Fluoride (APHA 4500)	x	
Ammonia (APHA 4500)	x	
Nitrate/Nitrite (APHA 4500)	x	
Mercury (EPA 7470A/7471/245.7)	x	

☒ All requested analyses conducted.

Comments:

4. LABORATORY REMARKS

☒ Detection limits increased due to matrix interferences.

Comments:

- 18580 – Selenium (Ni interference)
- 18581 – Selenium (Cl interference)
- 18582 – Selenium (B interference)

5. HOLDING TIME EVALUATION

ANALYSIS	HOLDING TIME (Days)	APPLICABLE	HT EXCEEDED	NOTES
Metals by ICP-OES	6 months			
Metals by ICP-MS	6 months	x		
Metals by HVASS	6 months	x		
TDS	7	x		
Chloride	28	x		
Fluoride	28	x		
Ammonia	28	x		
Nitrate/Nitrite	2	x		
Mercury	28	x		

☐ All analyses conducted within acceptable holding times.

Comments/Qualified Results:

- Need COC to evaluate TDS and nitrate/nitrite.

6. FIELD DUPLICATE SAMPLE RESULTS

☐ Duplicate sample submitted. ☒ No duplicate sample.

☐ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☐ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

7. BATCH QC RESULTS – BLANK SAMPLE

☒ Blank analysis results reported.

☒ All constituents non-detect in the blank sample.

☒ Reporting limits equivalent to project reporting limits.

Constituents detected in blank sample:

Comments/Qualified Results:

8. BATCH QC RESULTS – LABORATORY REPLICATE SAMPLES

☐ Replicate analysis results reported.

☐ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☐ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

BATCH QC RESULTS – REFRENCE SAMPLES

☒ Reference sample analysis results reported.

☐ All % Recovery meet EPA criteria (between 80 and 120%).

☐ All % Recovery meet lab criteria.

Comments/Qualified Results:

- The total aluminum sample by ICP-MS failed to meet EPA and ALS criteria. The dissolved ICP-MS reference sample reported an acceptable % recovery.
- One of two total boron analyses by ICP-MS failed to meet only EPA criteria. The IPC-MS boron reference sample % recovery was acceptable.

9. LABORATORY FOLLOW-UP

- Have requested COC from CEMI (email dated March 12, 2004).
- Have inquired about absence of laboratory replicate sample (email dated March 12, 2004).
- Inquire about aluminum reference sample % recovery.

10. ADDITIONAL COMMENTS

- Supporting documentation provided in *Phase I Kinetic Testing – QAQC.xls*
- HVAAS and ICP-MS analysis for Se and Sb – good reproducibility.
- HVAAS and ICP-MS analysis for As – 1 of 5 samples failed to meet RPD criteria.

C. Ross
Validator

03/14/04
Date

LABORATORY REFERENCE SAMPLES
Analysis Kinetic Testing - Week 0

QA/QC Report

Analyte		Result	Target	Units	DL	ALSQC#	Method	% Recovery
Bismuth	T-Bi	1.02	1	mg/L	0.1	376877	ICP-OES	102%
Bismuth	T-Bi	1.02	1	mg/L	0.05	377260	ICP-MS	102%
Lithium	T-Li	0.203	0.2	mg/L	0.01	376877	ICP-OES	102%
Lithium	T-Li	*0.5*	*0.5*	mg/L	0.5	377260	ICP-MS	100%
Phosphorus	T-P	1.97	2	mg/L	0.3	376877	ICP-OES	99%
Silicon	T-Si	1	1	mg/L	0.05	376877	ICP-OES	100%
Tin	T-Sn	1.03	1	mg/L	0.03	376877	ICP-OES	103%
Tin	T-Sn	1.01	1	mg/L	0.01	377260	ICP-MS	101%
Titanium	T-Ti	0.2	0.2	mg/L	0.01	376877	ICP-OES	100%
Aluminum	D-Al	0.0574	0.054	mg/L	0.001	377259	ICP-MS	106%
Antimony	D-Sb	0.00026	0.00023	mg/L	0.00005	377259	ICP-MS	113%
Arsenic	D-As	0.00075	0.00068	mg/L	0.0001	377259	ICP-MS	110%
Barium	D-Ba	0.0135	0.0122	mg/L	0.00005	377259	ICP-MS	111%
Beryllium	D-Be	*0.0005*	*0.0005*	mg/L	0.0005	377259	ICP-MS	100%
Cadmium	D-Cd	*0.00005*	*0.00005*	mg/L	0.00005	377259	ICP-MS	100%
Calcium	D-Ca	5.86	6.2	mg/L	0.02	377259	ICP-MS	95%
Chromium	D-Cr	*0.0005*	*0.0005*	mg/L	0.0005	377259	ICP-MS	100%
Cobalt	D-Co	*0.0001*	*0.0001*	mg/L	0.0001	377259	ICP-MS	100%
Copper	D-Cu	0.00188	0.00181	mg/L	0.0001	377259	ICP-MS	104%
Lead	D-Pb	0.000082	0.000086	mg/L	0.00005	377259	ICP-MS	95%
Magnesium	D-Mg	1.89	1.6	mg/L	0.005	377259	ICP-MS	118%
Manganese	D-Mn	0.00332	0.00337	mg/L	0.00005	377259	ICP-MS	99%
Molybdenum	D-Mo	0.000223	0.00021	mg/L	0.00005	377259	ICP-MS	106%
Nickel	D-Ni	0.00075	0.00067	mg/L	0.0001	377259	ICP-MS	112%
Potassium	D-K	0.678	0.68	mg/L	0.01	377259	ICP-MS	100%
Strontium	D-Sr	0.0283	0.0263	mg/L	0.0001	377259	ICP-MS	108%
Uranium	D-U	0.000049	0.00005	mg/L	0.00001	377259	ICP-MS	98%
Vanadium	D-V	*0.001*	*0.001*	mg/L	0.001	377259	ICP-MS	100%
Zinc	D-Zn	0.0011	*0.001*	mg/L	0.001	377259	ICP-MS	110%
Aluminum	T-Al	0.197	0.152	mg/L	0.01	377261	ICP-MS	**130%**
Antimony	T-Sb	0.299	0.262	mg/L	0.0002	377013	HVAAS	114%
Antimony	T-Sb	0.271	0.262	mg/L	0.001	377261	ICP-MS	103%
Arsenic	T-As	0.16	0.152	mg/L	0.0002	376986	HVAAS	105%
Arsenic	T-As	0.146	0.152	mg/L	0.001	377261	ICP-MS	96%
Barium	T-Ba	0.438	0.438	mg/L	0.0005	377261	ICP-MS	100%
Beryllium	T-Be	0.0374	0.0367	mg/L	0.005	377261	ICP-MS	102%
Boron	T-B	0.12	0.1	mg/L	0.1	377261	ICP-MS	120%
Cadmium	T-Cd	0.074	0.0767	mg/L	0.0005	377261	ICP-MS	96%
Chromium	T-Cr	0.122	0.125	mg/L	0.005	377261	ICP-MS	98%
Cobalt	T-Co	0.215	0.225	mg/L	0.001	377261	ICP-MS	96%
Copper	T-Cu	0.297	0.309	mg/L	0.001	377261	ICP-MS	96%
Lead	T-Pb	0.386	0.402	mg/L	0.0005	377261	ICP-MS	96%
Manganese	T-Mn	0.324	0.339	mg/L	0.0005	377261	ICP-MS	96%
Molybdenum	T-Mo	0.0972	0.095	mg/L	0.0005	377261	ICP-MS	102%
Nickel	T-Ni	0.204	0.203	mg/L	0.005	377261	ICP-MS	100%
Selenium	T-Se	0.0368	0.0365	mg/L	0.005	377261	ICP-MS	101%
Selenium	T-Se	0.0367	0.0365	mg/L	0.0005	377473	HVAAS	101%
Silver	T-Ag	0.0705	0.0733	mg/L	0.0001	377261	ICP-MS	96%
Strontium	T-Sr	0.344	0.354	mg/L	0.001	377261	ICP-MS	97%
Thallium	T-Tl	0.107	0.111	mg/L	0.001	377261	ICP-MS	96%
Vanadium	T-V	0.193	0.194	mg/L	0.01	377261	ICP-MS	99%
Zinc	T-Zn	0.145	0.151	mg/L	0.01	377261	ICP-MS	96%
Aluminum	T-Al	0.99	1	mg/L	0.2	376878	ICP-OES	99%
Antimony	T-Sb	0.28	0.28	mg/L	0.2	376878	ICP-OES	100%
Arsenic	T-As	0.49	0.49	mg/L	0.2	376878	ICP-OES	100%
Barium	T-Ba	0.526	0.525	mg/L	0.01	376878	ICP-OES	100%
Beryllium	T-Be	0.4	0.397	mg/L	0.005	376878	ICP-OES	101%
Boron	T-B	0.35	0.28	mg/L	0.1	376878	ICP-OES	**125%**
Cadmium	T-Cd	0.354	0.353	mg/L	0.01	376878	ICP-OES	100%

Chromium	T-Cr	0.168	0.167	mg/L	0.01	376878	ICP-OES	101%
Cobalt	T-Co	0.241	0.24	mg/L	0.01	376878	ICP-OES	100%
Copper	T-Cu	0.396	0.391	mg/L	0.01	376878	ICP-OES	101%
Iron	T-Fe	1	1.01	mg/L	0.03	376878	ICP-OES	99%
Lead	T-Pb	0.844	0.857	mg/L	0.05	376878	ICP-OES	98%
Manganese	T-Mn	2.25	2.26	mg/L	0.005	376878	ICP-OES	100%
Molybdenum	T-Mo	0.097	0.097	mg/L	0.03	376878	ICP-OES	100%
Nickel	T-Ni	0.627	0.611	mg/L	0.05	376878	ICP-OES	103%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	376878	ICP-OES	100%
Silver	T-Ag	0.21	0.21	mg/L	0.01	376878	ICP-OES	100%
Strontium	T-Sr	0.104	0.104	mg/L	0.005	376878	ICP-OES	100%
Thallium	T-Tl	0.35	0.38	mg/L	0.2	376878	ICP-OES	92%
Titanium	T-Ti	0.192	0.192	mg/L	0.01	376878	ICP-OES	100%
Vanadium	T-V	1.51	1.5	mg/L	0.03	376878	ICP-OES	101%
Zinc	T-Zn	0.12	0.121	mg/L	0.005	376878	ICP-OES	99%
Mercury	T-Hg	0.0102	0.01	mg/L	0.00001	376999	CVAFS	102%
Fluoride	F	1.03	1.02	mg/L	0.02	377041	Electrode	101%
Calcium	T-Ca	15.6	15.6	mg/L	0.05	376876	ICP-OES	100%
Calcium	T-Ca	15	15.6	mg/L	0.04	377258	ICP-MS	96%
Magnesium	T-Mg	5.59	5.85	mg/L	0.1	376876	ICP-OES	96%
Magnesium	T-Mg	6.42	5.85	mg/L	0.01	377258	ICP-MS	110%
Potassium	T-K	34	33.1	mg/L	2	376876	ICP-OES	103%
Potassium	T-K	33.3	33.1	mg/L	0.1	377258	ICP-MS	101%
Sodium	T-Na	40.2	39.1	mg/L	2	376876	ICP-OES	103%
Sodium	T-Na	38.7	39.1	mg/L	0.02	377258	ICP-MS	99%
Ammonia Nitrogen	N	11.2	11.4	mg/L	0.02	376955	Electrode	98%
Nitrite/Nitrate Nitrogen	N	18.8	17.1	mg/L	0.005	377632	Colourimetry	110%
Aluminum	T-Al	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Antimony	T-Sb	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Arsenic	T-As	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Barium	T-Ba	0.338	0.338	mg/L	0.01	376875	ICP-OES	100%
Beryllium	T-Be	0.0776	0.0751	mg/L	0.005	376875	ICP-OES	103%
Boron	T-B	0.2	0.23	mg/L	0.1	376875	ICP-OES	87%
Cadmium	T-Cd	0.094	0.088	mg/L	0.01	376875	ICP-OES	107%
Chromium	T-Cr	0.222	0.218	mg/L	0.01	376875	ICP-OES	102%
Cobalt	T-Co	0.291	0.28	mg/L	0.01	376875	ICP-OES	104%
Copper	T-Cu	0.295	0.287	mg/L	0.01	376875	ICP-OES	103%
Iron	T-Fe	0.387	0.368	mg/L	0.03	376875	ICP-OES	105%
Lead	T-Pb	0.251	0.264	mg/L	0.05	376875	ICP-OES	95%
Manganese	T-Mn	0.485	0.479	mg/L	0.005	376875	ICP-OES	101%
Molybdenum	T-Mo	0.148	0.149	mg/L	0.03	376875	ICP-OES	99%
Nickel	T-Ni	0.076	0.078	mg/L	0.05	376875	ICP-OES	97%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Silver	T-Ag	0.059	0.063	mg/L	0.01	376875	ICP-OES	94%
Strontium	T-Sr	0.373	0.367	mg/L	0.005	376875	ICP-OES	102%
Thallium	T-Tl	*0.2*	*0.2*	mg/L	0.2	376875	ICP-OES	100%
Tin	T-Sn	0.902	0.89	mg/L	0.03	376875	ICP-OES	101%
Titanium	T-Ti	0.099	0.093	mg/L	0.01	376875	ICP-OES	106%
Vanadium	T-V	0.101	0.097	mg/L	0.03	376875	ICP-OES	104%
Zinc	T-Zn	0.151	0.148	mg/L	0.005	376875	ICP-OES	102%
Total Dissolved Solids		239	236	mg/L	10	378131	Gravimetry	101%
Chloride	Cl	79.3	77.9	mg/L	0.5	376681	Colourimetry	102%
Chloride	Cl	7.74	7.79	mg/L	0.5	376682	Colourimetry	99%
Chloride	Cl	160	156	mg/L	0.5	376683	Colourimetry	103%

Non-detect values shown at the detection limit in italics.

Number of Parameters Failing EPA Criteria	2
%	1.8%

Number of Parameters Failing ALS Criteria	1
%	0.9%

Inorganic Data Validation Summary

1. PROJECT INFORMATION

Project	Eagle Mine - Kennecott	**Project No.**	043-1055
Date	March 14, 2004		
Laboratory	ALS Environmental		
SDG	ALS File No. U1045		
Description of Analysis	Phase I Kinetic Testing – Week 1 Results (Comprehensive)		
Report Date	March 9, 2004		
Validator	Cheryl Ross		

2. CHAIN OF CUSTODY

No. of Samples: __5__
No. of Duplicates: __0__

☐ Sample preservation documented on COC.

☐ Samples preserved correctly. ☐ Not Applicable.

☐ Sample temperature documented on COC.

☐ Samples maintained at 4 °C.

Comments:

- Have requested a copy of COC.

3. SUMMARY OF ANALYSES

Check all analyses included in SDG.

ANALYSIS		NOTES
Metals by ICP-OES		
Metals by ICP-MS	x	
Metals by HVASS	x	As x Sb x Se x
TDS	x	
Chloride (APHA 4500)	x	
Fluoride (APHA 4500)	x	
Ammonia (APHA 4500)	x	
Nitrate/Nitrite (APHA 4500)	x	
Mercury (EPA 7470A/7471/245.7)	x	

☒ All requested analyses conducted.

Comments:

4. LABORATORY REMARKS

☒ Detection limits increased due to matrix interferences.

Comments:

- 18588 – Limited sample volume.
- 18590 – Limited sample volume.
- 18589 – Elevated nickel.
- 18591 – Elevated boron.

5. HOLDING TIME EVALUATION

ANALYSIS	HOLDING TIME (Days)	APPLICABLE	HT EXCEEDED	NOTES
Metals by ICP-OES	6 months			
Metals by ICP-MS	6 months	x		
Metals by HVASS	6 months	x		
TDS	7	x		
Chloride	28	x		
Fluoride	28	x		
Ammonia	28	x		
Nitrate/Nitrite	2	x		
Mercury	28	x		

☐ All analyses conducted within acceptable holding times.

Comments/Qualified Results:

- Need COC to evaluate TDS and nitrate/nitrite.

6. FIELD DUPLICATE SAMPLE RESULTS

☐ Duplicate sample submitted. ☒ No duplicate sample.

☐ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☐ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

7. BATCH QC RESULTS – BLANK SAMPLE

☒ Blank analysis results reported.

☒ All constituents non-detect in the blank sample.

☒ Reporting limits equivalent to project reporting limits.

Constituents detected in blank sample:

Comments/Qualified Results:

8. BATCH QC RESULTS – LABORATORY REPLICATE SAMPLES

☒ Replicate analysis results reported.

☒ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☒ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

- TDS not analyzed in replicate sample.

9. BATCH QC RESULTS – REFRENCE SAMPLES

☒ Reference sample analysis results reported.

☐ All % Recovery meet EPA criteria (between 80 and 120%).

☐ All % Recovery meet lab criteria.

Comments/Qualified Results:

- Two of six aluminum reference samples failed to meet EPA and ALS criteria. The dissolved aluminum by ICP-MS reference analysis was acceptable.
- Two out of five boron reference samples failed to meet EPA criteria. The dissolved boron by ICP-MS reference analysis was acceptable.
- One out of four nickel reference samples by ICP-OES failed to meet EPA criteria. The dissolved nickel by ICP-MS reference analysis was acceptable.
- One out of four thallium reference samples by ICP-OES failed to meet EPA criteria. The dissolved nickel by ICP-MS reference analysis was acceptable.

10. LABORATORY FOLLOW-UP

- Have requested COC from CEMI (email dated March 12, 2004).
- Inquire about aluminum reference sample % recovery.

11. ADDITIONAL COMMENTS

- Supporting documentation provided in *Phase I Kinetic Testing – QAQC.xls.*
- HVAAS and ICP-MS analysis for Se and Sb – good reproducibility.
- HVAAS and ICP-MS analysis for As – 2 of 5 samples failed to meet RPD criteria.

C. Rm
Validator

05/05/04
Date

LABORATORY REPLICATE SAMPLES

Analysis Kinetic Testing - Week 1
Column 3

QA/QC Report

Analyte		Result	Target	Units	DL	ALSQC#	Method	QA/QC RPD
Chloride		198	198	mg/L	1	377152	Ion Chromatography	0%
Fluoride		0.022	0.028	mg/L	0.02	377152	Ion Chromatography or Electrode	+/-MDL
Ammonia Nitrogen		0.03	0.04	mg/L	0.02	377152	Electrode	+/-MDL
Nitrite/Nitrate Nitrogen		<0.005	<0.005	mg/L	0.005	377152	Ion Chromatography	0%
Aluminum	D-Al	0.0066	0.0066	mg/L	0.002	377152	ICP-MS	0%
Antimony	D-Sb	0.00145	0.00148	mg/L	0.0002	377152	ICP-MS	2%
Arsenic	D-As	0.00135	0.00148	mg/L	0.0002	377152	ICP-MS	9%
Barium	D-Ba	0.0537	0.056	mg/L	0.0001	377152	ICP-MS	4%
Beryllium	D-Be	<0.0010	<0.0010	mg/L	0.001	377152	ICP-MS	0%
Bismuth	D-Bi	<0.0010	<0.0010	mg/L	0.001	377152	ICP-MS	0%
Boron	D-B	0.025	0.024	mg/L	0.02	377152	ICP-MS	+/-MDL
Cadmium	D-Cd	<0.00010	<0.00010	mg/L	0.0001	377152	ICP-MS	0%
Calcium	D-Ca	14.1	13.9	mg/L	0.05	377152	ICP-MS	1%
Chromium	D-Cr	<0.0010	<0.0010	mg/L	0.001	377152	ICP-MS	0%
Cobalt	D-Co	0.00044	0.00042	mg/L	0.0002	377152	ICP-MS	+/-MDL
Copper	D-Cu	0.00577	0.00584	mg/L	0.0002	377152	ICP-MS	1%
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	377152	ICP-MS	0%
Lead	D-Pb	0.0002	0.0002	mg/L	0.0001	377152	ICP-MS	0%
Lithium	D-Li	<0.010	<0.010	mg/L	0.01	377152	ICP-MS	0%
Magnesium	D-Mg	58.7	57.6	mg/L	0.1	377152	ICP-MS	2%
Manganese	D-Mn	0.00848	0.00848	mg/L	0.0001	377152	ICP-MS	0%
Mercury	D-Hg	<0.000050	<0.000050	mg/L	0.00005	377152	ICP-MS	0%
Molybdenum	D-Mo	0.00157	0.00161	mg/L	0.0001	377152	ICP-MS	3%
Nickel	D-Ni	0.0169	0.0165	mg/L	0.001	377152	ICP-MS	2%
Phosphorus	D-P	<0.30	<0.30	mg/L	0.3	377152	ICP-MS	0%
Potassium	D-K	34.7	34.3	mg/L	2	377152	ICP-MS	1%
Selenium	D-Se	<0.0020	<0.0020	mg/L	0.002	377152	ICP-MS	0%
Silicon	D-Si	4.7	4.64	mg/L	0.05	377152	ICP-MS	1%
Silver	D-Ag	<0.000020	<0.000020	mg/L	0.00002	377152	ICP-MS	0%
Sodium	D-Na	29.6	28.7	mg/L	2	377152	ICP-MS	3%
Strontium	D-Sr	0.0921	0.0943	mg/L	0.0002	377152	ICP-MS	2%
Thallium	D-Tl	<0.00020	<0.00020	mg/L	0.0002	377152	ICP-MS	0%
Tin	D-Sn	0.00052	0.00055	mg/L	0.0002	377152	ICP-MS	+/-MDL
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	377152	ICP-MS	0%
Uranium	D-U	<0.000020	<0.000020	mg/L	0.00002	377152	ICP-MS	0%
Vanadium	D-V	<0.0020	<0.0020	mg/L	0.002	377152	ICP-MS	0%
Zinc	D-Zn	0.0025	0.0026	mg/L	0.002	377152	ICP-MS	+/-MDL
Antimony	D-Sb	<0.0020	<0.0020	mg/L	0.002	377581	HVAAS	0%
Arsenic	D-As	0.0009	0.00078	mg/L	0.0002	377581	HVAAS	+/-MDL
Selenium	D-Se	<0.00050	<0.00050	mg/L	0.0005	377581	HVAAS	0%

Number of Parameters Failing Criteria	0
%	0.0%

RPD = relative percent difference
Shaded and bolded QA/QC RPD values identify samples that fail QA/QC criteria.
Metals analysis by ICP-MS assumed for all metals.

RY REFERENCE SAMPLES

Analysis Kinetic Testing - Week 1

QA/QC Report

Analyte		Result	Target	Units	DL	ALSQC#	Method	% Recovery
Bismuth	T-Bi	1.06	1	mg/L	0.1	377363	ICP-OES	106%
Bismuth	T-Bi	1.01	1	mg/L	0.1	377588	ICP-OES	101%
Bismuth	T-Bi	1.02	1	mg/L	0.05	377827	ICP-MS	102%
Lithium	T-Li	0.205	0.2	mg/L	0.01	377363	ICP-OES	103%
Lithium	T-Li	0.202	0.2	mg/L	0.01	377588	ICP-OES	101%
Lithium	T-Li	*0.5*	*0.5*	mg/L	0.5	377827	ICP-MS	100%
Phosphorus	T-P	2.08	2	mg/L	0.3	377363	ICP-OES	104%
Phosphorus	T-P	2.05	2	mg/L	0.3	377588	ICP-OES	103%
Silicon	T-Si	1.03	1	mg/L	0.05	377363	ICP-OES	103%
Silicon	T-Si	1.02	1	mg/L	0.05	377588	ICP-OES	102%
Tin	T-Sn	1.04	1	mg/L	0.03	377363	ICP-OES	104%
Tin	T-Sn	1.01	1	mg/L	0.03	377588	ICP-OES	101%
Tin	T-Sn	1.02	1	mg/L	0.01	377827	ICP-MS	102%
Titanium	T-Ti	0.206	0.2	mg/L	0.01	377363	ICP-OES	103%
Titanium	T-Ti	0.202	0.2	mg/L	0.01	377588	ICP-OES	101%
Aluminum	D-Al	0.0562	0.054	mg/L	0.001	377826	ICP-MS	104%
Antimony	D-Sb	0.000258	0.00023	mg/L	0.00005	377826	ICP-MS	112%
Arsenic	D-As	0.00074	0.00068	mg/L	0.0001	377826	ICP-MS	109%
Barium	D-Ba	0.0132	0.0122	mg/L	0.00005	377826	ICP-MS	108%
Beryllium	D-Be	*0.0005*	*0.0005*	mg/L	0.0005	377826	ICP-MS	100%
Cadmium	D-Cd	*0.00005*	*0.00005*	mg/L	0.00005	377826	ICP-MS	100%
Calcium	D-Ca	5.9	6.2	mg/L	0.02	377826	ICP-MS	95%
Chromium	D-Cr	*0.0005*	*0.0005*	mg/L	0.0005	377826	ICP-MS	100%
Cobalt	D-Co	*0.0001*	*0.0001*	mg/L	0.0001	377826	ICP-MS	100%
Copper	D-Cu	0.00183	0.00181	mg/L	0.0001	377826	ICP-MS	101%
Lead	D-Pb	0.000081	0.000086	mg/L	0.00005	377826	ICP-MS	94%
Magnesium	D-Mg	1.51	1.6	mg/L	0.005	377826	ICP-MS	94%
Manganese	D-Mn	0.00338	0.00337	mg/L	0.00005	377826	ICP-MS	100%
Molybdenum	D-Mo	0.000207	0.00021	mg/L	0.00005	377826	ICP-MS	99%
Nickel	D-Ni	0.00067	0.00067	mg/L	0.0001	377826	ICP-MS	100%
Potassium	D-K	0.664	0.68	mg/L	0.01	377826	ICP-MS	98%
Strontium	D-Sr	0.029	0.0263	mg/L	0.0001	377826	ICP-MS	110%
Uranium	D-U	0.000051	0.00005	mg/L	0.00001	377826	ICP-MS	102%
Vanadium	D-V	*0.001*	*0.001*	mg/L	0.001	377826	ICP-MS	100%
Zinc	D-Zn	0.0012	*0.001*	mg/L	0.001	377826	ICP-MS	120%
Chloride	Cl	15.3	15	mg/L	0.5	377460	Ion Chromatography	102%
Chloride	Cl	15.3	15	mg/L	0.5	378006	Ion Chromatography	102%
Fluoride	F	2.08	2	mg/L	0.02	377460	Ion Chromatography	104%
Fluoride	F	2.07	2	mg/L	0.02	378006	Ion Chromatography	104%
Nitrite/Nitrate Nitrogen	N	6.97	6.8	mg/L	0.005	378006	Ion Chromatography	103%
Aluminum	T-Al	0.196	0.152	mg/L	0.01	377828	ICP-MS	**129%**
Antimony	T-Sb	0.308	0.262	mg/L	0.0002	377652	HVAAS	118%
Antimony	T-Sb	0.272	0.262	mg/L	0.001	377828	ICP-MS	104%
Arsenic	T-As	0.149	0.152	mg/L	0.001	377828	ICP-MS	98%
Arsenic	T-As	0.144	0.152	mg/L	0.0002	377835	HVAAS	95%
Barium	T-Ba	0.438	0.438	mg/L	0.0005	377828	ICP-MS	100%
Beryllium	T-Be	0.0366	0.0367	mg/L	0.005	377828	ICP-MS	100%
Boron	T-B	0.12	0.1	mg/L	0.1	377828	ICP-MS	120%
Cadmium	T-Cd	0.0748	0.0767	mg/L	0.0005	377828	ICP-MS	98%
Chromium	T-Cr	0.121	0.125	mg/L	0.005	377828	ICP-MS	97%
Cobalt	T-Co	0.222	0.225	mg/L	0.001	377828	ICP-MS	99%
Copper	T-Cu	0.301	0.309	mg/L	0.001	377828	ICP-MS	97%
Lead	T-Pb	0.385	0.402	mg/L	0.0005	377828	ICP-MS	96%
Manganese	T-Mn	0.326	0.339	mg/L	0.0005	377828	ICP-MS	96%
Molybdenum	T-Mo	0.0979	0.095	mg/L	0.0005	377828	ICP-MS	103%
Nickel	T-Ni	0.207	0.203	mg/L	0.005	377828	ICP-MS	102%
Selenium	T-Se	0.0367	0.0365	mg/L	0.0005	377473	HVAAS	101%
Selenium	T-Se	0.0374	0.0365	mg/L	0.005	377828	ICP-MS	102%
Silver	T-Ag	0.0717	0.0733	mg/L	0.0001	377828	ICP-MS	98%
Strontium	T-Sr	0.351	0.354	mg/L	0.001	377828	ICP-MS	99%
Thallium	T-Tl	0.105	0.111	mg/L	0.001	377828	ICP-MS	95%
Vanadium	T-V	0.191	0.194	mg/L	0.01	377828	ICP-MS	98%
Zinc	T-Zn	0.156	0.151	mg/L	0.01	377828	ICP-MS	103%

Aluminum	T-Al	0.99	1	mg/L	0.2	377364	ICP-OES	99%
Aluminum	T-Al	1.06	1	mg/L	0.2	377589	ICP-OES	106%
Antimony	T-Sb	0.28	0.28	mg/L	0.2	377364	ICP-OES	100%
Antimony	T-Sb	0.26	0.28	mg/L	0.2	377589	ICP-OES	93%
Arsenic	T-As	0.5	0.49	mg/L	0.2	377364	ICP-OES	102%
Arsenic	T-As	0.47	0.49	mg/L	0.2	377589	ICP-OES	96%
Barium	T-Ba	0.54	0.525	mg/L	0.01	377364	ICP-OES	103%
Barium	T-Ba	0.518	0.525	mg/L	0.01	377589	ICP-OES	99%
Beryllium	T-Be	0.403	0.397	mg/L	0.005	377364	ICP-OES	102%
Beryllium	T-Be	0.387	0.397	mg/L	0.005	377589	ICP-OES	97%
Boron	T-B	0.36	0.28	mg/L	0.1	377364	ICP-OES	**129%**
Boron	T-B	0.34	0.28	mg/L	0.1	377589	ICP-OES	**121%**
Cadmium	T-Cd	0.358	0.353	mg/L	0.01	377364	ICP-OES	101%
Cadmium	T-Cd	0.349	0.353	mg/L	0.01	37758G	ICP-OES	99%
Chromium	T-Cr	0.171	0.167	mg/L	0.01	377364	ICP-OES	102%
Chromium	T-Cr	0.167	0.167	mg/L	0.01	377589	ICP-OES	100%
Cobalt	T-Co	0.248	0.24	mg/L	0.01	377364	ICP-OES	103%
Cobalt	T-Co	0.241	0.24	mg/L	0.01	377589	ICP-OES	100%
Copper	T-Cu	0.403	0.391	mg/L	0.01	377364	ICP-OES	103%
Copper	T-Cu	0.394	0.391	mg/L	0.01	377589	ICP-OES	101%
Iron	T-Fe	1.02	1.01	mg/L	0.03	377364	ICP-OES	101%
Iron	T-Fe	0.975	1.01	mg/L	0.03	377589	ICP-OES	97%
Lead	T-Pb	0.868	0.857	mg/L	0.05	377364	ICP-OES	101%
Lead	T-Pb	0.842	0.857	mg/L	0.05	377589	ICP-OES	98%
Manganese	T-Mn	2.29	2.26	mg/L	0.005	377364	ICP-OES	101%
Manganese	T-Mn	2.23	2.26	mg/L	0.005	377589	ICP-OES	99%
Molybdenum	T-Mo	0.098	0.097	mg/L	0.03	377364	ICP-OES	101%
Molybdenum	T-Mo	0.093	0.097	mg/L	0.03	377589	ICP-OES	96%
Nickel	T-Ni	0.605	0.611	mg/L	0.05	377364	ICP-OES	99%
Nickel	T-Ni	0.616	0.611	mg/L	0.05	377589	ICP-OES	101%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	377364	ICP-OES	100%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	377589	ICP-OES	100%
Silver	T-Ag	0.213	0.21	mg/L	0.01	377364	ICP-OES	101%
Silver	T-Ag	0.212	0.21	mg/L	0.01	377589	ICP-OES	101%
Strontium	T-Sr	0.111	0.104	mg/L	0.005	377364	ICP-OES	107%
Strontium	T-Sr	0.106	0.104	mg/L	0.005	377589	ICP-OES	102%
Thallium	T-Tl	0.49	0.38	mg/L	0.2	377364	ICP-OES	**129%**
Thallium	T-Tl	0.39	0.38	mg/L	0.2	377589	ICP-OES	103%
Titanium	T-Ti	0.193	0.192	mg/L	0.01	377364	ICP-OES	101%
Titanium	T-Ti	0.19	0.192	mg/L	0.01	377589	ICP-OES	99%
Vanadium	T-V	1.53	1.5	mg/L	0.03	377364	ICP-OES	102%
Vanadium	T-V	1.48	1.5	mg/L	0.03	377589	ICP-OES	99%
Zinc	T-Zn	0.124	0.121	mg/L	0.005	377364	ICP-OES	102%
Zinc	T-Zn	0.119	0.121	mg/L	0.005	377589	ICP-OES	98%
Mercury	T-Hg	0.0102	0.01	mg/L	0.00001	377763	CVAFS	102%
Mercury	T-Hg	0.00973	0.01	mg/L	0.00001	377937	CVAFS	97%
Fluoride	F	1.01	1.02	mg/L	0.02	377822	Electrode	99%
Calcium	T-Ca	15.7	15.6	mg/L	0.05	377362	ICP-OES	101%
Calcium	T-Ca	15.7	15.6	mg/L	0.05	377587	ICP-OES	101%
Calcium	T-Ca	15.4	15.6	mg/L	0.04	377825	ICP-MS	99%
Magnesium	T-Mg	5.86	5.85	mg/L	0.1	377362	ICP-OES	100%
Magnesium	T-Mg	5.72	5.85	mg/L	0.1	377587	ICP-OES	98%
Magnesium	T-Mg	5.38	5.85	mg/L	0.01	377825	ICP-MS	92%
Potassium	T-K	34.4	33.1	mg/L	2	377362	ICP-OES	104%
Potassium	T-K	34.3	33.1	mg/L	2	377587	ICP-OES	104%
Potassium	T-K	34.9	33.1	mg/L	0.1	377825	ICP-MS	105%
Sodium	T-Na	40.9	39.1	mg/L	2	377362	ICP-OES	105%
Sodium	T-Na	40.9	39.1	mg/L	2	377587	ICP-OES	105%
Sodium	T-Na	41.1	39.1	mg/L	0.02	377825	ICP-MS	105%
Ammonia Nitrogen	N	11.3	11.4	mg/L	0.02	377834	Electrode	99%
Aluminum	T-Al	*0.2*	*0.2*	mg/L	0.2	377361	ICP-OES	100%
Aluminum	T-Al	0.51	*0.2*	mg/L	0.2	377586	ICP-OES	**255%**
Antimony	T-Sb	*0.2*	*0.2*	mg/L	0.2	377361	ICP-OES	100%
Antimony	T-Sb	*0.2*	*0.2*	mg/L	0.2	377586	ICP-OES	100%
Arsenic	T-As	*0.2*	*0.2*	mg/L	0.2	377361	ICP-OES	100%
Arsenic	T-As	*0.2*	*0.2*	mg/L	0.2	377586	ICP-OES	100%
Barium	T-Ba	0.345	0.338	mg/L	0.01	377361	ICP-OES	102%
Barium	T-Ba	0.338	0.338	mg/L	0.01	377586	ICP-OES	100%
Beryllium	T-Be	0.0784	0.0751	mg/L	0.005	377361	ICP-OES	104%
Beryllium	T-Be	0.0769	0.0751	mg/L	0.005	377586	ICP-OES	102%

Boron	T-B	0.21	0.23	mg/L	0.1	377361	ICP-OES	91%
Boron	T-B	0.21	0.23	mg/L	0.1	377586	ICP-OES	91%
Cadmium	T-Cd	0.087	0.088	mg/L	0.01	377361	ICP-OES	99%
Cadmium	T-Cd	0.091	0.088	mg/L	0.01	377586	ICP-OES	103%
Chromium	T-Cr	0.219	0.218	mg/L	0.01	377361	ICP-OES	100%
Chromium	T-Cr	0.225	0.218	mg/L	0.01	377586	ICP-OES	103%
Cobalt	T-Co	0.29	0.28	mg/L	0.01	377361	ICP-OES	104%
Cobalt	T-Co	0.289	0.28	mg/L	0.01	377586	ICP-OES	103%
Copper	T-Cu	0.299	0.287	mg/L	0.01	377361	ICP-OES	104%
Copper	T-Cu	0.296	0.287	mg/L	0.01	377586	ICP-OES	103%
Iron	T-Fe	0.38	0.368	mg/L	0.03	377361	ICP-OES	103%
Iron	T-Fe	0.378	0.368	mg/L	0.03	377586	ICP-OES	103%
Lead	T-Pb	0.253	0.264	mg/L	0.05	377361	ICP-OES	96%
Lead	T-Pb	0.266	0.264	mg/L	0.05	377586	ICP-OES	101%
Manganese	T-Mn	0.488	0.479	mg/L	0.005	377361	ICP-OES	102%
Manganese	T-Mn	0.492	0.479	mg/L	0.005	377586	ICP-OES	103%
Molybdenum	T-Mo	0.155	0.149	mg/L	0.03	377361	ICP-OES	104%
Molybdenum	T-Mo	0.151	0.149	mg/L	0.03	377586	ICP-OES	101%
Nickel	T-Ni	0.097	0.078	mg/L	0.05	377361	ICP-OES	**124%**
Nickel	T-Ni	0.093	0.078	mg/L	0.05	377586	ICP-OES	119%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	377361	ICP-OES	100%
Selenium	T-Se	*0.2*	*0.2*	mg/L	0.2	377586	ICP-OES	100%
Silver	T-Ag	0.066	0.063	mg/L	0.01	377361	ICP-OES	105%
Silver	T-Ag	0.066	0.063	mg/L	0.01	377586	ICP-OES	105%
Strontium	T-Sr	0.358	0.367	mg/L	0.005	377361	ICP-OES	98%
Strontium	T-Sr	0.36	0.367	mg/L	0.005	377586	ICP-OES	98%
Thallium	T-Tl	*0.2*	*0.2*	mg/L	0.2	377361	ICP-OES	100%
Thallium	T-Tl	*0.2*	*0.2*	mg/L	0.2	377586	ICP-OES	100%
Tin	T-Sn	0.88	0.89	mg/L	0.03	377361	ICP-OES	99%
Tin	T-Sn	0.873	0.89	mg/L	0.03	377586	ICP-OES	98%
Titanium	T-Ti	0.093	0.093	mg/L	0.01	377361	ICP-OES	100%
Titanium	T-Ti	0.095	0.093	mg/L	0.01	377586	ICP-OES	102%
Vanadium	T-V	0.097	0.097	mg/L	0.03	377361	ICP-OES	100%
Vanadium	T-V	0.106	0.097	mg/L	0.03	377586	ICP-OES	109%
Zinc	T-Zn	0.158	0.148	mg/L	0.005	377361	ICP-OES	107%
Zinc	T-Zn	0.152	0.148	mg/L	0.005	377586	ICP-OES	103%
Total Dissolved Solids		229	236	mg/L	10	378357	Gravimetry	97%

Non-detect values shown at the detection limit in italics.

Number of Parameters Failing EPA Criteria	6
%	3.5%

Number of Parameters Failing ALS Criteria	2
%	1.2%

Inorganic Data Validation Summary

1. PROJECT INFORMATION

Project	Eagle Mine - Kennecott	**Project No.**	043-1055
Date	March 14, 2004		
Laboratory	ALS Environmental		
SDG	ALS File No. U1206		
Description of Analysis	Phase I Kinetic Testing – Week 2 Results		
Report Date	March 11, 2004		
Validator	Cheryl Ross		

2. CHAIN OF CUSTODY

No. of Samples: __5___
No. of Duplicates: __1___

☐ Sample preservation documented on COC.

☐ Samples preserved correctly. ☐ Not Applicable.

☐ Sample temperature documented on COC.

☐ Samples maintained at 4 °C.

Comments:

- Have requested a copy of COC.

3. SUMMARY OF ANALYSES

Check all analyses included in SDG.

ANALYSIS		NOTES
Metals by ICP-OES	x	
Metals by ICP-MS		
Metals by HVASS		As Sb Se
TDS		
Chloride (APHA 4500)		
Fluoride (APHA 4500)		
Ammonia (APHA 4500)		
Nitrate/Nitrite (APHA 4500)		
Mercury (EPA 7470A/7471/245.7)		

☒ All requested analyses conducted.

Comments:

- Hg and U not included in ICP-OES suite.

4. LABORATORY REMARKS

☒ Detection limits increased due to matrix interferences.

Comments:

- 18649 – Nickel interference.

5. HOLDING TIME EVALUATION

ANALYSIS	HOLDING TIME (Days)	APPLICABLE	HT EXCEEDED	NOTES
Metals by ICP-OES	6 months	x		
Metals by ICP-MS	6 months			
Metals by HVASS	6 months			
TDS	7			
Chloride	28			
Fluoride	28			
Ammonia	28			
Nitrate/Nitrite	2			
Mercury	28			

☒ All analyses conducted within acceptable holding times.

Comments/Qualified Results:

6. FIELD DUPLICATE SAMPLE RESULTS

☒ Duplicate sample submitted. ☐ No duplicate sample.

☒ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☒ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results:

7. BATCH QC RESULTS – BLANK SAMPLE

☒ Blank analysis results reported.

☒ All constituents non-detect in the blank sample.

☒ Reporting limits equivalent to project reporting limits.

Constituents detected in blank sample:

Comments/Qualified Results:

- Reporting limits OK for Ca, Fe and Mg.
- Interferences result in higher than standard ICP-OES reporting limits.

8. BATCH QC RESULTS – LABORATORY REPLICATE SAMPLES

☒ Replicate analysis results reported.

☒ All RPDs < 20% (samples above 5 times the reporting limit (RL)).

☒ All results +/- 1 RL (samples below 5 times the RL).

Comments/Qualified Results: