Pebble Project

NORTHERN DYNASTY MINES INC.

DRAFT ENVIRONMENTAL BASELINE STUDIES

2004 PROGRESS REPORTS

CHAPTER 8. GEOCHEMICAL CHARACTERIZATION AND ARD/ML

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ACRONYMS

ABA	acid-base accounting
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADOT/PF	Alaska Department of Transportation and Public Facilities
agl	above ground level
AHRS	Alaska Heritage Resource Survey
ALS	ALS Environmental Laboratory
ANCSA	Alaska Native Claims Settlement Act
AP	acid potential
APE	area of potential effect
ASTM	American Society for Testing and Materials
ASTt	Arctic Small Tool tradition
BBNA	Bristol Bay Native Association
BLM	Bureau of Land Management
BP	before present
^{14}C	Carbon 14
CEMI	Canadian Environmental and Metallurgical Laboratory
CRM	cultural resources management
CUEQ%	copper equivalent grade
DEM	digital elevation model
EIS	environmental impact statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FR	Federal Register
GIS	geographic information system
GMU	Game Management Unit
GPS	global positioning system
GLM	general linear model
ICP	inductively coupled plasma
LIDAR	light detection and ranging
M.A.	Master of Arts
MCHTWG	Mulchatna Caribou Herd Technical Working Group
m^2	square meter(s)
MEND	mine environment meutral drainage
mi^2	square mile(s)

ML/ARD	metal leaching/acid rock drainage
MMS	Minerals Management Service
MODIS	moderate resolution imaging spectroradiometer
mph	miles per hour
NASA	National Aeronautics and Space Administration
NDM	Northern Dynasty Mines Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NP	neutralization potential
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
PAG	potentially acid-generating
PSD	Prevention of Significant Deterioration
QA	quality assurance
QAPP	quality assurance project plan
SHPO	State Historic Preservation Officer
SRB&A	Stephen R. Braund & Associates
SRK	SRK Consulting (Canada) Inc.
SWE	snow water equivalent
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHF	very high frequency

8. GEOCHEMICAL CHARACTERIZATION AND METAL LEACHING/ACID ROCK DRAINAGE

8.1 Introduction

This report presents the preliminary findings of the 2004 study of metal leaching/acid rock drainage (ML/ARD). The results presented in this report are for:

- Static acid-generation testing of rock core obtained prior to 2004 (including previous drilling by Cominco Alaska),
- Element scans for core collected in 2004 from the Tertiary cover rocks and periphery of the deposit near the eventual pit walls of the mine, and
- Static acid-generation testing of metallurgical waste products and water-chemistry analysis from process flowsheet development.

The report does not include results from leach tests and kinetic geochemical tests which are currently underway. As such, the data obtained provide an early indication of the possible geochemical nature of mine wastes but do not allow water-quality predictions to be provided.

8.2 Study Objectives

The ML/ARD study has been designed to characterize the materials that will be produced from the mining and milling process in terms of geochemical behavior and the chemistry of waters in contact with the wastes. The data produced from the geochemical testing will be used for prediction of tailings and mine-rock water chemistry and for the evaluation of alternative mine-waste deposition plans for operation and closure. Therefore, the overall objective of the geochemical characterization program is to provide data for assessment of environmental impact and for the design and mitigation measures to minimize potential for adverse environmental impact from mine-rock (or mine-waste) management facilities.

8.3 Study Area

The study area covers all mineral waste materials that could conceivably be generated by mining of economic mineralization to the maximum extent possible based on current understanding of the occurrence of metals within the deposit. The study area therefore comprises waste rock produced by extraction of rock for metal recovery, the pit walls of the deposit and rock extracted in the pit footprint for construction, and the tailings products.

The study area does not include the access or pipeline corridors.

8.4 Scope of Work

The research and field work for this study were conducted during 2004. The study was conducted by Linda Broughton, Professional Engineer, and Stephen Day, Professional Geologist. The study was conducted according to the approach described in the Draft Environmental Baseline Studies, Proposed 2004 Study Plan (NDM, 2004).

The major scope items of this study in 2004 were as follows:

- Site visit to view existing rock core.
- Selection of samples from existing rock core for static acid-generation testing.
- Selection of a laboratory for geochemical testing of samples.
- Initiation of static testing.
- Review of results and selection of samples for leach and kinetic geochemical tests.
- Input to selection of additional drill-holes to characterize eventual pit walls and review of element scan data for the cores.
- Liaison with the project metallurgists to characterize tailings products.

8.5 Methods

8.5.1 Site Visit

The Pebble Project site was visited in August 2004 by Linda Broughton and Stephen Day. The following activities were completed during the site visit:

- An overview of the site geology was provided by site personnel.
- A selection of diamond drill-holes were examined to better understood the project geology.
- A single hole in the Tertiary geological units was logged by SRK Consulting (Canada) Inc. (SRK) to provide guidance to site personnel on the level of detail expected to support the ML/ARD study. The resulting log is provided in Appendix 8-A).
- The deposit area and potential tailings deposition areas were inspected by helicopter. Locations of natural seepage were examined.

8.5.2 Pre-2004 Rock Sample Selection and Collection

NDM provided SRK with an Excel database containing drill-hole lithological and assay data for all previous drilling at the Pebble Deposit. The results include drilling undertaken by Cominco Alaska and Northern Dynasty Mines Inc. (NDM). The drilling undertaken by Cominco occurred between 1988 and 1997, while the NDM drilling occurred during 2002 and 2003. The database contains in excess of 16,300 sample intervals.

Sample selection was designed to ensure the following components would be represented in the testwork:

- All lithologies.
- All alteration types and zones identified in the database.
- The range of potential contaminant and sulfide values covering typical and extreme values.

As the core available for sampling has been in storage for a variable length of time, representative samples of the same lithology were collected from the older (Cominco) and newer (NDM) core. The purpose of this was to assess the extent of natural oxidation that has occurred during core storage.

Several iterative steps were followed to identify sampling intervals, as described below. The assay database was used primarily, with elements of the lithological database used and imported where required. The lithological database provided coding on alteration zones and types for the samples selected.

The database provided data relating to the Pebble Deposit and neighboring prospects. Therefore, a filter was first added that identified the drill-holes within the Pebble Deposit. This was done by using the X-Y coordinates of the resource land for the Pebble Deposit.

Within the resource land, drill-holes were selected to provide adequate spatial coverage for the 2 billion tonne pit outline. Approximately five boreholes per 2500 square meters (m^2) were initially selected, resulting in a total of 65 holes. The selection of samples also considered the availability of core based on a catalogue provided by NDM.

Simplified primary lithological codes based on the major rock type reported (the first character of NDM's lithology codes) were then assigned to each logged interval.

The lithological changes with depth at each of these drill-holes then was assessed using the database and was used to select samples. This process was assisted by color-coding of intervals according to the following parameters:

- Copper equivalent grade (CUEQ%, calculated by NDM).
- Percent sulfur (S%) determined by *aqua regia* digestions with inductively coupled plasma (ICP) finish used as an initial surrogate for total sulfur and acid potential.
- Percent calcium (Ca%) similarly determined and used as an initial surrogate for neutralization potential.
- Pyrite (calculated by NDM from sulfur less the sulfur associated with copper, zinc, and molybdenum).
- Sodium/potassium (Na/K—calculated by SRK as an indicator of degree of alteration).

The sulfur and calcium concentrations provided best available initial surrogates for acid potential and neutralization potential. The method used to determine sulfur is only an approximation of acid potential since the rock was expected to contain some gypsum ($CaSO_4.2H_2O$) which is not acid-generating. Sulfur determined by this method may underestimate acid potential due to the digestion used, or overestimate acid potential if sulfur is present in forms other than sulfides. Similarly, the use of calcium to represent neutralization potential is only an approximation based on experience at other sites since calcium occurs in minerals other than carbonates, including sulfates and silicates. In general, the calculation overestimates actual neutralization potential. All samples selected were subsequently tested using specific methods for sulfur forms and neutralization potential. Comparison of these results with the surrogates showed that the surrogates provided a reliable initial basis for sample selection.

To ensure that samples selected were representative of geochemical variations, scatter plots for each lithological type were carefully reviewed. Based on this gap analysis, further samples were selected to ensure all variations observed were represented in the intervals selected. Figure 1 provides an example of the distribution of samples selected for geological Unit Y (hornfelsed and mineralized host sedimentary units of Jurassic and Cretaceous age) with respect to copper, sulfur, and calcium content.

The list of 424 sample intervals selected is provided in Appendix 8-B. The locations of the drill-holes are shown in Figure 2. Using the list, NDM obtained the samples from core storage at Iliamna. Not all intervals requested were available, and the actual number of samples was 399. The samples were collected as whole or half core over the entire interval requested. Each sample typically consisted of two original sample intervals. Each separate interval was individually bagged, tagged, and shipped to Vancouver for testing.

8.5.3 2004 Drill-hole Location Selection and Sample Collection

Review of the pre-2004 database indicated that additional rock samples were needed to characterize the potential ultimate pit walls. Approximately nine equally spaced locations were chosen with reference to the project pit limits and contours of estimated pyrite content in the rock prepared by NDM. The final locations of the holes are shown on Figure 2.

The holes were drilled, logged, and sampled as part of NDM’s exploration program in 2004.

8.5.4 Laboratory Selection

A request-for-proposal to perform the specific geochemical tests required for the project was issued to three qualified laboratories in the Vancouver, B.C., area in June 2004. Two of the laboratories (ALS Environmental, and Canadian Environmental and Metallurgical [CEMI]) submitted a joint proposal. Vizon Scitech prepared a proposal in combination with another local water-testing laboratory (Cantest). After consideration of technical and cost factors, the team of ALS/CEMI was selected to do the work

8.5.5 Rock Sample Analysis

8.5.5.1 Pre-2004 Core

Prior to preparation and analysis of the core, SRK visually inspected all samples and photographed some samples at NDM’s Port Kells warehouse, primarily to document that the materials in each sample were relatively homogeneous.

Sample preparation involved several crushing, grinding, and splitting steps to reduce sample volume and to provide materials for static and kinetic testing.

All samples were analyzed for acid-base accounting (ABA) using the method of mine environment neutral drainage (MEND Program, 1991). The ABA included total sulfur, sulfur as sulfate, rinse pH, total inorganic carbon and neutralization potential (NP). Neutralization potentials were also determined on 10 percent of samples using the method of Sobek et al. (1978) for comparative purposes. Since the majority of samples had already been analyzed for metal concentrations as part of the exploration program, metal concentrations were only determined for the Tertiary rock types that had not been previously analyzed.

8.5.5.2 2004 Core

Samples collected during 2004 were tested as part of NDM's exploration drilling programs. Element scans were performed by ALS-Chemex in North Vancouver, British Columbia

8.5.6 Selection of Samples for Leach and Kinetic Testing of Rock

Based on results from testing of pre-2004 core samples (Section 8.6.1), samples were selected for leach and kinetic testing. Leach extractions will be performed as shake flasks tests using the protocol of Price (1997). At this stage, kinetic tests will be performed as humidity cells using a modification of ASTM (American Society for Testing and Materials) D5744-96.

8.5.6.1 Shake Flask Extractions

The objective of shake flask extractions is to evaluate the accumulation and solubility of contaminant load under a range of pH conditions. The distribution of paste pH in the acid-base accounting was used as a basis for selection of samples. Paste pH tends to overestimate actual pH of rock at low pHs due to the liberation of reactive carbonate and silicate fines by pulverization prior to ABA testing. Experience indicates that paste pHs below 5 are typically 1 pH unit higher than the coarse crushed rock. Therefore, paste pHs were grouped into the following categories for sample selection:

- Group 1 — Paste pH <5.5 (actual pH <~4.5)—Rock pH controlled by soluble aluminum and ferric iron species.
- Group 2 — Paste pH between 5.5 and 7—Rock with pH controlled by soluble aluminum and copper species.
- Group 3 — Paste pH greater than 7—Pre-Tertiary rock (elevated S) with pH controlled by carbonate mineral solubility.
- Group 4 — Paste pH greater than 7—Tertiary rock (low S) with pH controlled by carbonate mineral solubility.

Samples were chosen separately for Groups 3 and 4 to reflect the major differences in the rock types and possible differences in solubility of potential contaminants.

The target number for shake flask extractions for this testing was defined as 30. For Groups 1 and 2, the target number of samples was 10 each. For Groups 3 and 4, the target was five samples each. Selection of actual samples within the group was made using a random number generator. The target proportion of samples in each group was selected based on the proportion of available samples to target (Table 1). Each sample was assigned a random number which was compared to the proportion. If the random number was less than the proportion, the sample was selected. The resulting numbers of samples selected from each pH group are shown in Table 1.

TABLE 1.
Tally of Samples Selected for Shake Flask Extractions

pH Group	Available Samples	Target	Actual
1	39	10	11
2	72	10	11
3	214	5	4
4	51	5	6

8.5.6.2 Humidity Cells

The following primary criteria were considered when selecting humidity cell samples:

- **Age of the Core.** The varying age of the core enables testing of material that has already undergone oxidation and therefore potentially indicates weathering rates beyond the usual time frame for kinetic testing and project permitting.
- **Sulfur Content**. Rates of oxidation are invariably correlated with sulfur content. Testing of materials with a range of sulfur concentrations enables oxidation rates to be interpolated beyond the dataset.
- **Rock Type**. Rock type may be a factor due to differences in style of mineralization and gangue mineralogy. At least 15 different rock types have been identified, though at present the only relationships to rock type are the differences between the mineralized rock and Tertiary cover. For the mineralized rock, the different rock types were grouped into two logical major groups (country rock and intrusion), but the final selections were also checked to ensure that samples were selected from the major intrusive rock types.

Table 2 shows the matrix of primary selection criteria.

Secondary criteria were

- **Neutralization Potential**. The availability of neutralization potential determines whether rock will generate acid and timing of acidic leachate release. Samples with lower levels of NP were included in the selection to evaluate the transition to acidic conditions, and the availability and depletion of NP.
- **Concentration of Potential Contaminants.** Samples were selected to include a range of concentrations of arsenic, copper, molybdenum, selenium, and zinc.

Actual sample selection involved sorting the samples into the primary criteria indicated in Table 2. Within the criteria groupings, samples were sorted using an assigned random number. The sample near the middle of the sorted group was selected initially but then adjusted to reflect the secondary criteria. The resulting sample lists are shown in Tables 3 (pre- Tertiary) and 4 (Tertiary). Roughly two of each of the major pre-Tertiary intrusive rock units were selected and represent the range of compositional variation (gabbro, diorite, granodiorite, quartz monzodiorite, monzodiorite, monzonite, and intrusive breccia). The samples of Tertiary units were selected to characterize median and extreme sulfur concentrations.

TABLE 2.
Sample Selection Matrix for Humidity Cells

	Core Age	**1. 1989-1992**			**2. 1997**			**3. 2002-2003**		
Rock Types	Sulfur as Sulfide Concentration Range, %	i. <1.5	ii. 1.5 to 2.5	iii. >2.5	i. <1.5	ii. 1.5 to 2.5	iii. >2.5	i. <1.5	ii. 1.5 to 2.5	iii. >2.5
Tertiary Cover	Sediments	2 tests								
	Volcano-Sediments	2 tests								
Tertiary Intrusions	Basalt Dykes	2 tests								
Intrusions	A. Plutonic Rocks	1Ai[1]	1Aii	1Aiii	2Ai	2Aii	2Aiii	3Ai	3Aii	3Aiii
Host Rocks	B. Sedimentary and Volcano-sedimentary Units	1Bi	1Bii	1Biii	NS[2]	2Bii	2Biii	3Bi	3Bii	3Biii

Notes:

1. Designation of samples in Table 3.

2. NS = Dataset contains only one sample. No test proposed.

TABLE 3.
Samples Selected for Kinetic Testing—Pre-Tertiary

Rock Type	Sample ID #	Paste pH s.u.	Total S %	S-SO$_4$ %	S-S^{2-} %	NP$_{modified}$ kg CaCO$_3$/t	NP$_{modified}$/AP	As ppm	Cu %	Mo ppm	Zn ppm	Selection
Granodiorite-Quartz-Monzodiorite	046-0580-0600	8.0	1.45	0.01	1.44	8.0	0.18	9	0.22	102	21	1Ai
Monzodiorite	046-0113-0133	7.2	1.73	0.02	1.71	6.1	0.11	25	0.32	194	56	1Aii
Diorite/Gabbro	025-0617-0637	5.0	3.56	0.19	3.37	9.8	0.09	1013	0.60	157	96	1Aiii
Monzonite (near Stock A)	118-0468-0488	8.4	1.19	0.02	1.17	37.5	1.03	14	0.27	109	24	2Ai
Monzodiorite	117-0190-0210	7.5	1.90	0.04	1.86	5.6	0.10	0	0.32	0	0	2Aii
Intrusion Breccia	112-0460-0480	6.7	2.98	0.05	2.93	5.6	0.06	86	0.36	84	23	2Aiii
Intrusion Breccia	3124-0872-0887	8.4	1.47	0.05	1.42	45.5	1.03	24	0.10	244	86	3Ai
Granodiorite-Quartz-Monzodiorite	3069-0927-0947	6.5	2.48	0.04	2.44	3.2	0.04	54	0.24	137	59	3Aii
Diorite/Gabbro	3123-0438-0458	8.7	4.88	0.01	4.87	41.8	0.27	30	0.17	37	27	3Aiii
Andesitic Bedded Rocks (Volcaniclastic Sandstone, Wacke)	019-0072-0090	6.9	0.78	0.38	0.40	0.4	0.04	3	0.14	242	29	1Bi
Andesitic Bedded Rocks (Argillite, Siltstone)	033-0137-0155	8.4	2.21	0.02	2.19	26.5	0.39	48	0.22	123	56	1Bii
Andesitic Bedded Rocks (Volcaniclastic Sandstone, Wacke)	047-0350-0365	6.8	3.43	0.08	3.35	6.1	0.06	43	0.49	120	113	1Biii
Andesitic Bedded Rocks (Volcaniclastic Sandstone, Wacke)	118-1220-1238	7.7	2.59	0.11	2.48	32.6	0.42	11	0.27	199	16	2Bii
Andesitic Bedded Rocks (Argillite, Siltstone)	118-0520-0535	7.0	3.1	0.14	2.96	30.9	0.33	80	0.32	39	29	2Biii
Andesitic Bedded Rocks (Argillite, Siltstone)	3115-0988-1008	8.5	1.49	0.01	1.48	10.0	0.22	28	0.27	113	19	3Bi
Andesitic Bedded Rocks (Argillite, Siltstone)	3124-0188-0209	6.1	2.49	0.02	2.47	0.1	0.00	10	0.29	43	27	3Bii
Andesitic Bedded Rocks (Argillite, Siltstone)	3102-0568-0588	7.9	3.23	0.1	3.13	18.5	0.19	138	0.21	93	71	3Biii

TABLE 4.
Samples Selected for Kinetic Testing—Tertiary

Sample ID	**Paste pH** **s.u.**	**Total S** **%**	**S-SO$_4$** **%**	**S-S^{2-}** **%**	**NP$_{modified}$** **kg CaCO$_3$/t**	**NP/AP**
Sedimentary Units						
115-0054-0066	7.9	0.25	0.05	0.20	29.0	4.6
115-0142-0163	7.4	0.60	0.30	0.30	41.4	4.4
Volcano-sedimentary Units						
3129-0253-0272	9.1	0.11	0.01	0.10	83.8	26.8
3129-0417-0435	8.5	0.03	0.01	0.02	98.5	157.6
Intrusive Dykes						
117-1055-1071	8.2	0.26	0.01	0.25	108.5	13.89
3102-0958-0978	8.7	0.69	0.01	0.68	103.3	4.86

8.5.7 Characterization of Metallurgical Waste Products

In 2004, bench-scale testing of potential ore-type materials were conducted by Process Research Associates in Vancouver under the supervision of Morris Beattie. Tailings from the testing were shipped to CEMI. Currently, three types of tailings have been generated, designated as follows:

1. Scavenger Tails—Produced by rougher flotation followed by scavenger flotation.
2. Bulk Cleaner Tails—Produced by cleaner flotation followed by scavenger flotation.
3. Pyrite Tails—Produced by copper sulfide flotation and cleaning.

The first two types of tailings, which will be combined, represent a low sulfide product produced by bulk sulfide flotation.

The tailings products from process testing of five samples have been tested as follows:

- Solids samples are tested for ABA and metal content.
- Filtered solution samples are tested for general major ions and a metal scan.

One bioassay has been performed on a solution sample.

In December 2004, bulk tailings samples from process testing at G&T in Kamloops, British Columbia were shipped to CEMI. A testing program for these samples is currently being defined.

8.6 Results and Discussion

8.6.1 Rock Testing

8.6.1.1 Acid-Base Accounting on Pre-2004 Core

The overall number of samples of each rock tested are shown in Table 5

TABLE 5.
Number of Samples of Each Type Tested

Stratigraphic Section	Rock Type	Unit Designation	n
Quaternary Deposits	Ferricrete	Fc	2
	Overburden	Ob	8
Tertiary Rocks	Sedimentary Units	TC/TW/TY	24
	Volcanic Units	TA/TB/TD	17
Cretaceous Stratiform and Cross-cutting Plutonic Rocks	Diorite/Gabbro	D	45
	Granodiorite-Quartz-Monzodiorite	G (Gp and Gs)	70
	Monzodiorite	N	39
	Monzonite	F (and X2)	17
	Monzonite (near Stock A)	M	12
	Intrusion Breccia	X	23
	Porphyritic Monzodiorite to Quartz Monzodiorite	P	13
	Skarn	K	5
Jurassic to Cretaceous Sedimentary and Volcano-sedimentary Rocks	Andesitic Bedded Rocks (Argillite, Siltstone)	Y	90
	Andesitic Bedded Rocks (Volcaniclastic Sandstone, Wacke)	W	8
Other		R	17
		Z	9

The following paragraphs provide initial discussion of the data in terms of sulfur speciation, neutralization potential, and rock type characteristics.

Figure 3 compares total sulfur and sulfur as sulfate concentrations. As shown, the majority of samples contained much less sulfate than total sulfur, indicating the sulfur occurs primarily as sulfide minerals. A few samples contain primarily sulfur in the form of sulfate. The sulfate mineral is expected to be mainly gypsum, but in some cases, sulfide oxidation products (such as jarosite) may also be present. The difference in sulfur concentrations for pre-Tertiary and Tertiary (T) rock types is apparent. Tertiary rock types consistently have lower sulfur concentrations and relatively more sulfate. Sulfur concentrations in the pre-Tertiary rock types are typically between 1 and 5 percent sulfur up to maximum concentrations near 9 percent.

Figure 4 compares neutralization potential (NP) with total inorganic carbon (TIC carbon as carbonate). TIC has been converted to the same units as NP. The chart shows that carbonate tends to exceed neutralization potential. This indicates that carbonate probably occurs in forms such as ankerite that do not neutralize acid. Some negative neutralization potentials were obtained due to the presence of acidity in the sample formed in storage. Paste pHs as low as 4.1 were recorded.

Figure 5 is an overall chart of acid potential (AP—calculated from total sulfur less sulfur as sulfate) and NP. Diagonal lines on the chart indicate NP/AP = 1 (below which the rock is classified as potentially acid-generating, PAG) and NP/AP = 2 (above which the rock is classified as non-acid-generating, non-PAG). Between these lines, the classification is uncertain. The plot indicates that the pre-Tertiary rocks affected by mineralization are almost exclusively PAG, whereas Tertiary rocks are non-PAG due to the lower sulfur content and higher neutralization potential. A few samples of pre-Tertiary rock could not be classified but these represent an insignificant proportion of the material.

Due to the requirement for Tertiary rock as a construction material for the project, NDM completed a detailed geological assessment of rock core. This study confirmed the results of this ABA assessment that sulfur content is low and that carbonate content shown by a fizz test is high.

The data were assessed to evaluate the effects of age of the samples. Table 6 shows the number of samples in each age category. For each year grouping, percentiles for critical parameters (total S, S as sulfide, paste pH, and NP) were calculated.

TABLE 6.
Number of Samples By Drilling Year

Drilled Year	Number of Samples
1989	2
1990	20
1991	59
1992	10
1997	55
2002	15
2003	199

Evidence that oxidation has occurred in storage is illustrated by the general increase in sulfate sulfur relative to sulfur as the age of the core increased (Figure 6). The oxidized core (95th percentile) indicates that as much as 50 percent of sulfur in the core has oxidized, though more typically no more than 3 percent has oxidized, indicating that oxidation can be expected to continue for many more decades if the core is exposed to weathering. The increase in sulfate content is also matched by generally decreasing pH from a median value of 8 for the 2003 core to 6.6 for the 1990 core. The 5th percentile pHs decreased from 5.8 in 2002 to 4.7 in 1990. The 95th percentile indicates that some of the core remained relatively fresh (pH above 8). Neutralization potential showed an erratic though generally decreasing trend for each percentile (Figure 7). The 5th percentile NPs were all effectively zero and indicate that this low NP material has already generated acid in storage. The regression line for the 50th percentile implies that if core had been produced in 1983 it would be acidic (i.e., NP = 0 kg $CaCO_3$/t). Similarly, 95th percentile NP exposed in 1964 would be completely depleted.

These preliminary calculations indicate that it would take about 40 years for nearly all pre-Tertiary rock to become acidic under site conditions.

8.6.1.2 Element Scans on 2004 Core

To date, samples collected from drill-holes located near the ultimate pit walls have been analyzed for an element scan which includes sulfur. Sulfur concentrations determined by this method are semi-quantitative due to the type of digestion used. Down-hole sulfur trends are shown in Figure 8. Distances along core are shown relative to the approximate lowest elevation on the ultimate pit limits (289.6 meters). This would correspond to the final flood level. Elevations above this level ("zero" in the profiles) are therefore approximately the unflooded high wall of the pit at closure. The profiles are grouped approximately into three pit-wall sectors.

The South Wall (SRK-5, -6 and -7) show a range of sulfur concentrations above the pit wall. SRK-5 starts with approximately 33 meters of overburden which was not tested. The mineralized pre-Tertiary rock below the overburden contains over 3 percent sulfur. SRK-6 shows a similar profile but mineralized pre-Tertiary rock could be exposed. SRK-7 had generally low sulfur concentrations (<1 percent) due to intersection of unmineralized Tertiary dykes to a depth of 136 meters. Below this depth, sulfur concentrations increase in pre-Tertiary Rocks.

The Northwest Wall at SRK-8 and SRK-1 is primarily in mineralized pre-Tertiary rocks containing high concentrations of sulfur (exceeding 2 percent and generally over 5 percent). SRK-9 is also entirely in pre-Tertiary rocks but for the first 60 meters of core, sulfur concentrations were relatively low (below 1 percent). Below this depth, sulfur concentrations increased abruptly to greater than 5 percent. This may reflect a natural leached cap.

The East Wall is characterized by a thick sequence of unmineralized Tertiary cover rocks which is apparent in all three holes. Sulfur concentrations in the cover rocks tend to be below 1 percent. The sudden increase in sulfur concentrations at depth marks the contact between Tertiary cover and pre-Tertiary mineralized rocks. Both SRK-2 and I-204 showed a gradual decline in sulfur concentrations with depth.

Overall, the initial results from these holes are similar to the pre-2004 holes. The Tertiary cover rocks tend to have lower sulfur concentrations, whereas much higher sulfur concentrations are found in the mineralized pre-Tertiary rocks. Further testing of selected samples will evaluate the potential for acid generation by analysis of sulfur species and neutralization potential.

8.6.2 Metallurgical Waste Products

ABA testing of scavenger tails and bulk cleaner tails has confirmed that they are expected to contain low sulfur as sulfide concentrations resulting in acid potential of about 3 kg $CaCO_3$/t. Neutralization potentials were about 11 kg $CaCO_3$/t, resulting in NP/AP of 3.7. These tailings are not expected to generate acid.

No ABA results are available for the pyrite tails, but it is likely that these tailings will be potentially acid-generating by comparison with the mineralized pre-Tertiary rock.

Analysis of water samples produced from metallurgical testing indicates that process water can be expected to have relatively low concentrations of most parameters. Selected results are provided in Table 7. The pyrite tailings samples have been stored in pails with very shallow (1 inch) water covers. Two of the samples have shown acidic pHs (at different times), probably due to oxygen diffusion through the shallow water. The main effect of acidification was apparently a slight increase in copper concentrations.

TABLE 7.
Process Water Chemistry from Bench-scale Testing

Tailings Type	**pH**	**Sulfate**	**Hardness**	**Alkalinity**	**Sb**	**As**	**Cd**	**Cu**	**Mn**	**Mo**	**Se**	**Zn**
Statistic		**mg/L**	**mg$CaCO_3$ per L**	**mg$CaCO_3$ per L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Scavenger + Bulk Cleaner Tails												
Median	8.15	287	322	58	0.006	0.021	-0.00005	0.009	0.07	0.06	0.013	0.0003
Max	7.64	389	390	102	0.013	0.030	0.00023	0.017	0.14	0.35	0.017	0.006
Pyrite Tails (non-acidic)												
Median	7.26	978	1062	30	0.007	0.003	-0.00030	0.016	0.18	0.02	-0.003	0.005
Max	7.92	1830	1880	50	0.019	0.013	-0.00010	0.029	0.37	0.05	0.005	0.032
Pyrite Tails (acidic)												
Median	3.48	1615	1580	0	0.009	0.005	-0.00008	0.070	0.31	0.05	0.016	0.022

8.7 Summary

In 2004, geochemical studies were focused on the collection and testing of rock samples to estimate acid-generation potential, and the initial characterization of waste products from metallurgical testing. The results of these studies indicate the following:

- Tertiary cover rocks are dominantly non-acid-generating and contain low sulfur concentrations.
- The majority of mineralized pre-Tertiary waste rock is potentially acid-generating.
- Testing of rock core with variable ages (1 to 15 years) stored at the site showed progressive oxidation by conversion of sulfide to sulfate and decreasing neutralization potentials. Based on these results, the overall time frame for acidification of waste rock at Pebble Project appears to vary from 0 to 40 years.
- Testing of metallurgical products indicates that scavenger cleaner tailings are not potentially acid-generating. Pyrite tailings are expected to be potentially acid-generating.
- Process waters are not expected to contain elevated metal concentrations.

8.8 References

Mine Environment Neutral Drainage (MEND) Program. (1991). Acid Rock Drainage Prediction Manual. Mine Environment Neutral Drainage Program, Report 1.16.1b.

Northern Dynasty Mines Inc. (NDM). 2004. Draft Environmental Baseline Studies, Proposed 2004 Study Plan. Prepared for State of Alaska Large Mine Permitting Team, Department of Natural Resources. July 2.

Price, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. Reclamation Section, British Columbia Ministry of Energy and Mines. April.

Sobek A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and laboratory methods applicable to overburden and minesoils. USEPA Report No. 600/2-78-054, 203 pp.

FIGURES

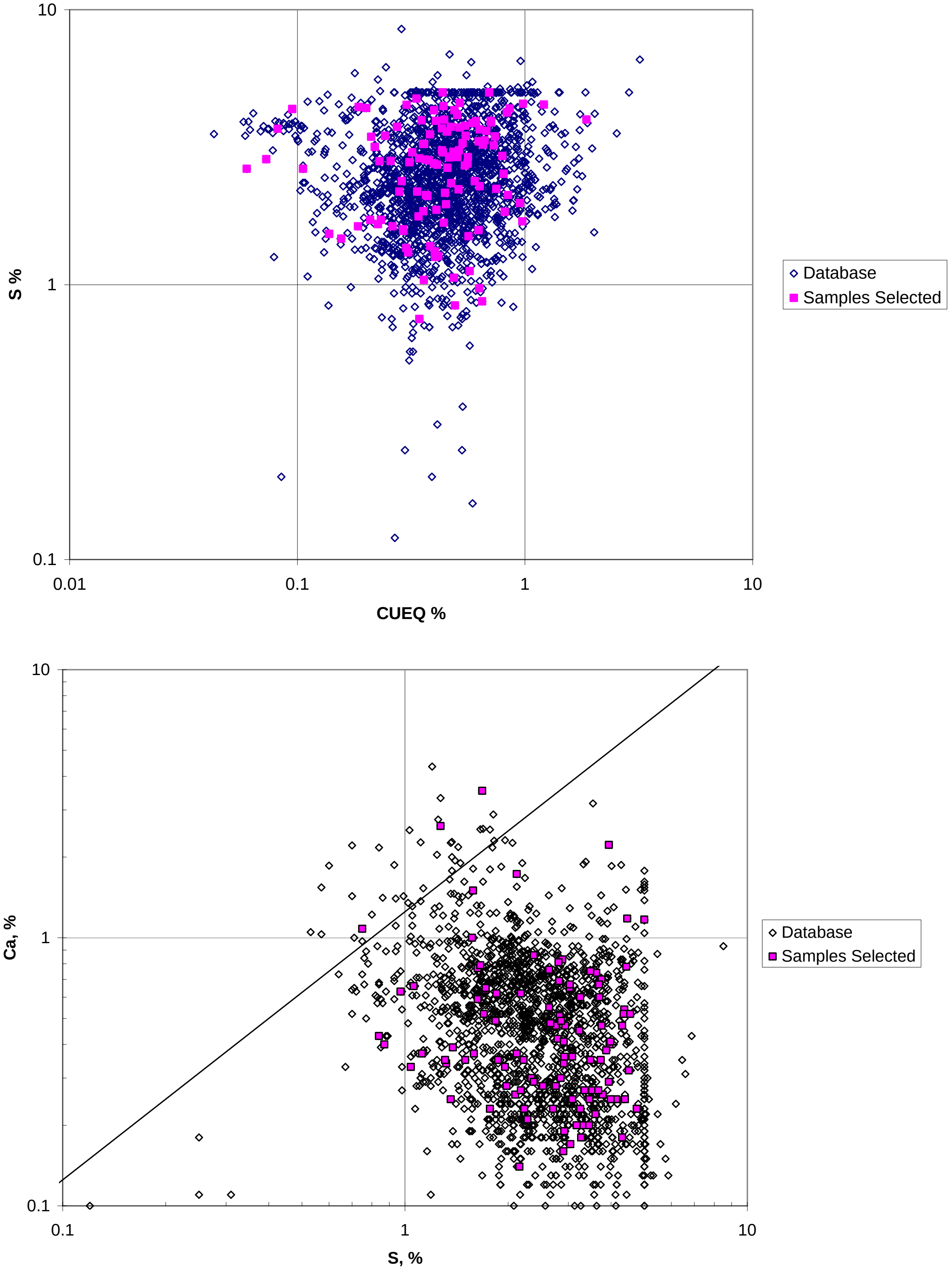

FIGURE 1. Example of Distribution of Samples for Unit Y with Respect to Copper, Sulfur, and Calcium Concentrations. The diagonal line on the lower graph indicates equivalent AP and NP if sulfur and calcium are used as AP and NP surrogates.

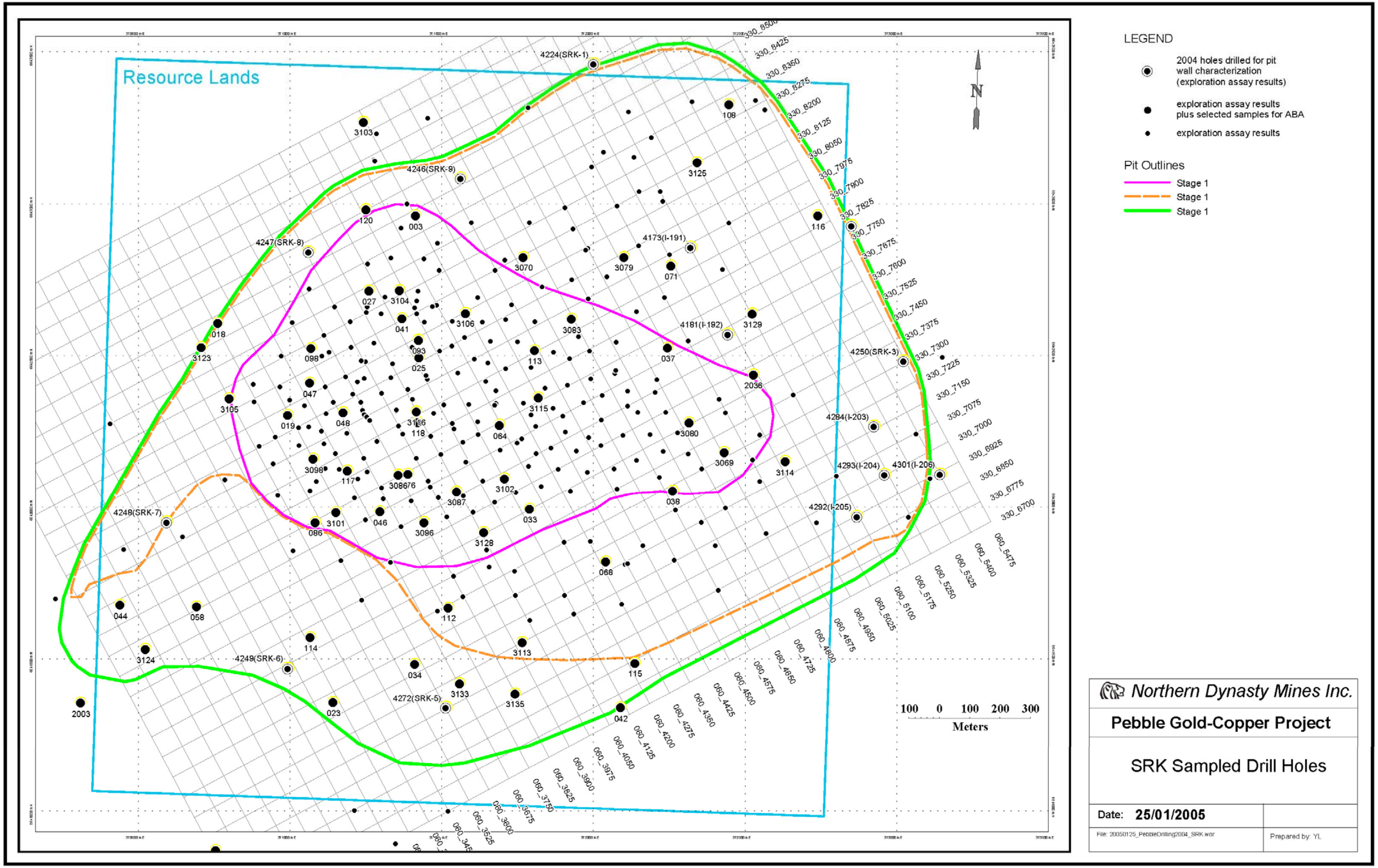

FIGURE 2. Location of Drill-holes Sampled

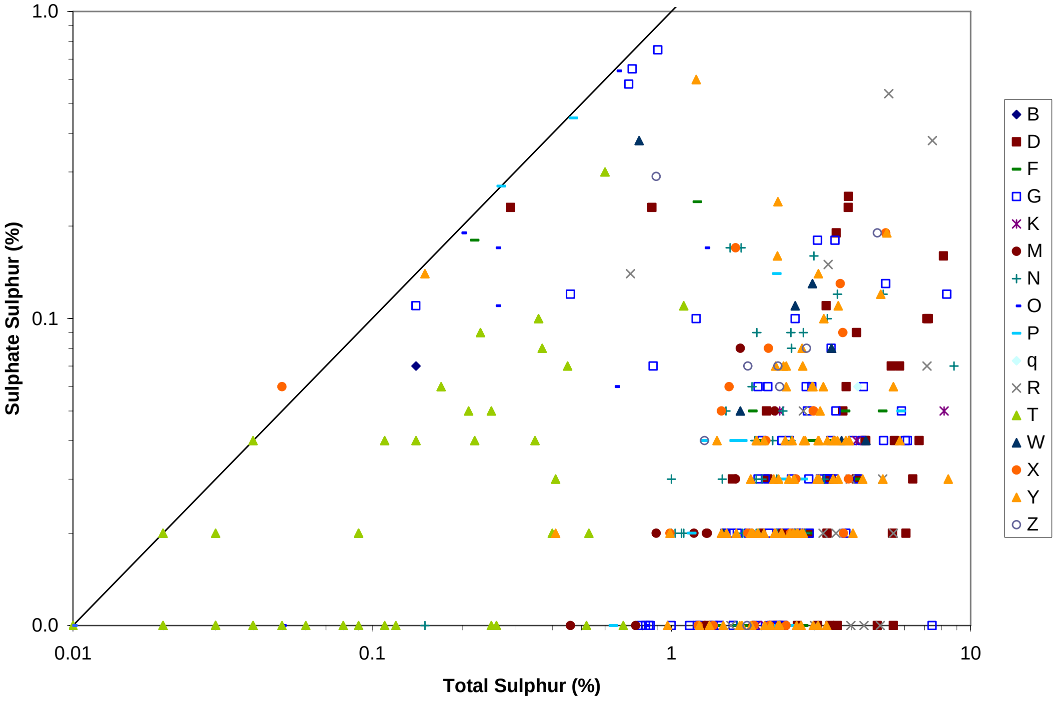

FIGURE 3. **Speciation of Sulfur.** Letters indicate rock type codes (refer to Table 5). The diagonal line indicates equivalent concentrations.

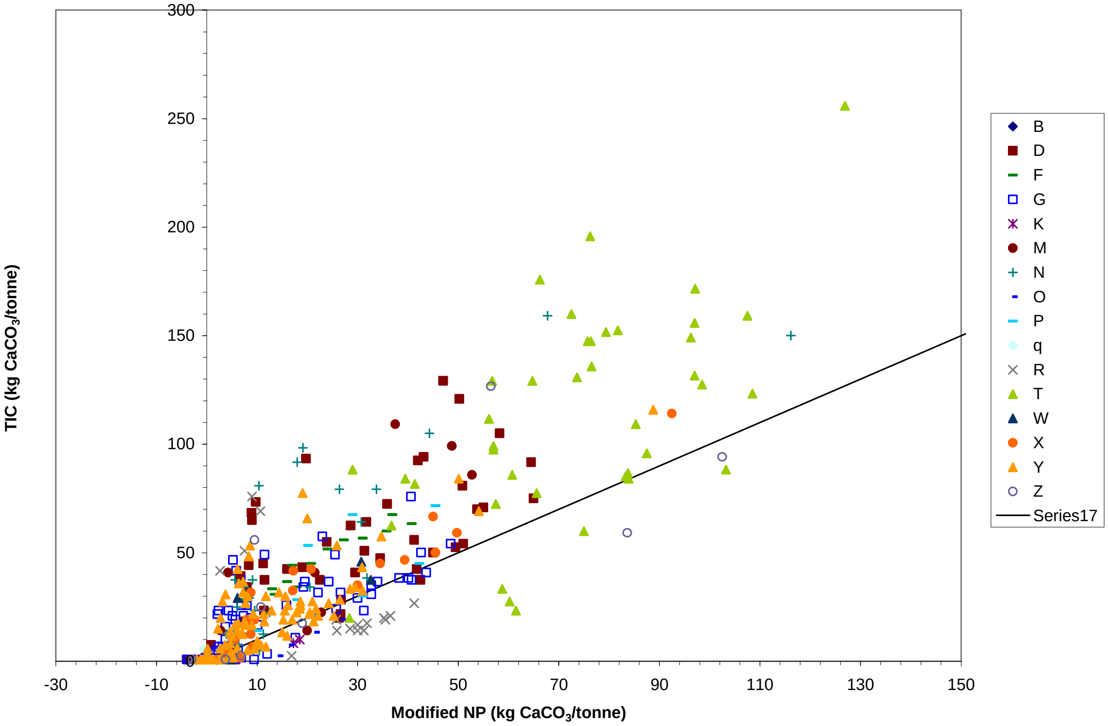

FIGURE 4. **Comparison of Neutralization Potential and Total Inorganic Carbon.** The diagonal line indicates equivalent concentrations.

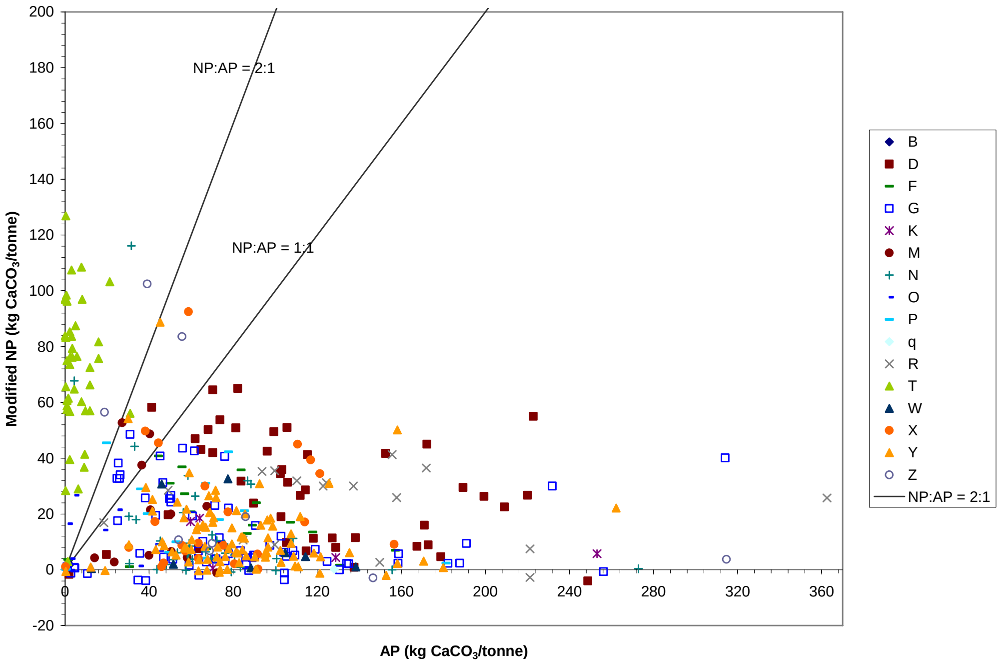

FIGURE 5. Neutralization Potential vs. Acid Potential

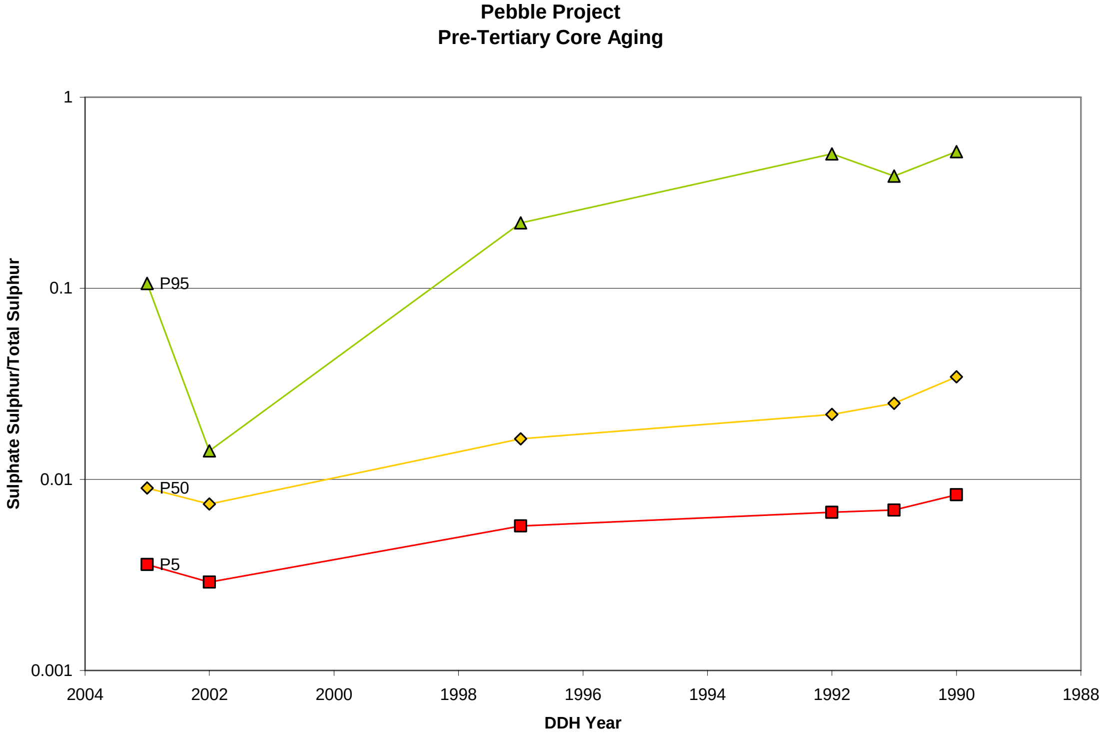

FIGURE 6. Sulfate to Total Sulfur Ratio as a Function of Age. Note that age increases from left to right.

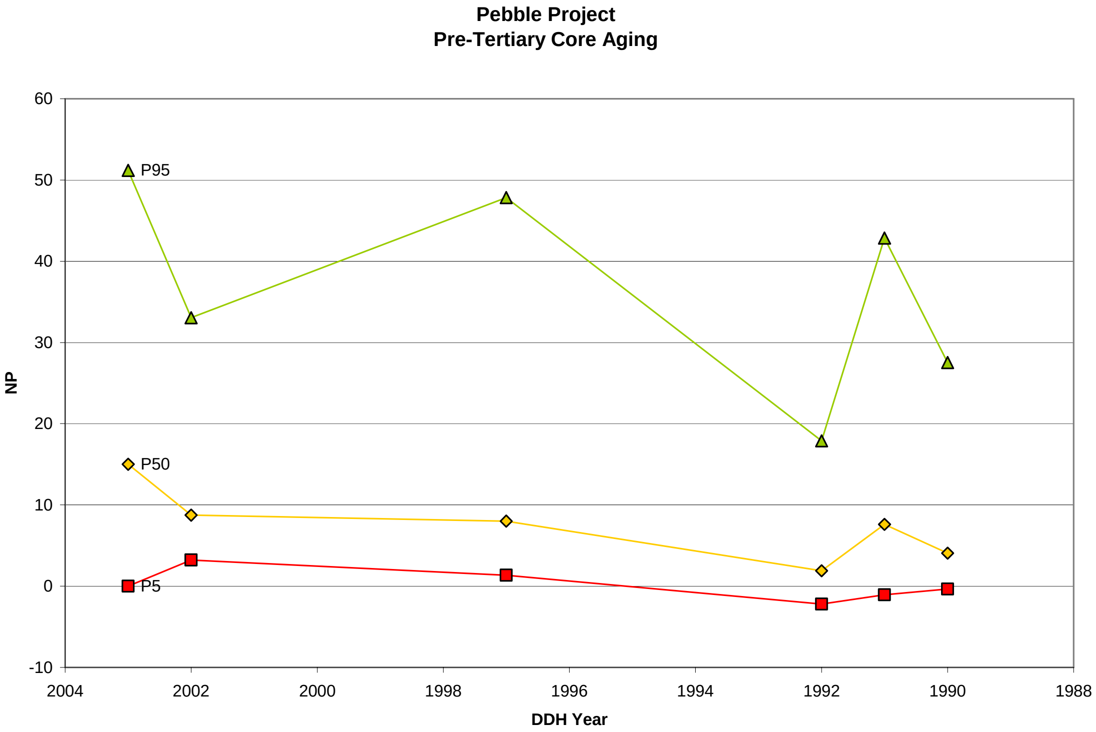

FIGURE 7. Neutralization Potential as a Function of Age

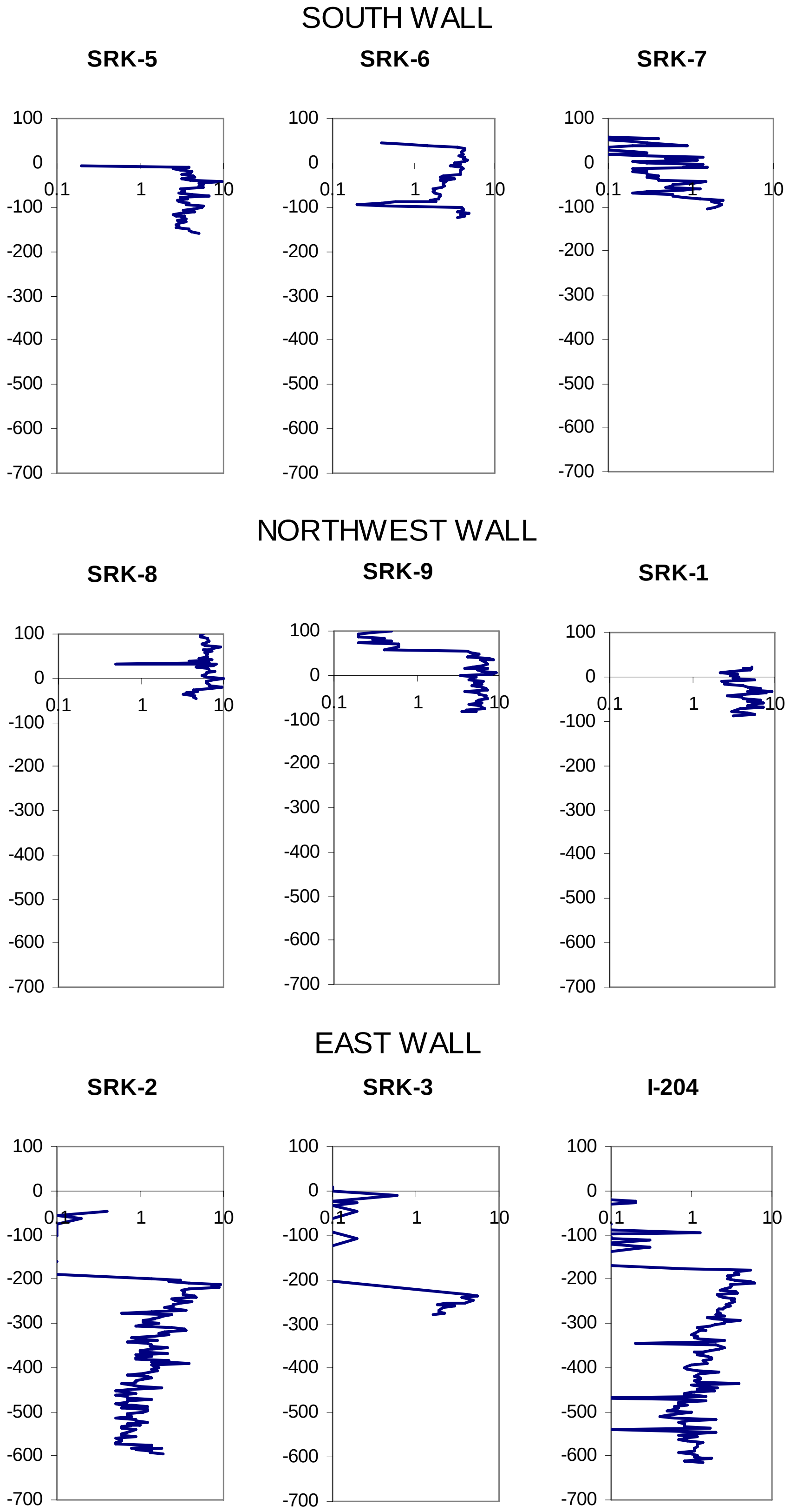

FIGURE 8. Down-hole ICP Sulfur Concentrations (in %) for Near Wall Drill-holes. The vertical axis is in meters relative to the lowest point on the pit boundary.

APPENDICES

Appendix 8-A
Example of Core Log Prepared by SRK

Project Pebble
Hole: GH04-37
Date: 25-Aug-04
Logged by: S. Day, SRK

Major Unit Interval		Other Description		Description	Alteration	Pyrite %	HCl Reaction (n, sl, mod, st)
Start feet	Finish feet	Start feet	Finish feet				
4	147			GRAVEL Rounded/sub-rounded, 0.5" to greater than 6" Components: Granodiorite (60%), basalt (20%), serpentinite (?) (5%), other (andesite, tuff) (15%) No sulfides, no HCl fizz	n	0	n
		4	30	Brown sand	n	-	-
147	180			REGOLITH/DIAMICTON Brown clayey silt, 1 mm brown spots, hard to tell original lithologies due to extensive weathering and conversion to clays, becomes more competent with depth.	n	-	-
		163	164	Cored interval of basaltic tuff	n	-	-
		176		black oxide coatings on fractures	n	-	-

Project Pebble
Hole: GH04-37
Date: 25-Aug-04
Logged by: S. Day, SRK

Major Unit Interval		Other Description		Description	Alteration	Pyrite %	HCl Reaction (n, sl, mod, st)
Start feet	Finish feet	Start feet	Finish feet				
180	205			FINE-GRAINED ANDESITE TUFF Grades from regolith above Fresh rock has maroon matrix with grey to grey/green angular clasts 1mm to 10 mm	n	-	-
		180	180.5	Orange/hbrown weathered, competent	n	-	-
		180.5	182	Maroon with 2 orange weathered fractures, light grey/green soft clay (~50%), 2-3% cubic disseminated pyrite, fresh, 0.5 mm, no HCl reaction.	n	2-3	n
		182.5	183	clay-rich, grey grading into regolith type material, no visible pyrite.	n	0	-
		183	183.5	Brown/yellow, completely weathered, no visible pyrite	n	0	-
		183.5	184	Grey/green, v. finely disseminated cubic pyrite (3%)	n	3	-
		184	186	Brown/yellow oxidized, orange/brown fracture coating at 185', black fracture coating at 185.5', becomes less oxidized at 186'	n	-	-
		186	187	Partially oxidized, 10% finely disseminated pyrite, cubic, ~1 mm.	n	10	-
		187	189	Maroon grey green, more competent, 1-2% v. fine grained disseminated cubic pyrite, fresh, no HCl reaction.	n	1-2	n
		189	189.8	Brown/yellow oxidized, no pyrite	n	0	-
		189.8	190.5	Maroon grey green, 5% disseminated cubic 0.5 mm pyrite.	n	5	-
		190.5	195.5	Brown/yellow oxidized, no pyrite.	n	0	-
		195.5	196.5	Sharp contact with oxidized rock, maroon grey/green. 1% to 2% finely disseminated cubic pyrite	n	1-2	-
		196.5	199	Olive/brown weathering, no pyrite	n	0	-
		199.5		Orange brown fracture coating (two directions - across and through core). Interva labelled incorrectly.	n	-	-
		199	200	Sharp contact to maroon grey green 0.5% disseminated pyrite, no HCl reaction, cubic 0.1 mm	n	0.5	n
		200		2-3% disseminated cubic pyrite mottles.	n	2-3	-
		200	203	Brown/yellow oxidized, black coating on fractures. Brown/red coatings on fractures, strongly oxidized, clay rich.	n	-	-
		203	204.5	Sharp contact to maroon grey/green, 1% fine grained dissemineated pyrite, 0.5 mm, cubic	n	1	-
		204.5	205	Sharp contact with brown/yellow oxidized, black coatings on fractures	n	-	-

Project Pebble
Hole: GH04-37
Date: 25-Aug-04
Logged by: S. Day, SRK

Major Unit Interval		Other Description		Description	Alteration	Pyrite %	HCl Reaction (n, sl, mod, st)
Start feet	Finish feet	Start feet	Finish feet				
205	206.5			AGGLOMERATE	n	-	-
				Maroon matrix with 1" light grey/green angular clasts, matrix supported.			
		205	205.2	5 to 10% disseminated cubic pyrite, 2-3 mm, twinned clusters of cubes, no HCl reaction.	n	5-10	n
		205.2	206.5	Pyrite disseminated throughout matrix and clasts	n	-	-
206.5	208.5			DACITE TUFF	n	1-2	-
				Grey/green, very competent, 1-2% disseminated cubic pyrite, less than 0.5 mm.			
		206.5	208	No HCl reaction	n	-	n
		208	208.5	Green acicular mineral (~25%), grey-brown matrix with strong HCl reaction. 0.5% pyrite, cubic.	n	0.5	st
208.5	210			VOLCANIC BRECCIA	n	5	n
				Maroon matrix, grey green angular to sub-angular clasts (<1%). Matrix supported 5% disseminated pyrite, cubic. No HCl reaction			
		208	210	Orange brown oxidation along fractures parralel to core axis.	n	-	-
210	229			FRACTURED AND OXIDIZED	n	-	n
				Rock type unclear, mostly competent, but clay altered in places			
				Yellow brown stain on core surfaces, dark brown stain on fracture surfaces, almost black. No reaction with HCl.			
		216	217	Andesite, green with diffuse pink masses (1 to 2 cm), strong HCl reaction, less than 1% disseminated pyrite grains (no crystals).	n	1	st
		218		1 mm pink veinlets, no HCl reaction.	n	-	n
229	235			AGGLOMERATE	n	1-2	mod
				Maroon matrix, grey/green fragments (up to 2"), 1 to 2% disseminated pyrite (<0.5 mm), cubic. Moderate HCl reaction in matrix. Matrix and framework supported.			

Project Pebble
Hole: GH04-37
Date: 25-Aug-04
Logged by: S. Day, SRK

Major Unit Interval		Other Description		Description	Alteration	Pyrite %	HCl Reaction (n, sl, mod, st)
Start feet	Finish feet	Start feet	Finish feet				
235	238.5			OXIDIZED ROCK Brown/yellow, incompetent, heavily fractured, black stains on fractures. No pyrite, no HCl reaction.	n	0	n
238.5	241			DACITE Grey/green, 2% disseminated non-crystalline pyrite (~1 mm). Moderate HCl reaction with matrix	n	2	mod
		238.5	238.6	5% pyrite (pyritohedrons), grey blue sulfide (unknown), sample collected.	n	5	
241	243.5			AGGLOMERATE Maroon matrix, grey-green clasts (up to 0.5"), 1-2% fine-grained disseminated cubic pyrite. Moderate HCl reaction with matrix. 0.2 mm calcite veinlets.	n	1-2	mod
		242	242.5	Grey/orange mottles, clay-altered, 1% cubic disseminated pyrite.	n	1	
		242.5	243.5	Darker green, 3 mm pyrite blebs	n	-	
243.5	252			ANDESITE Dark green/grey. 1% disseminated pyrite 1 mm, non-crystalline. Strong HCl reaction with matrix. 1 mm calcite veinlets. Pyrite content decreases downhole, variable but less than 1%	n	1	st
		247		White, soft frature coating.	n	-	-
		248	249	No pyrite, strong HCl reaction with matrix.	n	0	st
252	258			OXIDIZED ROCK Brown yellow with dark brown mottles. Brown/black fracture coatings. No pyrite, no HCl reaction, transition to fresh andesite.		0	n

Project Pebble
Hole: GH04-37
Date: 25-Aug-04
Logged by: S. Day, SRK

Major Unit Interval		Other Description		Description	Alteration	Pyrite %	HCl Reaction (n, sl, mod, st)
Start feet	Finish feet	Start feet	Finish feet				
258	278			ANDESITE 1% 1mm disseminated pyrite, non-crystalline. Hematite coating on fractures. Strong HCl reaction in matrix.	n	1	st
		262	262.5	Calcite amygdules	n	-	-
		264	265	3% pyrite	n	3	-
		265	267	Trace pyrite	n	Tr	-
		267	267.2	5% pyrite	n	5	-
		267.2	270	Trace pyrite	n	Tr	-
		271	273	0.5 mm 2 to 3% pyrite	n	2-3	-
		272		2 mm calcite veinlet	n	-	-
		273	275.5	Trace to 0.5% pyrite	n	Tr -0.5	-
		275.5	278	3% pyrite round 2 mm	n	3	-
278	280			DACITE Light green, 3% disseminated pyrite, 1 mm, weakly cubic. Very competent, Strong HCl reaction with matrix. Pyritte partially oxidized in most core.	n	3	st
280	283			ANDESITE AGGLOMERATE Large green fragments (40%) in maroon matrix. 1% 2 mm disseminmated cubic pyrite. Moderate to strong HCl reaction with matrix	n	1	mod-st
		281	281.6	Purple chert, no sulphide. Moderate HCl reaction with matrix.	n	0	mod
283	295			ANDESITE TUFF Maroon matrix. Grey green clasts (<1"). 1% disseminated pyrite, 0.5 to 1mm cubes. Competent. Strong HCl reactin with clasts.	n	1	st
		289	292	Slightly oxidized. No Hcl reaction. Mn-oxide dendrites	n		n
292				END OF HOLE			

Appendix 8-B
List of Samples Selected for Static Testing

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	**HOLE_ID**	**FROM_FT**	**TO_FT**	**LITHO**	**Early Type**	**Early Intens.**	**Late Type**	**Late Intens.**
COM	003	31	36	Y				
COM	003	36	41	Y				
COM	013	107	112	G				
COM	013	112	117	G				
COM	013	117	122	G				
COM	013	122	127	G				
COM	018	74	85	D				
COM	018	85	95	D				
COM	018	135	145	D/D	*p	m	t	s
COM	018	145	155	D/D	*p	m	t	s
COM	018	225	235	D/D	*p	m	t	s
COM	018	235	245	D/D	*p	m	t	s
COM	019	30	42	OB				
COM	019	42	51	OB				
COM	019	72	82	WY				
COM	019	82	90	WY				
COM	019	200	209	N.Y	b	m		
COM	019	209	220	N.Y	b	m		
COM	019	240	250	Y	b	w		
COM	019	250	260	Y	b	w		
COM	019	390	400	Gp-Pl	b	m	s	m
COM	019	400	410	Gp-Pl	b	m	s	m
COM	023	75	80	TDt				
COM	023	80	90	TDt				
COM	023	110	120	X.MP				
COM	023	120	130	X.MP				
COM	025	179	189	Y	k	m		
COM	025	189	199	Y	k	m		
COM	025	453	463	Y	k	w-s		
COM	025	463	473	Y	k	w-s		
COM	025	617	627	D	bl	m	k	m
COM	025	627	637	D	bl	m	k	m
COM	027	70	80	Y	kb	m	qspyi	m
COM	027	80	90	Y	kb	m	qspyi	m
COM	027	110	120	W	kb	m	qsp	m
COM	027	120	130	W	kb	m	qsp	m
COM	027	200	210	Y	kb	m	qsp	m
COM	027	210	220	Y	kb	m	qsp	m
COM	027	260	270	Y	kb	m	qsp	m
COM	027	270	280	Y	kb	m	qsp	m
COM	033	137	146	Y	b	m-w	s	m
COM	033	146	155	Y	b	m-w	s	m
COM	033	304	314	TBpd	e	m		
COM	033	314	323	TBpd	e	m		
COM	033	343	353	G-p	slk	w	b	w
COM	033	353	363	G-p	slk	w	b	w
COM	034	60	90	OB				

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
COM	034	100	108	X.DbGY	b	m		
COM	034	108	117	X.DbGY	b	m		
COM	037	0	182	TC				
COM	037	208	217	Y	bk	m	qsp	m
COM	037	217	227	Y	bk	m	qsp	m
COM	037	307	317	Gp	k	s	qsp	m
COM	038	49	58	R	kels	m	sp	w
COM	038	58	68	R	kels	m	sp	w
COM	038	189	200	R	kels	m	sp	w
COM	038	200	208	R	kels	m	sp	w
COM	038	311	321	Nb?	b	m	sp	m
COM	038	321	331	Nb?	b	m	sp	m
COM	041	0	10	Fc				
COM	041	10	20	Fc				
COM	041	20	30	Y	bk	m?	qsiy	m/s
COM	041	30	40	Y	bk	m?	qsiy	m/s
COM	041	94	104	Y	bk	m	qsp	s
COM	041	104	114	Y	bk	m	qsp	s
COM	041	244	254	N	bk	m	qsp	W/m
COM	041	254	260	N	bk	m	qsp	W/m
COM	041	280	290	D	bk	m	qspi	W/m
COM	041	290	300	D	bk	m	qspi	W/m
COM	041	500	510	Z			slqyi	m/s
COM	041	510	520	Z			slqyi	m/s
COM	041	538	548	Y	bk	m	qsp	m
COM	041	548	558	Y	bk	m	qsp	m
COM	041	728	738	*q	k	m/s	q-sp	
COM	041	738	748	*q	k	m/s	q-sp	
COM	042	60	70	Y	sqp	m		
COM	042	70	75	Y	sqp	m		
COM	042	270.7	280	D/G				
COM	042	280	290	D/G				
COM	042	360	370	Yb	b	m/s		
COM	042	370	380	Yb	b	m/s		
COM	044	96	106	Gp	s	m	bl	w-m
COM	044	106	116	Gp	s	m	bl	w-m
COM	044	190	200	Gp	s	m	bl	w-m
COM	044	200	210	Gp	s	m	bl	w-m
COM	044	225	235	X.HGDN-Y	l	m	s	m
COM	044	235	245	X.HGDN-Y	l	m	s	m
COM	044	305	315	N.H	bl	m/s		
COM	044	315	325	N.H	bl	m/s		
COM	044	343	353	Gp	k	m/s		
COM	044	353	363	Gp	k	m/s		
COM	046	38	50	Fc				
COM	046	50	63	Fc				
COM	046	63	73	Gp			y	s
COM	046	73	83	Gp			y	s
COM	046	113	123	N or Gp-p.			b	m
COM	046	123	133	N or Gp-p.			b	m
COM	046	195	205	Y	k	m/s		
COM	046	205	215	Y	k	m/s		
COM	046	259	269	N or Gp.Y	b	m		

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	**HOLE_ID**	**FROM_FT**	**TO_FT**	**LITHO**	**Early Type**	**Early Intens.**	**Late Type**	**Late Intens.**
COM	046	269	279	N or Gp.Y	b	m		
COM	046	308	318	G-p	b	m		
COM	046	318	328	G-p	b	m		
COM	046	363	373	N or Gp.Y	b	m		
COM	046	373	383	N or Gp.Y	b	m		
COM	046	563	573	N-p				
COM	046	573	580	N-p				
COM	046	580	590	GxN				
COM	046	590	600	GxN				
COM	047	117	126	WY	k	m-s		
COM	047	126	136	WY	k	m-s		
COM	047	226	236	WY	k	m-s		
COM	047	236	246	WY	k	m-s		
COM	047	350	360	WY	bl	m	qsp	m
COM	047	360	365	WY	bl	m	qsp	m
COM	047	462	472	Gph	l	m	s	m
COM	047	472	482	Gph	l	m	s	m
COM	047	592	602	Gph	l	m	s	m
COM	047	602	612	Gph	l	m	s	m
COM	048	135	145	Gp	k	m	qsp	m/s
COM	048	145	155	Gp	k	m	qsp	m/s
COM	048	172	180	Z			yqsp	s
COM	048	180	190	Gp	k-b	m	qsp	m/s
COM	048	200	210	Gp	k-b	m	qsp	m/s
COM	048	210	220	Gp	k-b	m	qsp	m/s
COM	048	760	770	Gp	k-b	m	qsp	m/s
COM	048	770	780	Gp	k-b	m	qsp	m/s
COM	058	58	68	P-k			yi	s
COM	058	68	78	P-k			yi	s
COM	058	348	358	P	bl-e	m/s	qsp	s
COM	058	358	368	P	bl-e	m/s	qsp	s
COM	058	378	388	N	bk	m	qsp	m/s
COM	058	388	398	N	bk	m	qsp	m/s
COM	058	398	408	Z.NPY				
COM	058	408	418	Z.NPY				
COM	058	428	438	X.DPYxN				
COM	058	438	448	X.DPYxN				
COM	064	0	30	OB				
COM	064	30	40	G	qsp	s		
COM	064	40	50	G	qsp	s		
COM	064	132	140	G	k	m		
COM	064	140	146.8	G	k	m		

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
COM	064	156	166	Y	k	w	b	w
COM	064	166	176	Y	k	w	b	w
COM	064	499	509	Y-W	k	m	b	m
COM	064	509	519	Y-W	k	m	b	m
COM	064	539	545	D/G	spq	m		
COM	064	545	553.7	D/G	spq	m		
COM	068	0	46	OB				
COM	068	46	56	Z.Y				
COM	068	56	66	Z.Y				
COM	068	95	105	D	qsp	m-s	b	m
COM	068	105	115	D	qsp	m-s	b	m
COM	068	235	245	D	qsp	m-s	b	m
COM	068	245	255	D	qsp	m-s	b	m
COM	068	265	275	Y-x	bl	m		
COM	068	275	285	Y-x	bl	m		
COM	068	500	510	G				
COM	068	510	520	G				
COM	071	313	323	R/Db	b-k	m	qsp	m
COM	071	323	333	R/Db	b-k	m	qsp	m
COM	071	353	363	R/Db	b-k	m	qsp	m
COM	071	363	373	R/Db	b-k	m	qsp	m
COM	071	423	433	R/Db	b-k	m	qsp	m
COM	071	433	443	R/Db	b-k	m	qsp	m/s
COM	071	473	483	R/Db	b-k	m	qsp	m/s
COM	071	483	493	R/Db	b-k	m	qsp	m/s
COM	076	438	448	D/N	qsp	s		
COM	076	448	458	D/N	*m	m	b	m
COM	076	518	528	D/N	*m	m	b	m
COM	076	528	538	D/N	*m	m	b	m
COM	076	608	618	D/N?	q	s		
COM	076	618	625.2	D/N?	q	s		
COM	086	0	67	OB				
COM	086	279	287	TBd				
COM	086	363	370	Np	s	m		
COM	086	370	377	Np	s	m		
COM	086	417	427	Gp-k	k	s		
COM	086	427	437	Gp-k	k	s		
COM	086	467	477	N.MH				
COM	086	477	487	N.MH				
COM	086	617	627	X.Db GN	slb	m		
COM	086	627	637	X.Db GN	slb	m		
COM	093	43	53	G-p	k	m	yqspi	m-s
COM	093	53	63	G-p	k	m	yqspi	m-s
COM	093	133	143	G-p	k	m	yqspi	m-s
COM	093	143	148	G-p	k	m	yqspi	m-s
COM	093	158	168	Y	bk	m-s	qsp	w-m
COM	093	168	178	Y	bk	m-s	qsp	w-m

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
COM	093	248	258	Y	bk	m-s	qsp	w-m
COM	093	258	268	Y	bk	m-s	qsp	w-m
COM	093	377	387	Y	bk	m-s	qsp	w-m
COM	093	387	394	Y	bk	m-s	qsp	w-m
COM	098	151	161	Y	k	m		
COM	098	161	171	Y	k	m		
COM	098	191	201	Z.Y				
COM	098	201	211	Y	kb	m		
COM	098	241	251	Y	kb	m		
COM	098	251	261	Y	kb	m		
COM	098	572	582	Gph	bsk	m		
COM	098	582	592	Gph	bsk	m		
COM	098	642	652	Gph	bsk	m		
COM	098	652	662	Gph	bsk	m		
COM	108	42	76	TB				
COM	108	76	157	TF				
COM	108	157	213	TCk				
COM	108	213	266	TW				
COM	108	266	283	TC				
COM	108	633	641	Y				
COM	108	641	650	Y				
COM	108	770	780	G				
COM	108	780	790	G				
COM	112	160	170	N.NM	b	m	k	w-m
COM	112	170	180	N.YM	k	m		
COM	112	220	230	N.H	k	s-m	s	m
COM	112	230	240	N.H	k	s-m	s	m
COM	112	300	310	N.H	k	s-m	s	m
COM	112	310	320	N.H	k	s-m	s	m
COM	112	400	410	N.H				
COM	112	410	420	N.H				
COM	112	460	470	X.MDbxN				
COM	112	470	480	X.MDbxN				
COM	113	40	50	Y	bk	w-m	qsp	w
COM	113	50	60	Y	bk	w-m	qsp	w
COM	113	90	100	Y	bk	w-m	qsp	w
COM	113	100	110	Y	bk	w-m	qsp	w
COM	113	170	180	G-p	k	m-s	qsp	w
COM	113	180	190	G-p	k	m-s	qsp	w
COM	113	360	370	Y	bk	m	qsp	w
COM	113	370	380	Y	bk	m	qsp	w
COM	113	510	520	Y	bk	m	qsp	m-s
COM	113	520	530	Y	bk	m	qsp	m-s
COM	114	0	55	OB				
COM	114	55	62	Pp				
COM	114	62	70	Pp				
COM	114	90	97	Pp				
COM	114	97	104	Pp				
COM	114	180	190	Ppk	l	m	kqspm	m-s
COM	114	190	200	Pp-k	e	m	l	m
COM	114	290	296	Ppk	k	w		
COM	114	296	303	Ppk	k	w		

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
COM	114	310	320	X.MDxN	b	m		
COM	114	320	330	X.MDxN	b	m		
COM	114	400	410	X.MD#b	k	m-s	qsp-k	s
COM	114	410	420	X.MD#b	k	m-s	qsp-k	s
COM	114	460	470	X.MD#b	k	m-s	qsp-k	s
COM	114	470	481	X.MD#b	k	m-s	qsp-k	s
COM	115	13.5	54	TC				
COM	115	54	264	TW				
COM	115	280	290	TA pd	y	m-s	s	m
COM	115	290	300	TA pd	y	m-s	s	m
COM	115	300	310	Y-W	#m	s	s	m-s
COM	115	310	320	Y-W	#m	s	s	m-s
COM	115	410	420	Y	s	w-m	qsp	m
COM	115	420	430	Y	s	w-m	qsp	m
COM	116	77	116	TBd				
COM	116	116	143	TBd				
COM	116	359.5	465	TBd				
COM	116	465	560	TBd				
COM	116	570	580	Gp	kb	m	qsp	m
COM	116	580	590	Gp	kb	m	qsp	m
COM	116	630	640	Gp	kb	m	qsp	m
COM	116	640	650	Gp	kb	m	qsp	m
COM	116	780	790	Gp	kb	m	qsp	m-s
COM	116	790	802	Gp	kb	m	qsp	m-s
COM	116	820	830	Y	b-k	m	qsp	w-m
COM	116	830	840	Y	b-k	m	qsp	w-m
COM	116	890	900	Y	b-k	m	qsp	w-m
COM	116	900	908	Y	b-k	m	qsp	w-m
COM	116	948	957	D-b	b-k	m	qsp	m-s
COM	116	957	966	D-b	b-k	m	qsp	m-s
COM	117	0	52.5	OB				
COM	117	70	80	N.M			iz	s
COM	117	80	90	N.M			iz	s
COM	117	160	167	Mpk-N				
COM	117	167	174	Mpk-N				
COM	117	190	200	N.YM				
COM	117	200	210	N.YM				
COM	117	233	240	Mp-k	b	m		
COM	117	240	250	Mp-k	b	m		
COM	117	300	310	Gp-k	m	m	k	m-s
COM	117	310	320	Gp-k	m	m	k	m-s
COM	117	560	570	Gpk	k	m	qsp	w-m
COM	117	570	579	Gpk	k	m	qsp	w-m

COMPANY	HOLE_ID	INTERVAL FROM_FT	TO_FT	LITHO	ALTERATION Early Type	Early Intens.	Late Type	Late Intens.
COM	117	590	600	Y	b	m-s	k	m
COM	117	600	610	Y	b	m-s	k	m
COM	117	630	640	Y	b	m-s	k	m
COM	117	640	650	Y	b	m-s	k	m
COM	117	1055	1063	TBd				
COM	117	1063	1071	TBd				
COM	118	150	160	N-.Y	k	m		
COM	118	160	170	N-.Y	k	m		
COM	118	190	200	Z.N				
COM	118	200	210	Z.N				
COM	118	220	230	Y				
COM	118	230	240	Y				
COM	118	260	270	Y				
COM	118	270	278	Y				
COM	118	336	345	Tbd				
COM	118	345	355	Tbd				
COM	118	390	400	TBd				
COM	118	400	410	TBd				
COM	118	468	478	Mkp-x			bl	m
COM	118	478	488	Mkp-x			bl	m
COM	118	497	507	N/D.-YM	qs	s		
COM	118	507	515	N/D.-YM	qs	s		
COM	118	519.5	527	Y				
COM	118	527	535	Y				
COM	118	565	575	Y	b	m		
COM	118	575	585	Y	b	m		
COM	118	650	660	D/N-.#b			qs	m
COM	118	660	670	D/N-.#b			qs	m
COM	118	710	720	Np-.#b D?			bl	m
COM	118	720	730	Np-.#b D?			bl	m
COM	118	760	770	D	b	w		
COM	118	770	780	D	b	w		
COM	118	890	900	N/D				
COM	118	900	910	N/D				
COM	118	980	990	N-p-.Y	k	w-m		
COM	118	990	1000	N-.Y-D	bl	m		
COM	118	1040	1050	N.Y-D	bl	m		
COM	118	1050	1060	N.Y-D	bl	m		
COM	118	1220	1230	WY	l	m		
COM	118	1230	1238	WY	l	m		
COM	118	1300	1310	Y			q	m
COM	118	1310	1320	Y			q	m
COM	118	1480	1490	X.YxN				
COM	118	1490	1500	X.YxN				
COM	120	75	85	OB				
COM	120	85	95	OB				
COM	120	116	124	R/Db	b	m	qsp	m
COM	120	124	130	R/Db	b	m	qsp	m

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
COM	120	260	270	R/Db	bela	m	qsp	m-w
COM	120	270	280	R/Db	bela	m	qsp	m-w
COM	120	380	390	R/Db	bela	m	qsp	m-w
COM	120	390	400	R/Db	bela	m	qsp	m-w
NDM	2001	0	130	Ob				
NDM	2001	130	150	Kqs				
NDM	2003	210	230	Kgde				
NDM	2003	335	356	Kgde				
NDM	2026	50	70	Kq				
NDM	2026	190	210	Kq				
NDM	2028	55	75.5	G/N				
NDM	2028	155	175	Y				
NDM	2028	310	330	G				
NDM	2028	430	450	Y				
NDM	2036	421	430	W	b-k	m-s	qsp	w-m
NDM	2036	430	440	W	b-k	m-s	qsp	w-m
NDM	2036	500	510	G-p	bk	m	qsp	m-s
NDM	2036	510	520	G-p	bk	m	qsp	m-s
NDM	2036	540	550	Y	b-k	m-s	qsp	w
NDM	2036	550	563.5	Y	b-k	m-s	qsp	w
NDM	2036	570	580	G-p	bk	m	qsp	m-s
NDM	2036	580	590	G-p	bk	m	qsp	m-s
NDM	2036	660	670	G-p	bk	m	qsp	m-s
NDM	2036	670	681.8	G-p	bk	m	qsp	m-s
NDM	2036	700	710	G-p	bk	m	qsp	m-s
NDM	2036	710	720	G-p	bk	m	qsp	m-s
NDM	3069	0	95.5	Ob				
NDM	3069	127	137	D	b		sp	
NDM	3069	137	147	D	b		sp	
NDM	3069	247	257	Z	y			
NDM	3069	257	267	Z	y			
NDM	3069	287	297	G	sq		-b	
NDM	3069	297	307	G	sq		-b	
NDM	3069	347	357	D	b		-sqp	
NDM	3069	357	367	D	b		-sqp	
NDM	3069	397	407	D	b		-sqp	
NDM	3069	407	417	D	b		-sqp	
NDM	3069	427	437	Y	b-k		sq	
NDM	3069	487	497	Y	b-k		sq	
NDM	3069	497	507	Y	b-k		sq	
NDM	3069	627	637	Y	b-k		sq-p	
NDM	3069	637	647	Y	b-k		sq-p	
NDM	3069	707	717	G	sqyp		k-b	
NDM	3069	717	727	G	sqyp		k-b	
NDM	3069	807	817	G	sqp		k-b	
NDM	3069	817	827	G	sqp		k-b	
NDM	3069	927	937	G	sqp		k-b	
NDM	3069	937	947	G	sqp		k-b	

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3069	1077	1087	G	sqp		k-b	
NDM	3069	1087	1097	G	sqp		k-b	
NDM	3070	0	45	Ob				
NDM	3070	74	84	D	sy-q		b	
NDM	3070	84	94	D	sy-q		b	
NDM	3070	204	214	D	b		sp	
NDM	3070	214	224	D	b		sp	
NDM	3070	284	294	D	b		sp	
NDM	3070	294	304	D	b		sp	
NDM	3070	464	474	Y	b		sqp	
NDM	3070	474	484	Y	b		sqp	
NDM	3070	594	604	G-p	+qsp			
NDM	3070	604	614	G-p	+qsp			
NDM	3070	634	644	G-p	+qsp			
NDM	3070	644	654	G-p	+qsp			
NDM	3079	499	509	D	b		qsp	
NDM	3079	509	519	D	b		qsp	
NDM	3079	589	599	TAd				
NDM	3080	75.4	85	D	eb		p	
NDM	3080	85	95	D	eb		p	
NDM	3080	129	139	G	sd		s	
NDM	3080	139	149	G	sd		s	
NDM	3080	179	189	G	sd		s	
NDM	3080	189	199	G	qsp			
NDM	3080	375	385	D	b			
NDM	3080	385	394	D	b			
NDM	3080	394	409	Y	b			
NDM	3080	409	419	Y	b			
NDM	3080	479	489	Y	sqp			
NDM	3080	489	499	Y	sqp			
NDM	3080	549	559	G^f	spq			
NDM	3080	559	569	G^f	sd			
NDM	3080	669	679	G^f	qsp			
NDM	3080	679	689	G^f	s-d			
NDM	3080	799	809	G^f	-sd		qsp	
NDM	3080	809	819	G^f	-sd		qsp	
NDM	3080	869	879	Y	-bk		-qsp	
NDM	3080	879	889	Y	-bk		-qsp	
NDM	3083	599	608	Y	b-k		-qsp	
NDM	3083	608	619	Y	b-k		-qsp	
NDM	3083	639	649	Y	b-k		-qsp	
NDM	3083	649	652	Y	b-k		-qsp	
NDM	3083	719	729	Y	b		-qsp	
NDM	3083	729	739	Y	b		-qsp	
NDM	3086	629	639	N.Y-M	b		-qs	
NDM	3086	639	649	N.Y-M	b		-qs	
NDM	3086	779	789	N.D-YM	b		s	
NDM	3086	789	799	N.D-YM	b		s	
NDM	3086	865.5	879	N.M	b		-k	

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3086	879	889	N.M	b		-k	
NDM	3086	908.6	919	TDd				
NDM	3086	949	959	N.M	b		-k	
NDM	3086	959	969	N.M	b		-k	
NDM	3086	979	980.9	N.MY	b			
NDM	3086	980.9	991.6	TBd				
NDM	3086	1009	1018.5	P-k			b	
NDM	3086	1018.5	1027	Pk			bk	
NDM	3086	1109	1117.3	Y	b			
NDM	3086	1117.3	1121.1	Y	b		k	
NDM	3086	1121.1	1126.2	TBd				
NDM	3086	1236.4	1245.4	N	bk		d	
NDM	3086	1245.4	1255.4	N	bk		d	
NDM	3086	1319	1329	G	wy		b	
NDM	3086	1329	1338	G	wy		b	
NDM	3087	22.5	29	Y				
NDM	3087	29	39.8	Y				
NDM	3087	164	165.7	G	qspd			
NDM	3087	165.7	170.5	G	qspd			
NDM	3087	170.5	180.5	G	qspd			
NDM	3087	209	219	Y			d	
NDM	3087	219	229	Y			d	
NDM	3087	359	369	Y				
NDM	3087	369	379	Y				
NDM	3087	509	519	Y				
NDM	3087	519	528.4	Y				
NDM	3087	539	549	D	b			
NDM	3087	549	559	D	b			
NDM	3087	786.5	798.5	Dxq	q-p			
NDM	3087	798.5	809	D				
NDM	3087	869.3	879	Yxq	qd			
NDM	3087	879	889	Yxq	qd			
NDM	3087	905.2	911.7	Mk.Y				
NDM	3087	911.7	919.3	Mk.Y				
NDM	3087	979	989	M	b			
NDM	3087	989	999	M	b			
NDM	3087	1046.7	1057	YxN/N.Y	q			
NDM	3087	1057	1067	YXN,Yxq	q			
NDM	3087	1143.2	1155.1	X.YP				
NDM	3087	1155.1	1159	X.YP	qs			
NDM	3096	0	58	OB				
NDM	3096	58	68	X.YMxN(?)			k,s,y	
NDM	3096	68	78	X.YM-DxN			k,s,y	
NDM	3096	108	118	X.YM-DxN			k,s,y	
NDM	3096	118	128	X.YM-DxN			k,s,y	
NDM	3096	168	178	N.DYM-				
NDM	3096	178	188	N.DYM-				
NDM	3096	235	248	Y	k		y,s	
NDM	3096	248	258	Y	k		y,s	

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3096	318	328	Y	k		y,s	
NDM	3096	328	338	Y	k		y,s	
NDM	3096	418	428	Y	k		s,y	
NDM	3096	428	438	Y	k		s,y	
NDM	3096	718	728	X	k		y,s	
NDM	3096	728	738	X	k		y,s	
NDM	3096	788	798	N	k,h		y,p	
NDM	3096	798	808	N	k,h		y,p	
NDM	3096	1006	1014	X	k		y,l,s	
NDM	3096	1014	1018	X	k		y,l,s	
NDM	3096	1088	1098	Tbd				
NDM	3096	1098	1108	Tbd				
NDM	3096	1158	1168	X	k		l,s	
NDM	3096	1228	1238	M	k		l	
NDM	3096	1238	1248	M				
NDM	3096	1258	1268	Y	q		k,s,l	
NDM	3096	1328	1338	M	k		l,s	
NDM	3096	1338	1348	M	k		l,s	
NDM	3096	1388	1398	P	k		s,i	
NDM	3096	1398	1408	P	k		s,i	
NDM	3096	1518	1528	P	k		s,i	
NDM	3096	1528	1538	P	k		s,i	
NDM	3096	1748	1758	G-q	k		l	
NDM	3096	1758	1768	G-q	k		l	
NDM	3098	138	148	N-p	b			
NDM	3098	148	158	N-p	b			
NDM	3098	238	248	Mpk	y			
NDM	3098	248	258.2	Mpk	y			
NDM	3098	353	362.6	M-k	k			
NDM	3098	362.6	370.6	M-k	k			
NDM	3098	418	428	Y	kb			
NDM	3098	428	438	Y	kb			
NDM	3098	488	498	Y-xk-pd	k			
NDM	3098	498	508	Y-xk-pd	k			
NDM	3098	656	666	Y-w	kb			
NDM	3098	666	676	Y-w	kb			
NDM	3098	712.2	717	G	ky		y	
NDM	3098	717	727	G	ky		y	
NDM	3098	778	788	G	ky		y	
NDM	3098	788	792	G	ky		y	
NDM	3098	908	918	G			ykd	
NDM	3098	918	928	G\	yk			
NDM	3098	1198	1208	G				
NDM	3098	1208	1218	G				
NDM	3101	110	118	X.M/Mx				
NDM	3101	118	138	X.M/Mx				
NDM	3101	240.3	251	Yxqd	y		qpd	
NDM	3101	251	261.5	Yxqd	y		qdp	
NDM	3101	308	328	TD				
NDM	3101	328	345.5	TD				

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	**HOLE_ID**	**FROM_FT**	**TO_FT**	**LITHO**	**Early Type**	**Early Intens.**	**Late Type**	**Late Intens.**
NDM	3101	378	388	Yxq-p	q		-k	
NDM	3101	388	398	Yxq-p	q		-k	
NDM	3101	548	558	Yxqp	qp		k	
NDM	3101	558	568	Yxq-p\	qk		p	
NDM	3101	738	748	M.ky/X.mk				
NDM	3101	748	761.2	M.ky/X.mk				
NDM	3101	978	985.3	YxP\P/M-k				
NDM	3101	985.3	994.6	Y-x				
NDM	3101	1038	1048	Mp-k	y			
NDM	3101	1048	1058	Mp-k	y			
NDM	3101	1160.6	1171.6	TBd				
NDM	3101	1201.4	1208.4	TBd				
NDM	3101	1226.1	1236	TBd				
NDM	3102	0	44	O/B				
NDM	3102	44	58	Y	k		y,d	
NDM	3102	58	68	Y	k		y,d	
NDM	3102	88	98	G^fp	k		y,d,l	
NDM	3102	254	268	TBd				
NDM	3102	268	276	TBd				
NDM	3102	398	408	Y	k		s,l	
NDM	3102	408	418	Y	k		s,l	
NDM	3102	568	578	Y	k		s,l	
NDM	3102	578	588	Y	k		s,l	
NDM	3102	623	628	D	k		b,s	
NDM	3102	628	638	D	k		b,s	
NDM	3102	798	808	D	k		b,s	
NDM	3102	808	818	D	k		b,s	
NDM	3102	938	948	D	k		b,s	
NDM	3102	948	952	D	k		b,s	
NDM	3102	958	968	TBd				
NDM	3102	968	978	TBd				
NDM	3102	1074	1078	Y	k		y,s	
NDM	3103	36	46	R	et			
NDM	3103	46	56	R	et			
NDM	3103	128.7	138.7	R	et			
NDM	3103	138.7	142.8	*qp				
NDM	3103	159	159.3	R			qsp	
NDM	3103	159.3	171.8	R	et			
NDM	3103	176	186	R	e		t	
NDM	3103	186	196	R	e		t	
NDM	3103	236	246	R	et			
NDM	3103	246	251.7	R	et			
NDM	3103	376	384	R				
NDM	3103	384	392.5	R				
NDM	3103	546	556	R	e/a			
NDM	3103	556	566	R	e/a			
NDM	3103	617	624.5	R	kq-b		e/a	
NDM	3103	624.5	636	R	e/a		kq-b	
NDM	3103	786	791.5	R	e/a		y	
NDM	3103	791.5	796.7	R	e/a		y	

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3103	888	896	R	e/a		y	
NDM	3103	896	901	R	e/a		y	
NDM	3104	0	18	O/B				
NDM	3104	77	87	G^p	S,y		k	
NDM	3104	87	98	G^p	S,y		k	
NDM	3104	128	138	G^p	S,y		k	
NDM	3104	138	148	G^p	S,y		k	
NDM	3104	238	248	G^p	K,y		s	
NDM	3104	248	258	G^p	K,y		s	
NDM	3104	378	388	Y				
NDM	3104	388	398	Y				
NDM	3104	458	468	M/P				
NDM	3104	468	479.5	M/P				
NDM	3104	538	548	Y	y/+/-d		q/k/	
NDM	3104	548	558	Y				
NDM	3104	588	598	N				
NDM	3104	598	608	N				
NDM	3104	718	728	Y	K/q		d,w	
NDM	3104	728	738	Y	K/q		d,w	
NDM	3104	848	858	P	k/q		d/w	
NDM	3104	858	868	P	k/q		d/w	
NDM	3104	978	988	Y	k/q		w/d,b	
NDM	3104	988	998	Y	k/q		w/d,b	
NDM	3104	1228	1238	D				
NDM	3104	1238	1244	D				
NDM	3104	1328	1338	D	b		k/d	
NDM	3104	1338	1346	D	b		k/d	
NDM	3104	1458	1468	Y	k/b		q/y	
NDM	3104	1468	1478	Y	k/b		q/y	
NDM	3105	138	148	N	qsp		-k	
NDM	3105	148	158	N	qsp		-k	
NDM	3105	198	200	N	qsp			
NDM	3105	200	208	N	qsp			
NDM	3105	268	278	G^c	qpw			
NDM	3105	418	428	G^c	-qpw		-bk	
NDM	3105	428	438	G^c	-qpw		-bk	
NDM	3105	638	648	G^c	qpws		bk	
NDM	3105	648	653	G^c	qpws		bk	
NDM	3105	1008	1018	G^c	qpwl		bk	
NDM	3105	1018	1028	G^c	qpwl		bk	
NDM	3105	1138	1148	G^c	bk		-qpwl	
NDM	3105	1148	1158	G^c	bk		-qpwl	
NDM	3105	1284.3	1291.5	Z	ys		a	
NDM	3105	1291.5	1299.5	Z	ys		a	
NDM	3105	1313	1321	Z.TBd	y		a	
NDM	3105	1321	1331.5	Z				
NDM	3105	1331.5	1348	TBd			y	
NDM	3105	1348	1368.7	TBd			y	
NDM	3105	1388	1398	G^c	bk		-qpw	
NDM	3105	1398	1408	G^c	bk		-qpw	

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3106	0	20	O/B				
NDM	3106	20	33	D	y,s,w		r	
NDM	3106	158	168	D	y,s,w		k	
NDM	3106	168	178	D	y,s,w		k	
NDM	3106	236	248	Y	y,s,w		k-	
NDM	3106	248	258	Y	y,s,w		k-	
NDM	3106	548	558	D	w,s,h,m		k,y	
NDM	3106	558	568	D	w,s,h,m		k,y	
NDM	3106	758	768	Y	k		b,s	
NDM	3106	768	778	Y	k		b,s	
NDM	3106	908	918	Y	k		b,s	
NDM	3106	918	928	Y	k		b,s	
NDM	3106	1128	1138	Y	b/k		d/s	
NDM	3106	1138	1148	Y	b/k		d/s	
NDM	3106	1288	1298	Y	b/k		s/y	
NDM	3106	1298	1308	Y	b/k		s/y	
NDM	3113	19	27	N/F.FD	k		qs	
NDM	3113	27	37	N/F.FD	k		qs	
NDM	3113	157	167	N.F-DY	k			
NDM	3113	167	177	N.F-DY	k			
NDM	3113	346.5	353	N.FDZ	y			
NDM	3113	353	357	N/DX	y		b	
NDM	3113	707	711.8	F.F-DY	k			
NDM	3113	711.8	717	F.F-YD	k			
NDM	3113	787	797	F.F-DY	k			
NDM	3113	797	807	F.F-DY	k			
NDM	3113	981.4	992	F.H(FDY)				
NDM	3113	992	1002	F.H(FDY)				
NDM	3114	0	427	TC^k				
NDM	3114	449	459	YW	qspy		-bk	
NDM	3114	459	469	YW	qspy		-bk	
NDM	3114	589	599	D	bk		qsp	
NDM	3114	599	600	D	bk		qsp	
NDM	3114	609	619	Y	bk		qsp	
NDM	3114	619	629	Y	bk		qsp	
NDM	3114	699	709	G^m	bk		qsp	
NDM	3114	779	789	G^m	bk		qsp	
NDM	3114	789	799	G^m	bk		qsp	
NDM	3114	1019	1029	G^m	bk		qsp	
NDM	3114	1029	1036	G^m	bk		qsp	
NDM	3114	1059	1069	Y	bk		-qsp	
NDM	3114	1069	1079	Y	bk		-qsp	
NDM	3115	38	48	G^m	qsp		k-b	
NDM	3115	298	308	Y	bk		-qsp	
NDM	3115	308	318	Y	bk		-qsp	
NDM	3115	478	488	Y	bk		-qsp	
NDM	3115	488	498	Y	bk		-qsp	
NDM	3115	678	688	D	b-k		qspw	
NDM	3115	688	698	D	b-k		qspw	
NDM	3115	768	778	D	b-k		qspw	
NDM	3115	778	788	D	b-k		qspw	

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3115	838	848	D	b-k		qspw	
NDM	3115	848	858	D	b-k		qspw	
NDM	3115	988	998	Y	b-k		-qsp	
NDM	3115	998	1008	Y	b-k		-qsp	
NDM	3115	1168	1178	G^c	qs		-k	
NDM	3115	1178	1188	G^c	qs		-k	
NDM	3116	728	733	D	bk-d		s	
NDM	3116	733	742	D	syp		bkd	
NDM	3116	934.5	948	M?	k-b		-qsp	
NDM	3116	948	958	M?	k-b		-qsp	
NDM	3116	1018	1028	YxP/M	bk-d			
NDM	3116	1028	1038	YxP/M	bk-d			
NDM	3116	1248	1259.5	WC?	b-k			
NDM	3116	1259.5	1268	WC?	kb		-qspy	
NDM	3116	1348	1358	G	yqs			
NDM	3116	1358	1368	G				
NDM	3123	148	158	X.H(DNNx`	b, py		k, s	
NDM	3123	158	168	X.H(DNNx`	b, py		k, s	
NDM	3123	178	188	X.H(DNNx`	b, py		k, s	
NDM	3123	188	198	X.H(DNNx`	b, py		k, s	
NDM	3123	248	258	Yxbp(l?)	b,		p, q	
NDM	3123	258	268	Yxbp(l?)	b,		p, q	
NDM	3123	438	448	D?	bp		l, q	
NDM	3123	448	458	Dp	s, p		b-k, l	
NDM	3123	488	498	Dp	s, p		b-k, l	
NDM	3123	498	503	Dp	s, p		b-k, l	
NDM	3123	648	658	D	b-k		s,p	
NDM	3123	658	668	D	b-k		s,p	
NDM	3123	744	754	X.HxN/X.Y				
NDM	3123	754	766	X.HxN/X.Y				
NDM	3124	0	137	OB				
NDM	3124	188	198	Y	b		k	
NDM	3124	198	209	Y	b		k	
NDM	3124	328	338	N/P			k,s	
NDM	3124	338	348	N			k,s	
NDM	3124	388	398	N/P			k,s	
NDM	3124	398	408	N/P			k,s	
NDM	3124	428	438	N/P			k,s	
NDM	3124	438	450	N			k,s	
NDM	3124	518	528	N/P			k,s,l	
NDM	3124	528	538	N/P			k,s,l	
NDM	3124	871.5	875.5	X.HxN^f				
NDM	3124	875.5	887	X.HxN^f				
NDM	3124	1218	1235	TB				
NDM	3125	99	109	D	bkpcm		qsp	
NDM	3125	109	119	D	bkpcm		qsp	
NDM	3125	239	249	D	bkmpc		qsp	
NDM	3125	249	259	D	bkmpc		qsp	
NDM	3125	349	359	D	bkmpc		qsp	
NDM	3125	359	369	D	bkmpc		qsp	
NDM	3125	379	389	D	bkmpc		qsp	
NDM	3125	389	399	D	bkmpc		qsp	

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3125	719	729	D	b/lp		kmp	
NDM	3125	729	739	D	b/lp		kmp	
NDM	3125	919	933	D/R	kmp		slp	
NDM	3125	1049	1059	N	qsp		k	
NDM	3125	1059	1069	N	qsp		k	
NDM	3128	39.3	48.5	D	lp		qps	
NDM	3128	48.5	56	D	lp		qps	
NDM	3128	76	88	X.FDM/pxn	kpbsc		qp	
NDM	3128	88	98	X.FDM/pxn	kpbsc		qp	
NDM	3128	298	308	X.FDM/pxn	kpbsc		qp	
NDM	3128	308	322.7	X.FDM/pxn	kpbsc		qp	
NDM	3128	518	528	P/N.DN/p	kbqmpc		qps	
NDM	3128	528	538	P/N.DN/p	kbqmpc		qps	
NDM	3128	658	668	X.DFxN/P\	lsy		kpbc	
NDM	3128	668	678	X.DFxN/P\	lsy		kpbc	
NDM	3128	738	748	P.DF	kbmpc		lsy	
NDM	3128	748	758	P.DF	kbmpc		lsy	
NDM	3128	808	818	P.DF	kbmpc		lsy	
NDM	3128	818	828	P.DF	kbmpc		lsy	
NDM	3128	938	948	X.DFxN/P/	kbpmc		qps	
NDM	3128	948	958	X.DFxN/P/	kbpmc		qps	
NDM	3129	0	499.8	TC				
NDM	3129	550	560	Y	sq		b	
NDM	3129	560	573.5	Y	sq		b	
NDM	3129	573.5	580	Gp	sqk		w	
NDM	3129	580	590	Gp	sqk		w	
NDM	3129	610	620	Gp	sqk		w	
NDM	3129	620	630	Gp	sqk		w	
NDM	3129	970	980	Y				
NDM	3129	1200	1210	Y	qs		qsbk	
NDM	3129	1210	1220	Y	qs		qsbk	
NDM	3129	1220	1230	Y	qs		qsbk	
NDM	3129	1230	1240	Y	qs		qsbk	
NDM	3129	1300	1310	G	sw		qskb	
NDM	3129	1310	1320	G	sw		qskb	
NDM	3133	100	118	X2				
NDM	3133	348	358	X2xx2qpw	kl		h	
NDM	3133	358	368	X2xX2qpw	k		lw	
NDM	3133	668	678	X2	kw		h	
NDM	3133	678	688	X2	kw		h	
NDM	3133	688	698	Fh	kw			
NDM	3133	698	708	Fh	k		w	
NDM	3133	758	768	Fh	k		w	
NDM	3133	768	778	Fh	k		w	
NDM	3133	808	818	X2	kb		ws-h	
NDM	3133	818	828	X2	kb		ws-h	
NDM	3133	1148	1158	X2	kb		wds	
NDM	3133	1158	1168	X2	kb		wds	
NDM	3135	80	88	X2	iw		qpk	
NDM	3135	88	98	X2	iw		qpk	
NDM	3135	198	208	X2	k-b		iw	
NDM	3135	208	218	X2	k-b		iw	

APPENDIX 8-B
List of Samples Selected for Kinetic Testing

		INTERVAL			ALTERATION			
COMPANY	HOLE_ID	FROM_FT	TO_FT	LITHO	Early Type	Early Intens.	Late Type	Late Intens.
NDM	3135	388	398	X2	s		w	
NDM	3135	398	408	X2	s		w	
NDM	3135	748	758	X2	s		w	
NDM	3135	758	768	X2	s		w	
NDM	3135	988	998	X2	s		kw	
NDM	3135	998	1008	X2	s		kw	
NDM	3135	1038	1048	Fh	s		wk	
NDM	3135	1048	1058	Fh	s		wk	
NDM	3135	1098	1108	Fh	s		wk	
NDM	3135	1108	1118	Fh	s		wk	
NDM	3135	1238	1248	Fh	s		wk	
NDM	3135	1248	1258	Fh	s		wk	