AMERICAN BULLION MINERALS LTD.

A GEOPHYSICAL REPORT ON GROUND MAGNETOMETER VLF-EM AND INDUCED POLARIZATION SURVEYS ON THE RED-CHRIS GOLD-COPPER PORPHYRY DEPOSIT

Liard Mining Division
British Columbia, Canada

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by

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AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

SUMMARY OF 1994 ENVIRONMENTAL PROGRAM

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SUMMARY

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 ENVIRONMENTAL PROGRAM

Scope-of-Work Completed:

- Initiated baseline data collection programs for hydrology, water quality, meteorology, and fish and wildlife in July 1994;
- Established database system to manage environmental data, and entered all 1994 data;
- Installed automatic water level recorder in "White Rock Canyon" (Site H2) in October 1994, and
- Prepared this 1994 year-end report.

Preliminary Findings:

- Creek flows between July 20 and November 3, 1994, were highest in Coyote Creek (Site H1) and descended in order of numbering, with "Red Rock Canyon" (Site H5) having the lowest flows; however, insufficient calibration data was available to calculate exact flows. Lowest and highest water levels during the 3½ month monitoring period were recorded in early August and late September 1994, respectively.
- General background water quality at the Red Chris Property (Sites W3, W4, W6, W7, W8 and W9) appears to be typical of mountain runoff streams, and is slightly alkaline;
- Elevated levels of physical parameters, anions, and dissolved and total metals were evident in runoff from the deposit area ("Red Rock Canyon" Site W5), and to a lesser extent at points downstream (Site W2 and Site W1). Many of these parameters exceeded Provincial and Federal criteria for protection of freshwater aquatic life;
- Between July 20 and November 3, 1994, temperatures ranged from a minimum of -16 °C on November 2, to a maximum of +29 °C on July 20, and the maximum precipitation recorded over a 24 hour period was 19.7 mm on August 14, 1994, and
- Moose, mountain goats and black bear were the predominant species observed by site personnel during the 1994 exploration field season.

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

SUMMARY OF 1994 ENVIRONMENTAL PROGRAM

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SECTION 1.0 - INTRODUCTION

An initial baseline environmental monitoring program at the American Bullion Minerals Ltd. (ABM) Red Chris property, located near Iskut, B.C., was established by Hallam Knight Piésold Ltd. (HKP) in July 1994, with additional monitoring equipment installed during a second site visit in October 1994. The program has primarily been maintained by ABM site personnel during their 1994 exploration program, with support from HKP, as necessary. The initial program established collection of baseline environmental data for the following areas of study:

- hydrology monitoring;
- water quality monitoring;
- meteorology monitoring; and
- record of fish and wildlife observations.

Previously unnamed geographical features within and surrounding the Red Chris property, such as the numerous small creeks where monitoring stations were established, were named by ABM site personnel in order to provide consistency with regard to data collection references, for example, for the fish and wildlife log. These names, as well as those already established are shown on Figure 1.0.

This report summarizes the environmental field work completed and data collected during 1994, and provides an outline for recommended tasks for the environmental program during 1995.

SECTION 2.0 - SUMMARY OF 1994 FIELD WORK

Environmental field work during the 1994 season was limited to establishing baseline monitoring programs for site hydrology, water quality and meteorology, and establishing a fish and wildlife observation log. Set up work was completed by HKP personnel during an initial site visit from July 19 to 22, 1994, with additional work completed during a second site visit from October 17 to 19, 1994. All other data collection was performed by ABM site personnel.

2.1 HYDROLOGY MONITORING PROGRAM

The initial hydrology monitoring program consisted of installation of 1 m long staff gauges at five selected locations in July 1994 (H1 to H5), and initial stream flow measurements for calibration at each station. The locations of the hydrology monitoring stations were selected based on proximity to the current exploration area and potential future mine development considerations.

An automatic water level recorder was installed at Station H2 in October 1994 to collect detailed hydrological site data. The recorder was programmed to collect hourly water level readings and proper operation was confirmed through link-up with a lap-top computer. A second set of stream flow calibration measurements were also taken during the October site visit, and the staff gauge at Station H1 was extended to 2 m in length, as autumn flows were reaching the top of the first staff gauge.

Water levels were recorded by ABM site personnel at the five stations every three days between July 21 and November 3, 1994. The locations of the hydrology monitoring stations are shown in Figure 1.0.

2.2 SURFACE WATER QUALITY MONITORING PROGRAM

Four sets of surface water quality samples were collected monthly between July and October 1994 at nine selected locations at the project site (W1 to W9); the first five water quality stations (W1 to W5) correspond to hydrology stations H1 to H5. The locations of the water quality monitoring stations were selected based on proximity to the current exploration area and potential future mine development considerations.

Samples scheduled to be collected at the end of September were collected on October 5, 1994, and samples were not collected in November since the exploration program was closed down for the season early in the month, approximately one week after the October samples had been collected. All samples, including duplicates and travel blanks, were preserved, as appropriate, and submitted to Analytical Services Laboratory Ltd. (ASL) in Vancouver for analyses of the following parameters:

- physical tests such as conductivity, pH, total dissolved and suspended solids, hardness and turbidity;
- anions such as alkalinity, chloride, fluoride and sulphate;
- nutrients such as ammonia, nitrate and nitrite nitrogen, and ortho-, dissolved and total phosphate;
- total cyanide;
- selected total and dissolved metals, and
- total organic carbon.

A single set of replicate samples was taken during each of the four 1994 sampling events and travel blanks were included three times as components of the water quality QA/QC program. Replicate samples were collected at Site W1 on July 20 and August 31, at Site W4 on October 5, and at Site W5 on October 31, 1994. Travel blanks were submitted on July 20, September 7, and October 5, 1994.

A sample of water from the camp freshwater supply was submitted with the October samples for analysis of most of the aforementioned parameters, and additionally: colour; dissolved silicate; dissolved mercury, and fecal and total coliform bacteria, which are part of the Health and Welfare Canada drinking water guidelines (1993). A sample of deionized water, prepared as a "bottle blank" for the drinking water sample, was analyzed only for total metals.

Samples were collected into pre-cleaned, acid-washed containers provided by ASL. Sample containers were rinsed thoroughly with water from the specific sample site three times prior to collection of the final sample, except for cyanide bottles which contained sodium hydroxide (NaOH) preservative and were only filled once. All sample containers were fully submersed during sample collection. Samples were preserved, as appropriate, and shipped to the project laboratory in coolers packed with ice.

Other than the first set of water quality samples, which were collected by HKP during the July site visit, all subsequent samples were collected by ABM site personnel. The locations of the water quality monitoring stations are shown in Figure 1.0.

2.3 METEOROLOGICAL MONITORING PROGRAM

A weather station, including a rain gauge and maximum and minimum temperature thermometers, was established during the July 1994 HKP site visit. Data was recorded twice daily by ABM personnel from July 20 until the 1994 exploration program ended on November 3. Temperature data could not be collected between September 21 and October 1, 1994, as the weather station was blown over and the thermometers broken during very high winds on September 21, 1994.

The location of the meteorological monitoring station is shown in Figure 1.0.

2.4 FISH AND WILDLIFE OBSERVATION LOG

A fish and wildlife log was informally established by the site helicopter pilot prior to the HKP visit. A log sheet was provided in the field manual prepared by HKP and was maintained by ABM site personnel until the 1994 exploration program ended in November. The record was not maintained between July 22 and August 22, 1994, as new staff were not made aware that this was part of their duty.

Location names referenced in the fish and wildlife logs are labelled on Figure 1.0.

SECTION 3.0 -SUMMARY OF FINDINGS

All 1994 environmental data collected by HKP and ABM personnel was entered into databases established for each of the study areas discussed above, to maximize the efficiency of data storage, analysis and reporting. The data has been reviewed by HKP and compared to government criteria, where applicable.

3.1 HYDROLOGY MONITORING PROGRAM

Hydrology monitoring and calibration data indicated that Coyote Creek (Site H1) had the highest flows, and flows decreased in the order of numbering, with "Red Rock Canyon" (Site H5) having the lowest flows. Although there is currently insufficient calibration data to determine the actual flows at each station, the lowest water depths were recorded in early August and highest water depths were recorded in late September, suggesting that the lowest and highest flows between July and November occurred at these times, respectively. The surface of the creeks at Site H2 and Site H5 had frozen over by the end of the exploration program in November 1994. Until further flow data is collected, including water depths and calibration measurements, no further conclusions can be inferred.

Staff gauge readings and flow calibration measurements are presented in Tables 3.1 and 3.2, respectively.

3.2 SURFACE WATER QUALITY MONITORING PROGRAM

Surface water quality data was reviewed with respect to general characteristics and was compared to both Provincial, Approved and Working Criteria for Water Quality, 1994 (AWCWQ) and Federal, Canadian Council of Ministers of Environment, 1991 (CCME) criteria for protection of freshwater aquatic life. These criteria, specific to the parameters tested, are summarized in Table 3.3.

Based on available data, a few observations can be made, though, there is currently insufficient data to fully analyze with respect to general water quality or seasonal trends. Results to date indicate that water quality at the Red Chris property is slightly alkaline with fairly good acid-buffering capacity, and is typical of mountain runoff streams in northern B.C. with respect to physical parameters, anions and nutrients.

Sample sites selected in order to monitor background water quality conditions and potential future impacts due to development, such as W3, W4, W6, W7, W8 and W9, generally contained low metals concentrations that did not exceeded AWCWQ or CCME criteria, though Site W6 consistently contained copper at or slightly above CCME criteria. This monitoring site was selected because it was thought to be isolated from the copper deposit; however, this data suggests that there is some influence from copper mineralization in the area. This contrasts with data from sites W8 and W9 which drain from the closer to the general deposit area and generally did not contain elevated levels of copper or other metals. Site W9 (Camp Creek) showed elevated levels of aluminum, and iron, and slightly elevated copper on October 5, 1994, when drill return-water overflowed into this catchment.

The sites selected to monitor water quality draining directly from the deposit area included: Site W5 (near the headwaters of "Red Rock Canyon"); Site W2 ("White Rock Canyon" below "Red Rock Canyon"), and Site W1 (Coyote Creek below "White Rock Canyon"). Data from these locations indicated that surface water near the headwaters of "Red Rock Canyon" reflects the mineralization of the deposit, containing levels of fluoride, sulphate, aluminum, cadmium, copper, iron, manganese and zinc exceeding AWCWQ and CCME criteria. The results also indicate that this influence is evident downstream at sites W2 and W1, though, with dilution the concentrations are not as high.

Review and analysis of QA/QC data involved calculation of the ratios of values for original versus duplicate data, to compare the two sets of data. All data generally matched very closely (i.e., ratios were close to 1.00), and in the instances where there was greater than a 20% difference were generally isolated to cases where one or both values were at or near the method detection limits. Data from replicate samples collected on August 31, and October 31, 1994, suggested that there may have been inconsistency in filtering technique for dissolved metals samples; however this was not reflected in data from the other monitoring sites. Elevated silver levels in the replicate collected on October 31, 1994, suggest the possibility of contamination from the laboratory, as this was not seen in any other samples.

Travel blank samples collected on July 20, and October 5, 1994, were generally clean, with most parameters below detection limits, though minor levels of suspended solids and ammonia nitrogen were seen in the October 5, 1994 travel blank. These slightly increased levels were also present in water quality samples collected during the same sampling event. The September 7, 1994, travel blank contained levels of physical parameters, anions, nutrients, and several total and dissolved metals above detection limits; however, this apparent contamination was not reflected in water quality samples collected during the same sampling event.

Drinking water from the camp supply was found to be of good quality when compared to Health and Welfare Canada drinking water guidelines. The only two parameters that slightly exceeded the guidelines were iron and colour, both of which are aesthetic objectives related to the appearance, taste and odour of the water, but are not health concerns. The elevated colour measurement is likely due to the slightly elevated iron level.

All surface water quality, QA/QC and drinking water data collected in 1994 is presented in Tables 3.4 to 3.14, inclusive.

3.3 METEOROLOGICAL MONITORING PROGRAM

Between July 20 and November 3, 1994, temperatures ranged from a minimum of -16 °C on November 2, to a maximum of +29 °C on July 20, and the maximum precipitation recorded over a 24 hour period was 19.7 mm on August 14, 1994. Insufficient meteorological data has been collected to date to be interpreted. Once sufficient data has been collected, this data will be used with available regional meteorological data to assist with assessment of hydrological conditions and to establish a water balance for a mine at the planning stage of development.

All meteorological data collected between July 20 and November 3, 1994, is presented in Table 3.15.

3.4 FISH AND WILDLIFE OBSERVATION LOG

The Red Chris property and surrounding area was divided into six main areas in order to organize fish and wildlife observation data; these areas included the:

- Ealue Lake area;
- Exploration area;
- Ishahcezetle Mountain area;
- Kluea Lake area;
- Spit Mountain area, and
- Todagin Mountain area.

Records included both sightings and signs of wildlife and were primarily recorded by ABM personnel and the helicopter pilot. Most observations were recorded in the areas of highest exploration activity, which included the exploration area, itself, and the Todagin Mountain area, which was on the flight path from the primary supply depot at the Tatogga Lake Resort, approximately 15 km south of Iskut, on Highway 37. These two areas accounted for approximately 63% of all the recorded observations.

Although a complete discussion of wildlife observations is not included here, the predominant species identified were moose, mountain goats and black bear. Other species observed included: bald eagles; beaver; foxes; grizzly bear; porcupine; wolverine; rainbow trout, and unidentified canine and ungulate species. Table 3.16 provides a summary of all fish and wildlife observations, including sub-totals for each area, and including a break-down of gender and maturity, where possible.

Table 3.1

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

HYDROLOGY MONITORING LOG
(Database)

Date	Staff Gauge Readings					Comments
	H1	H2	H3	H4	H5	
20-Jul-94	0.808	0.325				(installation & calibration)
21-Jul-94			0.310	0.120	0.170	(installation & calibration)
24-Jul-94	0.750	0.320	0.326	0.110	0.160	H2 - waves created by helicopter
27-Jul-94	0.726	0.290	0.320	0.106	0.157	H2 - correct (now covered)
30-Jul-94	0.730	0.292	0.355	0.118	0.163	
2-Aug-94	0.700	0.275	0.327	0.112	0.159	
5-Aug-94	0.662	0.280	0.314	0.102	0.154	
8-Aug-94	0.598	0.278	0.325	0.102	0.155	
11-Aug-94	0.527	0.263	0.305	0.106	0.148	
14-Aug-94	0.546	0.273	0.286	0.108	0.162	
17-Aug-94	0.568	0.260	0.310	0.098	0.161	
20-Aug-94	0.692	0.290	0.355	0.132	0.177	H1 - very murky
23-Aug-94	0.685	0.280	0.316	0.110	0.168	H1 - very murky
26-Aug-94	0.714	0.275	0.305	0.112	0.168	
29-Aug-94	0.735	0.260	0.290	0.100	0.159	H1 - clear
31-Aug-94	0.818	0.260	0.313	0.113	0.168	(collected water quality samples)
3-Sep-94	0.865	0.252	0.318	0.114	0.165	
6-Sep-94	0.901	0.275	0.330	0.128	0.185	
9-Sep-94	0.888	0.260	0.311	0.118	0.168	
12-Sep-94	0.912	0.283	0.328	0.125	0.180	
15-Sep-94	0.975	0.324	0.332	0.148	0.194	
18-Sep-94	0.986	0.326	0.322	0.142	0.188	
21-Sep-94						(no data collected)
24-Sep-94	1.003	0.370	0.333	0.170	0.216	Site H1 staff gauge under water
27-Sep-94	1.002	0.340	0.380	0.170	0.208	- " -
30-Sep-94	1.010	0.315	0.338	0.158	0.190	- " -
3-Oct-94	1.001	0.310	0.340	0.153	0.190	- " -
5-Oct-94	1.001	0.318	0.348	0.170	0.210	- " -. 1" fry @ W7. Drill water return above W9. (collected water quality samples).
8-Oct-94	0.994	0.310	0.337	0.155	0.202	
11-Oct-94	0.992	0.305	0.330	0.150	0.215	Ice at creek edge @ H5.
14-Oct-94	0.974	0.290	0.333	0.136	0.180	Ice at creek edge @ H5.
17-Oct-94	0.985	0.288	0.350	0.160	0.180	(calibration). H1 staff gauge increased to 2.0 m.
20-Oct-94	0.976	0.268	0.328	0.142	0.174	H2 @ 3:45 pm.
23-Oct-94	0.942	0.292	0.314	0.130		H2 @ 3:50 pm (partially frozen). H5 frozen (S.G. = 0.250 m).
26-Oct-94	0.944	0.250	0.323	0.123	0.170	H2 @ 12:06 pm. H5 had ice around staff gauge.
29-Oct-94	0.921	0.267	0.314	0.127	0.222	
31-Oct-94	0.885	0.300	0.300	0.100		H2 @ 3:50 pm (50% frozen). H3 had ice on staff gauge. H5 80% frozen (S.G. = 0.310 m).
3-Nov-94	0.867		0.320	0.102		H2 @ 2:46 pm (frozen). W3 had ice on edge. H5 frozen.

Table 3.2

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

SUMMARY OF HYDROLOGY STATION CALIBRATIONS

	H1		H2		H3		H4		H5	
Date	Staff Gauge	Flow (m^3/s)	Staff Gauge	Flow (m^3/s)	Staff Gauge	Flow (m^3/s)	Staff Gauge	Flow (m^3/s)	Staff Gauge	Flow (m^3/s)
Jul-94	0.808	1.414	0.325	0.805	0.310	0.206	0.120	0.087	0.170	0.058
Oct-94	0.985	1.137	0.288	0.568	0.350	0.257	0.160	0.148	0.180	0.081
Jan-00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan-00	0	0	0	0	0	0	0	0	0	0
Jan-00	0	0	0	0	0	0	0	0	0	0
Jan-00	0	0	0	0	0	0	0	0	0	0

Table 3.3

AMERICAN BULLION MINERALS, INC.
RED CHRIS PROJECT

1994 SUMMARY REPORT

British Columbia and Federal Water Quality Criteria For Protection of Freshwater Aquatic Life

	B.C. (AWCWQ)	Federal (CCME)
Total Dissolved Solids	+10 or 10%	
pH	6.5 to 9	6.5 to 10
Total Suspended Solids		+10 or 10%
Turbidity	+5 or 10%	
Alkalinity (total)	20 (sensitivity rating)	
Sulphate (dissolved)	100	
Ammonia Nitrogen	0.680 to 1.37 fn([pH]&[Temp])	
Nitrate Nitrogen	200	
Nitrite Nitrogen	0.06 to 0.6	0.06
Cyanide	0.01 (as WAD cyanide)	0.005 (as Free cyanide)
Aluminum (total)		0.005 to 0.1 fn(pH)
Antimony (total)	0.05	
Arsenic (total)	0.05	0.05
Barium (total)	5	
Beryllium (total)	0.0053	
Cadmium (total)	0.0002 to 0.0018 fn(Hardness)	0.0002 to 0.0018 fn(Hardness)
Chromium (total)	0.002 or 0.02	0.002 or 0.02
Cobalt (total)	0.05	
Copper (total)	0.002 + fn(Hardness)	0.002 to 0.004 fn(Hardness)
Iron (total)	0.3	0.3
Lead (total)	0.001 + fn(Hardness)	0.001 to 0.007 fn(Hardness)
Manganese (total)	0.1 to 1	
Mercury (total)	0.0001	0.0001
Molybdenum (total)	2	
Nickel (total)	0.025 to 0.150 fn(Hardness)	0.025 to 0.150 fn(Hardness)
Selenium (total)	0.001	0.001
Silver (total)	0.0001	0.0001
Uranium (total)	0.3	
Vanadium (total)	10	
Zinc (total)	0.03	0.03
Aluminum (dissolved)	0.05 + fn (pH)	
Calcium (dissolved)	8 (sensitivity rating)	

CCME - Canadian Council of Ministers of Environment, 1991 guidelines.

AWCWQ - Approved and Working Criteria for Water Quality in British Columbia, 1994.

TABLE 3.4

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W1 Water Quality Data - Coyote Creek Below "White Rock Canyon" confluence

Date		20-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	412	545	452	424
Total Dissolved Solids	mg/L	289	367	293	299
Hardness	mg/L CaCO3	219	292	224	227
pH	pH Units	8.21	8.31	7.80	8.11
Total Suspended Solids	mg/L	5	3	9	3
Turbidity	NTU	1.65	1.90	2.25	1.18
Anions					
Alkalinity (Total) *	mg/L CaCO3	162	188	169	171
Chloride (dissolved)	mg/L	0.6	0.5	0.6	0.6
Fluoride (dissolved)	mg/L	0.08	0.10	0.09	0.08
Sulphate (dissolved)	mg/L	63.8	113	80.8	61.0
Nutrients					
Ammonia Nitrogen	mg/L	<0.005	<0.005	0.009	<0.005
Nitrate Nitrogen	mg/L	0.023	0.013	0.020	0.022
Nitrite Nitrogen	mg/L	0.001	0.002	0.004	0.002
ortho-Phosphate	mg/L	0.003	0.003	0.001	0.002
Total Dissolved Phosphate	mg/L	0.004	0.004	0.006	0.006
Total Phosphorus	mg/L	0.007	0.005	0.009	0.009
Cyanide					
Total Cyanide	mg/L	0.001	<0.001	0.002	0.002
Total Metals					
Aluminum (total)	mg/L	0.075	0.053	0.082	0.063
Antimony (total)	mg/L	0.0002	0.0004	0.0002	0.0003
Arsenic (total)	mg/L	0.0006	0.0005	0.0005	0.0006
Barium (total)	mg/L	0.053	0.058	0.048	0.052
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	55.8	69.7	65.0	58.6
Chromium (total)	mg/L	0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	0.002	0.008	0.005	0.001
Iron (total)	mg/L	0.289	0.502	0.434	0.285
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	19.8	29.3	25.5	20.7
Manganese (total)	mg/L	0.060	0.129	0.089	0.083
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	0.001	<0.001	0.001
Nickel (total)	mg/L	<0.001	<0.001	0.002	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	2.92	2.99	3.09	3.25
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium (total)	mg/L	0.333	0.519	0.422	0.347
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00015	0.00018	0.00021	0.00010
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	0.006	0.018	0.017	0.007
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.019	0.041	0.036	0.052
Antimony (dissolved)	mg/L	0.0002	0.0003	0.0002	0.0003
Arsenic (dissolved)	mg/L	0.0003	0.0003	0.0003	0.0004
Barium (dissolved)	mg/L	0.050	0.058	0.045	0.052
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	55.3	68.6	53.6	57.4
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	0.001	0.001	0.002	<0.001
Iron (dissolved)	mg/L	0.036	<0.030	<0.030	0.072
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	19.7	29.3	21.9	20.2
Manganese (dissolved)	mg/L	0.047	0.119	0.062	0.071
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	<0.001	<0.001	0.002	<0.001
Potassium (dissolved)	mg/L	0.78	1.03	0.89	0.84
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	2.85	2.90	2.76	3.22
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	3.67	6.64	4.62	3.85
Strontium (dissolved)	mg/L	0.330	0.517	0.368	0.341
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00015	0.00018	0.00021	0.00010
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	0.010	0.006	0.007
Organics					
Total Organic Carbon	mg/L		1.9	1.9	2.3

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.

(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.

(open box) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.5

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W2 Water Quality Data - "White Rock Canyon" below "Red Rock Canyon"

Date		20-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	512	582	540	673
Total Dissolved Solids	mg/L	379	400	356	520
Hardness	mg/L CaCO3	275	308	260	389
pH	pH Units	8.40	8.45	8.30	8.32
Total Suspended Solids	mg/L	7	7	5	1
Turbidity	NTU	3.90	3.40	4.16	1.25
Anions					
Alkalinity (Total) *	mg/L CaCO3	179	184	182	229
Chloride (dissolved)	mg/L	0.6	<0.5	0.6	0.7
Fluoride (dissolved)	mg/L	0.09	0.10	0.10	0.10
Sulphate (dissolved)	mg/L	110	142	120	157
Nutrients					
Ammonia Nitrogen	mg/L	<0.005	<0.005	0.007	<0.005
Nitrate Nitrogen	mg/L	0.043	0.019	0.070	0.106
Nitrite Nitrogen	mg/L	0.002	0.002	0.004	0.002
ortho-Phosphate	mg/L	0.002	0.004	0.003	0.001
Total Dissolved Phosphate	mg/L	0.003	0.005	0.007	0.004
Total Phosphorus	mg/L	0.012	0.006	0.016	0.005
Cyanide					
Total Cyanide	mg/L	0.001	<0.001	0.001	0.002
Total Metals					
Aluminum (total)	mg/L	0.152	0.215	0.148	0.079
Antimony (total)	mg/L	0.0004	0.0005	0.0003	0.0008
Arsenic (total)	mg/L	0.0007	0.0004	0.0004	0.0004
Barium (total)	mg/L	0.050	0.051	0.046	0.054
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	0.0003	0.0003	<0.0002
Calcium (total)	mg/L	62.1	69.4	67.2	81.3
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	0.001	0.001	<0.001
Copper (total)	mg/L	0.004	0.022	0.014	0.003
Iron (total)	mg/L	0.707	1.07	1.05	0.400
Lead (total)	mg/L	<0.001	<0.001	0.001	<0.001
Magnesium (total)	mg/L	30.3	33.3	33.0	45.1
Manganese (total)	mg/L	0.081	0.110	0.117	0.067
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	0.001	<0.001	0.002
Nickel (total)	mg/L	<0.001	<0.001	0.002	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	2.59	2.82	2.71	2.83
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium (total)	mg/L	0.477	0.595	0.543	0.686
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00026	0.00031	0.00025	0.00041
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	0.035	0.053	0.049	0.025
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.042	0.030	0.064	0.030
Antimony (dissolved)	mg/L	0.0004	0.0005	0.0003	0.0005
Arsenic (dissolved)	mg/L	<0.0001	0.0002	0.0001	0.0003
Barium (dissolved)	mg/L	0.046	0.050	0.039	0.054
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	0.0003	<0.0002
Calcium (dissolved) *	mg/L	60.9	69.0	56.4	81.3
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	0.002	0.003	0.002	0.001
Iron (dissolved)	mg/L	0.031	<0.030	<0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	29.8	33.0	28.9	45.1
Manganese (dissolved)	mg/L	0.064	0.101	0.083	0.064
Molybdenum (dissolved)	mg/L	<0.001	0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	<0.001	<0.001	0.002	<0.001
Potassium (dissolved)	mg/L	0.95	1.07	0.95	1.16
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	2.43	2.66	2.42	2.80
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	5.99	6.98	5.74	8.61
Strontium (dissolved)	mg/L	0.465	0.587	0.481	0.686
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00025	0.00022	0.00025	0.00034
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	0.006	0.010	<0.005	0.013
Organics					
Total Organic Carbon	mg/L		1.0	1.4	1.3

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.

(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.

(outlined box) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.6

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W3 Water Quality Data - Quarry Creek

Date		21-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	317	333	302	328
Total Dissolved Solids	mg/L	214	202	186	218
Hardness	mg/L CaCO3	180	178	151	172
pH	pH Units	8.32	8.42	8.21	8.19
Total Suspended Solids	mg/L	<1	5	10	1
Turbidity	NTU	0.50	1.00	3.11	1.07
Anions					
Alkalinity (Total) *	mg/L CaCO3	164	174	159	165
Chloride (dissolved)	mg/L	0.6	<0.5	0.7	0.6
Fluoride (dissolved)	mg/L	0.06	0.06	0.06	0.05
Sulphate (dissolved)	mg/L	11.5	10.0	13.2	15.4
Nutrients					
Ammonia Nitrogen	mg/L	0.009	<0.005	0.007	<0.005
Nitrate Nitrogen	mg/L	0.008	0.008	<0.005	0.027
Nitrite Nitrogen	mg/L	0.001	0.002	<0.001	0.002
ortho-Phosphate	mg/L	0.001	0.002	0.001	<0.001
Total Dissolved Phosphate	mg/L	0.004	0.004	0.004	0.003
Total Phosphorus	mg/L	0.007	0.006	0.015	0.006
Cyanide					
Total Cyanide	mg/L	0.003	<0.001	0.003	<0.001
Total Metals					
Aluminum (total)	mg/L	0.021	0.013	0.009	0.044
Antimony (total)	mg/L	0.0001	0.0001	<0.0001	0.0002
Arsenic (total)	mg/L	0.0006	0.0009	0.0006	0.0006
Barium (total)	mg/L	0.057	0.058	0.047	0.046
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	53.0	50.9	52.1	48.7
Chromium (total)	mg/L	0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (total)	mg/L	0.139	0.165	0.106	0.155
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	11.7	12.7	12.8	13.0
Manganese (total)	mg/L	0.015	0.019	0.012	0.019
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	0.002	0.002	0.001	0.002
Nickel (total)	mg/L	<0.001	<0.001	0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	3.05	3.16	2.96	2.89
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	0.206	0.218	0.204	0.194
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00010	0.00008	0.00008	0.00011
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	<0.005	<0.005	<0.005	0.006
Antimony (dissolved)	mg/L	0.0001	0.0001	<0.0001	0.0002
Arsenic (dissolved)	mg/L	<0.0001	0.0007	0.0005	0.0004
Barium (dissolved)	mg/L	0.057	0.058	0.041	0.044
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	53.0	50.3	42.5	47.8
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (dissolved)	mg/L	0.051	0.051	<0.030	0.035
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	11.7	12.7	10.9	12.8
Manganese (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Molybdenum (dissolved)	mg/L	<0.001	0.002	<0.001	0.002
Nickel (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	0.61	0.85	0.98	0.76
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	3.05	3.12	2.73	2.82
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	2.36	2.38	2.36	2.32
Strontium (dissolved)	mg/L	0.206	0.217	0.176	0.193
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00009	0.00008	0.00008	0.00009
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		3.5	3.0	2.8

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.
[shaded box] - exceeds B.C. AWCWQ (1994) for protection of aquatic life.
[box] - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.7

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W4 Water Quality Data - Trail Creek

Date		21-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	297	316	245	305
Total Dissolved Solids	mg/L	203	199	154	199
Hardness	mg/L CaCO3	153	164	118	151
pH	pH Units	8.10	8.05	7.96	7.92
Total Suspended Solids	mg/L	1	2	2	<1
Turbidity	NTU	0.69	0.40	2.68	0.31
Anions					
Alkalinity (Total) *	mg/L CaCO3	118	122	94.8	115
Chloride (dissolved)	mg/L	0.5	<0.5	0.6	<0.5
Fluoride (dissolved)	mg/L	0.09	0.08	0.08	0.07
Sulphate (dissolved)	mg/L	40.0	43.8	34.3	38.7
Nutrients					
Ammonia Nitrogen	mg/L	0.007	<0.005	0.007	<0.005
Nitrate Nitrogen	mg/L	0.056	0.056	0.028	0.081
Nitrite Nitrogen	mg/L	0.002	0.002	<0.001	0.002
ortho-Phosphate	mg/L	0.002	0.002	0.003	<0.001
Total Dissolved Phosphate	mg/L	0.003	0.002	0.008	0.006
Total Phosphorus	mg/L	0.004	0.003	0.008	0.007
Cyanide					
Total Cyanide	mg/L	0.001	<0.001	0.002	<0.001
Total Metals					
Aluminum (total)	mg/L	0.023	0.011	0.086	0.028
Antimony (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Arsenic (total)	mg/L	<0.0001	0.0001	0.0001	0.0001
Barium (total)	mg/L	0.041	0.040	0.033	0.036
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	40.6	43.2	34.9	39.2
Chromium (total)	mg/L	0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	<0.001	<0.001	0.002	<0.001
Iron (total)	mg/L	0.058	0.037	0.164	0.034
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	12.7	14.0	11.4	13.4
Manganese (total)	mg/L	0.007	0.008	0.010	0.010
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	0.002
Nickel (total)	mg/L	<0.001	<0.001	0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	3.61	3.72	3.83	3.38
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	0.214	0.246	0.195	0.218
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00006	0.00005	0.00004	0.00007
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.009	<0.005	0.021	0.009
Antimony (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Arsenic (dissolved)	mg/L	<0.0001	0.0001	<0.0001	0.0001
Barium (dissolved)	mg/L	0.040	0.040	0.029	0.036
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	40.6	42.8	30.3	38.7
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (dissolved)	mg/L	<0.030	<0.030	0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	12.6	13.9	10.2	13.1
Manganese (dissolved)	mg/L	0.007	0.008	<0.005	0.009
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	0.62	0.72	0.51	0.66
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	3.57	3.69	3.50	3.30
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	3.37	4.28	3.33	3.64
Strontium (dissolved)	mg/L	0.213	0.244	0.175	0.215
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00006	0.00005	0.00004	0.00007
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		1.6	3.2	1.9

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.

(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.

(open box) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.8

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W5 Water Quality Data - "Red Rock Canyon"

Date		21-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	872	890	666	996
Total Dissolved Solids	mg/L	693	710	494	904
Hardness	mg/L CaCO3	467	491	338	549
pH	pH Units	7.81	7.86	7.41	7.71
Total Suspended Solids	mg/L	29	32	33	21
Turbidity	NTU	29.3	28.9	25.3	30.3
Anions					
Alkalinity (Total) *	mg/L CaCO3	80.0	68.3	63.2	79.3
Chloride (dissolved)	mg/L	0.9	<0.5	0.7	0.7
Fluoride (dissolved)	mg/L	0.39	0.40	0.30	0.41
Sulphate (dissolved)	mg/L	403	413	280	494
Nutrients					
Ammonia Nitrogen	mg/L	0.011	0.009	0.016	0.008
Nitrate Nitrogen	mg/L	0.021	0.008	0.009	0.015
Nitrite Nitrogen	mg/L	0.001	0.002	<0.001	0.001
ortho-Phosphate	mg/L	0.003	0.003	0.015	0.003
Total Dissolved Phosphate	mg/L	0.006	0.007	0.018	0.007
Total Phosphorus	mg/L	0.013	0.009	0.028	0.007
Cyanide					
Total Cyanide	mg/L	0.002	<0.001	0.002	<0.001
Total Metals					
Aluminum (total)	mg/L	1.260	1.610	1.390	0.864
Antimony (total)	mg/L	0.0003	0.0002	0.0002	0.0002
Arsenic (total)	mg/L	0.0009	0.0008	0.0011	0.0006
Barium (total)	mg/L	0.026	0.027	0.025	0.025
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	0.0035	0.0025	0.0026	0.0026
Calcium (total)	mg/L	141	152	116	162
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	0.018	0.013	0.009	0.012
Copper (total)	mg/L	0.156	0.194	0.134	0.088
Iron (total)	mg/L	9.42	11.3	8.92	7.21
Lead (total)	mg/L	<0.001	0.001	0.001	<0.001
Magnesium (total)	mg/L	28.5	28.7	23.4	36.2
Manganese (total)	mg/L	1.36	1.57	1.13	1.62
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	0.001
Nickel (total)	mg/L	0.003	0.005	0.006	0.005
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	5.42	6.12	5.21	4.90
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium (total)	mg/L	1.35	1.53	1.07	1.66
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00019	0.00016	0.00017	0.00017
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	0.482	0.572	0.416	0.517
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.080	0.053	0.052	0.073
Antimony (dissolved)	mg/L	0.0002	0.0002	0.0002	0.0002
Arsenic (dissolved)	mg/L	0.0006	<0.0001	<0.0001	0.0001
Barium (dissolved)	mg/L	0.024	0.024	0.017	0.020
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	0.0013	0.0005	0.0020
Calcium (dissolved) *	mg/L	140	150	100	161
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	0.008	0.004	<0.001
Copper (dissolved)	mg/L	0.002	0.003	0.002	0.005
Iron (dissolved)	mg/L	<0.030	<0.030	0.040	0.503
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	28.4	28.4	21.3	35.8
Manganese (dissolved)	mg/L	1.270	1.47	0.898	1.59
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	0.002	0.002	0.004	0.004
Potassium (dissolved)	mg/L	1.14	1.10	0.80	1.23
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	4.10	4.57	3.18	4.26
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Sodium (dissolved)	mg/L	6.67	8.26	5.77	8.26
Strontium (dissolved)	mg/L	1.33	1.49	0.982	1.64
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00014	0.00011	0.00013	0.00013
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	0.043	0.085	0.031	0.341
Organics					
Total Organic Carbon	mg/L		1.0	1.3	1.0

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.

(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.

(open box) - exceeds federal CCME guidelines for protection of aquatic life.

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TABLE 3.9

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W6 Water Quality Data - Trench Creek

Date		20-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	162	210	147	192
Total Dissolved Solids	mg/L	96	131	90	124
Hardness	mg/L CaCO3	76.4	104	67.1	90.8
pH	pH Units	7.86	8.06	7.76	7.91
Total Suspended Solids	mg/L	5	3	3	<1
Turbidity	NTU	0.81	1.10	1.41	0.47
Anions					
Alkalinity (Total) *	mg/L CaCO3	57.4	76.8	48.9	64.7
Chloride (dissolved)	mg/L	<0.5	<0.5	0.5	<0.5
Fluoride (dissolved)	mg/L	0.06	0.05	0.06	0.06
Sulphate (dissolved)	mg/L	21.2	28.1	21.5	25.1
Nutrients					
Ammonia Nitrogen	mg/L	0.038	<0.005	0.009	<0.005
Nitrate Nitrogen	mg/L	0.059	0.061	0.084	0.134
Nitrite Nitrogen	mg/L	0.001	0.002	0.003	0.003
ortho-Phosphate	mg/L	0.007	0.002	<0.001	0.002
Total Dissolved Phosphate	mg/L	0.008	0.003	0.003	0.003
Total Phosphorus	mg/L	0.011	0.004	0.003	0.005
Cyanide					
Total Cyanide	mg/L	0.001	<0.001	0.002	0.002
Total Metals					
Aluminum (total)	mg/L	0.048	0.023	0.049	0.048
Antimony (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (total)	mg/L	<0.0001	0.0002	0.0002	0.0002
Barium (total)	mg/L	0.031	0.038	0.025	0.032
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	27.0	37.6	26.1	31.3
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	0.005	0.005	0.005	0.004
Iron (total)	mg/L	0.069	0.049	0.081	0.042
Lead (total)	mg/L	0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	2.4	3.2	2.6	3.0
Manganese (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	0.013	0.017	0.009	0.015
Nickel (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	4.11	4.08	4.56	3.90
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	0.100	0.151	0.098	0.125
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00009	0.00010	0.00006	0.00010
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.044	<0.005	0.035	0.024
Antimony (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (dissolved)	mg/L	<0.0001	0.0002	0.0002	0.0002
Barium (dissolved)	mg/L	0.031	0.038	0.025	0.032
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	26.6	36.7	22.8	31.3
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	0.005	0.003	0.005	0.003
Iron (dissolved)	mg/L	<0.030	<0.030	0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	2.41	3.08	2.44	3.04
Manganese (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Molybdenum (dissolved)	mg/L	0.013	0.015	0.009	0.014
Nickel (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	0.33	0.41	0.32	0.37
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	4.06	3.89	4.08	3.83
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	1.87	1.93	1.97	1.81
Strontium (dissolved)	mg/L	0.100	0.146	0.093	0.125
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00009	0.00010	0.00006	0.00010
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		2.0	2.1	1.7

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.
[shaded box] - exceeds B.C. AWCWQ (1994) for protection of aquatic life.
[open box] - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.10

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W7 Water Quality Data - Coyote Creek above "White Rock Canyon" confluence

Date		21-Jul-94	7-Sep-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	324	338	320	330
Total Dissolved Solids	mg/L	218	228	196	223
Hardness	mg/L CaCO3	170	136	162	171
pH	pH Units	8.16	7.99	8.05	8.11
Total Suspended Solids	mg/L	3	3	<1	<1
Turbidity	NTU	0.48	1.23	0.75	0.45
Anions					
Alkalinity (Total) *	mg/L CaCO3	142	149	138	143
Chloride (dissolved)	mg/L	0.6	<0.5	0.5	0.5
Fluoride (dissolved)	mg/L	0.07	0.14	0.07	0.07
Sulphate (dissolved)	mg/L	32.0	35.3	32.2	33.9
Nutrients					
Ammonia Nitrogen	mg/L	0.009	<0.005	0.010	<0.005
Nitrate Nitrogen	mg/L	<0.005	<0.005	<0.005	0.006
Nitrite Nitrogen	mg/L	0.001	0.001	<0.001	0.001
ortho-Phosphate	mg/L	0.005	0.009	<0.001	0.002
Total Dissolved Phosphate	mg/L	0.005	0.012	0.004	0.005
Total Phosphorus	mg/L	0.005	0.012	0.011	0.005
Cyanide					
Total Cyanide	mg/L	0.001	0.001	0.002	0.002
Total Metals					
Aluminum (total)	mg/L	0.023	0.018	0.012	0.020
Antimony (total)	mg/L	<0.0001	0.0001	<0.0001	0.0001
Arsenic (total)	mg/L	0.0006	0.0005	0.0006	0.0006
Barium (total)	mg/L	0.052	0.051	0.047	0.052
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	49.0	47.9	51.3	49.9
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (total)	mg/L	0.063	0.038	0.057	0.037
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	12.2	14.4	13.3	14.3
Manganese (total)	mg/L	0.014	0.026	0.016	0.016
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	0.002
Nickel (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	3.08	2.65	3.31	3.28
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium (total)	mg/L	0.223	0.224	0.244	0.248
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00010	0.00008	0.00008	0.00011
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.007	0.007	<0.005	<0.005
Antimony (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (dissolved)	mg/L	<0.0001	0.0005	0.0005	0.0005
Barium (dissolved)	mg/L	0.050	0.051	0.047	0.048
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	48.1	44.9	44.7	46.9
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	12.1	13.9	12.1	13.0
Manganese (dissolved)	mg/L	0.008	0.005	<0.005	0.009
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	0.67	0.71	0.71	0.71
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	3.02	2.44	2.96	3.14
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	2.89	2.98	2.79	2.75
Strontium (dissolved)	mg/L	0.219	0.224	0.227	0.233
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00010	0.00008	0.00008	0.00005
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		2.9	2.5	2.6

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.
(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.
(open box) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.11

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W8 Water Quality Data - Thurston's Trickle

Date		22-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	335	340	299	349
Total Dissolved Solids	mg/L	226	210	180	232
Hardness	mg/L CaCO3	181	185	153	182
pH	pH Units	8.23	8.32	8.20	8.19
Total Suspended Solids	mg/L	1	<1	4	3
Turbidity	NTU	<0.10	0.15	0.12	<0.10
Anions					
Alkalinity (Total) *	mg/L CaCO3	153	156	133	159
Chloride (dissolved)	mg/L	0.6	<0.5	0.5	<0.5
Fluoride (dissolved)	mg/L	0.08	0.08	0.07	0.08
Sulphate (dissolved)	mg/L	30.8	29.6	26.7	32.5
Nutrients					
Ammonia Nitrogen	mg/L	<0.005	<0.005	0.006	<0.005
Nitrate Nitrogen	mg/L	0.023	0.006	0.011	0.058
Nitrite Nitrogen	mg/L	0.001	0.001	0.002	0.002
ortho-Phosphate	mg/L	0.002	0.001	<0.001	<0.001
Total Dissolved Phosphate	mg/L	0.003	0.002	<0.001	0.003
Total Phosphorus	mg/L	0.005	0.002	<0.001	0.003
Cyanide					
Total Cyanide	mg/L	0.001	<0.001	0.002	0.001
Total Metals					
Aluminum (total)	mg/L	0.005	<0.005	0.011	0.005
Antimony (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Barium (total)	mg/L	0.046	0.050	0.035	0.044
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	44.6	45.1	41.1	44.4
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	17.3	18.2	17.1	19.7
Manganese (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	0.001	<0.001	<0.001
Nickel (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	3.12	3.38	3.08	3.21
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	0.231	0.255	0.209	0.241
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00004	0.00004	0.00003	0.00004
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Antimony (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Barium (dissolved)	mg/L	0.046	0.047	0.035	0.040
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	44.1	44.6	36.1	42.1
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Iron (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	17.3	17.9	15.4	18.6
Manganese (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	0.37	0.46	0.31	0.39
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	3.11	3.32	2.74	3.03
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	2.50	2.58	2.05	2.40
Strontium (dissolved)	mg/L	0.231	0.251	0.195	0.229
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00004	0.00004	0.00003	0.00004
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		1.9	2.5	1.7

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.

(shaded box) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.

(open box) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.12

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Site W9 Water Quality Data - Camp Creek

Date		22-Jul-94	31-Aug-94	5-Oct-94	31-Oct-94
Physical Tests	Units				
Conductivity	umhos/cm	299	323	260	351
Total Dissolved Solids	mg/L	212	213	167	258
Hardness	mg/L CaCO3	146	156	115	169
pH	pH Units	7.94	8.00	7.71	7.85
Total Suspended Solids	mg/L	4	<1	10	6
Turbidity	NTU	1.14	1.10	13.3	2.85
Anions					
Alkalinity (Total) *	mg/L CaCO3	72.1	80.4	53.3	74.5
Chloride (dissolved)	mg/L	0.5	<0.5	0.8	<0.5
Fluoride (dissolved)	mg/L	0.11	0.10	0.09	0.12
Sulphate (dissolved)	mg/L	75.6	79.2	68.5	101
Nutrients					
Ammonia Nitrogen	mg/L	<0.005	<0.005	0.011	<0.005
Nitrate Nitrogen	mg/L	<0.005	<0.005	<0.005	<0.005
Nitrite Nitrogen	mg/L	0.002	0.001	0.007	0.001
ortho-Phosphate	mg/L	0.003	0.005	0.026	0.004
Total Dissolved Phosphate	mg/L	0.006	0.006	0.026	0.006
Total Phosphorus	mg/L	0.006	0.007	0.038	0.014
Cyanide					
Total Cyanide	mg/L	0.005	<0.001	0.006	0.004
Total Metals					
Aluminum (total)	mg/L	0.064	0.033	0.363	0.111
Antimony (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (total)	mg/L	<0.0001	<0.0001	<0.0001	0.0020
Barium (total)	mg/L	0.045	0.050	0.042	0.052
Beryllium (total)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	40.0	42.7	36.3	44.9
Chromium (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	0.007	<0.001	<0.001	<0.001
Copper (total)	mg/L	0.002	0.002	0.006	0.002
Iron (total)	mg/L	0.071	0.066	0.332	0.107
Lead (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	11.2	12.2	10.2	13.8
Manganese (total)	mg/L	0.005	0.007	0.011	0.010
Mercury (total)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (total)	mg/L	0.002	0.001	0.003	0.002
Selenium (total)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	5.19	5.10	5.22	5.22
Silver (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	0.289	0.343	0.279	0.346
Titanium (total)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00005	0.00004	0.00004	0.00005
Vanadium (total)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (total)	mg/L	<0.005	<0.005	0.005	<0.005
Dissolved Metals					
Aluminum (dissolved)	mg/L	0.029	0.020	0.127	0.043
Antimony (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Barium (dissolved)	mg/L	0.045	0.049	0.034	0.049
Beryllium (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Calcium (dissolved) *	mg/L	40.0	42.5	31.1	44.9
Chromium (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	0.001	0.001	0.003	0.001
Iron (dissolved)	mg/L	0.033	<0.030	<0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	11.2	12.1	9.05	13.8
Manganese (dissolved)	mg/L	<0.005	<0.005	<0.005	0.008
Molybdenum (dissolved)	mg/L	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	0.002	<0.001	0.003	0.001
Potassium (dissolved)	mg/L	0.41	0.47	0.40	0.46
Selenium (dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	5.19	5.00	4.71	5.21
Silver (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	5.49	5.82	4.26	6.18
Strontium (dissolved)	mg/L	0.289	0.340	0.251	0.346
Titanium (dissolved)	mg/L	<0.010	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00004	0.00004	0.00004	0.00005
Vanadium (dissolved)	mg/L	<0.030	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	<0.005	<0.005	<0.005	<0.005
Organics					
Total Organic Carbon	mg/L		5.0	6.1	4.0

* - BOLD VALUES for alkalinity and dissolved calcium indicate moderate or low acid buffering capacity.
(shaded) - exceeds B.C. AWCWQ (1994) for protection of aquatic life.
(boxed) - exceeds federal CCME guidelines for protection of aquatic life.

TABLE 3.13

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Surface Water QA/QC Data

Station #		Replicate Set 4: W5	W5 (Rep)	Orig:Rep	Travel Blanks		
Date		31-Oct-94	31-Oct-94	Ratio	20-Jul-94	7-Sep-94	5-Oct-94
Physical Tests	Units						
Conductivity	umhos/cm	996	996	1.00	1.7	6.8	1.1
Total Dissolved Solids	mg/L	904	889	1.02	<1	<1	<1
Hardness	mg/L CaCO3	549	536	1.02	0.19	1.31	<0.05
pH	pH Units	7.71	7.73	1.00	5.73	5.52	7.01
Total Suspended Solids	mg/L	21	15	1.40	<1	<1	4
Turbidity	NTU	30.3	30.5	0.99	<0.10	0.13	<0.10
Anions							
Alkalinity (Total)	mg/L CaCO3	79.3	79.2	1.00	<1.0	1.1	<1.0
Chloride (dissolved)	mg/L	0.7	0.7	1.00	<0.5	<0.5	<0.5
Fluoride (dissolved)	mg/L	0.41	0.41	1.00	<0.02	0.04	<0.02
Sulphate (dissolved)	mg/L	494	488	1.01	<1.0	<1.0	<1.0
Nutrients							
Ammonia Nitrogen	mg/L	0.008	0.006	1.33	<0.005	<0.005	0.007
Nitrate Nitrogen	mg/L	0.015	0.015	1.00	<0.005	0.102	<0.005
Nitrite Nitrogen	mg/L	0.001	0.001	1.00	<0.001	0.003	<0.001
ortho-Phosphate	mg/L	0.003	0.004	0.75	<0.001	<0.001	<0.001
Total Dissolved Phosphate	mg/L	0.007	0.004	1.75	<0.001	<0.001	<0.001
Total Phosphorus	mg/L	0.007	0.004	1.75	0.001	0.001	<0.001
Cyanide							
Total Cyanide	mg/L	<0.001	<0.001	1.00	0.001	<0.001	<0.001
Total Metals							
Aluminum (total)	mg/L	0.864	0.882	0.98	<0.005	0.052	<0.005
Antimony (total)	mg/L	0.0002	0.0002	1.00	<0.0001	<0.0001	<0.0001
Arsenic (total)	mg/L	0.0006	0.0006	1.00	<0.0001	<0.0001	<0.0001
Barium (total)	mg/L	0.025	0.024	1.04	<0.010	0.034	<0.010
Beryllium (total)	mg/L	<0.005	<0.005	1.00	<0.005	<0.005	<0.005
Bismuth (total)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	<0.10
Boron (total)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	<0.10
Cadmium (total)	mg/L	0.0026	0.0030	0.87	<0.0002	<0.0002	<0.0002
Calcium (total)	mg/L	162	160	1.01	<0.050	0.476	<0.050
Chromium (total)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Cobalt (total)	mg/L	0.012	0.012	1.00	<0.001	<0.001	<0.001
Copper (total)	mg/L	0.088	0.086	1.02	<0.001	0.008	<0.001
Iron (total)	mg/L	7.21	7.16	1.01	<0.030	<0.030	<0.030
Lead (total)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Magnesium (total)	mg/L	36.2	35.9	1.01	<0.010	0.048	<0.010
Manganese (total)	mg/L	1.62	1.60	1.01	<0.005	<0.005	<0.005
Mercury (total)	mg/L	<0.00001	<0.00001	1.00	<0.00001	<0.00001	<0.00001
Molybdenum (total)	mg/L	0.001	<0.001	2.00	<0.001	<0.001	<0.001
Nickel (total)	mg/L	0.005	0.004	1.25	<0.001	<0.001	<0.001
Selenium (total)	mg/L	<0.0005	<0.0005	1.00	<0.0005	<0.0005	<0.0005
Silicon (total)	mg/L	4.90	4.82	1.02	<0.050	0.60	<0.050
Silver (total)	mg/L	0.0001	0.0005	0.20	<0.0001	<0.0001	<0.0001
Strontium (total)	mg/L	1.66	1.65	1.01	<0.001	0.002	<0.001
Titanium (total)	mg/L	<0.010	<0.010	1.00	<0.010	<0.010	<0.010
Uranium (total)	mg/L	0.00017	0.00019	0.89	<0.00001	0.00002	<0.00001
Vanadium (total)	mg/L	<0.030	<0.030	1.00	<0.030	<0.030	<0.030
Zinc (total)	mg/L	0.517	0.509	1.02	<0.005	<0.005	<0.005
Dissolved Metals							
Aluminum (dissolved)	mg/L	0.073	0.016	4.56	<0.005	0.031	<0.005
Antimony (dissolved)	mg/L	0.0002	0.0002	1.00	<0.0001	<0.0001	<0.0001
Arsenic (dissolved)	mg/L	0.0001	<0.0001	2.00	<0.0001	<0.0001	<0.0001
Barium (dissolved)	mg/L	0.020	0.020	1.00	<0.010	0.034	<0.010
Beryllium (dissolved)	mg/L	<0.005	<0.005	1.00	<0.005	<0.005	<0.005
Bismuth (dissolved)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	<0.10
Boron (dissolved)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	<0.10
Cadmium (dissolved)	mg/L	0.0020	0.0020	1.00	<0.0002	<0.0002	<0.0002
Calcium (dissolved)	mg/L	161	157	1.03	<0.050	0.5	<0.050
Chromium (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Cobalt (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Copper (dissolved)	mg/L	0.005	0.002	2.50	<0.001	0.007	<0.001
Iron (dissolved)	mg/L	0.503	0.085	5.92	<0.030	<0.030	<0.030
Lead (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Magnesium (dissolved)	mg/L	35.8	35.0	1.02	<0.010	0.04	<0.010
Manganese (dissolved)	mg/L	1.59	1.55	1.03	<0.005	<0.005	<0.005
Molybdenum (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	0.004	0.004	1.00	<0.001	<0.001	<0.001
Potassium (dissolved)	mg/L	1.23	1.22	1.01	<0.01	<0.01	<0.01
Selenium (dissolved)	mg/L	<0.0005	<0.0005	1.00	<0.0005	<0.0005	<0.0005
Silicon (dissolved)	mg/L	4.26	4.12	1.03	<0.050	0.58	<0.050
Silver (dissolved)	mg/L	0.0001	0.0005	0.20	<0.0001	<0.0001	<0.0001
Sodium (dissolved)	mg/L	8.26	8.09	1.02	0.03	0.18	<0.01
Strontium (dissolved)	mg/L	1.64	1.60	1.03	<0.001	0.002	<0.001
Titanium (dissolved)	mg/L	<0.010	<0.010	1.00	<0.010	<0.010	<0.010
Uranium (dissolved)	mg/L	0.00013	0.00010	1.30	<0.00001	0.00002	<0.00001
Vanadium (dissolved)	mg/L	<0.030	<0.030	1.00	<0.030	<0.030	<0.030
Zinc (dissolved)	mg/L	0.341	0.323	1.06	<0.005	<0.005	<0.005
Organics							
Total Organic Carbon	mg/L	1.0	1.1	0.91		0.7	<0.5

TABLE 3.13

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Surface Water QA/QC Data

		Replicate Set 1			Replicate Set 2			Replicate Set 3		
Station #		W1	W1 (Rep)	Orig:Rep	W1	W1 (Rep)	Orig:Rep	W4	W4 (Rep)	Orig:Rep
Date		20-Jul-94	20-Jul-94	Ratio	31-Aug-94	31-Aug-94	Ratio	5-Oct-94	5-Oct-94	Ratio
Physical Tests	Units									
Conductivity	umhos/cm	412	413	1.00	545	546	1.00	245	249	0.98
Total Dissolved Solids	mg/L	289	289	1.00	367	367	1.00	154	155	0.99
Hardness	mg/L CaCO3	219	218	1.00	292	292	1.00	118	123	0.96
pH	pH Units	8.21	8.27	0.99	8.31	8.29	1.00	7.96	7.95	1.00
Total Suspended Solids	mg/L	5	3	1.67	3	7	0.43	2	1	2.00
Turbidity	NTU	1.65	1.68	0.98	1.90	2.80	0.68	2.68	2.59	1.03
Anions										
Alkalinity (Total)	mg/L CaCO3	162	162	1.00	188	189	0.99	94.8	95.7	0.99
Chloride (dissolved)	mg/L	0.6	0.6	1.00	0.5	<0.5	2.00	0.6	0.8	0.75
Fluoride (dissolved)	mg/L	0.08	0.08	1.00	0.10	0.10	1.00	0.08	0.07	1.14
Sulphate (dissolved)	mg/L	63.8	63.2	1.01	113	113	1.00	34.3	33.2	1.03
Nutrients										
Ammonia Nitrogen	mg/L	<0.005	<0.005	1.00	<0.005	0.006	0.42	0.007	0.013	0.54
Nitrate Nitrogen	mg/L	0.023	0.022	1.05	0.013	0.014	0.93	0.028	0.027	1.04
Nitrite Nitrogen	mg/L	0.001	0.002	0.50	0.002	0.002	1.00	<0.001	<0.001	1.00
ortho-Phosphate	mg/L	0.003	0.001	3.00	0.003	0.004	0.75	0.003	0.003	1.00
Total Dissolved Phosphate	mg/L	0.004	0.004	1.00	0.004	0.005	0.80	0.008	0.006	1.33
Total Phosphorus	mg/L	0.007	0.006	1.17	0.005	0.011	0.45	0.008	0.010	0.80
Cyanide										
Total Cyanide	mg/L	0.001	0.001	1.00	<0.001	<0.001	1.00	0.002	0.003	0.67
Total Metals										
Aluminum (total)	mg/L	0.075	0.069	1.09	0.053	0.052	1.02	0.086	0.097	0.89
Antimony (total)	mg/L	0.0002	0.0002	1.00	0.0004	0.0004	1.00	<0.0001	<0.0001	1.00
Arsenic (total)	mg/L	0.0006	0.0006	1.00	0.0005	0.0006	0.83	0.0001	0.0001	1.00
Barium (total)	mg/L	0.053	0.050	1.06	0.058	0.058	1.00	0.033	0.032	1.03
Beryllium (total)	mg/L	<0.005	<0.005	1.00	<0.005	<0.005	1.00	<0.005	<0.005	1.00
Bismuth (total)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	1.00	<0.10	<0.10	1.00
Boron (total)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	1.00	<0.10	<0.10	1.00
Cadmium (total)	mg/L	<0.0002	<0.0002	1.00	<0.0002	<0.0002	1.00	<0.0002	<0.0002	1.00
Calcium (total)	mg/L	55.8	55.2	1.01	69.7	69.5	1.00	34.9	36.1	0.97
Chromium (total)	mg/L	0.001	<0.001	2.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Cobalt (total)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Copper (total)	mg/L	0.002	0.002	1.00	0.008	0.004	2.00	0.002	0.001	2.00
Iron (total)	mg/L	0.289	0.265	1.09	0.502	0.496	1.01	0.164	0.150	1.09
Lead (total)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Magnesium (total)	mg/L	19.8	19.6	1.01	29.3	29.5	0.99	11.4	11.6	0.98
Manganese (total)	mg/L	0.060	0.057	1.05	0.129	0.129	1.00	0.010	0.011	0.91
Mercury (total)	mg/L	<0.00001	0.00004	0.13	<0.00001	<0.00001	1.00	<0.00001	<0.00001	1.00
Molybdenum (total)	mg/L	<0.001	0.001	0.50	0.001	<0.001	2.00	<0.001	0.001	0.50
Nickel (total)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	0.001	0.001	1.00
Selenium (total)	mg/L	<0.0005	<0.0005	1.00	<0.0005	<0.0005	1.00	<0.0005	<0.0005	1.00
Silicon (total)	mg/L	2.92	2.88	1.01	2.99	2.99	1.00	3.83	3.87	0.99
Silver (total)	mg/L	<0.0001	<0.0001	1.00	<0.0001	<0.0001	1.00	<0.0001	<0.0001	1.00
Strontium (total)	mg/L	0.333	0.328	1.02	0.519	0.521	1.00	0.195	0.196	0.99
Titanium (total)	mg/L	<0.010	<0.010	1.00	<0.010	<0.010	1.00	<0.010	<0.010	1.00
Uranium (total)	mg/L	0.00015	0.00015	1.00	0.00018	0.00019	0.95	0.00004	0.00004	1.00
Vanadium (total)	mg/L	<0.030	<0.030	1.00	<0.030	<0.030	1.00	<0.030	<0.030	1.00
Zinc (total)	mg/L	0.006	0.006	1.00	0.018	0.018	1.00	<0.005	<0.005	1.00
Dissolved Metals										
Aluminum (dissolved)	mg/L	0.019	0.018	1.06	0.041	0.021	1.95	0.021	0.021	1.00
Antimony (dissolved)	mg/L	0.0002	0.0002	1.00	0.0003	0.0004	0.75	<0.0001	<0.0001	1.00
Arsenic (dissolved)	mg/L	0.0003	0.0004	0.75	0.0003	0.0004	0.75	<0.0001	<0.0001	1.00
Barium (dissolved)	mg/L	0.050	0.050	1.00	0.058	0.058	1.00	0.029	0.032	0.91
Beryllium (dissolved)	mg/L	<0.005	<0.005	1.00	<0.005	<0.005	1.00	<0.005	<0.005	1.00
Bismuth (dissolved)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	1.00	<0.10	<0.10	1.00
Boron (dissolved)	mg/L	<0.10	<0.10	1.00	<0.10	<0.10	1.00	<0.10	<0.10	1.00
Cadmium (dissolved)	mg/L	<0.0002	<0.0002	1.00	<0.0002	<0.0002	1.00	<0.0002	<0.0002	1.00
Calcium (dissolved)	mg/L	55.3	55.2	1.00	68.6	68.8	1.00	30.3	31.7	0.96
Chromium (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Cobalt (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Copper (dissolved)	mg/L	0.001	0.001	1.00	0.001	0.001	1.00	<0.001	0.001	0.50
Iron (dissolved)	mg/L	0.036	0.036	1.00	<0.030	<0.030	1.00	0.030	0.030	1.00
Lead (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Magnesium (dissolved)	mg/L	19.7	19.6	1.01	29.3	29.2	1.00	10.2	10.6	0.96
Manganese (dissolved)	mg/L	0.047	0.047	1.00	0.119	0.120	0.99	<0.005	<0.005	1.00
Molybdenum (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Nickel (dissolved)	mg/L	<0.001	<0.001	1.00	<0.001	<0.001	1.00	<0.001	<0.001	1.00
Potassium (dissolved)	mg/L	0.78	0.78	1.00	1.03	1.03	1.00	0.51	0.51	1.00
Selenium (dissolved)	mg/L	<0.0005	<0.0005	1.00	<0.0005	<0.0005	1.00	<0.0005	<0.0005	1.00
Silicon (dissolved)	mg/L	2.85	2.86	1.00	2.90	2.91	1.00	3.50	3.38	1.04
Silver (dissolved)	mg/L	<0.0001	<0.0001	1.00	<0.0001	<0.0001	1.00	<0.0001	<0.0001	1.00
Sodium (dissolved)	mg/L	3.67	3.74	0.98	6.64	6.37	1.04	3.33	3.35	0.99
Strontium (dissolved)	mg/L	0.330	0.328	1.01	0.517	0.512	1.01	0.175	0.182	0.96
Titanium (dissolved)	mg/L	<0.010	<0.010	1.00	<0.010	<0.010	1.00	<0.010	<0.010	1.00
Uranium (dissolved)	mg/L	0.00015	0.00015	1.00	0.00018	0.00019	0.95	0.00004	0.00004	1.00
Vanadium (dissolved)	mg/L	<0.030	<0.030	1.00	<0.030	<0.030	1.00	<0.030	<0.030	1.00
Zinc (dissolved)	mg/L	<0.005	<0.005	1.00	0.010	0.007	1.43	<0.005	<0.005	1.00
Organics										
Total Organic Carbon	mg/L				1.9	1.5	1.27	3.2	3.1	1.03

TABLE 3.14

AMERICAN BULLION
RED CHRIS PROJECT

1994 SUMMARY REPORT

Drinking Water Quality Data

Sample		Camp Supply	Bottle Blank	H & W
Date		31-Oct-94	31-Oct-94	Criteria *
Physical Tests	Units			
Colour	CU	17.8		15
Conductivity	umhos/cm	231		
Total Dissolved Solids	mg/L	156		500
Hardness	mg/L CaCO3	106		
pH	pH Units	7.74		6.5 - 8.5
Total Suspended Solids	mg/L	<1		
Turbidity	NTU	3.37		5
Anions				
Alkalinity (Total)	mg/L CaCO3	56.8		
Chloride (dissolved)	mg/L	<0.5		250
Fluoride (dissolved)	mg/L	0.06		1.5
Silicate (dissolved)	mg/L	10.2		
Sulphate (dissolved)	mg/L	53.3		500
Nutrients				
Ammonia Nitrogen	mg/L			
Nitrate Nitrogen	mg/L	0.022		10.0
Nitrite Nitrogen	mg/L	0.007		1.0
Total Metals				
Aluminum (total)	mg/L		0.008	
Antimony (total)	mg/L		<0.0001	
Arsenic (total)	mg/L		<0.0001	0.025
Barium (total)	mg/L		<0.010	1.0
Beryllium (total)	mg/L		<0.005	
Bismuth (total)	mg/L		<0.10	
Boron (total)	mg/L		<0.10	5.0
Cadmium (total)	mg/L		<0.0002	0.005
Calcium (total)	mg/L		<0.050	
Chromium (total)	mg/L		<0.001	0.05
Cobalt (total)	mg/L		<0.001	
Copper (total)	mg/L		0.022	1.0
Iron (total)	mg/L		<0.030	0.3
Lead (total)	mg/L		<0.001	0.01
Magnesium (total)	mg/L		<0.010	
Manganese (total)	mg/L		<0.005	0.05
Mercury (total)	mg/L		<0.00001	0.001
Molybdenum (total)	mg/L		<0.001	
Nickel (total)	mg/L		<0.001	
Selenium (total)	mg/L		<0.0005	0.01
Silicon (total)	mg/L		<0.050	
Silver (total)	mg/L		<0.0001	
Strontium (total)	mg/L		<0.001	
Titanium (total)	mg/L		<0.010	
Uranium (total)	mg/L		<0.00001	0.10
Vanadium (total)	mg/L		<0.030	
Zinc (total)	mg/L		<0.005	5.0
Dissolved Metals				
Aluminum (dissolved)	mg/L	<0.20		
Arsenic (dissolved)	mg/L	<0.0001		0.025
Barium (dissolved)	mg/L	0.052		1.0
Boron (dissolved)	mg/L	<0.10		5.0
Cadmium (dissolved)	mg/L	<0.0002		0.005
Calcium (dissolved)	mg/L	29.9		
Chromium (dissolved)	mg/L	<0.015		0.05
Copper (dissolved)	mg/L	0.016		1.0
Iron (dissolved)	mg/L	0.350		0.3
Lead (dissolved)	mg/L	<0.001		0.01
Magnesium (dissolved)	mg/L	7.61		
Manganese (dissolved)	mg/L	0.019		0.05
Mercury (dissolved)	mg/L	<0.00005		0.001
Potassium (dissolved)	mg/L	0.30		
Selenium (dissolved)	mg/L	<0.0005		0.01
Sodium (dissolved)	mg/L	3.63		200
Zinc (dissolved)	mg/L	0.016		5.0
Bacteriological Tests				
Fecal Coliform Bacteria	MPN/100ml	0	0	0
Total Coliform Bacteria	MPN/100ml	0	0	

[shaded box] - exceeds Health & Welfare Canada (*) drinking water guidelines (1993).

Table 3.15

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

METEOROLOGICAL STATION DATA
(Database)

Date	Time	Maximum Temp (°C)	Minimum Temp (°C)	Observed Temp (°C)	Measured Rainfall (mm)	Total Daily Rainfall (mm)	Measured Snowfall (cm)	Total Daily Precipitation (mm)	Comments
20-Jul-94	4:45 PM	29.0	-	14.0					clear sky, sunny
21-Jul-94	7:15 AM	14.0	-	7.5	0.7				hail, clear sky, sunny
21-Jul-94	4:45 PM	18.5	8.0	18.5		0.7		0.7	clear sky, sunny
22-Jul-94	7:15 AM	18.5	3.5	14.0					clear sky, sunny
22-Jul-94	4:45 PM	23.2	12.0	22.0					clear sky, sunny
23-Jul-94	7:15 AM	22.0	5.6	15.6					clear sky, sunny
23-Jul-94	4:45 PM	23.4	15.4	23.4					clear sky, sunny
24-Jul-94	7:15 AM	23.4	6.0	15.4					clear sky, sunny
24-Jul-94	5:00 PM	25.3	15.4	24.5					clear sky, sunny
25-Jul-94	7:15 AM	24.5	8.5	17.0					clear sky, sunny
25-Jul-94	4:35 PM	21.3	16.0	16.5					overcast
26-Jul-94	7:15 AM	16.6	5.5	8.2	1.6				clear sky, sunny
26-Jul-94	4:45 PM	18.0	7.5	18.0		1.6		1.6	clear sky, sunny
27-Jul-94	7:15 AM	18.5	5.8	7.3	1.5				ground fog, clear sky, sunny
27-Jul-94	4:45 PM	18.7	5.0	17.6		1.5		1.5	high cloud, sunny
28-Jul-94	7:15 AM	18.3	-	13.5					high cloud, sunny
28-Jul-94	4:45 PM	11.2	15.0	18.0	0.3	0.3		0.3	high cloud, light rain (drizzle)
29-Jul-94	7:15 AM	18.2	7.0	8.8	8.4				ground fog, clear sky, sunny
29-Jul-94	4:45 PM	14.3	8.5	9.0	9.4	17.8		17.8	partially cloudy, sunny
30-Jul-94	7:15 AM	11.0	2.5	8.0	1.6				fog in valley,clear sky, sunny
30-Jul-94	4:45 PM	12.7	7.0	11.0		1.6		1.6	cloudy (50%)
31-Jul-94	7:15 AM	14.0	3.4	4.0	6.5				rain, fog
31-Jul-94	4:45 PM	9.8	3.4	9.5	1.3	7.8		7.8	cloudy
1-Aug-94	7:30 AM	14.8	1.3	8.0					clear sky, sunny
1-Aug-94	5:00 PM	20.4	-2.0	19.4					overcast
2-Aug-94	7:30 AM	17.4	5.7	11.8					overcast
2-Aug-94	5:00 PM	21.6	-2.0	20.5					overcast
3-Aug-94	7:30 AM	21.7	-2.0	18.3					clear sky, sunny
3-Aug-94	5:00 PM	25.1	17.7	24.0					overcast
4-Aug-94	7:30 AM	14.7	10.0	13.0	7.0				overcast
4-Aug-94	5:00 PM	18.2	12.5	18.0		7.0		7.0	overcast
5-Aug-94	7:30 AM	19.0	7.0	12.5					clear sky, sunny
5-Aug-94	5:00 PM	19.8	10.5	10.5	2.4	2.4		2.4	overcast, thunder
6-Aug-94	7:30 AM	11.8	7.4	9.5	1.0				sunny
6-Aug-94	5:00 PM	20.5	9.5	20.0		1.0		1.0	sunny
7-Aug-94	7:30 AM	21.0	9.2	10.0	9.8				overcast
7-Aug-94	5:00 PM	19.0	9.5	17.5		9.8		9.8	rain
8-Aug-94	7:30 AM	16.6	7.6	13.3	0.2				clear sky, sunny
8-Aug-94	5:00 PM	20.3	4.0	19.0		0.2		0.2	clear sky, sunny
9-Aug-94	7:30 AM	20.2	7.5	13.1					clear sky, sunny
9-Aug-94	5:00 PM	21.0	4.5	20.5					clear sky, sunny
10-Aug-94	7:30 AM	21.7	6.9	13.3					clear sky, sunny
10-Aug-94	5:00 PM	22.7	9.5	21.5					clear sky, sunny
11-Aug-94	7:30 AM	22.8	8.5	12.0					overcast
11-Aug-94	5:00 PM	-	-	-					overcast
12-Aug-94	7:30 AM	22.0	8.4	15.1					overcast
12-Aug-94	5:00 PM	23.0	7.0	22.7					overcast
13-Aug-94	7:30 AM	22.8	9.6	13.5					overcast
13-Aug-94	5:00 PM	22.0	9.5	13.0	3.7	3.7		3.7	rain, thunder
14-Aug-94	7:30 AM	14.2	7.7	13.7	8.1				sunny
14-Aug-94	5:00 PM	14.4	8.0	11.0	11.6	19.7		19.7	overcast
15-Aug-94	7:30 AM	12.4	6.1	7.2	0.1				overcast
15-Aug-94	5:00 PM	9.5	6.4	8.8	1.2	1.3		1.3	rain, fog
16-Aug-94	7:30 AM	9.3	2.0	6.3					sun, overcast
16-Aug-94	5:00 PM	15.9	5.8	15.4					sunny
17-Aug-94	7:30 AM	16.7	5.3	13.3					sunny
17-Aug-94	5:00 PM	15.6	7.7	14.9					sunny
18-Aug-94	7:30 AM	18.5	6.6	11.2					sunny
18-Aug-94	5:00 PM	13.3	6.8	23.2					sunny
19-Aug-94	7:30 AM	13.2	7.0	12.3					overcast
19-Aug-94	5:00 PM	22.5	9.2	20.2					overcast
20-Aug-94	7:30 AM	20.4	8.2	10.2	15.2				low fog
20-Aug-94	5:00 PM	15.4	10.0	15.4		15.2		15.2	clear sky, sunny
21-Aug-94	7:30 AM	15.4	5.5	7.5					overcast
21-Aug-94	5:00 PM	10.9	6.0	6.6	3.0	3.0		3.0	overcast
22-Aug-94	7:30 AM	7.1	2.4	4.0	3.8				overcast
22-Aug-94	5:00 PM	9.5	3.0	8.6	trace	3.8		3.8	mostly clear, some cloud, windy
23-Aug-94	7:30 AM	9.5	0.5	2.2	2.5				cloudy, drizzle
23-Aug-94	5:00 PM	9.1	1.5	7.0	trace	2.5		2.5	cloudy, drizzle
24-Aug-94	7:30 AM	8.7	1.5	3.0	0.4				cloudy, drizzle
24-Aug-94	5:00 PM	9.4	3.3	5.0	7.3	7.7		7.7	sunny
25-Aug-94	7:30 AM	9.3	-0.2	5.2	1.0				fog
25-Aug-94	5:00 PM	10.1	-0.1	10.0		1.0		1.0	cloudy
26-Aug-94	7:30 AM	10.5	0.0	5.6					clear sky, sunny
26-Aug-94	5:00 PM	17.7	5.0	17.5					clear sky, sunny
27-Aug-94	7:30 AM	19.0	5.0	8.4					clear sky, sunny
27-Aug-94	5:00 PM	19.4	3.0	18.5					clear sky, sunny
28-Aug-94	7:30 AM	19.2	3.5	8.7					clear sky, sunny

Table 3.15

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

METEOROLOGICAL STATION DATA
(Database)

Date	Time	Maximum Temp (°C)	Minimum Temp (°C)	Observed Temp (°C)	Measured Rainfall (mm)	Total Daily Rainfall (mm)	Measured Snowfall (cm)	Total Daily Precipitation (mm)	Comments
28-Aug-94	5:00 PM	18.6	8.0	18.6					clear sky, sunny
29-Aug-94	7:30 AM	18.6	3.5	9.5					clear sky, sunny
29-Aug-94	5:00 PM	15.5	9.6	15.0					cloudy
30-Aug-94	7:30 AM	19.0	3.4	9.0	2.3				rain
30-Aug-94	5:00 PM	15.0	3.5	12.5		2.3		2.3	cloudy
31-Aug-94	7:30 AM	15.0	2.5	3.5	4.0				fog
31-Aug-94	5:00 PM	13.0	1.9	12.6	0.8	4.8		4.8	cloudy, some sun
1-Sep-94	7:30 AM	13.2	-3.0	4.0					clear sky, sunny
1-Sep-94	5:00 PM	12.3	3.5	12.0					clear sky, sunny
2-Sep-94	7:30 AM	11.8	-0.5	2.6			5.5		fog, snow
2-Sep-94	5:00 PM	7.4	0.7	4.1				5.5	overcast
3-Sep-94	7:30 AM	4.5	-0.5	1.6			2.4		cloudy, snow
3-Sep-94	5:00 PM	-	-	-				2.4	cloudy
4-Sep-94	7:30 AM	6.6	-0.5	2.2					overcast
4-Sep-94	5:00 PM	5.8	1.8	3.9			1.2	1.2	overcast, drizzle
5-Sep-94	7:30 AM	4.0	0.0	2.2	4.2				overcast, drizzle
5-Sep-94	5:00 PM	8.2	2.0	6.8	2.6	6.8		6.8	overcast, drizzle
6-Sep-94	7:30 AM	7.3	0.1	1.7	5.1				overcast
6-Sep-94	5:00 PM	-	-	-		5.1		5.1	rain
7-Sep-94	7:30 AM	4.1	3.0	3.8	1				cloudy
7-Sep-94	5:00 PM	4.0	0.5	3.0	2.8	3.8		3.8	rain
8-Sep-94	7:30 AM	4.1	-1.0	1.5	0.8				fog
8-Sep-94	5:00 PM	9.6	-0.5	6.6	0.8	1.6		1.6	overcast
9-Sep-94	7:30 AM	8.3	-0.2	2.0					clear sky, sunny
9-Sep-94	5:00 PM	9.7	0.7	6.4					overcast
10-Sep-94	7:30 AM	9.0	-1.0	1.5	1.4				overcast
10-Sep-94	5:00 PM	5.3	1.5	4.8		1.4	2.6	4	sunny, some clouds & snow
11-Sep-94	7:30 AM	4.8	-3.0	-0.5					overcast, fog
11-Sep-94	5:00 PM	6.5	0.0	6.2					overcast, fog
12-Sep-94	7:30 AM	6.2	3.0	4.0	0.4				overcast, fog
12-Sep-94	5:00 PM	6.5	3.0	4.7	4.2	4.6		4.6	overcast, fog
13-Sep-94	7:30 AM	5.0	3.0	4.4	8.6				overcast, fog
13-Sep-94	5:00 PM	8.8	3.2	8.5	4	12.6		12.6	cloudy, windy
14-Sep-94	7:30 AM	8.8	2.0	4.2	0.2				high overcast
14-Sep-94	5:00 PM	7.8	2.0	6.5		0.2		0.2	high overcast
15-Sep-94	7:30 AM	7.7	1.3	2.3	6.2				cloudy, some sun
15-Sep-94	5:00 PM	8.4	1.5	5.6	0.4	6.6		6.6	mostly sunny, some high overcast
16-Sep-94	7:30 AM	8.4	1.7	3.8					overcast, windy
16-Sep-94	5:00 PM	4.2	1.6	5.3	3.6	3.6		3.6	light rain
17-Sep-94	7:30 AM	8.8	2.7	6.3	5.2				overcast, rain
17-Sep-94	5:00 PM	10.5	3.0	6.8	0.2	5.4		5.4	broken cloud
18-Sep-94	7:30 AM	6.9	0.5	2.0	trace				low overcast
18-Sep-94	5:00 PM	8.2	1.1	7.2	0.8	0.8		0.8	low overcast
19-Sep-94	7:30 AM	8.1	-2.0	-1.1					low overcast
19-Sep-94	5:00 PM	8.3	-1.5	2.5					mostly clear, some clouds
20-Sep-94	7:30 AM	4.7	-4.2	-1.2					clear sky, sunny, frost
20-Sep-94	5:00 PM	5.2	-3.5	4.5					clear sky, sunny
21-Sep-94	7:30 AM	7.7	2.0	6.8	1.9				high overcast
21-Sep-94	5:00 PM	-	-	-		1.9		1.9	hard rain, very windy
22-Sep-94	7:30 AM	-	-	-	18.6				sunny. Weather station blown over.
22-Sep-94	5:00 PM	-	-	-		18.6		18.6	sunny. Thermometers broken in storm.
23-Sep-94	7:30 AM	-	-	-					sunny
23-Sep-94	5:00 PM	-	-	-					sunny
24-Sep-94	7:30 AM	-	-	-	0.2				cloudy, overcast
24-Sep-94	5:00 PM	-	-	-	1.1	1.3		1.3	rain, windy
25-Sep-94	7:30 AM	-	-	-	0.5				partly cloudy, windy
25-Sep-94	5:00 PM	-	-	-		0.5		0.5	partly cloudy, windy
26-Sep-94	7:30 AM	-	-	-					partly cloudy, cold
26-Sep-94	5:00 PM	-	-	-					overcast
27-Sep-94	7:30 AM	-	-	-			15		overcast, snow (9.3 mm water content)
27-Sep-94	5:00 PM	-	-	-				9.3	overcast
28-Sep-94	7:30 AM	-	-	-					clear sky, sunny
28-Sep-94	5:00 PM	-	-	-					clear sky, sunny
29-Sep-94	7:30 AM	-	-	-					clear sky, sunny
29-Sep-94	5:00 PM	-	-	-					clear sky, sunny
30-Sep-94	7:30 AM	-	-	-					clear sky, sunny
30-Sep-94	5:00 PM	-	-	-					clear sky, sunny
1-Oct-94	7:00 AM	-	-	-			10		clear sky, sunny
1-Oct-94	5:00 PM	-	-	-				10	clear sky, sunny
2-Oct-94	7:00 AM	-	-7.5	-6.0					clear sky, sunny
2-Oct-94	5:00 PM	5.0	-6.0	3.0					clear sky, sunny
3-Oct-94	7:00 AM	6.0	1.0	5.0					clear sky, sunny
3-Oct-94	5:00 PM	12.0	2.0	11.4					clear sky, sunny
4-Oct-94	7:00 AM	12.0	3.0	9.0					clear sky, sunny
4-Oct-94	5:00 PM	-	-	-					clear sky, sunny
5-Oct-94	7:00 AM	10.0	-1.0	0.0	1.5				clear sky, sunny
5-Oct-94	5:00 PM	5.5	-1.0	3.0		1.5		1.5	clear sky, sunny
6-Oct-94	7:00 AM	5.0	-1.5	1.0	0.3				clear sky, sunny

Table 3.15

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

METEOROLOGICAL STATION DATA
(Database)

Date	Time	Maximum Temp (°C)	Minimum Temp (°C)	Observed Temp (°C)	Measured Rainfall (mm)	Total Daily Rainfall (mm)	Measured Snowfall (cm)	Total Daily Precipitation (mm)	Comments
6-Oct-94	5:00 PM	5.0	0.5	1.5		0.3		0.3	clear sky, sunny
7-Oct-94	7:00 AM	3.0	-3.0	-2.0					clear sky, sunny
7-Oct-94	5:00 PM	3.0	-2.5	1.0					clear sky, sunny
8-Oct-94	7:00 AM	2.0	-2.0	-1.0	trace				clear sky, sunny
8-Oct-94	5:00 PM	4.5	-2.0	1.5					clear sky, sunny
9-Oct-94	7:00 AM	2.5	-4.0	-3.0					clear sky, sunny
9-Oct-94	5:00 PM	3.0	-3.5	1.0					clear sky, sunny
10-Oct-94	7:00 AM	2.0	-4.0	-4.0					clear sky, sunny
10-Oct-94	5:00 PM	-	-	-					clear sky, sunny
11-Oct-94	7:00 AM	2.0	-7.0	-4.0					clear sky, sunny
11-Oct-94	5:00 PM	1.0	-1.0	-1.0					clear sky, sunny
12-Oct-94	7:00 AM	2.0	-3.0	-1.0			2		clear sky, sunny
12-Oct-94	5:00 PM	-	-	-				1	fog, snow
13-Oct-94	7:00 AM	-	-	-					fog, snow
13-Oct-94	5:00 PM	4.0	-2.0	-1.0				0.1	fog, snow
14-Oct-94	7:00 AM	0.0	-3.0	-2.0			1		low cloud, fog
14-Oct-94	5:00 PM	0.5	-2.5	0.0				1.2	low cloud, fog
15-Oct-94	7:00 AM	0.0	-3.0	-1.0					clear sky, sunny
15-Oct-94	5:00 PM	2.5	1.0	2.0					partly cloudy
16-Oct-94	7:00 AM	3.0	-1.0	1.0			6		snow
16-Oct-94	5:00 PM	3.5	1.0	1.5				2.4	snow
17-Oct-94	7:00 AM	-1.0	-1.0	-1.0					clear
17-Oct-94	5:00 PM	0.0	0.0	0.0				0.4	overcast
18-Oct-94	7:00 AM	-2.5	-2.5	-2.5					overcast, fog
18-Oct-94	5:00 PM	7.0	0.0	2.7					overcast, fog
19-Oct-94	7:00 AM	3.8	-3.4	2.8					overcast, fog
19-Oct-94	5:00 PM	2.5	-3.5	0.0					overcast, fog
20-Oct-94	7:00 AM	-3.5	-8.5	-2.0					snow, fog
20-Oct-94	5:00 PM	8.5	0.0	-3.0				0.4	snow, fog
21-Oct-94	7:00 AM	1.5	-4.5	-5.5			1		clear sky, sunny
21-Oct-94	5:00 PM	1.0	-3.0	-1.0			trace		cloudy
22-Oct-94	7:00 AM	-1.0	-6.0	-5.5					clear sky, sunny
22-Oct-94	5:00 PM	-1.5	-4.5	-4.0					partly cloudy
23-Oct-94	7:00 AM	-1.5	-9.5	-9.5					overnight storm, overcast
23-Oct-94	5:00 PM	-1.5	-8.5	-3.5					overcast
24-Oct-94	7:00 AM	-5.0	1.5	1.0			2.0		50% cloud cover
24-Oct-94	5:00 PM	2.0	-4.0	-2.5				0.8	50% cloud cover
25-Oct-94	7:00 AM	1.5	0.0	0.0			3.0		cloudy
25-Oct-94	5:00 PM	-	-	-				1.6	cloudy
26-Oct-94	7:00 AM	0.0	-5.0	-1.0	trace				clear sky, sunny
26-Oct-94	5:00 PM	1.0	-3.0	-3.0					overcast
27-Oct-94	7:00 AM	-2.0	-5.5	-4.0					partly cloudy
27-Oct-94	5:00 PM	0.0	-4.0	-4.0					partly cloudy
28-Oct-94	7:00 AM	-3.0	-6.0	-6.0					partly cloudy
28-Oct-94	5:00 PM	-2.0	-4.0	-3.0					partly cloudy
29-Oct-94	7:00 AM	-1.0	-3.0	-3.0					partly cloudy
29-Oct-94	5:00 PM	-1.0	-4.0	-4.0					partly cloudy
30-Oct-94	7:00 AM	-2.0	-7.5	-7.5					clear sky, sunny
30-Oct-94	5:00 PM	-3.0	-8.0	-7.0					clear sky, sunny
31-Oct-94	7:00 AM	-1.0	-12.0	-12.0					clear sky, sunny
31-Oct-94	5:00 PM	-4.0	-6.0	-5.0					clear sky, sunny
1-Nov-94	7:00 AM	0.0	-11.5	-10.5					clear sky, sunny
1-Nov-94	5:00 PM	0.0	-12.0	-12.0					clear sky, sunny
2-Nov-94	7:00 AM	-5.0	-16.0	-12.0					clear sky, sunny
2-Nov-94	5:00 PM	-2.5	-8.5	-3.5			1	1	clear sky, sunny
3-Nov-94	7:00 AM	-2.0	-4.0	-4.0			1		clear sky, sunny
								1	

Table 3.16

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY
1994 SUMMARY REPORT
FISH & WILDLIFE LOG SUMMARY

Area: Species	Traits	Ealue Lake: sighting	Ealue Lake: sign	Ealue Lake Count	Exploration Area: sighting	Exploration Area: sign	Exploration Area Count	Ishahcezetle Mtn.: sighting	Ishahcezetle Mtn. Count	Kluea Lake: sighting	Kluea Lake: sign	Kluea Lake Count	Spit Mountain: sighting	Spit Mountain Count	Todagin Mountain: sighting	Todagin Mountain Count	Sighting Count	Sign Count	Grand Total
Bald Eagle Count		3	0		1	0		0		0	0		0		0				4
Beaver Count		0	1		0	0		0		0	0		0		0				1
Black Bear	(unspecified)	1	1	2	0	0	0	0	0	0	1	1	1	1	4	4	6	2	8
	boar	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
	cub	2	0	2	0	0	0	0	0	0	0	0	0	0	1	1	3	0	3
	sow	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	2	0	2
Black Bear Count		4	1		0	0		0		0	1		1		7				14
Canine (unidentified) Count		0	1		0	0		0		0	0		0		0				1
Cross Fox Count		0	0		0	0		0		0	0		0		1				1
Fox Count		0	0		1	0		0		0	0		0		0				1
Grizzly Bear	(unspecified)	0	0	0	2	0	2	0	0	0	0	0	0	0	1	1	3	0	3
	cub	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	2	0	2
	sow	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1
Grizzly Bear Count		0	0		2	0		3		0	0		0		1				6
Moose	(unspecified)	0	1	1	1	1	2	0	0	1	1	2	0	0	2	2	4	3	7
	bull	0	0	0	4	0	4	0	0	0	0	0	0	0	2	2	6	0	6
	calf	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	2
	cow	0	0	0	1	0	1	0	0	3	0	3	0	0	8	8	12	0	12
Moose Count		0	1		6	1		0		4	1		0		14				27
Mountain Goat	(unspecified)	0	0	0	4	0	4	4	4	0	0	0	0	0	2	2	10	0	10
	herd	0	0	0	2	0	2	0	0	0	0	0	0	0	3	3	5	0	5
Mountain Goat Count		0	0		6	0		4		0	0		0		5				15
Porcupine Count		0	0		1	0		0		0	0		0		0				1
Rainbow Trout Count		1	0		0	0		0		0	0		0		0				1
Ungulate (unidentified) Count		0	0		0	0		0		0	1		0		0				1
Wolverine Count		0	0		1	0		0		0	0		0		0				1
Sub-totals	(unspecified)	5	4		11	1		4		1	3		1		10				40
	boar Count	0	0		0	0		0		0	0		0		1				1
	bull Count	0	0		4	0		0		0	0		0		2				6
	calf Count	0	0		0	0		0		0	0		0		2				2
	cow Count	0	0		1	0		0		3	0		0		8				12
	cub Count	2	0		0	0		2		0	0		0		1				5
	herd Count	0	0		2	0		0		0	0		0		3				5
	sow Count	1	0		0	0		1		0	0		0		1				3
Grand total		8	4	12	18	1	19	7	7	4	3	7	1	1	28	28	66	8	74

SECTION 4.0 - RECOMMENDED 1995 ENVIRONMENTAL PROGRAM

The permitting process for development of a mine in B.C. requires a detailed program of environmental and socioeconomic studies. The tasks completed to date have been discussed previously in this report; however, priority tasks for 1995 and remaining tasks for mine development at the Red Chris Property are outlined in the following sub-sections. All this information is summarized in Table 4.1.

4.1 PRIORITY TASKS

The environmental program for 1995 will ultimately be dependent on the planned schedule for development of a mine at the Red Chris property; however, assuming that the exploration program will continue next year, we recommend, as a minimum, maintenance of the current baseline data collection programs. This would involve resuming collection of hydrology and meteorology monitoring data, recording fish and wildlife observations, and resuming collection of monthly water quality monitoring samples.

A site visit will be required once during the winter months, preferably in February, to collect water quality monitoring samples, download the automatic water level recorder datalogger, and measure stream flows, if any water is running, for calibration of staff gauges. This will likely require on-site transportation by snowmobile or helicopter for two people, and an ice auger would be used to bore through ice on the creeks. We anticipate that many of the creeks will be frozen solid and it may not be possible to collect samples from all monitoring sites. It is important from a regulatory perspective to have at least one set of data collected during winter conditions and although this would ideally be in February, it may be possible to delay such a trip until early March, if this coordinates better with the planned commencement of the 1995 exploration program.

Additional site visits will be required during spring freshet conditions (April or May 1995) and early summer (June or July 1995) to download the hydrology datalogger and further calibrate staff gauges by measuring stream flows. Monitoring tasks, such as recording staff gauge readings, meteorological data and wildlife observations, and collecting monthly water quality samples, should be resumed by exploration personnel as early in the season as possible, and carried out as they were during the 1994 field season.

4.2 REMAINING TASKS

Remaining tasks for the permitting process are summarized in Table 4.1 and range from soil studies and collecting acid rock drainage (ARD) data from drill core, to detailed fisheries, vegetation and socioeconomic studies. The schedule for commencing these tasks is dependent on the planned development schedule for mine development; however, some of the studies require collection of data under a variety of seasonal conditions. For example, fisheries and benthic sampling require investigation during spring, summer and autumn conditions within the same calendar year, and the project will eventually require installation of an automatic weather station to record hourly temperature, precipitation, and wind speed and directional data. Other studies require detailed mine plan information, such as ore body location, grades and volume, mining technique, waste rock cut-off grades and volumes, ore and waste rock stockpile areas, tailings facility, mill facility and ancillary building locations and other considerations, before it is useful to collect data.

We recommend that additional environmental tasks for 1995 be determined after further discussion between American Bullion Minerals Ltd. (ABM) and Hallam Knight Piésold Ltd. early in the new year. Such discussions should focus on ABM's current development schedule and how the required environmental, geotechnical and socioeconomic studies can be streamlined to coordinate with exploration and development work, and assist ABM in meeting their schedule.

Table 4.1

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

1994 SUMMARY REPORT

Environmental Program Status

Tasks Completed:

Initiated baseline data collection programs for hydrology, water quality, meteorology, and fish and wildlife in July 1994;
Established database system to manage environmetnal data, and entered all 1994 data;
Installed automatic water level recorder at hydrology monitoring Site H2 in October 1994, and
Prepared 1994 year-end report.

1995 Priority Tasks

Hydrology - download and reset datalogger at Site H2, measure winter, spring and early summer flows to calibrate staff gauges;
Water Quality - collect winter and spring samples and resume baseline data collection program during 1995 exploration program;
Meteorology - resume baseline data collection program during 1995 exploration program, and
Fish & Wildlife Log - resume baseline data collection program during 1995 exploration program.

Remaining Tasks:

Physiography and Soils Investigation;
Acid Generation Potential Tests;
Meteorology and Air Quality Studies;
Groundwater Quality Assessment;
Groundwater Hydrology Assessment;
Vegetation and Forestry Resources Assessment;
Wildlife Resources Assessment;
Fisheries and Aquatic Resources Assessment;
Land Capability and Historic Use Assessment;
Archaeology and Heritage Resources Assessment;
Environmental Protection Strategies, and
Socioeconomic Studies and Investigations.

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

Plate 1: Exploration Camp and Drill Rigs (July '94)
("Red Rock Canyon" is first gully in background).

Plate 2: Hydrology and Water Quality Monitoring Site H5/W5
in "Red Rock Canyon."

Plate 3: Hydrology and Water Quality Monitoring Site H2/W2
in "White Rock Canyon."
Note Automatic Water Level Recorder mounted to tree in background.

AMERICAN BULLION MINERALS LTD.
RED CHRIS PROPERTY

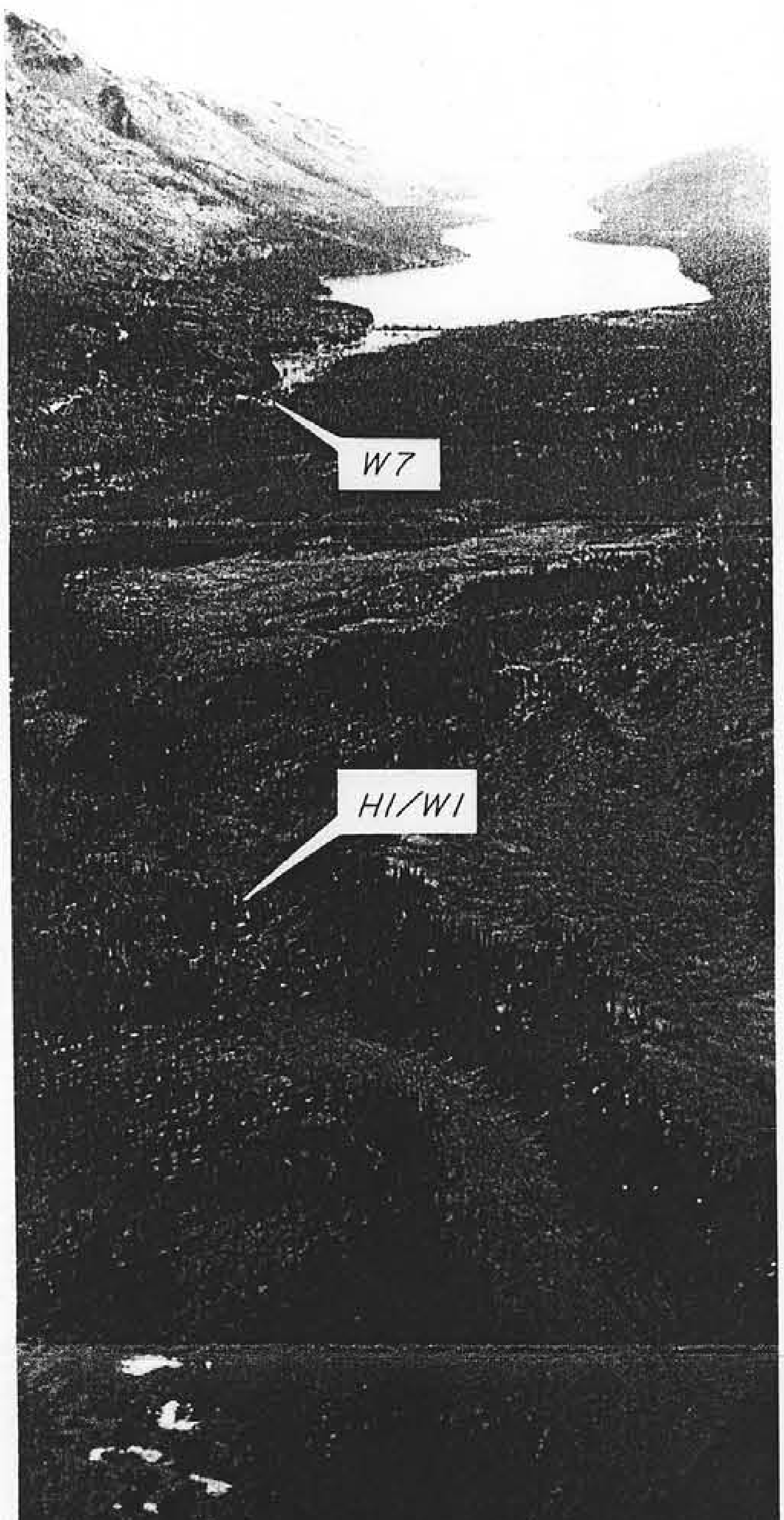

Plate 4: Coyote Creek (Site H1/W1 and W7); Ealue Lake in background.

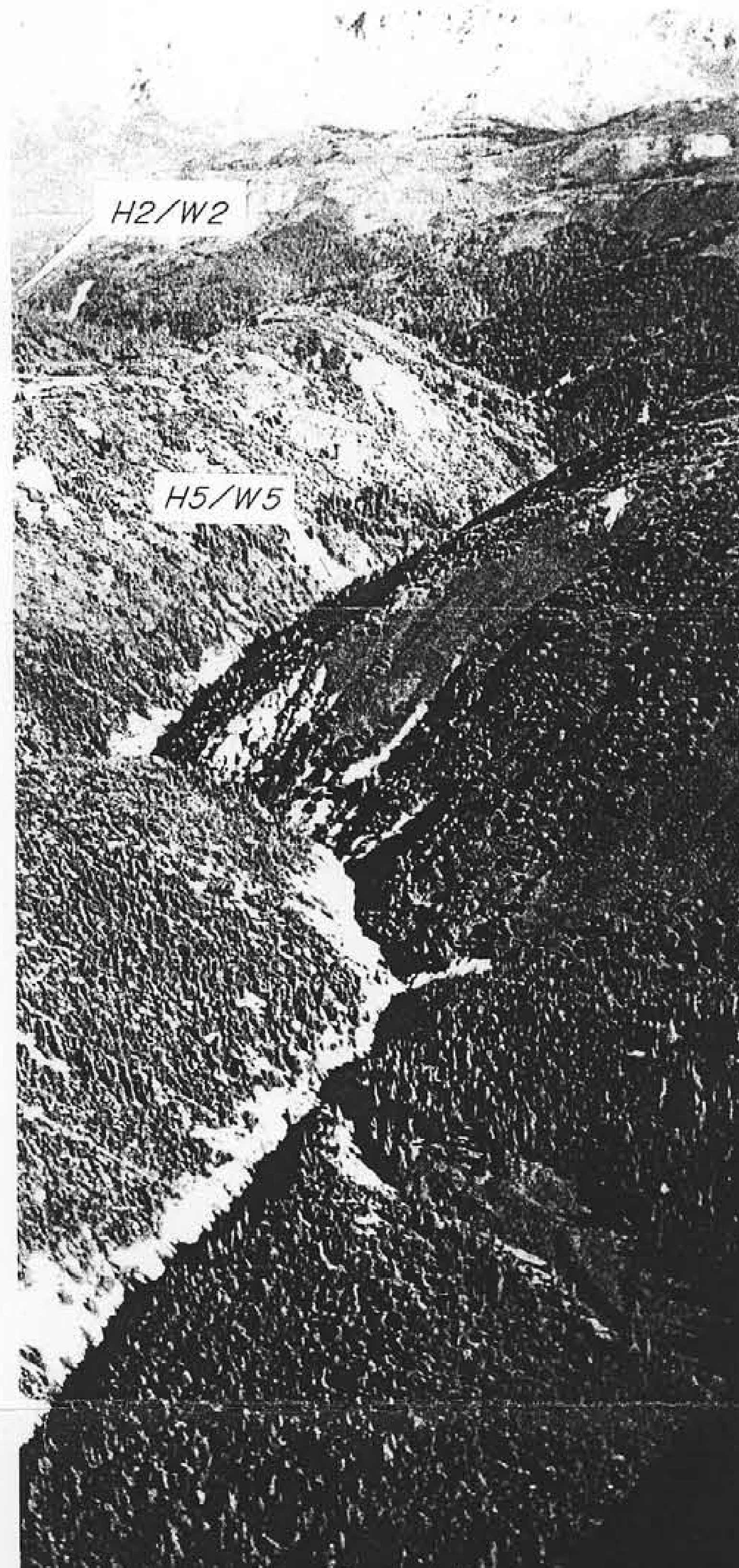

Plate 5: "Red Rock Canyon" (Site H5/W5); White Rock Canyon" (Site H2/W2) in background.

Hallam Knight Piésold Ltd.
ENVIRONMENTAL CONSULTANTS

Appendix XII

APPENDIX XII

RED - CHRIS PROPERTY

ACID BASE ACCOUNTING DATA and ANALYTICAL RESULTS

Drill Hole	Sample Number	Interval (m) From	To	Rock Type	Paste Ph	S-Total %	SO4 as S %	NP	AP	NNP	NP/AP	Comment
94-75	76001	3.66	5.18	MS	7.70	1.00	0.04	127.60	30.00	97.60	4.25	
94-75	76030	87.48	90.53	WS	9.10	0.37	0.04	90.73	10.31	80.42	8.80	
94-84	76660	17.37	20.12	NS	8.00	3.47	0.03	91.80	107.50	-15.70	0.85	
94-84	76689	96.62	99.67	SS	7.70	8.95	0.12	67.01	275.94	-208.93	0.24	
94-84	76730	215.49	218.54	MS	7.75	6.44	0.07	101.44	199.06	-97.62	0.51	
94-84	76755	285.60	288.65	WS	8.40	4.83	0.08	86.29	148.44	-62.15	0.58	
94-84	76768	322.17	325.22	VWS	8.60	3.87	0.29	78.33	111.88	-33.55	0.70	
94-91	77036	364.85	367.89	SS	8.10	4.47	0.05	77.42	138.13	-60.71	0.56	
94-95	77234	163.68	166.73	VWS	7.95	4.99	0.05	57.83	154.38	-96.55	0.37	
94-95	77251	211.68	214.88	NS	9.20	3.88	0.10	61.20	118.13	-56.93	0.52	
94-95	77291	326.44	329.49	MS	9.15	3.80	0.05	86.60	117.19	-30.59	0.74	
94-95	77325	422.30	424.43	WS	8.45	4.26	0.06	90.27	131.25	-40.98	0.69	
94-97	77448	337.41	340.46	SS	8.00	7.98	0.08	112.60	246.88	-132.28	0.46	
94-94	80043	14.02	17.07	SS	8.15	2.34	0.05	126.68	71.56	55.12	1.77	
94-94	80046	23.16	26.21	MS	8.00	1.30	0.04	75.27	39.38	35.89	1.91	
94-94	80065	78.03	81.08	VWS	9.25	1.81	0.07	105.87	54.38	51.49	1.95	
94-94	80078	114.60	117.65	WS	9.55	1.05	0.05	121.17	31.25	89.92	3.88	
94-94	80122	242.62	245.67	NS	8.55	3.34	0.04	24.48	103.13	-78.65	0.24	
94-99	80381	13.72	17.07	NS	7.40	6.14	3.48	21.72	83.13	-61.41	0.26	
94-101	80532	84.12	87.17	VWS	9.35	1.98	0.04	110.16	60.63	49.53	1.82	
94-101	80592	254.81	257.86	MS	9.50	0.69	0.04	100.36	20.31	80.05	4.94	
94-101	80616	322.48	324.92	WS	9.50	0.42	0.05	134.64	11.56	123.08	11.65	
94-106	80791	74.37	77.42	NS	7.45	5.75	0.03	13.16	178.75	-165.59	0.07	
94-106	80836	199.95	203.00	VWS	9.45	0.23	0.04	131.27	5.94	125.33	22.10	
94-106	80878	318.21	321.26	SS	8.20	1.87	0.02	26.93	57.81	-30.88	0.47	

APPENDIX XII

RED - CHRIS PROPERTY

ACID BASE ACCOUNTING DATA and ANALYTICAL RESULTS

Drill Hole	Sample Number	Interval From	Interval To	Rock Type	Ag ppm	Al %	As ppm	B ppm	Ba ppm	Be ppm	Bi ppm	Ca %
94-75	76001	3.66	5.18	MS	0.1	0.32	216	11	64	1.9	9	1.62
94-75	76030	87.48	90.53	WS	0.2	0.55	119	1	359	1.8	11	2.2
94-84	76660	17.37	20.12	NS	0.3	0.32	369	1	434	1.9	12	2.58
94-84	76689	96.62	99.67	SS	2.3	0.31	343	1	58	3.2	53	1.27
94-84	76730	215.49	218.54	MS	1.4	0.22	344	1	85	2.1	19	2.21
94-84	76755	285.60	288.65	WS	1.9	0.39	276	1	121	1.8	16	2.61
94-84	76768	322.17	325.22	VWS	1.9	0.6	93	1	160	2.1	16	1.47
94-91	77036	364.85	367.89	SS	0.3	0.25	222	1	58	1.7	14	1.33
94-95	77234	163.68	166.73	VWS	0.1	0.54	1	1	120	2	10	1.16
94-95	77251	211.68	214.88	NS	0.5	0.83	1	1	48	2.1	6	1.34
94-95	77291	326.44	329.49	MS	1.3	0.4	175	1	136	1.9	24	1.43
94-95	77325	422.30	424.43	WS	0.8	0.67	22	1	199	1.7	15	1.73
94-97	77448	337.41	340.46	SS	2.6	0.28	345	32	65	2.9	51	1.46
94-94	80043	14.02	17.07	SS	0.9	0.28	244	16	45	1.9	26	1.6
94-94	80046	23.16	26.21	MS	0.4	0.34	152	37	34	1.9	19	1.32
94-94	80065	78.03	81.08	VWS	0.9	0.29	166	1	186	1.1	1	2.94
94-94	80078	114.60	117.65	WS	0.1	0.33	214	21	228	2	10	1.59
94-94	80122	242.62	245.67	NS	0.1	0.37	1	2	43	1.5	5	0.52
94-99	80381	13.72	17.07	NS	0.3	0.47	1	4	57	1.5	3	2.13
94-101	80532	84.12	87.17	VWS	0.1	0.51	182	1	144	2	12	1.57
94-101	80592	254.81	257.86	MS	0.4	0.36	185	1	80	2	22	1.45
94-101	80616	322.48	324.92	WS	0.8	0.56	147	21	129	1.7	14	1.67
94-106	80791	74.37	77.42	NS	0.1	0.35	1	1	61	1.9	5	0.41
94-106	80836	199.95	203.00	VWS	0.3	0.39	206	1	113	1.9	11	1.58
94-106	80878	318.21	321.26	SS	10.5	0.13	304	1	32	3	99	0.32

APPENDIX XII

RED - CHRIS PROPERTY

ACID BASE ACCOUNTING DATA and ANALYTICAL RESULTS

Drill Hole	Sample Number	Interval From	To	Rock Type	Cd ppm	Co ppm	Cu ppm	Fe %	K %	Li ppm	Mg %	Mn ppm
94-75	76001	3.66	5.18	MS	0.1	6	1298	3.62	0.3	1	1.39	1376
94-75	76030	87.48	90.53	WS	0.1	6	2983	4.96	0.49	2	1.12	1078
94-84	76660	17.37	20.12	NS	0.1	8	4204	5.45	0.33	1	1.89	1641
94-84	76689	96.62	99.67	SS	0.1	11	10000	8.94	0.3	1	0.9	466
94-84	76730	215.49	218.54	MS	0.1	8	5730	6.3	0.24	1	1.1	1445
94-84	76755	285.60	288.65	WS	0.1	7	4636	5.45	0.22	3	1.4	346
94-84	76768	322.17	325.22	VWS	0.1	6	2898	3.99	0.42	4	1.35	352
94-91	77036	364.85	367.89	SS	0.1	9	2806	4.13	0.22	1	0.93	325
94-95	77234	163.68	166.73	VWS	0.1	7	1371	4.44	0.54	1	0.69	227
94-95	77251	211.68	214.88	NS	0.1	6	256	3.5	0.51	9	1.2	163
94-95	77291	326.44	329.49	MS	0.1	9	4776	4.15	0.45	1	0.99	301
94-95	77325	422.30	424.43	WS	0.1	8	2764	4.44	0.75	1	1.16	407
94-97	77448	337.41	340.46	SS	0.1	13	10000	7.22	0.33	1	1.1	960
94-94	80043	14.02	17.07	SS	0.1	6	5280	3.71	0.31	1	1.17	828
94-94	80046	23.16	26.21	MS	0.1	5	3644	3.67	0.33	2	0.92	751
94-94	80065	78.03	81.08	VWS	0.1	8	1128	4.26	0.16	1	1.19	1307
94-94	80078	114.60	117.65	WS	0.1	6	1230	3.9	0.37	1	1.25	847
94-94	80122	242.62	245.67	NS	0.1	5	559	2.92	0.33	2	0.3	477
94-99	80381	13.72	17.07	NS	0.1	5	70	2.49	0.24	8	0.55	239
94-101	80532	84.12	87.17	VWS	0.1	9	1988	4.21	0.33	5	1.54	903
94-101	80592	254.81	257.86	MS	0.1	6	4810	4.65	0.37	1	1.09	785
94-101	80616	322.48	324.92	WS	0.1	5	2337	3.08	0.47	3	1.37	647
94-106	80791	74.37	77.42	NS	0.1	6	327	4.36	0.38	1	0.24	52
94-106	80836	199.95	203.00	VWS	0.1	6	1763	4.35	0.16	5	1.26	874
94-106	80878	318.21	321.26	SS	0.1	6	10000	8.33	0.22	1	0.37	533

APPENDIX XII

RED - CHRIS PROPERTY

ACID BASE ACCOUNTING DATA and ANALYTICAL RESULTS

Drill Hole	Sample Number	Interval From	To	Rock Type	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	Sb ppm	Sr ppm	Th ppm
94-75	76001	3.66	5.18	MS	5	0.01	16	1040	33	55	124	1
94-75	76030	87.48	90.53	WS	4	0.06	20	1120	33	19	230	1
94-84	76660	17.37	20.12	NS	5	0.05	24	1170	41	11	171	1
94-84	76689	96.62	99.67	SS	6	0.03	29	620	30	19	40	1
94-84	76730	215.49	218.54	MS	3	0.02	24	780	44	24	52	1
94-84	76755	285.60	288.65	WS	3	0.03	20	1240	29	22	126	1
94-84	76768	322.17	325.22	VWS	5	0.05	17	1400	42	23	9890	2
94-91	77036	364.85	367.89	SS	22	0.02	21	580	24	12	47	1
94-95	77234	163.68	166.73	VWS	17	0.02	18	1170	20	30	87	1
94-95	77251	211.68	214.88	NS	5	0.09	14	1390	34	25	299	2
94-95	77291	326.44	329.49	MS	29	0.06	17	1170	33	17	156	2
94-95	77325	422.30	424.43	WS	14	0.04	16	1090	34	27	103	1
94-97	77448	337.41	340.46	SS	34	0.04	28	860	35	89	91	1
94-94	80043	14.02	17.07	SS	8	0.01	17	750	51	29	14	2
94-94	80046	23.16	26.21	MS	8	0.01	15	990	38	30	70	2
94-94	80065	78.03	81.08	VWS	8	0.04	19	1260	38	9	162	1
94-94	80078	114.60	117.65	WS	5	0.09	16	1060	24	11	174	1
94-94	80122	242.62	245.67	NS	30	0.07	12	970	134	12	112	1
94-99	80381	13.72	17.07	NS	4	0.02	12	1010	32	13	1046	1
94-101	80532	84.12	87.17	VWS	15	0.06	20	1210	56	17	127	2
94-101	80592	254.81	257.86	MS	8	0.06	15	920	36	34	102	1
94-101	80616	322.48	324.92	WS	14	0.07	15	1090	31	92	200	2
94-106	80791	74.37	77.42	NS	9	0.02	16	990	16	26	72	1
94-106	80836	199.95	203.00	VWS	5	0.03	19	1210	21	14	97	2
94-106	80878	318.21	321.26	SS	3	0.01	27	550	27	32	36	1

APPENDIX XII

RED - CHRIS PROPERTY

ACID BASE ACCOUNTING DATA and ANALYTICAL RESULTS

Drill Hole	Sample Number	Interval From	To	Rock Type	Ti %	V ppm	Zn ppm	Ga ppm	Sn ppm	W ppm	Cr ppm
94-75	76001	3.66	5.18	MS	0.01	51	111	1	1	3	17
94-75	76030	87.48	90.53	WS	0.01	59.9	105	1	1	6	68
94-84	76660	17.37	20.12	NS	0.01	67	119	1	1	5	68
94-84	76689	96.62	99.67	SS	0.01	51.7	80	1	1	10	151
94-84	76730	215.49	218.54	MS	0.01	22.4	64	1	1	4	47
94-84	76755	285.60	288.65	WS	0.01	57	44	2	1	4	45
94-84	76768	322.17	325.22	VWS	0.01	57.2	56	4	1	5	53
94-91	77036	364.85	367.89	SS	0.01	19.3	23	1	1	7	105
94-95	77234	163.68	166.73	VWS	0.01	18.7	16	1	1	6	84
94-95	77251	211.68	214.88	NS	0.01	56.2	23	8	1	7	92
94-95	77291	326.44	329.49	MS	0.01	42.5	44	4	1	5	52
94-95	77325	422.30	424.43	WS	0.01	35.4	23	2	1	8	121
94-97	77448	337.41	340.46	SS	0.01	34.2	50	1	1	6	76
94-94	80043	14.02	17.07	SS	0.01	23.7	113	3	1	6	76
94-94	80046	23.16	26.21	MS	0.01	35.9	280	1	1	4	43
94-94	80065	78.03	81.08	VWS	0.01	47.2	140	1	1	5	76
94-94	80078	114.60	117.65	WS	0.01	36.1	98	1	1	3	28
94-94	80122	242.62	245.67	NS	0.01	17.2	794	1	1	3	34
94-99	80381	13.72	17.07	NS	0.01	13.2	139	2	1	4	55
94-101	80532	84.12	87.17	VWS	0.01	65.5	319	2	1	6	68
94-101	80592	254.81	257.86	MS	0.01	52.8	92	1	1	7	97
94-101	80616	322.48	324.92	WS	0.01	52.1	79	5	1	8	97
94-106	80791	74.37	77.42	NS	0.01	8.9	26	1	1	2	28
94-106	80836	199.95	203.00	VWS	0.01	84.3	65	1	1	5	45
94-106	80878	318.21	321.26	SS	0.01	52.3	79	1	1	11	156

MINERAL • ENVIRONMENTS LABORATORIES
(DIVISION OF ASSAYERS CORP.)

SPECIALISTS IN MINERAL ENVIRONMENTS
CHEMISTS • ASSAYERS • ANALYSTS • GEOCHEMISTS

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TELEPHONE (604) 847-3004
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Assay Certificate

4V-1093-PA1

Company: **AMERICAN BULLION**
Project: RED CHRIS
Attn: Wayne Roberts

Date: NOV-02-94
Copy 1. American Bullion Minerals, Vancouver

We hereby certify the following Assay of 25 pulp samples submitted OCT-24-94 by W. Roberts.

Sample Number	Paste pH	S-Total %	S04 as S %	*NP	*AP	*NNP
76001	7.70	1.00	.04	127.60	30.00	97.60
76030	9.10	.37	.04	90.73	10.31	80.42
76660	8.00	3.47	.03	91.80	107.50	-15.70
76689	7.70	8.95	.12	67.01	275.94	-208.93
76730	7.75	6.44	.07	101.44	199.06	-97.62
76755	8.40	4.83	.08	86.29	148.44	-62.15
76768	8.60	3.87	.29	78.33	111.88	-33.55
77036	8.10	4.47	.05	77.42	138.13	-60.71
77234	7.95	4.99	.05	57.83	154.38	-96.55
77251	9.20	3.88	.10	61.20	118.13	-56.93
77291	9.15	3.80	.05	86.60	117.19	-30.59
77325	8.45	4.26	.06	90.27	131.25	-40.98
77448	8.00	7.98	.08	112.60	246.88	-132.28
80043	8.15	2.34	.05	126.68	71.56	55.12
80046	8.00	1.30	.04	75.27	39.38	35.89
80065	9.25	1.81	.07	105.87	54.38	51.49
80078	9.55	1.05	.05	121.17	31.25	89.92
80122	8.55	3.34	.04	24.48	103.13	-78.65
80381	7.40	6.14	3.48	21.72	83.13	-61.41
80532	9.35	1.98	.04	110.16	60.63	49.53
80592	9.50	.69	.04	100.36	20.31	80.05
80616	9.50	.42	.05	134.64	11.56	123.08
80791	7.45	5.75	.03	13.16	178.75	-165.59
80836	9.45	.23	.04	131.27	5.94	125.33
80878	8.20	1.87	.02	26.93	57.81	-30.88

NP-Neutralization Potential AP-Acid Potential
NNP-Net Neutralization Potential * Kg CaCO3 equivalent per tonne

Certified by ____________

MIN-EN LABORATORIES

NOV 15 1994

COMP: AMERICAN BULLION
PROJ: RED CHRIS
ATTN: Wayne Roberts

MIN-EN LABS — ICP REPORT

705 WEST 15TH ST., NORTH VANCOUVER, B.C. V7M 1T2
TEL:(604)980-5814 FAX:(604)980-9621

FILE NO: 4V-1093-PJ1+2
DATE: 94/11/02
* pulp * (ACT:F31)

SAMPLE NUMBER	AG PPM	AL %	AS PPM	B PPM	BA PPM	BE PPM	BI PPM	CA %	CD PPM	CO PPM	CU PPM	FE %	K %	LI PPM	MG %	MN PPM	MO PPM	NA %	NI PPM	P PPM	PB PPM	SB PPM	SR PPM	TH PPM	TI %	V PPM	ZN PPM	GA PPM	SN PPM	W PPM	CR PPM
76001	.1	.32	216	11	64	1.9	9	1.62	.1	6	1298	3.62	.30	1	1.39	1376	5	.01	16	1040	33	55	124	1	.01	51.0	111	1	1	3	17
76689	2.3	.31	343	1	58	3.2	53	1.27	.1	11	>10000	8.94	.30	1	.90	466	6	.03	29	620	30	19	40	1	.01	51.7	80	1	1	10	151
76768	1.9	.60	93	1	160	2.1	16	1.47	.1	6	2898	3.99	.42	4	1.35	352	5	.05	17	1400	42	23	9890	2	.01	57.2	56	4	1	5	53
77036	.3	.25	222	1	58	1.7	14	1.33	.1	9	2806	4.13	.22	1	.93	325	22	.02	21	580	24	12	47	1	.01	19.3	23	1	1	7	105
77234	.1	.54	1	1	120	2.0	10	1.16	.1	7	1371	4.44	.54	1	.69	227	17	.02	18	1170	20	30	87	1	.01	18.7	16	1	1	6	84
77251	.5	.83	1	1	48	2.1	6	1.34	.1	6	256	3.50	.51	9	1.20	163	5	.09	14	1390	34	25	299	2	.01	56.2	23	8	1	7	92
77291	1.3	.40	175	1	136	1.9	24	1.43	.1	9	4776	4.15	.45	1	.99	301	29	.06	17	1170	33	17	156	2	.01	42.5	44	4	1	5	52
77448	2.6	.28	345	32	65	2.9	51	1.46	.1	13	>10000	7.22	.33	1	1.10	960	34	.04	28	860	35	89	91	1	.01	34.2	50	1	1	6	76
80043	.9	.28	244	16	45	1.9	26	1.60	.1	6	5280	3.71	.31	1	1.17	828	8	.01	17	750	51	29	14	2	.01	23.7	113	3	1	6	76
80046	.4	.34	152	37	34	1.9	19	1.32	.1	5	3644	3.67	.33	2	.92	751	8	.01	15	990	38	30	70	2	.01	35.9	280	1	1	4	43
80078	.1	.33	214	21	228	2.0	10	1.59	.1	6	1230	3.90	.37	1	1.25	847	5	.09	16	1060	24	11	174	1	.01	36.1	98	1	1	3	28
80122	.1	.37	1	2	43	1.5	5	.52	.1	5	559	2.92	.33	2	.30	477	30	.07	12	970	134	12	112	1	.01	17.2	794	1	1	3	34
80381	.3	.47	1	4	57	1.5	3	2.13	.1	5	70	2.49	.24	8	.55	239	4	.02	12	1010	32	13	1046	1	.01	13.2	139	2	1	4	55
80532	.1	.51	182	1	144	2.0	12	1.57	.1	9	1988	4.21	.33	5	1.54	903	15	.06	20	1210	56	17	127	2	.01	65.5	319	2	1	6	68
80592	.4	.36	185	1	80	2.0	22	1.45	.1	6	4810	4.65	.37	1	1.09	785	8	.06	15	920	36	34	102	1	.01	52.8	92	1	1	7	97
80616	.8	.56	147	21	129	1.7	14	1.67	.1	5	2337	3.08	.47	3	1.37	647	14	.07	15	1090	31	92	200	2	.01	52.1	79	5	1	8	97
80791	.1	.35	1	1	61	1.9	5	.41	.1	6	327	4.36	.38	1	.24	52	9	.02	16	990	16	26	72	1	.01	8.9	26	1	1	2	28
80836	.3	.39	206	1	113	1.9	11	1.58	.1	6	1763	4.35	.16	5	1.26	874	5	.03	19	1210	21	14	97	2	.01	84.3	65	1	1	5	45
80878	10.5	.13	304	1	32	3.0	99	.32	.1	6	>10000	8.33	.22	1	.37	533	3	.01	27	550	27	32	36	1	.01	52.3	79	1	1	11	156

Appendix XIII

Vancouver Petrographics Ltd.

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Report # 940660 for:

Brian Thurston,
American Bullion Minerals Ltd.,
1500-675 West Hastings Street,
VANCOUVER, B.C., V6B 1N2

December, 1994

Samples: 1 to 34 (Note: Section & Offcut of #34 are labeled #35)

Summary:

A: Original Lithology

Samples are from a variably porphyritic intrusive centre. Two main phases of similar overall composition can be separated on the basis of mineralogy and textures of phenocrysts.

The first (**Unit 1** below = Main Phase?) contains anhedral to subhedral plagioclase phenocrysts in a very fine grained groundmass, and probably was intruded at slightly greater depth than the other rocks, which have a finer grained (original) groundmass. It generally does not contain mafic phenocrysts. A few varieties are present suggesting margins and core of an intrusion or slightly different but co-magmatic intrusions.

The other phase (**Unit 2** below) contains moderately abundant to abundant euhedral to subhedral plagioclase phenocrysts and less abundant euhedral to subhedral hornblende and biotite phenocrysts, and locally quartz phenocrysts and small apatite phenocrysts. The ratio of mafic/plagioclase phenocrysts is much higher than in Unit A.

The groundmass is generally too strongly altered to be useful in classification of rocks. Generally the original groundmass was dominated by cryptocrystalline to extremely fine and locally very fine grained plagioclase. A few samples have a bimodal size distribution of plagioclase grains in the groundmass.

Dikes (**Unit 3**) have distinctive textures and many are slightly more mafic that the intrusive rocks. No attempt has been made to make a classification among these rocks except to separate out dikes with amygdules, some of which have been described as "BEP" dikes. The presence of amygdules in itself probably is not a valid criterion on which to make a genetic classification of dikes.

In the following classification, the original compositions of the samples are used; for the groundmass in many samples this has required a speculative extrapolation, because the original texture and minerals were destroyed.

1A: Porphyritic Quartz Diorite/Dacite (Main Phase ?)

Samples contain moderately abundant, anhedral to locally subhedral megacrysts of plagioclase in a groundmass dominated by plagioclase, ankerite, sericite, and quartz

Sample 6 is a **hypabyssal porphyritic quartz diorite/dacite** containing anhedral plagioclase megacrysts in a groundmass of plagioclase, quartz, sericite, and ankerite.

Sample 7 is a **hypabyssal latite porphyry** (somewhat similar to Sample 6) containing abundant subhedral to anhedral phenocrysts of plagioclase in a groundmass of plagioclase, ankerite, and sericite, with much less opaque and quartz.

Sample 8 is a **porphyritic hypabyssal latite** (similar to Samples 6 and 7) containing anhedral to subhedral phenocrysts of plagioclase and minor ones of biotite and hornblende(?) in a very fine grained groundmass of plagioclase-ankerite-sericite with minor opaque and quartz.

1B: Porphyritic Latite/Trachy-latite

Samples contain minor plagioclase and K-feldspar phenocrysts

Sample 9 is a **slightly porphyritic latite** containing phenocrysts of plagioclase, K-feldspar, and biotite in an extremely fine grained groundmass dominated by K-feldspar, ankerite, plagioclase(?), sericite/biotite, quartz, and opaque (mainly magnetite/hematite).

Sample 20 is a **porphyritic latite** containing anhedral plagioclase and minor K-feldspar phenocrysts in a groundmass of K-feldspar, plagioclase, and quartz.

1C: Porphyritic Latite

Samples contain euhedral to subhedral phenocrysts of plagioclase and only minor mafic phenocrysts.

Sample 10 is a **porphyritic latite** containing phenocrysts of plagioclase and minor biotite in an extremely fine grained groundmass of plagioclase, secondary biotite, kaolinite, ankerite, and sericite.

Sample 11 is a **porphyritic hypabyssal latite** containing phenocrysts of plagioclase in a strongly replaced groundmass dominated by quartz with less abundant ankerite, opaque (pyrite and oxide) and sericite, with moderately abundant tourmaline suns.

Sample 12 is a **porphyritic latite** containing phenocrysts of plagioclase and minor hornblende and biotite in a groundmass of sericite/illite-quartz-ankerite.

2: Porphyritic Latite/Dacite to Hypabyssal Dacite/Granodiorite

Samples contain subhedral to euhedral phenocrysts of plagioclase and moderately abundant hornblende and/or biotite, and minor apatite (and quartz)

Sample 13 is a **porphyritic latite/dacite** containing phenocrysts of plagioclase, hornblende, and biotite in a groundmass dominated by quartz and plagioclase.

Sample 14 is a **hypabyssal, porphyritic latite/granodiorite** containing phenocrysts of plagioclase and biotite in a very fine grained groundmass of plagioclase and quartz.

Sample 16 is a **slightly porphyritic latite/dacite** containing minor phenocrysts of plagioclase and biotite in a patchy very fine to extremely fine grained groundmass dominated by plagioclase and quartz.

Sample 17 is a **slightly porphyritic latite/dacite** containing phenocrysts of plagioclase and minor hornblende and biotite in an extremely fine grained groundmass of plagioclase and quartz.

Sample 18 is a **latite porphyry** containing phenocrysts of plagioclase and hornblende in a groundmass of very fine grained plagioclase and quartz.

Sample 19 is a **latite porphyry** containing phenocrysts of plagioclase and minor hornblende and biotite in a groundmass of plagioclase and quartz with minor apatite.

Sample 21 is a **hypabyssal quartz diorite/dacite** containing phenocrysts of plagioclase, hornblende, and quartz and minor ones of biotite in a patchy, bimodal groundmass dominated by plagioclase.

Sample 22 is a **hypabyssal porphyritic latite** containing phenocrysts of plagioclase, hornblende, and biotite in a groundmass dominated by plagioclase and minor quartz.

Sample 23 is a **latite porphyry** containing phenocrysts of plagioclase, biotite, hornblende, and sphene in a groundmass dominated by plagioclase.

Sample 24 is a **porphyritic latite** containing phenocrysts of plagioclase, biotite, and minor hornblende in a groundmass dominated by plagioclase.

Sample 25 is a **porphyritic latite** containing phenocrysts of plagioclase and minor biotite and hornblende in a groundmass of plagioclase.

Sample 28 is a **porphyritic latite(?)** containing phenocrysts of plagioclase and biotite in a groundmass dominated by extremely fine grained sericite and quartz.

Sample 29 is a **porphyritic latite/dacite** containing phenocrysts of plagioclase, hornblende, and biotite in a groundmass of plagioclase-quartz.

Samples 15, 26, 27, and **30** are altered strongly and original textures destroyed, so classification is impossible.

3A: Dikes with amygdules of ankerite/calcite-quartz/chalcedony-(chlorite)

Sample 1 is a very fine grained **latite dike (BEP?)** dominated by prismatic plagioclase and interstitial plagioclase and mafic grains, with moderately abundant opaque/semi-opaque and minor quartz and apatite. Two amygdules 1.5 mm across have rims of ankerite and cores of calcite or chalcedony.

Sample 3 is a **porphyritic amygdaloidal lamprophyric andesite dike (BEP)** containing phenocrysts of hornblende and biotite in a groundmass containing lathy plagioclase grains and patches of chlorite and ankerite with interstitial kaolinite/illite and disseminated opaque/semi-opaque. Amygdules are of calcite-chlorite-opaque and minor quartz-chalcedony-(opaque).

Sample 4 is a coarser grained variety of the **latite/andesite (BEP?)** dike in Sample 1. It contains prismatic plagioclase with interstitial patches of plagioclase and mafic grains. Opaque and semi-opaque are moderately abundant. Minor minerals are quartz and apatite. Spheroidal replacement patches or amygdules up to 3 mm across are dominated by ankerite with minor quartz.

3B: Porphyritic Latite/Andesite, Andesite

These samples contain abundant plagioclase and hornblende phenocrysts and, in some samples, minor ones of sphene, biotite, and apatite

Sample 31 is a **porphyritic latite/andesite** containing phenocrysts of plagioclase and hornblende and minor sphene, biotite, and apatite in a groundmass of plagioclase/sericite/illite, hornblende, ankerite, and opaque.

Sample 32 is a **latite/dacite porphyry** containing phenocrysts of plagioclase and hornblende and minor ones of quartz and apatite are set in a very fine grained groundmass dominated by quartz, ankerite, and kaolinite with minor limonite replacement of ankerite and minor pyrite. Plagioclase is replaced by sericite/illite-kaolinite-(ankerite), and hornblende is replaced by ankerite. Replacement patches are of quartz.

Sample 33 is a **hypabyssal andesite porphyry** containing phenocrysts of plagioclase, hornblende and minor apatite in a groundmass of plagioclase-hornblende.

Sample 34 is an **andesite porphyry** which is very similar to Sample 33.

3C: Other Dikes

Sample 2 is an **andesite dike** containing phenocrysts of plagioclase, biotite, and hornblende in a groundmass containing very fine grained lathy plagioclase, disseminated pyrite grains in a cryptocrystalline, altered matrix of ankerite-sericite/illite, probably mainly after plagioclase.

Sample 5 is a fine grained **diabase** dominated by plagioclase and mafic minerals with minor opaque/semi-opaque and quartz. Moderately abundant patches/fragments(?) up to a few mm across of finer grained diabase commonly contain amygdules of ankerite.

B: Alteration of Phenocrysts and Groundmass

B1: General Notes

1. Alteration is typical of porphyry systems and commonly contain abundant carbonate. Carbonate is mainly ankerite with much less calcite. Distinction between these was made on relief in thin section and rate of reaction with cold, dilute HCl on the hand sample.

2. The main alteration assemblages are phyllic, phyllic/argillic, and potassic. A few samples contain propylitic or propylitic/argillic alteration. A few dikes contain fresh biotite phenocrysts, suggesting a K-stable SCC alteration, which may not be an equilibrium assemblage. Other dikes show an argillic alteration.

3. The alteration assemblages noted in thin section agree well with those from the field classification and are typical of other porphyry deposits.

4. In many cases, argillic alteration occurs in zones of potassic and phyllic alteration. This is interpreted as an argillic overprint on the pre-existing alteration assemblage. Some samples with an overlap between argillic alteration (retrograde) and phyllic alteration (primary) correlate with the field classification of Alteration Type #3 (mottled phyllic).

5. The classification by Leitch and Elliot (1976) is supported generally by the present suite of samples. They described much of the present phyllic zone as being an overprint on a pre-existing larger alkali feldspar-magnetite (potassic) core. No direct evidence was seen in this study to support or refute this claim. Evidence which might be useful to test this hypothesis would be the distribution of hematite after magnetite, assuming that magnetite was formed originally only in the potassic zone, and that it was altered to hematite but not destroyed during the phyllic overprint.

6. The potassic alteration zone (with secondary K-feldspar and/or biotite and/or magnetite) represents the core of the alteration system. Much of the primary magnetite has been replaced by hematite (martite).

7. Tourmaline occurs almost entirely as disseminated "suns", and as such cannot be distinguished in age from the phyllic alteration in which it most commonly occurs. Only one occurrence was noted of tourmaline in a vein.

8. Because this study was of thin sections only, the distribution opaque minerals can only be determined from textures of opaque grains and from hand-sample identification. Thus the distribution of Cu-bearing phases was not determined. Some misclassification may exist between oxide and pyrite. As well, the only estimate of degree of alteration of magnetite to hematite is the magnetism of the hand sample.

9. In one sample, later alteration in envelopes about a vein is carbonate-destructive.

B2: Classification of Samples with respect to Alteration Assemblages

Samples are grouped as follows with respect to alteration assemblages:

1: Potassic (in part with Argillic overprint)

Sample 9 K-feldspar-Ankerite-Sericite/Biotite-Opaque Alteration {Potassic}

The groundmass is dominated by K-feldspar, ankerite, plagioclase(?), sericite/biotite, quartz, and opaque (mainly magnetite/hematite).

Sample 10: Biotite-Sericite-Kaolinite-Ankerite Alteration {Potassic/Argillic};

Most plagioclase phenocrysts are replaced strongly by sericite-(ankerite) but a few are relatively fresh. Biotite phenocrysts are replaced completely by pseudomorphic muscovite with minor ankerite and Ti-oxide. Secondary biotite distribution is patchy. In the hand sample, a sharp contact separates a darker zone with moderately abundant biotite patches (as in the thin section) from a paler zone with much less biotite.

Sample 11 K-Feldspar-Quartz-Ankerite-Sericite-Tourmaline-Magnetite/Hematite-Pyrite Alteration {Potassic/Phyllic};

Phenocrysts of plagioclase are replaced moderately by K-feldspar. The groundmass is of quartz with less abundant ankerite, opaque (pyrite and oxide) and sericite, with moderately abundant tourmaline suns.

Sample 20 K-feldspar-Quartz-Ankerite-Pyrite-Magnetite-Sericite Alteration {Potassic}

Plagioclase phenocrysts are replaced strongly by sericite, and biotite is replaced by pseudomorphic muscovite and lenses of ankerite and minor Ti-oxide.

2a: Phyllic

Sample 1 Sericite/Illite-Ankerite Alteration {Phyllic}

Sample 6 Weak Sericite-Ankerite-Quartz-Pyrite Alteration {Phyllic}

Plagioclase is altered slightly to sericite and ankerite.

Sample 7 Ankerite-Sericite Alteration {Phyllic}

Plagioclase is altered moderately to pale green sericite and ankerite.

Sample 8 Sericite-Ankerite-Pyrite Alteration {Phyllic}

Plagioclase phenocrysts are altered moderately to sericite-(ankerite), biotite is replaced completely by pseudomorphic muscovite with minor ankerite and Ti-oxide, and hornblende(?) is replaced by sericite-ankerite-opaque.

Sample 15 Strong Quartz-Sericite-Pyrite-Ankerite Alteration {Phyllic}

The sample is altered very strongly to sericite-quartz-pyrite-ankerite and most original textures were destroyed.

Sample 16 Sericite/Illite-Pyrite-(Carbonate) Alteration {Phyllic}

Plagioclase phenocrysts are altered completely to sericite/illite. Biotite phenocrysts are altered completely to muscovite.

Sample 18 Sericite/Illite-Ankerite-(Pyrite) Alteration {Phyllic}

Plagioclase phenocrysts are replaced by sericite/illite. Hornblende(?) phenocrysts are replaced by extremely fine intergrowths of sericite/illite, ankerite, opaque, and leucoxene.

Sample 19 Sericite-Ankerite-Quartz Alteration {Phyllic}

Plagioclase phenocrysts are replaced by sericite-(ankerite). Mafic phenocrysts are replaced by muscovite-ankerite-quartz.

Sample 22 Sericite-Ankerite/Calcite-Pyrite Alteration {Phyllic}

Phenocrysts are altered completely as follows: plagioclase to calcite/ankerite-sericite-(kaolinite), hornblende to sericite-calcite, and biotite to pseudomorphic muscovite.

Sample 23 Calcite/Ankerite-Sericite-Tourmaline-Pyrite Alteration {Phyllic}

Plagioclase phenocrysts are altered to sericite-calcite, and biotite and hornblende phenocrysts are altered completely to muscovite, ankerite/calcite, patches of pyrite and lenses of Ti-oxide. Tourmaline forms irregular patches, seams, and radiating clusters in the groundmass and in and bordering mafic phenocrysts.

Sample 24 Ankerite-Sericite-Pyrite-(Quartz-Apatite) Alteration {Phyllic}

Plagioclase phenocrysts are altered moderately to ankerite-(sericite). Biotite phenocrysts are replaced by pseudomorphic muscovite with lenses of ankerite and patches of pyrite and minor quartz and apatite. Hornblende phenocrysts are replaced by quartz, ankerite, pyrite, and apatite. The groundmass is replaced slightly by sericite and minor illite.

Sample 25 Quartz-Ankerite-Sericite-Pyrite Alteration {Phyllic}]

Phenocrysts are altered completely as follows: plagioclase to sericite-(ankerite), biotite to muscovite-ankerite, and hornblende to kaolinite-pyrite-ankerite. Plagioclase in the groundmass is altered moderately to sericite and ankerite.

Sample 26 Strong Quartz-Sericite-Pyrite-(Kaolinite) Alteration {Phyllic}

The sample was altered strongly to quartz-sericite/illite-pyrite and almost all of the original texture was destroyed.

Sample 29 Sericite-Ankerite-Quartz-Pyrite-(Tourmaline) Alteration {Phyllic}

Plagioclase phenocrysts are altered completely to sericite-(ankerite). Hornblende phenocrysts are altered to quartz-sericite-ankerite-(pyrite), and biotite phenocrysts are altered to muscovite-ankerite-pyrite.

Sample 30 Quartz-Sericite-Ankerite-Opaque Alteration {Phyllic}

The host rock is altered and replaced strongly by quartz and sericite/illite with locally abundant ankerite and opaque.

Sample 32 Sericite/Illite-Kaolinite-Ankerite-Quartz Alteration {Phyllic/Argillic}

Plagioclase phenocrysts are altered to sericite/illite-kaolinite-(ankerite), and hornblende phenocrysts are altered to ankerite.

Sample 34 Sericite-Pyrite Alteration {Phyllic}

The sample is very similar to Sample 33, but is more strongly altered. Phenocrysts are altered as follows: plagioclase strongly to sericite/illite-ankerite, hornblende completely to sericite-ankerite-opaque-leucoxene, and biotite completely to muscovite-ankerite.

2b: Phyllic/Argillic

Sample 12 Quartz-Ankerite-Sericite/Illite-Pyrite-Kaolinite Alteration {Phyllic/Argillic}

Plagioclase phenocrysts are altered moderately to strongly to sericite/illite-ankerite, hornblende phenocrysts are replaced completely by kaolinite-ankerite-sericite/illite-opaque, and biotite phenocrysts are replaced by muscovite-(kaolinite).

Sample 13 Sericite-Ankerite-Quartz-Kaolinite-Pyrite Alteration {Phyllic/Argillic}

Plagioclase phenocrysts are altered to sericite-ankerite-kaolinite, hornblende phenocrysts are altered to kaolinite-ankerite-(sericite-quartz), and biotite phenocrysts are altered to ankerite-muscovite/sericite-(kaolinite).

Sample 14 Kaolinite-Sericite/Illite-Ankerite-Pyrite Alteration {Phyllic/Argillic}

Plagioclase phenocrysts are replaced by kaolinite-ankerite-sericite/illite, and biotite phenocrysts are replaced by muscovite-(ankerite-pyrite) or less commonly by kaolinite-ankerite-pyrite. In the groundmass, plagioclase is replaced in irregular patches by illite/kaolinite.

Sample 17 Sericite/Illite-Ankerite-Pyrite-(Kaolinite) Alteration {Phyllic/Argillic}

Phenocrysts are replaced completely to sericite-ankerite, with opaque and leucoxene common in altered hornblende, and quartz in altered biotite.

Sample 21 Sericite-Pyrite-Illite-Kaolinite Alteration {Phyllic/Argillic}

Plagioclase phenocrysts are altered strongly to sericite. Plagioclase/ hornblende phenocrysts are altered completely to kaolinite-ankerite. Biotite phenocrysts are replaced by muscovite/illite. In the coarser grained groundmass of very fine to fine grained plagioclase and quartz, plagioclase is altered moderately to sericite. In the finer grained groundmass, plagioclase is replaced by cryptocrystalline illite-kaolinite.

Sample 27 Strong Alteration: Kaolinite-Sericite-Quartz-Pyrite {Phyllic/Argillic}

The sample contains patches of strongly altered host rock (kaolinite/illite-sericite-quartz-opaque)

Sample 28 Quartz-Sericite-Pyrite-Kaolinite Alteration {Phyllic/Argillic}

Phenocrysts are altered completely as follows: plagioclase to kaolinite/illite-(sericite-quartz) and biotite to muscovite-quartz. Much of the sample is more strongly altered to patches of sericite-kaolinite and of quartz and disseminated opaque, and original texture was destroyed.

3. Propylitic (/Argillic) and Propylitic(/Phyllic)

Sample 31 Sericite-Ankerite-(Chlorite) Alteration {Phyllic/Propylitic}

Plagioclase is altered strongly to sericite/illite-(ankerite), hornblende is replaced by sericite-ankerite-leucoxene or chlorite/muscovite-(ankerite), biotite is replaced by muscovite-ankerite-Ti-oxide, and sphene is replaced by ankerite-leucoxene.

Sample 33 Chlorite-Calcite-(Sericite/Illite) Alteration {Propylitic}

Phenocrysts are altered as follows: plagioclase slightly to sericite, and hornblende strongly to chlorite-calcite.

4. K-stable SCC

Sample 2 Quartz-Sericite/Illite-Ankerite-(Chlorite) Alteration [K-stable SCC]

Plagioclase phenocrysts are altered to quartz-ankerite-(sericite), and hornblende phenocrysts are altered to quartz-chlorite-ankerite-sericite. Biotite phenocrysts are relatively fresh. This suggests that the alteration is a K-stable sericite-chlorite-clay (SCC) alteration.

Sample 3 Calcite-Chlorite-Ankerite-Kaolinite/Illite Alteration [K-stable SCC]

Hornblende phenocrysts are altered to calcite-chlorite-Ti-oxide-(quartz). Biotite phenocrysts are fresh. Amygdules are of calcite-chlorite-opaque and minor quartz-chalcedony-(opaque). Replacement patches and veinlets are of calcite-chlorite/biotite-opaque and minor ankerite. The alteration type is K-stable SCC.

5: Argillic

Sample 4 Kaolinite/(Illite)-Ankerite Alteration {Argillic}

This sample is a coarser grained variety of the dike in Sample 1. Prismatic plagioclase is altered completely to kaolinite-[illite].

Sample 5 Kaolinite-Ankerite Alteration {Argillic}

Plagioclase is altered to kaolinite and mafic minerals altered to ankerite.

C: Replacement Patches and Veinlets

Replacement patches, veins, and veinlets commonly are related somewhat in mineralogy and texture. Insufficient data were available to determine a sequence of events such as presented by Leitch and Elliot. The only general statement which can be made is the following:

More than one stage of many of the vein types are present, thus age relations between similar vein types in different samples may be ambiguous. As an example of this, Leitch and Elliot described magnetite veins as early. However, one set of magnetite(?) veins is later than one set of quartz veins.

Replacement and vein types are summarized below, without any attempt to classify different types of veins between samples. Notes are given for samples where age relations exist.

Sample 1 **Veinlets of Quartz-Ankerite-(Sericite)**

Sample 3 **Calcite-Chlorite/Biotite-Opaque-(Ankerite) Replacement Patches and Veinlets**

Sample 4 **Replacement Patches/Amygdules of Ankerite-(Quartz)**

Sample 5 **Kaolinite and Ankerite Veinlets**

Sample 6 **Replacement Patches of Quartz-(Pyrite);**
Veins, Veinlets of Quartz-(Ankerite-Pyrite); Seams & Patches of Sericite

Sample 7 **Veinlets of Ankerite-(Quartz-Opaque) and Ankerite-Kaolinite(?)**
Quartz-Pyrite-(Ankerite) Vein (in drill core sample only)

The drill core contains a vein up to 5 mm wide of quartz and pyrite. The thin section contains a vein of ankerite-quartz-opaque and veinlets of ankerite. On one side of the hand sample is a vein up to several mm wide of quartz with a centre-line up to 1 mm wide of pyrite with minor patches of ankerite. Late veinlets are of ankerite-kaolinite(?).

Sample 8 **Quartz-Ankerite-(Pyrite-Sericite), Pyrite Veinlets,**

A veinlet at one end of the section is of quartz and ankerite with minor pyrite and sericite. A second veinlet is of quartz. Much smaller veinlets are of pyrite-(quartz-ankerite).

Sample 9 **Quartz-Opaque-Ankerite-Sericite Veins, Veinlets;**
Magnetite/Hematite-(Quartz-Ankerite) Veinlets;
Late Lenses of Kaolinite-Ankerite, Seams of Sericite

Mainly early veins and veinlets and replacement patches are of quartz with much less opaque, ankerite, kaolinite, and sericite; most of these are cut by veinlets of opaque (mainly magnetite/hematite)-ankerite. A few quartz-rich veinlets may post-date the opaque-rich veinlets. Late lenses are of kaolinite-calcite/ankerite. Late irregular, wispy seams are of sericite.

Sample 10 **Ankerite-Quartz-Opaque-Kaolinite Vein**

Sample 11 **Quartz Vein with Core of Pyrite**

Sample 12 **Veins, Veinlets of Ankerite-Pyrite-Kaolinite-(Quartz)**

Sample 13 **Veins of Quartz-(Ankerite-Pyrite), Veinlet of Pyrite-(Ankerite-Sericite)**

Sample 14 **Vein and Veinlets of Ankerite**

Sample 15 **Quartz Veins, Pyrite Veinlets**

Several subparallel veins are of quartz. A few discontinuous veinlets are of pyrite. Minor veinlets cutting the quartz veins are of apatite, opaque, ankerite, and sericite.

Sample 16 **Veins of Pyrite-Quartz-(Tourmaline-Calcite), Quartz-Calcite-Pyrite, and Calcite-(Quartz-Pyrite)**

Early veins are of pyrite-quartz-calcite-(tourmaline). Later veins are of quartz-calcite-pyrite and calcite-(quartz-pyrite).

Sample 17 **Quartz-rich Replacement Patches; Ankerite, Quartz, Pyrite Veinlets**

Sample 18 **Replacement Patches of Quartz; Quartz-(Pyrite) Veins, Late Ankerite Veinlet**

Sample 19 **Quartz Replacement; Quartz Vein and Veinlets; Pyrite-Quartz Veinlet**

Sample 20 **Quartz-Pyrite-(Magnetite?)-Ankerite-(Sericite) Veins, Veinlets**

A major vein and several veinlets are of quartz with patches of opaque, ankerite, and sericite.

Sample 21 **Calcite-(Quartz) Vein, Quartz-(Calcite) Veinlets**

Sample 22 **Quartz-Calcite-Pyrite-(Ankerite-Apatite-Tourmaline) Replacement**

Sample 23 **Quartz-Calcite-Pyrite Veins/Veinlets; Calcite-Pyrite Veinlet**

Sample 25 **Replacement Patches of Quartz-Pyrite-Apatite); Veinlet of Quartz-Apatite**

Sample 26 **Replacement patches, Veins, Veinlets of Quartz-Pyrite**

Sample 27 **Strong Replacement by Quartz-(Pyrite) Veins; Pyrite-(Calcite) Veinlets**

Sample 28 **Veins of Quartz-(Pyrite-Calcite);**
Veinlets of Pyrite-Calcite-Quartz; Calcite-(Opaque)

Sample 29 **Veins and Veinlets of Quartz-Ankerite-Pyrite-Sericite;**
Late Veinlets of Opaque-Ankerite and Pyrite (with a carbonate-destructive alteration envelope)

Veins up to 8 mm wide and a few veinlets are of quartz with much less ankerite, pyrite, and sericite. A few veinlets cutting the main vein are of pyrite-ankerite or pyrite. In the dark (in hand sample) branching band up to 3 mm wide, the groundmass is of sericite-quartz-pyrite with only minor ankerite. Where this band cuts a large quartz vein, it contains several veinlets of pyrite. This suggests that it is a late carbonate-destructive alteration associated with deposition of pyrite.

Sample 30 Quartz-Ankerite-Opaque Veins, Late Ankerite Veinlets; Breccia Groundmass of Quartz-Opaque

Veins are of quartz with minor to abundant ankerite and opaque. They are truncated and offset along a few major seams of brecciation dominated by quartz and opaque.

Sample 31 Replacement Patches of Quartz-Opaque; Veinlets of Ankerite-Opaque-Quartz, Opaque, Ankerite

A few replacement patches are of quartz-(opaque). Early veinlets are of ankerite-opaque-quartz and opaque. Late veinlets are of ankerite.

Sample 32 Quartz Replacement

Sample 33 Quartz-Calcite-(K-feldspar-Opaque) Replacement Patches Calcite-(Quartz-Sericite/Illite-Opaque-Kaolinite?) Vein, Veinlets

Sample 34 Quartz-(Ankerite) Replacement Patches; Veins, Veinlets of Ankerite-(Quartz)

Replacement patches are dominated by quartz with much less ankerite. Irregular, early veins and veinlets are of ankerite with much less quartz. Late veinlets are of ankerite.

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Sample 1: 94-132 324.6 m Latite/Andesite Dike (BEP?);
Sericite/Illite-Ankerite Alteration {Phyllic};
Amygdules of Ankerite-Calcite and Ankerite-Chalcedony;
Veinlets of Quartz-Ankerite-(Sericite)

The sample is a very fine grained dike dominated by prismatic plagioclase (altered to sericite/illite and ankerite) and interstitial plagioclase and mafic grains (altered mainly to ankerite), with moderately abundant opaque/semi-opaque and minor quartz and apatite. Two amygdules 1.5 mm across have rims of ankerite and cores of calcite or chalcedony. A few veinlets are of quartz-ankerite-(sericite).

prismatic plagioclase	45-50%	(altered to sericite/illite-(ankerite)
interstitial minerals	40-45	(altered to ankerite-[sericite/illite])
opaque, semi-opaque	3- 4	
quartz	0.7	
apatite	0.3	
specular hematite	0.1	
amygdules		
ankerite-calcite, ankerite-chalcedony	0.3	
veinlets		
quartz-ankerite-(sericite)	3- 4	

Plagioclase forms prismatic grains averaging 0.1-0.2 mm in length. Alteration is complete to cryptocrystalline sericite/illite and minor ankerite.

Interstitial to prismatic plagioclase, finer grained plagioclase and mafic grains are altered completely to patches of extremely fine to very fine grained ankerite with much less sericite/illite.

Opaque/semi-opaque (probably leucoxene after ilmenite and hematite after magnetite) forms disseminated, subhedral, equant grains averaging 0.02-0.05 mm in size. Specular hematite forms disseminated slender plates up to 0.15 mm long.

Quartz forms interstitial grains averaging 0.07-0.1 mm in size.

Apatite forms acicular to elongate prismatic grains averaging 0.07-0.15 mm long.

One spherical amygdule is rimmed by subhedral ankerite and has a core of medium grained calcite with strongly warped extinction and one prismatic grain of quartz 0.3 mm long. The other spherical amygdule is rimmed by euhedral ankerite grains averaging 0.1-0.3 mm in size with an interstitial core of extremely fine grained chalcedony, in part in radiating to sub-radiating spherical to colloform aggregates 0.15-0.2 mm in size showing delicate growth zones near their margins.

Veinlets averaging 0.1-0.3 mm wide are dominated by extremely fine grained quartz or extremely fine to very fine grained ankerite, with minor to locally abundant ones of cryptocrystalline sericite.

Sample 2: 94-79 232.15 m Andesite Dike: Quartz-Sericite/Illite-Ankerite-(Chlorite) Alteration [K-stable SCC]

Phenocrysts of plagioclase, biotite, and hornblende are set in a groundmass containing very fine grained lathy plagioclase, disseminated pyrite grains in a cryptocrystalline, altered matrix of ankerite-sericite/illite, probably mainly after plagioclase. Plagioclase phenocrysts are altered to quartz-ankerite-(sericite), and hornblende phenocrysts are altered to quartz-chlorite-ankerite-sericite. Biotite phenocrysts are relatively fresh. This suggests that the alteration is a K-stable sericite-chlorite-clay (SCC) alteration.

phenocrysts		
plagioclase	3- 4%	
biotite	2- 3	
hornblende	1- 2	
groundmass		
plagioclase laths	50-55	
matrix		
ankerite-sericite/illite	30-35	(mainly after plagioclase)
opaque	2- 3	(in part magnetite)
quartz	0.1	

Plagioclase forms euhedral to subhedral phenocrysts averaging 0.5-1.2 mm in size which commonly occur in clusters of a few phenocrysts. Some have pointed ends. Alteration is complete quartz, ankerite, and locally sericite in widely varying proportions, generally with quartz dominant. Quartz forms strongly interlocking grains averaging 0.03-0.07 mm in size. Ankerite forms extremely fine to very fine grains and patches. Sericite forms dense, cryptocrystalline to extremely fine grained aggregates. Some quartz-rich patches contain moderately abundant dusty opaque.

Biotite forms phenocrysts ranging from 0.3-2 mm long; many have somewhat rounded terminations. Pleochroism is from pale or light to medium brown. Grains are mainly fresh. A few are replaced slightly to moderately by quartz grains averaging 0.02-0.05 mm in size. A few are altered in patches to pseudomorphic muscovite.

Hornblende(?) forms a few euhedral phenocrysts up to 2 mm long. Alteration is complete to extremely fine grained aggregates of quartz, sericite, chlorite, and ankerite.

In the groundmass, plagioclase forms unoriented, lathy grains averaging 0.1-0.15 mm long. Alteration is complete to cryptocrystalline sericite/illite and much less ankerite. Interstitial material (probably originally dominated by plagioclase with lesser mafic material) is altered completely to ankerite and sericite/illite.

Opaque forms disseminated, grains with a bimodal distribution. Coarser, subhedral to euhedral grains average 0.05-0.1 mm in size, with a few up to 0.4 mm across. Finer grains average 0.01-0.02 mm in size. The rock is moderately magnetic, suggesting that some of the opaque is magnetite. It may be magnetite replaced partly by hematite/martite.

Quartz forms disseminated grains averaging 0.02-0.03 mm in size and a few up to 0.05 mm across.

Sample 3: 94-112 229.5 m Porphyritic Amygdaloidal Lamprophyric Andesite Dike (BEP); Calcite-Chlorite/Biotite-Pyrite and Quartz-Chalcedony-Opaque Amygdules Calcite-Chlorite-Ankerite-Kaolinite/Illite Alteration [K-stable SCC] Calcite-Chlorite/Biotite-Opaque-(Ankerite) Replacement Patches and Veinlets

Phenocrysts of hornblende and biotite are set in a groundmass containing lathy plagioclase grains and patches of chlorite and ankerite with interstitial kaolinite/illite and disseminated opaque/semi-opaque. Hornblende phenocrysts are altered to calcite-chlorite-Ti-oxide-(quartz). Biotite phenocrysts are fresh. Amygdules are of calcite-chlorite-opaque and minor quartz-chalcedony-(opaque). Replacement patches and veinlets are of calcite-chlorite/biotite-opaque and minor ankerite. The alteration type is K-stable SCC.

phenocrysts		
hornblende	4- 5%	
biotite	2- 3	
groundmass		
lathy plagioclase	20-25	
matrix		
plagioclase	20-25	(altered to kaolinite/illite)
chlorite	10-12	
ankerite	5- 7	
opaque	1- 2	
amygdules		
calcite-chlorite-opaque	3- 4	
quartz-chalcedony-(opaque)	0.1	
replacement patches, veinlets		
calcite	10-12	
chlorite/biotite	2- 3	
pyrite	0.5	
ankerite	0.2	

Hornblende(?) forms a few subhedral, prismatic phenocrysts from 2-5 mm long and others averaging 0.3-0.5 mm long. Alteration is complete to intergrowths of calcite, chlorite, and much less Ti-oxide and quartz. Calcite forms fine to medium grains. Chlorite forms clusters of extremely fine grains, in part with sub-radiating to fibrous textures, commonly intergrown with patches averaging 0.05-0.12 mm across of cryptocrystalline Ti-oxide. Quartz forms scattered grains averaging 0.05-0.1 mm in size. One phenocryst contain a patch 0.15 mm across of sphene(?) with an unusual radiating texture. Hornblende also forms a few prismatic phenocrysts averaging 0.5-1 mm in length which are altered completely to extremely fine to very fine grained calcite and minor seams and patches of chlorite.

Biotite forms subhedral to anhedral phenocrysts averaging 0.5-0.8 mm in size and a few up to 2.53 mm long. Pleochroism is from pale to medium brown. Grains are fresh to altered slightly to chlorite/biotite. Some contain moderately abundant, disseminated patches of Ti-oxide.

(continued)

In the groundmass, plagioclase forms lathy grains averaging 0.07-0.15 mm long. These are altered partly to kaolinite/sericite. Chlorite forms patches averaging 0.05-0.1 mm in size of cryptocrystalline, pale green flakes. Interstitial to these are patches of cryptocrystalline kaolinite/illite(?). Opaque (oxide?) forms disseminated grains averaging 0.01-0.02 mm in size, and a few patches averaging 0.03-0.07 mm across.

Amygdules up to 2.5 mm in size are dominated by very fine to fine grained calcite, with locally abundant chlorite/biotite and opaque. Chlorite/biotite forms radiating aggregates of flakes averaging 0.05-0.15 mm long. Pleochroism is from pale yellowish green to light, slightly bluish green. In a few amygdules, seams in patches of chlorite/biotite are of medium brown, cryptocrystalline to extremely fine grained flakes oriented perpendicular to the centre-line of the seam. Other equant patches up to 0.1 mm across are of unoriented, cryptocrystalline flakes of the same mineral. Amygdules grade in texture into replacement patches.

One amygdule 1 mm across has a rim of chalcedonic quartz which forms patches with a radiating texture outwards from the walls of the amygdule. Intergrown with chalcedony are a few grains of ankerite 0.05 mm in size. The core of the amygdule is of a few fine grained, sub-radiating quartz grains showing a delicate growth texture of concentric rings. Bordering the amygdule on one side are a few patches up to 0.2 mm across of opaque.

Replacement patches up to a few mm across and smaller veinlets are dominated by fine to medium grained calcite. In cores of a few are selvages of cryptocrystalline ankerite between calcite grains. Chlorite/biotite forms patches up to 0.2 mm across of radiating flakes with pleochroism from pale yellowish green to light bluish green. Pyrite forms anhedral grains averaging 0.2-0.5 mm in size. One patch contains a few relic biotite phenocrysts averaging 0.3-1 mm in size. Pyrite forms a few irregular patches up to 1 mm in size, probably of replacement origin.

Sample 4: 94-126 300.4 m Latite/Andesite Dike (BEP?): Kaolinite/(Illite)-Ankerite Alteration {Argillic}; Replacement Patches/Amygdules of Ankerite-(Quartz)

This sample is a coarser grained variety of the dike in Sample 1. It contains prismatic plagioclase phenocrysts (altered completely to kaolinite-[illite]) with interstitial patches dominated by ankerite and minor kaolinite/illite, quartz and sericite (after plagioclase and mafic grains). Opaque and semi-opaque are moderately abundant. Minor minerals are quartz and apatite. Spheroidal replacement patches or amygdules up to 3 mm across are dominated by ankerite with minor quartz.

plagioclase	50-55%	(altered completely to kaolinite-[illite])
ankerite	35-40	(interstitial to plagioclase)
opaque, semi-opaque	4- 5	(leucoxene, hematite)
quartz	1	
specular hematite	0.5	
apatite	0.3	
replacement patches/amygdules		
ankerite	4- 5	
quartz	0.1	

Plagioclase forms prismatic grains averaging 0.3-0.7 mm long. Alteration is complete to cryptocrystalline to extremely fine grained kaolinite/illite.

Interstitial patches are dominated by extremely fine to very fine grained ankerite, with minor kaolinite/illite.

Opaque and semi-opaque form equant, subhedral grains averaging 0.05-0.08 mm in size. Specular hematite forms slender plates averaging 0.1-0.3 mm long and a few up to 0.5 mm long.

Quartz forms disseminated, interstitial, equant grains averaging 0.07-0.12 mm in size.

Apatite forms acicular to elongate prismatic grains averaging 0.1-0.2 mm long, and a few up to 0.3 mm long.

A few spheroidal patches (amygdules?) up to 2 mm across are of aggregates of ankerite, which show a very fine grained texture, possibly formed in part by recrystallization of coarser grains. A few amygdules up to 3 mm across are of very fine grained ankerite with minor interstitial grains of quartz from 0.05-0.3 mm in size.

Sample 5: 94-114 30 m **Diabase, Fragments of Finer Grained Diabase with Amygdules of Ankerite; Kaolinite-Ankerite Alteration {Argillic}; Kaolinite and Ankerite Veinlets**

The sample has the texture of a fine grained diabase, with plagioclase altered to kaolinite and mafic minerals altered to ankerite. Minor minerals are opaque/semi-opaque and quartz. Moderately abundant patches/fragments(?) up to a few mm across of finer grained diabase commonly contain amygdules of ankerite. A few veinlets are of kaolinite and of ankerite.

plagioclase	
coarser grains	20-25%
groundmass	30-35
clinopyroxene(?)	25-30
opaque, semi-opaque	3- 4
quartz	1
fragments (?)	
finer grained diabase	8-10
amygdules (in fragments)	
ankerite	3- 4
veinlets, lenses	
kaolinite	2- 3
ankerite	0.4

Plagioclase forms subhedral prismatic grains up to 0.7 mm long. In the groundmass it forms anhedral patches up to 0.15 mm in size. Coarser grains are replaced by cryptocrystalline kaolinite. Grains in the groundmass are altered to similar kaolinite with minor to moderately abundant dusty opaque.

Clinopyroxene(?) forms a few prismatic grains up to 0.5 mm in length. Replacement is complete to ankerite and minor patches of kaolinite. In the groundmass, clinopyroxene forms grains averaging 0.05-0.1 mm in size, which are replaced completely by ankerite.

Opaque/semi-opaque forms disseminated, subhedral grains averaging 0.02-0.03 mm in size.

Quartz forms disseminated grains averaging 0.05-0.07 mm in size.

Fragments (?) up to a few cm long of finer grained diabase consist of more intimate intergrowths of kaolinite and patches of ankerite, and contain moderately abundant elongate leucoxene as platy clusters averaging 0.1-0.15 mm long and dusty, disseminated grains. Many of these fragments contain a spherical to ellipsoidal patch (amygdule?) up to 0.7 mm in size dominated by very fine to extremely fine grained ankerite.

Wispy veinlets averaging 0.1-0.2 mm wide are of cryptocrystalline kaolinite (possibly after plagioclase or possibly primary).

A few veinlets averaging 0.03-0.07 mm wide are of very fine grained ankerite.

Sample 6: 94-114 204.2 m **Hypabyssal Porphyritic Quartz Diorite/Latite; Sericite-Ankerite-Quartz-Pyrite Alteration {Phyllic}; Replacement Patches of Quartz-(Pyrite); Veins, Veinlets of Quartz-(Ankerite-Pyrite); Seams & Patches of Sericite**

Anhedral plagioclase megacrysts are set in a groundmass of plagioclase, quartz, sericite, and ankerite. Plagioclase is altered slightly to sericite and ankerite. A few replacement patches are dominated by quartz with minor pyrite. Abundant veins are of quartz or quartz-(pyrite-ankerite). Late seams are of sericite.

megacrysts		
plagioclase	30-35%	
groundmass		
plagioclase	12-15	
ankerite	8-10	
sericite	7- 8	
quartz	4- 5	(gradational into replacement quartz)
pyrite	1- 2	
tourmaline	0.2	
apatite	0.1	
sphene(?)	0.1	
replacement patches		
quartz	2- 3	
pyrite	0.3	
veins, veinlets		
1) quartz	20-25	
pyrite	2- 3	
ankerite	0.5	
2) sericite	3- 4	

Plagioclase forms anhedral megacrysts averaging 0.3-0.8 mm in size and a few up to 2 mm across. These grade down in size to groundmass plagioclase which averages 0.05-0.1 mm in grain size with a few patches of grains from 0.02-0.03 mm in size. The anhedral nature of the coarser plagioclase grains is distinct from the other hypabyssal porphyritic rocks in the suite. Alteration is slight to cryptocrystalline sericite and ankerite. Grains contain minor dusty hematite giving them a pale brown color in thin section and the pink color of the hand sample.

In the groundmass, quartz forms anhedral grains averaging 0.02-0.05 mm in size. Ankerite forms anhedral grains averaging 0.03-0.05 mm in size. Sericite forms anhedral flakes averaging 0.015-0.03 mm in size

Pyrite forms clusters up to 1.5 mm in size of anhedral grains averaging 0.03-0.15 mm in size. It commonly is intergrown with ankerite and sericite.

Tourmaline forms radiating patches up to 0.6 mm across of prismatic grains up to 0.27 mm long. Pleochroism is from pale to medium/dark green.

(continued)

Apatite forms anhedral grains averaging 0.07-0.15 mm in size and a few up to 0.2 mm long. Many contain abundant dusty semi-opaque/opaque inclusions.

A few patches up to 0.4 mm across are of cryptocrystalline to extremely fine grained aggregates of ankerite and leucoxene/hematite, possibly after sphene.

Replacement patches up to 1.5 mm in size are dominated by quartz grains averaging 0.07-0.15 mm in size, with minor to locally moderately abundant pyrite grains averaging 0.05-0.1 mm in size..

Veins up to 3.5 mm wide (in thin section; up to 6 mm wide in hand sample) are dominated by quartz grains averaging 0.1-0.4 mm in size. Opaque forms disseminated grains averaging 0.05-0.15 mm in size and a few up to 0.7 mm across. Ankerite forms anhedral grains averaging 0.05-0.1 mm in size and locally up to 0.6 mm in size. Some are altered to dusty limonite(?) which gives them a very high apparent relief. Sericite forms patches of extremely fine grains.

A few late veinlet averaging 0.02-0.05 mm wide of pyrite with minor ankerite cut across a large quartz vein; the veinlet was broken and segments separated slightly.

Lensy seams and patches up to 1 mm wide are of extremely fine grained sericite. These cut the host rock and some of the quartz veins. In some seams and patches, grains are unoriented. In others, or at least parts of them, grains are in sub-parallel orientation perpendicular to walls of the seam.

Sample 7: 94-100 182.2 m Hypabyssal Latite Porphyry (Plagioclase); Ankerite-Sericite Alteration {Phyllic}; Veinlets of Ankerite-(Quartz-Opaque) and Ankerite-Kaolinite(?) Quartz-Pyrite-(Ankerite) Vein (in core sample only)

The sample is somewhat similar to Sample 6. Abundant subhedral to anhedral phenocrysts of plagioclase are set in a groundmass of plagioclase, ankerite, and sericite, with much less opaque and quartz. Plagioclase is altered moderately to pale green sericite and ankerite. The core contains a vein up to 5 mm wide of quartz and pyrite. The thin section contains a vein of ankerite-quartz-opaque and veinlets of ankerite. On one side of the hand sample is a vein up to several mm wide of quartz with a centre-line up to 1 mm wide of pyrite with minor patches of ankerite. Late veinlets are of ankerite-kaolinite(?).

phenocrysts	
plagioclase	25-30%
groundmass	
plagioclase	30-35
ankerite	17-20
sericite	7- 8
opaque	3- 4
quartz	3- 4
apatite	0.3
veins, veinlets	
ankerite-quartz-pyrite	2- 3

Plagioclase forms anhedral to subhedral phenocrysts(megacrysts) averaging 0.5-1.5 mm in size and a few up to 2.5 mm long. Alteration is slight to strong to cryptocrystalline to extremely fine grained sericite and minor ankerite.

In the groundmass, plagioclase forms anhedral, moderately interlocking grains averaging 0.02-0.05 mm in size. It is intergrown with patches of very fine grained ankerite and extremely fine grained sericite. Quartz forms minor interstitial patches of extremely fine to very fine grains.

Opaque forms disseminated grains averaging 0.03-0.1 mm in size. It is concentrated in patches up to 1 mm in size of equant grains averaging 0.02-0.05 mm in size.

Apatite forms subhedral to anhedral grains averaging 0.05-0.1 mm in size and a few up to 0.2 mm long.

A composite vein zone 0.2-0.4 mm wide contains a discontinuous veinlet of quartz-opaque up to 0.2 mm wide containing quartz grains averaging 0.03-0.1 mm in size and opaque grains averaging 0.05-0.1 mm in size. It is cut by a more-continuous veinlet of ankerite averaging 0.2-0.3 mm wide. Ankerite forms a diffuse, comb-textured aggregate of grains oriented perpendicular to the vein walls. A few narrower veinlets are of ankerite.

Sample 8: 94-129 300 m **Porphyritic Hypabyssal Latite (Plagioclase-[Biotite]); Sericite-Ankerite-Pyrite Alteration {Phyllic}; Quartz-Ankerite-(Pyrite-Sericite), Pyrite Veinlets,**

The sample is similar to Samples 6 and 7. Anhedral to subhedral phenocrysts of plagioclase and minor ones of biotite and hornblende(?) are set in a very fine grained groundmass of plagioclase-ankerite-sericite with minor opaque and quartz. Plagioclase phenocrysts are altered moderately to sericite-(ankerite), biotite is replaced completely by pseudomorphic muscovite with minor ankerite and Ti-oxide, and hornblende(?) is replaced by sericite-ankerite-opaque. A veinlet at one end of the section is of quartz and ankerite with minor pyrite and sericite. A second veinlet is of quartz. Much smaller veinlets are of pyrite-(quartz-ankerite).

phenocrysts	
plagioclase	25-30%
biotite	0.3
hornblende	0.3
groundmass	
plagioclase	30-35
quartz	15-17
ankerite	12-15
sericite	5- 7
opaque	2- 3
apatite	0.3
veinlets	
quartz-ankerite-(pyrite-sericite), quartz	1-2
pyrite-(quartz-ankerite)	0.1

Plagioclase forms subhedral to anhedral phenocrysts averaging 0.5-1.5 mm in size. Surrounding groundmass plagioclase commonly is in optical continuity with the phenocrysts, but has a pale brown color . Alteration is moderate to strong to sericite and minor to moderately abundant patches of ankerite.

Biotite forms subhedral to anhedral phenocrysts averaging 0.3-0.5 mm in size and one ragged phenocryst 1.7 mm long. Smaller phenocrysts are replaced completely by pseudomorphic muscovite with minor lenses of ankerite parallel to cleavage and minor disseminated cryptocrystalline Ti-oxide. The large phenocryst is replaced by pseudomorphic muscovite with very abundant lenses parallel to cleavage of ankerite and moderately abundant Ti-oxide.

Two patches up to 2 mm in size may be altered hornblende phenocrysts. They consist of unoriented aggregates of sericite with less abundant ankerite, moderately abundant opaque and minor quartz and leucoxene.

(continued)

In the groundmass, plagioclase forms slightly to moderately interlocking grains ranging in size in irregular patches from 0.01-0.02 mm to 0.05-0.1 mm in size. Alteration is slight to cryptocrystalline sericite and dusty hematite, which probably is why the grains have a pale brown color in thin section and pink color in the hand sample.

Quartz forms interstitial patches of grains averaging 0.02-0.05 mm in size and locally up to 0.3 mm across. A few of these are up to 2 mm across, and somewhat resemble replacement patches in some of the other samples.

Ankerite forms disseminated anhedral grains averaging 0.02-0.07 mm in size.

Sericite forms disseminated, extremely fine grained flakes, which locally grade into ragged, coarser muscovite flakes from 0.05-0.1 mm in length.

Opaque forms disseminated grains and clusters up to 0.5 mm in size of grains averaging 0.03-0.08 mm in size.

Apatite forms anhedral grains averaging 0.07-0.15 mm in size and a few clusters up to 0.5 mm across of similar grains. It commonly contain minor to moderately abundant dusty semi-opaque/opaque inclusions.

The main vein is up to 0.5 mm wide and is dominated by moderately interlocking quartz grains averaging 0.07-0.15 mm in size. Ankerite forms patches of equant grains averaging 0.04-0.07 mm in size. Opaque forms a few clusters of anhedral grains averaging 0.03-0.05 mm in size. Sericite forms a few patches of extremely fine grained flakes. A second discontinuous vein nearby 0.4-0.5 mm wide is of quartz grains averaging 0.05-0.2 mm in size.

A few wispy, discontinuous veinlets up to 0.03 mm wide are of extremely fine grained opaque and less abundant quartz and/or ankerite.

Sample 9: 94-80 201.7 m **Slightly Porphyritic Latite (Plagioclase, K-feldspar); K-feldspar-Ankerite-Sericite/Biotite-Opaque Alteration {Potassic}; Quartz-Opaque-Ankerite-Sericite Veins, Veinlets; Magnetite/Hematite-(Quartz-Ankerite) Veinlets; Late Lenses of Kaolinite-Ankerite, Seams of Sericite**

Minor plagioclase, K-feldspar, and biotite phenocrysts are set in an extremely fine grained groundmass dominated by K-feldspar, ankerite, plagioclase(?), sericite/biotite, quartz, and opaque (mainly magnetite/hematite). Mainly early veins and veinlets and replacement patches are of quartz with much less opaque, ankerite, kaolinite, and sericite; most of these are cut by veinlets of opaque (mainly magnetite/hematite)-ankerite. A few quartz-rich veinlets may post-date the opaque-rich veinlets. Late lenses are of kaolinite-calcite/ankerite. Late irregular, wispy seams are of sericite.

phenocrysts		
plagioclase	4- 5%	
K-feldspar	0.3	
biotite	trace	
groundmass		
K-feldspar	20-25%	
ankerite	20-25	
sericite/biotite	7- 8	
plagioclase(?)	7- 8	
quartz	5- 7	
opaque	2- 3	(magnetite/hematite)
apatite	trace	
veins, veinlets, replacement patches		
1) magnetite/hematite-ankerite-(quartz-apatite-sericite)	3- 4	
2) quartz-(opaque-ankerite-kaolinite-sericite)	12-15	
3) kaolinite-calcite/ankerite	0.8	
4) sericite	2- 3	

Plagioclase forms subhedral phenocrysts averaging 0.5-0.7 mm in size and a few up to 1.5 mm long. Alteration is complete to extremely fine grained sericite with moderately abundant ankerite concentrated along grain borders and coarse fractures.

K-feldspar forms a few anhedral phenocrysts up to 0.6 mm across; alteration is moderate to strong to patches of extremely fine grained ankerite and sericite.

Biotite forms a phenocryst 0.25 mm long; alteration is complete to pseudomorphic muscovite and patches of ankerite.

The groundmass is dominated by cryptocrystalline to extremely fine grained K-feldspar and plagioclase(?) with less abundant quartz and sericite/biotite. The presence of plagioclase is suspected because the yellow stain on the offcut block is not as pervasive or intense as would be expected if all the cryptocrystalline feldspar were K-feldspar. Ankerite forms ragged disseminated grains and dense replacement patches up to 0.7 mm across of grains averaging 0.02-0.05 mm in size.

(continued)

Opaque (magnetite/hematite) forms patches up to 1 mm in size of grains averaging 0.05-0.1 mm in size with interstitial ankerite and sericite.

Biotite is concentrated moderately towards one end of the section. Pleochroism is from nearly colorless to pale to light brown, and from pale to medium brown in a few coarser grains averaging 0.03-0.05 mm in size.

Apatite forms disseminated grains averaging 0.03-0.05 mm in size.

A few replacement patches up to 3 mm across are of very fine grained quartz. The largest replacement patch is cut by a veinlet of slightly coarser grained quartz. .

The main vein in one corner of the section is 2.5 mm wide and is dominated by sub-mosaic to slightly interlocking quartz grains averaging 0.05-0.2 mm in size. Opaque forms disseminated patches and lenses of very fine grains (textures suggest that much of it is magnetite/hematite). Ankerite forms disseminated grains and patches interstitial to opaque. Sericite occurs with ankerite and opaque (some patches of opaque-ankerite-sericite may be fragments of host rock). Apatite forms one anhedral grain 0.15 mm across. Other smaller veins and veinlets are of similar texture and composition; narrower veinlets have proportionally finer grains. Some of these contain patches up to 0.15 mm across of extremely fine grained kaolinite.

A few veinlets up to 0.4 mm wide are of very fine grained opaque (magnetite altered to hematite) with locally minor quartz, ankerite, sericite, or apatite. Most of these cut quartz-rich veinlets.

A few lenses up to 1 mm wide and discontinuous veinlets up to 0.4 mm wide are of extremely fine grained kaolinite and minor to moderately abundant disseminated, subhedral calcite/ankerite grains averaging 0.03-0.07 mm in size. One of these cuts a quartz veinlet.

Sericite is concentrated moderately in wispy seams averaging 0.03-0.05 mm in width. Some of these cut and offset opaque-rich veinlets.

Sample 10: (Early Hole) **Porphyritic Latite (Plagioclase, Biotite); Biotite-Sericite-Kaolinite-Ankerite Alteration {Potassic/Argillic}; Ankerite-Quartz-Opaque-Kaolinite Vein**

Phenocrysts of plagioclase and minor biotite are set in an extremely fine grained groundmass of plagioclase, secondary biotite, kaolinite, ankerite, and sericite. Most plagioclase phenocrysts are replaced strongly by sericite-(ankerite) but a few are relatively fresh. Biotite phenocrysts are replaced completely by pseudomorphic muscovite with minor ankerite and Ti-oxide. The distribution of secondary biotite is patchy. In the hand sample, a sharp contact separates a darker zone with moderately abundant biotite patches (as in the thin section) from a paler zone with much less biotite. A vein is of ankerite-quartz-opaque-kaolinite.

phenocrysts			
plagioclase	15-17%		
biotite	0.3		
groundmass			
plagioclase	35-40	quartz	0.7
ankerite	12-15	apatite	0.7
biotite	10-12	opaque	0.3
sericite	10-12	leucoxene	minor
kaolinite	7- 8	zircon	trace
vein			
ankerite-quartz-opaque-kaolinite	1- 2		

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.7-1.7 mm in size. Alteration is mainly strong to complete to cryptocrystalline to extremely fine grained sericite and kaolinite and minor patches of extremely fine grained ankerite. At one end of the section, alteration in some grains is weak.

Biotite forms two ragged phenocrysts from 1.6-1.7 mm long. Alteration is complete to pseudomorphic muscovite with minor lenses of ankerite and disseminated Ti-oxide.

The groundmass is dominated by cryptocrystalline to very fine grained plagioclase with less abundant disseminated biotite, ankerite, kaolinite, and sericite. Biotite is concentrated moderately to strongly in patches of equant flakes averaging 0.01-0.015 mm in size and a few flakes from 0.03-0.1 mm long. Pleochroism is from pale to light or medium brown.

Kaolinite and ankerite commonly occur together in patches of extremely fine grains

Quartz forms disseminated grains averaging 0.02-0.05 mm in size, and is concentrated in a few replacement patches up to 0.3 mm in size

Apatite forms anhedral, in part irregular grains averaging 0.03-0.07 mm in size. In places it is concentrated in patches up to 1 mm in size, in part with interstitial biotite and in part intergrown with ankerite and opaque. Opaque is concentrated in a few patches up to 0.6 mm in size of grains averaging 0.02-0.07 mm in size, and a few disseminated grains averaging 0.02-0.03 mm in size. Leucoxene forms disseminated irregular to dendritic patches averaging 0.02-0.05 mm in size of cryptocrystalline grains intergrown with biotite. Zircon forms subhedral prismatic grains averaging 0.05-0.08 mm long.

A vein 1 mm wide is of very fine grained ankerite, quartz, and opaque (pyrite) and extremely fine grained patches of kaolinite.

Sample 11: 94-77 212.3 m **Porphyritic Hypabyssal Latite (Main); K-Feldspar-Quartz-Ankerite-Sericite-Tourmaline-Magnetite/Hematite-Pyrite Alteration {Potassic/Phyllic}; Veins of Quartz and Quartz-Pyrite**

Phenocrysts of plagioclase (replaced moderately by K-feldspar) are set in a strongly replaced groundmass dominated by quartz with less abundant ankerite, opaque (pyrite and oxide) and sericite, with moderately abundant tourmaline suns. Early veins and veinlets are of quartz containing moderately abundant patches of host rock. One late vein is of quartz with a core of pyrite; phyllic alteration may be related to this vein.

phenocrysts	
plagioclase	12-15%
groundmass	
quartz	20-25
ankerite	10-12
opaque	3- 4
sericite	3- 4
kaolinite	0.7
tourmaline	0.2
apatite	0.1
veins	
1) quartz	30-35
2) quartz-pyrite	7- 8

Plagioclase forms anhedral phenocrysts averaging 0.5-1.2 mm in size. Grains are replaced moderately to locally strongly by extremely fine grained sericite and ankerite. Where grains are not replaced by sericite-ankerite they are replaced moderately by K-feldspar and dusty hematite (without destruction of the internal texture of plagioclase).

In the groundmass quartz and ankerite form very fine grained aggregates. Sericite forms interstitial, extremely fine grains mainly interstitial to patches of ankerite. Quartz is concentrated moderately in replacement patches up to 1.5 mm in size in which grains average 0.2-1 mm in size. These patches commonly contain minor ankerite, opaque, and sericite as in the main vein.

Opaque (magnetite, altered to hematite, and pyrite) forms disseminated grains and patches up to 0.6 mm in size of equant grains averaging 0.02-0.07 mm in size and locally up to 0.4 mm in size. Pyrite is concentrated strongly near the quartz-pyrite vein.

Kaolinite forms patches up to 0.3 mm in size of extremely fine grains, commonly intergrown coarsely with ankerite.

Tourmaline forms clusters up to 0.15 mm across of extremely fine, radiating, fibrous to prismatic grains. Pleochroism is form nearly colorless to medium green.

Apatite forms disseminated anhedral grains averaging 0.05-0.1 mm in size.

(continued)

The main quartz vein up to a several mm wide is dominated by anhedral grains averaging 0.2-0.5 mm in size. Related veinlets averaging 0.1-0.5 mm wide are of quartz grains averaging 0.1-0.3 mm in size, with a few apatite grains up to 0.15 mm in size. Numerous fragments up to a few mm across in the vein are of altered host rock, commonly dominated by ankerite with disseminated patches averaging 0.05-0.2 mm in size of very fine grained opaque, and a few patches of extremely fine grained kaolinite.

A late vein up to 3 mm wide has an outer zone of quartz similar to that in the earlier veins. The core up to 1 mm wide is dominated by very fine to fine grained pyrite with interstitial patches and lenses of very fine grained ankerite and extremely fine grained sericite.

Sample 12: 94-108 207 m **Porphyritic Latite (Plagioclase, [Hornblende, Biotite]); Quartz-Ankerite-Sericite/Illite-Pyrite-Kaolinite Alteration {Phyllic/Argillic}; Veins, Veinlets of Ankerite-Pyrite-Kaolinite-(Quartz)**

Phenocrysts of plagioclase and minor hornblende and biotite are set in a groundmass of sericite/illite-quartz-ankerite. Plagioclase phenocrysts are altered moderately to strongly to sericite/illite-ankerite, hornblende phenocrysts are altered completely to kaolinite-ankerite-sericite/illite-opaque, and biotite phenocrysts are altered completely to muscovite-(kaolinite). A vein is of ankerite-pyrite-sericite/illite-kaolinite-(quartz). Veinlets are of ankerite-pyrite.

phenocrysts	
plagioclase	20-25%
hornblende	2- 3
biotite	0.5
groundmass	
sericite/illite	25-30
quartz	15-20
plagioclase	7- 8
ankerite	5- 7
kaolinite	2- 3
pyrite	0.5
apatite	0.2
replacement patches	
quartz-ankerite-pyrite	0.7
veins, veinlets	
ankerite-pyrite-sericite/illite-kaolinite-(quartz)	3- 4

Plagioclase forms subhedral phenocrysts averaging 1-2 mm in length. Alteration is strong to cryptocrystalline to extremely fine grained sericite/illite and sericite, minor to moderately abundant patches of extremely fine grained ankerite, and minor patches of extremely fine grained kaolinite. In several patches up to a few mm across, it appears that cryptocrystalline sericite/illite alteration is later than coarser grained sericite alteration of plagioclase.

A few hornblende(?) phenocrysts up to 1.7 mm in size are replaced by kaolinite-ankerite-sericite-opaque-(quartz-Ti-oxide). One hornblende/biotite phenocryst is replaced by skeletal muscovite intergrown intimately with very fine grained quartz and minor ankerite lenses.

Biotite forms flakes up to 0.7 mm long. Alteration is complete to skeletal aggregates of sub-parallel flakes of sericite/muscovite, patches of unoriented kaolinite, and disseminated grains of opaque and Ti-oxide. The sericite/muscovite to kaolinite ratio varies widely between flakes.

In the groundmass, quartz generally forms equant, slightly interlocking grains averaging 0.02-0.03 mm in size. In a few patches associated with cryptocrystalline sericite/illite, quartz forms very irregular patches of grains averaging 0.05-0.1 mm in grain size. Textures in some of these patches suggest a replacement origin.

In several patches, plagioclase forms equant grains averaging 0.02-0.05 mm in size; alteration is slight to sericite.

(continued)

Ankerite forms disseminated grains averaging 0.02-0.04 mm in size and a few patches of grains up to 0.07 mm in size.

Sericite forms disseminated flakes averaging 0.015-0.02 mm in size. Sericite/illite patches up to a few mm across may represent a later, retrograde alteration from phyllic to argillic.

Kaolinite forms equant patches averaging 0.2 mm in size of extremely fine grained flakes.

Opaque (probably mainly pyrite) forms disseminated, anhedral grains averaging 0.05-0.1 mm in size and a few up to 0.3 mm across.

Apatite forms anhedral grains averaging 0.05-0.07 mm in size.

A few replacement patches up to 1 mm long are of very fine grained quartz, ankerite, and opaque (pyrite).

A vein in one corner of the section 0.9 mm wide is dominated by ankerite oriented perpendicular to the walls of the vein. Pyrite forms lenses up to 0.4 mm wide parallel to the length of the vein and disseminated grains averaging 0.05-0.1 mm in size. Ankerite locally has a delicately banded growth structure parallel to vein walls. A few discontinuous veinlets 0.05-0.08 mm wide of very fine grained pyrite-(ankerite) branch off the main vein.

A vein 0.4-1 mm wide is of ankerite-opaque-sericite/illite-kaolinite-(quartz). Ankerite forms equant grains averaging 0.05-0.08 mm in size. Opaque is concentrated in lenses averaging 0.1 mm wide parallel to the length of the vein and in disseminated grains up to 0.3 mm in size. Sericite/illite forms patches up to 0.2 mm in size of cryptocrystalline flakes. Kaolinite is concentrated in patches up to 1 mm in size of cryptocrystalline flakes. Quartz forms disseminated grains averaging 0.05 mm in size.

A discontinuous veinlet 0.05 mm wide is of ankerite with patches of extremely fine grained kaolinite.

Sample 13: 94-108 236.8 m

Porphyritic Latite/Dacite (Plagioclase, Hornblende); Sericite-Ankerite-Quartz-Kaolinite-Pyrite Alteration {Phyllic/Argillic}; Veins of Quartz-(Ankerite-Pyrite), Veinlet of Pyrite-(Ankerite-Sericite)

Phenocrysts of plagioclase, hornblende, and biotite are set in a groundmass dominated by quartz with much less ankerite and sericite. Plagioclase phenocrysts are altered to sericite-ankerite-kaolinite, hornblende phenocrysts are altered to kaolinite-ankerite-(sericite-quartz), and biotite phenocrysts are altered to ankerite-muscovite/sericite-(kaolinite). Two veins are of quartz with minor patches of ankerite and pyrite. A veinlet is of pyrite with minor ankerite and sericite.

phenocrysts	
plagioclase	12-15%
hornblende	7- 8
biotite	2- 3
apatite	0.2
groundmass	
quartz	40-45
ankerite	4- 5
sericite	4- 5
pyrite	0.3
veins, veinlets	
1) quartz-(ankerite-pyrite)	2- 3
2) ankerite-quartz-kaolinite	0.5
3) pyrite-(ankerite-sericite)	0.1

Plagioclase forms subhedral to euhedral, prismatic phenocrysts averaging 0.8-1.7 mm in length. Alteration is complete to extremely fine grained sericite and minor to moderately abundant, extremely fine grained ankerite and kaolinite. A few grains are replaced mainly by kaolinite with much less abundant ankerite and sericite.

Hornblende forms subhedral, prismatic phenocrysts averaging 1-2 mm long. Alteration is complete to extremely fine grained aggregates of ankerite and kaolinite with minor to locally moderately abundant sericite and quartz or to aggregates of very fine grained ankerite and quartz, much less sericite, and moderately abundant disseminated patches of leucoxene.

Biotite forms phenocrysts averaging 0.5-1 mm long and one 2 mm long. Alteration is complete to ankerite, ragged grains of pseudomorphic muscovite or aggregates of subparallel, extremely fine grained sericite flakes, and minor patches of kaolinite and lenses of Ti-oxide. Some mafic phenocrysts are difficult to classify between hornblende and biotite.

Apatite forms anhedral grains averaging 0.1-0.2 mm in size and locally up to 0.4 mm long. It is concentrated in a few patches up to 0.8 mm in size of anhedral grains averaging 0.07-0.15 m in size intergrown with very fine grained ankerite and with a core to the patch of extremely fine grained kaolinite.

(continued)

Sample 13: 94-108 236.8 m (page 2)

The groundmass is dominated by slightly interlocking quartz grains averaging 0.02-0.05 mm in size and locally up to 0.2 mm across. Ankerite forms disseminated grains averaging 0.03-0.05 mm in size. Opaque forms disseminated grains averaging 0.02-0.05 mm in size. Sericite forms disseminated extremely fine grained flakes. It is concentrated strongly in several patches up to 3 mm in size in which it forms patches of unoriented extremely fine grained flakes intergrown coarsely with very fine grained quartz. Some sericite-rich patches are rimmed by very fine grained ankerite. A few of the patches of sericite may be secondary after biotite or plagioclase phenocrysts. Kaolinite forms patches up to 0.1 mm in size of extremely fine grained flakes.

Two sub-parallel veins averaging 0.5-1 mm wide are dominated by slightly to moderately interlocking quartz grains averaging 0.03-0.08 mm in size. In the wider part of one vein are irregular patches of extremely fine to very fine grained opaque, commonly intergrown with and surrounded by ankerite. Ankerite adjacent to pyrite commonly contains abundant dusty limonite/hematite(?) which give the grains a medium brown color.

A diffuse veinlet 0.2-0.3 mm wide is dominated by very fine grained ankerite; near one end are a few patches of very fine grained quartz and others of extremely fine grained kaolinite.

A veinlet averaging 0.05 mm wide is dominated by pyrite with minor ankerite.

Sample 14: 94-123 200.3 m **Hypabyssal, Porphyritic Latite/Granodiorite; Kaolinite-Sericite/Illite-Ankerite-Pyrite Alteration {Phyllic/Argillic}; Vein and Veinlets of Ankerite**

Phenocrysts of plagioclase and biotite are set in a very fine grained groundmass containing plagioclase, quartz, sericite/illite, kaolinite, ankerite, and pyrite. Plagioclase phenocrysts are replaced by kaolinite-ankerite-sericite/illite, and biotite phenocrysts are replaced by muscovite-(ankerite-pyrite) or less commonly by kaolinite-ankerite-pyrite. In the groundmass, plagioclase is replaced in irregular patches by illite/kaolinite. A vein in the hand sample and a veinlet in the section are of ankerite.

phenocrysts			
plagioclase	17-20%		
biotite	7- 8		
groundmass			
plagioclase	35-40	ankerite	2- 3%
quartz	10-12	sericite	2- 3
illite/kaolinite	10-12	apatite	0.2
pyrite	4- 5	tourmaline	0.1
vein, veinlets ankerite	0.3	(1-2% in hand sample)	

Plagioclase forms euhedral phenocrysts averaging 1-1.5 mm in size, and a few up to 2.5 mm long. Alteration is complete to cryptocrystalline to extremely fine grained aggregates of kaolinite with disseminated ragged grains of ankerite and disseminated flakes and patches of sericite.

Biotite forms subhedral phenocrysts averaging 0.3-1 mm in size and a few up to 1.5 mm across. Alteration is complete to pseudomorphic muscovite or locally chlorite, with minor to abundant patches of ankerite, pyrite, and locally kaolinite and disseminated, extremely fine grained patches and lenses of Ti-oxide.

The groundmass is dominated by plagioclase and lesser quartz grains. In some patches grains average 0.1-0.3 mm in size, and in others they average 0.05-0.1 mm across. Plagioclase forms slightly interlocking grains whose alteration ranges from slight to sericite to complete to cryptocrystalline illite/kaolinite, which has a pale brown color from dusty semi-opaque. A lens 1.7 mm long and 0.6 mm wide and a few smaller patches are of quartz grains averaging 0.1-0.2 mm in size.

Ankerite forms ragged patches averaging 0.1-0.3 mm in size.

Pyrite forms patches averaging 0.3-1 mm in size and locally up to 2.5 mm across of subrounded grains averaging 0.1-0.5 mm in size. It commonly is concentrated with biotite phenocrysts.

Apatite forms disseminated patches up to 0.35 mm in size of anhedral grains averaging 0.02-0.03 mm in size.

Tourmaline forms minor radiating aggregates up to 0.25 mm across of prismatic grains. Some are colorless, and others are pleochroic from nearly colorless to light green.

A veinlet 0.1-0.2 mm wide is dominated by very fine grained ankerite.

Sample 15: 94-124 103.5 m **Strong Quartz-Sericite-Pyrite-Ankerite Alteration {Phyllic}; Quartz Veins, Pyrite Veinlets**

The sample is altered very strongly to sericite-quartz-pyrite-ankerite and most original textures were destroyed. Several subparallel veins are of quartz. A few discontinuous veinlets are of pyrite. Minor veinlets cutting the quartz veins are of apatite, opaque, ankerite, and sericite.

sericite	35-40%
quartz	20-25
pyrite	7- 8
ankerite	7- 8
muscovite	2
apatite	0.3
tourmaline	minor
veins, veinlets	
1) quartz	17-20
2) pyrite	2- 3
3) apatite, sericite, pyrite	0.1

Sericite forms patches up to a few mm across of extremely fine grains, commonly intergrown with coarser grains of muscovite. One patch up to 5 mm long is of cryptocrystalline sericite/illite with disseminated flakes of muscovite, patches of opaque, and minor quartz.

Muscovite forms disseminated flakes averaging 0.1-0.3 mm in size and a few up to 0.6 mm long containing minor lenses of Ti-oxide. These probably are pseudomorphic after biotite.

Quartz forms anhedral grains averaging 0.1-0.4 mm in size. It is concentrated in irregular patches up to 2 mm in size and in a few veins up to 1.5 mm wide.

Pyrite forms disseminated grains averaging 0.05-0.2 mm in size.

Ankerite forms disseminated patches averaging 0.5-1.5 mm in size of anhedral grains averaging 0.05-0.1 mm in size.

Apatite forms a few ragged to skeletal patches averaging 0.5-0.9 mm in size of grains averaging 0.03-0.05 mm in size.

Tourmaline(?) forms a few sub-radiating clusters up to 0.15 mm in size of prismatic to acicular grains. They range in color from colorless to pleochroic from pale to light green.

Pyrite forms one vein 0.5-0.7 mm wide cutting a quartz vein. It also forms several discontinuous veinlets up to 0.2 mm wide, some of which cut some of the other quartz veins.

A few late veinlets which forms in fractures up to 0.1 mm wide perpendicular to the length of one quartz vein are of apatite, sericite, pyrite, and ankerite.

Sample 16: 94-126 70.6 m Slightly Porphyritic Latite/Dacite; Sericite/Illite-Pyrite-(Carbonate) Alteration {Phyllic}; Veins of Pyrite-Quartz-(Tourmaline-Ankerite), Quartz-Calcite-Pyrite and Calcite-(Quartz-Pyrite)

Minor phenocrysts of plagioclase and biotite are set in a patchy very fine to extremely fine grained groundmass dominated by sericite/illite, quartz/plagioclase, and disseminated pyrite with minor carbonate and trace tourmaline. Plagioclase phenocrysts are altered completely to sericite/illite. Biotite phenocrysts are altered completely to muscovite. Early veins are of pyrite-quartz-(tourmaline-ankerite). Later veins are of quartz-calcite-pyrite and calcite-(quartz-pyrite).

phenocrysts		
plagioclase	8-10%	
biotite	4- 5	
quartz	trace	
groundmass		
quartz/(plagioclase)	40-45	
sericite/illite	25-30	
pyrite	3- 4	
carbonate	0.5	(calcite/ankerite)
tourmaline	minor	
veins, veinlets		
1) pyrite-quartz-(tourmaline-ankerite)	4- 5	
2) quartz-calcite-pyrite	3- 4	
3) calcite-(quartz-pyrite)	0.5	

Plagioclase forms subhedral phenocrysts averaging 0.5-1 mm in size and a few from 1-2 mm across. Alteration is complete to pale brown cryptocrystalline to extremely fine grained sericite/illite.

Biotite forms a few phenocrysts from 0.7-1 mm in size. Alteration is complete to very fine grained muscovite. In the finer grained matrix, it forms ragged grains averaging 0.1-0.7 mm in size; these are replaced by muscovite with abundant dusty opaque.

Quartz forms one rounded phenocryst 0.2 mm across in the finer grained groundmass.

Much of the groundmass consists of an intergrowth of cryptocrystalline sericite and extremely fine grained quartz/plagioclase. Scattered patches up to a few mm across in the groundmass contain very fine grained quartz intergrown with patches of extremely fine grained sericite. Pyrite forms disseminated, subhedral grains averaging 0.05-0.08 mm in size. It is concentrated in a few patches and lenses up to 0.7 mm in size.

Carbonate (calcite and/or ankerite) forms disseminated grains averaging 0.05-0.15 mm in size, commonly associated with very fine grained quartz and grains averaging 0.02-0.05 mm in size associated with sericite (after plagioclase).

Tourmaline forms a few patches up to 0.2 mm in size of radiating, prismatic grains up to 0.07 mm long with pleochroism from colorless to pale green.

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Early veins up to 1 mm wide are dominated by pyrite with a few patches of very fine to fine grained quartz and others of ankerite. Tourmaline forms disseminated acicular grains in some quartz patches, and forms a few sub-radiating aggregates of prismatic grains up to 0.4 mm long with pleochroism from colorless to pale green. Ankerite forms a few equant patches and several lenses along fractures in pyrite.

A vein 3 mm wide in one corner of the section is dominated by fine to medium grained quartz with interstitial patches of calcite up to 1 mm in size and patches of pyrite up to 1.3 mm long. Age relations with the other types of veins and veinlets is uncertain.

A late veinlet 0.5-1 mm wide is dominated by very fine grained calcite, with minor quartz and pyrite concentrated mainly along borders of the veinlet. It cuts and offsets an early pyrite-quartz-tourmaline vein 1.7 mm.

Sample 17: 94-123 344.3 m Slightly Porphyritic Latite/Dacite; Sericite/Illite-Ankerite-Pyrite-(Kaolinite) Alteration {Phyllic/Argillic}; Quartz-rich Replacement Patches; Ankerite, Quartz, Pyrite Veinlets

Phenocrysts of plagioclase and minor hornblende and biotite are set in an extremely fine grained groundmass of sericite/illite, quartz and ankerite with disseminated pyrite. Phenocrysts are replaced completely to sericite-ankerite, with opaque and leucoxene common in altered hornblende, and quartz in altered biotite. A few replacement patches are of quartz. Veinlets are of very fine grained ankerite, quartz, and pyrite.

phenocrysts		**replacement patches**	
plagioclase	10-12%	quartz	4- 5
hornblende	2- 3	**veinlets**	
biotite	1- 2	ankerite	0.2
groundmass		quartz	0.5
sericite/illite	30-35	pyrite	0.3
quartz	20-25		
ankerite	17-20		
pyrite	4- 5		
leucoxene	0.3		
apatite	0.2		

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.5-1.5 mm in size and a few up to 2 mm across. Replacement is complete to cryptocrystalline to extremely fine grained sericite/illite, ankerite, and minor kaolinite.

Hornblende forms subhedral to euhedral phenocrysts up to 2 mm long. Alteration is complete to extremely fine grained aggregates of sericite and ankerite with moderately abundant patches of very fine grained opaque and extremely fine grained leucoxene.

Ragged patches from 0.3-0.5 mm in size probably represent altered biotite phenocrysts. They contain minor skeletal aggregates of muscovite/sericite intergrown with extremely fine grained patches of quartz, pyrite, and minor ankerite and sericite.

The groundmass contains variable amounts of quartz, sericite/illite, and ankerite. Quartz forms equant grains averaging 0.02-0.05 mm in size. Sericite/illite forms cryptocrystalline to extremely fine grained flakes. Ankerite forms anhedral to euhedral grains averaging 0.03-0.08 mm in size. Pyrite forms disseminated grains averaging 0.05-0.15 mm in size; it is concentrated moderately in irregular patches up to 0.5 mm in size.

Leucoxene forms disseminated patches averaging 0.05-0.1 mm in size of cryptocrystalline aggregates intergrown with groundmass minerals. It has a medium brown color, suggesting that it also contains some limonite.

Apatite forms subhedral to anhedral grains averaging 0.15-0.35 mm in size; grains commonly contain moderately abundant, cryptocrystalline semi-opaque inclusions.

The replacement patch is up to 2 mm across and consists of very fine to medium grained quartz intergrown with patches of groundmass.

A few discontinuous veinlets and lenses up to 2 mm long and 0.15 mm wide are of pyrite.

A veinlet 0.05-0.08 mm wide is of very fine grained ankerite.

A few discontinuous veinlets up to 0.1 mm wide are of very fine grained quartz.

Sample 18: 94-77 93.1 m **Latite Porphyry (Plagioclase, Hornblende); Sericite/Illite-Ankerite-(Pyrite) Alteration {Phyllic}; Replacement Patches of Quartz; Quartz-(Pyrite) Veins, Late Ankerite Veinlet**

Phenocrysts of plagioclase and hornblende(?) are set in a groundmass of very fine grained plagioclase, quartz, and pyrite. Plagioclase phenocrysts are replaced by sericite/illite. Hornblende(?) phenocrysts are replaced by extremely fine intergrowths of sericite/illite, ankerite, opaque, and leucoxene. A few replacement patches are of quartz. A few veins and veinlets are of quartz-(pyrite). A late veinlet of ankerite cuts one quartz-(pyrite) vein.

phenocrysts	
plagioclase	25-30%
hornblende	8-10
groundmass	
sericite/illite	20-25
ankerite	15-17
quartz	5- 7
plagioclase	5- 7
pyrite	2- 3
leucoxene	0.5
apatite	0.1
tourmaline	minor
replacement patches	
quartz	2
veins, veinlets	
quartz-(pyrite)	4- 5
ankerite	0.3

Plagioclase forms subhedral phenocrysts averaging 0.8-1.5 mm in size and a few up to 2.5 mm across. Alteration is mainly strong to complete to extremely fine grained to cryptocrystalline sericite/illite with minor to moderately abundant disseminated patches of ankerite averaging 0.01-0.03 mm in size. A few grains are only moderately altered to patches of sericite/illite and ankerite.

Hornblende phenocrysts average 1.5-3 mm long. They are replaced completely by cryptocrystalline to extremely fine grained aggregates of ankerite and sericite, with minor quartz and locally moderately abundant pyrite. Apatite forms a few subhedral inclusions up to 0.25 mm in size.

The groundmass is variable in composition. Plagioclase forms scattered grains and patches of a few grains averaging 0.2-0.3 mm in size. Alteration of these is slight to moderate to sericite/illite. Some patches are dominated by extremely fine to very fine grained quartz. Some consist of extremely fine grained quartz intergrown with ankerite and sericite/illite. In places, outlines of phenocrysts were destroyed, so distinction between groundmass and phenocrysts is difficult.

(continued)

Pyrite forms disseminated grains averaging 0.02-0.07 mm in size, and a few from 0.1-0.2 mm in size.

Leucoxene is concentrated in patches up to 0.2 mm in size as ragged, extremely fine grains intergrown with sericite/illite and ankerite.

Apatite forms disseminated, anhedral to subhedral grains averaging 0.05-0.1 mm in size, and a few up to 0.3 mm across.

Tourmaline forms a few sub-radiating clusters of prismatic grains up to 0.2 mm long. Pleochroism is from light yellowish green to medium/dark emerald green.

Replacement patches up to 1.5 mm across are of very fine grained quartz with minor inclusions of pyrite, leucoxene, and sericite/illite, probably relics of the host rock.

A few veinlets up to 0.5 mm wide are of very fine grained quartz with minor disseminated, anhedral pyrite grains averaging 0.03-0.07 mm in size. The main vein is cut by a veinlet 0.1-0.15 mm wide of very fine grained ankerite.

Sample 19: 94-128 247 m **Latite Porphyry: (Plagioclase, Hornblende, Biotite); Sericite-Ankerite-Quartz Alteration {Phyllic}; Quartz Replacement; Quartz Vein and Veinlets; Pyrite-Quartz Veinlet**

Phenocrysts of plagioclase and minor hornblende and biotite are set in a variable groundmass dominated by patches of extremely fine grained quartz, sericite, and ankerite with disseminated pyrite and apatite. Plagioclase phenocrysts are replaced by sericite-(ankerite). Mafic phenocrysts are replaced by muscovite-ankerite-quartz. Replacement patches are of quartz. Veins and veinlets are of quartz, and a veinlet is of pyrite-quartz.

phenocrysts	
plagioclase	20-25%
biotite	2- 3
hornblende	1- 2
groundmass	
quartz	20-25
sericite	20-25
ankerite	15-17
pyrite	2- 3
apatite	0.5
leucoxene	0.3
tourmaline	minor
replacement patches	
quartz	2- 3
veins, veinlets	
quartz	4- 5
pyrite-quartz	0.2

Plagioclase forms subhedral phenocrysts averaging 1-1.7 mm in size and a few up to 2.5 mm long. Alteration is complete to extremely fine grained to cryptocrystalline sericite/illite.

Biotite forms ragged phenocrysts up to 1.2 mm long. Alteration commonly is to pseudomorphic muscovite intergrown with extremely very fine grained quartz and lenses parallel to cleavage of ankerite. Several flakes are replaced by cryptocrystalline illite in sub-parallel orientation parallel to original biotite cleavage. A few lenses up to 2.5 mm long (after biotite?) consist of unoriented flakes of muscovite averaging 0.15-0.2 mm in size intergrown with patches of very fine grained ankerite and quartz. Muscovite contains moderately abundant dusty semi-opaque/opaque.

Hornblende(?) forms a few subhedral prismatic phenocrysts up to 1.2 mm long; it is replaced completely by very fine grained quartz with minor sericite.

The groundmass consists of very fine grained quartz intergrown with extremely fine grained sericite and ankerite.

Ankerite also forms anhedral grains up to 0.3 mm in size which contain abundant dusty semi-opaque, which gives then a high relief and semi-opaque appearance.

Pyrite forms anhedral grains averaging 0.03-0.1 mm in size, which commonly are concentrated in irregular patches up to 0.7 mm in size.

(continued)

Apatite forms anhedral grains averaging 0.1-0.2 mm in size. They contain moderately abundant, extremely fine grained semi-opaque inclusions.

Tourmaline forms sub-radiating aggregates up to 0.2 mm in size of prismatic grains up to 0.1 mm long. Pleochroism is from pale to light/medium green.

Replacement or late magmatic patches up to 0.8 mm in size are of single grains or aggregates of a few grains of quartz.

The main vein is up to 2.5 mm wide and dominated by fine to medium grained quartz with ragged patches of sericite-ankerite-(pyrite) as in the groundmass of the rock. A vein 0.5 mm wide is of quartz grains averaging 0.1-0.3 mm in size. A few veinlets from 0.05-0.1 mm wide are of very fine grained quartz.

A discontinuous veinlet averaging 0.05-0.1 mm wide is of pyrite and less abundant quartz.

Sample 20: 94-106 326 m **Porphyritic Latite (Plagioclase, K-feldspar); K-feldspar-Quartz-Ankerite-Pyrite-Magnetite-Sericite Alteration {Potassic}; Quartz-Pyrite-(Magnetite?)-Ankerite Veins, Veinlets**

Anhedral plagioclase and minor K-feldspar phenocrysts are set in a groundmass dominated by extremely fine grained K-feldspar and quartz with patches are of ankerite-opaque (pyrite and magnetite/hematite). Plagioclase phenocrysts are replaced strongly by sericite, and biotite is replaced by pseudomorphic muscovite and lenses of ankerite and minor Ti-oxide. A major vein and several veinlets are of quartz with patches of opaque, ankerite, and sericite.

phenocrysts		
plagioclase	8-10%	
K-feldspar	4- 5	
biotite	minor	
apatite	trace	
groundmass		
K-feldspar	20-25	
quartz	15-17	
ankerite	4- 5	
opaque	4- 5	(pyrite and magnetite/hematite)
apatite	trace	
veins		
1) quartz	35-40	
pyrite	3- 4	
ankerite	1- 2	
sericite	0.3	

Plagioclase forms anhedral phenocrysts averaging 0.7-1.5 mm in size and a few up to 2 mm long. Alteration is complete to extremely fine grained sericite, with minor to moderately abundant ankerite, commonly concentrated along margins of grains.

K-feldspar forms anhedral phenocrysts averaging 0.5-0.8 mm in size and a few up to 1.5 mm across. Alteration is slight to disseminated, subhedral to euhedral ankerite grains averaging 0.05-0.08 mm in size and scattered patches of extremely fine grained sericite. Some K-feldspar in the phenocrysts may be secondary after plagioclase phenocrysts.

Biotite forms two equant phenocrysts averaging 0.4-0.5 mm across. Alteration is complete to pseudomorphic muscovite with minor to moderately abundant lenses of ankerite and minor disseminated Ti-oxide.

Apatite forms one anhedral grain 0.3 mm across.

(continued)

The groundmass is dominated by equant K-feldspar grains averaging 0.01-0.015 mm in size with interstitial quartz grains of similar or finer grain size. Irregular patches up to a few mm across and vague veinlets up to 1 mm wide are of very fine grained, anhedral to euhedral ankerite and very fine grained opaque (probably magnetite altered partly to hematite). Apatite forms anhedral to subhedral grains averaging 0.04-0.07 mm in size.

A major vein averaging 1 cm wide is dominated by sub-mosaic to slightly interlocking quartz grains averaging 0.05-0.4 mm in size and a few up to 1 mm across. Opaque forms irregular patches up to 0.9 mm in size which are concentrated near one side of the vein. Ankerite forms irregular, commonly interstitial grains averaging 0.05-0.2 mm in size; a few quartz grains have euhedral terminations against ankerite grains. Sericite is concentrated in a few patches up to 0.5 mm long; these probably represent fragments of altered plagioclase phenocrysts.

Several veinlets averaging 0.05-0.08 mm wide are of very fine grained quartz.

Sample 21: 94-122 80.6 m Hypabyssal Quartz Diorite/Dacite; Sericite-Pyrite-Illite-Kaolinite Alteration (Phyllic/Argillic); Calcite-(Quartz) Vein, Quartz-(Calcite) Veinlets

Phenocrysts of plagioclase, plagioclase/hornblende, quartz and minor biotite are set in a patchy, bimodal groundmass. Plagioclase phenocrysts are altered strongly to sericite. Plagioclase/ hornblende phenocrysts are altered completely to kaolinite-ankerite. Biotite phenocrysts are replaced by muscovite/illite. In the coarser grained groundmass of very fine to fine grained plagioclase and quartz, plagioclase is altered moderately to sericite. In the finer grained groundmass, plagioclase is replaced by cryptocrystalline illite-kaolinite. A vein is of calcite-(quartz) and a few related veinlets are of quartz-(calcite).

phenocrysts	
plagioclase	5- 7%
plagioclase/hornblende	7- 8
quartz	2- 3
biotite	0.3
groundmass	
plagioclase	50-55
illite/kaolinite	17-20
quartz	7- 8
pyrite	3- 4
kaolinite	1- 2
apatite	0.5
tourmaline	minor
vein, veinlets	
calcite-quartz	1- 2

Plagioclase forms subhedral to euhedral phenocrysts averaging 1-1.5 mm in length. Replacement is strong to extremely fine grained sericite.

Other phenocrysts of similar size and shape (plagioclase or hornblende) are replaced completely by cryptocrystalline kaolinite and abundant patches of ankerite averaging 0.03-0.05 mm in size, with minor sericite flakes.

Quartz forms sub-rounded phenocrysts up to 0.8 mm in size.

Biotite forms ragged phenocrysts up to 0.9 mm long and clusters of finer grains intergrown with pyrite patches. Biotite is replaced completely by pseudomorphic muscovite with patches of cryptocrystalline illite/sericite.

The groundmass is bimodal in grain size. In some patches, plagioclase forms anhedral, equant grains averaging 0.2-0.3 mm in size. Alteration is slightly to moderate to extremely fine grained sericite. Quartz forms anhedral grains averaging 0.1-0.3 mm in size, and several grains averaging 0.5-0.7 mm across, which grade texturally into the phenocrysts. Coarser quartz grains generally are irregular in outline and are rimmed by groundmass plagioclase. A few patches up to 1.7 mm in size are of very fine to fine grained quartz.

In other patches, the groundmass contains minor to moderately abundant quartz grains averaging 0.02-0.05 mm in size intergrown with patches of cryptocrystalline illite/kaolinite. A few patches up to 0.3 mm in size are of extremely fine grained kaolinite.

(continued)

Pyrite is concentrated in a few clusters up to 1 mm in size of anhedral grains averaging 0.05-0.3 mm in size. It also forms disseminated grains averaging 0.03-0.1 mm in size.

Apatite forms anhedral grains averaging 0.07-0.15 mm in size, commonly associated with pyrite-rich clusters.

Tourmaline forms a few ragged clusters up to 0.2 mm in size of sub-radiating to unoriented, colorless, prismatic grains up to 0.05 mm long, mainly in patches of illite/kaolinite.

A discontinuous vein up to 0.5 mm wide is dominated by calcite grains averaging 0.05-0.2 mm in size, with much less abundant quartz grains averaging 0.03-0.07 mm in size. A few veinlets averaging 0.05-0.1 mm wide are dominated by very fine grained quartz with much less calcite.

Sample 22: 94-112 121.8 m Hypabyssal Porphyritic Latite (Plagioclase-Hornblende-Biotite Phenocrysts); Sericite-Ankerite/Calcite-Pyrite Alteration {Phyllic}; Quartz-Calcite-Pyrite-(Ankerite-Apatite-Tourmaline) Replacement

Phenocrysts of plagioclase, hornblende, and biotite are set in an extremely fine grained groundmass dominated by equant plagioclase with much less sericite and minor quartz. Phenocrysts are altered completely as follows: plagioclase to calcite/ankerite-sericite-(kaolinite), hornblende to sericite-calcite, and biotite to pseudomorphic muscovite. Replacement patches are dominated by quartz and calcite with much less pyrite and minor ankerite, apatite, and tourmaline.

phenocrysts		
plagioclase	17-20%	
hornblende	5- 7	
biotite	2- 3	
sphene	0.1	
apatite	0.1	
groundmass		
plagioclase	55-60	
sericite	7- 8	
opaque	2- 3	(mainly pyrite)
quartz	1- 2	
leucoxene	minor	
replacement patches		
quartz-calcite-pyrite-ankerite-apatite-(tourmaline)	2- 3	

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.5-1.5 mm in size, and a few up to 2 mm long. Alteration is complete to patches of very fine grained calcite and/or ankerite and minor to moderately abundant extremely fine grained sericite. Several grains contain minor to moderately abundant patches of extremely fine grained kaolinite.

Hornblende forms subhedral to euhedral phenocrysts averaging 1-1.7 mm in size and a few up to 2.5 mm long. Alteration is to intergrowths of sericite and calcite with minor to moderately abundant disseminated patches of sphene. Sericite commonly is in subparallel orientation parallel to the c-axis of the original hornblende grain. This feature, the presence of disseminated sphene, and the shape of some euhedral phenocrysts are the main ways in which original hornblende is distinguished from original plagioclase.

Biotite forms subhedral phenocrysts averaging 0.5-0.8 mm in length and a few up to 1 mm long. Alteration is complete to pseudomorphic muscovite, which was recrystallized slightly to strongly to extremely fine grained flakes with slightly disoriented extinction positions. Ti-oxide forms 1-3% disseminated patches in biotite flakes.

Sphene forms a few euhedral to subhedral grains up to 0.5 mm long; alteration is complete to leucoxene.

Apatite forms a few anhedral, ragged to subhedral phenocrysts up to 0.6 mm in size. These contain moderately abundant dusty pyrite inclusions.

In the groundmass, plagioclase forms equant, slightly interlocking grains averaging 0.02-0.03 mm in size. Sericite forms disseminated flakes averaging 0.005-0.015 mm in size.

(continued)

Opaque (mainly pyrite) is concentrated in patches up to 0.6 mm in size as clusters of anhedral to subhedral grains averaging 0.02-0.1 mm in size. It also forms disseminated, equant grains averaging 0.05-0.1 mm in size and a few up to 1 mm across.

Leucoxene is concentrated in equant patches up to 0.15 mm in size of cryptocrystalline grains.

A few replacement patches up to 2 mm in size are dominated by very fine to fine grained quartz and calcite, with local concentrations of pyrite. Along the rim of one large patch is a zone averaging 0.05 mm wide of extremely fine grained ankerite. In the core of this patch, fine grained quartz contains minor clusters of acicular tourmaline grains up to 0.1 mm long. Another large patch contains a few apatite grains up to 0.2 mm in size in a quartz-rich core. Apatite grains contain moderately abundant dusty pyrite inclusions. A few patches up to 0.3 mm across are dominated by radiating clusters of tourmaline needles; pleochroism is from colorless to pale green. Some patches of quartz contain minor acicular tourmaline grains up to 0.15 mm long.

Sample 23: 94-112 169.1 m Latite Porphyry (Plagioclase, Biotite, Hornblende, Sphene); Calcite/Ankerite-Sericite-Tourmaline-Pyrite Alteration {Phyllic}; Quartz-Calcite-Pyrite Veins/Veinlets; Calcite-Pyrite Veinlet

Phenocrysts of plagioclase, biotite, hornblende, and sphene are set in a groundmass dominated by plagioclase. Plagioclase phenocrysts are altered to sericite-calcite, and biotite and hornblende phenocrysts are altered completely to muscovite, ankerite/calcite, patches of pyrite and lenses of Ti-oxide. Tourmaline forms irregular patches, seams, and radiating clusters in the groundmass and in and bordering mafic phenocrysts. A vein and a few veinlets are of very fine grained quartz-calcite-opaque. A veinlet is of calcite-opaque. The opaque is mainly pyrite.

phenocrysts	
plagioclase	20-25%
biotite	8-10
hornblende	3- 4
sphene	1- 2
groundmass	
plagioclase	45-50
sericite	2- 3
tourmaline	2
opaque	1- 2
carbonate	1- 2
vein, veinlets	
1) quartz-calcite-pyrite	3
2) calcite-pyrite	0.3

Plagioclase forms subhedral, prismatic phenocrysts averaging 1-1.7 mm long and a few up to 2.5 mm long. Alteration is complete to cryptocrystalline to extremely fine grained sericite and minor to moderately abundant patches of extremely fine grained calcite.

Biotite forms subhedral phenocrysts averaging 0.3-0.8 mm long and a few up to 1.8 mm in size. Alteration is complete to pseudomorphic muscovite with moderately abundant patches of Ti-oxide and opaque. Some larger grains also contain moderately abundant patches of ankerite. Many grains are rimmed by thin selvages of massive to extremely fine grained tourmaline and some contain irregular patches and seams of similar tourmaline..

Hornblende forms a few euhedral phenocrysts up to 2.5 mm in size, with angular cross-sections up to 0.7 mm across. Alteration is complete to muscovite/sericite, ankerite, patches of opaque, and disseminated leucoxene. Tourmaline forms dense patches along grain borders and some cleavage planes. It is distinguished from biotite mainly by the outlines of prismatic crystals.

In the groundmass, plagioclase forms equant, slightly interlocking grains averaging 0.02-0.04 mm in size which grade down in size to interstitial patches of cryptocrystalline plagioclase. It is altered slightly to disseminated flakes of sericite and irregular patches of calcite.

(continued)

Tourmaline forms disseminated patches showing a variety of textures. Some patches up to 0.5 mm across are of sub-radiating to radiating aggregates of prismatic grains. A few patches up to 0.3 mm in size are of massive anhedral to subhedral /euhedral prismatic tourmaline grains up to 0.05 mm long. Pleochroism is from pale yellowish green to medium green.

Patches averaging 0.2-0.4 mm in size are of extremely fine grained to cryptocrystalline leucoxene intergrown with pyrite. A few patches up to 0.3 mm in size are of leucoxene after subhedral to euhedral sphene. Pyrite also forms disseminated grains in the groundmass averaging 0.03-0.07 mm in size.

A vein up to 1 mm wide and a veinlet 0.3-0.8 mm wide are dominated by slightly interlocking quartz grains averaging 0.1-0.15 mm in size. Calcite is concentrated moderately along the margins as irregular patches of extremely fine grain size. Pyrite forms disseminated grains averaging 0.05-0.1 mm in size in the vein and lenses up to 1 mm long parallel to the length of the veinlet.

A veinlet up to 0.2 mm wide is of very fine grained calcite with lenses of pyrite. Calcite is in sub-parallel orientation at a low angle to vein walls, suggesting that it formed in a strained environment.

Sample 24: 94-84 193 m **Porphyritic Latite (Plagioclase, Biotite, (Hornblende); Ankerite-Sericite-Pyrite-(Quartz-Apatite) Alteration {Phyllic}**

Phenocrysts of plagioclase, biotite, and minor hornblende are set in a groundmass dominated by extremely fine grained, equant plagioclase with moderately abundant pyrite. Plagioclase phenocrysts are altered moderately to ankerite-(sericite). Biotite phenocrysts are replaced by pseudomorphic muscovite with lenses of ankerite and patches of pyrite and minor quartz and apatite. Hornblende phenocrysts are replaced by quartz, ankerite, pyrite, and apatite. The groundmass is replaced slightly by sericite and minor illite.

phenocrysts			
plagioclase	20-25%		
biotite	5- 7		
hornblende	1- 2		
groundmass			
plagioclase	55-60	apatite	0.2
sericite	5- 7	illite	0.2
pyrite	4- 5	tourmaline	minor
quartz	2- 3	zircon	trace

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.5-1.5 mm in size. Alteration is moderate to strong to ragged patches of ankerite and minor to moderately abundant, extremely fine grained sericite and very fine grained muscovite.

Biotite forms subhedral to anhedral phenocrysts averaging 0.3-0.8 mm in size and a few up to 3.5 mm long. Alteration is complete to pseudomorphic muscovite with minor to abundant patches of ankerite and minor Ti-oxide patches and lenses. Several grains are replaced moderately to strongly by pyrite. A few grains contain minor to moderately abundant very fine grained secondary quartz. Some grains contain moderately abundant, extremely fine gained apatite intergrown with patches of sericite and minor ankerite.

A few rectangular to anhedral patches up to 1 mm in size of very fine grained quartz and less abundant ankerite may be secondary after hornblende phenocrysts. Some of these also contain minor to moderately abundant patches of pyrite and of apatite.

A few patches up to 0.4 mm in size are of extremely fine grained, interlocking grains of apatite. Apatite also forms a few subhedral prismatic grains up to 0.15 mm long.

In the groundmass, plagioclase forms equant, slightly interlocking grains averaging 0.005-0.02 mm in size. Alteration is slightly to locally moderate to patches of extremely fine grained sericite and minor ankerite.

Pyrite forms irregular patches up to 1.5 mm in size of anhedral grains averaging 0.05-0.2 mm in size, and minor disseminated grains averaging 0.02-0.03 mm in size.

Quartz forms disseminated grains averaging 0.02-0.03 mm in size and a few patches of grains from 0.03-0.05 mm in size.

A few patches up to 0.6 mm across are of cryptocrystalline to extremely fine grained illite.

Tourmaline forms a few radiating clusters up to 0.15 mm in size of prismatic to acicular grains. Pleochroism is from colorless to pale green. Zircon forms euhedral, stubby, prismatic grains up to 0.03 mm long and anhedral, equant grains up to 0.05 mm across.

Sample 25: 94-99 60.9 m **Porphyritic Latite (Plagioclase, Biotite Phenocrysts); Quartz-Ankerite-Sericite-Pyrite-Kaolinite Alteration {Phyllic/Argillic}; Veinlet of Quartz-Apatite**

Phenocrysts of plagioclase and minor biotite and hornblende are set in a groundmass of plagioclase altered moderately to sericite and ankerite, with replacement patches of quartz and moderately abundant pyrite and apatite. Phenocrysts are altered completely as follows: plagioclase to sericite-(ankerite), biotite to muscovite-ankerite, and hornblende to kaolinite-pyrite-ankerite. A veinlet is of quartz and apatite.

phenocrysts			
plagioclase	12-15%		
biotite	2- 3		
hornblende	2- 3		
quartz	trace		
groundmass			
plagioclase	40-45	pyrite	4- 5%
sericite	12-15	apatite	1- 2
quartz	12-15	kaolinite	0.5
ankerite	7- 8	zircon	trace
veinlet			
quartz-apatite	0.2		

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.7-2 mm long. Alteration is complete to extremely fine grained sericite and minor to abundant patches of extremely fine to very fine grained ankerite.

Hornblende forms subhedral phenocrysts up to 1 mm in size. Alteration is complete to unoriented, extremely fine grained kaolinite flakes intergrown with abundant pyrite and moderately abundant ankerite, and outlines of phenocrysts are mainly destroyed.

Biotite forms phenocrysts up to 1 mm long which are altered completely to pseudomorphic to very fine grained muscovite with lenses of Ti-oxide and moderately to very abundant ankerite.

Quartz forms a subrounded phenocryst 0.5 mm across.

In the groundmass, plagioclase forms slightly interlocking grains averaging 0.015-0.03 mm in size. Alteration is slight to moderate to sericite and less abundant ankerite.

Quartz forms grains averaging 0.02-0.05 mm in size. Interstitial patches of quartz grade texturally into coarser grained, irregular replacement patches of quartz up to 1.5 mm in size in which grains average 0.05-0.2 mm in size and a few are up to 0.5 mm across.

Pyrite forms clusters averaging 0.2-0.5 mm in size of anhedral grains averaging 0.02-0.05 mm in size. It is concentrated in a few patches up to 1.5 mm across of similar grains. Apatite forms disseminated anhedral grains averaging 0.03-0.05 mm in size. A few patches up to 0.5 mm in size are dominated by anhedral apatite and pyrite intergrown with minor to moderately abundant sericite and ankerite.

Kaolinite forms a few patches up to 0.3 mm in size of flakes averaging 0.03-0.05 mm in size.

Zircon forms a subhedral prismatic grain 0.1 mm long associated with a biotite phenocryst.

A veinlet averaging 0.2 mm wide is of very fine grained apatite and quartz.

Sample 26: 94-107 118 m **Porphyritic Latite(?); Strong Quartz-Sericite-Pyrite-Alteration {Phyllic}; Veins, Veinlets of Quartz-Pyrite**

The sample was altered strongly to quartz-sericite/illite-pyrite and almost all of the original texture was destroyed. Sericite is concentrated in patches some of which may represent replaced plagioclase phenocrysts. Patches of illite may be secondary after biotite phenocrysts. Quartz and pyrite form irregular replacement patches, veins, and veinlets.

phenocrysts (?)		
biotite	2- 3	(altered to illite)
groundmass		
quartz	35-40%	
sericite	30-35	(after plagioclase?)
pyrite 7- 8		
illite	12-15	(after plagioclase?)
apatite	0.1	
tourmaline	minor	
zircon	trace	
veins, veinlets		
quartz-pyrite	5- 7	

A few patches up to 1 mm long in size are of cryptocrystalline to extremely fine grained illite. It is stained light to medium brown by limonite? It may be secondary after biotite phenocrysts.

Sericite is concentrated in irregular to locally rectangular patches up to 1.5 mm in size, in which it forms unoriented, extremely fine grained aggregates. Muscovite forms disseminated ragged flakes averaging 0.1-0.2 mm in size associated with patches of sericite. Also intergrown with sericite is cryptocrystalline illite(?), which is stained light brown by limonite.

Quartz forms anhedral grains averaging 0.1-0.3 mm in size. A few quartz patches up to 1.5 mm in size contain anhedral grains up to 0.8 mm long.

Pyrite forms disseminated, anhedral grains averaging 0.07-0.2 mm in size.

Apatite forms a few patches up to 0.2 mm in size of anhedral grains averaging 0.015-0.02 mm in size.

A few patches up to 0.2 mm in size are of radiating aggregates of prismatic tourmaline grains up to 0.12 mm long. Pleochroism is from colorless to light/medium green.

Zircon forms a subhedral grain 0.08 mm long in a patch of sericite.

Veins up to 2.5 mm wide are dominated by quartz grains averaging 0.2-0.7 mm in size and a few grains up to 1.2 mm across. The main vein contains minor interstitial patches up to 0.2 mm in size of pyrite and of extremely fine grained sericite. One vein up to 1 mm wide is of very fine grained quartz and pyrite.

Sample 27: 94-93 314 m **Strong Alteration: Kaolinite-Sericite-Quartz-Pyrite {Phyllic/Argillic); Strong Replacement by Quartz-(Pyrite) Veins; Late Pyrite-(Calcite) Veinlets**

The sample contains patches of strongly altered host rock (kaolinite/illite-sericite-quartz-opaque) replaced by vein material composed of quartz with minor pyrite. Late veinlets are of pyrite with local lenses of calcite.

host rock	
kaolinite/illite	10-12%
quartz	10-12
sericite	7- 8
calcite	0.3
replacement patches, veins	
quartz	60-65
pyrite	2- 3
sericite	0.5
muscovite	0.2
tourmaline	trace
late veinlets	
pyrite-(calcite)	1- 2

In the relic patches of host rock, kaolinite/illite forms patches up to 1.5 mm across of cryptocrystalline grains with a pale to light brown color caused by limonite. Some patches contain minor to moderately abundant pyrite grains averaging 0.05-0.1 mm in size, which commonly are rimmed by extremely fine grained sericite. Calcite forms a few patches up to 0.3 mm in size of grains averaging 0.05 mm in size. Some of the kaolinite/illite patches probably are secondary after plagioclase phenocrysts. In places, kaolinite/illite-rich patches grade into patches of extremely fine grained illite/sericite.

Elsewhere, patches of kaolinite/illite/sericite are intergrown intimately with quartz grains averaging 0.03-0.07 mm in size; these patches probably represent original groundmass, and the grain size of quartz may reflect the original grain size of the groundmass.

Muscovite is concentrated in a few patches up to 0.7 mm in size as flakes averaging 0.07-0.12 mm long intergrown with pyrite grains averaging 0.05-0.2 mm in size.

Pyrite is concentrated in a few patches up to 3 mm in size as clusters of anhedral to subhedral grains from 0.05-0.5 mm in size intergrown with sericite/muscovite, sericite, and quartz.

Replacement patches are dominated by quartz grains averaging 0.2-0.5 mm in size, and contain a few grains up to several mm across. Pyrite forms interstitial patches averaging 0.1-0.2 mm in size. Sericite forms disseminated patches of extremely fine grains. A few of these contain minor to moderately abundant calcite. A few patches up to 0.5 mm in size of cryptocrystalline kaolinite/illite may be relic patches of host rock.

Tourmaline forms minor radiating clusters up to 0.12 mm in size in coarse quartz grains. Pleochroism is from colorless to pale green.

Late, discontinuous seams/veinlets averaging 0.07-0.25 mm wide of pyrite cut some of the large quartz grains. These are associated with the interstitial pyrite patches, and together they probably represent a late event which followed the main quartz-rich replacement. A few of the veinlets contain a lens up to 1.5 mm long of very fine grained calcite.

Sample 28: 94-114 256.8 m Porphyritic Latite(?); Plagioclase, Biotite Phenocrysts; Quartz-Sericite-Pyrite-Kaolinite Alteration {Phyllic/Argillic}; Veins of Quartz-(Pyrite-Calcite/Ankerite); Veinlets of Pyrite-Calcite-Quartz; Calcite-(Opaque)

In a few patches in which primary textures are preserved, phenocrysts of plagioclase and biotite are set in a groundmass dominated by extremely fine grained sericite and quartz. Phenocrysts are altered completely as follows: plagioclase to kaolinite/illite-(sericite-quartz) and biotite to muscovite-quartz. Much of the sample is more strongly altered to patches of sericite-kaolinite and of quartz and disseminated opaque, and original texture was destroyed. Abundant veins and replacement patches are of quartz-(pyrite-calcite). A few late veinlets are of pyrite-calcite-quartz and of calcite-(pyrite).

phenocrysts			
plagioclase	4- 5%		
biotite	1- 2		
groundmass			
sericite	25-30	Ti-oxide	minor
quartz	12-15	limonite/hematite	minor
kaolinite/illite	10-12	tourmaline	trace
apatite	0.1	zircon	trace
carbonate	minor		
veins, veinlets			
1) quartz-(pyrite-calcite/ankerite)	40-45		
2) pyrite-calcite-quartz	4- 5		
3) calcite-(pyrite)	0.3		

Plagioclase forms subhedral to euhedral phenocrysts averaging 0.8-1.2 mm in size and a few up to 2 mm long. Alteration is complete to cryptocrystalline pale to light brown kaolinite/illite and much less sericite and quartz.

Biotite forms a few ragged to subhedral phenocrysts from 1-3.5 mm long. Grains are replaced by skeletal patches of pseudomorphic muscovite intergrown with moderately to very abundant patches of very fine grained quartz. Some also contain moderately abundant dusty Ti-oxide and minor patches of kaolinite/illite and disseminated pyrite.

Several equant patches up to 1 mm in size contain abundant very fine grained pyrite intergrown with quartz grains containing moderately abundant leucoxene, and locally apatite and/or ankerite/calcite. These may be secondary after mafic (hornblende?) phenocrysts.

Where the original groundmass was moderately preserved, the phenocrysts are set in a groundmass dominated by extremely fine grained sericite and very fine grained quartz.

Apatite is concentrated in patches up to 0.8 mm in size as extremely fine grained aggregates intergrown intimately with quartz of similar grain size.

Tourmaline forms a patch 0.1 mm across of radiating, acicular grains with pleochroism from colorless to pale green. Zircon forms an anhedral, equant grain 0.07 mm in size in a patch of sericite-kaolinite.

(continued)

Where the primary texture was destroyed, the groundmass consists of patches dominated by extremely fine grained sericite and patches of pale to light brown, cryptocrystalline kaolinite/illite, with disseminated grains of quartz averaging 0.02-0.05 mm in size. The groundmass is replaced moderately to strongly in irregular patches by coarser grained quartz averaging 0.1-0.2 mm in grain size, which contains minor to moderately abundant disseminated grains and patches of sericite. A few equant replacement patches up to 0.3 mm in size are of interlocking quartz grains averaging 0.015-0.02 mm in size.

Limonite/hematite forms irregular, skeletal patches of cryptocrystalline grains associated with some patches of pyrite.

Veins up to several mm wide are dominated by quartz grains averaging 0.2-0.8 mm in size, with a few up to 1.2 mm long. Borders with the host rock commonly are diffuse and are marked by zones of moderate to strong quartz replacement. Pyrite forms irregular patches up to 1 mm in size of grains averaging 0.05-0.2 mm in size. Calcite/ankerite forms patches of grains up to 0.6 mm in size, mainly near borders of the grains, and scattered patches of grains averaging 0.1-0.2 mm in size elsewhere in the veins.

The early veins are cut by discontinuous veinlets of pyrite-calcite. Late veinlets up to 1.5 mm wide of massive pyrite and minor interstitial calcite cut some of the quartz veins. Where these veinlets cut the host rock, they consist of pyrite and quartz. Where they cut the quartz veins and locally elsewhere, the veins are recrystallized slightly to moderately to extremely fine grained aggregates of quartz along braided seams.

A few late discontinuous veinlets up to 0.1 mm wide are of calcite with minor pyrite.

Sample 29: 94-77 235.1 m **Porphyritic Latite/Dacite: (Plagioclase, Hornblende, Biotite) Sericite-Ankerite-Quartz-Pyrite-(Tourmaline) Alteration {Phyllic}; Veins and Veinlets of Quartz-Ankerite-Pyrite-Sericite; Late Veinlets of Opaque-Ankerite and Pyrite (with a carbonate-destructive alteration envelope)**

Phenocrysts of plagioclase, hornblende, and biotite are set in an altered groundmass of quartz, sericite, and ankerite. Plagioclase phenocrysts are altered completely to sericite-(ankerite). Hornblende phenocrysts are altered to quartz-sericite-ankerite-(pyrite), and biotite phenocrysts are altered to muscovite-ankerite-pyrite. Veins up to 8 mm wide and a few veinlets are of quartz with much less ankerite, pyrite, and sericite. A few veinlets cutting the main vein are of pyrite-ankerite or pyrite. In the dark (in hand sample) branching band up to 3 mm wide, the groundmass is of sericite-quartz-pyrite with only minor ankerite. Where this band cuts a large quartz vein, it contains several veinlets of pyrite. This suggests that it is a late carbonate-destructive alteration associated with deposition of pyrite.

phenocrysts			
plagioclase	8-10%		
hornblende	3- 4		
biotite	2- 3		
groundmass			
sericite	25-30	pyrite	0.5%
ankerite	15-17	tourmaline	0.1
quartz	15-17	zircon	trace
main-stage veins, veinlets			
quartz-ankerite-pyrite-sericite	20-25 (15-20 in hand sample)		
late veinlets			
1) ankerite-pyrite	0.5		
2) pyrite	0.1		

Plagioclase forms subhedral phenocrysts up to 2 mm in size. Alteration is complete to sericite and minor to moderately abundant ankerite/calcite, and outlines of phenocrysts generally are destroyed. Phenocrysts are recognized because of their vaguely rectangular shape and relative absence of disseminated pyrite.

Hornblende forms subhedral to anhedral, prismatic phenocrysts averaging 0.7-1.5 mm in size and locally up to 2 mm long. Alteration is to ankerite-quartz-sericite with minor pyrite. Some phenocrysts are difficult to classify as biotite or hornblende.

Biotite forms subhedral phenocrysts up to 1.2 mm long. Alteration is complete to muscovite, with minor to moderately abundant patches of pyrite and ankerite.

In the groundmass, quartz forms equant grains averaging 0.02-0.05 mm in size. It is intergrown with extremely fine grained sericite and ankerite in widely varying amounts. Pyrite forms disseminated grains averaging 0.03-0.07 mm in size. Tourmaline forms disseminated, clusters up to 0.2 mm across of radiating acicular to prismatic grains. Pleochroism is from light to dark green. Zircon forms minor euhedral grains up to 0.025 mm long in biotite phenocrysts.

(continued)

Sample 29: 94-77 235.1 m (page 2)

Veins up to 8 mm wide are dominated by fine grained quartz. Quartz grains commonly are strained slightly to moderately, with strained zones commonly containing moderately abundant dusty semi-opaque which gives them a light brown color. Ankerite forms very fine to fine grains, concentrated mainly along the margins of the vein; it commonly contains dusty limonite(?) which gives it a light to medium brown color. Pyrite forms disseminated, very fine grains, mainly interstitial to quartz grains. Pyrite also forms late seams which cut across the veins. Sericite is concentrated moderately to strongly in patches up to 1 mm in size as extremely fine, unoriented flakes. Veinlets averaging 0.1-0.3 mm wide are mainly of very fine grained quartz with minor ankerite and pyrite.

The largest vein is cut by a few seams 0.1-0.2 mm wide of ankerite-pyrite. In much of the seams, ankerite forms a thin rim about a core of pyrite; elsewhere the seams are dominated by ankerite with scattered pyrite grains.

The latest event produced the dark forked zone (up to 3 mm wide) in the offcut block. This is dominated by extremely fine grained sericite and less abundant quartz with moderately abundant disseminated pyrite. Where the zone cuts the main-stage quartz-(ankerite-pyrite) vein it consists of several discontinuous veinlets averaging 0.02-0.04 mm wide of pyrite.

Sample 30: 94-127 241 m **Quartz-Sericite-Ankerite-Opaque {Phyllic} Alteration; Replacement Patches of Quartz-Ankerite-Opaque; Quartz-Ankerite-Opaque Veins, Late Ankerite Veinlets; Breccia Groundmass of Quartz-Opaque**

The part of the section which represents the host rock is poorly preserved, thus its description is incomplete. The host rock is altered and replaced strongly by quartz and sericite/illite with locally abundant ankerite and opaque. Veins are of quartz with minor to abundant ankerite and opaque. They are truncated and offset along a few major seams of brecciation dominated by quartz and opaque.

host rock	
quartz	20-25%
sericite/illite	15-17
ankerite	4- 5
opaque	1
apatite	minor
Ti-oxide	minor
replacement	
quartz	12-15
ankerite	3- 4
opaque	2
tourmaline	minor
veins, veinlets	
quartz	17-20
ankerite	3- 4
opaque	3- 4
sphalerite	trace
breccia groundmass	
quartz	7- 8
opaque	2- 3

In the altered host rock, quartz forms anhedral grains averaging 0.05-0.15 mm in size. Sericite/illite forms patches up to 0.2 mm in size of cryptocrystalline grains. Opaque forms disseminated anhedral grains averaging 0.05-0.1 mm in size. Ankerite forms disseminated, anhedral grains averaging 0.05-0.08 mm in size and a few patches up to 0.35 mm. Apatite forms subhedral grains averaging 0.02-0.03 mm long. Ti-oxide forms equant patches up to 0.05 mm across. A few angular patches up to 1.1 mm in size are of cryptocrystalline sericite/illite/kaolinite(?) with minor acicular Ti-oxide grains up to 0.02 mm long.

Irregular replacement patches up to a few m across are of very fine to fine grained quartz and ankerite in widely varying amounts. Opaque is abundant in irregular patches up to 1.5 mm in size, with grain size ranging from extremely fine to 0.3 mm. Tourmaline forms a few patches up to 0.3 mm in size of sub-radiating, prismatic grains averaging 0.05 mm long; pleochroism is from pale to light/medium green. The color commonly is deepest at the base of the crystals, and palest towards the radiating ends.

Replacement patches up to 1.5 mm in size are of slightly to moderately interlocking quartz grains averaging 0.05-0.3 mm in size, with much less ankerite and opaque. Textures suggest that some of these may represent fragments of once-more-continuous replacement patches and lenses.

(continued)

Discontinuous veins up to 3 mm wide are of similar to slightly coarser grained quartz with minor to abundant opaque grains (up to 0.5 mm in size) and patches of ankerite (averaging 0.05-0.1 mm in grain size). In one vein, pale orange sphalerite forms a few equant grains up to 0.15 mm across. One vein up to 2 mm wide is dominated by fine to medium grained ankerite with minor patches of very fine grained quartz and others of extremely fine grained kaolinite.

The widest vein, which is mainly quartz, is cut by a few veinlets averaging 0.1-0.15 mm in width of very fine grained ankerite with scattered grains up to 0.15 mm in size of opaque.

Several of the veins are truncated against a major zone of brecciation.

A band up to a few mm wide is of strongly brecciated rock, much of it with a pale brown color. The band has a sharp bend near one side of the section. It contains sparse to locally moderately abundant angular fragments of quartz averaging 0.02-0.03 mm in size in a groundmass averaging 0.003-0.007 mm in size of quartz/kaolinite(?) with less abundant sericite/illite and minor to abundant opaque. Opaque occurs as disseminated grains and as lenses up to 0.3 mm wide. The breccia groundmass is cut by veinlets of quartz-(ankerite) up to 0.05 mm wide.

Sample 31: 94-112 180.3 m Porphyritic Latite/Andesite (Plagioclase, Hornblende); Sericite-Ankerite-(Chlorite) Alteration {Phyllic/Propylitic}; Replacement Patches of Quartz-Opaque; Veinlets of Ankerite-Opaque-Quartz, Opaque, Ankerite

Phenocrysts of plagioclase and hornblende and minor sphene, biotite, and apatite are set in a groundmass of plagioclase/sericite/illite, hornblende, ankerite, and opaque. Plagioclase is altered strongly to sericite/illite-(ankerite), hornblende is replaced by sericite-ankerite-leucoxene or chlorite/muscovite-(ankerite), biotite is replaced by muscovite-ankerite-Ti-oxide, and sphene is replaced by ankerite-leucoxene. A few replacement patches are of quartz-(opaque). Early veinlets are of ankerite-opaque-quartz and opaque. Late veinlets are of ankerite.

phenocrysts	
plagioclase	17-20%
hornblende	10-12
sphene	0.5
biotite	0.3
apatite	0.2
groundmass	
plagioclase	50-55
ankerite	5- 7
hornblende	3- 4
opaque	3- 4
leucoxene	0.2
apatite	0.1
replacement patches	
quartz	1
opaque	0.2
veins, veinlets	
1) ankerite-opaque-quartz	4- 5
2) opaque	0.1
3) late ankerite	0.3

Plagioclase forms euhedral to subhedral phenocryst averaging 1-1.5 mm in size. Alteration is moderate to very strong to cryptocrystalline to extremely fine grained sericite/illite and minor to moderately abundant patches of ankerite.

Hornblende forms subhedral to euhedral phenocrysts averaging 0.5-1.7 mm in size. These grade down in size to moderately abundant grains in the groundmass averaging 0.07-0.2 mm long. Most large grains are replaced by pseudomorphic muscovite with patches of ankerite, leucoxene, and minor opaque, and a few large ones and many smaller ones are replaced by pseudomorphic aggregates of pale green chlorite or chlorite/muscovite. Some contain a few inclusions of subhedral to euhedral apatite averaging 0.05-0.1 mm in length.

Sphene forms equant, anhedral to subhedral grains averaging 0.15-0.5 mm in size. Alteration is complete to ankerite and leucoxene.

(continued)

Biotite forms anhedral to subhedral phenocrysts form 0.3-0.6 mm long. Alteration is complete to pseudomorphic chlorite (or less commonly muscovite) with lenses of ankerite and patches of leucoxene.

Apatite forms subhedral to euhedral prismatic grains averaging 0.2-0.35 mm in length and up to 0.2 mm in cross-section.

In the groundmass, plagioclase forms interlocking grains averaging 0.01-0.02 mm in size and interstitial patches of cryptocrystalline grains. Alteration is slight to moderate to cryptocrystalline illite/kaolinite. Ankerite forms disseminated anhedral grains averaging 0.02-0.05 mm in size. The distribution and alteration of hornblende were described above in the section on phenocrysts. Opaque forms disseminated, anhedral grains averaging 0.02-0.03 mm in size. Apatite forms subhedral to euhedral grains averaging 0.07-0.1 mm in size.

Replacement patches up to 0.8 mm in size are of quartz grains averaging 0.07-0.15 mm in size and minor to moderately abundant opaque grains averaging 0.05-0.15 mm in size and locally up to 0.6 mm across. A few replacement patches up to 0.7 mm long are of quartz grains averaging 0.03-0.07 mm in size.

In the hand sample, a vein is 1.5 mm wide. In the thin section, the main veinlet averages 0.5 mm wide and is dominated by ankerite with patches of opaque and a few lenses of quartz and of opaque. A veinlet is 0.05-0.07 mm wide. The margins of the larger vein and all of the veinlet are of extremely fine grained ankerite with a finely banded texture with grains oriented perpendicular to walls of the veinlet. The core of the vein is dominated by very fine grained ankerite. Opaque forms moderately abundant anhedral grains averaging 0.1-0.3 mm in size. Quartz is concentrated near one end as lenses up to 0.2 mm wide of very fine to fine grains in the core of the vein.

Late veinlets cutting the early banded ankerite veinlets are up to 0.1 mm wide and composed of very fine grained ankerite.

A discontinuous veinlet up to 0.05 mm wide is of opaque.

Sample 32: 94-126 395 m **Latite/Dacite Porphyry (Plagioclase-Hornblende); Sericite/Illite-Kaolinite-Ankerite-Quartz Alteration {Phyllic/Argillic}; Quartz Replacement**

Phenocrysts of plagioclase and hornblende and minor ones of quartz and apatite are set in a very fine grained groundmass dominated by quartz, ankerite, and kaolinite with minor limonite replacement of ankerite and minor pyrite. Phenocrysts are altered completely as follows: plagioclase to sericite/illite-kaolinite-(ankerite), and hornblende to ankerite. Replacement patches are of quartz.

phenocrysts			
plagioclase	12-15%	quartz	0.2
hornblende	7- 8	apatite	minor
groundmass			
quartz	25-30	limonite/ankerite	1
ankerite	17-20	pyrite	1
kaolinite	15-17	leucoxene	0.7
		apatite	1
replacement patches			
quartz	4- 5		

Plagioclase forms euhedral to subhedral phenocrysts averaging 1-1.7 mm in size and a few up to 2.5 mm long. Alteration is to cryptocrystalline to extremely fine grained aggregates of sericite/illite and kaolinite, commonly with minor patches of ankerite. A few coarser plagioclase grains contain moderately abundant ankerite concentrated moderately to strongly near their margins.

Hornblende forms phenocrysts averaging 1.2-2 mm long and a few up to 3 mm long. Alteration is complete to ankerite with minor opaque and leucoxene. Some grains contain moderately abundant to abundant inclusions of apatite averaging 0.05-0.1 mm in size and most contain moderately abundant inclusions of leucoxene, commonly oriented parallel to the original c-axis of hornblende.

Quartz forms a few subrounded phenocrysts up to 0.9 mm in size. Along the margins of these, quartz is intergrown slightly to moderately with groundmass quartz (which contains dusty semi-opaque/opaque inclusions.

Apatite forms a few subhedral to euhedral phenocrysts from 0.2-0.35 mm in length.

In the groundmass, quartz forms slightly to moderately interlocking grains averaging 0.05-0.15 mm in size. Grains contain moderately abundant dusty inclusions. Ankerite forms anhedral grains averaging 0.08-0.15 mm in size. Kaolinite is concentrated in patches up to a few mm across of cryptocrystalline grains, commonly intergrown with very fine grained ankerite.

Limonite and limonite/altered ankerite form equant grains averaging 0.1-0.2 mm in size. These have a medium orange-brown color. Opaque forms disseminated grains averaging 0.1-0.2 mm in size. Leucoxene forms disseminated patches averaging 0.02-0.05 mm in size; it is concentrated moderately to strongly in patches of kaolinite. Apatite forms subhedral to euhedral grains averaging 0.07-0.12 mm in size.

Replacement patches up to 1.5 mm in size are of fine grained quartz which is strained slightly to moderately and recrystallized slightly to finer sub-grain aggregates.

Sample 33: 94-105 123.7 m Hypabyssal Andesite Porphyry (Plagioclase, Hornblende); Chlorite-Calcite-(Sericite/Illite) Alteration {Propylitic}; Quartz-Calcite-(K-feldspar-Opaque) Replacement Patches; Calcite-(Quartz-Sericite/Illite-Opaque-Kaolinite?) Vein, Veinlets

Phenocrysts of plagioclase, hornblende, and minor apatite are set in a groundmass of plagioclase-(hornblende-ankerite) with replacement patches of quartz-calcite-(K-feldspar-opaque). Grain size of hornblende is gradational between phenocrysts and groundmass. Phenocrysts are altered as follows: plagioclase slightly to sericite, and hornblende strongly to chlorite-calcite. Replacement patches are of quartz and calcite with minor K-feldspar and opaque. A vein and veinlets are of calcite with lenses of quartz-(sericite/illite) and minor opaque.

phenocrysts			**replacement patches**	
plagioclase	20-25%		quartz	3- 4%
hornblende	12-15		calcite	0.5
apatite	0.3		K-feldspar	0.2
groundmass			opaque	0.1
plagioclase	40-45		**veins, veinlets**	
hornblende	3- 4		calcite-(quartz-sericite/illite-opaque-	
ankerite	3- 4		kaolinite?)	4- 5
opaque	1	(mainly pyrite)		
sphene/oxide	0.7			
apatite	0.2			

Plagioclase forms euhedral phenocrysts averaging 0.5-1.5 mm in size and a few up to 2 mm long. Alteration is slight to disseminated sericite.

Hornblende forms euhedral phenocrysts averaging 0.8-2 mm in length and 0.5-1 mm in cross-section, and a few from 3-7 mm long. Alteration is complete to intergrowths of chlorite and calcite with minor opaque and leucoxene. Some grains contain moderately abundant inclusions of apatite. Apatite also forms subhedral to euhedral phenocrysts averaging 0.15-0.3 mm in length and a few up to 0.4 mm across.

In the groundmass, plagioclase forms equant, moderately interlocking grains averaging 0.02-0.04 mm in size, which grade down in size to much less abundant interstitial grains less than 0.005 mm in size. Hornblende (altered to chlorite-[calcite]) forms subhedral to euhedral grains averaging 0.05-0.1 mm in size, and grading upwards in size to that of the hornblende phenocrysts.

Sphene or oxide forms patches averaging 0.1-0.5 mm in size; alteration is complete to rims of opaque and cores of cryptocrystalline chlorite. In some patches, irregular patches of opaque extend well into the cores.

Opaque (probably mainly pyrite) forms equant, subhedral to euhedral grains averaging 0.05-0.1 mm in size. Apatite forms disseminated grains averaging 0.05-0.1 mm in size.

(continued)

Replacement patches averaging 0.3-0.7 mm in size and locally up to 1.5 mm across are of quartz grains averaging 0.05-0.2 mm in size with less abundant calcite grains averaging 0.05-0.1 mm in size, opaque grains averaging 0.07-0.15 mm in size, and minor very fine grained chlorite. A few patches also contain minor to moderately abundant K-feldspar grains averaging 0.1-0.15 mm in size. A few interstitial patches up to 1.5 mm in size are dominated by fine to medium grained calcite with minor subhedral to euhedral grains of quartz and opaque concentrated near borders of the patches.

A discontinuous, slightly braided vein/veinlet up to 0.8 mm wide is dominated by very fine to fine grained, slightly interlocking calcite grains. Quartz forms a few irregular lenses up to 0.3 mm wide of extremely fine grained aggregates, in part with wispy selvages of sericite flakes between quartz grains. Opaque forms scattered very fine grains. One lens is of cryptocrystalline to extremely fine grained sericite/illite and kaolinite(?). A few smaller veinlets from 0.05-0.15 mm wide are of very fine grained calcite with patches of cryptocrystalline to extremely fine grained sericite/illite-quartz/kaolinite(?).

Sample 34: 94-98 281.8 **Altered Andesite Porphyry (Plagioclase, Hornblende); Sericite-Pyrite Alteration {Phyllic}; Quartz-(Ankerite) Replacement Patches; Veins, Veinlets of Ankerite-(Quartz)**

The sample is very similar to Sample 33, but is more strongly altered. Abundant phenocrysts of plagioclase and hornblende and minor ones of biotite are set in a groundmass dominated by plagioclase with much less sericite, ankerite, quartz, leucoxene, pyrite, and apatite. Phenocrysts are altered as follows: plagioclase strongly to sericite/illite-ankerite, hornblende completely to sericite-ankerite-opaque-leucoxene, and biotite completely to muscovite-ankerite. Replacement patches are dominated by quartz with much less ankerite. Irregular, early veins and veinlets are of ankerite with much less quartz. Late veinlets are of ankerite.

phenocrysts	
plagioclase	20-25%
hornblende	10-12
biotite	0.3
apatite	minor
groundmass	
plagioclase	45-50
ankerite	5- 7
leucoxene	1
pyrite	0.5
apatite	0.5
zircon	trace
replacement patches	
quartz-(ankerite)	3- 4
veins, veinlets	
1) ankerite-(quartz)	3- 4
2) ankerite	1- 2

Plagioclase forms euhedral to subhedral, prismatic phenocrysts averaging 1-1.5 mm long. Alteration is strong to extremely fine grained to cryptocrystalline sericite/illite and slight to strong to patches of very fine grained ankerite.

Hornblende forms subhedral to euhedral phenocrysts from 0.5-1.5 mm in size. Alteration is complete to cryptocrystalline to extremely fine grained aggregates of sericite with patches of ankerite and moderately abundant leucoxene and opaque. Minerals commonly are oriented parallel to the long axis of the crystal. Many phenocrysts contain one or two inclusions of apatite averaging 0.07-0.15 mm in length and locally up to 0.3 mm long. Most contain moderately abundant opaque inclusions averaging 0.01-0.03 mm in size and leucoxene inclusions averaging 0.005 mm in size.

Biotite forms a few phenocrysts averaging 0.3-0.8 mm in size. Alteration is to pseudomorphic muscovite with minor to moderately abundant lenses of ankerite and of Ti-oxide along cleavage planes.

Apatite forms a subhedral, prismatic phenocryst 0.8 mm long.

(continued)

In the groundmass, plagioclase forms subhedral grains averaging 0.05-0.15 mm in size with interstitial patches of anhedral, interlocking grains ranging from 0.005-0.05 mm in size. Alteration of coarser grains generally is moderate to sericite/illite as in the phenocrysts, but a few grains are relatively fresh. Some patches of the groundmass are replaced more strongly by extremely fine grained sericite/illite and patches of ankerite averaging 0.02-0.05 mm in size. Opaque forms disseminated anhedral to subhedral grains averaging 0.03-0.1 mm in size, and a few up to 0.2 mm across. Leucoxene forms disseminated patches averaging 0.02-0.05 mm in size of cryptocrystalline aggregates. Quartz forms disseminated grains and patches averaging 0.02-0.05 mm in size. Apatite forms disseminated subhedral grains averaging 0.08-0.15 mm long. Zircon forms a few subhedral to euhedral, prismatic grains averaging 0.03-0.04 mm long in hornblende phenocrysts.

Replacement patches averaging 0.1-0.3 mm in size are of very fine grained quartz and minor to moderately abundant ankerite of similar grain size.

A vein from 0.4-1 mm wide is dominated by fine to medium grained ankerite (especially in the core) with moderately abundant very fine grained quartz, ankerite and minor opaque along the margins. A few quartz veinlets up to 0.05 mm wide are related to this vein.

A few veinlets up to 0.6 mm wide are of very fine grained ankerite. One of these cuts across the coarser ankerite vein.

Appendix XIV

A GEOSTATISTICAL RESOURCE EVALUATION

of

THE RED CHRIS COPPER-GOLD DEPOSIT

for

AMERICAN BULLION MINERALS LTD.

by

G.H. Giroux, P.Eng., MASc.
Montgomery Consultants Ltd.

February 10, 1995

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FIGURES

TABLES

APPENDICES

1.0 SUMMARY AND CONCLUSIONS

At the request of American Bullion Minerals Ltd. a geological resource was calculated for the Red Chris Porphyry Copper-Gold Deposit.

The deposit is located approximately 10 km east of the Stewart-Cassiar Highway, near the community of Iskut and 200 km by road north of the port of Stewart.

The deposit is hosted by the elongate monzodiorite Red Stock containing a pervasive phyllitic alteration and both fracture controlled and disseminated copper-gold mineralization.

Data for this study was provided by American Bullion in the form of 132 drill holes with gold and copper assays. A total of 2,604 specific gravity measurements were available for analysis with the mean value of 2.79 used in tonnage calculations.

The geology was simplified for the resource evaluation into three rock types: plutonic plagioclase hornblende main phase porphyry (containing most of the mineralization), plutonic plagioclase hornblende late phase porphyry and waste volcanics, sediments and dykes. These rock domains were digitized from cross sections with contacts transferred to level plans. The level plans were then interpreted and digitized to produce a three dimensional geologic block model for blocks 30 x 30 x 15 m. in dimension.

Variography indicated a nested anisotropic spherical model for copper with longest range of 400 m. at azimuth 025. An isotropic spherical model was indicated for gold with a range of 70 m.

Grades for copper and gold were interpolated by ordinary kriging for each block in the geologic model coded as main phase porphyry or late phase porphyry. A total of 14,618 blocks were estimated. The total geologic resource at a .4 % Cu cutoff is 100 million tonnes averaging 0.54 % Cu and .46 g Au / tonne.

Blocks were classified as proven, probable and possible based on relative kriging estimation errors which in turn are based on distance and direction of drill hole composites from the block being estimated. The results are summarized for a series of Cu cutoffs below.

Cu Cutoff (%)	Classification	Tonnes	Cu (%)	Au (g/t)
0.20	Proven	11,220,000	0.40	0.30
	Probable	169,720,000	0.40	0.31
	Proven+Probable	180,940,000	0.40	0.31
	Possible	139,440,000	0.35	0.28
0.30	Proven	7,120,000	0.49	0.36
	Probable	109,190,000	0.48	0.37
	Proven+Probable	116,310,000	0.48	0.37
	Possible	69,830,000	0.46	0.35
0.40	Proven	4,330,000	0.58	0.41
	Probable	61,050,000	0.59	0.47
	Proven+Probable	65,380,000	0.59	0.47
	Possible	34,730,000	0.57	0.45
0.50	Proven	2,750,000	0.66	0.46
	Probable	38,460,000	0.68	0.56
	Proven+Probable	41,210,000	0.68	0.55
	Possible	19,620,000	0.67	0.54

2.0 INTRODUCTION

At the request of Wayne Roberts of American Bullion Minerals Ltd. a geologic resource evaluation was completed for the Red Chris Porphyry Copper-Gold Deposit south of Dease Lake near Iskut, B.C. The data was provided by American Bullion and consisted of drill hole location information, assays for copper and gold and geologic data. No site visit was made. The purpose of this estimate was to update a previous preliminary estimate made in January 1995 with no geologic control (Giroux, 1995). For this resource estimate the geology was used to control the estimation process. The grade block model produced is suitable for input into open pit optimization software to produce a minable resource.

3.0 DATA ANALYSIS

Data was provided by American Bullion in the form of collar coordinates, down hole survey information, assay information and down hole geologic information for a total of 184 drill holes. Only recent drill holes numbered 1 to 132 were used in this estimate (see Figure 1).

An arithmetic histogram (Appendix 1) for copper in 15 m. composites showed a skewed distribution with grades ranging from 0.001 % Cu to 3.88 % Cu and a mean grade 0.284 % Cu. When grades were transformed to logs the copper histogram showed a series of overlapping lognormal distributions. A cumulative frequency plot allowed for separating these populations: 22.6 % of the data had a mean of 0.034 % Cu representing background, 69.1 % of the data had a mean of 0.225 and represented the main mineralized event and two upper populations totalling 8.3 % with a mean of > .8 % Cu represented high grade. A threshold of 0.6 % Cu separated the high grade material from the main mineralization for the purpose of modelling.

No duplicate analysis were evaluated for this study.

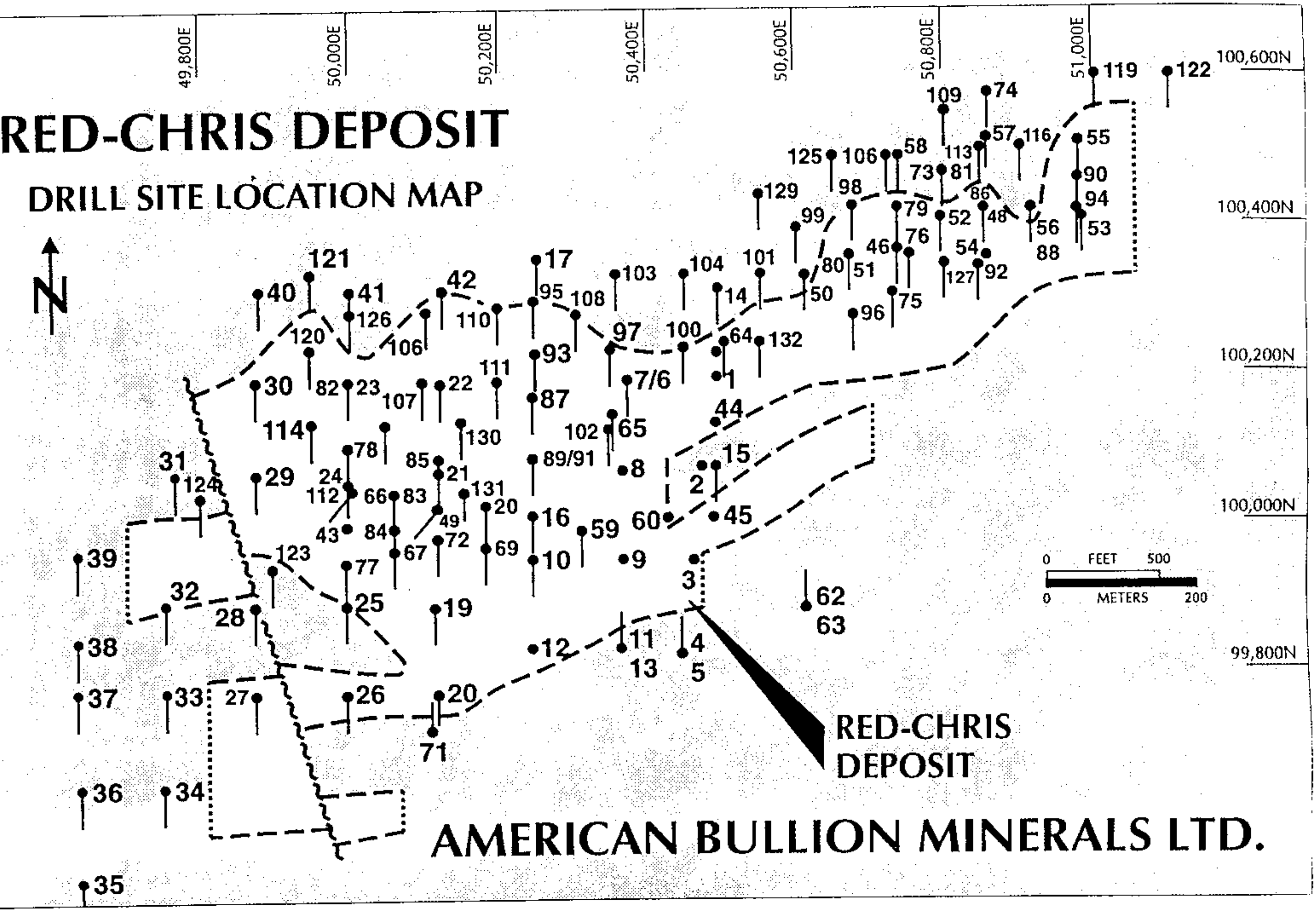

RED-CHRIS DEPOSIT
DRILL SITE LOCATION MAP
N
49,800E
50,000E
50,200E
50,400E
50,600E
50,800E
51,000E
100,600N
100,400N
100,200N
100,000N
99,800N
0 FEET 500
0 METERS 200
119 122 109 74 57 116 55 125 106 58 113 73 81 90 129 98 86 94 99 79 52 48 56 53 76 88 46 54 121 17 104 101 80 51 127 92 103 42 95 108 14 50 75 40 41 96 126 110 120 106 97 100 64 132 93 111 30 82 23 107 22 1 7/6 87 44 114 65 102 130 78 15 85 89/91 8 31 21 24 29 2 124 112 66 83 131 20 16 60 45 49 43 84 59 72 39 123 69 67 10 9 3 77 62 32 25 63 28 19 11 38 12 4 13 5 26 20 27 37 33 71 36 34 35
RED-CHRIS DEPOSIT
AMERICAN BULLION MINERALS LTD.

Figure 1

A total of 2,604 specific gravity measurements were available for analysis. A histogram of SG's shows a normal distribution centred on the mean of 2.79 (see Figure 2). A scatter plot of specific gravity versus Cu grade shows no real correlation with both high and low SG's present throughout the entire range of copper values (see Figure 3). As a result a specific gravity value of 2.79 was used in tonnage calculations.

3.1 Drill Hole Composites

For this resource estimate geology was utilized to control the estimation process in two ways.

First certain geologic units were identified on cross section by American Bullion geologists. These outlines were digitized and level plans at 15 m. intervals were produced. The geologic units were shown on each level plan and joined to form polygons. These polygons were then digitized from level plans to produce a three dimensional geologic model. The rock units coded and digitized were as follows:

Code	-	Rock Type Digitized
5	-	Waste
10	-	PPHL - Plutonic Plagioclase Hornblende Late Phase Porphyry
20	-	DQCA - Dyke - Quartz Carbonate Amygdules
30	-	SLST - Siltstones
40	-	VOLC - Volcanics
50	-	ANDS - Andesites
100	-	PPHM - Plutonic Plagioclase Hornblende Main Phase Porphyry

Secondly the rocks were grouped for estimation purposes as follows:

Code	-	Rock Type Estimated
0	-	Waste, DQCA, SLST, VOLC, ANDS
1	-	PPHL
2	-	PPHM

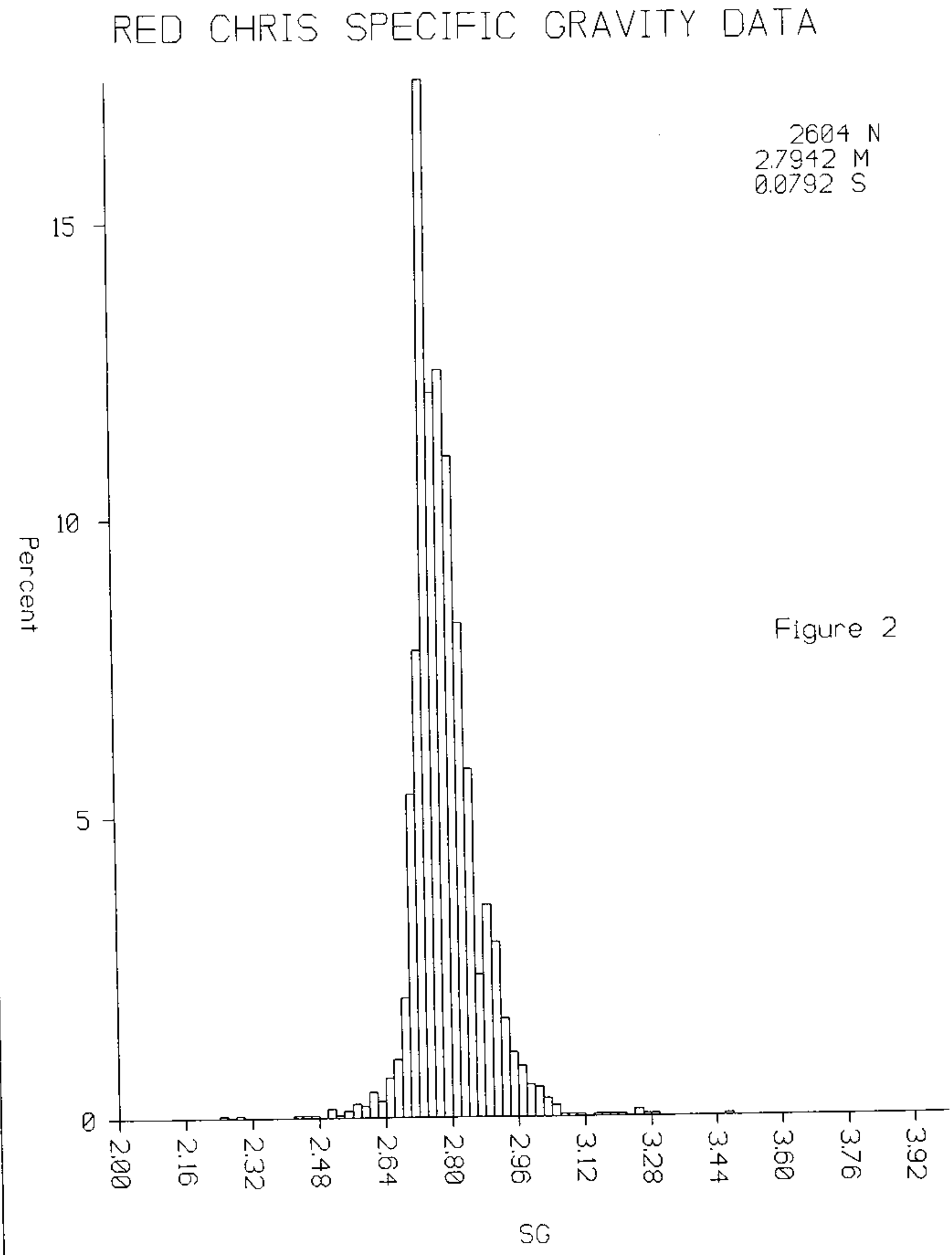

RED CHRIS SPECIFIC GRAVITY DATA
2604 N
2.7942 M
0.0792 S
Percent
15
10
5
0
SG
2.00
2.16
2.32
2.48
2.64
2.80
2.96
3.12
3.28
3.44
3.60
3.76
3.92

Figure 2

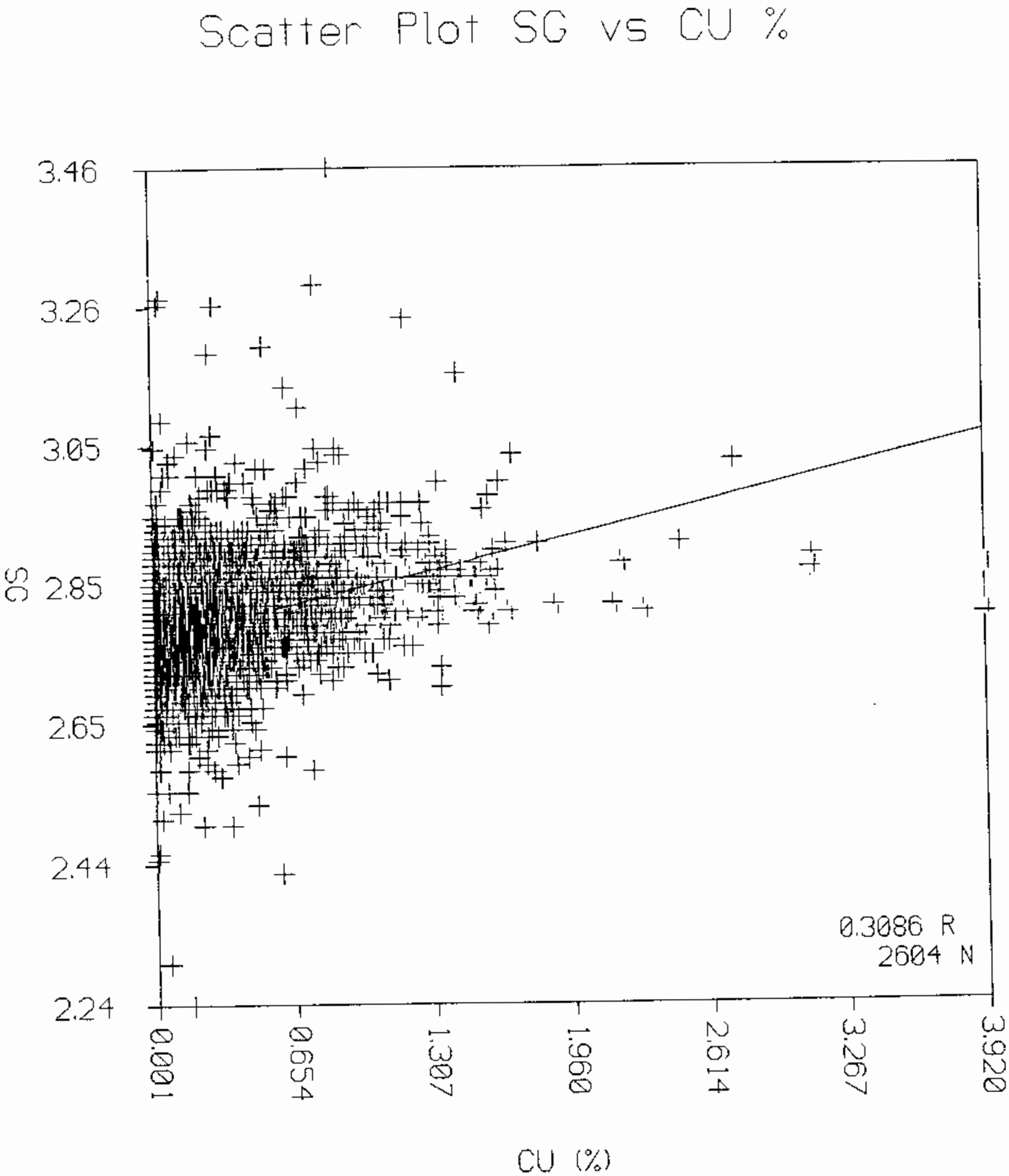

Scatter Plot SG vs CU %
SG
3.46
3.26
3.05
2.85
2.65
2.44
2.24
0.001
0.654
1.307
1.960
2.614
3.267
3.920
CU (%)
0.3086 R
2604 N

Figure 3

From- to intervals corresponding to the above three codes (0, 1 or 2) were provided by American Bullion. Uniform 15 m. composites were produced down the hole that honoured the contacts between these rock units. Small intervals at rock contacts less than 7.5 m. were combined with the sample above. Intervals of less than 7.5 m. of one rock type contained within a second were combined with the surrounding rock as they would represent internal dilution. Units 1 (Late Phase Porphyry) and 2 (Main Phase Porphyry) were modelled and estimated. In this way grades were not "smoothed" across rock boundaries from higher grade Main Phase Porphyry to lower grade Late Phase Porphyry or visa versa.

4.0 SEMI-VARIOGRAM MODELLING

4.1 Introduction

In nature the grade or value of a particular sample in three dimensional space is expected to be affected by its position and its relationship with its neighbours, (ie. mineralization is not usually random and is influenced by such things as rock porosity, fracturing, distance from source etc.) The fundamental principal behind geostatistics, developed by George Matheron, takes this dependence into account and is known as the theory of regionalized variables. The procedure or tool to quantify both the amount and direction of this dependence is called the semi-variogram.

A semi-variogram is the fundamental autocorrelation tool of geostatistical procedures. It is defined as half of the mean squared difference of a variable for values separated by a distance h as given by the formula:

$$\gamma(h) = \frac{\sum_{i=1}^{n} (x_i - (x_{i+h}))^2}{2n}$$

where,	$\gamma(h)$	is the semi-variogram
	x_i	is the value at location i
	x_{i+h}	is the value at a distance h from i
and	n	is the number of $x_i - (x_{i+h})$ pairs

Gamma (h) is a 3-dimensional function, commonly dependent on direction within a deposit which can also differ from one geological environment to another. An experimental semi-variogram is determined from a set of experimental data (e.g. assay values at known locations) and is shown graphically as a plot of gamma (h) versus h (lag or sample spacing). For practical applications a smooth mathematical model is fitted to the normally saw-toothed graph of an experimental semi-variogram. The most common form of mathematical model in general is the spherical or Matheron model (shown in Figure 4) and given by the formula:

$$\gamma(h) = C_o + C_1 \; (1.5\, h/a - .5\, h^3 / a^3) \qquad \text{for } h \leq a$$
$$= C_o + C_1 \qquad \text{for } h > a$$

where	C_o	is the nugget effect
	C_1	is the structural component
	$C_o + C_1$	is the sill
	a	is the range (or influence of samples)
and	h	is the lag or sample spacing

In many cases where the value of $\gamma(h)$ increases systematically with grade it is convenient to determine a relative semi-variogram in which $\gamma(h)/m^2$ is plotted versus h, where m is the mean value of all samples used to determine an experimental semi-variogram. In this way two (or more) semi-variograms determined for different data sets (with different mean values) become more-or-less equivalent. An alternate approach is to transform (e.g. logarithmic or multigaussian) all the data and then produce normal semi-variograms or semi-variograms of transformed data such as precious metal values.

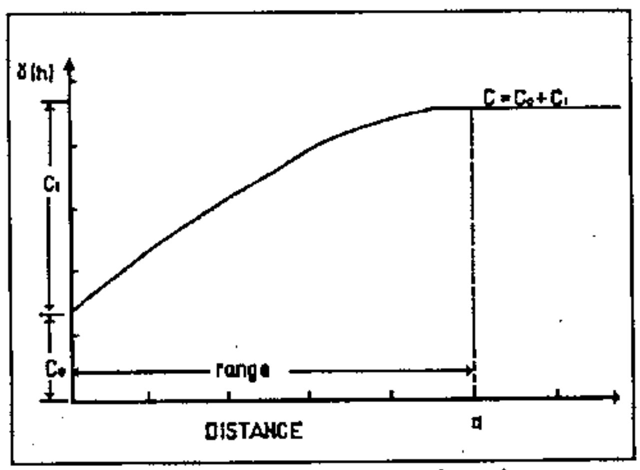


Figure 4 : Ideal spherical semi-variogram model, gamma(h) vs. distance. Co is nugget effect, C is sill value and a is range over which samples are correlated.

4.2 Copper

Composites from the Main Phase Porphyry with less than 0.6 % Cu were used to model copper as this distribution of copper grades represented the main mineralizing event. Relative semi-variograms were produced in four horizontal directions and from these a geometric anisotropy was modelled with longest range in Azimuth 025 and shortest range in Azimuth 115. Nested models were used to fit the data indicating two structures. The semi-variograms are included as Appendix 2 with parameters summarized below.

Nugget Effect (C0)	-	0.100		
Short Range Structure (C1)	-	0.200	-	Range 75 m. at Az. 115
			-	Range 75 m. at Az. 025
Long Range Structure (C2)	-	0.300	-	Range 250 m. at Az. 115
			-	Range 400 m. at Az. 025

4.3 Gold

Composites from the Main Phase Porphyry with gold values less than 1.0 g/t were used to model gold. There was no indication of anisotropy present and a simple spherical model was fit to the average of all horizontal directions. The relative semi-variogram is shown in Appendix 2 with parameters summarized below.

Nugget Effect (C0)	-	0.200
Structural Component (C1)	-	0.650
Sill	-	0.850
Range	-	70 m.

5.0 BLOCK MODELLING BY KRIGING

5.1 Introduction

Kriging, commonly referred to as BLUE (best, linear, unbiased estimator), is a method of determining a weighted average in such a way that the geostatistical estimation variance of the weighted average is minimized. For each block (or point) to be estimated the method involves the solution of a set of linear equations in which unknowns are sample weighting factors (that sum to one) and known coefficients are variances and covariances determined from the semi-variogram model. There are (n+1) equations to solve if there are n samples requiring weighting factors. The general form of kriging equations for the specific case of 3 samples for which weighting factors are required, is as follows:

$$\lambda_1\gamma(s_1\ s_1) + \lambda_2\gamma(s_1\ s_2) + \lambda_3\ \gamma(s_1\ s_3) + \mu = \gamma\ (s_1\ \ B)$$
$$\lambda_1\gamma(s_2\ s_1) + \lambda_2\gamma(s_2\ s_2) + \lambda_3\ \gamma(s_2\ s_3) + \mu = \gamma\ (s_2\ \ B)$$
$$\lambda_1\gamma(s_3\ s_1) + \lambda_2\gamma(s_3\ s_2) + \lambda_3\ \gamma(s_3\ s_3) + \mu = \gamma\ (s_3\ \ B)$$
$$\lambda_1 + \lambda_2 + \lambda_3 = 1$$

where,

λ_i	is the weight for sample s_i
$\gamma(s_i\ s_j)$	is the semi-variogram value between sample s_i and sample s_j
$\gamma(s_i\ B)$	is the mean semi-variogram value between samples and B (the block to be estimated)
μ	is the Lagrange multiplier, a factor that enters the solution of the equation because of the mathematical methodology involved.

In practice, a general block kriging procedure is as follows:

(1) A data file is searched to locate all data within a predetermined, arbitrary distance from the block to be estimated. The distance is normally set so that a practical number of samples will be obtained (say 5 to 20) for each block estimate.

(2) Semi-variogram values (or covariances and variances) are then determined for all sample pairs to provide the matrix of coefficients on the left hand side of the kriging equations (i.e. all the $\gamma(s_i\ s_j)$.

(3) Sample to block semi-variogram values ($\gamma(s_i\ B)$) (or covariances) are calculated for each sample to provide values for the right hand side of the kriging equations.

(4) Kriging equations are solved for the weighting factors using an appropriate solution procedure.

(5) A kriged block estimate is then determined as follows:

$$\lambda_1 s_1 + \lambda_2 s_2 + \lambda_3 s_3 = Z_k$$

where, λ_i *is the weighting factor for sample value* s_i

and Z_k is the kriging estimator

(6) A kriging error (variance) is determined from the formula:

$$\sigma^2 = \lambda_1\ (s_1\ B) + \lambda_2\ (s_2\ B) + \lambda_3\ (s_3\ B) - \mu - \gamma(BB)$$

where σ^2 is the kriging variance

$\lambda_i(s_i\ B)$ is the sample to block covariance

μ is the Lagrange multiplier

and $\gamma(BB)$ is the average point to point covariance for all points within block B. This is a constant for a given semi-variogram model and a constant block size.

(7) The procedure from 1 to 6 above is repeated successively for each block to be estimated.

5.2 Geologic Block Model

A geologic block model was created by Steffen Robertson & Kirsten from sections and level plans produced by American Bullion. Polygons representing the three main rock types were digitized from level plans at 15 m. intervals. A block model with blocks 30 x 30 x 15 m. in dimension, was superimposed on the three dimensional geologic solids based on the following coordinates.

NW Corner of block grid	49,540 E	100,600 N
SE Corner of block grid	51,190 E	99,460 N
Top level	Crest - 1545	Toe - 1530
Bottom level	Crest - 1020	Toe - 1005
55 blocks E-W	38 Blocks N-S	36 Benches

5.3 Results

The method for grade interpolation was ordinary kriging. Based on the geologic block model an estimate was attempted for each block with codes 1 or 2. For blocks coded as 1 (Late Phase Porphyry) only composites coded 1 were searched and likewise for code 2 (Main Phase Porphyry). If a minimum of four composites were found within a search area of 75 m. x 75 m. x 38 m. vertical from the block centre the block was estimated. If not, a grade was not interpolated for the block.

The results are summarized as a grade-tonnage tables for a range of copper cutoff values for each rock type in Tables 1 and 2. Gold values contained within the blocks above each cutoff interval are shown.

TABLE 1 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Main Phase Porphyry Using SG=2.79

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	444,330,000.	.316	.248
.150	385,610,000.	.345	.270
.200	320,380,000.	.379	.296
.250	251,640,000.	.421	.328
.300	186,140,000.	.473	.364
.350	137,400,000.	.526	.410
.400	100,110,000.	.584	.458
.450	77,700,000.	.630	.505
.500	60,830,000.	.674	.549
.550	47,420,000.	.716	.592
.600	36,760,000.	.757	.642
.650	25,910,000.	.813	.721
.700	18,120,000.	.873	.815
.750	13,150,000.	.929	.897
.800	9,640,000.	.987	.969
.850	7,720,000.	1.028	1.021
.900	6,210,000.	1.065	1.056
.950	4,820,000.	1.106	1.107
1.000	3,620,000.	1.149	1.150
1.100	2,110,000.	1.223	1.224
1.200	1,130,000.	1.299	1.274
1.300	450,000.	1.380	1.404
1.400	150,000.	1.448	1.554
1.500	38,000.	1.510	1.440

TABLE 2 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Late Phase Dykes

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	640,000.	.110	.079

5.4 Classification

Classification of a resource into the traditional Proven, Probable and Possible categories has always involved a subjective evaluation on the part of the practitioner. This is especially true when there are no underground workings available and the estimate is based purely on drill holes and surface sampling. The confidence one can place on interpolated grades depends directly on two sources of error.

First, there must be confidence in geologic continuity. Are the mineralized beds more or less continuous along strike and are contacts consistent and easy to trace or do faults and/or disconformities disrupt geologic interpretation from cross section to cross section ?

The second area of concern involves continuity of mineralization within geologic units. The semi-variogram allows us to quantify the degree of confidence that mineralization is continuous in various directions through the deposit. For copper, the range of the semi-variograms, or the maximum distance that two samples are correlated, varied from a maximum of 450 m. to a minimum of 250 m. These ranges compare with a drilling grid on less than 100 m. centres (see Figure 1).

The degree of confidence one can place on a kriged block grade is expressed as a kriging variance. By dividing by the kriged grade and converting to a percentage, this confidence can be expressed as a relative estimation error. The relative estimation error for each kriged block can be used to classify the block into Proven, Probable and Possible categories. Unfortunately there is no standard way of relating errors to categories as the estimation errors are not only related to sample density and continuity of mineralization but also to the size of the block estimated. Obviously as block size increases the errors of estimation will decrease. There is always a 'trade-off' between small blocks that accurately depict geologic units and large blocks with low estimation errors.

For the Red Chris deposit reasonable size estimation blocks (30 x 30 x 15 m) were chosen.

As a result, relative estimation errors for copper range from +/- 19% to 100%. When a histogram of copper estimation errors is produced (see Figure 5), one can see three overlapping populations of errors; a lower population (centred about 27 %), a middle population (centred about 50 %) and a upper population (centred about 80 %). Since the geologic continuity for this deposit is good, the sample density is relatively close and the range for semi-variograms is longer than most sample spacings the categories Proven, Probable and Possible were assigned to these three populations. Using the thresholds that separate these three populations of 35% and 68%, it was therefore possible to classify each block into Proven, Probable or Possible on the basis of it's estimation error. Grade-tonnage tables showing the results for each category are shown as Tables 3 to 8.

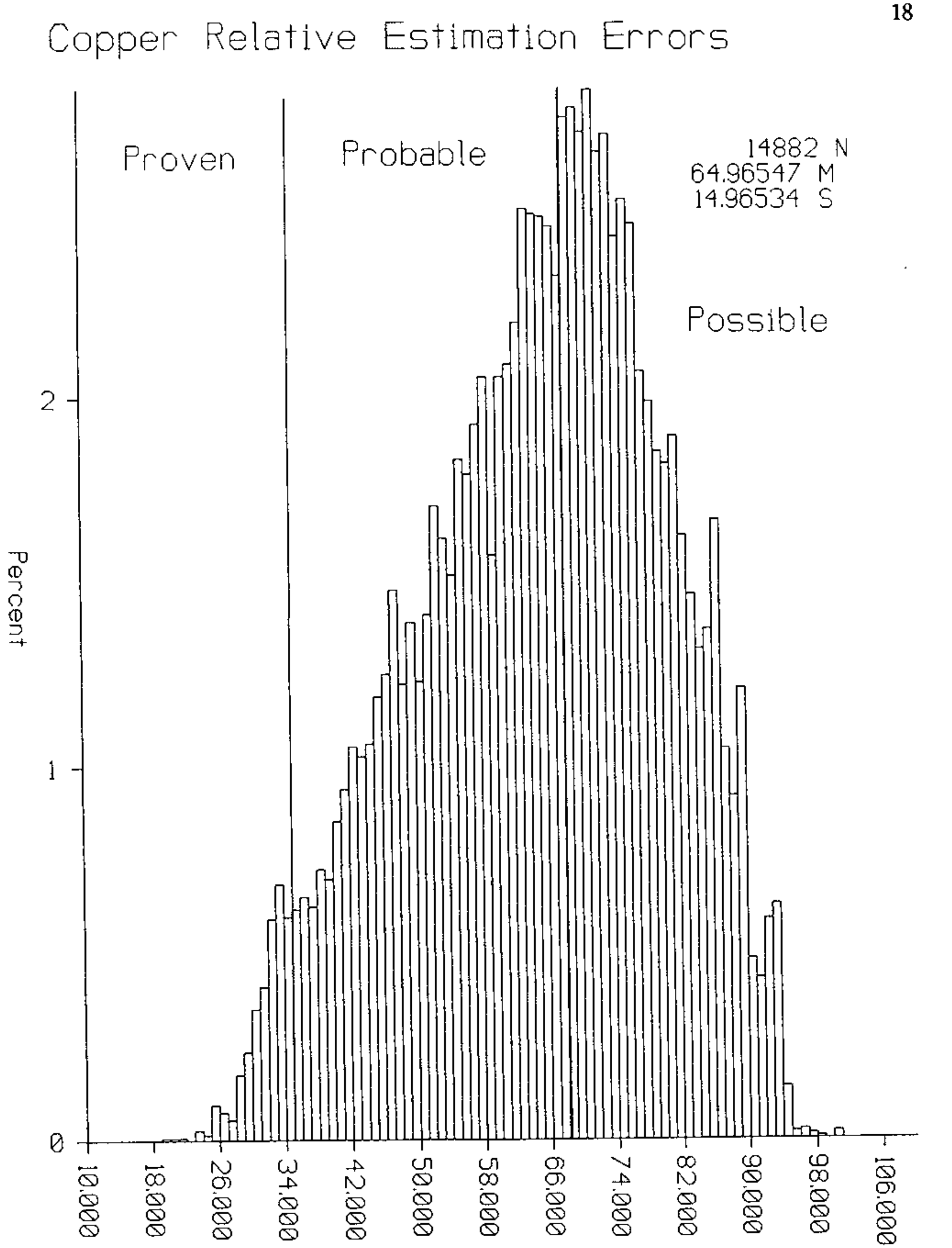

Copper Relative Estimation Errors
Proven
Probable
Possible
14882 N
64.96547 M
14.96534 S
Percent
0
1
2
10.000
18.000
26.000
34.000
42.000
50.000
58.000
66.000
74.000
82.000
90.000
98.000
106.000
Relative Cu Error %

Figure 5

TABLE 3 : *Red Chris Grade-Tonnage for In Situ Geologic Resource*
1995 Results for Main Phase Porphyry Using SG=2.79
Classed as Proven

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	15,330,000.	.334	.251
.150	13,450,000.	.364	.272
.200	11,220,000.	.401	.297
.250	8,960,000.	.446	.325
.300	7,120,000.	.490	.357
.350	5,500,000.	.539	.383
.400	4,330,000.	.583	.412
.450	3,390,000.	.627	.434
.500	2,750,000.	.664	.456
.550	2,070,000.	.710	.493
.600	1,360,000.	.784	.569
.650	980,000.	.846	.651
.700	720,000.	.908	.699
.750	640,000.	.931	.728
.800	450,000.	1.000	.826
.850	340,000.	1.059	.846
.900	260,000.	1.109	.902
.950	190,000.	1.186	1.009
1.000	150,000.	1.233	1.016
1.100	150,000.	1.233	1.016
1.200	110,000.	1.268	1.142
1.300	38,000.	1.352	1.351

TABLE 4 : *Red Chris Grade-Tonnage for In Situ Geologic Resource*
1995 Results for Late Phase Dykes Using SG=2.79
Classed as Proven

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	38,000.	.147	.110

TABLE 5 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Main Phase Porphyry Using SG=2.79
Classed as Probable

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Grade > Cutoff Au (g/t)
.100	220,530,000.	.343	.270
.150	198,610,000.	.366	.287
.200	169,720,000.	.399	.311
.250	138,760,000.	.438	.339
.300	109,190,000.	.482	.372
.350	81,470,000.	.536	.418
.400	61,050,000.	.591	.468
.450	48,170,000.	.636	.516
.500	38,460,000.	.677	.558
.550	30,400,000.	.718	.601
.600	23,470,000.	.760	.653
.650	17,180,000.	.810	.719
.700	12,470,000.	.862	.792
.750	8,550,000.	.924	.884
.800	6,140,000.	.984	.955
.850	4,970,000.	1.022	1.008
.900	4,030,000.	1.056	1.038
.950	3,200,000.	1.091	1.072
1.000	2,180,000.	1.144	1.123
1.100	1,170,000.	1.230	1.205
1.200	640,000.	1.304	1.253
1.300	260,000.	1.382	1.352
1.400	110,000.	1.463	1.552
1.500	38,000.	1.510	1.440

TABLE 6 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Late Phase Dykes Using SG=2.79
Classed as Probable

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Grade > Cutoff Au (g/t)
.100	188,000.	.111	.083

TABLE 7 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Main Phase Porphyry Using SG=2.79
Classed as Possible

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	208,480,000.	.286	.224
.150	173,560,000.	.318	.251
.200	139,440,000.	.353	.278
.250	103,920,000.	.397	.312
.300	69,830,000.	.457	.353
.350	50,430,000.	.509	.399
.400	34,730,000.	.571	.447
.450	26,140,000.	.620	.494
.500	19,620,000.	.668	.544
.550	14,950,000.	.714	.586
.600	11,940,000.	.749	.628
.650	7,760,000.	.814	.733
.700	4,930,000.	.897	.891
.750	3,950,000.	.939	.952
.800	3,050,000.	.990	1.020
.850	2,410,000.	1.035	1.071
.900	1,920,000.	1.076	1.115
.950	1,430,000.	1.129	1.197
1.000	1,280,000.	1.146	1.213
1.100	790,000.	1.210	1.292
1.200	380,000.	1.299	1.349
1.300	150,000.	1.384	1.508
1.400	38,000.	1.405	1.561

TABLE 8 : Red Chris Grade-Tonnage for In Situ Geologic Resource
1995 Results for Late Phase Dykes Using SG=2.79
Classed as Possible

Cutoff (Cu %)	Tonnes > Cutoff (tonnes)	Grade > Cutoff Cu (%)	Au (g/t)
.100	410,000.	.106	.074

6.0 CERTIFICATE

I, G.H. Giroux, of 982 Broadview Drive, North Vancouver, British Columbia, do hereby certify that:

1. I am a consulting geological engineer with an office at #701 - 675 West Hastings Street, Vancouver, British Columbia.

2. I am a graduate of the University of British Columbia in 1970 with a B.A. Sc. and in 1984 with a M.A. Sc. both in Geological Engineering.

3. I have practised my profession continuously since 1970.

4. I am a member in good standing of the Association of Professional Engineers of the Province of British Columbia.

5. This report is based on a study of available data provided by American Bullion Minerals Ltd. and no site visit was made.

6. I have no interest, either direct or indirect in the properties or securities of American Bullion Minerals Ltd., nor do I expect to receive any such interest.

G. H. Giroux, P.Eng., MASc.
February 10, 1995

APPENDIX 1

HISTOGRAMS AND CUMULATIVE PROBABILITY PLOTS FOR RED CHRIS COPPER

```
10:47:32   RED CHRIS COPPER FROM 15M. COMPOSITES                    10/20/94

########################################################################
SUMMARY STATISTICS and HISTOGRAM                        ARITHMETIC VALUES

 Variable = CU                  Unit =   %                   N =  1360

     Mean =     0.284        Min =     0.001  1st Quartile =     0.081
Std. Dev. =     0.324        Max =     3.878        Median =     0.199
     CV % =   114.299   Skewness =     3.525  3rd Quartile =     0.356

========================================================================
  %   cum %   cls int           (# of bins = 32  -  bin size =    0.125)
----- -----  -------            --------------------------------------
 0.00  0.04   -0.062
19.78 19.80    0.064            ******************************* -->   72
28.75 48.53    0.189            ******************************* -->  104
22.43 70.94    0.314            ******************************* -->   82
 9.85 80.79    0.439            ************************************
 6.54 87.33    0.564            ************************
 3.97 91.29    0.689            **************
 3.09 94.38    0.814            ***********
 1.40 95.78    0.939            *****
 1.40 97.17    1.064            *****
 0.88 98.05    1.189            ***
 0.22 98.27    1.314            *
 0.44 98.71    1.439            **
 0.29 99.01    1.564            *
 0.29 99.30    1.689            *
 0.22 99.52    1.814            *
 0.00 99.52    1.940
 0.07 99.60    2.065
 0.07 99.67    2.190
 0.00 99.67    2.315
 0.00 99.67    2.440
 0.07 99.74    2.565
 0.00 99.74    2.690
 0.00 99.74    2.815
 0.15 99.89    2.940            *
 0.00 99.89    3.065
 0.00 99.89    3.190
 0.00 99.89    3.315
 0.00 99.89    3.440
 0.00 99.89    3.565
 0.00 99.89    3.690
 0.00 99.89    3.815
 0.07 99.96    3.941
------------------------------------------------------------------------
                               0         1         2         3         4

                     Each "*" represents approximately 3.7 observations.

########################################################################
```

10:47:41 RED CHRIS COPPER FROM 15M. COMPOSITES 10/20/94

##

SUMMARY STATISTICS and HISTOGRAM LOGARITHMIC VALUES

Variable = CU Unit = % N = 1360

Mean =	-0.7905	Min =	-3.0000	1st Quartile =	-1.0915
Std. Dev. =	0.5111	Max =	0.5886	Median =	-0.7011
CV % =	64.6559	Skewness =	-0.6358	3rd Quartile =	-0.4486

Anti-Log Mean = 0.162 Anti-Log Std. Dev. : (-) 0.050
(+) 0.526

%	cum %	antilog	cls int	(# of bins = 32 - bin size = 0.1158)
0.00	0.04	0.001	-3.0579	
0.29	0.33	0.001	-2.9421	*
0.00	0.33	0.001	-2.8264	
0.00	0.33	0.002	-2.7106	
0.00	0.33	0.003	-2.5948	
0.00	0.33	0.003	-2.4791	
0.00	0.33	0.004	-2.3633	
0.00	0.33	0.006	-2.2475	
0.22	0.55	0.007	-2.1318	*
0.22	0.77	0.010	-2.0160	*
2.06	2.83	0.013	-1.9003	*******
1.84	4.67	0.016	-1.7845	*******
1.91	6.58	0.021	-1.6687	*******
2.57	9.15	0.028	-1.5530	*********
3.24	12.38	0.037	-1.4372	************
3.01	15.39	0.048	-1.3215	***********
4.26	19.65	0.062	-1.2057	****************
5.51	25.17	0.081	-1.0899	********************
6.40	31.56	0.106	-0.9742	***********************
7.06	38.61	0.139	-0.8584	**************************
8.31	46.91	0.181	-0.7426	******************************
10.96	57.86	0.236	-0.6269	******************************* --> 40
12.35	70.21	0.308	-0.5111	******************************* --> 45
8.09	78.29	0.402	-0.3954	*****************************
7.21	85.49	0.525	-0.2796	**************************
5.66	91.15	0.686	-0.1638	*********************
4.26	95.41	0.895	-0.0481	****************
2.65	98.05	1.169	0.0677	**********
0.81	98.86	1.526	0.1834	***
0.66	99.52	1.992	0.2992	**
0.22	99.74	2.600	0.4150	*
0.15	99.89	3.394	0.5307	*
0.07	99.96	4.431	0.6465	
				0 1 2 3 4

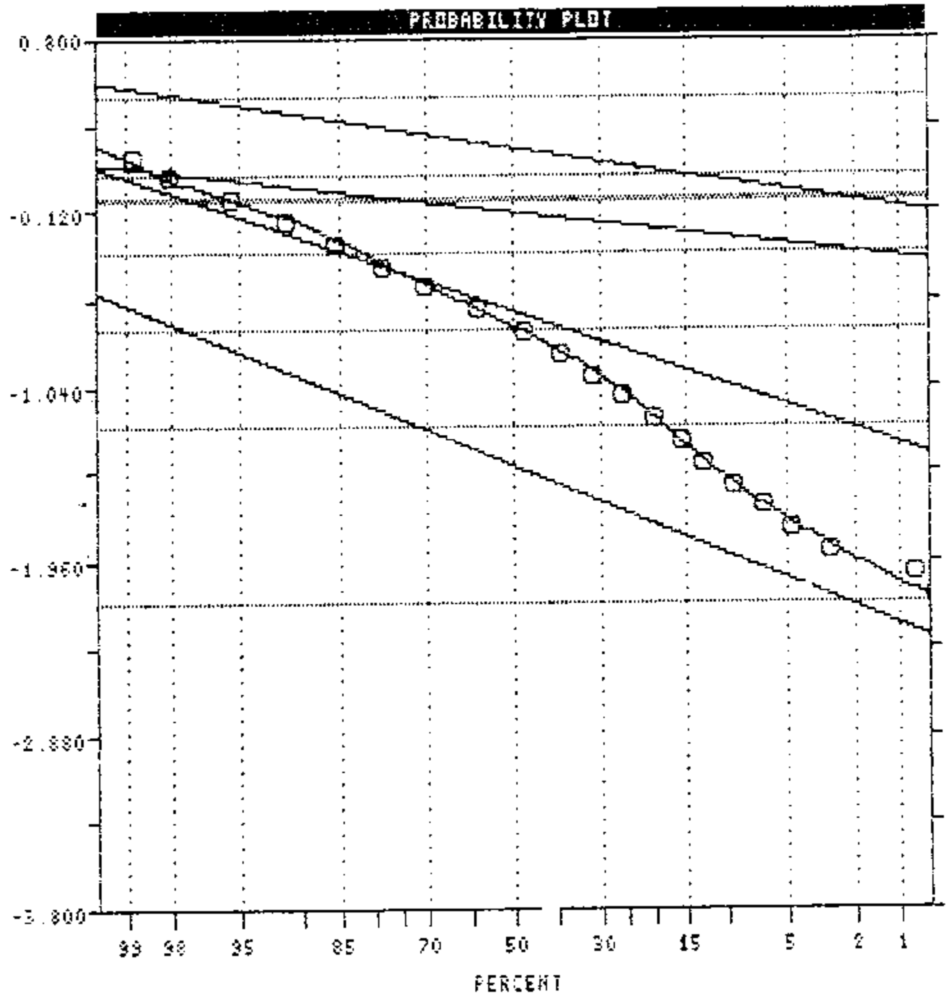
Each "*" represents approximately 3.7 observations.

##

10:50:02

10/20/94

RED CHRIS COPPER FROM 15M. COMPOSITES



LOGARITHMIC VALUES

=========== ======

VARIABLE = CU

UNIT = %

N = 1360

N CI = 32

POPULATIONS

===========

Pop.	Mean	Std.Dev.	%
1	-1.4663	0.3643	22.6
2	-0.6485	0.3014	69.1
3	-0.1232	0.1003	7.2
4	0.2079	0.1369	1.2

Pop.	THRESHOLDS	
1	-2.1949	-0.7378
2	-1.2512	-0.0458
3	-0.3311	0.0727
4	-0.0659	0.4816

CLASS INTERVAL ML

PARAMETER ESTIMATES

##

PARAMETER SUMMARY STATISTICS FOR PROBABILITY PLOT ANALYSIS

Data File Name = D:\DATA\REDCHRIS\RCCOMP.PPP

Variable = CU Unit = % N = 1360
N CI = 32

Transform = Logarithmic Number of Populations = 4

# of Missing Observations = 0.

==

Class Interval Data Maximum Likelihood Parameter Estimates

Maximum LN Likelihood Value = -3892.838

Parameterized Degrees of Freedom = 7

Population	Mean		Std Dev	Percentage
1	0.034	-	0.015	22.56
		+	0.079	
2	0.225	-	0.112	69.05
		+	0.450	
3	0.743	-	0.589	7.17
		+	0.937	
4	1.614	-	1.178	1.22
		+	2.212	

==

Default Thresholds.

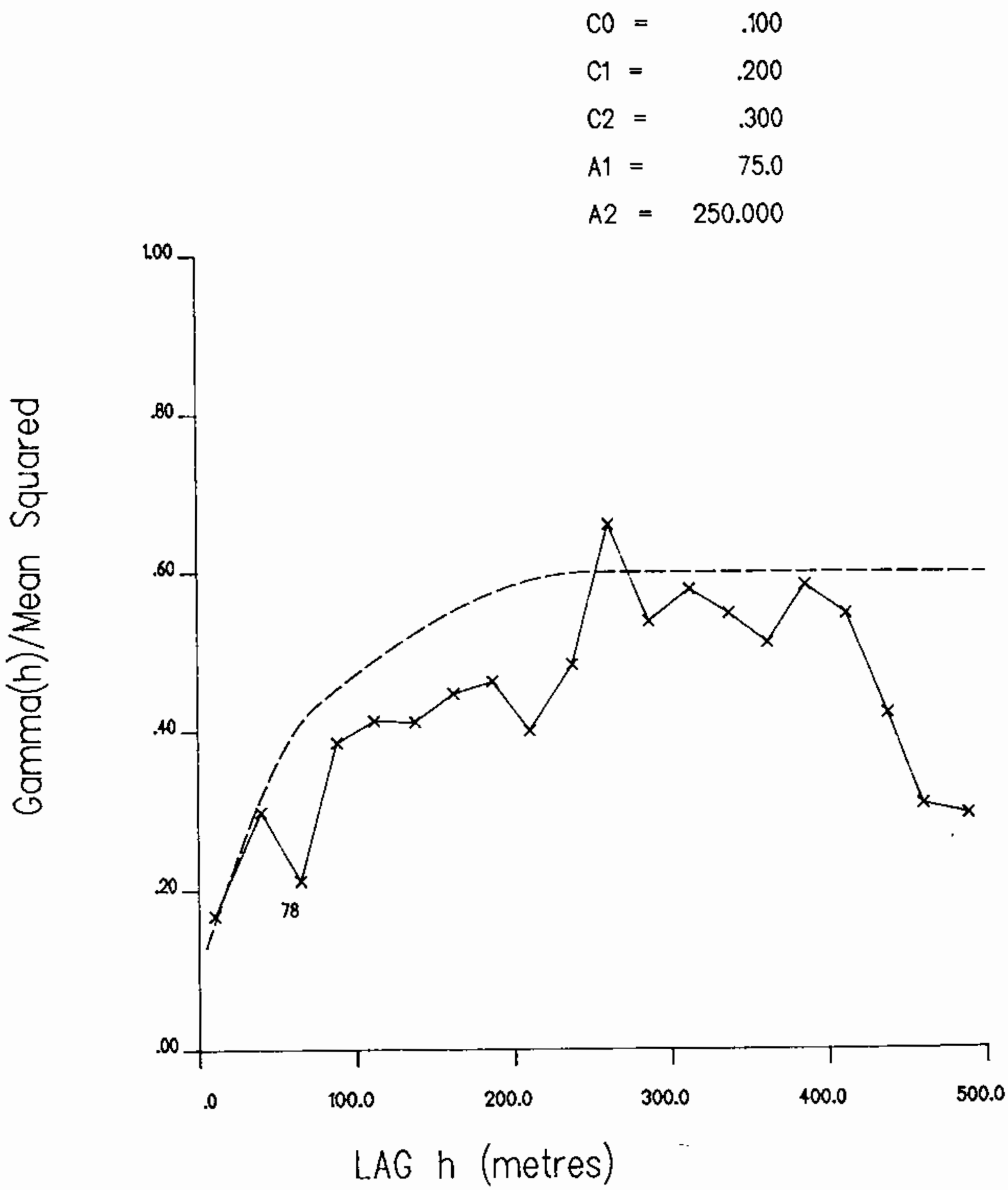
Standard Deviation Multiplier = 2.0

Pop.	Thresholds	
1	0.006	0.183
2	0.056	0.900
3	0.467	1.182
4	0.859	3.031

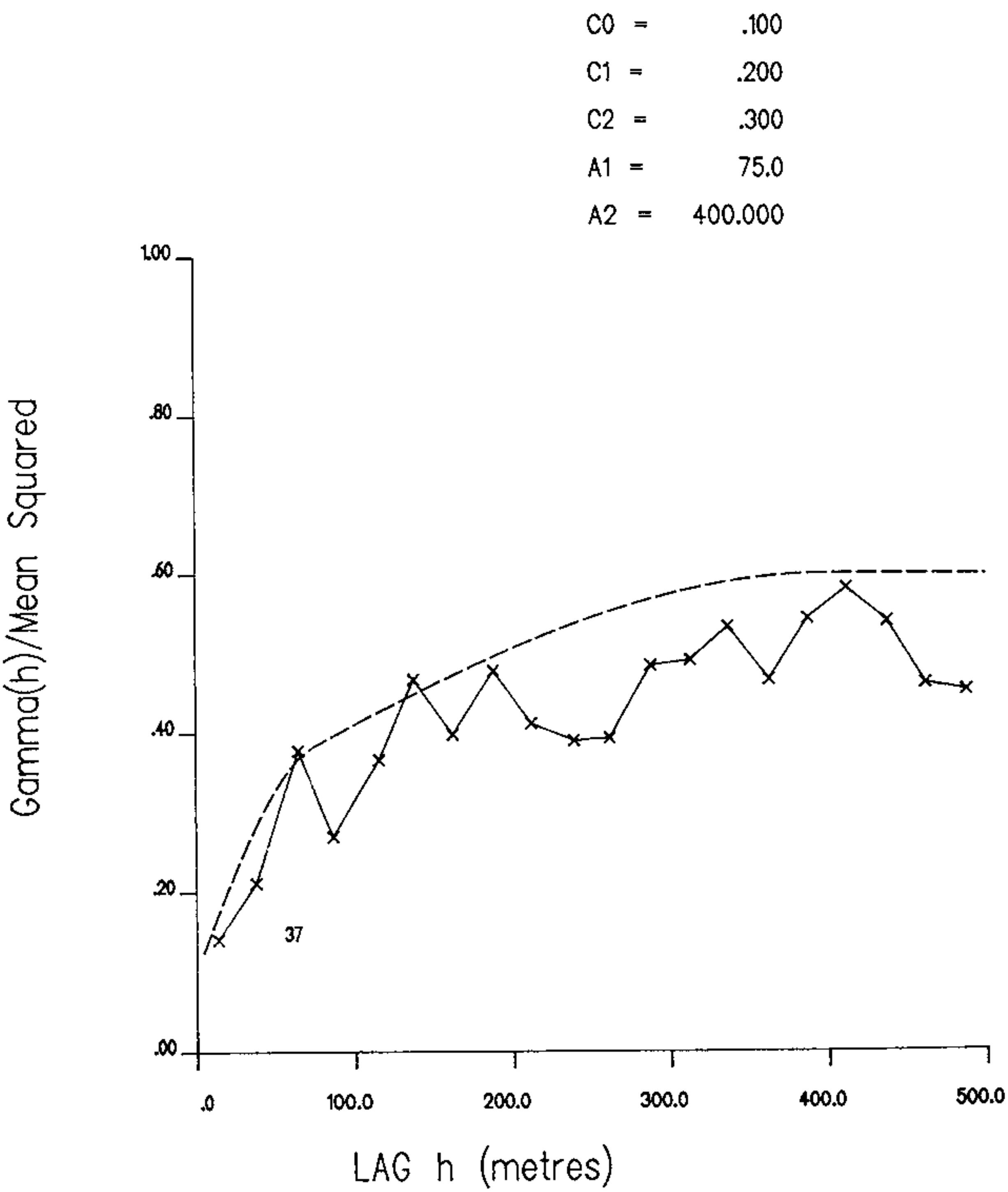
##

APPENDIX 2

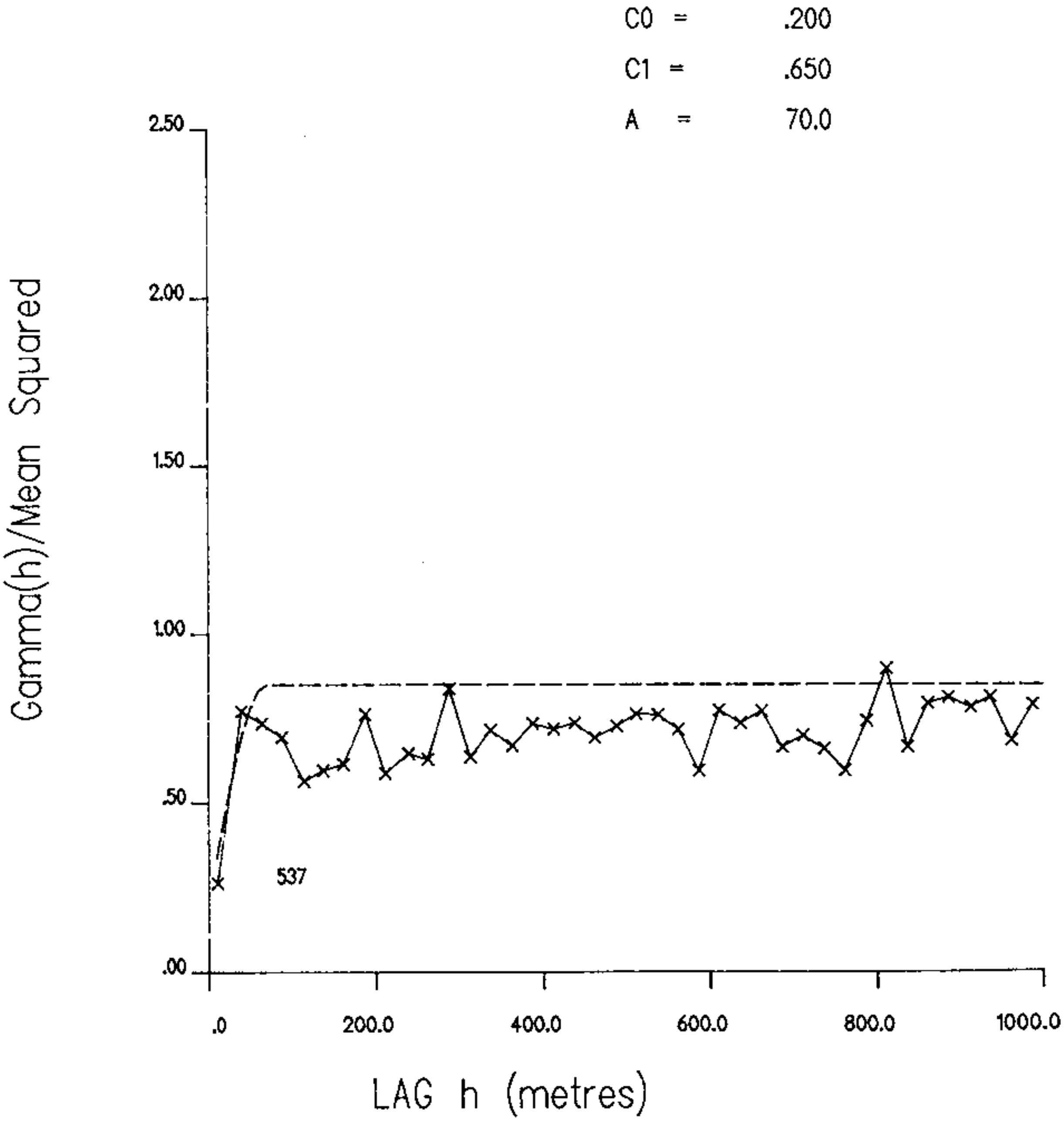
RELATIVE SEMI-VARIOGRAMS
FOR
COPPER
AND
GOLD



RED CHRIS Cu < 0.6% UNIT 2 Azimuth 115



RED CHRIS Cu < 0.6% UNIT 2 Azimuth 025



RED CHRIS Au < 1.0 g/t - Average