Ancient Pacific Margin Natmap Part IV: Surficial Mapping and Till Geochemistry in the Swift River Area, Northwestern British Columbia

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KEYWORDS: *Quaternary, Surficial Geology, Till, Geochemistry, Exploration, Swift River, Teslin Lake.*

INTRODUCTION

An integrated surficial mapping and detailed till geochemistry project was conducted in the summer of 1999 by the British Columbia Geological Survey Branch in northwestern British Columbia. Recent volcanogenic massive sulphide (VMS) discoveries such as Kudz Ze Kayah and Wolverine and intrusive related gold deposits like Pogo within the Yukon-Tanana Terrane have provided an impetus for geological studies to examine similar age rocks in British Columbia. These deposits are an important source of copper, zinc, gold and silver. Previous mapping indicates that the Big Salmon Complex (Mihalynuk *et al*., 1998) and Dorsey Terrane (Nelson, 1999) are Yukon-Tanana equivalent and contain appropriate rocks/stratigraphy to host mineralization. Given the widespread drift cover in the study area and high mineral potential, there was an obvious need to integrate Quaternary studies to develop exploration strategies for new buried targets. This study is a component of the Ancient Pacific Margin NATMAP project and associated work includes bedrock mapping (Nelson, this volume; Mihalynuk *et al*., this volume) and multi-media geochemical surveys (Cook and Pass, this volume).

Surficial mapping was completed over the Big Salmon Complex to understand the local glacial history and aid in the interpretation of geochemical data. Mapping of surficial sediments defines the distribution of preferred sampling media (*e.g.* till) and bedrock exposure. Compilation of ice-flow indicator data enables the reconstruction of local paleo-ice-flow history and can consequently be used to define the methodologies for sampling down ice dispersal patterns. Till sampling assists in defining the size and shape of geochemical anomalies over a known mineral showings as well as select perspective host rocks. Characterization of geochemical signatures and dispersal in the study area will assist in the development of future geochemical exploration projects.

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The main objectives of the program were to stimulate exploration and economic activity in the area by:

- producing a 1:100 000 surficial geology map, identifying unconsolidated units suitable for geochemical sampling and tracing of mineral anomalies to their bedrock sources;
- collecting and mapping ice-flow indicators (*e.g.* striae, drumlins) to establish paleo-ice-flow directions to assist in the interpretation of geochemical trends;
- conducting till geochemical case studies at known prospects to better develop and refine the geochemical response of mineralization; and
- further defining areas of high mineral potential through till geochemistry.

The results of the surficial mapping component, including an interpretation of surficial deposits, and detailed geochemical studies are briefly described in this paper.

PHYSIOGRAPHIC AND GEOLOGIC SETTING

The study area, covering about 4,000 square kilometres, is located in northwestern British Columbia approximately 100 kilometres north-east of Atlin (Figure 1) and is coincident with NTS map areas 104N/9, 16 and 104O NW. The gently rolling Nisutlin Plateau covers the western half of the area, and the rugged Stikine Range of Cassiar Mountains the eastern margin. Teslin Lake forms the western margin of the area, whereas the northern boundary is shared with the British Columbia-Yukon border. Elevations range from nearly 700 metres to more than 2,100 metres above sea level. Simpson Peak (2,173 metres) is the highest mountain in the region. The Alaska Highway, the primary road access, crosses the northern portion of the area.

The rolling topography of the Nisutlin Plateau is covered by thick glacial sediments. Several bluffs and ridges composed of bedrock are found throughout the plateau, but few rise more than 300 metres above their surroundings. Many lakes occur in the area, most ranging in size from small ponds (10's of metres) to 5 kilometres. Teslin Lake, the largest water body in the study area is nearly

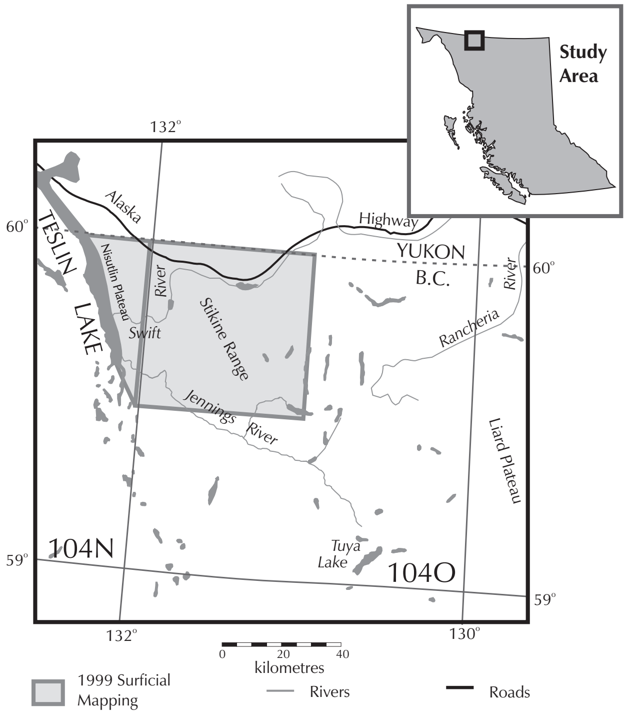

Figure 1. Location of Swift River study area, north western British Columbia.

200 kilometres long. Swamps and marshes cover areas where drainage is poor.

Mountains of the Stikine Range have sharp peaks linked by narrow arêtes. Their scree strewn slopes are generally steep and cut by cirques. Deep, broad north-south trending valleys are filled with thick deposits of glacial sediments which are being reworked by modern fluvial systems. Kettle lakes and moraine dammed lakes are common.

VEGETATION AND CLIMATE

The Swift River area lies within the boreal white and black spruce, spruce-willow-birch, and alpine tundra biogeoclimatic zones (MacKinnon *et al.*, 1992). Winters are long and cold, and summers short, cool and wet. The ground remains frozen for much of the year. Mean annual temperatures are commonly below 0°C and precipitation in the valleys averages 400 to 500 millimetres per year (BC Ministry of Environment, 1978).

The relatively well-drained shores of Teslin Lake and river valleys are covered with trembling aspen and lodgepole pine. Where the topography is flat and poorly drained, the landscape is typically a mosaic of black spruce bogs and white spruce and trembling aspen stands. In the subalpine areas, stands of stunted white spruce and fir grow on the lower slopes. Above treeline (1500 metres), long, cold winters create conditions too severe for the growth of most woody plants. This zone is dominated by dwarf shrubs (*e.g.* birch, willow), herbs, mosses, lichens, and grassland (MacKinnon *et al.*, 1992).

BEDROCK GEOLOGY

Bedrock geology studies were initially completed within the region by Gabrielse (1969), Aitken (1959) and Watson and Mathews (1944). Most recently, detailed mapping has been conducted by Mihalynuk *et al.*, (2000b) in the Big Salmon Complex and by Nelson *et al.* (2000) in the Dorsey Terrane to the southeast. Devono-Mississippian rocks of the Big Salmon Complex underlie much of the study area (Figure 2).

The Big Salmon Complex is a sequence of stratified rocks that have been metamorphosed and undergone several episodes of folding (Mihalynuk *et al.*, 1998; Nelson *et al.*, 1998). From youngest to oldest, stratified units include siliciclastic rocks and interbedded felsic tuffs, limestone, manganiferous chert, quartz-rich greywacke, orthogneiss and greenstone dominated by epiclastics (Mihalynuk *et al.*, 2000).

The Big Salmon Complex rocks have been intruded by Jurassic and Cretaceous granitoids and are overlain by Pleistocene to Recent basalt of the Tuya Formation. The exact age of the basalts is unknown, however, volcanic activity preceded and then continued during a time of glaciation (Gabriesle, 1969). For a complete description of the geology of the Big Salmon Complex, refer to Mihalynuk *et al.* (this volume).

Mineral Showings

The Arsenault copper prospect (MINFILE 104O 011) is the only developed property in the area with potential for hosting VMS mineralization. It is located approximately 14 kilometres south of the Smart and Swift Rivers confluence, on the west side of Mount Francis (Figure 2). Copper mineralization was discovered on the property in the 1940's (Sawyer, 1979) and geological and geochemical work was performed on the property in 1967 (Sawyer, 1967) and 1970's (Sawyer, 1979; Phendler, 1982). Exploration work included trenching, geophysical surveys (airborne EM, magnetometer, induced polarization), soil surveys, geological mapping and diamond drilling.

Host rocks include interbedded metasedimentary and metavolcanic lithologies such as carbonates, quartzite and schist. Mineralization at the surface is best exposed in quartz-rich strata containing disseminated and blebs of chalcopyrite and pyrite with associated epidote, garnet, actinolite, magnetite and wollastonite in contact with carbonate. Sawyer (1979) also reported traces of bornite, molybdenite, piedmontite (manganese-epidote) and spessartine (manganese-garnet).

The type of mineralization forming the Arsenault prospect is poorly understood. Although quartz-carbonate association and calc-silicate mineralogy and textures suggest a skarn association, there are no significant intrusive bodies exposed nearby (Mihalynuk *et al.*, 1998). A volcanogenic origin has also been proposed (Sawyer, 1979) and recent work has centred on the VMS potential of the host rocks in the area (Traynor, 1999). Elevated selenium in soils also supports a syngenetic origin as the

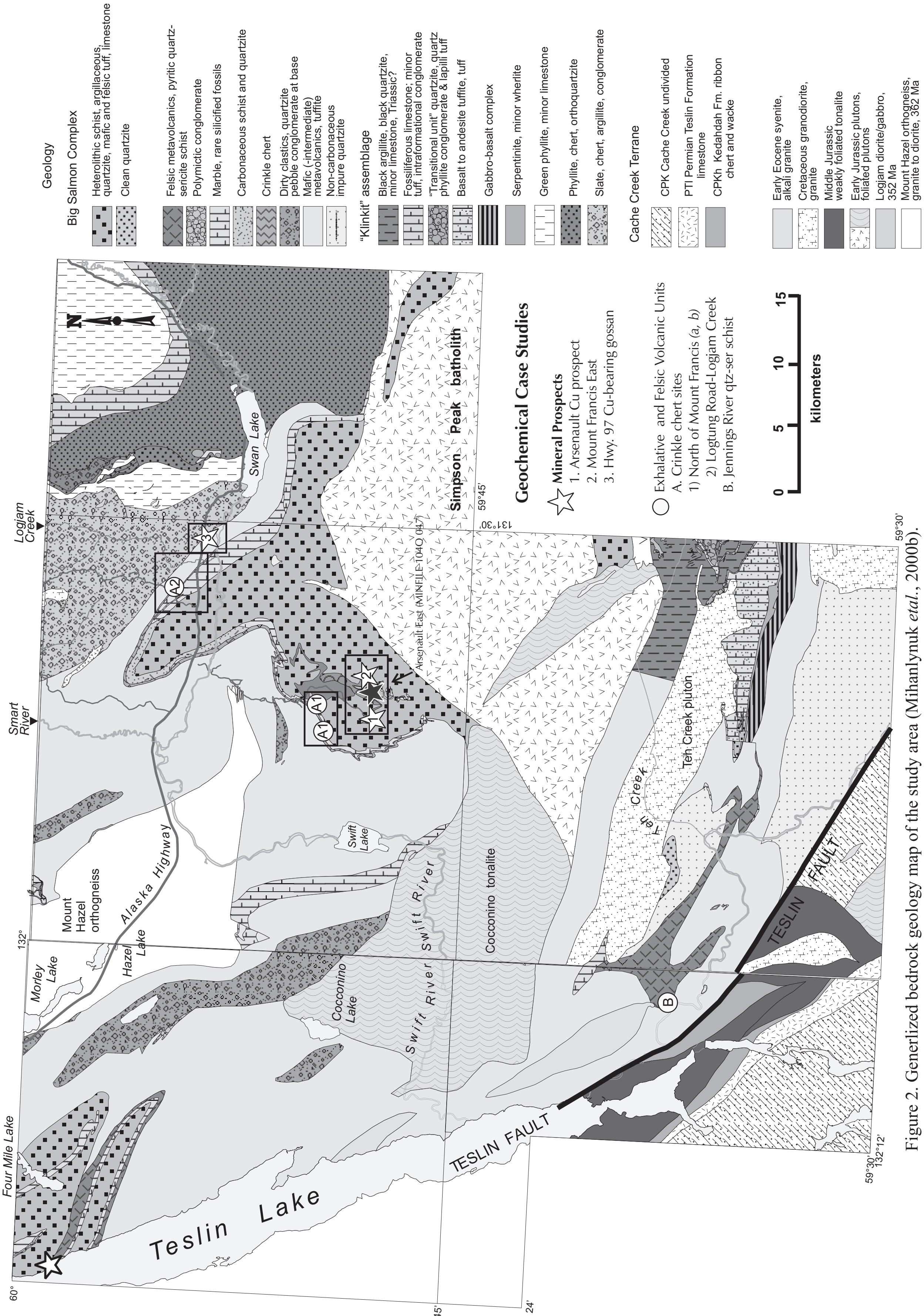

Figure 2. Generlized bedrock geology map of the study area (Mihanlynuk *etal.*, 2000b).

VMS deposits in the Yukon Tanana Terrane (*e.g.* Kudz Ze Kayah and Wolverine) are selenium-rich (Cook and Pass, this volume).

Arsenault East (MINFILE 104O 047), a new mineral occurrence interpreted as occurring in about the same 100 metres stratigraphic interval as the Arsenault prospect, was discovered by Mihalynuk *et al.* (1998) on the east flank of Mount Francis. The showing consists of a 10 metre-long chalcopyrite-bearing vein replacement zone developed in carbonate rocks. Another new mineral occurrence discovered by Mihalynuk *et al.* (1998) includes the Highway 97 Cu-bearing gossum(MINFILE 104O 054; Figure 2).

METHODOLOGIES

During an initial compilation phase, all existing geological and geochemical information for the area was evaluated. Surficial maps of Klassen (1982, 1978) and Morison and Klassen (1997) provided background data on the types of sediments expected. Regional mapping by the Geological Survey of Canada (Gabrielse, 1969) and British Columbia Department of Mines (Watson and Mathews, 1944) provided additional information on the type and distribution of surficial sediments as well as paleo-ice-flow patterns. Regional Geochemical Survey (RGS, 1978, 1979) stream and lake sediment data and property scale geochemical surveys (*e.g.* Sawyer, 1967) provided limited geochemical information for the area.

Airphoto analysis and 'pretyping' followed the terrain classification system of Howes and Kenk (1997). Air photos at a scale of 1:70,000 (flight lines BC88063, BC88080 and BC37067) were used in the map generation. Thirty-three 1:20,000 digital TRIM maps were tiled for the base map, produced at a scale of 1:100,000 (Dixon-Warren and Hickin, 2000). About 20 per cent of the preliminary polygon interpretations were verified through field checking, corresponding to a Terrain Survey Intensity Level D (Resources Inventory Committee, 1996).

Field Methods

Fieldwork was conducted over a four week period during July and August from a base camp on Morley Lake, near the British Columbia-Yukon border. Most fieldwork was helicopter supported. Road access was restricted to the northern portion of the study area along the Alaska Highway (Highway 97) and along spur roads to borrow pits and mineral showings.

At each field verification station some or all of the following was recorded: UTM location, elevation, general slope, type of exposure (*e.g.* road cut, river cut), geographic landforms (*e.g.* terrace, floodplain, ridge), type of bedrock (if present), unconsolidated surface material and expression (terrain polygon designation), and orientation of striations/grooves/stoss and lee forms. Surficial sediments were described and interpreted at relevant stations. Logged information included: number of units, stratification, bedding thickness, sorting, texture, structures, and colour (wet and dry), clay content, clast content (per cent), clast roundness and size, and dominant lithologies.

Forty-five bulk sediment samples (approximately 5 kilograms in size) were collected for geochemical analysis at six sites in the study area. Basal till was the preferred media, although colluviated tills and colluvium were sampled where necessary. Natural exposures and hand excavation were used to obtain samples from undisturbed C horizon material. At each site, the above information was recorded, in addition to: type of exposure (*e.g.* roadcut, rivercut, excavated trench); depth to sample from top of soil; matrix or clast-supported diamicton; consolidation; matrix texture; structures; clast shape, size and lithology; clast percentages; and colour. Table 1 compares some the descriptive properties of each sample collected.

Till samples were submitted to Bondar Clegg-Intertek Laboratories, North Vancouver, for drying and sieving to <63 microns (-230 mesh). A 5 gram and 25 gram portion split were taken from the <63 micron samples. Acme Analytical Laboratories, Vancouver, analyzed the 5 gram split for a suite of trace elements by aqua regia digestion-ICPMS (inductively coupled plasma mass spectroscopy; Table 2) and for major element oxides by lithium metaborate ($LiBO_2$) fusion-ICP (11 oxides, loss on ignition and 7 minor elements; Table 4). The 25 gram split was submitted to Activation Laboratories, Ancaster, Ontario, for thermal neutron activation analysis (INAA) for 35 elements (Table 3). Data for 29 elements (gold, antimony, arsenic, barium, bromine, calcium, cerium, cesium, chromium, cobalt, europium, hafnium, iron, lanthanum, lutetium, molybdenum, neodymium, rubidium, samarium, scandium, selenium, sodium, tantalum, terbium, thorium, tungsten, uranium, ytterbium, and zinc) are reported here. Additional data for six other elements (silver, mercury, iridium, nickel, tin and strontium) are not reported due to factors such as low elemental abundance and inadequate detection limits.

Quality Control

Quality control is important for distinguishing geochemical trends caused by geological features versus those resulting from anthropogenic influences, spurious sampling or analytical errors. In order to evaluate geochemical sampling and analytical variability, field triplicate samples, laboratory duplicate samples and reference standards were incorporated in the sample suites submitted for commercial laboratory analysis. The standards, triplicates and duplicates are inserted into each batch of 20 prepared samples to measure accuracy and precision. Each batch of 20 samples contained sixteen routine till samples, a field triplicate collected adjacent to a routine sample, a blind duplicate sample split from one of the sixteen samples prior to analysis, and a control reference standard containing material of known element concentrations (either Canada Centre for Mineral and Energy Technology certified standard or a Geological Survey Branch 'prepared bulk standard'). Commonly, elements

TABLE 1
DESCRIPTION OF TILL PHYSICAL PROPERTIES

Station	Sample	NTS Mapsheet	UTME[1] (NAD83)	UTMN[1] (NAD83)	Material	Structure	Matrix	Colour	Clast (%)	Clast Range (cm)	X-Size (cm)	Roundness Range	X-Roundness	Sample Depth (m)
Crinkle Chert - North of Mount Francis														
ADW99-120	996025	104 O/13	346065	6636115	M	massive	sdy-cly	Grey	10	<1 - 30	2	A - R	SR	0.45
ADW99-120	996026	104 O/13	346065	6636115	M	massive	sdy-cly	Grey	10	<1 - 30	2	A - R	SR	0.45
ADW99-120	996027	104 O/13	346065	6636115	M	massive	sdy-cly	Grey	10	<1 - 30	2	A - R	SR	0.45
ADW99-105A	996029	104 O/13	348746	6636773	CM	massive	sd	Brown grey	35	<1 - >50	2	VA - WR	SR	0.40
ADW99-106A	996030	104 O/13	348601	6636847	M	massive	cly-slt	Olive grey	10	<1 - 75	0.5	A - R	SR	0.40
ADW99-107	996031	104 O/13	348394	6636795	M	massive	cly-slt	Olive grey	10	<1 - 75	0.5	A - R	SR	0.40
ADW99-108	996032	104 O/13	348444	6636712	M	massive	slty-sd	Brown grey	15	<1 - 10	1	A - R	SR	0.40
ADW99-109	996033	104 O/13	348504	6636553	M	massive	silt-sd	Brown grey	35	<1 - >50	2	VA - WR	SR	0.30
ADW99-110	996034	104 O/13	348635	6636661	CM	massive	slty-sd	Brown grey	35	<1 - >50	2	VA - WR	SR	0.30
ADW99-113	996035	104 O/13	346247	6636142	CM	massive	slty-sd	Tan grey	20	<1 - 5	<1	A - R	SR	0.30
ADW99-114	996036	104 O/13	346247	6636142	CM	massive	slty-sd	Tan grey	20	<1 - 5	<1	A - R	SR	0.30
ADW99-115	996037	104 O/13	346247	6636142	CM	massive	slty-sd	Tan grey	20	<1 - 5	<1	A - R	SR	0.30
ADW99-112	996038	104 O/13	346303	6636214	M	massive	slty-sd	Brown grey	10	<1 - 10	1	SA - SR	SR	0.40
ADW99-118	996045	104 O/13	346137	6636074	M	massive	sdy-cly	Brown grey	15	<1 - 8	0.75	A - R	SR	0.60
ADW99-119	996046	104 O/13	346227	6636128	M	massive	sdy-slt	Brown grey	25	<1 - 12	1	A - SR	SA	0.65
Crinkle Chert - Logtung Road														
ADW99-123	996047	104 O/13	355511	6645963	M	massive	sdy-cly-slt	Tan grey	15	<1 - 10	1	A - SR	SA	0.30
ADW99-124	996048	104 O/13	355421	6645940	M	massive	cly	Olive grey	15	<1 - 6	0.5	A - R	SR	0.40
ADW99-125	996050	104 O/13	355589	6645886	M	massive	cly	Medium grey	10	<1 - 8	0.5	A - R	SR	0.20
ADW99-126	996051	104 O/13	357515	6644440	M	massive	slty-cly	Tan grey	30	<1 - 200	1	A - SR	SA	0.30
Jennings River Quartz-Sericite Schist														
ADW99-116	996039	104 N/9	667150	6612984	M	massive	slty-cly	Olive grey	10	<1 - 30	2	VA - R	SR	0.60
ADW99-117	996042	104 N/9	667080	6612977	M	massive	slty-cly	Dark grey	20	<1 - 30	2	VA - R	SR	0.50
ADW99-117	996043	104 N/9	667080	6612977	M	massive	slty-cly	Dark grey	20	<1 - 30	2	VA - R	SR	0.50
ADW99-116	996044	104 N/9	667150	6612984	M	massive	slty-cly	Olive grey	10	<1 - 30	2	VA - R	SR	0.60
Arsenault Prospect														
ADW99-102	996020	104 O/13	347294	6632957	M?	massive	cly-slt	Olive brown	10	<1 - 8	0.5	A - SR	SA	0.50
ADW99-103	996022	104 O/13	347182	6632718	CM	massive	cly-slty-sd	Grey	15	<1 - 7	0.5	A - SR	SA	0.35
ADW99-104	996023	104 O/13	347391	6632697	CM	massive	sd-cly-slty	Grey	25	<1 - 30	1	A - SR	SA	0.40
ADW99-105	996024	104 O/13	347940	6633436	C	massive	sd	Red brown	40	<1 - 50	2	VA - SR	SA	0.60
ADW99-106	996028	104 O/13	347819	6633485	CM	massive	slty-cly-sd	Grey	15	<1 - 3	0.5	SA - R	SR	0.80
Mount Francis East														
ADW99-091	996008	104 O/13	350388	6633477	CM	massive	slty-sd	Brown	35	<1 - 40	2	VA - R	SA	0.80
ADW99-092	996012	104 O/13	350289	6633424	CM	massive	slty-sd	Brown	35	<1 - 40	2	VA - R	SA	0.50
ADW99-093	996013	104 O/13	350427	6633480	CM	massive	slty-sd	Brown	20	<1 - 25	1	VA - SR	A	0.70
ADW99-094	996014	104 O/13	350735	6633273	CM	massive	sd	Orange brown	15	<1 - 25	2	VA - R	SA	0.80
ADW99-095	996016	104 O/13	350801	6633262	CM	massive	slty-sd	Light grey	20	<1 - 30	2	VA - A	SA	1.00
ADW99-096	996017	104 O/13	350780	6633180	CM	massive	slty-sd	Grey	20	<1 - 25	2	VA - SA	SA	0.20
ADW99-097	996018	104 O/13	351056	6632892	FG?	massive	sdy-cl	Brown grey	20	<1 - 30	1	A - R	SR	0.60
ADW99-098	996019	104 O/13	351018	6632982	FG?	massive	sd	Brown	40	<1 - 25	2	VA - WR	SR	0.50
Highway 97 Prospect														
ADW99-049	996002	104 O/13	359017	6643685	M	massive	slty-sd	Tan brown	10	0.5 - 20	1	SA - R	SR	0.50
ADW99-050	996003	104 O/13	359032	6643716	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30
ADW99-052	996004	104 O/13	359102	6643685	M	massive	slty-sd	Tan brown	10	<1 - 10	1	A - SR	SA	0.15
ADW99-051	996005	104 O/13	359029	6643772	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30
ADW99-053	996006	104 O/13	358964	6643682	M	massive	cly-slt	Grey	5	<0.5 - 1	<1	SA - SR	R	0.45
ADW99-054	996007	104 O/13	359102	6643718	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30
ADW99-055	996009	104 O/13	358959	6643684	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30
ADW99-055	996010	104 O/13	358959	6643684	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30
ADW99-055	996011	104 O/13	358959	6643684	M	massive	slty-cly	Olive grey	15	<1 - 60	2	A - SR	SA	0.30

[1] values accurate within 50 metres

Notes

M = basal till	X-Roundness = mean roundness
C = colluvium	WR = well rounded
CM = colluviated till	R = rounded
FG = glaciofluvial	SB = subrounded
cly = clay	SA = subangular
slt =silt	A = angular
sd = sand	VA = very angular
X-Size = mean size	

TABLE 2
DETECTION LIMITS AND GEOCHEMICAL RESULTS FOR INDUCTIVELY COUPLED PLASMA MASS SPECTROSCOPY (ICPMS)

	Element	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	U	Au	Th	Sr	Cd	Sb	Bi	V
	Units	(ppm)	(ppm)	(ppm)	(ppm)	(ppb)	(ppm)	(ppm)	(ppm)	(%)	(ppm)	(ppm)	(ppb)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Sample	Detection Limit	0.01	0.01	0.01	0.1	2	0.1	0.1	1	0.01	0.1	0.1	1	0.1	0.5	0.01	0.02	0.02	2
Crinkle Chert - North of Mt. Francis																			
996021	ADUP 996025	0.52	29.36	12.02	47.0	24	28.6	9.3	345	2.39	6.3	0.7	3	4.6	21.6	0.13	0.41	0.16	68
996025	FieldTRIP 1	0.49	27.09	11.76	45.2	41	27.8	9.0	338	2.31	6.4	0.7	3	4.5	21.0	0.08	0.39	0.16	67
996026	FieldTRIP 2	0.45	24.29	11.63	39.7	17	22.1	7.2	295	2.10	5.8	0.8	3	4.7	20.2	0.06	0.38	0.15	59
996027	FieldTRIP 3	0.42	24.51	12.62	40.6	17	22.6	6.9	281	2.19	5.6	0.8	3	4.9	19.6	0.09	0.40	0.16	61
996029		1.80	57.82	13.65	85.0	55	33.0	16.5	375	3.74	42.1	0.9	5	4.5	19.4	0.10	0.83	0.38	74
996030		1.74	56.69	13.79	83.8	48	32.8	15.9	373	3.67	43.7	0.9	4	4.6	19.6	0.09	0.74	0.40	72
996031		1.20	32.87	10.33	62.6	100	25.1	10.6	367	2.85	13.0	0.8	5	2.7	18.8	0.11	0.48	0.29	65
996032		1.56	28.25	12.37	65.4	68	31.1	12.9	456	3.32	41.0	0.6	3	4.6	13.7	0.15	0.77	0.77	66
996033		4.09	32.23	12.39	58.2	51	30.4	13.0	422	2.67	18.3	0.8	73	5.1	13.0	0.12	0.51	0.19	64
996034		10.73	64.65	8.01	88.5	86	22.9	15.1	368	5.09	13.4	0.8	13	5.8	20.0	0.11	0.46	0.13	56
996035		0.65	35.21	11.69	55.9	15	35.0	13.4	500	2.80	12.4	1.6	2	4.7	12.0	0.05	0.39	0.25	75
996036		0.73	41.93	12.68	65.3	10	36.1	14.3	430	3.06	17.7	1.0	2	5.4	11.0	0.12	0.42	0.19	83
996037		0.87	31.95	12.91	60.5	17	33.5	13.9	352	2.98	10.9	0.9	3	4.9	10.6	0.09	0.44	0.16	74
996038		0.58	29.92	8.83	49.7	32	35.4	12.2	392	2.49	6.5	0.6	2	3.6	22.7	0.12	0.35	0.14	69
996045		0.66	38.97	10.25	54.0	18	28.1	12.4	380	2.78	8.7	0.6	3	4.2	14.6	0.06	0.34	0.23	69
996046		0.59	29.10	9.89	50.6	27	38.2	13.7	521	2.53	10.3	0.5	3	3.4	22.1	0.03	0.34	0.14	73
Crinkle Chert - Logtung Road																			
996047		0.91	28.41	10.33	56.1	86	30.5	8.3	345	2.33	9.9	0.9	3	8.7	25.4	0.16	1.06	0.21	46
996048		1.04	39.51	14.12	66.4	130	39.1	10.9	562	2.68	12.8	0.9	3	9.6	30.9	0.41	1.25	0.24	52
996050		1.12	41.76	10.15	70.8	187	40.1	10.4	409	2.78	14.0	0.9	10	9.8	29.2	0.16	1.42	0.24	52
996051		1.00	39.84	14.84	72.3	127	33.1	16.8	1273	2.83	29.9	0.9	4	7.9	53.5	0.37	2.72	0.24	34
996041	ADUP 996051	0.96	37.79	13.16	71.5	126	32.4	16.1	1245	2.74	29.8	0.8	5	7.8	53.9	0.31	2.78	0.42	33
Jennings River Quartz-Sericite Schist																			
996039		5.57	82.57	11.92	104.7	242	88.7	21.0	715	3.97	14.4	1.4	3	2.9	104.0	0.55	1.16	0.23	75
996042		1.49	49.38	6.61	76.7	128	65.7	19.9	666	3.40	7.2	1.2	4	4.5	91.0	0.28	0.48	0.16	69
996043		4.78	74.97	10.05	90.5	242	90.3	23.0	790	3.67	10.4	1.7	4	2.9	106.0	0.47	0.90	0.19	75
996044		4.55	74.44	9.96	96.7	194	85.6	20.7	705	3.74	10.9	1.0	2	3.1	107.4	0.50	0.92	0.45	73
Arsenault Prospect																			
996020		2.44	589.98	13.83	236.2	168	47.7	16.5	647	3.65	15.2	1.0	8	7.8	24.3	2.41	0.52	0.50	75
996022		2.62	387.65	8.54	64.6	90	35.8	13.9	547	3.10	14.3	1.1	7	6.1	24.8	0.22	0.39	0.50	66
996023		2.60	227.26	12.88	71.2	101	38.2	16.1	558	3.21	35.4	1.4	15	8.8	19.0	0.26	0.65	0.33	63
996024		2.39	157.55	20.86	84.8	81	42.2	23.4	978	3.43	32.2	1.3	28	6.4	15.0	0.48	0.60	0.56	58
996028		2.32	104.35	19.44	67.1	66	25.3	13.8	701	3.03	22.8	1.5	2	2.5	28.8	0.21	0.39	0.44	72
Mount Francis East																			
996008		1.74	35.72	11.30	64.8	61	27.6	11.2	485	2.94	25.9	1.4	3	2.8	14.8	0.22	0.61	0.21	49
996012		2.06	93.88	10.14	74.4	130	52.2	15.5	649	2.84	41.1	1.6	2	4.2	16.4	0.27	0.75	0.50	56
996013		2.20	50.09	8.54	56.9	64	38.7	20.3	602	2.90	24.6	1.3	3	4.7	12.0	0.20	0.74	0.21	60
996014		2.12	116.38	11.14	90.1	114	74.0	19.8	537	2.76	54.3	2.0	6	6.2	21.0	0.38	0.63	0.32	47
996016		2.09	132.88	11.52	132.4	458	77.3	13.8	560	2.56	13.4	13.5	11	3.0	28.9	0.36	0.51	0.25	47
996017		2.46	97.23	13.71	116.8	249	49.1	17.5	927	3.19	26.0	3.7	3	3.4	23.5	0.66	0.58	0.29	65
996018		2.14	76.45	11.67	76.4	150	39.7	12.0	595	2.67	40.8	2.8	4	2.6	30.8	0.30	0.56	0.32	58
996019		1.69	39.63	8.50	86.9	117	29.4	10.4	491	2.22	12.2	2.6	2	2.1	35.9	0.26	0.36	0.18	50
Highway 97 Prospect																			
996002		0.72	53.05	11.54	50.4	37	36.9	11.1	361	2.77	13.3	1.3	4	10.1	19.2	0.08	0.95	0.28	61
996003		0.79	55.17	9.67	60.2	50	39.1	10.3	449	2.78	12.3	1.0	4	7.9	22.9	0.08	0.94	0.26	58
996004		0.58	54.01	9.65	57.5	99	35.1	11.7	307	2.72	8.1	0.8	3	6.6	15.7	0.06	0.58	0.21	59
996005		0.58	23.21	9.58	36.8	20	25.2	8.5	303	2.03	9.4	1.0	2	8.1	18.8	0.06	0.63	0.21	44
996006		1.03	24.14	8.60	61.3	54	37.7	13.5	411	2.62	6.4	1.3	3	5.4	33.8	0.11	0.53	0.20	55
996007		0.69	27.81	7.69	42.7	69	28.8	8.1	339	2.24	8.6	1.0	2	7.2	20.2	0.06	0.68	0.19	47
996009	FieldTRIP 1	0.64	22.32	7.90	39.0	42	23.1	7.2	319	1.92	7.7	0.9	< 1	6.9	24.7	0.07	0.62	0.38	40
996001	ADUP 996009	0.67	22.79	7.83	38.8	42	22.7	7.4	322	1.96	7.3	0.9	5	6.7	25.2	0.07	0.68	0.33	40
996010	FieldTRIP 2	0.71	22.62	8.14	39.1	38	24.3	7.6	319	2.02	8.5	1.0	3	7.6	26.6	0.09	0.66	0.24	41
996011	FieldTRIP 3	0.70	20.46	7.72	39.8	41	23.7	7.4	318	1.96	7.7	0.9	10	6.8	25.7	0.06	0.62	0.19	40
	Median	1.56	49.38	11.14	65.4	81	35.8	13.7	485	2.83	13.4	1.0	3	4.7	21.0	0.16	0.60	0.24	63
	Mean	1.95	80.64	11.30	73.9	101	41.1	14.1	525	2.96	19.0	1.5	7	5.4	29.7	0.27	0.70	0.29	61
	Std. dev.	1.86	104.73	2.85	32.9	86	18.0	4.1	203	0.59	12.7	2.0	12	2.2	25.5	0.38	0.41	0.14	11
	Minimum	0.49	22.32	6.61	36.8	10	22.9	7.2	303	1.92	6.4	0.5	<1	2.1	10.6	0.03	0.34	0.13	34
	Maximum	10.73	589.98	20.86	236.2	458	90.3	23.4	1273	5.09	54.3	13.5	73	9.8	107.4	2.41	2.72	0.77	83

TABLE 2 CONTINUED
DETECTION LIMITS AND GEOCHEMICAL RESULTS FOR INDUCTIVELY COUPLED PLASMA MASS SPECTROSCOPY (ICPMS)

	Element	Ca	P	La	Cr	Mg	Ba	Ti	B	Al	Na	K	W	Tl	Hg	Se	Te	Ga	S
	Units	(%)	(%)	(ppm)	(ppm)	(%)	(ppm)	(%)	(ppm)	(%)	(%)	(%)	(ppm)	(ppm)	(ppb)	(ppm)	(ppm)	(ppm)	(%)
Sample	Detection Limit	0.01	0.001	0.5	0.5	0.01	0.5	0.001	1	0.01	0.001	0.01	0.2	0.02	5	0.1	0.02	0.02	0.02
Crinkle Chert - North of Mt. Francis																			
996021	ADUP 996025	0.40	0.065	14.4	47.8	0.82	511.5	0.199	< 1	1.86	0.099	0.10	0.2	0.09	13	0.6	0.06	5.70	<0.01
996025	FieldTRIP 1	0.39	0.063	14.2	46.3	0.82	510.3	0.201	< 1	1.88	0.110	0.09	0.2	0.09	11	0.6	0.07	5.50	<0.01
996026	FieldTRIP 2	0.38	0.063	14.5	38.8	0.70	424.6	0.184	2	1.71	0.088	0.08	0.2	0.08	12	0.6	0.04	4.80	<0.01
996027	FieldTRIP 3	0.38	0.063	14.9	39.4	0.73	440.3	0.192	1	1.82	0.095	0.08	0.2	0.09	18	0.6	0.05	5.20	<0.01
996029		0.29	0.056	15.8	45.7	0.94	210.2	0.155	1	2.43	0.051	0.06	<0.2	0.09	9	1.7	0.32	6.10	<0.01
996030		0.29	0.054	15.8	46.3	0.94	210.2	0.157	< 1	2.44	0.051	0.07	0.2	0.09	11	1.6	0.29	6.10	0.01
996031		0.26	0.057	14.1	41.3	0.73	178.7	0.151	< 1	2.00	0.027	0.09	<0.2	0.09	15	0.9	0.15	6.90	0.01
996032		0.23	0.038	11.0	45.1	0.85	129.3	0.141	1	2.15	0.021	0.13	0.3	0.10	27	0.9	0.14	7.60	0.01
996033		0.18	0.022	11.9	42.6	0.83	132.0	0.141	1	2.28	0.027	0.11	0.3	0.11	25	0.6	0.07	6.40	0.01
996034		0.12	0.058	13.8	22.4	1.29	160.6	0.122	< 1	3.37	0.034	0.22	0.2	0.24	48	1.3	0.11	8.20	0.11
996035		0.16	0.024	8.8	44.4	0.81	251.5	0.173	2	2.66	0.027	0.10	0.2	0.10	34	0.7	0.08	6.50	<0.01
996036		0.16	0.033	9.6	46.2	1.00	303.8	0.177	1	3.18	0.035	0.15	0.2	0.11	39	0.8	0.09	7.50	<0.01
996037		0.16	0.037	8.8	46.5	0.89	308.8	0.154	1	3.23	0.026	0.13	0.2	0.11	39	0.8	0.06	7.20	<0.01
996038		0.30	0.026	11.1	44.2	0.71	210.7	0.192	1	1.75	0.048	0.07	0.2	0.08	20	0.6	0.06	5.10	<0.01
996045		0.28	0.043	8.9	39.0	0.95	336.6	0.158	< 1	2.41	0.048	0.13	0.3	0.08	23	0.6	0.06	7.00	<0.01
996046		0.30	0.022	9.0	44.7	0.81	458.2	0.196	< 1	1.98	0.057	0.09	<0.2	0.09	15	0.7	0.06	5.50	<0.01
Crinkle Chert - Logtung Road																			
996047		0.40	0.059	21.8	36.8	0.58	205.8	0.124	< 1	1.55	0.051	0.13	0.2	0.10	62	0.5	0.05	4.50	<0.01
996048		0.44	0.048	22.3	43.5	0.64	274.9	0.119	1	1.92	0.049	0.21	0.2	0.13	103	0.6	0.07	5.50	<0.01
996050		0.48	0.057	21.5	40.3	0.65	274.2	0.109	1	1.76	0.041	0.19	0.2	0.12	109	0.7	0.06	5.40	0.01
996051		3.09	0.061	18.8	26.5	0.69	232.3	0.070	< 1	1.44	0.017	0.18	0.5	0.06	37	1.1	0.08	3.00	<0.01
996041	ADUP 996051	2.99	0.059	18.4	26.9	0.64	222.0	0.068	< 1	1.38	0.018	0.18	0.5	0.07	42	1.4	0.11	3.20	<0.01
Jennings River Quartz-Sericite Schist																			
996039		2.08	0.085	10.7	73.8	1.45	480.5	0.217	3	1.61	0.059	0.13	<0.2	0.17	180	2.0	0.12	4.80	0.20
996042		1.64	0.085	13.2	56.9	1.44	344.0	0.261	1	1.69	0.090	0.16	<0.2	0.12	81	0.9	0.10	5.30	<0.01
996043		2.28	0.085	10.6	69.6	1.57	477.6	0.215	2	1.70	0.060	0.13	<0.2	0.15	189	1.3	0.12	5.00	0.11
996044		2.04	0.085	11.4	64.9	1.34	464.5	0.205	3	1.57	0.050	0.13	<0.2	0.17	143	1.9	0.13	5.10	0.02
Arsenault Prospect																			
996020		0.62	0.073	19.3	57.5	1.26	263.1	0.202	1	2.24	0.066	0.18	0.3	0.13	29	0.9	0.35	6.80	<0.01
996022		0.58	0.078	18.2	48.3	1.11	182.8	0.196	< 1	1.83	0.076	0.12	0.3	0.09	16	1.0	0.41	5.70	<0.01
996023		0.47	0.065	21.5	49.7	1.13	195.1	0.196	< 1	1.96	0.051	0.15	0.3	0.13	14	0.8	0.21	5.50	<0.01
996024		0.27	0.091	17.7	48.6	0.93	117.5	0.141	< 1	2.32	0.016	0.10	0.3	0.09	55	1.2	0.31	5.60	0.01
996028		0.74	0.056	16.1	56.3	1.52	157.9	0.155	< 1	2.30	0.015	0.08	<0.2	0.07	17	1.1	0.12	9.20	0.03
Mount Francis East																			
996008		0.35	0.042	17.8	38.5	0.53	124.0	0.112	1	1.38	0.011	0.10	0.2	0.07	24	1.0	0.09	6.20	0.02
996012		0.33	0.040	21.3	48.5	0.60	161.1	0.130	1	1.47	0.014	0.10	<0.2	0.08	19	1.3	0.10	5.20	0.02
996013		0.15	0.039	14.3	39.8	0.49	85.5	0.157	1	1.49	0.010	0.06	0.3	0.07	14	0.9	0.12	4.80	0.02
996014		0.41	0.055	23.5	36.2	0.56	118.1	0.108	1	1.27	0.015	0.07	0.2	0.07	18	1.3	0.13	4.30	0.03
996016		0.82	0.085	131.8	49.2	0.64	163.8	0.098	2	1.71	0.019	0.07	0.3	0.09	104	1.1	0.08	3.70	0.05
996017		0.59	0.062	34.8	53.3	0.66	336.9	0.145	1	1.82	0.015	0.13	0.2	0.08	44	1.4	0.11	6.80	0.03
996018		0.78	0.069	25.1	42.5	0.57	202.2	0.108	1	1.81	0.018	0.13	0.2	0.10	39	1.5	0.09	6.00	0.04
996019		0.99	0.076	17.4	39.1	0.47	192.4	0.101	2	1.57	0.019	0.11	<0.2	0.09	48	1.1	0.07	5.60	0.03
Highway 97 Prospect																			
996002		0.30	0.022	18.7	52.8	0.60	278.8	0.128	2	2.33	0.034	0.19	0.3	0.14	78	1.1	0.09	7.50	<0.01
996003		0.30	0.031	18.1	43.4	0.58	286.0	0.137	2	1.74	0.045	0.20	0.2	0.12	78	0.5	0.09	6.00	<0.01
996004		0.27	0.024	11.7	40.5	0.74	298.9	0.139	1	2.61	0.025	0.14	0.3	0.12	18	0.5	0.07	7.20	<0.01
996005		0.22	0.018	17.9	39.2	0.47	310.8	0.115	1	1.79	0.039	0.13	0.2	0.10	44	0.4	0.05	5.50	<0.01
996006		0.56	0.050	13.6	51.5	0.90	261.6	0.202	2	1.98	0.095	0.15	<0.2	0.11	18	0.6	0.06	6.00	<0.01
996007		0.30	0.025	15.6	38.5	0.50	224.8	0.123	1	1.65	0.038	0.13	0.2	0.10	47	0.7	0.06	5.20	<0.01
996009	FieldTRIP 1	0.33	0.018	14.6	32.6	0.45	168.3	0.115	2	1.44	0.041	0.15	0.2	0.10	30	0.6	0.07	4.60	<0.01
996001	ADUP 996009	0.33	0.018	14.3	32.0	0.44	166.4	0.114	2	1.41	0.041	0.15	0.2	0.09	30	0.6	0.06	4.80	<0.01
996010	FieldTRIP 2	0.33	0.018	16.4	31.6	0.47	185.6	0.121	1	1.50	0.043	0.16	0.2	0.10	35	0.8	0.08	5.20	<0.01
996011	FieldTRIP 3	0.33	0.019	14.7	31.7	0.45	171.6	0.115	2	1.46	0.042	0.16	0.2	0.09	27	0.7	0.07	4.90	0.01
	Median	0.33	0.055	15.8	44.7	0.81	224.8	0.145	1	1.83	0.038	0.13	0.2	0.10	34	0.9	0.09	5.60	0.01
	Mean	0.61	0.052	18.8	45.7	0.84	250.8	0.152	1	1.99	0.040	0.13	0.2	0.11	48	1.0	0.12	5.89	0.02
	Std. dev.	0.66	0.022	18.9	9.9	0.31	108.7	0.041	1	0.50	0.024	0.04	0.1	0.03	44	0.4	0.09	1.21	0.04
	Minimum	0.12	0.018	8.8	22.4	0.45	85.5	0.070	<1	1.27	0.010	0.06	<0.2	0.06	9	0.4	0.05	3.00	<0.01
	Maximum	3.09	0.091	131.8	73.8	1.57	510.3	0.261	3	3.37	0.110	0.22	0.5	0.24	189	2.0	0.41	9.20	0.20

Notes:

TABLE 3
DETECTION LIMITS AND GEOCHEMICAL RESULTS BY THERMAL NEUTRON ACTIVATION ANALYSIS (INAA)

	Element	Au	As	Ba	Br	Ca	Co	Cr	Cs	Fe	Hf	Mo	Na	Rb	Sb	Sc
	Units	(ppb)	(ppm)	(ppm)	(ppm)	(%)	(ppm)	(ppm)	(ppm)	(%)	(ppm)	(ppm)	(%)	(ppm)	(ppm)	(ppm)
Sample	Detection Limit	2	0.5	50	0.5	1	1	5	1	0.02	1	1	0.01	15	0.1	0.1
Crinkle Chert - North of Mt. Francis																
996021	ADUP 996025	2	8.1	1400	2.2	2	14	122	2	4.27	6	5	2.05	66	1.1	19.2
996025	FieldTRIP 1	9	7.0	1300	1.6	2	13	118	2	4.31	6	8	2.06	59	1.1	19.0
996026	FieldTRIP 2	4	6.8	1100	2.2	2	10	103	2	3.58	6	5	1.86	53	0.9	16.2
996027	FieldTRIP 3	12	6.7	1100	<0.5	2	11	98	2	3.74	6	8	1.91	50	0.9	16.9
996029		<2	44.3	1100	2.0	2	19	114	2	5.37	6	10	1.52	73	1.5	18.4
996030		<2	44.2	1000	2.4	1	18	114	2	5.24	6	8	1.48	65	1.1	18.2
996031		5	15.2	1000	5.6	2	13	120	3	4.44	6	10	1.45	70	0.9	16.7
996032		<2	42.3	960	6.6	1	16	118	3	5.27	6	9	1.36	66	1.2	16.1
996033		<2	20.4	770	5.7	2	17	113	3	4.47	6	11	1.64	64	1.2	15.8
996034		21	16.1	770	9.5	1	19	54	4	7.45	4	22	0.88	73	0.8	18.9
996035		12	13.2	1300	6.6	1	19	112	2	4.64	5	8	1.59	56	1.1	18.6
996036		7	18.3	850	9.3	2	18	102	2	4.59	5	5	1.57	60	1.0	19.4
996037		4	11.3	790	6.5	2	16	101	2	4.27	4	4	1.47	52	1.0	17.0
996038		4	7.5	790	1.7	2	16	135	2	4.14	5	7	1.83	52	0.8	16.7
996045		4	11.4	920	4.1	1	17	101	2	4.49	5	4	1.82	60	1.0	18.4
996046		6	12.2	1500	2.5	1	19	132	2	4.45	5	6	1.78	56	1.5	18.6
Crinkle Chert - Logtung Road																
996047		<2	10.5	910	2.8	1	10	103	4	3.20	5	8	1.30	105	1.6	12.6
996048		<2	12.6	950	1.8	1	11	96	4	3.48	5	7	1.09	108	2.0	13.2
996050		3	15.0	970	4.1	1	12	113	5	3.93	5	8	1.20	102	2.3	14.5
996051		5	28.0	960	<0.5	4	18	76	3	3.87	5	9	0.69	103	4.1	15.4
996041	ADUP 996051	3	27.6	920	<0.5	4	17	77	2	3.79	5	11	0.66	93	4.0	15.5
Jennings River Quartz-Sericite-Schist																
996039		9	16.0	1400	<0.5	4	26	181	2	5.89	4	13	1.32	51	1.9	17.0
996042		4	8.8	910	3.8	4	26	170	2	5.46	4	8	1.62	54	0.9	17.2
996043		6	12.3	1300	3.2	4	26	181	3	5.54	4	13	1.40	48	1.6	17.1
996044		4	12.2	1300	<0.5	4	24	172	3	5.45	4	12	1.29	53	1.5	16.7
Arsenault Prospect																
996020		11	17.5	890	<0.5	2	20	127	2	5.88	6	8	1.47	78	1.0	19.0
996022		12	14.8	760	<0.5	2	17	123	2	5.11	6	10	1.55	77	0.9	17.3
996023		17	39.4	990	<0.5	2	20	142	2	5.39	7	16	1.34	91	1.2	19.2
996024		10	35.4	690	14.3	2	27	135	2	5.55	6	16	1.14	80	1.1	16.3
996028		14	24.7	640	6.4	2	16	136	2	4.72	6	12	1.09	71	0.8	16.4
Mount Francis East																
996008		<2	27.8	910	10.4	2	13	123	2	4.44	7	11	0.86	95	1.2	13.1
996012		13	42.9	920	13.3	2	19	182	2	4.67	9	15	1.14	72	1.2	16.8
996013		5	26.7	930	4.8	2	23	170	2	5.14	9	14	1.36	73	1.3	15.0
996014		17	55.4	900	5.3	3	24	135	2	4.98	8	18	1.40	64	1.3	15.9
996016		13	16.0	900	14.8	3	17	161	4	4.43	8	23	1.28	71	0.8	20.7
996017		4	27.3	1100	8.4	3	21	151	3	5.01	7	19	1.24	109	1.3	16.4
996018		10	38.3	760	8.5	2	14	121	2	3.94	6	14	1.21	77	1.0	14.0
996019		7	13.0	760	6.4	2	12	104	2	3.54	6	13	1.42	70	0.7	12.7
Highway 97 Prospect																
996002		5	16.1	1100	3.0	1	14	119	4	4.62	5	11	1.32	115	2.0	17.4
996003		8	15.9	1100	2.6	1	13	110	4	4.44	5	12	1.39	99	2.0	16.1
996004		7	9.7	880	3.3	1	14	98	4	4.30	5	9	1.20	69	1.3	13.7
996005		5	11.2	1000	2.7	1	10	91	3	3.42	6	<1	1.36	107	1.3	13.8
996006		<2	8.5	1200	2.3	1	17	128	3	4.29	5	<1	1.54	104	1.3	15.9
996007		<2	11.0	950	2.9	2	10	96	4	3.47	5	<1	1.30	87	1.3	13.7
996009	FieldTRIP 1	<2	8.8	960	2.7	2	10	94	3	3.38	6	6	1.43	109	1.3	12.5
996001	ADUP 996009	<2	7.9	940	2.9	2	10	95	3	3.30	5	10	1.41	102	1.1	12.3
996010	FieldTRIP 2	<2	9.4	920	3.3	2	9	103	3	3.41	6	10	1.44	95	1.2	13.1
996011	FieldTRIP 3	<2	8.3	910	2.5	2	9	95	3	3.22	5	10	1.37	82	1.1	12.1
	Median	5	15.9	950	3.3	2	17	119	2	4.49	6	10	1.36	72	1.2	16.7
	Mean	7	20.5	978	4.8	2	17	124	3	4.65	6	10	1.38	77	1.3	16.4
	Std. dev.	5	12.6	196	3.8	1	5	29	1	0.84	1	5	0.26	20	0.6	2.1
	Minimum	<2	7.0	640	<0.5	1	10	54	2	3.20	4	<1	0.69	48	0.7	12.5
	Maximum	21	55.4	1500	14.8	4	27	182	5	7.45	9	23	2.06	115	4.1	20.7

TABLE 3 CONTINUED
DETECTION LIMITS AND GEOCHEMICAL RESULTS BY THERMAL NEUTRON ACTIVATION ANALYSIS (INAA)

	Element	Se	Ta	Th	U	W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Mass
	Units	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(g)
Sample	Detection Limit	3	0.5	0.5	0.5	1	50	0.1	3	5	0.1	0.2	0.5	0.2	0.05	n/a
Crinkle Chert - North of Mt. Francis																
996021	ADUP 996025	<3	1.6	8.4	2.6	<1	64	30.5	68	29	5.8	1.6	0.6	3.0	0.45	24.45
996025	FieldTRIP 1	<3	1.5	8.1	2.3	<1	112	30.1	64	27	5.6	1.5	0.8	3.0	0.47	24.23
996026	FieldTRIP 2	<3	1.1	7.9	2.4	<1	95	28.0	61	22	5.1	1.3	0.7	2.7	0.40	28.73
996027	FieldTRIP 3	<3	1.3	8.1	2.4	<1	89	28.3	63	24	5.0	1.4	0.6	2.8	0.42	30.44
996029		<3	1.0	8.4	2.5	<1	117	32.2	65	26	5.6	1.4	0.7	3.1	0.46	25.61
996030		<3	0.6	8.5	2.6	<1	124	32.0	64	24	5.5	1.4	0.7	3.1	0.46	26.81
996031		<3	1.7	8.7	2.5	<1	100	30.7	63	25	4.8	1.2	0.7	2.8	0.43	29.21
996032		<3	1.3	8.9	2.5	<1	129	25.8	59	19	4.4	1.1	0.6	2.3	0.36	26.42
996033		<3	1.4	9.7	2.7	2	127	27.3	59	20	4.4	1.2	0.6	2.4	0.37	26.70
996034		<3	1.0	9.8	2.3	1	124	26.2	47	14	3.5	0.9	0.5	2.4	0.36	27.15
996035		<3	1.1	7.7	3.4	2	100	23.5	54	19	3.8	1.1	<0.5	2.2	0.33	29.73
996036		<3	1.2	8.2	2.6	<1	100	21.9	50	16	4.0	1.0	0.7	2.2	0.33	28.10
996037		<3	0.9	7.6	2.4	<1	110	20.2	47	17	3.9	1.0	0.6	2.1	0.33	28.50
996038		<3	0.9	6.3	2.2	1	99	25.7	55	19	4.0	1.2	0.6	2.3	0.35	28.54
996045		<3	1.0	7.0	1.4	2	95	21.2	45	16	3.6	1.1	0.7	2.4	0.36	29.05
996046		<3	0.9	7.2	2.6	<1	92	23.6	50	15	3.9	1.2	0.5	2.5	0.37	27.62
Crinkle Chert - Logtung Road																
996047		<3	1.8	14.2	2.9	<1	82	38.9	80	28	5.0	1.2	0.9	3.3	0.52	27.63
996048		<3	1.2	14.3	2.8	<1	59	38.9	75	30	6.6	1.2	0.8	3.3	0.52	28.80
996050		<3	1.9	15.1	2.5	2	118	39.8	76	27	6.9	1.3	0.9	3.8	0.57	29.14
996051		<3	0.7	10.9	2.1	3	114	35.1	74	25	5.8	1.3	0.8	2.9	0.49	26.48
996041	ADUP 996051	<3	1.0	10.7	2.1	2	96	33.2	71	25	5.3	1.3	0.8	2.8	0.43	29.59
Jennings River Quartz-Sericite-Schist																
996039		<3	0.9	5.4	2.3	<1	156	24.5	52	23	5.1	1.5	0.7	2.7	0.40	25.27
996042		<3	1.2	6.9	2.6	<1	121	25.3	53	19	4.9	1.5	0.7	2.7	0.40	29.64
996043		<3	1.1	5.5	2.6	<1	139	23.5	48	20	4.7	1.5	0.7	2.7	0.39	26.40
996044		<3	1.3	5.3	2.0	<1	130	23.1	49	18	4.8	1.4	<0.5	2.6	0.38	27.79
Arsenault Prospect																
996020		<3	1.8	10.9	3.0	3	285	38.0	75	31	6.4	1.5	0.9	3.4	0.53	28.87
996022		<3	1.6	9.8	3.4	<1	130	37.2	74	28	6.2	1.6	0.8	3.0	0.45	29.88
996023		<3	1.0	13.3	4.0	<1	128	46.9	94	35	7.0	1.6	0.8	3.4	0.50	26.28
996024		<3	1.4	13.6	3.8	2	135	37.4	102	30	6.5	1.6	0.8	3.1	0.46	26.96
996028		<3	1.6	11.1	3.9	<1	109	33.4	74	28	5.4	1.3	0.6	3.2	0.48	27.91
Mount Francis East																
996008		<3	1.6	12.4	4.1	3	114	34.7	76	29	6.3	1.7	0.9	3.6	0.52	27.20
996012		<3	1.7	12.5	4.8	2	138	44.0	147	38	8.0	1.9	0.9	3.8	0.59	29.77
996013		<3	1.7	11.5	4.5	2	127	38.2	83	27	5.7	1.5	0.9	3.3	0.51	29.37
996014		<3	1.7	13.9	4.8	2	161	48.6	124	35	7.7	2.0	0.9	3.9	0.58	27.60
996016		<3	1.8	16.3	19.2	2	233	186.0	113	163	27.9	5.7	3.0	13.3	2.10	25.57
996017		<3	1.9	13.9	6.4	2	173	58.5	120	53	10.9	2.8	1.5	4.6	0.65	26.64
996018		<3	1.4	10.2	4.4	<1	116	41.8	74	30	6.5	1.6	1.0	3.2	0.47	30.58
996019		<3	0.8	8.4	4.2	<1	143	33.0	63	27	5.2	1.3	0.8	2.7	0.43	27.07
Highway 97 Prospect																
996002		<3	1.2	16.1	3.5	2	128	38.2	81	26	5.5	1.2	<0.5	2.7	0.41	25.05
996003		<3	1.7	13.4	2.2	<1	114	37.1	74	31	6.7	1.6	1.0	3.7	0.57	26.29
996004		<3	1.2	10.4	2.6	2	77	25.8	54	20	4.1	0.8	0.5	2.3	0.35	26.48
996005		<3	1.6	13.5	3.2	<1	65	35.4	77	24	5.5	1.2	0.7	3.0	0.46	26.94
996006		<3	1.3	9.2	3.3	<1	136	27.9	61	24	4.9	1.3	0.7	2.4	0.38	25.06
996007		<3	1.9	12.3	3.8	<1	85	30.5	68	22	4.9	1.1	0.6	2.5	0.38	27.30
996009	FieldTRIP 1	<3	1.6	12.4	3.3	<1	100	31.2	74	22	5.0	1.2	0.7	2.5	0.38	27.09
996001	ADUP 996009	<3	1.9	11.8	2.8	<1	97	30.8	69	22	4.9	1.0	0.6	2.7	0.40	27.92
996010	FieldTRIP 2	<3	1.3	12.6	3.4	<1	90	33.1	70	25	5.3	1.0	0.7	2.7	0.41	26.33
996011	FieldTRIP 3	<3	1.5	12.5	2.8	<1	95	30.6	69	20	4.7	1.0	0.7	2.5	0.39	28.01
	Median	3	1.3	10.2	2.8	1	118	32.2	68	25	5.4	1.3	0.7	2.9	0.45	27.20
	Mean	3	1.3	10.5	3.5	1	123	36.4	72	29	6.0	1.5	0.8	3.2	0.48	27.48
	Std. dev.	0	0.4	3.0	2.7	1	40	25.3	23	23	3.8	0.8	0.4	1.7	0.27	1.53
	Minimum	<3	0.6	5.3	1.4	<1	59	20.2	45	14	3.5	0.8	<0.5	2.1	0.33	24.23
	Maximum	3	1.9	16.3	19.2	3	285	186.0	147	163	27.9	5.7	3.0	13.3	2.10	30.58

Notes:

ADUP = analytical duplicate

FieldTRIP = field triplicate

TABLE 4
DETECTION LIMITS AND GEOCHEMICAL RESULTS FOR MAJOR OXIDES BY $LiBO_2$ FUSION INDUCTIVELY COUPLED PLASMA (ICP)

	Element	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ba	Ni	Sr	Zr	Y	Nb	Sc	LOI	C/TOT	S/TOT	SUM
	Units	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(%)	(%)	(%)	(%)
Sample	Detection Limit	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.001	5	5	5	5	5	10	1	0.1	0.01	0.01	0.01
Crinkle Chert - North of Mt. Francis																							
996021	ADUP 996025	67.26	12.85	5.32	2.24	2.47	2.54	1.48	0.96	0.18	0.07	0.014	1391	36	220	182	22	12	7	4.2	0.22	0.02	99.79
996025	FieldTRIP 1	68.71	12.23	5.07	2.48	2.35	2.31	1.34	1.07	0.19	0.04	0.014	1526	35	241	204	23	14	8	3.6	0.22	<0.01	99.64
996026	FieldTRIP 2	68.85	12.57	4.91	2.14	2.48	2.54	1.49	0.96	0.18	0.05	0.012	1315	26	216	191	21	13	7	3.3	0.24	<0.01	99.69
996027	FieldTRIP 3	68.68	12.94	5.05	2.09	2.49	2.59	1.56	0.95	0.17	0.08	0.012	1293	28	212	179	21	13	7	3.1	0.24	<0.01	99.92
996029		63.36	14.89	7.25	2.28	1.90	2.01	1.76	0.95	0.17	0.07	0.015	1419	45	202	213	23	13	8	4.9	0.54	0.02	99.77
996030		64.17	14.29	6.96	2.26	1.81	1.91	1.66	0.94	0.16	0.07	0.014	1406	36	209	209	24	14	8	5.3	0.54	0.02	99.77
996031		64.49	13.32	5.71	2.03	1.90	1.82	1.70	1.03	0.20	0.08	0.015	1289	28	223	225	21	15	7	7.4	1.63	0.02	99.90
996032		63.07	12.32	6.38	2.27	1.85	1.61	1.59	0.92	0.13	0.06	0.014	1180	34	203	218	16	12	7	9.4	2.41	0.01	99.81
996033		65.94	12.71	5.49	2.39	1.92	1.91	1.36	0.98	0.07	0.07	0.013	967	34	221	214	18	13	7	6.9	1.04	0.01	99.90
996034		53.95	15.25	9.28	2.95	1.57	1.03	1.54	0.84	0.19	0.12	0.007	1133	27	128	157	15	13	9	12.5	2.07	0.12	99.40
996035		61.39	14.90	6.57	2.40	2.10	2.32	1.60	0.94	0.07	0.19	0.013	1553	49	170	164	18	12	8	7.2	0.85	<0.01	99.92
996036		60.44	14.96	6.37	2.48	1.85	2.24	1.55	0.86	0.09	0.12	0.011	1034	37	143	156	17	11	8	8.8	1.04	<0.01	99.92
996037		60.96	14.58	6.12	2.19	1.96	2.15	1.41	0.80	0.10	0.09	0.011	985	38	160	143	16	11	7	9.4	1.27	0.02	99.93
996038		67.10	12.74	5.57	2.09	2.66	2.48	1.35	0.96	0.08	0.12	0.015	994	44	246	157	17	12	7	4.6	0.36	0.01	99.92
996045		63.51	13.92	6.00	2.53	2.29	2.44	1.43	0.83	0.12	0.08	0.011	1098	34	167	134	16	12	7	6.6	0.66	0.01	99.92
996046		66.59	13.09	5.89	2.36	2.50	2.31	1.35	0.95	0.07	0.15	0.015	1738	53	235	140	17	12	7	4.4	0.27	<0.01	99.92
Crinkle Chert - Logtung Road																							
996047		72.66	11.05	4.19	1.50	1.56	1.69	1.87	0.82	0.15	0.06	0.011	1053	31	155	151	27	16	5	4.2	0.36	<0.01	99.93
996048		70.45	11.24	4.61	1.63	1.57	1.38	1.96	0.83	0.13	0.08	0.012	1117	40	147	162	31	17	6	5.6	0.55	<0.01	99.67
996050		68.02	12.13	5.28	1.78	1.70	1.58	2.03	0.84	0.17	0.07	0.013	1220	48	160	163	34	17	6	6.0	0.55	<0.01	99.79
996051		59.59	14.15	5.49	1.58	5.35	0.98	2.98	0.68	0.15	0.16	0.009	1086	38	151	151	23	< 10	6	8.4	1.09	<0.01	99.68
996041	ADUP 996051	61.13	13.38	5.23	1.74	5.07	0.88	2.58	0.76	0.16	0.19	0.009	1195	37	169	172	25	10	7	8.2	1.10	0.02	99.53
Jennings River Quartz-Sericite-Schist																							
996039		59.78	11.22	7.57	3.29	4.85	1.78	1.48	1.05	0.23	0.13	0.020	1614	110	279	116	22	14	7	7.8	0.80	0.25	99.44
996042		60.19	11.67	6.85	3.66	4.96	2.04	1.36	1.28	0.23	0.16	0.020	1240	77	340	146	23	20	7	6.9	0.72	0.01	99.53
996043		58.52	11.43	7.22	3.60	5.20	1.86	1.48	1.07	0.24	0.13	0.023	1563	107	290	116	21	14	7	8.3	1.07	0.16	99.30
996044		59.32	11.49	7.35	3.26	4.80	1.81	1.53	1.06	0.24	0.14	0.020	1629	92	278	114	21	14	7	8.4	0.95	0.02	99.66
Arsenault Prospect																							
996020		60.55	14.07	7.63	3.17	3.18	1.93	1.81	0.95	0.20	0.11	0.016	1029	52	209	183	25	14	8	5.8	0.22	0.02	99.58
996022		64.11	13.16	6.75	3.11	3.32	2.08	1.66	1.02	0.20	0.07	0.016	964	40	238	204	24	15	7	4.2	0.18	0.01	99.85
996023		63.75	13.83	6.38	3.21	2.60	1.57	2.22	1.07	0.18	0.10	0.016	1166	43	199	246	28	16	8	4.6	0.23	<0.01	99.74
996024		55.00	12.35	6.96	3.05	2.44	1.38	1.43	1.04	0.29	0.15	0.018	858	47	206	211	23	16	7	15.5	4.19	0.05	99.75
996028		55.93	12.78	6.26	3.29	2.75	1.45	1.61	1.03	0.25	0.10	0.016	759	27	165	200	21	18	6	14.3	3.83	0.08	99.90
Mount Francis East																							
996008		61.22	12.54	6.14	2.17	2.12	1.12	2.27	1.08	0.20	0.10	0.017	1152	34	158	276	29	16	6	10.6	2.50	0.04	99.78
996012		62.08	13.24	6.35	2.30	2.63	2.14	2.23	1.15	0.16	0.10	0.024	1220	61	186	303	32	19	7	7.1	1.35	0.03	99.73
996013		64.51	11.86	6.77	2.10	2.60	2.30	1.65	1.18	0.13	0.16	0.020	1040	48	195	288	22	22	6	6.4	1.06	0.01	99.88
996014		64.26	11.76	6.15	2.71	3.60	1.69	1.63	1.03	0.17	0.13	0.016	1036	74	266	267	28	17	6	6.4	1.11	0.03	99.75
996016		55.98	11.12	5.66	2.74	3.58	1.59	1.29	1.08	0.35	0.10	0.021	973	88	259	291	126	17	9	16.0	4.35	0.02	99.72
996017		56.86	12.53	6.57	2.24	2.71	1.60	1.84	1.06	0.27	0.15	0.018	1183	53	192	221	44	19	7	13.7	3.56	0.05	99.75
996018		55.97	12.61	5.70	1.97	3.08	1.75	1.74	0.92	0.25	0.10	0.015	1043	45	233	231	28	14	6	15.6	4.38	0.07	99.88
996019		56.42	12.14	4.86	1.60	3.41	2.00	1.55	0.81	0.25	0.08	0.012	1014	28	281	215	22	12	5	16.6	4.83	0.01	99.91
Highway 97 Prospect																							
996002		67.63	12.71	5.63	1.59	1.50	1.57	1.72	0.85	0.07	0.02	0.012	1061	38	134	165	20	14	7	6.3	0.47	<0.01	99.78
996003		68.16	12.32	5.74	1.59	1.63	1.74	1.88	0.78	0.09	0.07	0.013	1191	47	162	155	29	16	6	5.6	0.34	0.02	99.79
996004		65.34	13.46	5.81	1.84	1.87	1.58	1.53	0.85	0.08	0.07	0.012	1079	39	152	143	17	14	5	7.1	0.77	0.03	99.69
996005		71.60	11.54	4.40	1.28	1.43	1.69	1.68	0.77	0.06	0.03	0.011	1148	32	169	170	21	14	5	4.9	0.40	<0.01	99.57
996006		65.43	13.34	5.55	2.28	2.20	1.96	1.95	0.97	0.15	0.07	0.014	1321	42	207	150	18	16	6	5.7	0.56	0.01	99.81
996007		71.01	11.13	4.50	1.39	1.55	1.65	1.67	0.75	0.08	0.07	0.011	1089	31	170	158	19	14	5	5.6	0.65	0.02	99.57
996009	FieldTRIP 1	72.02	10.91	4.13	1.36	1.73	1.75	1.75	0.77	0.06	0.07	0.010	1015	24	168	167	18	14	5	5.0	0.79	<0.01	99.70
996001	ADUP 996009	71.12	11.43	4.36	1.37	1.82	1.85	1.89	0.79	0.06	0.04	0.012	995	35	167	162	18	14	5	4.8	0.77	0.01	99.70
996010	FieldTRIP 2	72.11	11.10	4.23	1.30	1.72	1.79	1.80	0.71	0.06	0.04	0.010	987	23	159	155	19	13	5	4.7	0.62	0.01	99.71
996011	FieldTRIP 3	72.20	10.99	4.17	1.31	1.70	1.76	1.77	0.74	0.06	0.01	0.010	1013	25	164	154	17	14	5	4.7	0.67	0.03	99.58
	Median	63.51	12.61	6.12	2.28	2.29	1.78	1.65	0.95	0.16	0.10	0.014	1117	40	199	167	22	14	7	6.9	0.80	0.01	99.77
	Mean	63.17	12.76	6.08	2.34	2.60	1.81	1.69	0.95	0.16	0.10	0.015	1175	47	202	188	25	15	7	7.9	1.34	0.03	99.75
	Std. dev.	4.99	1.22	1.04	0.65	1.09	0.36	0.32	0.13	0.07	0.04	0.004	222	21	50	50	17	3	1	3.6	1.32	0.05	0.16
	Minimum	53.95	10.91	4.13	1.28	1.43	0.98	1.29	0.68	0.06	0.02	0.007	759	24	128	114	15	<10	5	3.6	0.18	<0.01	99.30
	Maximum	72.66	15.25	9.28	3.66	5.35	2.48	2.98	1.28	0.35	0.19	0.024	1738	110	340	303	126	22	9	16.6	4.83	0.25	99.93

Notes:
ADUP = analytical duplicate
FieldTRIP = field triplicate

of field triplicates display a larger measure of variability as compared to the analytical duplicates as the former represent three different (but adjacent) samples, whereas the latter is two parts of the same original sample. In general, the key elements (*e.g.* copper, cadmium, lead, selenium) showed good reproducibility in field triplicates and analytical duplicates (Table 5). For example, two field duplicates (996009, 996010) reported differences of 1.3 per cent and 0.3 per cent for copper and zinc, respectively. Two analytical duplicates (996001 and 996009) also showed good reproducibility for copper and zinc recording differences of 2.1 per cent and 0.5 per cent, respectively.

Results from the insertion of three CANMET reference material indicate acceptable levels of analytical precision (less than 10 per cent) for key elements in till. For instance, copper and zinc recorded relative standard deviations (RSD) of 1.8 and 2.1 per cent, respectively (Table 5).

GLACIAL HISTORY AND STRATIGRAPHY

Ryder and Maynard (1991) and Clague (1989) provide a limited regional overview of the Quaternary geology of northern British Columbia. Although there is little chronological information for the northern Cordilleran ice sheet available, evidence suggests processes were similar to those in the south of the province (Ryder *et al.*, 1991). Dates collected from lavas flows and organics show multiple glaciations, separated by warmer interglacial periods, occurred during late Pliocene (1.64 to 5.2 Ma) and Pleistocene (0.01 to 1.64 Ma).

TABLE 5
PERCENT DIFFERENCES FOR KEY ELEMENTS FROM ANALYTICAL (996001 AND 996009) AND FIELD (996009 AND 996010) DUPLICATES. RELATIVE STANDARD DEVIATION (%RSD) CALCULATED FROM 3 CANMET REFERENCE STANDARDS

Element		Detect. L. (ppm)	Anal. Dups (%)	Field Dups (%)	%RSD
Silver	Ag	2	0.0	10.0	2.5
Bismuth	Bi	0.02	14.1	45.2	2.0
Cadmium	Cd	0.01	0.0	25.0	5.0
Cobalt	Co	0.1	2.7	5.4	1.8
Copper	Cu	0.01	2.1	1.3	1.8
Manganese	Mn	1	0.9	0.0	1.6
Molybedum	Mo	0.01	4.6	10.4	3.3
Lead	Pb	0.01	0.9	3.0	3.1
Selenium	Se	0.1	0.0	28.6	9.1
Zinc	Zn	0.1	0.5	0.3	2.1

Detect. L. = Detection Limit
Anal. Dups = Analytical Duplicates
Field Dups = Field Duplicates
RSD = Relative Standard Deviation

The Fraser glaciation (late Wisconsinan in age), the last ice advance, largely obscured any evidence of earlier glacial and non-glacial events. For example, reconnaissance work along the Kechika River to the east suggest only one till sheet to be present in exposed settings (Bobrowsky, pers. comm., 1999). Several other authors also noted no evidence of multiple glaciations in northern British Columbia (*e.g.* Watson and Mathews, 1944; Kerr, 1948). Where glacial and interglacial sediments are preserved, dates are obtained only at scattered localities. To the southeast near Finlay River, Bobrowsky and Rutter (1992) collected a series of dates spanning from early Holocene to middle Wisconsinan time (10,000 to 37,190 ka) from multiple glacial and non-glacial sediments. To the east, in the Atlin area, Levson and Blyth (1993) collected radiocarbon dates from organics lying stratigraphically between till and placer gravels. Peat and wood fragments yielded dates of 31ka BP and 36 ka BP (middle Wisconsinan in age). Potassium-argon dates (0.5 to 3.6 Ma) attained from basalts interbedded with the placer deposits indicate some of the gravels are interglacial, although most are preglacial in age. Aitken (1959) also recorded two tills and associated outwash overlying a third till and outwash in a placer camp near Atlin. Peat radiocarbon dates suggest the lowest till may be older than 37,000 years (Miller, 1976), corresponding to a early Wisconsinan glaciation. To the south, Spooner *et al.* (1996) estimated the age of a regional advance, beneath basalt flows in the Stikine River valley. Potassium-argon dates and paleomagnetic analysis imply the sediments to be between 330-360 ka, corresponding to a pre-Illinoian isotope stage 10.

Additional stratigraphic evidence of multiple Cordilleran ice advances, but no absolute dating, has also been noted in northern British Columbia. In the Atlin area, Levson (1992) noted up to three auriferous gravel sequences interbedded with till. In the Omineca Mountains near Uslika Lake, glaciolacustrine silts deposited in a moraine dammed lake are overlain by till (Roots, 1954). In the Dease River valley, two separate ice advances are suggested by a sequence where till is overlain by silts with a superimposed esker complex (Gabrielse, 1969). However, whether these represent two advances of the Fraser Glaciation, as in the two upper tills Aitken's study area (see above), or two distinct glaciations is unclear.

Fraser Glaciation

Earlier workers noted that the development of the last ice sheet appears to have been preceded by an episode of alpine glaciation which was long enough for the development or redevelopment of erosional landforms. Gabrielse (1969) noted rounded spurs and cirque headwalls modified by meltwater erosion in the Cassiar Mountains. Aitken (1959) cited over-ridden cirques and rounded aretes.

In the early phases of glaciation, ice built up due to the growth of cirque and valley glaciers in the Coast Mountains and higher parts of the Skeena Mountains. Alpine glaciers also developed in the Cassiar Mountains and many parts of the Stikine Plateau. Due to the many centres of ice accumulations, ice sheet morphology and flow patterns were complex at the time of coalescence. Local shifts in ice-flow directions did occur due to changes in the relative influence of topographic control on thickening and thinning ice (Ryder and Maynard, 1991).

Advancing glaciers from the local mountains dammed river valleys forming lakes across the region (Ryder and Maynard, 1991). As the ice overrode these areas and thickened, the extensive ice-sheet rose to an elevation of at least 2000 metres as shown by erratics (Watson and Mathews, 1944). Roots (1954) recorded glacial limits up to 2300 metres in the Omineca Mountains whereas Johnston (1926) and Gabrielse (1969) noted heights of 2100 metres in the Cassiar Mountains.

Deglaciation occurred partly by frontal retreat of ice tongues and partly by downwasting of stagnant ice. Paleo-ice-flow directions altered according to increasing topographic control. Widely distributed small bodies of glaciolacustrine sediments indicate that numerous lakes existed during deglaciation. Large esker complexes as well as kames and kettles dot the valley floors, indicating that ice stagnation was the dominant deglacial process in the mountainous areas. Local re-advances or pauses occurred during the late phase of the Fraser Glaciation. Recessional moraines and kame terraces mark ice margins during pauses in ice retreat. Morainal ridges bounding cirques could also be attributed to the growth and decay of alpine glaciers reoccupying cirques after the last ice sheet disappeared (Aitken, 1959).

Since glaciation, previously deposited glaciogenic sediments have been reworked by colluvial processes under paraglacial conditions and resedimented at the base of steep slopes. Similarly, paraglacial alluvial-fan sedimentation was active during deglaciation and has continued until the present. If Holocene glacial activity occurred it was restricted to high cirques in alpine areas. Fluvial terrace, floodplain and active channel deposits have also formed along valley floors during the Holocene.

SURFICIAL SEDIMENTS

The surficial sediments within the study area were deposited during the last cycle of the Fraser Glaciation and ensuing post-glacial activity. At lower elevations, on gentle slopes and plateaus, the bedrock topography is mantled by variable amounts of a massive, matrix-supported diamicton. Deposits range from a thin veneer (<1 metre) to a thick (≈45 metres) mantle. The physical properties of these diamictons suggest they are basal tills derived from lodgement processes (*e.g.* Dreimanis, 1988).

In general, basal till deposits are massive to very poorly-stratified, dark olive grey (or brown) and moderately to highly-consolidated (Photo 1). The matrix is commonly fissile with a high clay content. Deposits are dense, compact, and cohesive. Clast content ranges from 5 per cent to 40 per cent, with a mean of 15 per cent. Clast size ranges from granular (<1 centimetre) to boulder (>1metre), averaging 1 to 2 centimetres. Clasts occur in a range of roundness, but most are subangular. Clast lithologies are variable and include local bedrock. Many clasts (≤25 per cent) are striated and faceted. In some areas, particularly along or at the base of steep slopes, tills are reworked and colluviated.

Lateral and recessional moraines are common in the Cassiar Mountains (Photo 2). Till ridges range from 10's to 100's of meters in length and are no more than 20 metres in width. Moraines mark the location of ice pauses during local glacier retreat. Surficial sediments are commonly dissected by meltwater channels and can be used to establish the sequential positions of the edge of the ice (Photo 3).

Glaciofluvial, glaciolacustrine, modern fluvial and organic materials dominate valley settings. Deposits of massive to well-stratified sand, gravel and silt are evident in upland valley and as terraces throughout the study area. Coarse gravel beds range from open framework clast-supported beds to very well-stratified sands with normal, reverse or no grading (Photo 4). Ripples and cross-stratified beds are common. Load structures are locally preserved. Such sediments likely represent ice-proximal to ice-distal facies deposited during deglaciation. In the

Photo 1. Basal lodgement till exposed in a road cut along the Alaska Highway.

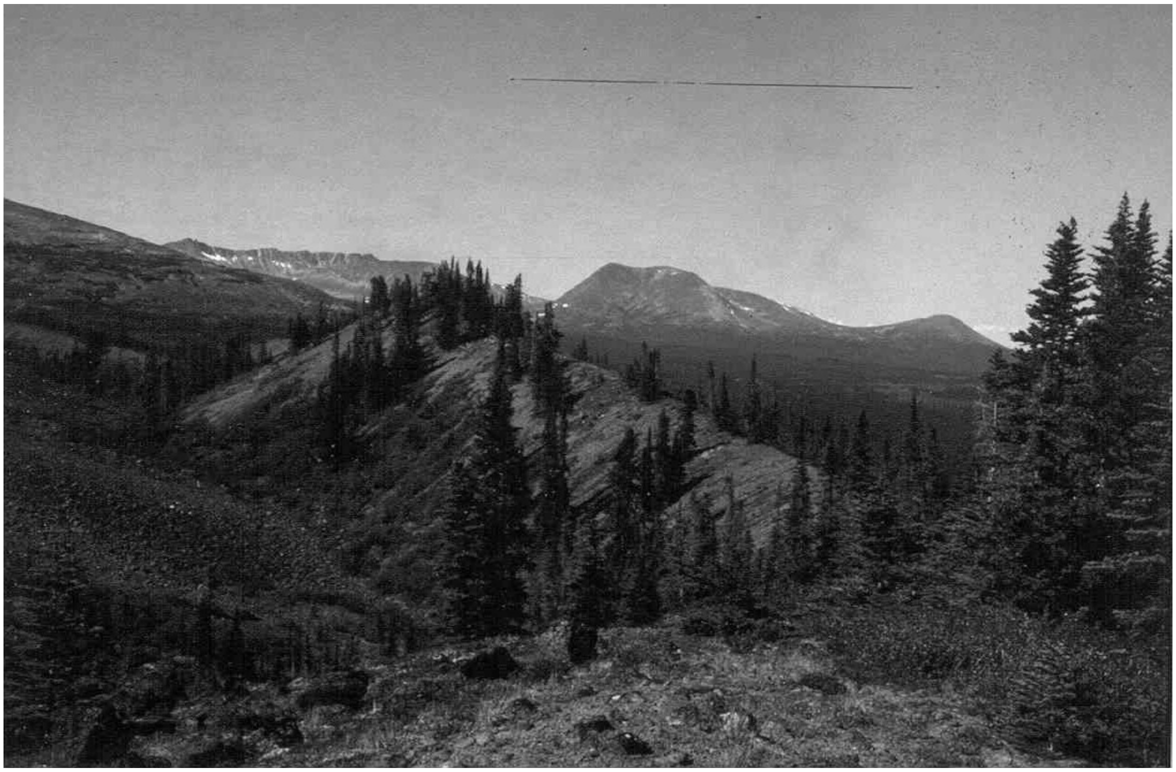

Photo 2. Lateral moraine in the Cassiar Mountains marking the ice margin during glacial retreat.

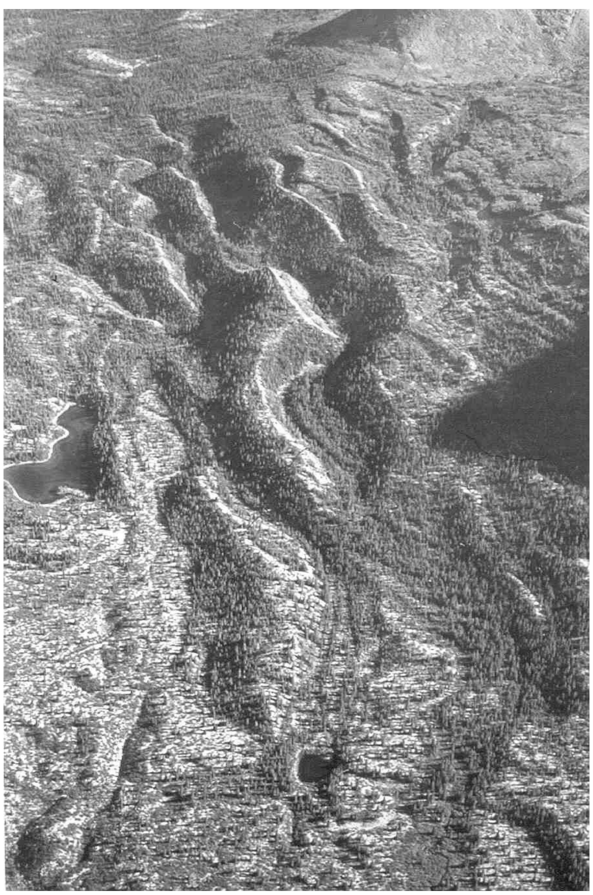

Photo 3. Meltwater channels developed on slope in Cassiar Mountains composed of thick till.

Photo 4. Glaciofluvial gravels exposed along the Jennings River.

deep, broad valleys in the Cassiar Mountains, esker complexes and kame and kettle topography are abundant. Eskers range from 10's to 100's metres in length. Kettles, identified by their circular shape, have formed where abandoned ice blocks were left to slowly ablate while sedimentation occurred around them (Photo 5).

Along the Swift River valley and Teslin Lake, thick sequences of fine sand, silt and clay form terraces above the modern day floodplain. The terraces occur below 900 metres in elevation. Exposures show rhythmically laminated, horizontal, tabular beds. Rip-up clasts and dropstones are common. Individual rhythmites have sharp basal contacts and vary in thickness from a few millimetres to several tens of centimetres. In select areas, glaciolacustrine rhythmites lie stratigraphically between two till layers (Figure 3). Occasionally, thin (<2 metres) sequences of glaciofluvial sands and gravels cap the rhythmites. The contact between the upper till and underlying unit is commonly abrupt and erosive. Rhythmites are often convoluted and contain load structures. The two diamictons exhibit similar physical properties such as colour, texture, and structure. The glaciolacustrine sediments are the remnants of a lake formed by the damming of the Teslin trench by advancing glaciers. Whether the tills are the result of two advances of the same ice sheet, or of two separate glaciations, is unclear without dating.

Modern fluvial, colluvial and organic deposits are found throughout the study area. Large modern floodplains dominate valley settings, with large alluvial fans forming along valley margins. Deposits includes clean, well-sorted and stratified sand and gravel. Clasts are well-rounded and of variable lithologies.

Intense post-glacial erosion within the area has produced widespread colluvial debris. Deposition and accumulation of these sediments result from direct, gravity-induced movement involving no agent of transportation such as water or ice, although the moving material may have contained water and/or ice. Colluvium can be massive to crudely-stratified, poorly-sorted to moderately-sorted, matrix to clast-supported and monolithic to polylithic, depending on source material. Clast size ranges from granular to boulder and shapes are variable. Deposits commonly occur in veneer or blanket accumulations or as large cones along steep valley walls and slopes.

Organic deposits commonly occur in areas of poor drainage such as marshes and swamps. Deposits are common along floodplains, along old meltwater channels, and between drumlinoid features. In areas of higher elevations, including plateaus, organic material accumulates where bedrock topography traps surface water to form bogs.

Photo 5. Eskers and kettle lakes in Cassiar Mountains. Landforms are produced under stagnant ice during glacial retreat.

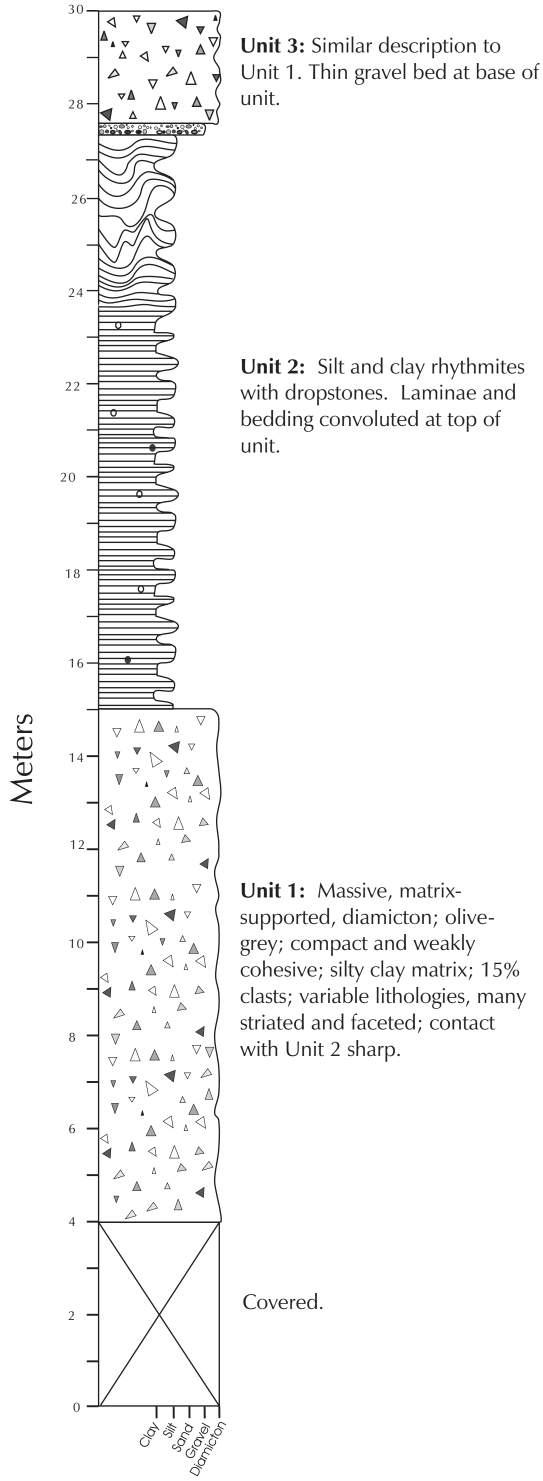

Figure 3. Stratigraphic section of two tills and glaciolacustrine sediments exposed along the Jennings River.

Ice-Flow

Mapping of ice-flow indicators (Photo 6) reveals trends similar to those suggested by other authors (*e.g.* Ryder and Maynard, 1987; Clague, 1989; Jackson, 1994). At the glacial maximum, an ice divide developed over the Cassiar Mountains between the Liard and Teslin Plateaus (Figure 4). Ice flowed westerly from the mountains and upon reaching the Teslin Depression, moved northerly into the Yukon. In contrast, on the east side of the Cassiar peaks, ice flowed northeast toward the Liard plateau and into the Yukon. It is unclear if the Cordilleran Ice sheet was influenced at all times by underlying topography or if a true continental ice sheet, with flow directions independent of underlying topography, developed. However, local flow directions did alter in accordance with increasing topographic control as the ice thinned.

A second set of cross-cutting striae and stoss and lee forms was documented at seven locations along the shore of Teslin Lake and the Alaska Highway corridor. A second, older (?) northeasterly flow event may have occurred across the study area.

TILL GEOCHEMISTRY

Forty-five till samples were collected for geochemical analyses in the area of six geochemical case study locations. The studies focused on sampling till over: 1) exhalative and felsic metavolcanics packages with potential for hosting polymetallic massive sulphide deposits (*e.g.* copper-bearing crinkled chert); and 2) mineral prospects (*e.g.* Arsenault MINFILE 104O 011). The case studies and collected samples are summarized in Table 6. Data listed here complements the work of Cook and Pass (this volume).

Felsic Volcanic and Exhalative Packages

The following case studies were conducted over horizons with perceived potential for hosting base metal mineralization: a) copper-bearing crinkle chert (north of Mount Francis and Logtung Road); and b) Jennings River quartz-sericite schist. Results discussed are based on aqua regia ICPMS determinations unless otherwise stated.

Copper-Bearing Crinkle Chert

Minor sulphide mineralization and copper staining have been found at select sites within a distinct marker horizon of crinkle chert. This unit is characteristically white to pink in colour, thinly bedded to laminated and contorted. Least recrystallized beds have purple-grey to greenish-coloured fresh surfaces comprised of silica, lesser argillite and minor ash tuff. Recrystallized beds are quartzite with white mica. Commonly, piedmontite (manganese-epidote) has coloured the rocks pink and red. Idiomorphic garnet, specular hematite and staurolite are present. The unit is best exposed in the Mount Hazel, Logjam Creek and Mount Francis areas in the Smart River (104O/13) map area (Mihalynuk *et al.*, 1998).

Two bedrock samples collected by (Mihalynuk *et al.*, 1998), have highly anomalous concentrations of barium (average 2254 ppm, INAA) in the chert unit, compared to

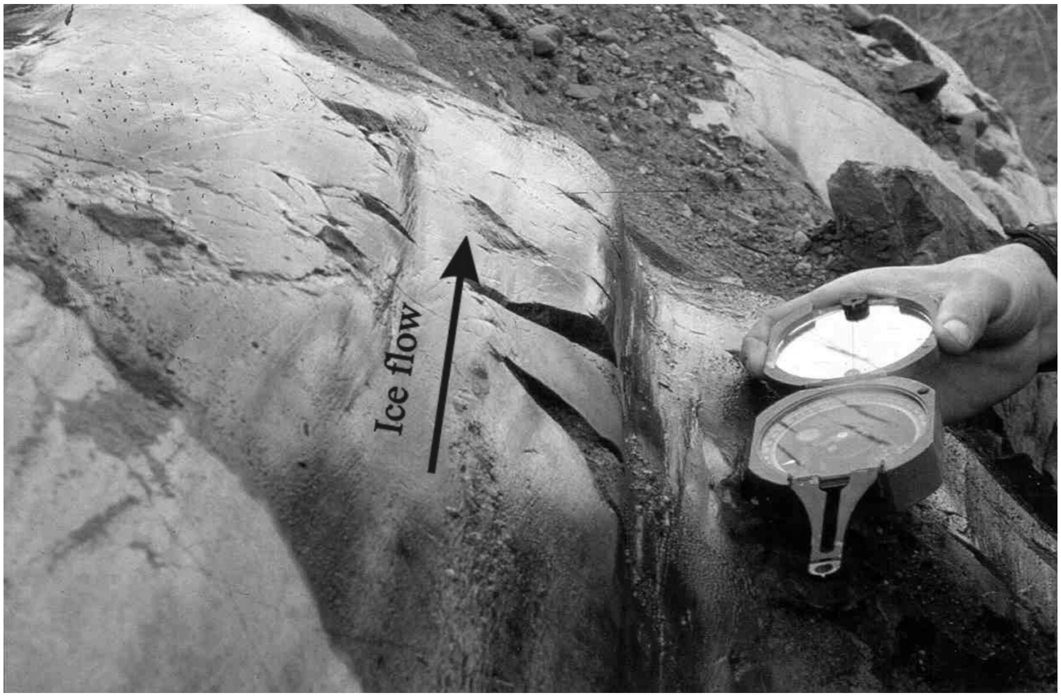

Photo 6. Striated and grooved bedrock surface, exposed along the Alaska Highway. Ice-flow was from east to west.

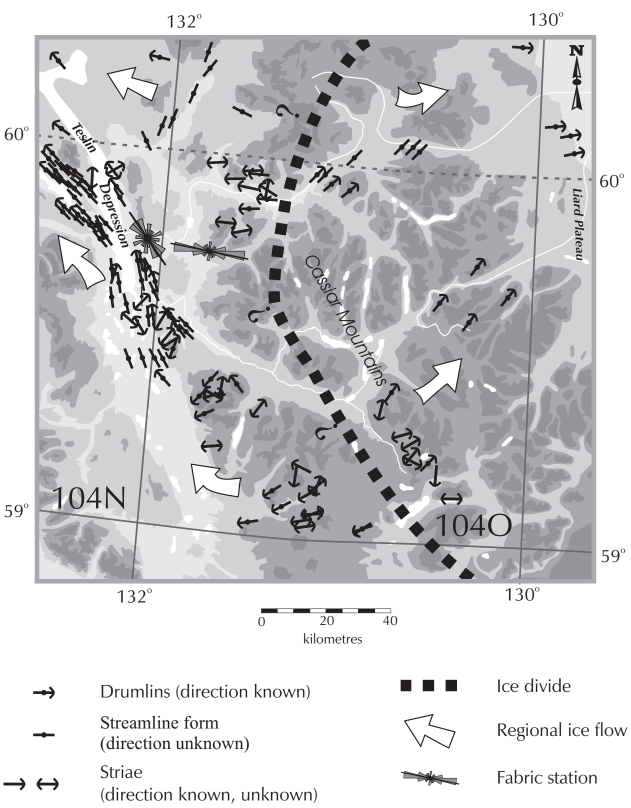

Figure 4. Summary of ice-flow directions for the study area. Position of ice divide is approximate. Data compiled from Dixon-Warren and Hickin (2000), Morison and Klassen (1997), Jackson , L.E. (1994), Klassen (1978), Gabrielse (1968), Watson and Mathews (1944).

many of the other lithologies in the study (average 59 ppm; N=28). Cook and Pass (this volume) also detected anomalous values in 5 chert samples with barium ranging from 1600 to 19,000 ppm (Cook and Pass, this volume; Table 4). Elevated barium levels may be a useful element to distinguish crinkle quartzite from other fine grained quartzites within the study area (Mihalynuk *et al.*, 1998).

1) North of Mount Francis

Two small bedrock knobs, located approximately 2 kilometres apart, are composed of metasedimentary rocks, (east knob), and crinkle chert (west knob; Figure 2). The Arsenault prospect is about 3 kilometres to the south and the Alaska Highway is 9 kilometres to the north. Ten thin (<2 metres thick) till and colluviated till sites were sampled within the area, six on the east knob, four on the west knob (Figure 5). Three samples were also collected from thin (<50 centimetres) colluvial debris directly over bedrock on the west knob. Eight soil profiles were collected in select till pits by Cook and Pass (this volume; Tables 5, 6, and 7). Ice-flow is inferred to be from east to west, as indicated by striae observed within the area.

Samples collected on the east knob have lower barium values (770-1100 ppm, INAA) than samples collected over the chert unit (790-1500 ppm, INAA; Table 7). The east knob is expected to have lower barium concentrations due to its up-ice location from the chert unit. Key base metal concentrations, *e.g.* copper and zinc, were at or near background (median) concentrations for all stations (Table 2). High barium values were detected in both colluvial debris (*e.g.* 996035, 1300 ppm, INAA) over bedrock and till (*e.g.* 996046, 1500pm, INAA) dispersed down-ice

TABLE 6
SUMMARY OF TILL GEOCHEMISTRY
CASE STUDY SAMPLING SITES

Case Study		NTS Mapsheet	MINFILE	Samples
Exhalative:	Crinkle Chert - North of Mount Francis	104O/13	n/a	996029, 996030, 996031, 996032, 996033, 996034, 996025, 996026, 996027, 996035, 996036, 996037, 996038, 996045, 996046
	Crinkle Chert - Logtung Road	104O/13	n/a	996047, 996048, 996050, 996051
Felsic Volcanic:	Jennings River quartz-sericite schist	104N/9	n/a	996039, 996042, 996043, 996044
Mineral Prospects:	Arsenault Prospect	104O/13	104O 011	996020, 996022, 996023, 996024, 996028
	Mount Francis East	104O/13	n/a	996008, 996012, 996013, 996014, 996016, 996017, 996018, 996019
	Highway 97 Prospect	104O/13	104O 054	996002, 996003, 996004, 996005, 996006, 996007, 996009, 996010, 996011

TABLE 7
GEOCHEMICAL RESULTS FOR BARIUM (INAA) AND MANGANESE AT THE CRINKLE CHERT, NORTH OF MOUNT FRANCIS

Sample		Ba (ppm)	Mn (ppm)
East Knob			
996029		1100	375
996030		1000	373
996031		1000	367
996032		960	456
996033		770	422
996034		770	368
West Knob			
996025	Field Trip. 1	1300	338
996026	Field Trip. 2	1100	295
996027	Field Trip. 3	1100	281
996035		1300	500
996036		850	430
996037		790	352
996038		790	392
996045		920	380
996046		1500	521

Field Trip. = field triplicate

of the knob, indicating both sediment types are suitable for sample media.

Although there is no regional till data to compare these results against, several such surveys have been conducted in central and southern British Columbia. Results show median values between 380-850 ppm for barium and 508-805 ppm for manganese (*s*ee Table 8; Cook and Pass, this volume). Thereby, high barium concentrations do appear unique in this area, particularly for the crinkle chert unit. However, manganese concentrations (Table 7) are indistinguishable from background levels in other parts of the province. More information on soil and rock geochemistry collected here is given by Cook and Pass (this volume).

2) Logtung Road

The crinkle chert unit is clearly exposed along Logtung Road, 1.5 kilometres north of the Alaska Highway and 1 kilometres west of Logjam Creek. Three samples were collected along an east-west traverse, parallel to paleo-ice-flow directions (Figure 6). Striated bedrock within the case study area indicate ice-flow was from the east to the west. The sampling medium, inferred to be basal till, was gleyed and moist. At least 10 centimetres of peat overlay the till. No samples were collected to the east, as no suitable sampling media were available. One grab sample (996051) was also obtained from a thick unweathered basal till sequence exposed along the Logjam Creek, 150 metres north of the junction of the Alaska Highway and Logjam Creek (Figure 6). Outcrop, bark and twig, stream sediment and water samples were collected by Cook and Pass (this volume), but results are not yet available.

Base metal values were low in all samples collected west of Logtung Road. Copper and zinc ranged from 28.41 to 41.76 ppm and 56.1 to 70.8 ppm, respectively. Barium, the key signature element for the crinkle chert unit, ranged from 910 to 970 ppm (INAA). Sample 996051, collected from unweathered till, recorded high concentration of barium (960 ppm, INAA), but metal concentrations; *e.g.* copper (39.84 ppm), and zinc (72.3 ppm) were also low (Tables 2 and 3).

Low base metal concentrations may reflect the removal of more mobile metals from till by leaching; although, results could also reflect a lack of mineralization at this location. However, the elevated geochemically less mobile barium values still successfully reflect the

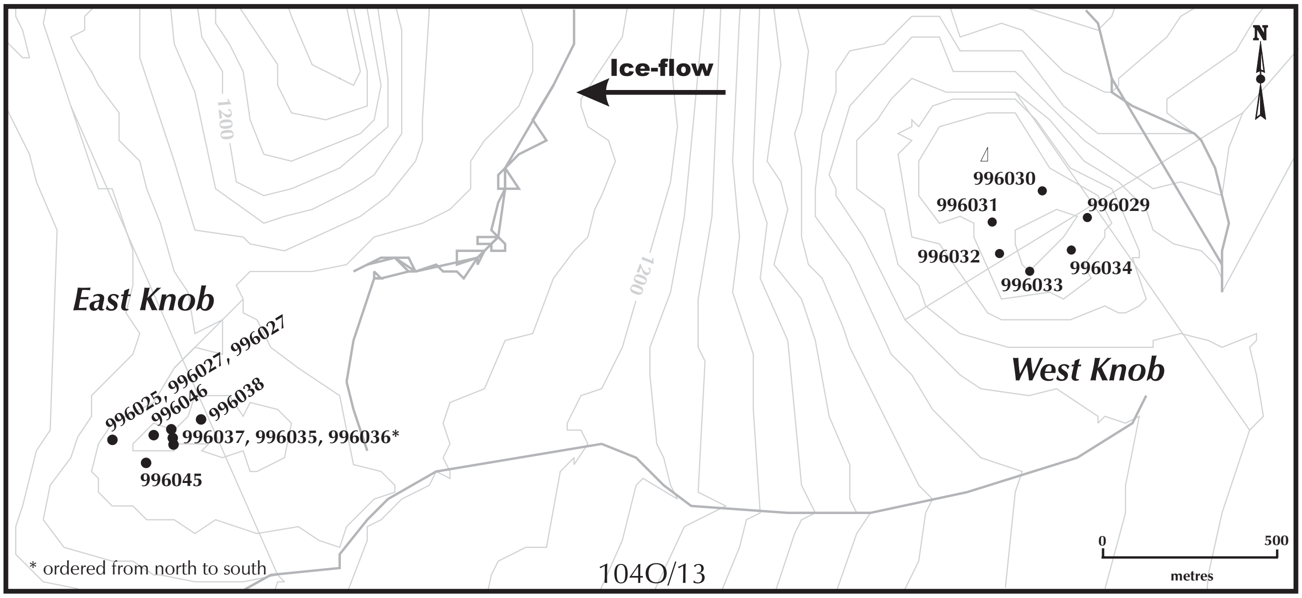

Figure 5. Approximate location of crinkle chert sampling sites, north of Mount Francis. Regional ice-flow was from east to west. Cook and Pass (this volume) summarize soil data collected at this site.

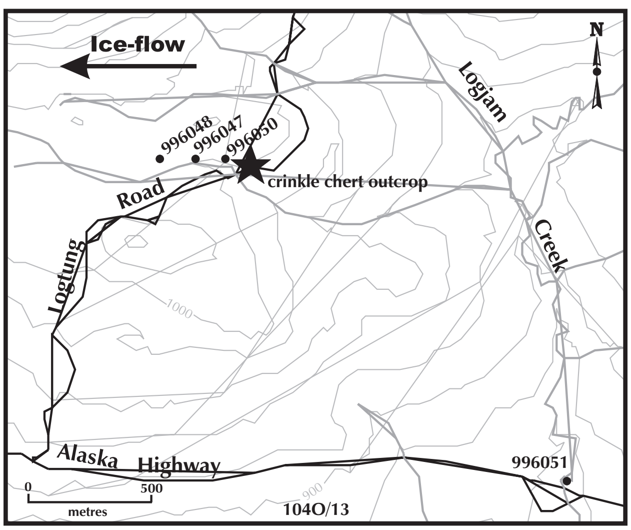

Figure 6. Approximate location of crinkle chert sampling site, Logtung Road. Regional ice flow was from east to west.

proximity of the crinkle chert unit. Elevated barium values recorded at the site adjacent to Logjam Creek suggest that a source area enriched in these two elements lies nearby.

Jennings River Quartz-Sericite Schist

On the north side of the Jennings River, surficial sediments were sampled over a quartz-sericite schist, to test its potential for associated polymetallic mineralization. A composite rock sample (99-SJC-12), collected across a 1.5 metre-wide altered pyritic quartz-sericite schist horizon yielded only background-level concentrations of copper (20 ppm), zinc (17 ppm), cobalt (4.7 ppm) and barium (320 ppm, INAA; Cook and Pass, this volume). The bedrock is overlain by a 12 to 14 metres thick sequence of basal till, and is capped by 2 metres of glaciolacustrine sediments (silt and clay rhythmites). Ice-flow was established to be from the south-east based on ice-flow indicators such as drumlins, striae and stoss and lee forms.

Two till profiles, comprised of two samples each, were collected from the exposure to evaluate the geochemical response to underlying bedrock (Figure 7 and Table 8). Sample 996044, collected within 1 metre of bedrock was situated 3 metres below sample 996039 (Profile A). Sample 996042, collected near the contact of the glaciolacustrine sediments and till units, was sampled approximately 10 metres up section from sample 996043, sampled within 2 metres of bedrock (Profile B). Profile A is 30 metres to the east of Profile B. Cook and Pass (this volume) also collected two soil profile from the overlying glaciolacustrine sediments, to demonstrate the poor geochemical response of this sample media.

Results indicate base metal elements detected in the soils have weaker geochemical signature than in the underlying till. For example, copper and zinc values in the B horizon are 19.17 ppm and 50.7 ppm, respectively, whereas, in the underlying till they are 74.97 ppm and 90.7 ppm (see Table 5 of Cook and Pass, this volume). As basal till is generally a first derivative product of bedrock, it will carry a strong geochemical signature of its parent material and therefore is a preferred sampling media for geochemical exploration (Shilts, 1976). In contrast, glaciolacustrine sediments have been extensively reworked and more distally derived and consequently, tracing an anomaly back to a source area is more complex.

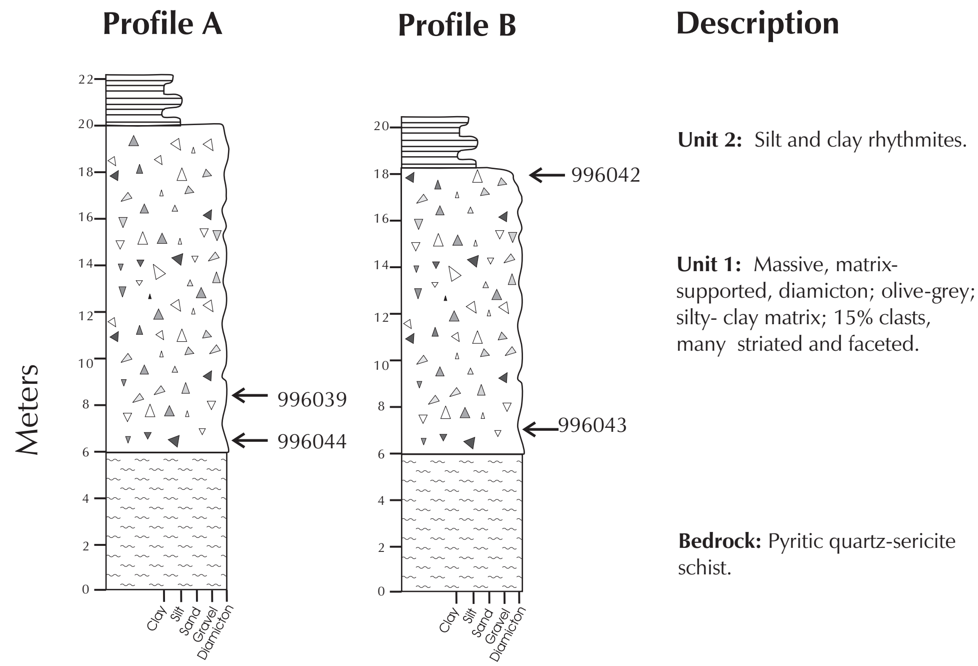

Figure 7. Stratigraphic sections showing sample sites over the pyritic quartz-sericite schist. Cook and Pass (this volume) summarize soil profile data collected at this site.

TABLE 8
CONCENTRATIONS OF KEY ELEMENTS FROM TILL PROFILE DATA COLLECTED OVER THE PYRITIC JENNINGS RIVER QUARTZ-SERICITE SCHIST

Sample	Height[1] (m)	Mo (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Co (ppm)	Cd (ppm)	Se (ppm)
Profile A								
996039	4	5.57	82.57	11.92	104.7	21.0	0.55	2.0
996044	<1	4.55	74.44	9.96	96.7	20.7	0.50	1.9
Profile B								
996042	10	1.49	49.38	6.61	76.7	19.9	0.28	0.9
996043	2	4.78	74.97	10.05	90.5	23.0	0.47	1.3

[1] measured in metres above bedrock

Tills sampled near bedrock report higher elemental values than those collected up profile (Table 8). For example, elevated copper (74.44-82.57 ppm), zinc (90.5-104.7 ppm), cobalt (20.7-23.0 ppm), cadmium (0.47-0.55 ppm) and selenium (1.3-2.0 ppm) occur in the samples 996039, 996043 and 996044. In contrast, sample 996042 recorded comparatively lower values: 49.38 ppm copper; 76.7 ppm zinc; 19.9 ppm cobalt; 0.28 ppm cadmium; and 0.9 ppm selenium. Close to the bedrock, the geochemical signature from the parent material will be more pronounced in overlying sediments as the source is relatively close. In contrast, sediments higher in the profile have been transported from farther up-ice, and the concentrations detected are lower due to dilution (Miller, 1984). Sample 996039, collected approximately 4 metres above bedrock, has consistently higher elemental concentrations than the two underlying samples. Sediments collected may be part of a metal rich dispersal plume derived from a source, up-ice to the south.

Mineral Prospect Studies

Till sampling was conducted over the Arsenault copper prospect (MINFILE 104O 011) and Highway 97 (MINFILE 104O 054) showing to define their geochemical signatures. Sampling was also conducted on the east side of Mount Francis to further characterize the geochemistry of a RGS anomaly most-likely associated with the mineralized rocks of the Arsenault prospect.

Arsenault Prospect

A previous soil geochemical study conducted by Sawyer (1967) provides an indication to the configuration of dispersal patterns one can expect around the Arsenault prospect (Figure 8). Although ice-flow indicators suggest a westerly regional flow in the area, ice may have been locally deflected southward around the northeast trending Mount Francis. The trend of copper dispersal plumes parallels ice flow, showing a broad discontinuous zone of ribbon-shaped plumes extending southwest. Secondary downslope dispersion has overprinted the original dispersal plumes, attenuating the southern boundaries of the plumes. These results should be cautiously interpreted as no description of type of sediment sampled (*e.g.* B or C horizon, colluvium or till) was provided in the original report.

To further characterize the geochemical signature of the Arsenault showing, samples were collected adjacent to two exploration trenches on a subsidiary western ridge of Mount Francis. Cook and Pass (their Tables 5, 6 and 7;

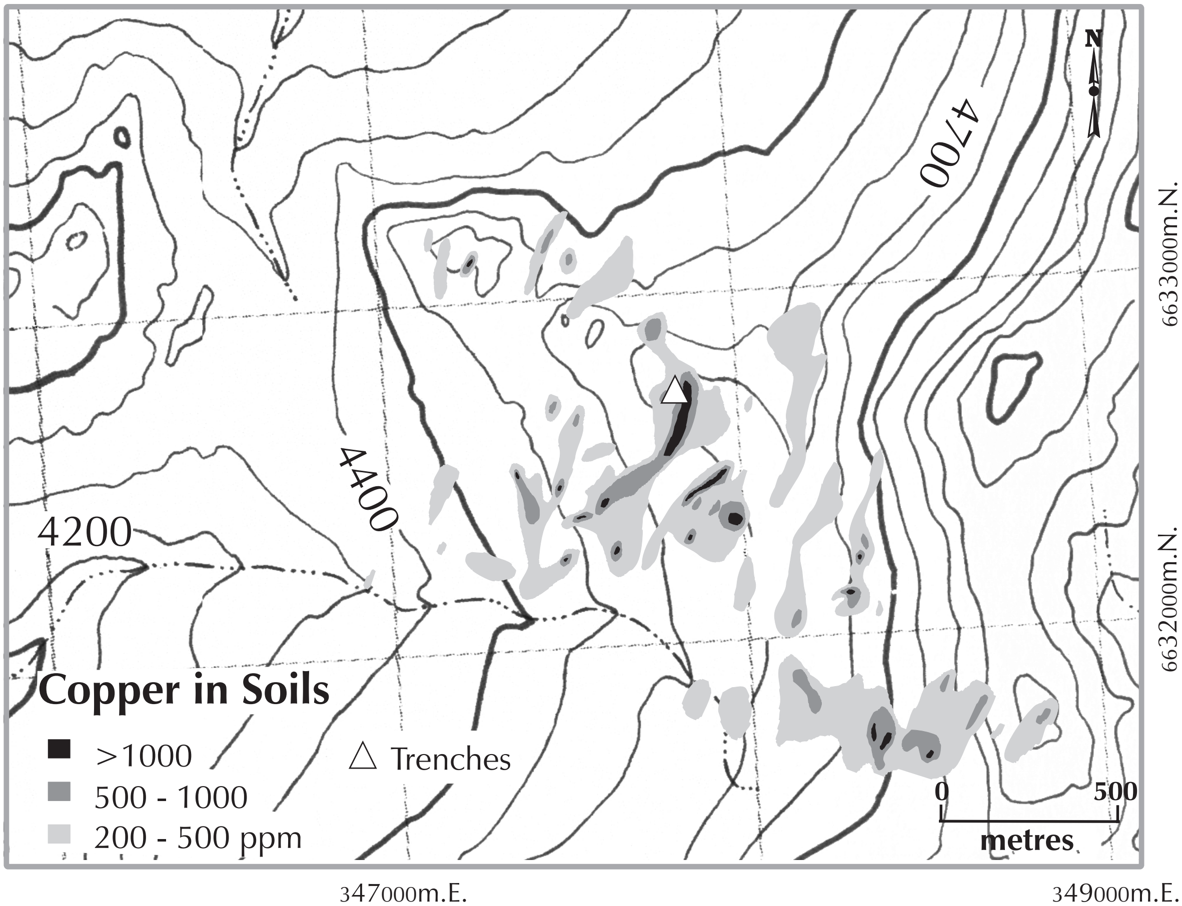

Figure 8. Copper in soils at the Arsenault prospect. Modified after Sawyer (1967).

this volume) sampled two soil profiles here, as well as collected stream sediment and water samples to the northwest. Three till samples were collected 200 metres southwest of the trenches and two samples 200 metres to the northeast (Figure 9). Samples were approximately 100 metres apart along an east-west traverse. Surficial materials were thin (<1 metre), discontinuous and colluviated. Ice-flow was from the east to west, based on the orientation of striae recorded in the area. However, ice may have been locally deflected by topographic influences. Solifluction lobes, resulting from slow downslope movement of unconsolidated surficial material, indicates that surface debris was subject to colluvial processes.

Soil data contained values as high as 4977 ppm copper, 142 ppm molybdenum, 77 ppb mercury and 29 ppm selenium in colluvium (sample 996509) over bedrock (their Table 5, Cook and Pass, this volume). Mineral-rich debris is also detected in the till, resulting in a strong copper-zinc-cadmium-selenium signature (Table 9). Elevated concentrations of copper (104.35-589.98 ppm), zinc (64.6-236.2 ppm), cadmium (0.21-2.41 ppm), and selenium (0.8-1.2 ppm) were recorded in all the samples. Samples collected to the southwest (996020, 996022, and 996023) have higher copper values than the two samples (996024 and 996028) collected northeast of the trenches. These results echo the observations of Sawyer (1967) who recorded anomalous zones (>200 ppm) of copper in soil samples collected to the southwest of the property (Figure 8). The thin, colluviated samples indicate transport distance was limited and the potential source area, associated with the mineralized rocks surrounding this prospect, lies up-slope towards the east.

Mount Francis East

Limited trace element data area available through RGS program for the map area 104O (RGS, 1979). Cook and Pass collected additional samples to verify the original RGS anomalies, identify possible sources and investigate metal speciation (Cook and Pass, this volume; Table 1; RGS, 1979). East of the Arsenault prospect, a RGS stream water sample collected at approximately 1300 metres returned elevated values of copper (104 ppm), zinc (130 ppm) and cobalt (8 ppm). To further define the anomaly and evaluate if high elemental values are reflected in the surficial sediments above and below, eight samples of thin colluviated material were collected along 3 northeast-southwest transects in the drainage basin (Figure 9). Sample spacing was approximately 30 metres, along transects at about 1450 metres, 1300 metres and 1200

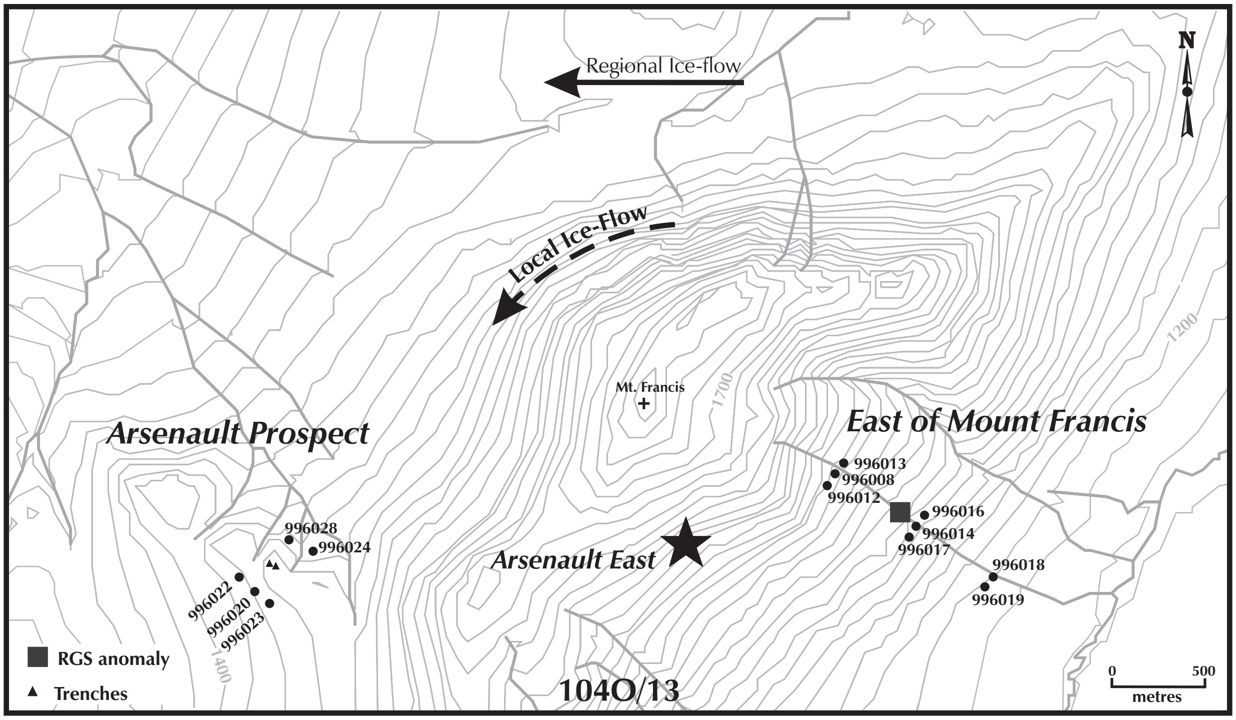

Figure 9. Location of sampling sites at the Arsenault prospect Mount Francis East. Regional ice-flow was from east to west; however, ice was probably locally deflected to the south around Mount Francis. Cook and Pass (this volume) summerize soil profile data collected at the trenches.

TABLE 9
CONCENTRATIONS OF KEY ELEMENTS IN TILLS AT THE ARSENAULT PROSPECT

Sample	Mo (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Co (ppm)	Cd (ppm)	Se (ppm)
Southwest of Exploration Trenches							
996020	2.44	589.98	13.83	236.2	16.5	2.41	0.9
996022	2.62	387.65	8.54	64.6	13.9	0.22	1.0
996023	2.60	227.26	12.88	71.2	16.1	0.26	0.8
Northeast of Exploration Trenches							
996024	2.39	157.55	20.86	84.8	23.4	0.48	1.2
996028	2.32	104.35	19.44	67.1	13.8	0.21	1.1

metres. Regional ice-flow was inferred to be from the east to the west, however, it was probably deflected to the south by Mount Francis.

Key elements reached anomalous levels the tills (Table 2). Copper concentrations ranged from low (35.72 ppm) to elevated levels (132.33 ppm). Other elements such as zinc (56.9-132.4 ppm), cobalt (10.4-20.3 ppm), arsenic (13.0-55.4 ppm, INAA) and selenium (0.8 to 1.3 ppm) showed similar patterns. More sampling is required to accurately delineate the source area more sampling is required; however, the colluvial nature of the surface material requires that it be northwest, in the upper portion of the drainage basin, along the strike of the slope. It is likely genetically related to the Arsenault and Arsenault East showings.

Highway 97 Prospect

A greenstone unit composed of resistant, dark green to black-weathered basalt and intermediate to mafic tuff lies west of Mount Francis and both east and west of Logjam Creek. Well-bedded, bright green, aphanitic lapilli tuff is the most common lithology, with massive flows equivocally identified in only a few localities.

Along Highway 97, a 3-metre wide gossanous zone, cross-cut by north northwest trending quartz-chlorite-magnetite-pyrite chalcopyrite veins (<30 centimetres thick) was first reported by Mihalynuk (1998) in the greenstone unit 3.5 kilometres west of Swan Lake. Mineralized chips sampled collected returned 0.2 per cent copper, 165 ppm cobalt, 210 ppm arsenic and 45 ppm tungsten (Mihalynuk *et al.*, 1998). This unit stratigraphically underlies the crinkled chert unit.

Till sampling was conducted here to establish the extent of dispersal of mineralized debris from this source. Seven till sites were sampled in area of thin basal till (<2 metres), four to the north of the highway and three to the south (Figure 10). Cook and Pass (this volume) also collected thin oxidized soil (996502) and rubble sample (996503R) over the mineralization as well as a cobble sample (99-SJC-03) at station 996002. Paleo-ice-flow directions are inferred to be from the east to the west based on striae and stoss and lee forms exposed along the Alaska Highway.

Only the rock samples collected by Cook and Pass (this volume) have elevated metal concentrations, (*e.g.* copper 228.92 ppm), whereas the till samples show background (median) or near background concentrations of copper and other base metals (Table 2). Detection of the dispersal plume may have been disrupted during highway construction.

CONCLUSIONS

Surficial mapping and geochemical studies over the Big Salmon Complex and adjacent rocks in northwest British Columbia has shown that:

- basal till, the preferred sampling medium, is abundant on gentle slopes and plateaus at lower elevations
- an ice divide may have existed within the study area between the Nisutlin and Liard plateaus complicating ice-flow patterns;
- till, a first derivative product of bedrock, carries a stronger geochemical signature then other sampling media;
- trace metals commonly associated with massive sulphides, including copper, zinc, and cadmium as well as important pathfinder elements such as selenium and cobalt, detected over favourable host rocks;
- high concentrations of barium were detected in surficial media around the copper-bearing crinkle chert and seems to be a useful pathfinder for the unit; and
- a strong copper-zinc-cadmium signature was detected in surficial media associated with the Arsenault property; elevated selenium was also detected in samples suggesting a VMS origin for the mineralization .

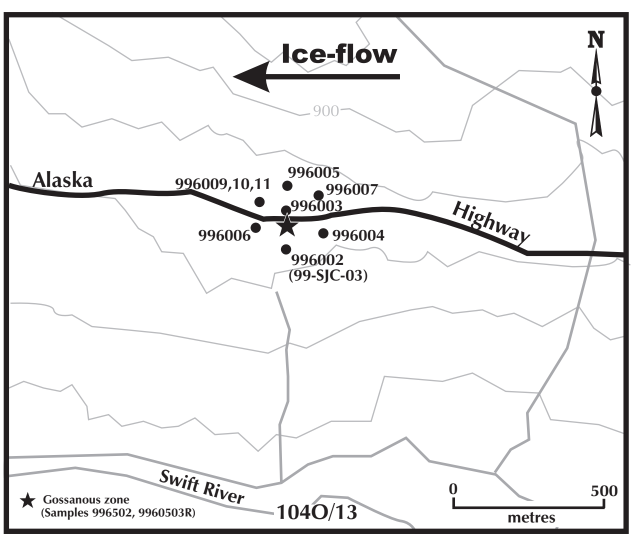

Figure 10. Approximate location of Highway 97 sampling sites. Cook and Pass (this volume) summarize soil profile and rock data collected at this case study.

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