Ancient Pacific Margin Part V: Preliminary Results of Geochemical Studies for VMS Deposits in the Big Salmon Complex, Northern British Columbia (104N/9, 16; 104O/11, 12, 13, 14)

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INTRODUCTION

The Yukon-Tanana Terrane extends southeasterly from eastern Alaska to northern British Columbia. Successful exploration for volcanogenic massive sulphide (VMS) deposits (*e.g*. Kudz Ze Kayah, Wolverine) within this prospective belt of rocks in the southern Yukon has focused attention on the VMS potential of its proposed southern extensions within northern British Columbia. Recent mapping of these Yukon-Tanana correlative rocks just south of the Yukon border, the Big Salmon Complex and the Dorsey Terrane, by Mihalynuk *et al.* (2000; 1998) and Nelson (2000; 1999), identified prospective Devonian-Mississippian stratigraphy and reinforced their potential for hosting VMS deposits. Volcanogenic massive sulphide deposits are a major source of copper, zinc, gold and silver in Canada and British Columbia, and over the period 1995-1998 massive sulphide exploration represented 11.3 to 37.3 per cent of exploration targets in the province each year (*e.g.* Schroeter, 1999). Other than baseline Regional Geochemical Surveys (RGS), no systematic interpretative work or detailed geochemical studies have been conducted in this part of northern British Columbia to characterize element signatures and geochemical dispersal of either VMS deposits or their volcanic host rocks within the surficial environment.

The purpose of this project is to highlight the potential for VMS mineralization in Yukon-Tanana correlative rocks of the Big Salmon Complex by characterizing the surficial geochemical responses of known VMS prospects and their felsic and mafic volcanic host rocks. These results, and those of RGS interpretation studies, will be used to formulate geochemical exploration models for the region. During the 1999 field season, seven geochemical case studies were conducted in the Big Salmon Complex using a variety of surficial media including stream sediments, moss mats, stream waters, soil profiles, vegetation and rock. This paper discusses available RGS data and briefly outlines preliminary geochemical results of the case studies. Only soil profile and rock results were available at the time of writing. Colluvial soil profiles at the Arsenault copper prospect (MINFILE 104O 011), for example, contain highly elevated levels of copper, molybdenum and selenium, among other elements. As well, soils on till and colluvium near exposures of barium-rich exhalative crinkled chert units contain elevated barium concentrations which, in tills, generally increase down profile. Remaining results, including stream water geochemical studies undertaken as part of a University of Victoria B.Sc. thesis (Pass, in preparation) will be presented at a later date.

This project is a component of the Ancient Pacific Margin NATMAP Project, and is being carried out in conjunction with integrated bedrock and surficial geology mapping programs (Mihalynuk *et al*., this volume; Nelson, this volume; Dixon-Warren and Hickin, this volume). It is a northern counterpart to VMS geochemical studies conducted by Lett *et al.* (1999) in comparable rocks of the Kootenay Terrane in southern British Columbia.

PROJECT COMPONENTS AND OBJECTIVES

This project has two components. The first involves office compilation and interpretation of existing RGS data, in both the Big Salmon Complex and adjacent northern British Columbia terranes, to identify those areas potentially favourable for VMS-associated alteration and mineralization. The second involves site-specific field and laboratory studies in the Big Salmon Complex. These field studies, begun in 1999, are the subject of this paper.

Multi-media case study investigations were conducted at regionally-anomalous groups of watersheds in two parts of the Big Salmon Complex in 1999 (Figures 1 and 2). A further five case studies were conducted with Dixon-Warren and Hickin (this volume) at known VMS prospects (*e.g.* Arsenault copper prospect), some recently-mapped felsic and mafic metavolcanic packages, and at barium-manganese-rich chert horizons (Figures 1 and 2). Objectives of these studies are to characterize geochemical signatures and responses of: i) VMS mineralization and associated hydrothermal alteration assemblages, and ii) potential felsic and mafic metavolcanic host units and exhalative horizons, in various surficial media such as soil profiles, tills, stream sediments, moss mats and stream waters to determine which may be suit-

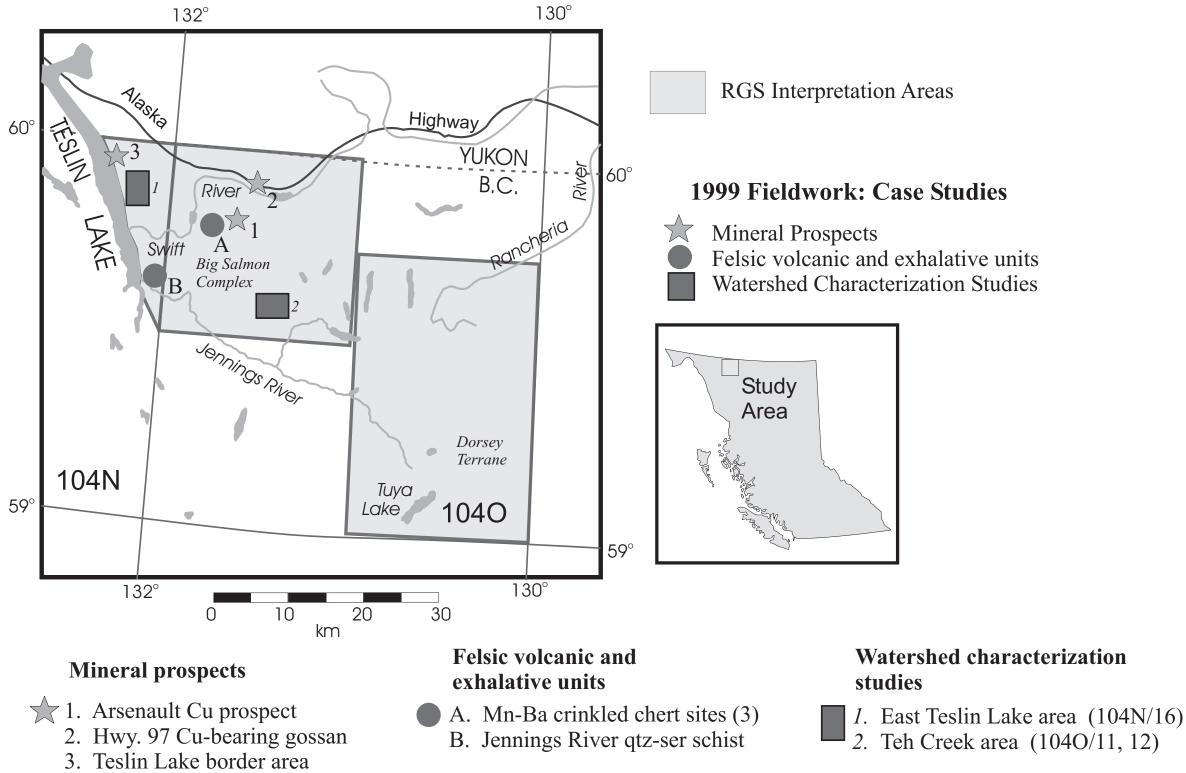


Figure 1. General location map showing 1999 field case study locations.

able for geochemical exploration. Subsequent laboratory studies will focus on size fraction analysis and heavy mineral concentrates of clastic sediments and soils to aid in speciation of the mineralization, alteration and related elements in the weathering environment. Characterization of geochemical signatures and dispersal in this area will aid in further interpretation of regional geochemical data and will help in the development of more effective geochemical exploration methods. Identifying the most effective geochemical exploration methods for VMS deposits is the principal objective of this project.

GEOLOGICAL SETTING AND MINERAL DEPOSITS OF THE BIG SALMON COMPLEX

Bedrock mapping of the Jennings River and Atlin map areas was first carried out at 1:250 000 scale by Gabrielse (1969) and Aitken (1959), respectively. More recently, detailed 1:50 000 scale geological mapping has been conducted by Mihalynuk *et al.* (in press, 2000, 1998) in the Big Salmon Complex and by Nelson (2000, 1999) in the Dorsey Terrane to the southeast. The Big Salmon Complex underlies much of the study area (Figure 2) and is situated east of Teslin Lake in the northwest part of the Jennings River area and the northeast part of the Atlin area. Geology has been described by Mihalynuk *et al.* (this volume, 1998), and the following is taken from those accounts.

The Devono-Mississippian Big Salmon Complex is a sequence of five volcano-sedimentary rock units, all but the oldest of which are correlable with Yukon-Tanana Terrane rocks of the Finlayson Lake belt (Mihalynuk *et al.*, 1998; Nelson *et al.*, 1998). They comprise: i) a variable youngest succession of siliceous clastic rocks and minor carbonates; ii) grey to white limestone with tuff and conglomerate interbeds; iii) thinly bedded to laminated manganiferous 'crinkled' chert; iv) a succession of quartz-rich clastic rocks and immature greywacke, and v) a thick oldest succession of greenstone, primarily mafic to intermediate tuffs with lesser basaltic flows. The Early Mississippian Mount Hazel orthogneiss is exposed in the interior of the Big Salmon Complex. Intrusive rocks in the study area include, among others, the Early Jurassic Simpson Peak batholith and Coconino tonalite.

Surficial geology of the study area is described by Dixon-Warren and Hickin (this volume, 2000) and will not be discussed at length here. In general, thick till sequences mantle plateau areas and gentle slopes, with colluvium common on steep slopes and in areas of higher relief. Thick accumulations of fluvial sediments occur in valleys, and pockets of glaciolacustrine material are found along Teslin Lake and the Alaska Highway.

Known mineral occurrences the Big Salmon Complex area include the Arsenault copper prospect (MINFILE 104O 011) and several small copper showings described by Mihalynuk *et al.* (1998, this volume). These are discussed in more detail in the case study sections of this paper, and their locations are shown in Figure 2 and

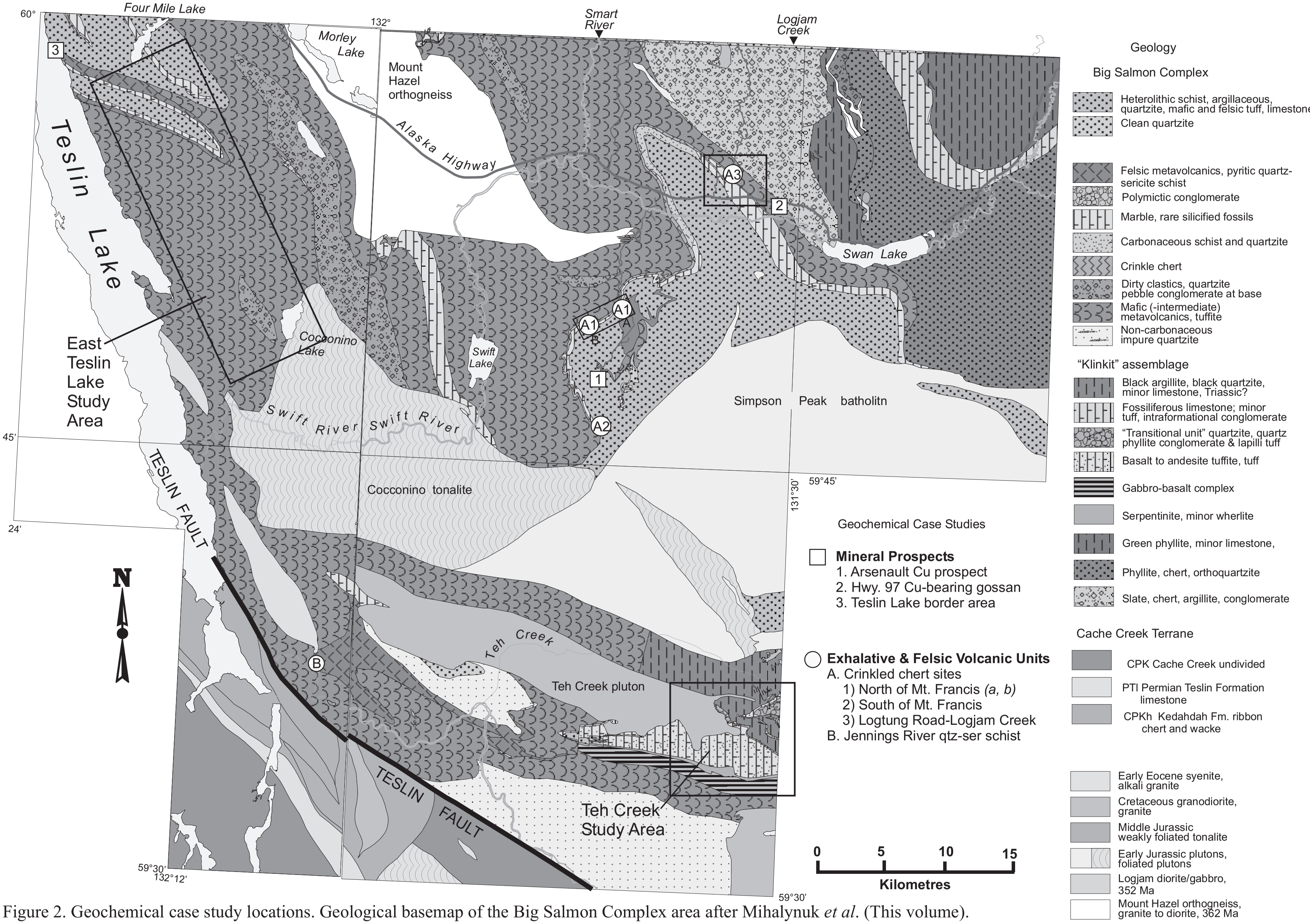


Figure 2. Geochemical case study locations. Geological basemap of the Big Salmon Complex area after Mihalynuk *et al*. (This volume).

on geochemical plot maps (Figures 4-6). For exploration purposes, Mihalynuk *et al.* (1998) suggested two stratigraphic intervals in the Big Salmon Complex as being most prospective for VMS-style mineralization: i) porphyritic blue quartz-eye dacite tuff similar to that at the Arsenault prospect, and ii) barium and manganese-bearing piedmontite schist of the crinkled chert unit, which is interpreted as partly exhalative in origin. Geochemical dispersal studies of the crinkled chert are an important component of this study.

RGS DATA RESULTS IN THE BIG SALMON COMPLEX AREA

The British Columbia Regional Geochemical Survey (RGS) program contains multi-element geochemical data for over 42 000 stream sediment sites covering approximately 65 per cent of the province. RGS stream sediment geochemical data is available for most of north-central and northwestern British Columbia, with the exception of the Dease Lake area (NTS 104J). RGS coverage is available for the Atlin (NTS 104N), Jennings River (NTS 104O) and McDame (NTS 104P) map areas, but is restricted to a small suite of trace elements such as copper, zinc and cobalt determined by atomic absorption spectroscopy (AAS). These are some of the earliest RGS surveys completed in the province. Samples were collected in 1977 and 1978 at a density of one site per 13 square kilometres, and the data was released in the following year (RGS, 1978, 1979). These results, and those of the adjoining Wolf Lake (NTS 105B) map area in the southern Yukon, were also presented graphically by the Geological Survey of Canada (NGR, 1981) as part of the 1:2 000 000 coloured compilation map series. The release of corresponding instrumental neutron activation analysis (INA) stream sediment data for gold, arsenic, antimony, rare earth and other elements in these three areas, reanalyzed by the British Columbia Geological Survey Branch as part of the RGS Archive Program, is scheduled for summer, 2000 (Jackaman *et al.*, this volume; Jackaman, in preparation). Data packages will include the earlier AAS data, and results for all elements will be graphically portrayed using drainage basin geochemical maps.

As part of this study, a subset of 252 stream sediment and 33 lake sediment RGS sites covering all or part of six 1:50 000 map areas east of Teslin Lake (104N/9, 16; 104O/11, 12, 13, 14) was selected for regional data interpretation in the Big Salmon Complex area. Summary statistics and boxplots for zinc, copper, lead, cobalt and additional elements are given in Table 1 and Figure 3, respectively. Geochemical maps showing the regional distribution of copper and zinc are shown in Figures 4 and 5. Numerous stream sediment sites have elevated geochemical signatures, not associated with known showings, which may reflect the presence of buried VMS mineralization. No subdivision of statistics on underlying geology is attempted, as new geological maps of the area are currently being prepared (Mihalynuk *et al.*, 2000) to replace that of Mihalynuk *et al.* (1996; Figures 4 through 6).

The following methods were used for preparation and analysis of RGS stream sediments and lake sediments in the Atlin (RGS, 1978) and Jennings River (RGS, 1979) map areas. Stream sediments were prepared in and analyzed by contract laboratories. They were air-dried, sieved through a -80 mesh (<177 microns) screen, and ball milled prior to analysis for zinc, copper, lead, nickel, cobalt, silver, manganese, iron and molybdenum by AAS following aqua regia digestion. Tin and mercury (NTS 104N only) were also determined with an AAS finish. Tungsten was determined colorimetrically following pyrosulfate fusion and dithiolcarbonate complexing, and uranium was determined by neutron activation. Analytical data for lake sediments, obtained from relatively low-lying areas of the Teslin Lake region in both Atlin and Jennings River map areas, is available for zinc, copper, lead, nickel, cobalt, silver, manganese, iron, molybdenum, mercury (104N only), tungsten and uranium. These were determined by the same methods outlined for stream sediments. In comparison to stream sediments, loss on ignition (LOI) data is available for lake sediments, whereas tin data is not. No INA data will be available for lake sediment sites. Water geochemical data for uranium, fluoride and pH is, however, available for both streams and lakes in these map areas.

Similar sample preparation and analytical methods permit results of older RGS surveys of the late 1970s to be compared to those conducted more recently, despite some minor differences in the element suites. For instance, no data is available in the Atlin and Jennings River areas for LOI in stream sediments, or for sulphate in waters. Tungsten, formerly determined colorimetrically, is now determined by INA. Arsenic and antimony were not determined in the earlier surveys, but are routinely included in both AAS and INA analytical suites. Regional stream sediment geochemical data is also available for adjoining areas of the southern Yukon as Geological Survey of Canada Open File reports, but these are not considered.

DESCRIPTION OF THE STUDY AREAS

Three types of geochemical case study investigations were conducted (Figure 1):

1) Watershed characterization of anomalous areas
2) Prospective felsic volcanic horizons and exhalative units (*e.g.* crinkled chert)
3) Mineral deposit or prospect case studies (*e.g.* Arsenault copper prospect)

Summary data for the number of samples of each of the various sample media collected over the case studies are given in Tables 2 and 3.

TABLE 1
SUMMARY STATISTICS FOR SELECTED ELEMENTS: RESULTS OF RGS STREAM AND LAKE SEDIMENT SURVEYS IN THE STUDY AREA, JENNINGS RIVER AND ATLIN MAP AREAS

Stream Sediments

	Cu *(ppm)*	Zn *(ppm)*	Pb *(ppm)*	Ag *(ppm)*	Co *(ppm)*	Fe *(%)*	Mn *(ppm)*	Mo *(ppm)*	Ni *(ppm)*	W *(ppm)*	pH
Median	**22**	**54**	**2**	**0.1**	**7**	**1.95**	**410**	**1**	**19.5**	**2**	**7.5**
Mean	29.5	61.7	3	0.13	8.1	2.08	670.7	2	21.6	3.6	7.4
± 1s	30.3	41.5	3.4	0.08	5.3	0.84	1845.2	2.7	15.3	9.5	0.50
Min	4	14	1	0.1	1	0.60	80	1	2	2	5.5
Max	295	475	26	0.7	57	9.10	28500	23	162	120	8.4
C.V.	1.025	0.672	1.109	0.667	0.657	0.402	2.751	1.326	0.705	2.639	0.067
N=sites	*252*	*252*	*252*	*252*	*252*	*252*	*252*	*252*	*252*	*252*	*252*

Lake Sediments

	Cu *(ppm)*	Zn *(ppm)*	Pb *(ppm)*	Ag *(ppm)*	Co *(ppm)*	Fe *(%)*	Mn *(ppm)*	Mo *(ppm)*	Ni *(ppm)*	W *(ppm)*	pH
Median	**52**	**84**	**2**	**0.1**	**11**	**2.65**	**525**	**8**	**46**	**2**	**8.0**
Mean	60	84.5	2	0.12	11.8	2.81	845.8	10.1	46.8	2	8.1
± 1s	29.4	28.4	1.5	0.07	6.8	1.54	1186.8	8.0	19.9	0	0.32
Minimum	16	22	1	0.1	1	0.30	165	2	12	2	7.3
Maximum	140	152	7	0.4	27	6.65	6550	43	104	2	8.5
C.V.	0.490	0.336	0.734	0.534	0.580	0.550	1.403	0.790	0.426	0.000	0.039
N=sites	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*

Watershed Characterization Studies

Watershed characterization studies were conducted in two areas of the Big Salmon Complex with elevated RGS multi-element geochemical signatures: the East Teslin Lake area of the Nisutlin Plateau and the Teh Creek area of the Cassiar Mountains (Figures 1 and 2). They are investigations of the comparative geochemical responses, in several adjoining watersheds, of different types of drainage sediment and water samples in order to quantify differences in geochemical contrast. The two study areas are paired in that they have similar underlying geology but are located in very different physiographic environments. Similar projects to verify original RGS anomalies and identify possible metal sources have also been undertaken elsewhere in British Columbia (Cook *et al.*, 1992; Sibbick and Laurus, 1995; Cook, in preparation).

Area Selection

Element sum ranking of RGS data characteristic of volcanogenic massive sulphide (VMS) deposits was used to select the two areas. Briefly, the method used is as follows: zinc, copper, lead, silver, cobalt and iron data for both RGS stream sediment and lake sediment sites were independently summed using the following algorithm: Zn + Cu + (10*Pb) + (100*Ag) + Co + (10*Fe). Lead and iron results were multiplied by a factor of 10, and silver by 100, to bring all elements to equivalent orders of magnitude, as based on regional median concentrations. The resulting site scores for both streams and lakes were ranked and plotted (Figure 6), and two groups of adjoining watersheds in the upper five percentiles of combined data rankings selected for further study. Similar element combinations (Zn-Cu-Pb-Ag; Zn-Cu-Pb-Ag-Co) yielded comparable results. Neither of the two areas are known to host any VMS or related deposits, and no detailed geological mapping had been conducted here prior to 1997.

Field Methods

A variety of drainage sediment and stream water suites were sampled in each area. Original RGS stream sediment sites in each drainage were resampled, and several additional media including moss mats, bulk sieved (-18 mesh) sediments and moss mats, stream waters and suspended solids were also obtained at most sites. Some adjoining watersheds not included in the prior RGS surveys were incorporated into these studies. The water geochemical component in the two study areas, focusing on the suspended and dissolved loads in stream water, is the object of a B.Sc. Honours thesis by Pass (in preparation) at the University of Victoria.

a) East Teslin Lake Area (NTS 104N/16)

The study area is located in the Gladys River map area (NTS 104N/16) in the Nisutlin Plateau along the east shore of Teslin Lake, immediately south of the British Columbia-Yukon border (Photo 1). The approximately

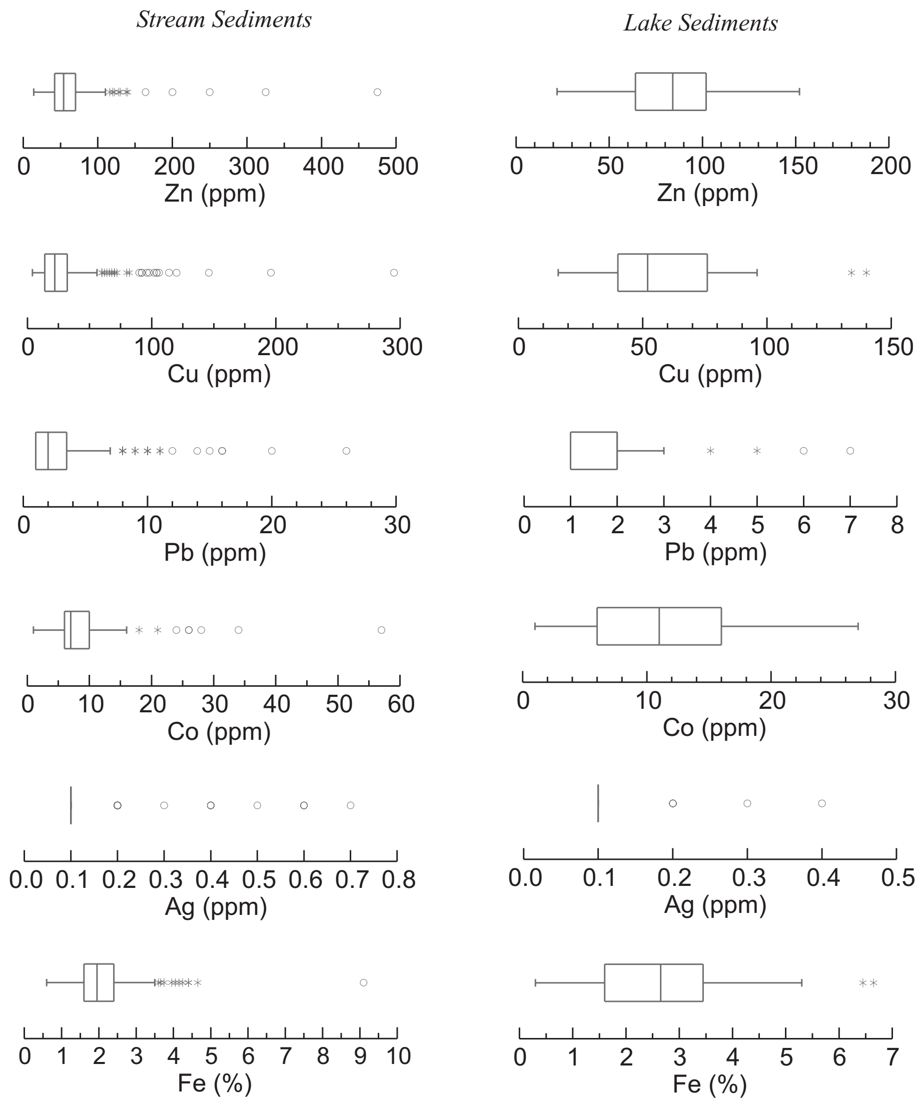


Figure 3. Boxplots showing distribution of zinc, copper, lead, cobalt, silver and iron (AAS) in RGS stream sediments (n=252 sites) and lake sediments (n=33 sites) in the study area. *See* Table 1 for summary statistics.

20 kilometre-long area is heavily drift-covered and extends from Four Mile Lake in the north to Coconino Lake in the south (Figure 2). The plateau area is characterized by rolling till-covered terrain (maximum elevation: 1485 metres) which drops steeply to the southwest within a few kilometres of Teslin Lake, where the adjacent flats (elevation: approximately 700-760 metres) are floored by post-glacial glaciolacustrine silts and till (Dixon-Warren and Hickin, 2000, in press). Numerous small streams drain into small lakes and wetlands in the low-lying base of slope area. The plateau area and wetlands are heavily forested with stands of white and black spruce, respectively. Bedrock geology of this region was mapped as predominantly Mississippian greenstone and chlorite schist by Aitken (1959) and Gabrielse (1969). Recent mapping at 1:50 000 scale (Mihalynuk *et al.*, 1998, in press) shows the area is underlain by mafic volcanic flows and tuffs such as greenstone and chlorite schist, with lesser meta-argillite and marble units, which strike in a northwesterly direction roughly parallel to Teslin Lake. Some felsic volcanics are in the northern part of the study area just south of the Yukon border.

RGS stream sediment geochemical data here between Four Mile and Coconino lakes exhibit an elevated copper-cobalt±iron±manganese trend which, for the most part, is within the upper five percentiles of data for most of these elements in the regional study area. Copper concentrations in three adjoining RGS streams here are in the range 90-114 ppm, approximately 4-5 times the regional median copper concentration (22 ppm). Furthermore, both Four Mile and Coconino Lakes, which bound these stream sediment sites to the north and south, contain elevated sediment Cu concentrations of 104 ppm and 140 ppm, respectively (Figure 4). Other, smaller lakes, in the low-lying area along Teslin Lake which receive drainage from the Nisutlin Plateau also exhibit locally high levels of copper in sediment. In particular, three small lakes northwest and southwest of Coconino Lake contain 54-90

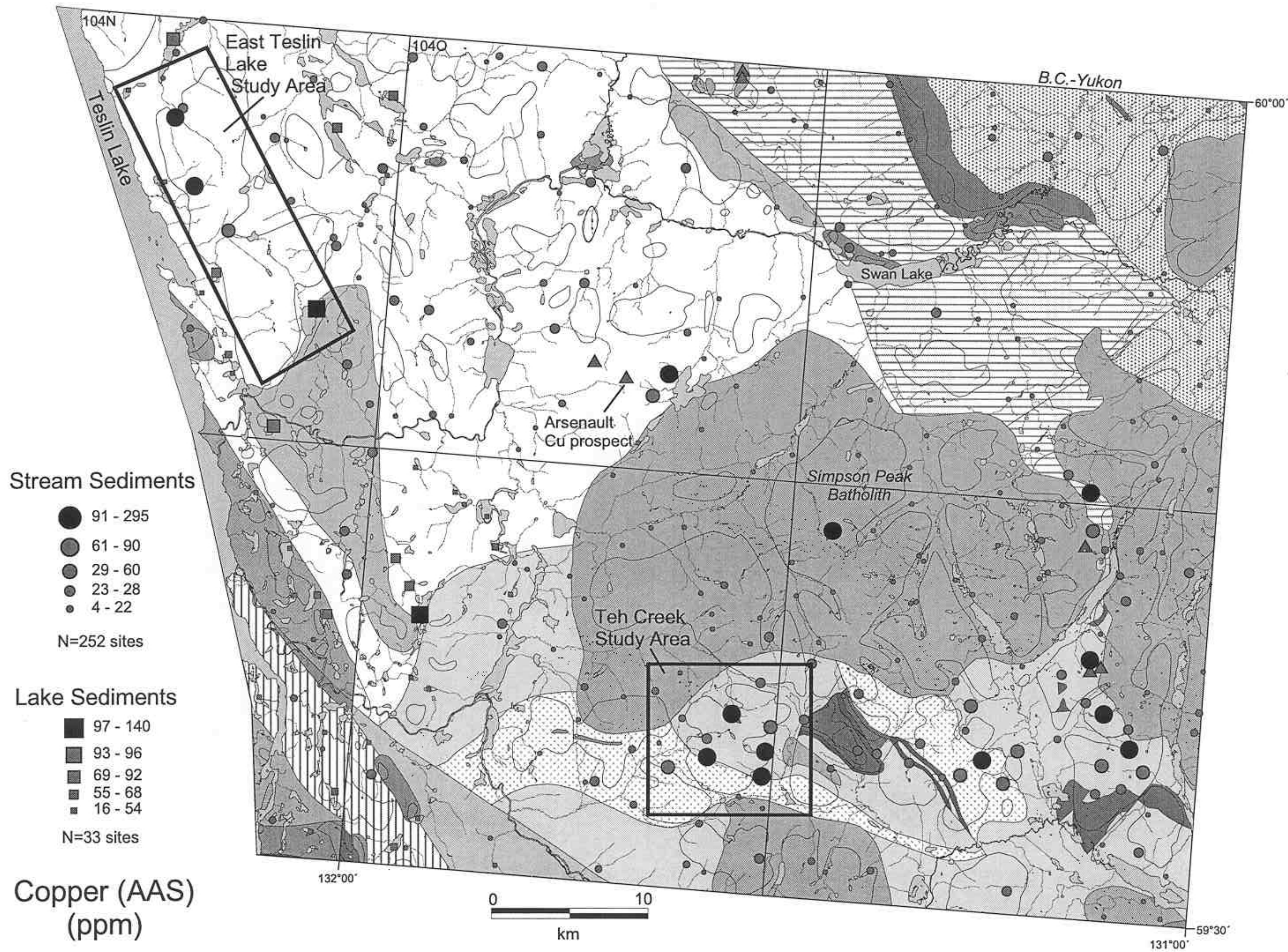


Figure 4. Distribution of copper (ppm) in RGS stream and lake sediments in the study area. Symbol sizes correspond, in each case, to upper limits of the 50th percentile, 70th percentile, 90th percentile, 95th percentile and top 5 percentiles as per standard RGS format. Locations of watershed characterization studies are outlined. Geology from Mihalynuk *et al.* (1996). Minfile locations are shown by triangles.

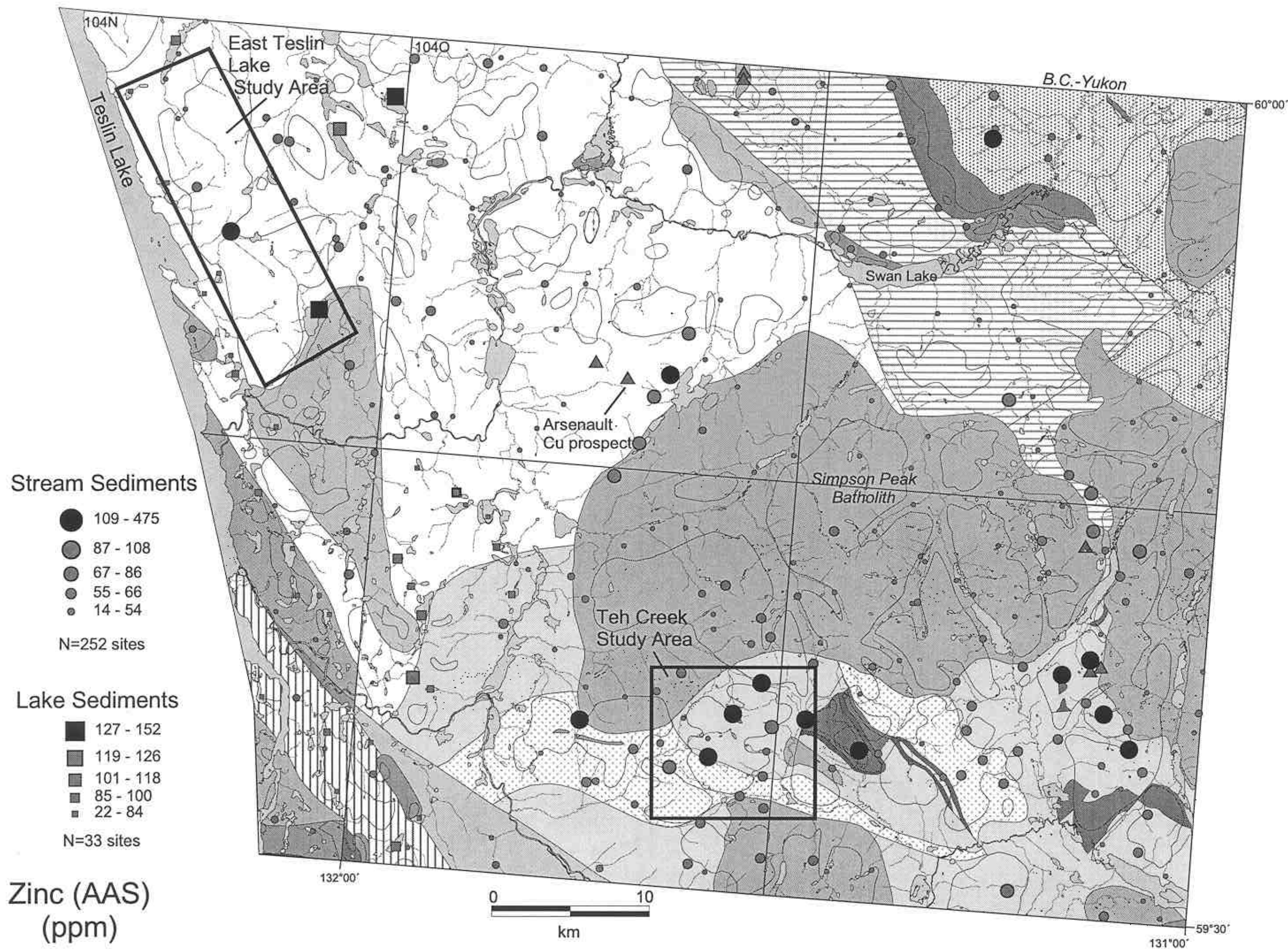


Figure 5. Distribution of zinc (ppm) in RGS stream and lake sediments in the study area. Geology from Mihalynuk *et al.* (1996). MINFILE locations are shown by triangles.

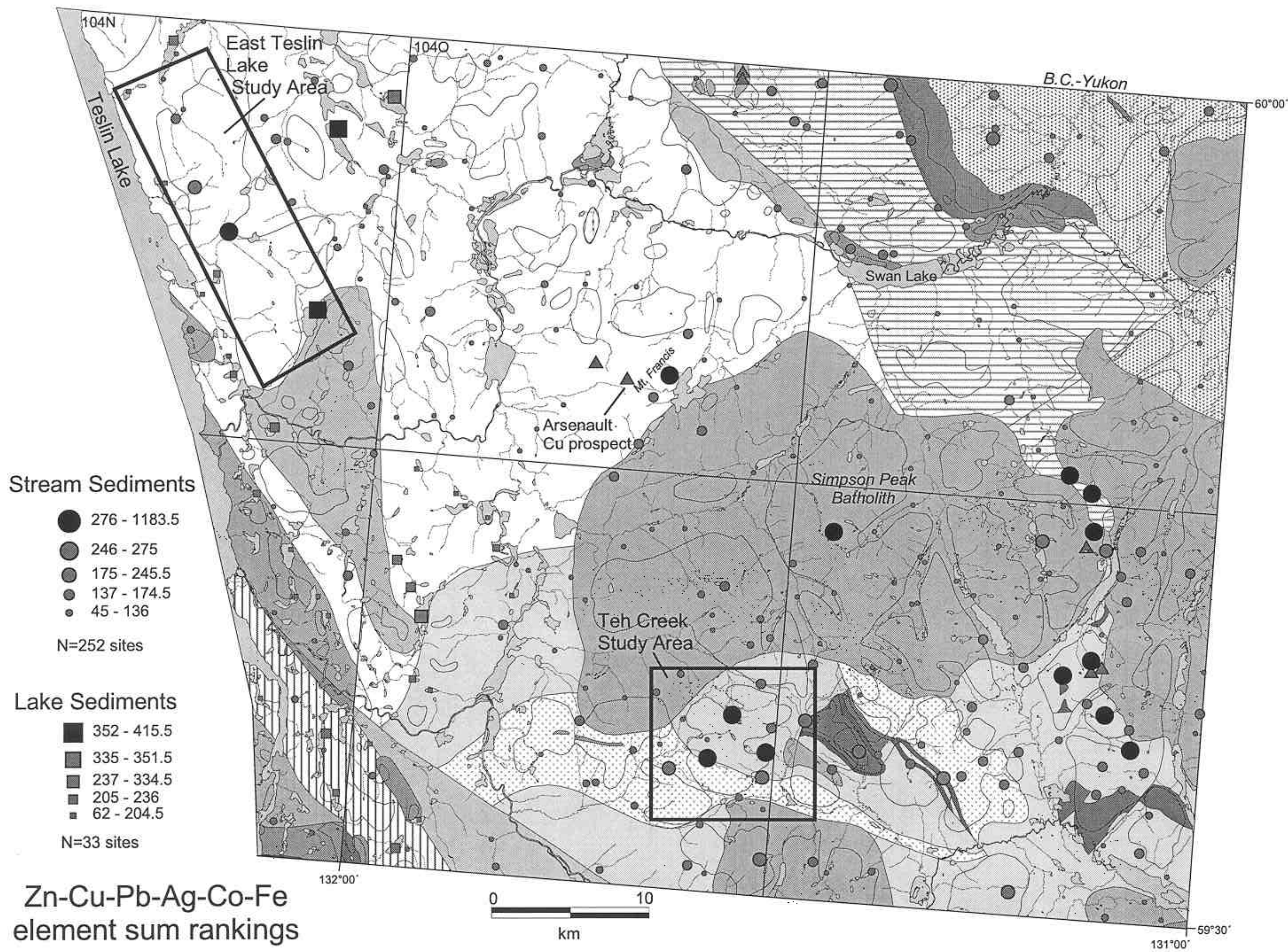


Figure 6. Distribution of Zn-Cu-Pb-Ag-Co-Fe element sum rankings for RGS stream and lake sediments in the study area. Geology from Mihalynuk *et al.* (1996). MINFILE locations are shown by triangles.

TABLE 2
SAMPLE SUMMARY MEDIA: 1999 GEOCHEMIAL STUDIES IN THE BIG SALMON COMPLEX

		Number of Sites Watershed Studies		Stratigraphic Units		Cu Prospects				
		Nisutlin Plateau	Teh Creek area	a	b	1	2	3	***Total Sites***	*Total Samples*
Routine Drainage	Stream sediments	9	10	4	-	4*	-	-	**27**	29
Sediments	Moss mats	8	3	3	-	4*	-	-	**18**	20
Sieved Drainage	Sieved stream sediments	4	7	3	-	2	-	-	**16**	16
Sediments	Bulk moss mats	5	-	-	-	-	-	-	**5**	5
Soil Profiles	*Total No. of Soil Profiles*	-	-	*12*	*2*	*2*	*1*	-	***17***	
	Mineral Soil Horizons**			18	4	4	1	-	**27**	29
	Underlying rock or rubble	-	-	4	-	2	1	-	**7**	7
Waters	RGS-Suite	9	10	5	-	6	-	-	**30**	34
	ICP-MS (cations only)	-	-	5	-	5	-	-	**10**	10
	ICP-MS full package	9	10	-	-	-	-	-	**19**	23
Vegetation	Bark	-	-	3	-	-	-	1	**4**	4
	Twigs	-	-	3	-	-	-	-	**3**	3
Rocks	Outcrop, till pit cobbles, etc.	3	4	8	1	1	2	3	**22**	22

a Crinkle chert localities (*see* Table 3)
b Jennings River qtz-ser schist

1 Arsenault Cu prospect
2 Hwy. 97 Cu prospect
3 Teslin lakeshore Cu prospect

* 6 sites total (sediments and waters)
** figures do not include underlying till samples of Dixon-Warren and Hickin (this volume)

TABLE 3
SAMPLE MEDIA SUMMARY: CRINKLED CHERT STUDY AREAS

		Number of Sites Each Study Area 1a	1b	2	3	*Totals*
Routine Drainage	Stream sediments	-	-	-	4*	4
Sediments	Moss mats	-	-	-	3*	3
Sieved Drainage	Sieved stream sediments	-	-	-	3	3
Sediments	Bulk moss mats	-	-	-	-	-
Soil Profiles	*Number of Soil Profiles*	*4*	*4*	*4*	-	*12*
	Mineral Soil Horizons**	5	8	5	-	18
	Underlying rock or rubble	4	-	-	-	4
Waters	RGS-Suite	-	-	-	5	5
	ICP-MS (cations only)	-	-	-	5	5
	ICP-MS full package	-	-	-	-	-
Vegetation	Bark	-	-	-	3	3
	Twigs	-	-	-	3	3
Rocks	Outcrop, till pit cobbles, etc.	1	3	1	3	8

Crinkled chert sites: 1a Mount Francis North (North Arsenault area)
1b Mount Francis North (North Arsenault area)
2 Mount Francis South, southwest of the Arsenault showing
3 Logtung Road-Logjam Creek area

* total of 5 sites
** figures do not include underlying till samples of Dixon-Warren and Hickin (this volume)

ppm copper in sediment. No RGS data were available, prior to this study, for the streams draining the adjacent plateau uplands here. In addition to the foregoing, elevated cobalt concentrations up to 16 ppm in stream sediments and 27 ppm in lake sediments are also present in this anomalous zone. Concentrations of other elements such as zinc, lead and silver which may be constituents of VMS deposits are generally lower. Only a single stream sediment site, for instance, contains elevated zinc up to 325 ppm. Nevertheless, combined Zn-Cu-Pb-Ag-Co-Fe element rankings (Figure 6) also show this trend.

Nine sites were sampled here in 1999. In addition to resampling original RGS sites, infill sampling was conducted north of, south of and between the three anomalous RGS creeks to better define anomalous watershed patterns and their relation to underlying geology. The pattern of elevated copper and other elements is largely restricted to westward or northward-draining watersheds, and background levels of copper in lake sediments, most of which are in the Teslin Lake area, are relatively high (median: 54 ppm) compared to other parts of British Columbia. RGS watersheds east of the plateau ridge axis contain much lower copper concentrations, up to about 36 ppm. No data for the background copper content of the greenstone unit is available.

b) Teh Creek Area (NTS 104O/11, 12)

The study area is located in a rugged area of the Cassiar Mountains (Photo 2), approximately 35 kilometres south of the Alaska Highway, along the border of the Klinkit Lake map area (NTS 104O/11) and another un-

Photo 1. View to the northwest of the Nisutlin Plateau and Teslin Lake, with Dawson Peaks in background.

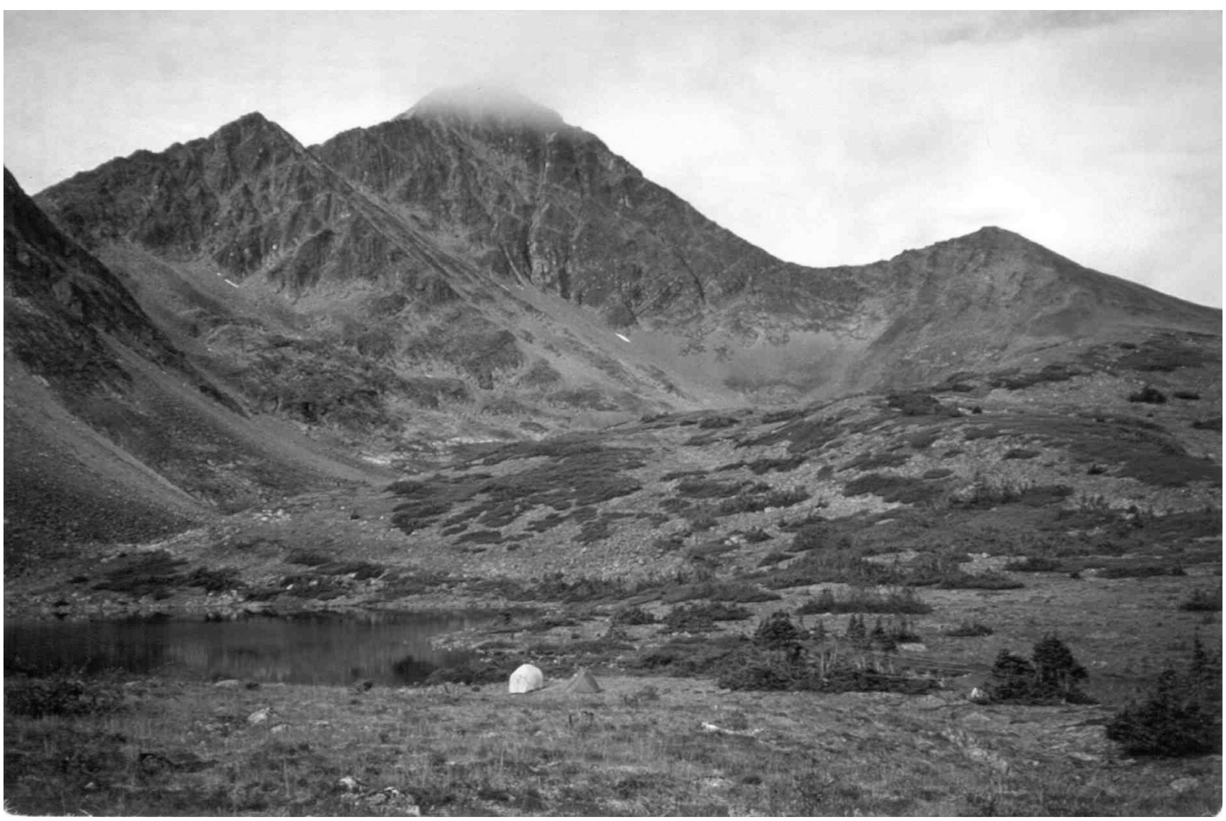


Photo 2. Fly camp in the Teh Creek area of the Cassiar Mountains.

named map area (NTS 104O/12). The area, approximately 7 kilometres by 7 kilometres, is centred on an unnamed mountain southeast of Teh Creek, a tributary of the Jennings River. The geological setting is similar to that of the East Teslin Lake area, but the physiographic setting is different. The area is characterized by steep, roughly east-west trending, ridges (maximum elevation: approximately 1900 metres) separated by tarn-filled cirques (elevation: 1400-1600 metres). Much of the area is above treeline. Extensive talus and colluvium deposits cover the lower slopes. Stream drainage from the cirques flows west and east into wide valleys and then to the Jennings River, in the latter case via Butsih and Klinkit creeks. Bedrock geology of the region, which is directly south of the southern contact of the Simpson Peak Batholith, was mapped as predominantly Carboniferous argillite, volcanic flows and tuffs by Gabrielse (1969). Recent detailed mapping (Mihalynuk *et al.*, 2000) indicates that the northern and central parts of the study area are mainly underlain by argillite and volcanic rocks, respectively, while the southern portion is underlain by newly-recognized gabbroic and ultramafic units.

RGS stream sediment geochemical data in the study area exhibit an elevated copper-cobalt-iron±zinc±nickel trend which is within the upper five percentiles of data for most of these elements in the regional study area. Copper concentrations in four of five adjoining RGS streams at the core of the study area (Figure 4) are in the range 104-196 ppm (regional 95th percentile: 90 ppm), approximately 5-10x the regional median copper concentration (22 ppm). Sediment cobalt concentrations in the same four streams are in the range 13-26 ppm (regional 95th percentile: 14 ppm), and are as high as 28 ppm in other adjoining watersheds. Nickel concentrations are also very high in the southern part of the study area, in the range 44-162 ppm (regional 95th percentile: 42 ppm) in three adjoining watersheds. The elevated nickel and, in part, cobalt content of RGS stream sediments in the south part of the study area are attributed to the serpentinized ultramafic and gabbroic rocks exposed here.

Ten sites were sampled in this area during 1999. The field study area is centred on the copper-cobalt RGS trend and does not encompass all of the anomalous area. Nevertheless two different, and somewhat weaker, element trends are also apparent in watersheds to the east of the immediate study area, neither of which was investigated in the field. First, several watersheds to the immediate northeast and east display elevated element signatures more typical of sedex environments, with elevated zinc concentrations in the range 120-200 ppm (regional 95th percentile: 108 ppm), and silver concentrations locally in the range 0.4-0.7 ppm. By comparison, 86 per cent of the sites in the study region have only 0.1 ppm silver. Secondly, several watersheds located about 10 kilometres east of the present study area contain elevated lead or moderately elevated copper concentrations. Elevated lead concentrations of 11-12 ppm (regional 95th percentile: 10 ppm) are present in two of the watersheds, while moderately elevated copper concentrations of 62-98 ppm occur in five adjacent watersheds. In the latter case, most copper concentrations are within the 90-95th percentile of the regional data set.

Combined Zn-Cu-Pb-Ag-Co-Fe element rankings (Figure 6) appear as a composite of the above copper-cobalt, zinc and copper trends for this area. These rankings are greatest in the core of the study area, where copper-cobalt levels are highest, and progressively decrease eastward in watersheds where zinc-silver, and then copper concentrations, predominate.

Felsic Volcanic and Exhalative Units Case Studies

Case studies were conducted at two horizons with potential for hosting polymetallic VMS deposits, the crinkled chert unit and a quartz-sericite schist unit exposed along the Jennings River.

a) Crinkled Chert (NTS 104O/13)

A unit of crinkled chert occurs widely throughout the northwestern part of the Big Salmon Complex (Mihalynuk, 2000, this volume). The crinkled chert, or crinkle quartzite as it is also known, forms a distinctive marker horizon 25 to 60 metres thick and has been interpreted to have an exhalative origin (Nelson, 1997). It was first described by Nelson (1997) and Mihalynuk *et al.* (1998), and the following description is from those accounts. The crinkled chert unit is white to pink-weathering, thinly-bedded to laminated, and contorted; it has been mapped as metachert, quartz-piedmontite-muscovite schist, and quartz-muscovite schist. It is resistant to weathering and is distinguished by a localized pink to red colour attributed to the presence of piedmontite, a manganese-epidote (Mihalynuk *et al.*, 1998). The most prominent exposures of the crinkled chert unit are in the Mount Hazel, Logjam Creek and Mt. Francis areas in the Smart River (NTS 104O/13) map area (Mihalynuk *et al.*, 2000).

The crinkled chert unit was suggested by Mihalynuk *et al.* (1998) to be one of two Big Salmon Complex units most prospective for base metal massive sulphide exploration. An exposure of piedmontite-hematite metachert overlying metarhyolite (quartz-muscovite schist) on Hazel Ridge was reported by Nelson (1997) as analogous to chert iron formation (exhalite?) stratigraphy at the Wolverine deposit in the Yukon, where the mineralized horizon is above quartz-sericite schist and below chert-magnetite iron formation. To investigate surficial geochemical signature and response of these chert units in the Big Salmon Complex, geochemical orientation studies were conducted at three localities (Figure 2) in the Smart River (NTS 103O/13) area where the unit is exposed: i) north of Mt. Francis, ii) the southwest Mt. Francis area, and iii) the Logtung Road-Logjam Creek area. These studies involved mostly soil profiling at the first two sites, and stream sediment, water and vegetation sampling at the latter.

North of Mt. Francis

The study site is located on two small knobs, approximately 2 kilometres apart, situated about 3 kilometres north of the Arsenault property and about 9 kilometres south of the Swift River and the Alaska Highway. A total of eight soil profiles were obtained from the vicinity of crinkled chert exposures here (Mihalynuk, 2000), four on the eastern knob and four on the western knob. Thin colluvial soils and additional tills were also sampled at several locations at the western site (Dixon-Warren and Hickin, this volume).

Southwest Mt. Francis

The study site is situated on a small knob of a ridge on the southwest flank of Mt. Francis, approximately 8 kilometres southeast of Swift Lake. It forms the southernmost segment of a continuous band of crinkled chert mapped by Mihalynuk *et al.* (2000). Thin, mostly colluvial soils were sampled at four profile sites above this unit.

Logtung Road-Logjam Creek area

The study site is located adjacent to the Logtung deposit access road, west of Swan Lake, which joins the Alaska Highway about 3 kilometres west of Logjam Creek. The most comprehensive crinkled chert study was conducted here, where the unit is exposed on either side of the Logtung Road approximately 2.6 kilometres north of the highway. Rock samples were obtained from exposures east and west of the road, and outer bark and twigs of lodgepole pine (*Pinus contorta*) at both localities were also sampled. Outcrop, bark and twig samples were also obtained from a quartzite exposure just west of the 1.2 kilometre point on the Logtung road. Stream sediment and/or water samples were obtained at five sites in the area. Samples were collected from a small eastward-flowing stream draining the immediate area of the crinkled chert exposure, and at its confluence with Logjam Creek about 1.5 kilometres to the east. Sediments and waters were also obtained from Logjam Creek, just upstream of the Alaska Highway, and from an unnamed creek about 4 kilometres west of the Logtung road, opposite the intersection of the Arsenault access road with the highway. This stream catchment area overlies the same crinkled chert unit on the western limb of a regional fold (Mihalynuk *et al.,* 2000).

b) Jennings River quartz-sericite schist (NTS 104N/09)

An exposure of quartz-sericite schist was examined on the north side of the Jennings River, about 4 kilometres east of Teslin Lake. Bedrock here is overlain by till and glaciolacustrine sediments which are exposed on the river bank. Ice flow here is from southeast to northwest (Dixon-Warren and Hickin, this volume). Two till profiles and two soil profiles were sampled above, and down ice of, this exposure, respectively.

Mineral Prospect Case Studies

Case studies were conducted at three potential mineral prospects in the Big Salmon Complex, the Arsenault copper prospect and two lesser showings described by Mihalynuk *et al.* (1998), the Highway 97 copper-bearing gossan and the Teslin lakeshore altered tuff.

a) Arsenault copper prospect (NTS 104O/13; MINFILE 104O 011)

Stream sediments, waters and soil profiles were sampled in several areas near the Arsenault copper prospect (Photo 3)**,** the best-explored mineral prospect in the Big Salmon Complex of British Columbia. The Arsenault prospect (elevation: approximately 1440 metres) is located about 12 kilometres south of the Alaska Highway and 7 kilometres east of Swift Lake (Figure 2). The prospect was discovered in the 1940's and has been described in several assessment reports (*e.g.* Turnbull and Simpson, 1970; Sawyer, 1967, 1979; Phendler, 1982). It consists of stratabound disseminated to layered chalcopyrite, pyrrhotite and pyrite in complexly-deformed amphibolite-grade chlorite-actinolite schist. The mineral assemblage is skarn-like, but no significant plutonic bodies are exposed, and the prospect has been interpreted as initially volcanogenic in origin (Sawyer, 1979; Phendler, 1982; Traynor, 1999). More recent exploration work (Traynor, 1999) has focused on VMS potential of metasedimentary and metavolcanic rocks exposed on the central ridge of the property. Another prospect, the Arsenault East (MINFILE 104O 047), is located on the east slope of Mt. Francis and consists of a 10 metre-long chalcopyrite-bearing vein replacement zone developed in limestone. Mihalynuk *et al*. (1998) interpreted it as occurring in about the same 100 metre stratigraphic interval as the Arsenault prospect; chip sampling across the 2.5 metre width of the skarn-like zone returned copper, zinc and cobalt concentrations of 4.6 per cent, 0.3 per cent and 322 ppm, respectively.

Extensive soil sampling on the Arsenault property (Sawyer, 1967; Turnbull and Simpson, 1970) identified zones of elevated copper concentrations up to 3620 ppm (Figure 5 of Dixon-Warren and Hickin, this volume). In addition, several RGS sites in streams on the eastern and northern flanks of Mt. Francis have elevated copper, zinc or copper-zinc concentrations (Figures 4 and 5). For example, elevated copper concentrations of 70-104 ppm (95^{th} percentile: 90 ppm) are present in two streams draining the eastern flank of Mt. Francis. Elevated zinc concentrations here are more widely distributed, with four sites draining the eastern and northern flanks of the ridge with 100-130 ppm (95^{th} percentile: 108 ppm).

Six additional stream sediment and water sites were sampled in the Mt. Francis area during 1999 to supplement available RGS stream sediment data, including one site which was re-sampled. Four sites were sampled on the eastern flank of Mt. Francis, infilling areas between anomalous RGS streams and encompassing stream drainage from the Arsenault East prospect. Two sites were

Photo 3. Excavating soil profile 2 in a trench at the Arsenault copper prospect.

sampled to the west in intermittent streams draining the area of Arsenault mineralization, where two colluvial soils were profiled in old exploration trenches. Sediment and water geochemical data for this area will be reported at a later date.

b) Highway 97 Copper-bearing Gossan (NTS 104O/13; MINFILE 104O 054)

One soil profile and six till sites were sampled above a copper-bearing gossan exposed along the Alaska Highway (Highway 97) about 3.5 kilometres west of Swan Lake. Tills and soils were sampled north and south of the highway in conjunction with Dixon-Warren and Hickin (this volume) to test the dispersal, if any, of mineralized material from this site. The presence of chalcopyrite-bearing veins in Big Salmon Complex greenstone here was first reported here by Mihalynuk *et al*. (1998), and the following summary is taken from that account. Several north-northwest trending quartz-chlorite-magnetite-pyrite-chalcopyrite veins (maximum thickness: 30 centimetres) occur in a 3 metre wide gossanous zone in the Big Salmon Complex greenstone unit. Mihalynuk *et al.* (1998) reported chip samples taken over a 1.5 metre interval of 80 per cent vein material to contain 0.2 per cent copper, 165 ppm cobalt, 210 ppm arsenic and 45 ppm tungsten.

c) Teslin Lake border area (NTS 104N/16; MINFILE 104N 135)

Limited geochemical sampling was conducted at the Teslin Lake border area occurrence to investigate the distribution of copper and other elements here. The occurrence was described by Mihalynuk *et al.* (1998). It comprises a series of copper-bearing pyritic gossan zones in phyllitic to schistose mafic to felsic tuffaceous rocks, quartz-sericite schists and siltstones which are exposed over approximately one kilometre along the east shore of Teslin Lake. Individual gossanous layers are strongly pyritic (up to 10 per cent), with trace chalcopyrite occurring as clots and stringers. Mihalynuk *et al.* (1998) reported that a single grab sample returned 2.2 per cent copper and 28 ppm silver, but upon repeat sampling equally cupiferous zones could not be located.

No soil profiles or tills were developed or are present over the occurrences, and no active stream drainages occur here. Geochemical sampling was restricted to the outer bark of a single gnarled lodgepole pine (*Pinus contorta*) growing on pyritic bedrock, and to sampling gossanous bedrock.

FIELD SAMPLING, PREPARATION AND ANALYTICAL METHODS

A brief description of field sampling, preparation and analytical methods for various sample media is given below:

Soil Profiles

A total of 17 soil profiles were sampled, mostly near exposures of the crinkled chert unit, to determine the relative distribution of trace elements among various soil horizons. In all, samples were obtained from 27 mineral soil horizons and 7 underlying bedrock or rubble levels (Table 1). Till samples, if present at any given site, were in most cases collected and data reported for by Dixon-Warren and Hickin (this volume) as part of surficial geological studies of the Big Salmon Complex area. Soils in many areas here, particularly those of greater relief, are thin and relatively juvenile due to colluvial movement. Many soil profiles comprise just a thin veneer of colluvium above bedrock.

Soil horizons at profile sites were sampled from pits, or from excavations in trench walls (*e.g.* Arsenault prospect; Photo 3). Horizons were sampled from the bottom up to avoid cross-contamination. Preparation and analytical procedures are identical to those of till samples (Dixon-Warren and Hickin, this volume). Sample preparation was conducted at Intertek Testing Services-Bondar Clegg, North Vancouver. Samples were air-dried and split into two equal parts. One half was archived. The second half was disaggregated and sieved through a -230 mesh (<63 micron) stainless steel sieve until sufficient material was obtained for analysis. Two splits of each sample were taken. One 10 gram split was submitted to Acme Analytical Laboratories Ltd., Vancouver, for two analytical suites: i) analysis of trace elements including zinc, copper, lead, silver, molybdenum, cobalt, iron, manganese and nickel (Table 5) by inductively coupled plasma-mass spectrometry (ICP-MS) and inductively coupled plasma-emission spectroscopy (ICP-ES) techniques following aqua regia digestion, and ii) determination of major element oxides by lithium metaborate ($LiBO_2$) fusion and an ICP-ES finish (Table 7). Loss on ignition (LOI), total carbon and total sulphur were also determined. A second, approximately 30 gram, split of each sample was submitted to Activation Laboratories, Ancaster, Ontario, for analysis of gold and 34 additional elements using thermal instrumental neutron activation analysis (INA). 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 in Table 6. Data for six other elements (silver, mercury, irridium, nickel, tin and strontium) are not reported due to inadequate detection limits, low element abundance and/or poor precision.

Stream Sediments and Moss Mats

Collection, preparation and analysis of stream sediment and moss mat samples was conducted to the standards of the British Columbia RGS program. Field duplicate samples were obtained in each block of 20 samples. Preparation of sediment and moss mat samples was done at Rossbacher Laboratory, Burnaby, using standard RGS procedures. Stream sediments were air-dried (<35°C) and dry sieved to -80 mesh (< 177 microns) using stainless steel sieves. In preparation of moss mat samples (*e.g.* Gravel and Matysek, 1989), fine sediment is disaggregated from the moss fronds in a ceramic mortar, and passed through a -18 mesh (<1 millimetre) sieve prior to sieving to -80 mesh (<177 microns). Two splits of each sample were taken. One split was submitted to Acme Analytical Laboratories Ltd., Vancouver, for analysis of a suite of trace elements including zinc, copper, lead, silver, molybdenum, cobalt and iron by inductively coupled plasma-mass spectrometry (ICP-MS) and inductively coupled plasma-emission spectroscopy (ICP-ES) techniques following aqua regia digestion. Gold is also determined directly by ICP-MS on the 1 gram sample used in this procedure; depending on sample mineralogy, not all of the gold may be released by the acid. Loss on ignition (LOI) was also determined. A second, approximately 30 gram, split of each sample was submitted to Activation Laboratories, Ancaster, Ontario, for total analysis of gold and 34 additional elements using thermal instrumental neutron activation analysis (INA). Analytical results for stream sediments and moss mats are not included in this paper, and will be released at a later date.

Bulk Drainage Sediments

Bulk stream sediment and moss mat samples were obtained, where possible, to aid in speciation of elements of interest (*e.g.* copper, zinc, barium, manganese) with respect to size and density fractions of the sediment, and to compare results between these two varieties of drainage sediment and routine -80 mesh sediments. Bulk sediments were obtained in the field by wet-sieving sediment material through a Nalgene -18 mesh (<1 millimetre) nylon sieve until a several-kilogram sample was obtained. Owing to the practical difficulties in attempting to wet-sieve fine-grained moss mat material in the field, a bulk moss mat sample was instead collected at these sites, where possible.

Sieved stream sediments were air-dried at the Analytical Science Laboratory of the Geological Survey Branch, Victoria, disaggregated, and mechanically dry-sieved to 5 size fractions (-10+40, -40+80, -80+140, -140+230 and -230 mesh). In the case of bulk moss mats, samples were transferred to large paper bags and air-dried in Victoria, and then submitted to Rossbacher Laboratory, Burnaby, for disaggregation and dry sieving to -18 mesh (<1 millimetre) using a nylon sieve. Prepared samples were returned to Victoria for size-fraction sieving, as above.

In both cases, the resulting sediment and moss mat size fractions were weighed, and representative splits submitted to Acme Analytical Laboratories Ltd., Vancouver, and Activation Laboratories, Ancaster, Ontario for analysis of trace and precious metals corresponding to those of sediments and moss mats outlined in the previous section. In addition, heavy mineral concentrates (HMC) will be prepared from some size fractions using heavy liquid techniques to separate any particulate barite and sulphide grains which may be associated with nearby VMS mineralization.

Stream Waters

At least two paired water samples were obtained at each stream site using high-density polyethylene (HDPE) bottles: i) a raw water sample (250 millilitre) similar to that routinely collected during RGS surveys, and ii) a filtered (45 millimetre, cellulose filter) and acidified water sample (125 millilitre) for major element and trace element analysis. All samples were kept in coolers for preservation. Unfiltered raw stream water samples were not subjected to any additional preparation procedures, and were analyzed for the standard RGS water analytical suite (uranium, fluoride, sulphate, pH) at CanTech Laboratories, Inc., Calgary. An aliquot of unfiltered water was retained for determination of conductivity and total dissolved solids (TDS) using a Corning Checkmate 90 conductivity/TDS meter.

In addition to the foregoing, sampling for anions, cations, dissolved mercury, particulate organic carbon and suspended solids (trace metals) were also conducted as part of watershed characterization studies in the Teslin Lake and Teh Creek areas (Photo 4). These sites are the study of a B.Sc. thesis at the University of Victoria on the geochemistry of dissolved, suspended and bed loads in streams by the junior author (Pass, in preparation). Collection and preparation methods used for these samples, which comprise the majority of stream water sites, are those of Telmer (1997) and are summarized below:

Trace Metals in Suspended load / Stream Water Cations, Anions and Dissolved Mercury

Stream waters at depth were collected in a one litre Nalgene HDPE bottle, and filtered to 0.45 microns using vinyl filter paper (47 millimetre Millipore, HV Filter type) in a Swinnex 47 millimetre filter holder with a 50 millilitre plastic rubber-less syringe. Samples were filtered into a 125 millilitre HDPE bottle for a cation sample, a second 125 millilitre HDPE bottle for an anion sample, and into a 50 millilitre Fisher Brand disposable centrifuge tube for the dissolved mercury sample. Dissolved mercury is defined as all BrCl-oxidizable mercury forms and species in the filtrate of an aqueous solution that has been filtered through a 0.45 micron filter (EPA, 1999). Up to approximately one litre of additional water was filtered, but not retained (exact volume recorded), for the collection of sufficient suspended solid matter for trace metal analysis. The syringe type used was specially chosen as it lacked the black rubber plunger tip, common to most syringes, that could be a source of zinc contamination. Similarly, vinyl filter papers were used here as they are less likely to absorb the dissolved load, have a more repeatable tare and are resistant to acid digestion during analysis (K. Telmer, personal communication, 1999).

The syringe and collection bottle were rinsed three times in stream water prior to use. Cation and anion sam-

Photo 4. Water sampling in the Teh Creek area, Cassiar Mountains.

ple bottles were transported into the field containing deionized water and were only opened and emptied once sampling began on site. These bottles were then rinsed three times with an aliquot of filtered water before sample collection. Prior to placing the filter paper into the filter holder, the latter and a pair of tweezers were generously rinsed with deionized water and the filter paper placed into the holder with tweezers. Subsequent to sampling, the filter paper was removed from the filter holder, using tweezers, and stored in a watertight HDPE scintillation vial (ESBE Scientific, 6.5 millilitre) for storage. After filtration, cation samples were acidified with 0.5 millilitre of Seastar Chemicals concentrated ultra pure nitric acid (HNO_3) at base camp that evening. Filtered water for mercury samples were added to centrifuge tubes containing 0.5 millilitres of bromium chloride (BrCl) (EPA, 1999), added each morning from a stock bottle using a Brinkmann Eppendorf repeater pipette with disposable tip. All samples were kept in a cooler following collection. Solution samples of cations, minor elements, rare earth elements and some major elements, as well as digested suspended solids, were analyzed using a VG Plasmaquad 2S ICP-MS. Dissolved anions and major cations were analyzed using a Dionex DX-120 liquid chromatograph (Isocratic), with a AS-14 ion separation column. Dissolved mercury was analyzed using a Perkin Elmer 50A Mercury Analyzer System (cold vapor flameless atomic absorption). The junior author conducted all analyses at the University of Victoria.

To minimize contamination and maintain sample purity, two bottles of nitric acid and bromium chloride were taken to the field. One set of chemicals was used for the Teslin Lake study area and individual case studies, and the other set for the Teh Creek study area. Chemicals were kept in a separate cooler for storage. Deionized water was transported to the field from the University of Victoria in two ten gallon Nalgene carboys and dispensed as needed into Nalgene LDPE squeeze bottles for daily fieldwork. New syringes and one-litre collection bottles were used as often as possible. To further minimize any potential contamination during transportation and storage, the entire suite of up to 6 samples types were packaged into a large watertight Whirlpak bag at each sampling site.

Particulate Organic Carbon (POC) in the Suspended Load

Stream waters were collected at depth in a one litre Nalgene HDPE bottle in the exact position of the stream in which the above-mentioned trace metal, cation, anion and dissolved mercury samples were collected. The syringe was rinsed three times with stream water before sampling began, while the collection bottle was rinsed three times with steam water before and between samplings. For these samples a 60 millilitre VWR plastic syringe with black rubber plunger tip was used, as these syringes are easier to use and the samples were not analyzed for metal content. Glass fiber filter papers (0.45 micron, 47 millimetre, Millipore Brand) were inserted into the Swinnex 47 millimetre filter holder, pre-rinsed with deionized water, using similarly-rinsed tweezers. Stream water was filtered, although not retained, up to a volume of about one litre (exact volume recorded). Deionized water-rinsed tweezers were then used to place the filter into a watertight HDPE scintillation vial (ESBE Scientific, 6.5millilitre) for storage. The sample was then placed into a watertight Whirlpak bag with the other site samples.

Vegetation

A small number of vegetation samples were obtained, primarily near exposures of the crinkled chert unit along Logtung Road. In all, outer bark and twigs of lodgepole pine (*Pinus contorta*) were obtained at four and three sites, respectively. Sampling procedures were consistent with those of Dunn (1995, 1999). Outer bark samples were collected by vertically scraping the back of hand-held pruning snips along the bark, with the sample collected in a small paper bag held beneath. Twig samples were obtained by snipping about 30-40 centimetres of recent growth from the ends of tree branches, and collected in large paper grocery bags.

Vegetation samples were dried and then ashed at 470^0-500^0C for 24 hours at the Geological Survey of Canada, Ottawa, using a Duncan pottery kiln. Needles were separated from the twigs and ashed separately. Ashed bark, twig and needle samples were submitted to Acme Analytical Laboratories Ltd., Vancouver for analysis of trace and precious elements by ICP-MS/ES techniques as outlined above for sediments and soils. Data will be reported at a later date.

Rocks

No systematic lithogeochemical studies were attempted by the authors, but a small number of outcrop grab samples, stream bed float and till pit cobbles were collected and analyzed for trace and precious elements. Rock samples were split into two bags. One was archived for later reference; the second was crushed and pulverized in the Geological Survey Branch Laboratory, Victoria using a jaw crusher and steel ring mill, respectively. One 10 gram split was submitted to Acme Analytical Laboratories Ltd., Vancouver, for trace element determination by inductively coupled plasma-mass spectrometry (ICP-MS) and inductively coupled plasma-emission spectroscopy (ICP-ES) techniques following aqua regia digestion. A second sample split (30 gram) was submitted to Activation Laboratories, Ancaster, Ontario for INA determination of gold and additional elements. No major element oxide determinations were conducted. Selected ICP and INA rock geochemical data for crinkled chert samples only are given in Table 4.

TABLE 4
SELECTED ROCK GEOCHEMICAL DATA: CRINKLED CHERT

INA

Cr. Chert Study Locality	Field Number	Description	UTM Zone	UTME Nad83	UTMN Nad83	Au (ppb) INA	Au2* (ppb) INA	As (ppm) INA	Ba (ppm) INA	Co (ppm) INA	Cr (ppm) INA	Fe % INA	Na % INA	Rb (ppm) INA	Sb (ppm) INA	Sc (ppm) INA	Th (ppm) INA	U (ppm) INA	W (ppm) INA	La (ppm) INA	Ce (ppm) INA	Nd (ppm) INA	Sm (ppm) INA	Eu (ppm) INA	Tb (ppm) INA	Yb (ppm) INA	Lu (ppm) INA	Mass g
1b	99-SJC-13	till pit cobble**	9	346227	6636128	172	325	9.7	2900	16	196	1.31	0.07	37	0.6	8.6	2.3	0.5	1	6.8	24	7	1.6	0.4	0.5	0.7	0.10	37.63
1b	99-SJC-14	outcrop	9	346245	6636140	1	-	6.9	19000	11	122	0.96	0.07	28	6.5	4.3	1.6	2.3	1	4.8	21	16	0.8	0.2	0.5	0.4	0.07	37.30
	99-SJC-14	*Analytical dup.*				*1*	-	*6.0*	*16000*	*10*	*241*	*0.97*	*0.06*	*21*	*5.3*	*4.0*	*1.6*	*2.3*	*1*	*4.4*	*20*	*12*	*0.8*	*0.2*	*0.5*	*0.3*	*0.06*	*39.43*
1b	99-SJC-15	outcrop	9	346250	6636140	1	-	1.2	2100	5	249	0.54	0.05	21	0.1	2.0	0.5	0.5	1	1.0	4	5	0.2	0.2	0.5	0.2	0.05	35.99
2	99-SJC-11	outcrop	9	347106	6629383	1	-	52.1	2100	39	248	2.06	0.22	30	3.6	11.2	3.6	0.7	1	13.7	41	12	3.0	0.8	0.5	1.8	0.27	33.53
3	99-SJC-16	outcrop	9	355750	6645900	1	-	1.6	1600	21	173	1.61	0.12	56	0.7	9.1	2.9	0.5	1	11.5	36	10	2.3	0.6	0.5	1.2	0.17	34.48
3	99-SJC-17	outcrop	9	355600	6646000	1	-	2.2	2700	22	164	1.69	0.06	44	0.9	8.9	2.8	0.5	1	5.2	24	5	1.2	0.3	0.5	1.2	0.20	35.81

ICP-MS

Study Locality	Field Number	Description		UTME Nad83	UTMN Nad83	Mo (ppm) ICPMS	Cu (ppm) ICPMS	Pb (ppm) ICPMS	Zn (ppm) ICPMS	Ag (ppb) ICPMS	Ni (ppm) ICPMS	Co (ppm) ICPMS	Mn (ppm) ICPMS	Fe (%) ICPMS	As (ppm) ICPMS	U (ppm) ICPMS	Au (ppb) ICPMS	Th (ppm) ICPMS	Sr (ppm) ICPMS	Cd (ppm) ICPMS	Sb (ppm) ICPMS	Bi (ppm) ICPMS	V (ppm) ICPMS
1b	99-SJC-13	till pit cobble**	9	346227	6636128	0.08	30.81	1.49	19.5	2	34.4	9.2	708	0.39	8.2	0.1	1	0.4	19.3	0.01	0.02	0.02	2
1b	99-SJC-14	outcrop	9	346245	6636140	0.06	16.35	7.07	7.9	2	8.7	4.1	853	0.20	6.3	2.0	1	0.9	57.5	0.01	0.4	0.11	2
	99-SJC-14	*Analytical dup.*				*0.15*	*20.71*	*7.56*	*11.6*	*2*	*13.8*	*5.5*	*900*	*0.33*	*5.4*	*2.2*	*2*	*0.9*	*73.3*	*0.01*	*0.43*	*0.12*	*2*
1b	99-SJC-15	outcrop	9	346250	6636140	0.09	11.71	0.56	6.2	2	10.7	2.5	218	0.22	1.0	0.1	1	0.1	18.7	0.01	0.02	0.02	2
2	99-SJC-11	outcrop	9	347106	6629383	0.17	119.9	5.94	45.1	5	51.7	21.7	2595	0.70	22.1	0.6	1	0.8	44.2	0.03	2.38	0.06	13
3	99-SJC-16	outcrop	9	355750	6645900	0.08	0.87	1.6	36.3	2	31.7	15.0	515	0.64	0.7	0.1	7	1	7.7	0.01	0.32	0.03	7
3	99-SJC-17	outcrop	9	355600	6646000	0.08	4.82	1.82	42.3	5	33.8	17.6	612	0.75	1.1	0.1	1	1.6	34.6	0.02	0.35	0.05	5

Study Locality	Field Number	Description		UTME Nad83	UTMN Nad83	Ca (%) ICPMS	P (%) ICPMS	La (ppm) ICPMS	Cr (ppm) ICPMS	Mg (%) ICPMS	Ba (ppm) ICPMS	Ti (%) ICPMS	B (ppm) ICPMS	Al (%) ICPMS	Na (%) ICPMS	K (%) ICPMS	W (ppm) ICPMS	Tl (ppm) ICPMS	Hg (ppb) ICPMS	Se (ppm) ICPMS	Te (ppm) ICPMS	Ga (ppm) ICPMS	S (%) ICPMS
1b	99-SJC-13	till pit cobble**	9	346227	6636128	0.04	0.01	1.2	104.2	0.28	1057.7	0.005	1	0.38	0.008	0.13	0.2	0.04	5	0.1	0.02	1.6	0.01
1b	99-SJC-14	outcrop	9	346245	6636140	0.02	0.006	3.0	59.7	0.10	2648.7	0.003	1	0.14	0.004	0.06	0.2	0.02	5	0.1	0.02	0.6	0.04
	99-SJC-14	*Analytical dup.*				*0.01*	*0.006*	*2.7*	*128.6*	*0.15*	*2719.5*	*0.005*	*1*	*0.26*	*0.009*	*0.11*	*0.2*	*0.04*	*5*	*0.1*	*0.02*	*1.2*	*0.04*
1b	99-SJC-15	outcrop	9	346250	6636140	0.01	0.003	0.5	134.3	0.08	1076.1	0.002	1	0.19	0.007	0.10	0.2	0.03	5	0.1	0.02	0.8	0.06
2	99-SJC-11	outcrop	9	347106	6629383	0.17	0.011	2.8	121.0	0.33	1068.9	0.073	1	0.39	0.009	0.17	0.2	0.09	5	0.1	0.02	3.0	0.03
3	99-SJC-16	outcrop	9	355750	6645900	0.06	0.01	3.7	85.7	0.37	299.1	0.03	1	0.48	0.007	0.19	0.2	0.04	5	0.1	0.02	2.1	0.01
3	99-SJC-17	outcrop	9	355600	6646000	0.05	0.013	1.8	86.4	0.44	1369.1	0.019	1	0.49	0.004	0.12	0.2	0.02	15	0.1	0.02	2.3	0.04

* Au2 determined from a different split of the original pulverized sample pulp, using the same laboratory
** pit cobble sampled from soil profile 1 at this study area. Site corresponds to till sample 996046 of Dixon-Warren and Hickin (this volume)

QUALITY CONTROL PROCEDURES AND RESULTS

Field and analytical duplicate samples were included in the various sediment, soil, water and other analytical suites, along with control reference standards containing appropriate concentration ranges of copper, zinc and other base metals. In the water studies, field blank samples were taken using distilled water to monitor for potential contamination during sampling (Pass, in preparation). Only those results for soil profile and rock analytical suites are discussed here. Refer to Dixon-Warren and Hickin (this volume) for duplicate and triplicate results of associated C horizon till samples.

In the case of soil profiles, field duplicate results, denoted as Rep '10' (original) and Rep '20' (duplicate) samples in Tables 5-7, indicate acceptable levels of combined field, preparatory and analytical precision. For example, two field duplicate pairs returned copper concentrations of i) 1370.2/1258.9 ppm in a colluvial Bm horizon soil at the Arsenault prospect, and ii) 50.3/41.9 ppm in an Ah horizon at crinkled chert locality 1b, indicating that precision is acceptable at both the upper and lower ends of the concentration range. INA barium results for the same two field duplicate pairs are 160/220 ppm and 910/970 ppm, respectively. Interestingly, comparatively elevated and precise INA gold concentrations are also present in these two sample pairs, at 29/23 ppb and 16/20 ppb, respectively.

Results for two analytical duplicate pairs in soils (Tables 5-7) also show acceptable precision. Precision of analytical duplicate results is typically greater than that obtained for field duplicates because they are a measure of analytical precision only. To illustrate, coefficient of variation (CV) between analytical duplicates from the same high-copper soil horizon at the Arsenault prospect (996507) is just 0.8 per cent, compared to 6.0 per cent between the field duplicates mentioned above. Similar results occur for cobalt, manganese, arsenic, gold, molybdenum and numerous other elements, particularly for the aqua regia-ICP suite (Table 5). In the case of rocks (Table 4), a crinkled chert sample (99-SJC-14) from the North Mt. Francis area reported 19000 ppm barium (INA) versus 16000 ppm in a duplicate taken from the crushed field sample. The crinkled chert also returned concentrations of 853 ppm manganese (duplicate: 900 ppm), 11 ppm cobalt (duplicate: 10 ppm) and 6.5 ppm antimony (duplicate: 5.3 ppm).

Insertions of a CANMET certified reference material, soil standard SO-2, and of two internal Geological Survey Branch standards indicate acceptable levels of analytical accuracy for relevant elements in soils. To illustrate, a single insertion of SO-2 returned an INA barium concentration of 870 ppm, marginally lower than the certified value of 966 ± 67 ppm, as well as 134 ppm zinc (certified value: 124 ± 5 ppm) and 5.45 per cent iron (certified value: 5.56 ± 0.16 per cent). Certified values are from Bowman (1994). More control standards results will be provided upon completion of all analytical work.

RESULTS AND DISCUSSION

Only rock (Table 4) and soil profile (Tables 5-7) geochemical data were available at the time of writing. The following results are confined to case studies where several soil profiles were obtained, such as the crinkled chert sites. Drainage sediment, water and vegetation geochemical data obtained for watershed characterization studies in the Teslin Lake and Teh Creek areas will be given at a later date.

Felsic Volcanic and Exhalative Units Case Studies

Crinkled Chert (NTS 104O/13)

Rock and soil geochemical results are reported here for the three crinkled chert study localities: north of Mt. Francis, south of Mt. Francis, and Logtung road. No soil profiles were conducted at Logtung road, where basal tills are poorly distributed (Dixon-Warren and Hickin, this volume), and results here are limited to bedrock geochemical data. Analytical results for a single till pit cobble are also shown, although they are excluded from the summary statistics.

i) Rock Geochemistry

Selected ICP-MS and INA rock geochemical data (Table 4) for five crinkled chert outcrop grab samples show that this unit is characterized by highly elevated barium concentrations (mean: 5500 ppm; median: 2100 ppm) in the range 1600-19000 ppm (INA). They also have moderately elevated, although variable, concentrations of manganese (median: 612 ppm) in the range 218-2595 ppm, and of cobalt (median: 21 ppm INA) in the range 5-39 ppm. Barium is a lithophile element and is most abundant in felsic magmatic rocks (up to 1200 ppm) where it may substitute for K^+. Barium concentrations in sandstones, however, are in the range only 100-320 ppm (Kabata-Pendias and Pendias, 1992), with a reported median concentration of 170 ppm for sandstone and quartzite (Rose *et al.,* 1979). Typical concentration ranges of manganese and cobalt in sandstones are 0.3-10 ppm and 100-500 ppm, respectively (Kabata-Pendias and Pendias, 1992).

One crinkled chert sample (99-SJC-14), from the North Mt. Francis area, returned 19000 ppm (1.9 per cent) barium, suggesting the presence of barite. An analytical duplicate of the same material returned similar barium results (16000 ppm). Results here support those of Mihalynuk *et al.* (1998), who reported the presence of elevated barium concentrations (mean: 2254 ppm; 2 samples) in the crinkled chert unit relative to other sedimentary rocks sampled. Mihalynuk *et al.* (1998) suggested that elevated barium content might be a useful means of distinguishing crinkled chert from other fine-grained quartzites in the Big Salmon Complex. Results here support that assertion. Elevated barium levels are present in crinkled chert samples from all three study areas (Table

TABLE 5
SOIL PROFILE DATA: ICP-MS

Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	Mo (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppb)	Ni (ppm)	Co (ppm)	Mn (ppm)	Fe (%)	As (ppm)	U (ppm)	Au ppb	Th (ppm)	Sr (ppm)	Cd (ppm)	Sb (ppm)
996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	0.65	42.08	11.50	60.0	59	36.0	12.6	589	2.75	12.0	0.9	4	9.0	31.7	0.14	0.92
996503R	R	15-25	py rubble over bedrock					0.50	228.92	4.12	63.3	290	16.0	24.6	631	7.09	70.6	0.2	7	0.8	22.5	0.05	7.58
996504	Bm	0-20	oxidized colluvium		9	347508	6633107	16.93	585.60	15.59	67.4	120	42.3	45.4	778	10.15	39.0	1.2	8	4.2	20.5	0.23	0.59
996505	C	20-50	colluvium					51.85	809.30	23.16	33.5	170	27.3	36.7	1082	16.64	52.8	1.4	25	2.6	14.7	0.35	0.52
996506R	R	50-65	rubbly bedrock					19.03	195.73	13.87	79.4	159	26.4	7.4	221	0.94	7.1	1.1	1	8.8	22.7	0.54	0.30
996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	53.36	1370.24	13.28	18.4	319	38.5	31.7	1372	22.98	53.5	2.8	26	5.5	7.2	0.22	0.75
996508	*Bm*	*0-45*	*colluvium*	*20*				*61.70*	*1258.87*	*10.88*	*18.4*	*225*	*37.2*	*29.3*	*1327*	*18.99*	*51.1*	*2.2*	*17*	*3.4*	*5.5*	*0.23*	*0.61*
996501			analytical duplicate	*80*				*51.57*	*1354.81*	*13.64*	*16.9*	*306*	*38.2*	*30.7*	*1377*	*22.68*	*53.3*	*2.9*	*22*	*5.3*	*7.0*	*0.25*	*0.80*
996509	C	45-65	colluvium					142.16	4977.16	13.79	17.0	664	69.5	74.4	2869	32.84	48.6	6.5	29	4.5	10.6	0.57	0.33
996510R	R	65-90	rubbly bedrock					114.03	1546.05	4.73	16.8	733	45.0	16.7	678	17.02	8.0	3.4	15	3.5	10.1	0.15	0.28
996034*	C	30-37	till		9	348635	6636661	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
996526R	R	>37	rubble					4.39	26.87	4.10	52.1	50	9.7	22.9	306	2.48	0.7	0.9	3	3.7	27.2	0.09	0.09
996511	Bm	0-14	oxidized colluvium		9	348397	6636759	2.74	63.47	14.93	83.3	266	23.2	17.9	317	4.60	99.7	0.7	15	2.9	20.4	0.15	0.80
996512	C	15-30	colluvium					1.43	28.10	10.93	107.6	164	22.3	13.9	271	3.50	23.5	0.5	4	2.6	13.7	0.20	0.55
996513R	R	>30	rubble over bedrock					0.13	28.06	3.38	96.3	38	6.3	9.1	679	3.73	3.5	0.8	1	1.9	19.5	0.06	0.14
996514	Ahe	0 - 8/10			9	348444	6636712	2.48	29.85	10.64	42.3	288	15.3	4.2	115	1.08	6.2	0.9	1	0.1	26.4	0.84	0.39
996515	Bm/BC	8/10-30	oxidized till					1.95	18.47	9.20	61.6	42	24.5	10.9	397	3.39	11.9	0.5	2	4.2	13.5	0.10	0.51
996032*	C	30-45	till					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
996517R	R	>45	py rubble					0.84	30.89	14.45	88.3	215	10.6	8.4	437	3.92	3.0	1.0	2	3.5	28.2	0.11	0.15
996518	Bm	5-30			9	348746	6636773	0.76	20.00	8.77	44.3	41	28.6	13.8	333	2.55	6.8	0.6	4	4.2	12.3	0.20	0.52
996029*	C	30-40	till					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
996519R	R	40-55	rubble					0.50	74.93	10.42	185.4	83	6.5	23.9	381	6.20	1.8	0.1	1	0.7	18.0	0.10	0.04
996520	Bm/C	0-18	oxidized till		9	347107	6629382	0.96	18.82	10.02	56.3	36	28.3	12.7	451	3.19	3.0	0.6	1	2.5	10.2	0.12	0.26
996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	1.28	21.48	11.10	65.1	32	29.1	14.5	625	4.29	2.2	0.7	1	2.9	9.5	0.09	0.32
996523	C	12-32	till					0.83	77.51	8.11	76.2	24	43.6	17.8	521	3.24	2.9	1.0	4	4.1	19.3	0.09	0.40
996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	1.09	47.10	10.76	70.2	168	46.6	16.2	419	3.18	5.7	0.7	2	4.1	12.3	0.10	0.52
996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	1.03	29.11	9.68	63.7	30	45.5	16.3	483	3.34	5.0	0.7	2	4.5	15.0	0.23	0.44
996521			analytical duplicate	*80*				*0.91*	*27.59*	*9.22*	*62.7*	*26*	*44.9*	*16.0*	*476*	*3.32*	*5.1*	*0.7*	*3*	*4.3*	*14.4*	*0.24*	*0.40*
996531	Bm	0 - 12/15			9	667080	6612977	1.50	19.17	6.51	50.7	84	35.7	14.0	394	3.06	1.2	0.4	1	2.3	24.1	0.08	0.23
996532	IC	12/15 - 45	glaciolacustrine sediment					0.49	35.20	5.58	48.4	42	46.1	13.6	373	2.98	1.7	1.3	2	4.0	37.5	0.04	0.24
996043*	IIC	10-12m	till					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
996533	Ah	0-18			9	667060	6613045	2.28	19.08	2.97	9.2	327	14.5	1.6	113	0.26	0.1	7.7	2	0.1	179.3	0.41	0.77
996534	C	18-50	glaciolacustrine sediment					1.57	46.49	6.44	73.1	105	57.1	15.2	455	3.63	3.9	0.6	3	4.2	60.2	0.13	0.36
996535	Ae	0 - 5/7			9	346227	6636128	0.52	5.49	10.96	27.1	17	5.8	3.7	116	1.33	0.1	0.4	3	2.7	12.7	0.16	0.24
996536	Bf	5/7 - 15						0.76	12.94	9.68	55.6	26	19.8	11.2	283	3.29	6.0	0.4	1	3.2	12.7	0.11	0.32
996537	BC	15-35						0.73	25.65	11.74	52.1	21	43.4	18.1	374	2.91	9.9	0.5	2	3.9	16.5	0.07	0.31
996046*	C	35-65	till					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
996538	Bf	2-20			9	346137	6636074	1.09	25.24	12.26	51.3	33	20.6	10.1	292	3.49	6.0	0.6	1	3.8	13.8	0.08	0.36
996045*	C	20-60	till					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
996539	Ah	0-12		10	9	346065	6636115	0.28	50.32	9.20	15.4	331	9.8	1.4	23	0.56	0.4	2.6	8	0.1	13.5	0.07	0.42
996540	*Ah*	*0-12*		*20*				*0.38*	*41.87*	*12.74*	*17.0*	*286*	*9.9*	*1.7*	*28*	*0.73*	*0.9*	*2.8*	*7*	*0.1*	*13.8*	*0.05*	*0.45*
996025*	C	16-45	till					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
996527	Ae	0-5			9	346303	6636214	0.59	4.80	13.88	17.2	12	4.6	2.6	223	0.93	0.1	0.3	1	1.0	12.4	0.19	0.18
996528	Bf	5-15						1.06	16.92	13.61	52.1	44	32.4	13.9	290	3.63	8.4	0.4	1	3.0	13.3	0.18	0.37
996529	B	15-30						0.82	27.68	14.88	60.0	41	44.8	17.3	400	3.12	9.0	0.5	3	4.2	18.9	0.14	0.40
996038*	C	30-40	till					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

TABLE 5 CONTINUED
SOIL PROFILE DATA: ICP-MS

Study Area	Profile	Soil Profile Type	Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	Bi (ppm)	V (ppm)	Ca (%)	P (%)	La (ppm)	Cr (ppm)	Mg (%)	Ba (ppm)	Ti %	B (ppm)	Al (%)	Na (%)	K (%)	W (ppm)	Tl (ppm)	Hg (ppb)	Se (ppm)	Te (ppm)	Ga (ppm)	S (%)
Hwy. 97	1	Orthic eutric	996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	0.34	50	0.65	0.050	21.4	35.5	0.62	249.8	0.126	3	1.66	0.029	0.21	0.2	0.13	81	0.1	0.14	5.3	0.01
Cu Prospect		brunisol	996503R	R	15-25	py rubble over bedrock					2.39	78	0.44	0.052	5.2	70.4	1.28	32.0	0.062	2	2.12	0.047	0.15	5.5	0.03	12	2.5	1.86	8.1	2.06
104O/13																														
Arsenault	1	Orthic eutric	996504	Bm	0-20	oxidized colluvium		9	347508	6633107	1.38	58	1.11	0.078	12.2	34.3	0.62	98.5	0.102	2	1.66	0.013	0.06	0.4	0.08	49	19.3	1.45	5.6	0.05
Cu Prospect		brunisol	996505	C	20-50	colluvium					1.50	37	3.12	0.101	13.5	14.8	0.32	66.9	0.064	2	1.18	0.008	0.02	1.4	0.04	37	18.9	1.68	5.7	0.05
104O/13			996506R	R	50-65	rubbly bedrock					0.16	25	0.82	0.169	16.9	60.0	0.77	51.4	0.120	1	0.99	0.043	0.33	0.3	0.06	8	0.6	0.14	4.0	0.05
	2	Orthic eutric	996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	3.37	20	1.41	0.078	12.1	9.8	0.15	37.3	0.080	2	0.65	0.008	0.01	1.2	0.03	58	50.8	4.71	3.3	0.11
		brunisol	*996508*	*Bm*	*0-45*	*colluvium*	*20*				*2.26*	*20*	*1.50*	*0.067*	*8.7*	*10.2*	*0.16*	*34.1*	*0.048*	*2*	*0.61*	*0.009*	*0.02*	*1.1*	*0.03*	*44*	*36.1*	*3.21*	*3.1*	*0.09*
			996501			analytical duplicate	*80*				*3.39*	*20*	*1.38*	*0.078*	*11.6*	*8.5*	*0.15*	*37.5*	*0.081*	*3*	*0.65*	*0.008*	*0.01*	*0.8*	*0.03*	*59*	*49.9*	*4.78*	*3.1*	*0.09*
			996509	C	45-65	colluvium					3.49	6	1.02	0.089	18.4	9.3	0.07	70.5	0.018	1	0.37	0.008	0.01	1.1	0.02	77	28.9	5.71	1.3	0.13
			996510R	R	65-90	rubbly bedrock					1.51	10	0.77	0.048	6.9	9.5	0.15	12.6	0.059	1	0.30	0.040	0.01	0.4	0.02	15	22.9	2.26	1.8	0.14
Crinkled Chert	1	brunisol	996034*	C	30-37	till		9	348635	6636661	0.13	56	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	8.2	0.11
Locality 1a			996526R	R	>37	rubble					0.08	23	0.54	0.065	9.8	67.0	0.82	84.2	0.092	1	2.00	0.148	0.36	0.2	0.23	6	0.3	0.02	6.4	0.32
N of Mt. Francis																														
104O/13	2	Orthic eutric	996511	Bm	0-14	oxidized colluvium		9	348397	6636759	0.40	67	0.13	0.059	8.7	27.1	0.84	131.0	0.084	3	3.22	0.019	0.09	0.2	0.14	121	0.8	0.17	6.8	0.09
		brunisol	996512	C	15-30	colluvium					0.23	69	0.14	0.041	9.9	28.9	0.52	114.3	0.136	2	2.31	0.012	0.08	0.2	0.11	105	0.4	0.07	7.9	0.04
			996513R	R	>30	rubble over bedrock					0.03	92	0.67	0.065	4.1	45.7	1.77	60.8	0.137	1	2.87	0.121	0.07	0.2	0.02	14	0.3	0.04	7.5	0.20
	3	Orthic eutric	996514	Ahe	0 - 8/10			9	348444	6636712	0.21	25	0.65	0.143	12.1	11.4	0.07	198.1	0.015	2	0.71	0.007	0.04	0.2	0.04	143	0.4	0.03	2.6	0.13
		brunisol	996515	Bm/BC	8/10-30	oxidized till					0.22	74	0.25	0.029	12.8	38.7	0.62	114.4	0.178	2	1.66	0.013	0.12	0.2	0.09	34	0.2	0.06	8.7	0.01
			996032*	C	30-45	till					0.77	66	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	7.6	0.01
			996517R	R	>45	py rubble					0.27	81	1.03	0.089	6.7	95.1	1.21	446.7	0.138	1	2.66	0.063	0.15	0.2	0.05	9	2.0	0.24	6.5	0.16
	4	Eluviated	996518	Bm	5-30			9	348746	6636773	0.26	50	0.17	0.030	12.3	35.5	0.59	129.0	0.123	1	2.33	0.016	0.10	0.2	0.10	62	0.3	0.03	5.2	0.01
		eutric brunisol**	996029*	C	30-40	till					0.38	74	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	6.1	0.01
			996519R	R	40-55	rubble					0.12	208	0.89	0.048	2.5	45.1	2.95	1122.6	0.214	1	4.38	0.078	1.63	0.2	0.48	7	1.1	0.09	13.4	0.26
Crinkled Chert	1	Orthic eutric	996520	Bm/C	0-18	oxidized till		9	347107	6629382	0.20	65	0.16	0.055	13.0	40.7	0.82	123.5	0.173	2	1.84	0.009	0.15	0.2	0.13	62	0.3	0.04	7.0	0.03
Locality 2		brunisol																												
SW Mt. Francis	2	Orthic eutric	996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	0.67	92	0.14	0.053	12.8	55.1	0.79	163.1	0.337	3	2.27	0.010	0.10	0.2	0.17	81	0.4	0.11	11.5	0.03
104O/13		brunisol	996523	C	12-32	till					0.25	81	0.27	0.050	15.1	46.7	0.99	319.9	0.216	2	2.31	0.017	0.13	0.2	0.16	48	0.3	0.08	7.1	0.01
	3	Orthic eutric	996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	0.24	66	0.14	0.024	13.9	47.9	0.88	204.4	0.156	3	2.35	0.011	0.11	0.2	0.16	43	0.4	0.05	6.4	0.01
		brunisol																												
	4	Orthic eutric	996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	0.21	67	0.26	0.065	14.6	55.5	1.00	171.4	0.191	3	2.01	0.013	0.13	0.2	0.15	47	0.3	0.06	6.5	0.01
		brunisol	*996521*			analytical duplicate	*80*				*0.17*	*67*	*0.26*	*0.064*	*14.0*	*51.4*	*0.93*	*158.3*	*0.178*	*2*	*1.87*	*0.012*	*0.13*	*0.2*	*0.14*	*43*	*0.2*	*0.07*	*6.1*	*0.01*
Jennings River	1	Orthic eutric	996531	Bm	0 - 12/15			9	667080	6612977	0.14	75	0.38	0.023	7.9	58.6	0.64	263.5	0.221	1	1.97	0.028	0.05	0.2	0.08	23	0.4	0.02	6.1	0.01
qtz-ser schist		brunisol**	996532	IC	12/15 - 45	glaciolacustrine sediment					0.14	67	0.48	0.049	15.9	65.2	0.87	308.9	0.279	1	1.64	0.065	0.07	0.2	0.05	42	0.1	0.05	5.0	0.01
104N/09			996043*	IIC	10-12m	till					0.19	75	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	5.0	0.11
	2	Orthic melanic	996533	Ah	0-18			9	667060	6613045	0.07	14	4.65	0.056	1.3	4.5	0.46	245.0	0.012	13	0.25	0.013	0.01	0.2	0.02	67	11.1	0.04	0.6	0.36
		brunisol	996534	C	18-50	glaciolacustrine sediment					0.16	69	1.07	0.073	15.8	62.2	1.12	285.3	0.268	4	1.88	0.061	0.17	0.2	0.11	71	0.2	0.06	6.2	0.01
Crinkled Chert	1	Humo-ferric	996535	Ae	0 - 5/7			9	346227	6636128	0.23	46	0.17	0.023	12.9	20.3	0.21	158.2	0.190	1	0.85	0.009	0.03	0.2	0.06	23	0.1	0.03	6.7	0.01
Locality 1b		podzol	996536	Bf	5/7 - 15						0.18	84	0.20	0.052	10.1	31.3	0.72	232.1	0.169	1	2.09	0.018	0.08	0.2	0.07	42	0.1	0.05	7.6	0.01
NW of Mt. Francis			996537	BC	15-35						0.16	74	0.26	0.037	9.0	45.9	0.90	437.4	0.207	2	2.74	0.029	0.10	0.2	0.09	39	0.1	0.07	6.4	0.01
104O/13			996046*	C	35-65	till					0.14	73	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	5.5	0.01
	2	Humo-ferric	996538	Bf	2-20			9	346137	6636074	0.23	87	0.17	0.024	9.8	41.7	0.74	406.3	0.222	2	2.62	0.016	0.11	0.2	0.10	40	0.2	0.04	10.0	0.01
		podzol**	996045*	C	20-60	till					0.23	69	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	7.0	0.01
	3	Orthic melanic	996539	Ah	0-12		10	9	346065	6636115	0.12	14	0.14	0.202	13.6	18.7	0.09	702.5	0.008	2	1.68	0.006	0.03	0.2	0.04	320	0.9	0.06	3.6	0.12
		brunisol	*996540*	*Ah*	*0-12*		*20*				*0.17*	*17*	*0.13*	*0.150*	*16.7*	*32.3*	*0.12*	*769.8*	*0.012*	*2*	*1.97*	*0.008*	*0.05*	*0.2*	*0.06*	*363*	*0.9*	*0.05*	*5.0*	*0.10*
			996025*	C	16-45	till					0.16	67	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	5.5	0.01
	4	Humo-ferric	996527	Ae	0-5			9	346303	6636214	0.20	42	0.15	0.017	10.3	12.2	0.15	134.8	0.169	1	0.65	0.008	0.05	0.2	0.05	33	0.1	0.03	5.7	0.01
		podzol	996528	Bf	5-15						0.17	77	0.21	0.031	8.1	37.2	0.70	185.9	0.179	2	2.49	0.016	0.09	0.2	0.06	34	0.2	0.05	7.1	0.01
			996529	B	15-30						0.22	75	0.27	0.023	10.1	52.2	1.03	289.4	0.210	2	2.96	0.029	0.11	0.2	0.10	33	0.2	0.05	6.4	0.01
			996038*	C	30-40	till					0.14	69	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	5.1	0.01

* C-horizon tills at 6 soil profiles from those of Dixon-Warren & Hickin (this volume)
One sample (996025) is the first of three triplicate samples. *See* Dixon-Warren and Hickin (this volume) for further details.
** thin Aej horizon present but not sampled

UTM locations accurate to ~ 100 metres
Tentative soil types after Canadian System of Soil Classification (Agriculture Canada, 1987) not included here
Mineral horizons only are shown; LFH horizons (not sampled) are not included here

TABLE 6
SOIL PROFILE DATA: INA

Study Area	Profile	Soil Profile Type	Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	Au (ppb)	As (ppm)	Ba (ppm)	Br (ppm)	Ca (%)	Co (ppm)	Cr (ppm)	Cs (ppm)	Fe (%)	Hf (ppm)	Mo (ppm)	Na (%)	Rb (ppm)
Hwy. 97	1	Orthic eutric	996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	5	11.6	950	1.5	2	12	91	3	3.63	5	1	1.29	90
Cu Prospect		brunisol	996503R	R	15-25	py rubble over bedrock					7	70.5	140	0.5	1	27	120	1	9.15	3	1	3.03	17
104O/13																							
Arsenault	1	Orthic eutric	996504	Bm	0-20	oxidized colluvium		9	347508	6633107	25	35.3	450	5.9	4	40	93	3	12.70	4	13	1.05	45
Cu Prospect		brunisol	996505	C	20-50	colluvium					29	48.0	260	3.1	7	31	52	1	19.90	2	43	0.71	42
104O/13			996506R	R	50-65	rubbly bedrock					1	7.1	470	0.5	5	13	154	1	2.63	4	18	2.37	53
	2	Orthic eutric	996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	29	50.1	160	6.4	5	27	37	1	27.40	2	44	0.71	15
		brunisol	996508	Bm	0-45	colluvium	20				23	51.8	220	5.7	6	27	38	1	25.20	2	55	0.99	30
			996501			analytical duplicate	80				33	51.8	120	6.6	5	28	37	1	28.10	2	47	0.74	15
			996509	C	45-65	colluvium					35	45.6	80	6.8	4	61	17	1	34.10	1	114	0.21	15
			996510R	R	65-90	rubbly bedrock					15	11.6	50	1.9	5	21	61	1	27.60	1	102	1.10	15
Crinkled Chert	1	brunisol	996034*	C	30-37	till		9	348635	6636661	21	16.1	770	9.5	1	19	54	4	7.45	4	22	0.88	73
Locality 1a			996526R	R	>37	rubble					4	1.8	260	0.5	3	25	118	2	3.73	4	3	1.53	35
N of Mt. Francis																							
104O/13	2	Orthic eutric	996511	Bm	0-14	oxidized colluvium		9	348397	6636759	27	94.8	880	18.5	1	16	65	2	5.58	4	1	1.19	49
		brunisol	996512	C	15-30	colluvium					10	26.4	680	17.5	1	13	89	2	4.47	6	2	1.32	60
			996513R	R	>30	rubble over bedrock					1	4.8	560	0.5	4	10	96	1	5.74	3	1	1.47	31
	3	Orthic eutric	996514	Ahe	0 - 8/10			9	348444	6636712	1	6.6	720	11.1	1	6	62	3	1.88	4	6	0.79	15
		brunisol	996515	Bm/BC	8/10-30	oxidized till					10	14.5	710	3.8	1	12	103	3	4.36	6	1	1.29	65
			996032*	C	30-45	till					1	42.3	960	6.6	1	16	118	3	5.27	6	9	1.36	66
			996517R	R	>45	py rubble					1	4.1	1100	0.5	4	9	162	2	5.34	4	1	1.01	43
	4	Eluviated	996518	Bm	5-30			9	348746	6636773	1	9.7	750	12.9	2	17	107	3	3.83	6	1	1.46	70
		eutric brunisol**	996029*	C	30-40	till					1	44.3	1100	2	2	19	114	2	5.37	6	10	1.52	73
			996519R	R	40-55	rubble					1	1.6	3100	0.5	2	25	88	5	8.88	2	1	0.70	107
Crinkled Chert	1	Orthic eutric	996520	Bm/C	0-18	oxidized till		9	347107	6629382	1	6.0	820	13.2	1	14	128	5	4.76	7	2	1.07	100
Locality 2		brunisol																					
SW Mt. Francis	2	Orthic eutric	996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	3	6.3	830	26.2	1	16	168	4	5.71	6	2	1.26	75
104O/13		brunisol	996523	C	12-32	till					6	6.1	1500	4.7	1	21	118	3	4.54	5	1	1.56	57
	3	Orthic eutric	996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	3	8.3	1200	11.5	1	19	144	4	4.45	7	1	1.44	81
		brunisol																					
	4	Orthic eutric	996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	1	8.1	920	7.7	1	19	173	3	4.68	7	3	1.36	61
		brunisol	996521			analytical duplicate	80				3	9.1	900	7.6	2	19	179	4	4.90	7	1	1.41	64
Jennings River	1	Orthic eutric	996531	Bm	0 - 12/15			9	667080	6612977	1	4.4	840	0.5	2	18	150	1	4.30	4	1	1.73	49
qtz-ser schist		brunisol**	996532	IC	12/15 - 45	glaciolacustrine sediment					3	3.7	930	0.5	3	16	155	1	4.38	4	1	1.84	46
104N/09			996043*	IIC	10-12m	till					6	12.3	1300	3.2	4	26	181	3	5.54	4	13	1.40	48
	2	Orthic melanic	996533	Ah	0-18			9	667060	6613045	1	1.7	370	20.0	6	2	17	1	0.62	1	1	0.32	15
		brunisol	996534	C	18-50	glaciolacustrine sediment					3	6.5	830	3.4	3	16	131	2	4.65	4	1	1.43	58
Crinkled Chert	1	Humo-ferric	996535	Ae	0 - 5/7			9	346227	6636128	8	5.6	770	1.5	2	6	96	2	2.52	8	2	1.84	63
Locality 1b		podzol	996536	Bf	5/7 - 15						10	14.5	750	3.7	2	13	88	2	4.77	6	1	1.73	60
NW of Mt. Francis			996537	BC	15-35						6	13.6	980	2.6	3	19	121	2	4.38	4	1	1.49	48
104O/13			996046*	C	35-65	till					6	12.2	1500	2.5	1	19	132	2	4.45	5	6	1.78	56
	2	Humo-ferric	996538	Bf	2-20			9	346137	6636074	2	9.7	880	4.1	1	11	99	2	4.65	5	1	1.47	55
		podzol**	996045*	C	20-60	till					4	11.4	920	4.1	1	17	101	2	4.49	5	4	1.82	60
	3	Orthic melanic	996539	Ah	0-12		10	9	346065	6636115	16	5.3	910	13.3	1	2	42	2	1.10	2	1	0.48	15
		brunisol	996540	Ah	0-12		20				20	6.3	970	12.7	1	4	55	2	1.37	2	3	0.75	32
			996025*	C	16-45	till					9	7.0	1300	1.6	2	13	118	2	4.31	6	8	2.06	59
	4	Humo-ferric	996527	Ae	0-5			9	346303	6636214	3	3.8	660	1.5	2	5	88	2	2.02	7	1	1.93	89
		podzol	996528	Bf	5-15						4	12.8	770	3.5	2	17	110	2	5.10	5	2	1.63	61
			996529	B	15-30						3	12.2	890	1.3	2	20	124	2	4.52	5	2	1.70	52
			996038*	C	30-40	till					4	7.5	790	1.7	2	16	135	2	4.14	5	7	1.83	52

* C-horizon tills at 6 soil profiles from those of Dixon-Warren & Hickin (this volume) One sample (996025) is the first of three triplicate samples. *See* Dixon-Warren and Hickin (this volume) for further details.

** thin Aej horizon present but not sampled
UTM locations accurate to ~ 100 metres
Tentative soil types after Canadian System of Soil Classification (Agriculture Canada, 1987)

TABLE 6 CONTINUED
SOIL PROFILE DATA: INA

Study Area	Profile	Soil Profile Type	Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	Sb (ppm)	Sc (ppm)	Se (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	W (ppm)	Zn (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	Mass (g)
Hwy. 97	1	Orthic eutric	996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	1.4	13.7	3	1.5	11.7	2.4	1	107	32.6	58	23	5.3	0.9	0.6	2.6	0.39	30.24
Cu Prospect		brunisol	996503R	R	15-25	py rubble over bedrock					9.6	17.0	3	0.6	1.6	0.5	9	112	10.0	20	10	3.0	0.9	0.5	2.0	0.28	34.44
104O/13																											
Arsenault	1	Orthic eutric	996504	Bm	0-20	oxidized colluvium		9	347508	6633107	1.0	12.5	16	0.9	8.0	3.0	4	105	24.7	48	17	4.1	1.0	0.6	1.8	0.27	30.56
Cu Prospect		brunisol	996505	C	20-50	colluvium					0.7	7.5	14	0.5	5.5	3.2	3	50	22.3	41	16	3.3	1.0	0.5	2.0	0.30	33.30
104O/13			996506R	R	50-65	rubbly bedrock					0.5	19.6	3	1.2	18.1	4.1	2	123	53.6	92	34	7.8	1.6	0.9	3.4	0.51	41.43
	2	Orthic eutric	996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	1.0	5.8	44	0.5	7.1	4.5	1	50	19.7	33	14	2.9	0.7	0.5	1.4	0.22	31.07
		brunisol	*996508*	*Bm*	*0-45*	*colluvium*	*20*				*0.8*	*5.8*	*32*	*0.5*	*5.4*	*3.5*	*1*	*55*	*15.4*	*29*	*11*	*2.5*	*0.6*	*0.5*	*1.2*	*0.19*	*33.25*
			996501			analytical duplicate	*80*				*1.0*	*6.0*	*47*	*0.5*	*7.4*	*4.5*	*1*	*64*	*19.9*	*33*	*12*	*3.0*	*0.8*	*0.5*	*1.3*	*0.19*	*32.17*
			996509	C	45-65	colluvium					0.5	3.6	24	0.5	5.0	8.4	2	55	22.6	26	17	3.7	0.9	0.5	2.7	0.40	34.35
			996510R	R	65-90	rubbly bedrock					0.3	6.2	25	0.5	4.0	5.8	1	75	9.6	17	6	2.0	0.6	0.5	1.4	0.21	31.35
Crinkled Chert	1	brunisol	996034*	C	30-37	till		9	348635	6636661	0.8	18.9	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
Locality 1a			996526R	R	>37	rubble					0.2	21.1	3	1.4	6.0	2.5	1	99	35.2	57	17	4.3	0.9	0.7	3.5	0.51	37.22
N of Mt. Francis																											
104O/13	2	Orthic eutric	996511	Bm	0-14	oxidized colluvium		9	348397	6636759	1.5	16.7	3	0.7	6.3	1.4	2	130	17.5	33	11	2.8	0.7	0.5	1.4	0.21	22.91
		brunisol	996512	C	15-30	colluvium					0.9	12.0	3	0.5	6.8	2.1	1	150	20.9	40	15	3.2	0.7	0.5	1.5	0.23	24.86
			996513R	R	>30	rubble over bedrock					1.0	31.0	3	0.9	3.3	2.2	2	138	16.2	30	11	2.5	0.8	0.5	1.6	0.24	33.65
	3	Orthic eutric	996514	Ahe	0 - 8/10			9	348444	6636712	0.5	9.6	3	0.5	5.7	2.8	1	102	25.3	45	22	3.7	0.9	0.5	1.7	0.21	4.22
		brunisol	996515	Bm/BC	8/10-30	oxidized till					1.0	12.4	3	1.4	7.7	1.9	1	103	24.6	45	17	3.8	0.8	0.5	1.8	0.28	25.77
			996032*	C	30-45	till					1.2	16.1	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
			996517R	R	>45	py rubble					0.4	18.8	3	0.8	5.0	2.4	1	129	16.9	30	13	3.2	0.9	0.5	2.2	0.31	28.45
	4	Eluviated	996518	Bm	5-30			9	348746	6636773	1.1	13.3	3	1.8	8.3	1.6	1	132	26.3	52	22	4.0	1.0	0.5	2.0	0.31	27.23
		eutric brunisol**	996029*	C	30-40	till					1.5	18.4	3	1	8.4	2.5	1	117	32.2	65	26	5.6	1.4	0.7	3.1	0.46	25.61
			996519R	R	40-55	rubble					0.3	37.0	3	0.5	1.6	0.5	1	237	12.7	23	12	3.0	0.8	0.5	1.7	0.35	37.39
Crinkled Chert	1	Orthic eutric	996520	Bm/C	0-18	oxidized till		9	347107	6629382	1.0	15.8	3	1.6	9.0	2.4	1	88	35.4	70	27	5.2	1.4	0.6	2.5	0.38	24.46
Locality 2		brunisol																									
SW Mt. Francis	2	Orthic eutric	996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	0.9	14.7	3	2.2	8.0	2.8	1	50	30.3	61	20	4.8	1.2	0.5	2.3	0.35	21.93
104O/13		brunisol	996523	C	12-32	till					1.0	19.1	3	1.2	8.4	2.9	3	86	31.5	66	27	5.4	1.4	0.5	2.8	0.46	28.48
	3	Orthic eutric	996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	1.2	15.6	3	1.6	9.2	2.2	1	126	32.1	64	23	4.8	1.1	0.7	2.5	0.37	29.50
		brunisol																									
	4	Orthic eutric	996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	1.0	16.7	3	1.6	9.9	2.5	1	104	31.8	65	23	5.0	1.2	0.7	2.5	0.37	28.63
		brunisol	*996521*			analytical duplicate	*80*				*1.1*	*17.5*	*3*	*0.5*	*9.0*	*2.9*	*3*	*161*	*33.7*	*66*	*23*	*5.2*	*1.2*	*0.7*	*2.5*	*0.38*	*28.87*
Jennings River	1	Orthic eutric	996531	Bm	0 - 12/15			9	667080	6612977	0.6	14.0	3	1.5	4.3	1.7	1	123	18.8	31	13	3.3	0.9	0.5	1.7	0.25	27.32
qtz-ser schist		brunisol**	996532	IC	12/15 - 45	glaciolacustrine sediment					0.7	17.0	3	1.5	5.1	2.5	1	128	25.6	37	21	5.3	1.5	0.7	2.1	0.33	28.73
104N/09			996043*	IIC	10-12m	till					1.6	17.1	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
	2	Orthic melanic	996533	Ah	0-18			9	667060	6613045	0.5	2.1	12	0.5	1.3	10.7	1	50	4.4	7	5	0.6	0.3	0.5	0.4	0.06	13.18
		brunisol	996534	C	18-50	glaciolacustrine sediment					0.8	14.9	3	1.3	5.2	1.3	1	114	22.0	33	19	4.3	1.2	0.6	2.1	0.31	31.00
Crinkled Chert	1	Humo-ferric	996535	Ae	0 - 5/7			9	346227	6636128	0.9	11.6	3	1.4	6.7	2.2	1	50	26.3	42	19	4.2	1.1	0.6	2.2	0.33	28.27
Locality 1b		podzol	996536	Bf	5/7 - 15						1.0	15.5	3	1.5	5.2	2.0	1	101	20.3	34	13	3.4	0.8	0.5	1.8	0.27	29.87
NW of Mt. Francis			996537	BC	15-35						1.2	16.2	3	0.5	5.7	2.0	1	104	18.0	30	16	3.3	0.9	0.5	1.6	0.25	29.85
104O/13			996046*	C	35-65	till					1.5	18.6	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
	2	Humo-ferric	996538	Bf	2-20			9	346137	6636074	0.8	13.9	3	1.2	5.2	2.5	1	95	19.0	30	15	3.1	0.8	0.5	1.7	0.26	27.26
		podzol**	996045*	C	20-60	till					1.0	18.4	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
	3	Orthic melanic	996539	Ah	0-12		10	9	346065	6636115	0.7	21.7	3	0.5	7.4	5.4	1	59	20.4	33	13	3.5	0.8	0.5	1.0	0.15	11.63
		brunisol	*996540*	*Ah*	*0-12*		*20*				*1.1*	*20.5*	*3*	*0.9*	*7.7*	*4.6*	*1*	*66*	*23.2*	*35*	*20*	*4.0*	*0.9*	*0.5*	*1.2*	*0.17*	*12.84*
			996025*	C	16-45	till					1.1	19.0	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
	4	Humo-ferric	996527	Ae	0-5			9	346303	6636214	0.8	11.6	3	1.5	5.7	2.4	1	90	22.4	45	14	3.5	0.9	0.5	2.2	0.34	24.21
		podzol	996528	Bf	5-15						1.0	16.6	3	1.3	5.0	1.5	1	102	19.6	41	13	3.4	1.0	0.5	2.1	0.31	27.33
			996529	B	15-30						1.0	17.4	3	0.5	6.1	1.5	1	94	21.2	42	18	3.5	0.9	0.5	2.1	0.31	30.68
			996038*	C	30-40	till					0.8	16.7	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

Mineral horizons only are shown;
LFH horizons (not sampled) are
not included here

TABLE 7
SOIL PROFILE DATA: MAJOR ELEMENTS

Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)	MnO (%)	Cr_2O_3 (%)
996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	68.38	11.59	5.06	1.77	2.22	1.66	2.06	0.77	0.16	0.10	0.029
996503R	R	15-25	py rubble over bedrock					-	-	-	-	-	-	-	-	-	-	-
996504	Bm	0-20	oxidized colluvium		9	347508	6633107	47.56	9.96	18.82	2.40	5.07	1.49	1.15	0.77	0.26	0.17	0.018
996505	C	20-50	colluvium					36.81	6.71	30.30	1.85	10.03	1.09	0.48	0.47	0.31	0.24	0.011
996506R	R	50-65	rubbly bedrock					-	-	-	-	-	-	-	-	-	-	-
996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	30.37	4.23	40.03	2.03	6.64	0.92	0.26	0.35	0.29	0.31	0.004
996508	*Bm*	*0-45*	*colluvium*	*20*				*34.73*	*4.23*	*35.88*	*2.19*	*8.10*	*1.42*	*0.28*	*0.32*	*0.28*	*0.34*	*0.007*
996501			analytical duplicate	*80*				*30.44*	*4.23*	*40.00*	*2.02*	*6.65*	*0.97*	*0.26*	*0.35*	*0.28*	*0.32*	*0.006*
996509	C	45-65	colluvium					18.81	2.06	54.93	1.29	4.36	0.34	0.05	0.16	0.13	0.52	< .001
996510R	R	65-90	rubbly bedrock					-	-	-	-	-	-	-	-	-	-	-
996034*	C	30-37	till		9	348635	6636661	53.95	15.25	9.28	2.95	1.57	1.03	1.54	0.84	0.19	0.12	0.007
996526R	R	>37	rubble					-	-	-	-	-	-	-	-	-	-	-
996511	Bm	0-14	oxidized colluvium		9	348397	6636759	49.55	15.29	8.24	2.03	1.61	1.69	1.64	0.71	0.16	0.07	0.018
996512	C	15-30	colluvium					57.78	12.13	6.22	1.46	1.65	1.79	1.46	0.87	0.12	0.06	0.027
996513R	R	>30	rubble over bedrock					-	-	-	-	-	-	-	-	-	-	-
996514	Ahe	0 - 8/10			9	348444	6636712	35.86	6.38	2.40	0.49	1.72	1.05	1.05	0.63	0.66	0.04	0.015
996515	Bm/BC	8/10-30	oxidized till					65.14	11.24	6.35	1.90	2.02	1.70	1.84	1.01	0.09	0.09	0.030
996032*	C	30-45	till					63.07	12.32	6.38	2.27	1.85	1.61	1.59	0.92	0.13	0.06	0.014
996517R	R	>45	py rubble					-	-	-	-	-	-	-	-	-	-	-
996518	Bm	5-30			9	348746	6636773	62.78	12.36	5.03	1.82	2.12	1.88	1.67	0.83	0.12	0.08	0.028
996029*	C	30-40	till					63.36	14.89	7.25	2.28	1.90	2.01	1.76	0.95	0.17	0.07	0.015
996519R	R	40-55	rubble					-	-	-	-	-	-	-	-	-	-	-
996520	Bm/C	0-18	oxidized till		9	347107	6629382	58.27	12.62	6.46	2.12	1.57	1.43	2.17	1.08	0.18	0.09	0.031
996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	50.29	13.07	7.89	1.99	1.45	1.63	2.13	1.35	0.27	0.11	0.031
996523	C	12-32	till					62.21	13.87	6.38	2.51	2.02	2.14	1.82	1.08	0.19	0.11	0.030
996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	62.36	13.17	5.96	2.27	1.62	1.86	1.90	0.99	0.09	0.08	0.031
996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	61.59	12.50	6.55	2.62	2.27	1.91	2.05	1.14	0.19	0.11	0.036
996521			analytical duplicate	*80*				*61.63*	*12.66*	*6.65*	*2.64*	*2.30*	*1.92*	*1.93*	*1.14*	*0.20*	*0.11*	*0.037*
996531	Bm	0 - 12/15			9	667080	6612977	65.91	12.18	5.68	1.91	2.78	2.32	1.25	1.14	0.06	0.08	0.030
996532	IC	12/15 - 45	glaciolacustrine sediment					65.17	12.31	5.83	2.28	3.47	2.55	1.44	1.11	0.16	0.08	0.029
996043*	IIC	10-12m	till					58.52	11.43	7.22	3.60	5.20	1.86	1.48	1.07	0.24	0.13	0.023
996533	Ah	0-18			9	667060	6613045	9.07	2.11	0.74	1.02	8.68	0.37	0.31	0.12	0.20	0.02	0.001
996534	C	18-50	glaciolacustrine sediment					60.57	12.45	6.83	2.91	3.77	2.19	1.51	1.14	0.25	0.09	0.029
996535	Ae	0 - 5/7			9	346227	6636128	72.92	11.14	3.36	1.09	2.02	2.59	1.71	1.13	0.09	0.06	0.032
996536	Bf	5/7 - 15						65.48	12.64	6.42	2.07	2.11	2.46	1.54	0.93	0.16	0.08	0.029
996537	BC	15-35						63.99	13.67	6.49	2.46	2.61	2.25	1.50	1.01	0.09	0.12	0.032
996046*	C	35-65	till					66.59	13.09	5.89	2.36	2.50	2.31	1.35	0.95	0.07	0.15	0.015
996538	Bf	2-20			9	346137	6636074	63.67	13.18	6.65	1.95	1.91	2.19	1.47	1.02	0.06	0.08	0.030
996045*	C	20-60	till					63.51	13.92	6.00	2.53	2.29	2.44	1.43	0.83	0.12	0.08	0.011
996539	Ah	0-12		10	9	346065	6636115	19.61	6.17	1.32	0.29	0.75	0.65	0.53	0.35	0.79	0.01	0.010
996540	*Ah*	*0-12*		*20*				*25.36*	*7.24*	*1.89*	*0.46*	*0.73*	*0.93*	*0.80*	*0.43*	*0.68*	*0.02*	*0.014*
996025*	C	16-45	till					68.71	12.23	5.07	2.48	2.35	2.31	1.34	1.07	0.19	0.04	0.014
996527	Ae	0-5			9	346303	6636214	71.39	11.29	2.76	0.77	1.89	2.68	1.74	1.05	0.13	0.07	0.019
996528	Bf	5-15						62.26	13.40	6.89	1.97	2.24	2.06	1.49	0.88	0.04	0.08	0.020
996529	B	15-30						64.14	14.09	6.07	2.36	2.30	2.22	1.58	0.90	0.09	0.09	0.034
996038*	C	30-40	till					67.10	12.74	5.57	2.09	2.66	2.48	1.35	0.96	0.08	0.12	0.015

* C-horizon tills at 6 soil profiles from those of Dixon-Warren & Hickin (this volume)
One sample (996025) is the first of three triplicate samples. See Dixon-Warren

** thin Aej horizon present but not sampled
UTM locations accurate to ~ 100 metres
Tentative soil types after Canadian System of Soil Classification (Agriculture Canada, 1987)

TABLE 7 CONTINUED
SOIL PROFILE DATA: MAJOR ELEMENTS

Study Area	Profile	Soil Profile Type	Sample	Soil Horizon	Depth (cm)	Material	Rep	UTM Zone	UTME Nad83	UTMN Nad83	Ni (ppm)	Sr (ppm)	Zr (ppm)	Y (ppm)	Nb (ppm)	Sc (ppm)	LOI (%)	C/Tot (%)	S/Tot (%)	Sum (%)
Hwy. 97	1	Orthic eutric	996502	Bm(Ap?)	0-15	disturbed (?) soil		9	358942	6643867	45	184	136	26	10	10	5.8	0.92	0.03	99.76
Cu Prospect		brunisol	996503R	R	15-25	py rubble over bedrock					-	-	-	-	-	-	-	-	-	-
104O/13																				
Arsenault	1	Orthic eutric	996504	Bm	0-20	oxidized colluvium		9	347508	6633107	39	157	128	19	10	10	12.2	2.68	0.03	99.96
Cu Prospect		brunisol	996505	C	20-50	colluvium					32	101	123	20	10	5	11.4	1.93	0.05	99.76
104O/13			996506R	R	50-65	rubbly bedrock					-	-	-	-	-	-	-	-	-	-
	2	Orthic eutric	996507	Bm	0-45	oxidized colluvium	10	9	347433	6633132	46	55	96	15	10	3	14.2	2.34	0.11	99.67
		brunisol	*996508*	*Bm*	*0-45*	*colluvium*	*20*				*42*	*51*	*101*	*13*	*10*	*3*	*11.9*	*2.00*	*0.03*	*99.72*
			996501			analytical duplicate	*80*				*42*	*56*	*110*	*16*	*10*	*3*	*14.3*	*2.32*	*0.06*	*99.87*
			996509	C	45-65	colluvium					67	39	64	33	10	2	16.6	1.38	0.12	99.29
			996510R	R	65-90	rubbly bedrock					-	-	-	-	-	-	-	-	-	-
Crinkled Chert	1	brunisol	996034*	C	30-37	till		9	348635	6636661	27	128	157	15	13	9	12.5	2.07	0.12	99.40
Locality 1a			996526R	R	>37	rubble					-	-	-	-	-	-	-	-	-	-
N of Mt. Francis																				
104O/13	2	Orthic eutric	996511	Bm	0-14	oxidized colluvium		9	348397	6636759	28	148	112	13	10	14	18.7	4.65	0.09	99.86
		brunisol	996512	C	15-30	colluvium					24	173	150	14	10	9	16.2	4.69	0.06	99.90
			996513R	R	>30	rubble over bedrock					-	-	-	-	-	-	-	-	-	-
	3	Orthic eutric	996514	Ahe	0 - 8/10			9	348444	6636712	20	128	130	15	10	7	49.4	21.90	0.18	99.79
		brunisol	996515	Bm/BC	8/10-30	oxidized till					33	199	180	17	10	10	8.4	1.75	0.04	99.95
			996032*	C	30-45	till					34	203	218	16	12	7	9.4	2.41	0.01	99.81
			996517R	R	>45	py rubble					-	-	-	-	-	-	-	-	-	-
	4	Eluviated	996518	Bm	5-30			9	348746	6636773	39	214	158	16	10	9	11.1	2.67	0.02	99.96
		eutric brunisol**	996029*	C	30-40	till					45	202	213	23	13	8	4.9	0.54	0.02	99.77
			996519R	R	40-55	rubble					-	-	-	-	-	-	-	-	-	-
Crinkled Chert	1	Orthic eutric	996520	Bm/C	0-18	oxidized till		9	347107	6629382	34	148	174	20	10	10	13.6	4.29	0.05	99.76
Locality 2		brunisol																		
SW Mt. Francis	2	Orthic eutric	996522	Bm	0-12	oxidized colluvium (?)		9	347117	6629382	33	135	196	20	10	10	19.6	6.29	0.07	99.96
104O/13		brunisol	996523	C	12-32	till					51	209	168	25	10	14	7.3	1.19	0.04	99.89
	3	Orthic eutric	996524	Bm/C	0-25	oxidized colluvium		9	347157	6629382	48	181	188	20	10	10	9.3	1.85	0.01	99.82
		brunisol																		
	4	Orthic eutric	996525	Bm/C	0-35	colluviated till (?)		9	347097	6629382	51	193	185	22	10	12	8.8	1.84	0.04	99.92
		brunisol	*996521*			analytical duplicate	*80*				*54*	*195*	*211*	*22*	*10*	*12*	*8.5*	*1.89*	*0.03*	*99.88*
Jennings River	1	Orthic eutric	996531	Bm	0 - 12/15			9	667080	6612977	58	262	125	19	10	12	6.3	1.09	0.01	99.79
qtz-ser schist		brunisol**	996532	IC	12/15 - 45	glaciolacustrine sediment					72	309	116	28	10	15	4.8	0.40	0.02	99.40
104N/09			996043*	IIC	10-12m	till					107	290	116	21	14	7	8.3	1.07	0.16	99.30
	2	Orthic melanic	996533	Ah	0-18			9	667060	6613045	21	257	16	< 10	10	2	77.2	31.80	0.34	99.92
		brunisol	996534	C	18-50	glaciolacustrine sediment					63	275	116	25	10	14	7.7	1.20	0.01	99.62
Crinkled Chert	1	Humo-ferric	996535	Ae	0 - 5/7			9	346227	6636128	23	222	212	19	10	9	3.6	0.77	0.01	99.89
Locality 1b		podzol	996536	Bf	5/7 - 15						24	190	158	18	10	10	5.8	0.87	0.01	99.86
NW of Mt. Francis			996537	BC	15-35						50	219	135	17	10	12	5.5	0.46	0.01	99.91
104O/13			996046*	C	35-65	till					53	235	140	17	12	7	4.4	0.27	0.01	99.92
	2	Humo-ferric	996538	Bf	2-20			9	346137	6636074	31	188	153	17	10	10	7.6	1.16	0.01	99.96
		podzol**	996045*	C	20-60	till					34	167	134	16	12	7	6.6	0.66	0.01	99.92
	3	Orthic melanic	996539	Ah	0-12		10	9	346065	6636115	20	84	51	12	10	15	69.5	36.50	0.16	100.09
		brunisol	*996540*	*Ah*	*0-12*		*20*				*22*	*87*	*64*	*13*	*10*	*14*	*61.3*	*31.90*	*0.15*	*99.97*
			996025*	C	16-45	till					35	241	204	23	14	8	3.6	0.22	0.01	99.64
	4	Humo-ferric	996527	Ae	0-5			9	346303	6636214	33	229	183	20	10	10	5.1	1.37	0.02	99.03
		podzol	996528	Bf	5-15						51	198	139	19	10	14	8.2	1.57	0.01	99.67
			996529	B	15-30						90	212	133	21	10	14	5.4	0.50	0.01	99.43
			996038*	C	30-40	till					44	246	157	17	12	7	4.6	0.36	0.01	99.92

Mineral horizons only are shown;
LFH horizons (not sampled) are not included here

4), but another quartzite otherwiser similar to crinkled chert returned only low barium and manganese concentrations.

No detailed lithogeochemical sampling of crinkled chert units was attempted. With regard to other elements, crinkled cherts here exhibit, in most cases, only background-level concentrations of copper (mean: 30.7 ppm), zinc (mean: 27.6 ppm), lead (mean: 3.4 ppm), molybdenum (mean: 0.10 ppm), selenium (mean: 0.1 ppm) and gold (mean: 1 ppb). However, one dark maroon-coloured sample (99-SJC-11) from the South Mt. Francis area has, in addition to elevated barium (2100 ppm), highest concentrations of copper (119 ppm), manganese (2595 ppm), iron (2.06 per cent INA), cobalt (39 ppm INA), arsenic (52.1 ppm INA) and antimony (3.6 ppm INA) relative to other pink or grey specimens sampled.

ii) Soil Profile Geochemistry

Twelve soil profiles were sampled at crinkled chert localities 1 and 2, in areas to the north and south of Mt. Francis, respectively. Barium concentrations up to 1500 ppm (INA) occur in till and colluvial C-horizon soils sampled at eight profiles (Table 6) north of Mt. Francis area (localities 1a,b). The highest concentrations here are present at site 1b (range: 790 - 1500 ppm) nearer the crinkled chert exposures, while somewhat lower barium concentrations (range: 680-960 ppm) occur in the more distal profiles sampled at site 1a. Similar barium levels (range: 820 - 1500 ppm) are present in thin till and colluvial C-horizon veneer above crinkled chert at site 2 south of Mt. Francis. INA reanalysis of remaining sample material from the horizon with the highest barium content here (996523; 1500 ppm) returned a similar 1600 ppm barium. There is no regional till barium data available for adjacent parts of northern British Columbia with which to compare these results. However, many are elevated relative to publicly-available barium data for regional geochemical surveys of central and southern British Columbia tills (Table 8), for which survey medians are in the range 380-850 ppm barium. Most soil manganese concentrations in this study do not differ appreciably from regional medians, which are in the range 508-805 ppm.

Barium concentrations increase down profile in most crinkled chert-area soils here (Table 6), particularly those in tills. Down profile increases in barium are seen in both till profiles at locality 1a, all four till profiles at locality 1b, and the sole multi-horizon till profile at locality 2. Two examples of relevant profiles, a brunisol and a podzol, from crinkled chert locality 1 are shown in Figure 7. In the first case (locality 1a, profile 3), barium concentrations increase down profile from 720 ppm in the near-surface Ahe horizon, to 960 ppm in C horizon till, and finally to 1100 ppm in underlying bedrock rubble. In the second case (locality 1b, profile 1), barium concentrations double down profile, increasing from 770 ppm in the

TABLE 8
BARIUM AND MANGANESE CONCENTRATIONS (PPM) IN VARIOUS BRITISH COLUMBIA TILLS

	Big Salmon Complex *Dixon-Warren (this volume)**	Babine Porphyry Belt, Nechako Plateau *Levson et al. (2000)*	Fawnie Creek map area, Nechako Plateau *Levson et al. (1994)*	Chedakuz Creek map area, Nechako Plateau *Weary et al. (1997)*	Louis Creek-Chu Chua Creek area Southcentral B.C. *Bobrowsky et al. (1998)*	Adams Lake Plateau Area, Southcentral B.C. *Bobrowsky et al. (1997)*	Northern Vancouver Island *Bobrowsky and Sibbick (1996)*	Total Sites
Ba (ppm)								
Median	**930**	**780**	**660**	**-**	**770**	**850**	**380**	
Mean	942	786.7	677.7	-	773.8	885.5	394.8	
SD	263	153.8	105.9	-	279.0	317.9	167.9	
CV	-	0.195	0.156	-	0.4	0.4	0.4	
Minimum	210	360	430	-	50	260	50	
90th pctile.	-	980	820	-	1000 *(87.3%)*	1100 *(87%)*	600 *(90.6%)*	
95th pctile.	-	1100	850	-	1200 *(95.5%)*	1300 *(94.2%)*	680 *(95.4%)*	
Maximum	1500	1600	960	-	2200	4600	1500	
N=sites	*45*	*937*	*171*	-	*331*	*500*	*434*	***2418***
Mn (ppm)								
Median	**440**	**715**	**508**	**538**	**569**	**733**	**805**	
Mean	513	760.9	535.8	546.4	615.0	812.9	962	
SD	228	380.2	231.0	206	388.7	448.1	699.6	
CV	-	0.500	0.431	0.377	0.6	0.6	0.7	
Minimum	281	70	164	160	106	161	43	
90th pctile.	-	1238	834	786	869	1373 *(90.5%)*	*1775 (90.3%)*	
95th pctile.	-	1422	941	887	991	1773 *(95.2%)*	2320 *(95.2%)*	
Maximum	1273	3664	1259	1156	6061	2759	5041	
N=sites	*45*	*937*	*171*	*151*	*331*	*496*	*435*	***2566***

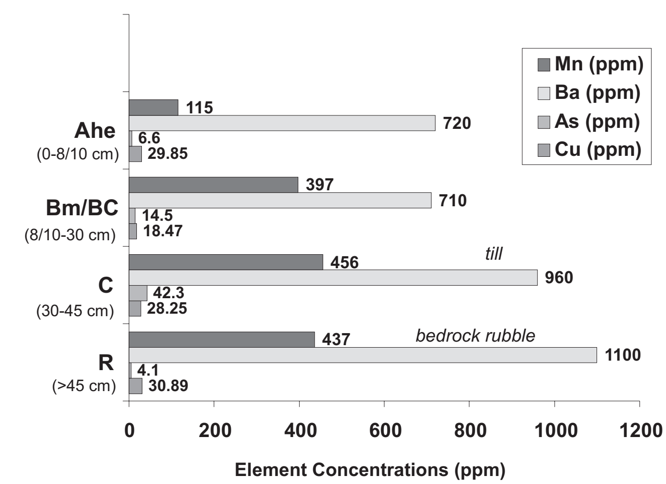
Determinations made on -230 mesh (<63 micron) fraction of tills
Barium: total barium determined by INA
Manganese: aqua regia digestion - ICP-ES (ICP-MS for data of Dixon-Warren and Hickin, this volume)

* Not a regional-scale geochemical survey

surficial Ae horizon of the humo-ferric podzol (Photo 5) through to 1500 ppm in C horizon till. There appears to be a close relationship here between till geochemical results and the type of entrained material. A subangular to angular cobble of pink piedmontite schist (99-SJC-13) from this pit, one of several such clasts uncovered, returned similarly elevated barium and manganese concentrations of 2900 ppm (INA) and 708 ppm, respectively. Interestingly, it also returned 172 ppb gold (INA), whereas the enclosing soil horizons here have relatively low but uniform gold concentrations in the range 6-10 ppb. Subsequent reanalysis of remaining pulverized sample material by INA returned corroborative high barium and gold concentrations of 3300 ppm and 325 ppb, respectively.

There are additional similarities between the two profiles beyond the greater barium concentrations at depth. First, differences in barium concentrations between the two uppermost horizons (*e.g.* Ahe and Bm; Ae and Bf) are minimal compared to the much greater differences between these and the underlying C horizon tills. This relation also holds for the barium distribution in till from some other areas, such as profile 1 at the Jennings River study area (Table 6). Secondly, several other elements also increase down profile. These include manganese, zinc and, generally, iron and arsenic. Manganese concentrations, for instance, in the two C horizon tills (437-521 ppm) are 4 times greater than in the eluviated Ae or Ahe horizons near the surface. Some elements are distributed differently between the two profiles. Copper, for instance, is relatively constant with depth in the brunisol but increases with depth in the podzol. In this case the podzolic Bf horizon (12.94 ppm) has 2 times the copper content of the near-surface Ae horizon (5.49 ppm), but less than half that of C horizon till (29.1 ppm). This is attributed to the characteristically much greater clay content of till relative to near-surface mineral horizons.

A) Crinkled Chert Site 1a: Soil Profile 3



B) Crinkled Chert Site 1b: Soil Profile 1

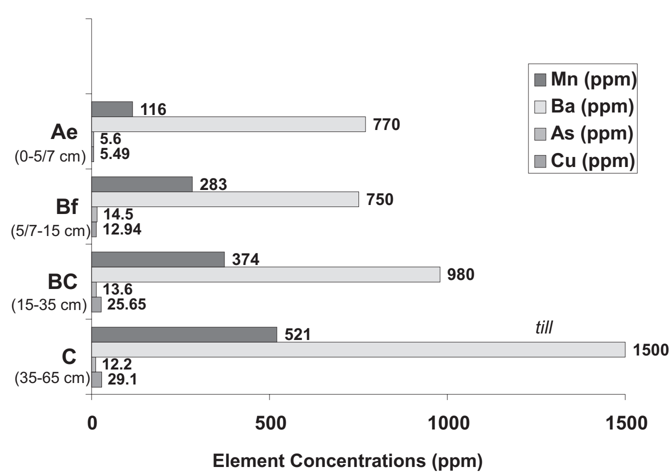


Figure 7. Manganese and copper (ICP-MS) and barium and arsenic (INA) concentrations in A) brunisolic and B) podzolic soil profiles in till at crinkled chert site 1. *See* Tables 4-6 for complete data listings.

Photo 5. Soil profile 1 (humo-ferric podzol) at crinkled chert site 1b northwest of Mt. Francis.

With regard to colluvial soils profiled adjacent to crinkled cherts, most have just a single horizon so there is insufficient data to compare barium distributions in till versus colluvial profiles. However, barium behaves in an opposite manner at one brunisolic profile (2) at locality 1a, decreasing with depth from 880 ppm (colluvial Bm horizon) to 560 ppm in underlying bedrock rubble. This is attributed to the downslope movement of higher-barium colluvial material above bedrock with a lower barium content. Interestingly, the highest gold concentrations in crinkled chert-area soil profiles also occur here. Gold distribution is similar to that of barium, decreasing down profile from 27 ppb in near-surface soil to just 1 ppb in bedrock rubble (Table 6).

Jennings River Quartz-sericite Schist (NTS 104N/09)

A composite rock sample (99-SJC-12) across the approximately 1.5 metre-wide altered quartz-sericite schist horizon exposed on the north side of the Jennings River yielded only background-level metal concentrations of 20 ppm copper, 17 ppm zinc, 4.7 ppm cobalt and 320 ppm barium (INA). The rock outcrop is overlain by 12-14 metres of till and glaciolacustrine sediment, forming a steep riverbank exposure. Irrespective of the low metal concentrations in outcrop, till copper concentrations reported here by Dixon-Warren and Hickin (this volume) are in the range 49-83 ppm, with higher concentrations occurring at higher levels in the till. Till barium (INA) levels are similarly high here, in the range 910-1400 ppm.

Results here provide a good example of how an understanding of surficial materials and Quaternary processes can be applied to interpreting geochemical data. Neither of the two soil pits dug at the top of the riverbank above altered quartz-sericite schist were deep enough to intercept till beneath about 2 metres of exotic glaciofluvial sediment. However, till was sampled at a site (996043) on the steep riverbank about 10-12 metres below soil profile 1, and about 2 metres above the altered horizon. Geochemical results for this composite profile (Tables 5 and 6) provide a good illustration of the potential differences in metal concentrations between surficial materials of varying origins, and of the pitfalls in sampling soils, even when potentially close to mineralization, without understanding their derivation. Differences in metal concentrations between the near-surface brunisolic Bm horizon, and the glaciolacustrine IC horizon from which it developed, are relatively minor when compared to metal concentrations in the underlying till. Till is a first-derivative product of bedrock, and is inferred to have formed here from the up-ice entrainment of relatively locally-derived material. Conversely, low-metal glaciolacustrine sediments have typically been transported great distances and been extensively reworked. Copper concentrations, for example, in the glaciolacustrine Bm and IC horizons (996531 and 996532) are relatively low (19-35 ppm), but are 75 ppm in the underlying till. Similarly, barium (840-930 ppm INA) and mercury (23-42 ppb) levels in the glaciolacustrine soils are considerably less than the corresponding till concentrations of 1300 ppm and 189 ppb, respectively. Similar differences between glaciolacustrine soil horizons and underlying till are also evident for molybdenum, lead, zinc, arsenic, silver and cobalt, among others.

Mineral Prospect Case Studies

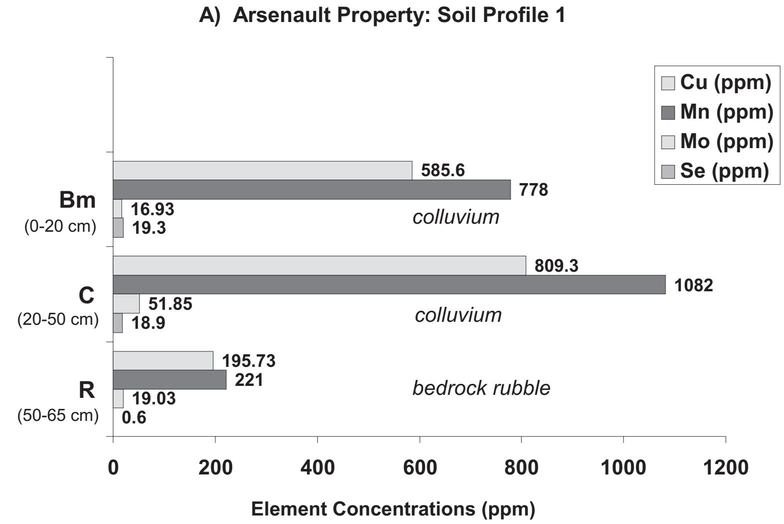
Arsenault Prospect (NTS 104O/13; MINFILE 104O 011)

Highly elevated concentrations of copper, molybdenum and several other elements are present in two soil profiles conducted at old exploration trenches at the Arsenault prospect (Figure 8). Both profiles are characterized by brunisolic soils developed in a thin colluvial veneer above bedrock.

Highest metal concentrations are in soil profile 2 (Tables 5-7) in the eastern wall of the westernmost trench. This profile is characterized by a Cu-Mo-Fe-Co-As-Se-Au-Ag-Bi geochemical signature. Elevated copper concentrations increase down profile, from 1370 ppm in the near-surface Bm horizon to 4977 ppm in deeper colluvium (45-65 cm depth). Molybdenum and cobalt levels display similar relations, increasing down profile in the ranges 53-142 ppm, and 31.7-74.4 ppm, respectively. Similar down profile trends are also exhibited by iron (maximum: 32.8 per cent) and manganese (maximum: 2869 ppm). Angular bedrock rubble sampled from the bottom of the soil pit (996510R) contains lower, but nonetheless highly elevated concentrations of copper (1546 ppm), molybdenum (114 ppm) and iron (17.0 per cent).

Profile 1, on the east wall of the easternmost trench, is characterized by a more restricted Cu-Mo-Fe-Co-As-Se-Au geochemical signature. Elevated copper concentrations, although lower than in profile 2, similarly increase down profile, from 586 ppm in the colluvial Bm horizon to 809 ppm in underlying colluvium. Molybdenum, iron and arsenic display similar trends (Tables 5 and 6). As with profile 2, underlying gneissic bedrock rubble (996506R) contains comparatively lower but nonetheless elevated copper (196 ppm) and molybdenum (19 ppm) levels. However, a significant difference here are the lower cobalt, iron, arsenic, manganese, selenium and gold concentrations in rock relative to overlying colluvial soils. For example, rock cobalt content is only 7.4 ppm relative to a range of 36.7 - 45.4 ppm in soils.

Other interesting similarities between the two profiles, beyond their base metal signatures, are elevated concentrations of gold and selenium and relatively low concentrations of zinc and barium. Gold concentrations in the four colluvial soil horizons here (Tables 5 and 6) are



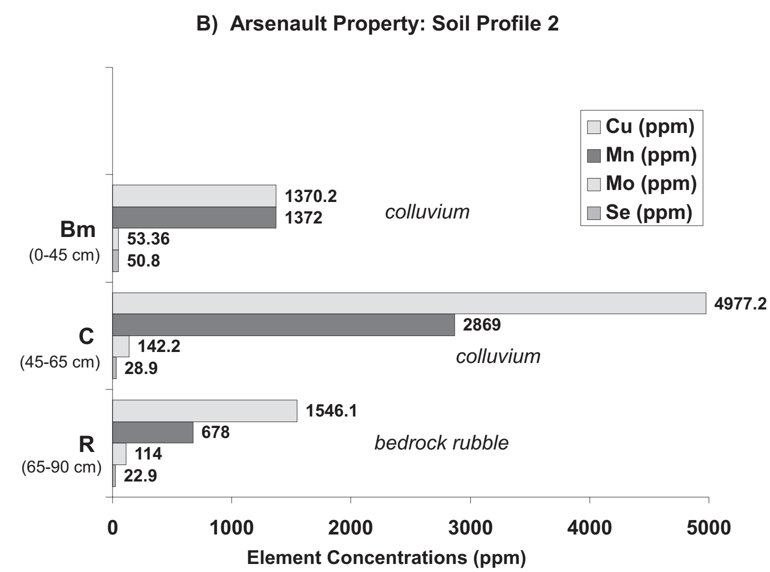


Figure 8. Copper, manganese, molybdenum and selenium concentrations (ICP-MS) in two colluvial soil profiles at the Arsenault copper prospect. *See* table 5 for complete data listings.

in the range 25-35 ppb (INA), and are relatively constant with depth. Selenium levels are high here. They are in the range 18.9-19.3 ppm in profile 1, and in the range 28.9-50.8 ppm in profile 2 where, interestingly, elevated selenium (22.9 ppm) is also present in the underlying rubbly bedrock. In contrast, relatively low zinc and barium concentrations in the mineral horizons do not exceed 67.4 ppm and 450 ppm, respectively.

The range of elements reported here and by Dixon-Warren and Hickin (this volume), although limited to a few sites, is much greater than those from previous soil geochemical surveys of the Arsenault prospect. Soil samples obtained by Sawyer (1967) and Turnbull and Simpson (1970) were collected using hand augers or mattocks, screened to -80 mesh using nylon screens, and analyzed for copper and/or molybdenum using colorimetric or acid digestion-AAS techniques. Turnbull and Simpson (1970) reported that elevated soil copper levels were coincident with known mineralization, particularly in the east-west trending ridge area where skarn-like copper mineralization is exposed at surface. However, no information is given about the types of surficial materials sampled (*e.g.* till versus colluvium) in either survey, which might assist in indicating the glacial or colluvial transport directions (*e.g.* downice or downhill) necessary for effective follow-up of geochemical anomalies. Similarly, there is no indication that any orientation studies were conducted which might indicate the most effective horizons and/or sieve size fractions to sample at this deposit. Soils of Turnbull and Simpson (1970) are reported to have been from the B-horizon, while those of Sawyer (1967) are not specified. Sawyer (1967) stated that sampling was intended to have been from a common horizon, but that the variable soil cover of the area made this difficult to achieve. Property-scale copper results of Sawyer (1967) are reproduced by Dixon-Warren and Hickin (this volume).

Highway 97 Copper-bearing Gossan (NTS 104O/13; MINFILE 104O 054)

A single profile sampled immediately above the gossan exposure, on the south side of the Alaska Highway, comprises a thin oxidized till (996502) above rubbly siliceous pyritic greenstone (996503R; Tables 4 and 5) in the bottom of the pit. Elevated concentrations of copper (229 ppm), cobalt (24.6 ppm), arsenic (70.6 ppm), antimony (9.6 ppm INA) and bismuth (2.39 ppm) are present in the greenstone rubble, but are considerably lower in the overlying soil material, which was likely disturbed and displaced during road construction. Only background levels of copper (42 ppm) are present. As outlined earlier, a similar though more pronounced geochemical signature was reported by Mihalynuk *et al.* (1998) for the gossanous outcrop here.

A similar suite of elevated metal concentrations was also obtained for an angular limonitic cobble (99-SJC-03) sampled from one of the till pits (996002; Dixon-Warren and Hickin, this volume) south of the highway. Elevated levels of copper (132 ppm), cobalt (27.4 ppm) and antimony (24.2 ppm INA) were obtained. Dixon-Warren (this volume) reported only background concentrations of copper in till pits north and south of the highway. Dispersal patterns, if any, of copper-bearing till from this locality may never be conclusively established, as the orientation of the Alaska Highway here is approximately parallel to the glacial transport direction (Dixon-Warren and Hickin, 2000).

Teslin Lake Border Area (NTS 104N/16; MINFILE 104N 135)

Three grab samples of gossanous bedrock (99-SJC-06 to -08) were obtained on the east shore of Teslin Lake. The most interesting results are from a site about 3 kilometres south of the Yukon border, where a grab sample (99-SJC-07) from an approximately 1 metre-wide pyrite-rich zone of altered limonitic schist returned highly elevated concentrations of gold (338 pppb) and arsenic (308 ppm), along with elevated antimony (4.7 ppm) and silver (0.4 ppm). These were determined by INA on a 33.59 gram sample. A comparable result of 309 ppb gold was also determined directly by aqua regia digestion - ICP-MS on a separate 1 gram split, suggesting that the gold present in the rock occurs in a very fine-grained form. No chalcopyrite was observed, as reflected in the very low copper content (7 ppm) of the sample. INA reanalysis of the remaining pulverized sample material (22.46 gram sample) returned corroboratory concentrations of 350 ppb gold, 325 ppm arsenic and 5.7 ppm antimony. A split of the original crushed sample material is presently being reanalyzed by fire assay methods at a second laboratory.

In the remaining cases, a grab sample of pyritic quartz-veined garnet mica schist (99-SJC-06) obtained from the northern end of the lake shore outcrop belt (Mihalynuk *et al.*, 1998) returned moderately high arsenic levels (43.1 ppm INA), but only background concentrations of copper (39 ppm) and cobalt (5.7 ppm). Another grab sample of limonitic rock (99-SJC-08) from the vicinity of a prior assay site of Mihalynuk *et al.* (1998) yielded elevated levels of copper (148 ppm), cobalt (28.1 ppm), silver (0.35 ppm), arsenic (62.8 ppm INA) and antimony (4.6 ppm INA), somewhat lower than earlier-reported results of 2.2 per cent copper and 28 ppm silver. Relatively high levels of cerium (56-105 ppm INA) and lanthanum (31.6-59.4 ppm INA) occur in all three rocks. Barium concentrations are in the range 440-610 ppm (INA).

METALLOGENY OF YUKON-TANANA TERRANE VMS DEPOSITS: APPLICATIONS TO GEOCHEMICAL EXPLORATION IN THE BIG SALMON COMPLEX

Volcanogenic massive sulphide deposits are typically polymetallic and high grade but often areally small. They present a more difficult geochemical exploration target in glaciated regions relative to, for example, porphyry copper deposits, which are associated with large hydrothermal alteration systems. An understanding of the geological and mineralogical characteristics of VMS deposits in general as well as those found elsewhere in the Yukon-Tanana Terrane is a necessary prerequisite for successful geochemical exploration in the Big Salmon Complex. Each deposit type has geochemical signatures related to host rock geology, alteration type and sulphide ore mineralogy which can be used in locating the dispersed remnants of the deposits in the surficial environment. Kuroko-type copper-lead-zinc VMS deposits typically have thin chert or barite exhalative horizons at upper levels and at peripheries, and have footwall alteration zones with quartz, sericite or chlorite zoning outwards to clay minerals, albite and carbonate (Hoy, 1995). They may have multi-element geochemical signatures with elevated levels of copper, zinc, lead, barium, silver, gold and other elements. Cyprus-type copper VMS deposits in mafic volcanics typically show iron and manganese enrichment of footwall stringer zones and may have overlying exhalative horizons of iron-rich mudstone or chert (Hoy, 1995). These deposits may also have a simpler sulphide mineralogy and a more limited copper-zinc geochemical signature.

Metallogeny of Yukon-Tanana Terrane VMS Deposits

Volcanogenic massive sulphide deposits and prospects occur in three main areas of the Yukon-Tanana Terrane other than the Big Salmon Complex (Hunt, 1997): the Finlayson Lake area (YT), the Dawson-Alaska border area (YT) and the Delta district of eastern Alaska. In the latter case, for instance, Devonian metavolcanic and metasedimentary rocks of the Delta district host more than 35 generally Kuroko-type copper-lead-zinc VMS deposits (Lange *et al.,* 1993). During the 1990's, exploration of the Finlayson Lake belt has uncovered several new copper-zinc-lead massive sulphide deposits, including the Kudz Ze Kayah (KZK), Wolverine, Fyre Lake, and Money deposits. Exploration of the Finlayson Lake belt is at a more advanced stage than in the Big Salmon Complex. The following section outlines their distinctive geological features and the geochemical exploration methods used to help discover them, and offers some preliminary suggestions for geochemical exploration in the Big Salmon Complex.

Finlayson Lake belt VMS deposits occur primarily within the 'middle package' of the Yukon-Tanana Terrane: Late Devonian to mid-Mississippian Nasina Assemblage quartzite, schist, marble and metavolcanic rocks and their equivalents, (Hunt, 1997). The two largest, Kudz Ze Kayah (KZK) and Wolverine, are Kuroko-style VMS deposits within Early Mississippian felsic metavolcanic and carbonaceous sedimentary rocks. KZK (11 million tonnes grading 5.9% Zn, 0.9% Cu, 1.5% Pb, 130 grams per tonne Ag and 1.3 grams per tonne Au; Burke, 1999) and Wolverine (6.2 million tonnes grading 12.7% Zn, 1.3% Cu, 1.5% Pb, 371 grams per tonne Ag and 1.76 grams per tonne Au; Burke, 1999) are characterized by relatively fine- to medium-grained pyrite-sphalerite-chalcopyrite-galena massive sulphide mineralization. High silver grades and selenium content are present at Wolverine. The Fyre Lake deposit (Kona deposit) is a Besshi-type copper-cobalt-gold deposit within a chlorite schist host (Blanchflower *et al.*, 1997; Hunt, 1997). Mineralization occurs as massive pyrite-pyrrhotite with subordinate chalcopyrite-sphalerite. The Money copper-zinc prospect is hosted by similar, but less metamorphosed, pillow basalt (Hunt, 1997), and may be either a Besshi or Cyprus-type VMS occurrence. The Eldorado prospect comprises massive sulphides, pyrrhotite-pyrite stringers and quartz-arsenopyrite lenses in black shale, argillite and phyllite (Hunt, 1997). Several additional VMS prospects, Ice, Mamu and Wolf, also occur in the Pelly Mountains volcanic belt (Hunt, 1997), which may be correlative with Yukon-Tanana rocks.

Some Geological Similarities: Host Rocks, Alteration Mineralogy and Ore Geochemistry

A common feature of several Finlayson Lake belt deposits, other than KZK, is their proximity to siliceous iron formation marker horizons interpreted to be exhalative in origin. The Wolverine deposit is associated with a siliceous exhalite and baritic magnetite iron formation (Murphy and Piercey, 1999). At Fyre Lake, massive sulphide float boulders and coincident soil geochemical and geophysical anomalies are spatially associated with several horizons of stratiform iron formation. These horizons, hosted by metamorphosed mafic volcanic and volcaniclastic rocks, have inferred surface traces over 3.2 kilometres in the Kona Creek cirque (Blanchflower *et al.,* 1997). At the Wolf deposit, a semi-massive barite/carbonate exhalite zone occurs stratigraphically just above the overturned massive sulphide zone (Gibson *et al.,* 1999). At Mamu, fragmental felsic metavolcanics contain pyrite-bearing horizons which weather to prominent gossans. The pyritic cherts or tuffs here are also thought to represent exhalative horizons (Doherty, 1997).

Direct comparisons of alteration and sulphide mineralogy between the Finlayson Lake belt and Big Salmon Complex are more difficult to make because of the relatively few prospects known south of the Yukon border. With regard to alteration, Mg-chlorite footwall alteration zones envelope pyrite-chalcopyrite-pyrrhotite stringer mineralization at Wolverine (Tucker *et al.*, 1997). Sulphide ore zones of Finlayson Lake area deposits such as KZK and Wolverine are characterized by high silver and selenium concentrations, and soil profiles at the Arsenault prospect have relatively high levels of selenium.

Geochemical Exploration for VMS Deposits in the Finlayson Lake Belt

Stream sediment and soil geochemical methods together with surface indications of mineralized float played a major role in exploration of the Finlayson Lake belt. The discovery of KZK by Cominco resulted from the follow-up, in 1992 and 1993, of anomalous zinc, lead and copper results from an NGR stream sediment survey which had been conducted by the Geological Survey of Canada in 1988 (Northern Miner, 1997). Elevated soil geochemical results, together with the 1993 discovery of mineralized sulphide float, led to the geophysical and drilling programs which outlined the deposit. Interestingly, an earlier low-density regional stream sediment survey conducted by Cominco in the late 1970's had failed to locate the deposit (Northern Miner, 1997). Initial reconnaissance exploration by Atna Resources, which led to the 1995 discovery of the Wolverine deposit, was also based on government regional geochemical data (Northern Miner, 1995). Drilling of subsequent multi-element soil geochemical anomalies led to the discovery of the deposit (Tucker *et al.*, 1997). NGR stream sediment geochemical signatures around KZK, Wolverine and related deposits were reported by Hunt (1998a).

Soil geochemical results, discovery of surface sulphide float and, in some cases, the position of natural vegetation 'kill zones' (Northern Miner, 1995; Hunt, 1998b) have also been instrumental in the discovery and development of other deposits in the Finlayson Lake belt. Doherty (1997) stated that elevated molybdenum in soils is considered to be an indicator of felsic-hosted VMS mineralization in the area. At Fyre Lake, a large massive sulphide boulder found in 1960 on an esker near the south end of Fire Lake led to the original discovery of outcropping mineralization in Kona Creek (Blanchflower *et al.,* 1997). Massive sulphide float and coincident soil geochemical anomalies here were spatially associated with several horizons of stratiform iron formation (Blanchflower *et al.*, 1997). Ferricrete was also reported from nearby creeks (Hunt, 1997). At the Money deposit, elevated copper (>100 ppm) in soils parallel prospective stratigraphy for several hundred metres, and pyritic sulphide boulders occur as float in adjacent Boulder Creek. According to Hunt (1997), the Cyprus-type Ice property was discovered from a single 2000 ppm copper in soil anomaly.

There is considerable scope for the use of other geochemical methods in the Big Salmon Complex, including lithogeochemistry and vegetation sampling. Lithogeochemical sampling was considered by Sebert and Hunt (1999) to be a useful tool in discriminating chlorite schist hosting mineralization at the Fyre Lake deposit from barren chlorite schist units. They stated that chlorite schist hosting the Kona zones originated from a boninitic protolith, distinctive from the tholeitic nature of other mafic metavolcanics of the area. Relative to other chlorite schist units, the Kona Cirque chlorite schist host exhibits a relatively distinctive major and trace element geochemical signature (higher MgO, SiO_2, Cr; lower TiO_2, Zr) and a distinctive rare earth element (REE) pattern. A more comprehensive lithogeochemical study by Piercey *et al.* (1999), results of which are beyond the scope of this paper, outlined four volcanic rock units in the Finlayson Lake area as being most prospective for hosting VMS mineralization. In contrast to lithogeochemistry, there is little published information on the use of biogeochemical exploration methods in the Yukon-Tanana Terrane. Biogeochemical orientation studies were conducted at two Yukon sites by Hunt *et al.* (1997): Matson Creek, and Bradens Canyon south of Dawson. At Matson Creek, an unglaciated area, black spruce twig geochemical results for copper, zinc, silver, cadmium and lead are generally coincident with B-horizon soil geochemical anomalies associated with known mineralization. At the glaciated Bradens Canyon site, however, twig geochemical results for mostly white spruce were of background levels only. They did not correlate with either paired soil sample results or with anomalous concentrations of lead, zinc, copper and other elements in NGR stream sediments.

Soil geochemistry and surface prospecting have been used successfully in the Finlayson Lake belt, but much of the area where the deposits occur are bedrock-dominated with only thin till and colluvial veneers (Jackson, 1994). Thin soils are more likely to reflect the presence nearby mineralization than are thick tills, where glacial dispersal distances are typically greater. There is little detailed orientation study information available on surficial materials, soil types and glacial dispersal distances here which might be applied to till-covered parts of the Big Salmon Complex.

SUMMARY AND RECOMMENDATIONS

Geochemical studies were conducted in several localities near regionally anomalous RGS watersheds, known mineral prospects and felsic volcanic units during the 1999 field season. Preliminary results are limited here to those obtained for soil profiles and rocks. Colluvial soil profiles at the Arsenault copper prospect contain highly elevated levels of copper, molybdenum and selenium, among other elements. Till and colluvial soil profiles near exposures of barium-rich exhalative crinkled chert units contain elevated barium concentrations which, in tills, generally increase down profile.

Preliminary recommendations are given here for VMS geochemical exploration in the Big Salmon Complex (Table 9). They are based on limited data available at time of writing, and are derived in part from general geological characteristics and geochemical signatures of Kuroko-style VMS deposits (*e.g.* Hoy, 1995), and from those characteristics of the Finlayson Lake belt deposits in particular. Recommendations are modified from those of Allan *et al.* (1972) who, with reference to lake sediment geochemical exploration in the Slave Province, proposed that various scales of geochemical exploration (*e.g.* regional to detailed) for Archean polymetallic massive sulphide deposits in the Canadian Shield follow hierarchical geochemical indicators related to geology, alteration and mineralogy of progressively smaller target areas:

- favourable felsic volcanic belts
- exhalative sedimentary rocks
- VMS alteration assemblages
- VMS sulphide mineral zones

More comprehensive recommendations will be prepared at a later date. Any sampling plan, particularly for regional-scale surveys, should consider the relatively small areal extent of VMS deposits and use a greater sampling density than might be used for, for example, porphyry copper deposit exploration. Modern multi-element analytical techniques such as ICP-MS provide a much wider range of useful elements than were available to explorationists previously, when often only a few elements such as copper and molybdenum were routinely determined.

PROPOSED FUTURE WORK

Future studies and survey work will involve both office and field components, and will focus on i) thematic compilation projects, ii) continued deposit-scale geochemical studies, iii) release of RGS archive data, and iv) collection and release of new RGS data:

i) Continued compilation and interpretation of existing RGS data for adjacent terranes in northern British Columbia, notably a) those parts of the southeastern Dorsey Terrane recently mapped by Nelson (this volume) and, b) those areas underlain by Slide Mountain Terrane and northern Cache Creek Terrane rocks across six 1:250,000 map areas (NTS 104I, K, M, N, O, P). There is considerable potential for new VMS discoveries in these relatively unexplored parts of the province. The Slide Mountain Terrane hosts the Ice deposit in the southern Yukon as well as the Lang Creek showing (MINFILE 104P 008) in northern British Columbia. In the Cache Creek Terrane, Permo-Triassic bimodal mafic-felsic volcanics and subordinate sedimentary rocks host the Kutcho Creek (MINFILE 104I 060) copper-zinc deposit (Childe and Schiarizza, 1997; Barrett *et al.*, 1996). The VMS potential of parts of the Cache Creek Group has also been highlighted by recent mapping of rhyodacite units within the French Range Formation (Mihalynuk and Cordey, 1997). Thematic RGS geochemical maps will be prepared for each terrane to highlight those elements typically associated with VMS deposits and their host rocks.

TABLE 9
GEOCHEMICAL EXPLORATION FOR KUROKO-TYPE VMS DEPOSITS (AFTER ALLAN *ET AL*., 1972)

1) Favourable felsic volcanic belts	Elevated K, Si Locally elevated Cu, Zn and related elements Depleted in Mg, Fe, Ti, Ni
2) Exhalative carbonate and iron-rich sediments	Elevated Mn, Ba
3) Alteration zones	Elevated Mg and K, depleted Na and Ca, at quartz-sericite-chlorite-rich cores of footwall alteration pipes
4) Sulphide mineral zones	Elevated Cu, Zn, Pb, Ag, Ba, Fe, As, Se, related elements

ii) Continuation of geochemical case studies in the Big Salmon Complex, and new case study investigations of geochemical dispersal at VMS and other prospects in the Dorsey, Cache Creek and Slide Mountain Terranes.

iii) Release of new RGS stream sediment archive data for the Atlin (NTS 104N), Jennings River (NTS 104O) and McDame (NTS 104P) map areas is planned for early summer, 2000.

iv) Stream sediment-lake sediment RGS coverage is proposed for the Dease Lake (NTS 104J) map area, the last remaining unsurveyed area in the region. Completion of RGS coverage there would provide necessary regional data to evaluate the VMS and Pogo-style deposit potential of the area, and allow completion of thematic geochemical maps for the Cache Creek Terrane.

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