882908 Nov. 9/99

Field Season Summary Report - Mid-Coast VMS Project

Introduction

The "Ecstall metamorphic complex" is a mid-Devonian greenstone belt located southeast of Prince Rupert (Figure 1). Exploration over the past century has located 23 volcanogenic massive sulphide (VMS) occurrences - 3 of these have drill-indicated reserves (Figure 2). Showings continue to be discovered in outcrop (4 this season alone) indicating an underexplored tract. A mining-camp study (mineral deposit study) of this logistically favourable, underexplored VMS district is long overdue.

Ecstall Belt rocks and immediately adjacent country rocks are prospective for:

- **Mid-Devonian Zn-Cu "Kuroko-type" VMS deposits**
- Mid-Devonian precious metal-rich Eskay Creek-type VMS deposits
- Early Jurassic porphyry Cu-Au deposits, epithermal veins & intrusion-associated Au-po veins
- **Mid-Cretaceous intrusion-associated gold vein systems (Fort Knox type)**
- Eocene porphyry Mo-Ag deposits and Ag-Pb-Zn veins
- Jurassic, Cretaceous or Eocene skarn deposits

Current research (Univ. of Arizona) suggests that the prospective Ecstall Belt stratigraphy could extend continuously 300 km southeast to the Bella Coola area (Figure 3).

Field Season Objectives (from PIAP)

- **1999 field program: 5 weeks mapping in the northern Ecstall belt, and scoping out logistics for work on rest of this belt in future field seasons**

Accomplishments (in 3 weeks of field work)

- Mapped all of the northern logging road network of the Ecstall Belt.
- Completed reconnaissance (helicopter-borne) examination of the regional terrain and stratigraphy with geologists from Bishops Resources Ltd.
- Visited showings owned by Bishop Resources, plus one other prospect.

Area mapped: 250 km^2 on NTS sheet 103I (Figures 1 and 2)

Samples: 94 samples collected for: assay, whole rock chemistry, thin section, polished thin section, and geochronology.

Mineral occurrences visited: 3. Scotia deposit; Lucky Friday and Mariposite prospects.

Mineral showings discovered: two exposures of quartz-sericite-pyrite schist and one outcrop of pyritic chert - assays awaited

Client interactions: Four days of joint fieldwork with geologists of Bishop Resources Ltd.; plus extensive discussions; plus acquisition of their complete geological database.

Student training: Chris Gallagher has become proficient in the use of ArcView

Advances in geological understanding:

- Metavolcanic package can be reliably subdivided.
- Pyritic felsic strata (and other units) can be mapped out regionally.
- Improved description of all lithologies over previous reports.
- Tentative establishment of stratigraphic top indicates a gross volcano-sedimentary succession similar to that of the Finlayson Lakes district of the Yukon (geochron results are required in order to confirm this interpretation).
- Substantial corrections are necessary / have been made to existing maps
- The belt is extremely underexplored - new surface showings continue to be discovered. This year's discovery, "Lucky Friday" is a 50-metre-long pyritic exposure along a continuous roadcut that was located through regional stream geochemistry (!)
- The prospective metavolcanic rocks of the Ecstall Belt continue northwards across the Skeena River into an area that is currently unmapped.

Safety Record

Days in field per crew member: Alldrick - 30; Gallagher - 28

There were no injuries during this year's field season.

With the demise of single-sideband-radio support (expediters using SBX radio systems) and the shutdown of BC Tel's VHF telephone service, it will be essential to have a **satellite telephone** package available for use in our isolated fly-camps next year. Luckily the price for these units is dropping dramatically - they can be rented for as little as $200 / month this season and should be even less expensive by next year.

A larger (3/4 ton, 4x4) truck will be essential. Actually, it was essential this year.

Output Planned

- Two Geological Fieldwork reports:
  Geology and Mineral Potential of the Northern Ecstall Belt
  Hidden Flaws in Cordilleran Geology
- Open File Map: Northern Ecstall Belt - 2 sheets @ 1:20,000
- Open File Map: Anyox - 1 sheet @ 1:20,000
- Poster Display: Left half - modified Massey map / Right half - Ecstall map

Industry Activity

Bishop Resources Ltd. ran the only exploration program in the belt this season. Their project consisted of assessment-credit-level work spread over their large claim holdings, and was largely directed at continued follow-up of their 1997 regional stream sediment and moss-mat geochem survey results.

Budget

The project budget is itemized on the attached table. The expenditures shown in this table are **not final** (there are more lab analyses and thin sections to submit, as well as publication and Round-Up related expenses). However, this project will come in well under budget at the end of the fiscal year. This is primarily a result of a much-shortened field season due to:

- field equipment shortage caused by vehicle reassignments (tiny truck)
- rescheduling of summer staff due to an employee injury
- loss of all time (July) specially set aside for field season planning & preparation

These factors contributed to a shortened field season (3 weeks *vs.* 5 weeks planned).

Project Status and Recommendations

- Initial short `recce' season has been completed with sufficient data collected to allow the release of a preliminary map set.
- Project should continue next year with a two-man field crew, over a 6 to 7 week season.
- If the annual Whitehorse `Geoscience Forum' meeting has significant presentations on Finlayson Belt geology - it would be useful to attend this meeting
- A satellite telephone set, and a larger, ¾-ton 4x4 truck will be essential equipment for next season.
- With a view to the `big picture' of: (1) a long-term study of the coastal VMS deposits throughout BC, and (2) improved understanding of precious-metal rich VMS deposits of the Cordillera, a visit to the **Green's Creek mine** in SE Alaska would be valuable.

Submitted by: **D.J. Alldrick** October 5, 1999

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STOB	CATEGORY	BUDGET	ITEM	AMOUNT	SUB-TOTALS
10	**Travel**				
	Per Diem	2,800.00		3,185.35	
	Hotels	1,200.00		598.47	
	Travel	4,000.00	Ferry	536.80	
	Travel Sub-Total	**8,000.00**			**4,320.62**
20	**Contracts, Services**				
	Zircon Dates	2 @ $2,000		*4,000.00*	
	Lithogeochem	2,500.00		*350.00*	
	Thin Sections	2,500.00	T.S. & P.T.S.	*1,200.00*	
	Contracts Sub-Total	**9,000.00**			**5,550.00**
50	**Equipment**				
	Field Equipment		hand lenses	180.18	
			2 raingear	243.93	
			2 cruiser vests	*170.00*	
			GSA photoscales	*20.00*	
	Maps, air photos, books	5,000.00	digital TRIM maps	1,926.00	
			mylar TRIM maps	409.81	
			sepia TRIM maps	313.08	
			sepia TRIM maps	244.82	
			large xeroxes	231.76	
			air photo order 1	656.18	
			air photo order 2	670.89	
			books & maps	106.88	
	Planes & helicopters	6,000.00	**($670/hr + fuel)**	1,531.88	
	Miscellaneous			*650.00*	
	Equipment Sub-Total	**11,000.00**			**7,185.41**
67	**Computers**	**0.00**			
	GRAND TOTALS	**$40,000.00**			**29,003.78**

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FIGURE 1:

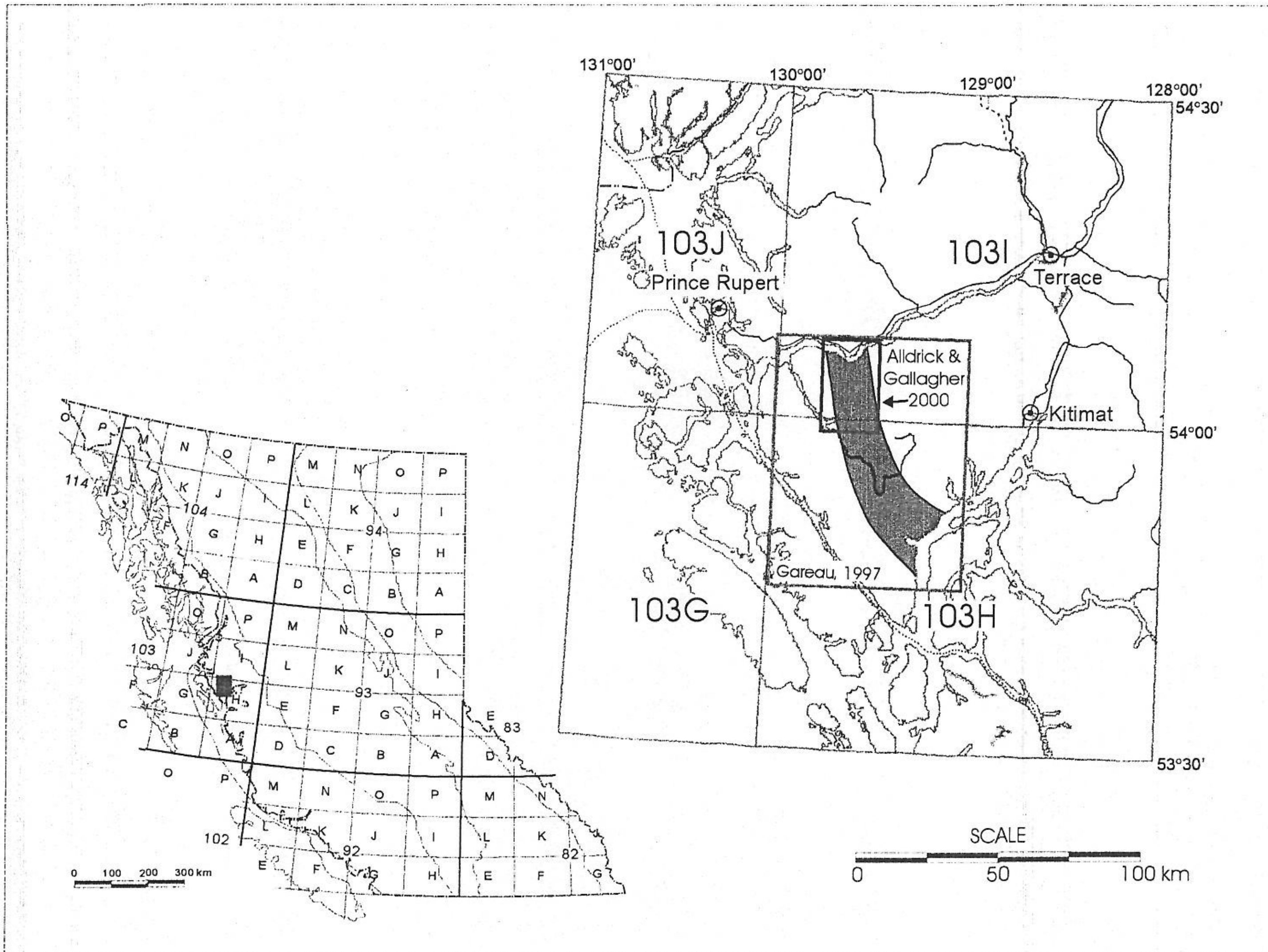

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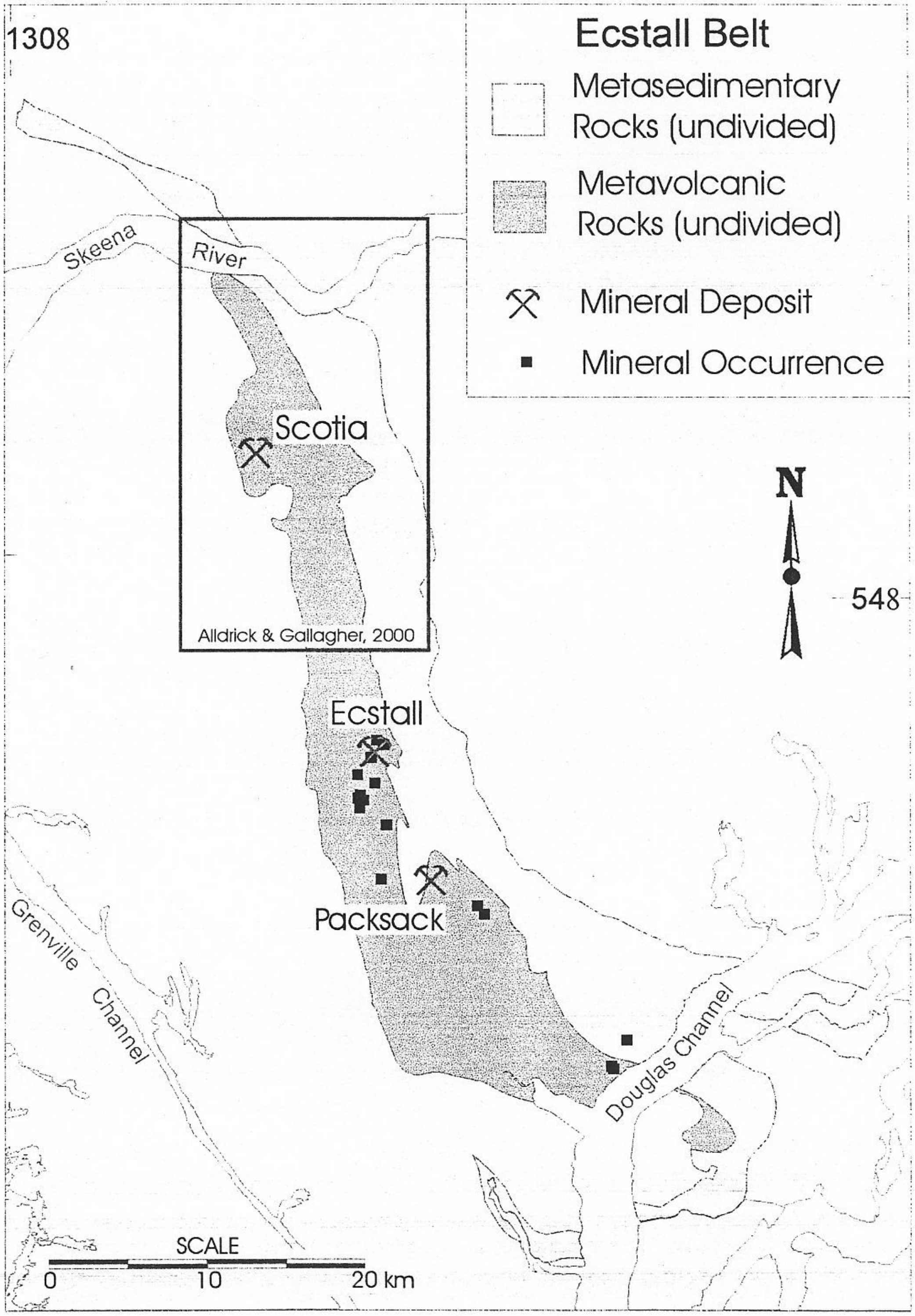
FIGURE 2.



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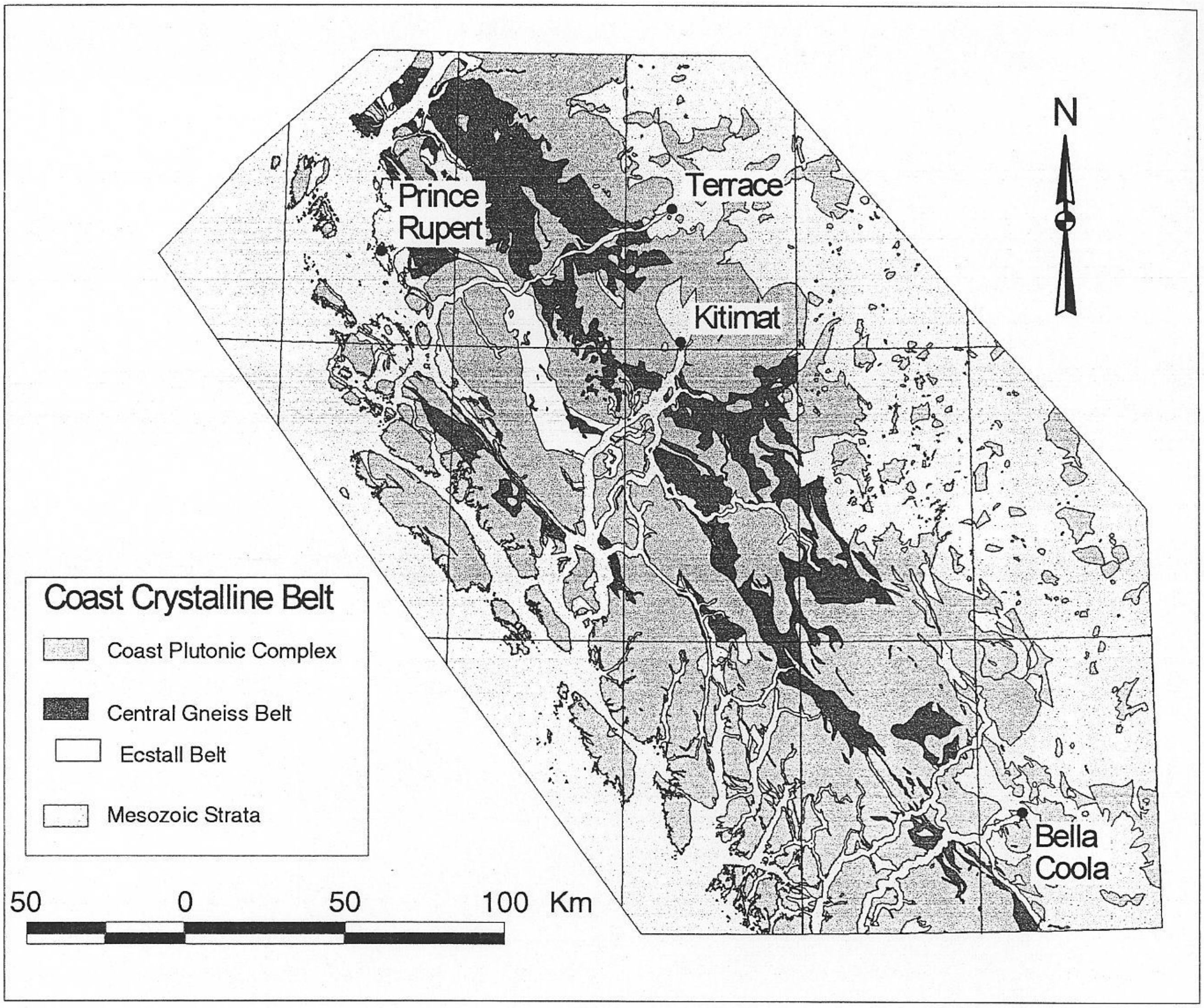

FIGURE 3

(31 VMS occurrences)

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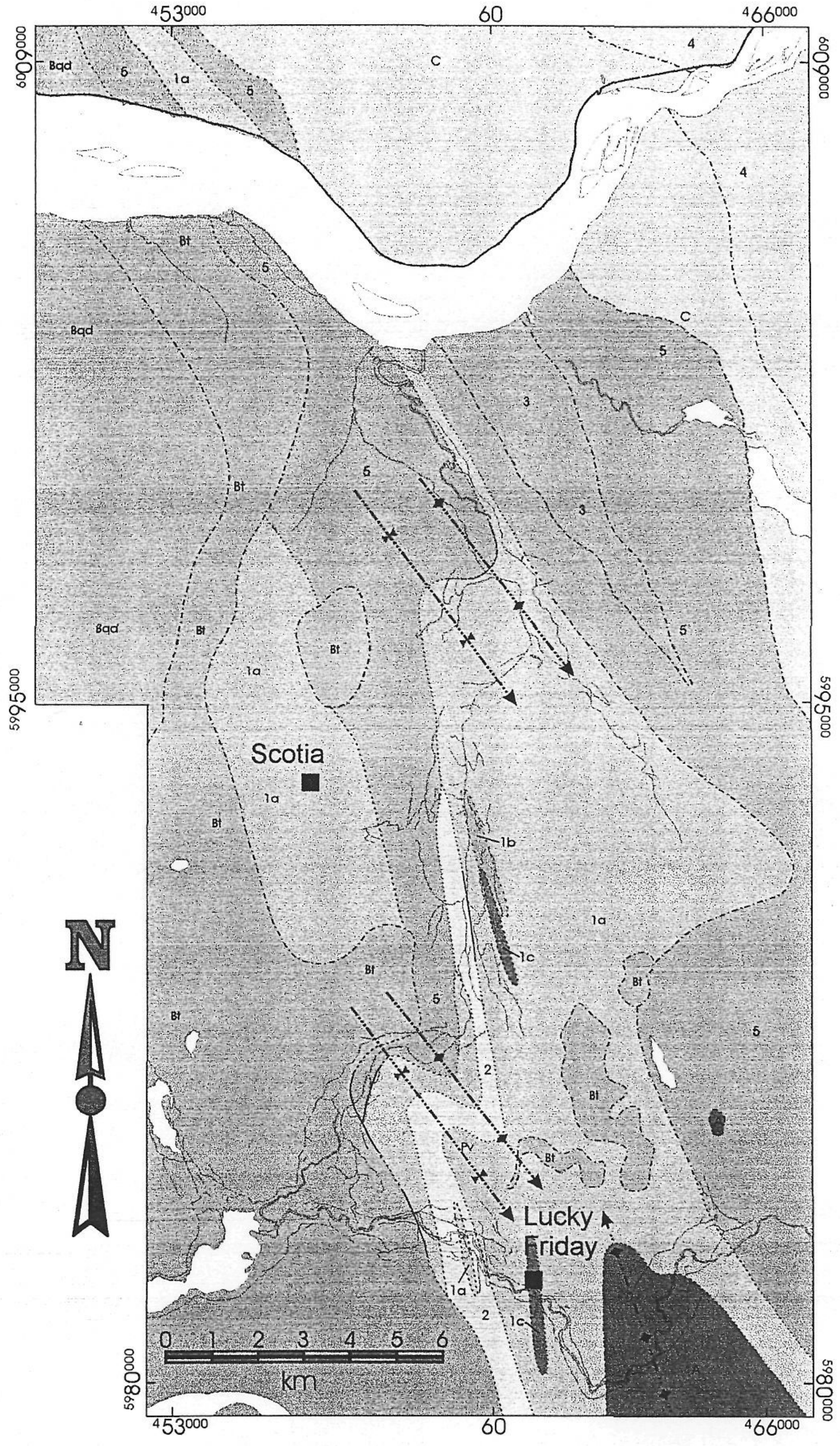
- 7.5% of area of province
- 12.2% of VMS occurrences in province

FIGURE 4.



Simplified Geology of the northern Ecstall Belt.

Alldrick & Gallagher.

LEGEND for FIGURE 4.

LEGEND
STRATIFIED ROCKS

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PALEOZOIC (Devonian ?)

GNEISS

5 Mafic to intermediate gneiss. Biotite epidote hornblende mafic gneiss. Resistant, black to greenish black rock. Commonly migmatitic in northern areas. Medium grained, granular. Locally contains pyrite-, garnet- and diopside-rich boudins and lenses. Medium grained, granular, light grey weathering biotite q-f gneiss is present in southern portions of unit.

METASEDIMENTARY ROCKS

4 Mixed metasedimentary rocks of the Khtada Lake area. Not mapped in this study. See Hollister (1977, 1982) for description.

3 Quartzite Unit of Gareau (1997). Not mapped in this study. May be correlative with unit 2.

2 Quartzite and Quartz Schist: Quartzite is a light grey, resistant rock, >95% quartz. Fine grained to very fined grained. Laminations of muscovite with trace to minor pyrite. Interlayered with garnet biotite quartz schist in the southern map area

METAVOLCANIC ROCKS

1c Felsic Volcanic Rocks: Pyritic quartz biotite muscovite schist to semi-schist ± garnet. Fissile and recessive. Commonly associated with quartz-rich metasediments within metavolcanic unit. Prominent gossanous exposures can be traced across terrain.
Garnet biotite quartz schist to phyllite and muscovite quartzite interlayered on the 5-to-10 metre scale with mafic and felsic metavolcanic rocks.

1b Intermediate Volcanic Rocks: Hornblende biotite quartz feldspar semi-schist ± epidote. Dark grey to black medium grained rock. Resistant. Hornblende biotite rich partings on cm-spacing.

1a Mafic Volcanic Rocks: Hornblende biotite plagioclase schist ± pyrite ± garnet; dark black to rusty red recessive and commonly fissile, rare discontinuous carbonate lenses, homogeneous on outcrop scale, locally displays relict volcaniclastic tecture.

INTRUSIVE ROCKS

TERTIARY - 56.8 6 0.1 Ma (Late Paleocene)

C **Quottoon Pluton**: hornblende ± biotite tonalite to quartz diorite with abundant screens of gneiss and common rafts of metasedimentary rock. Medium to coarse grained. Strongly foliated throughout and locally lineated along western margin.

CRETACEOUS - 93.5 ± 1 Ma (early Late Cretaceous)

B **Ecstall Pluton**: Epidote hornblende biotite metatonalite (**Bt**) to metaquartzdiorite (**Bqd**) and diorite, with minor biotite hornblende quartz diorite. Medium to coarse grained. Moderately foliated. Up to 5% fine to medium grained epidote is a characteristic feature.

DEVONIAN - 385 ± 4 Ma (Middle Devonian)

A **Big Falls Orthogneiss**. Biotite hornblende meta-tonalite/trondhjemite ± garnet ± epidote. Light grey, fine to medium grained. Texture varies from plagioclase augen gneiss to fine grained plagioclase porphyritic gneiss to mylonite. Probably co-magmatic with the volcanic rocks of unit 1

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TABLE 1:
ORE RESERVES in ECSTALL BELT.

PROPERTY	Deposit	YEAR	CATEGORY	SIZE	Cu	Pb	Zn	Ag	Au
				(mT)	%	%	%	g/T	g/T
Scotia	Scotia / Albere	1984	DI / probable	150,000		1.4	13.3	25.0	
	Scotia / Albere	1997	DI / probable	224,000	0.2	1.2	12.2	23.0	0.55
	Scotia / Albere	1997	global	1,240,000	0.1	0.4	3.8	13.0	0.25
	TOTAL	**1997**	**global**	**1,240,000**	**0.1**	**0.4**	**3.8**	**13.0**	**0.25**
Ecstall	North			3,100,000	0.8		2.0	17.1	0.5
	South			3,000,000	0.5		3.0	20.2	0.5
	TOTAL	1993	unclassified	**6,349,700**	**0.6**		**2.5**	**20.0**	**0.5**
Packsack	North								
	South								
	TOTAL	1986	unclassified	**2,700,000**	**0.5**	**0.01**	**0.2**	**34.0**	**0.3**
ECSTALL BELT TOTAL RESOURCE				**10,289,700**	**0.5**	**0.05**	**2.1**	**22.8**	**0.4**

Dist To
Mans +
Ron
Nov. 9/99

END OF FIELD SEASON REPORT
1999
Barry Ryan

In the early part of the summer I organized coal talks at Sparwood SE BC and Tumbler Ridge. I prepared a talk on ash chemistry and coal washing and organized the rest of the speakers. Two dropped out leaving me to give an additional talk on CBM. In conjunction with these events I organized mine visits to 6 of the 8 coal mines in BC.

After the coal symposium I started organizing a selenium project. This has involved approximately 3 weeks field work conducted in July (2 weeks) and September (1 week). During the field work coal and rock samples from the 5 mines in SE BC were collected. In most cases the samples cover the full section disturbed by mining. Samples were also collected of coarse refuse, tails and material from settling ponds. To date about 200 samples have been crushed split pulverized and sent for Se analysis and about 40 results received. In total about 400 samples were collected but I will not be analyzing all of them. Once results have been received some samples will also be sent for oxide analysis and coal quality work.

Because of the time required to complete Se analyses (1 month plus) I do not expect to complete a write-up this year. I hope however to finish a paper on coal reconciliation and a paper on coal washing, both of which are now in rough draft stage. I will prepare a draft to circulate to the mines as soon as possible and aim to produce an open file or field work article for 2000. I have written a rough draft of the introduction which is included .

I worked with Maggie Dittrick from Cranbrook in the field and neither of us sustained any injuries.

Considerable part of my time is taken up by non project work. This includes general inquiries, coal assessment reports, CBM and land use issues.

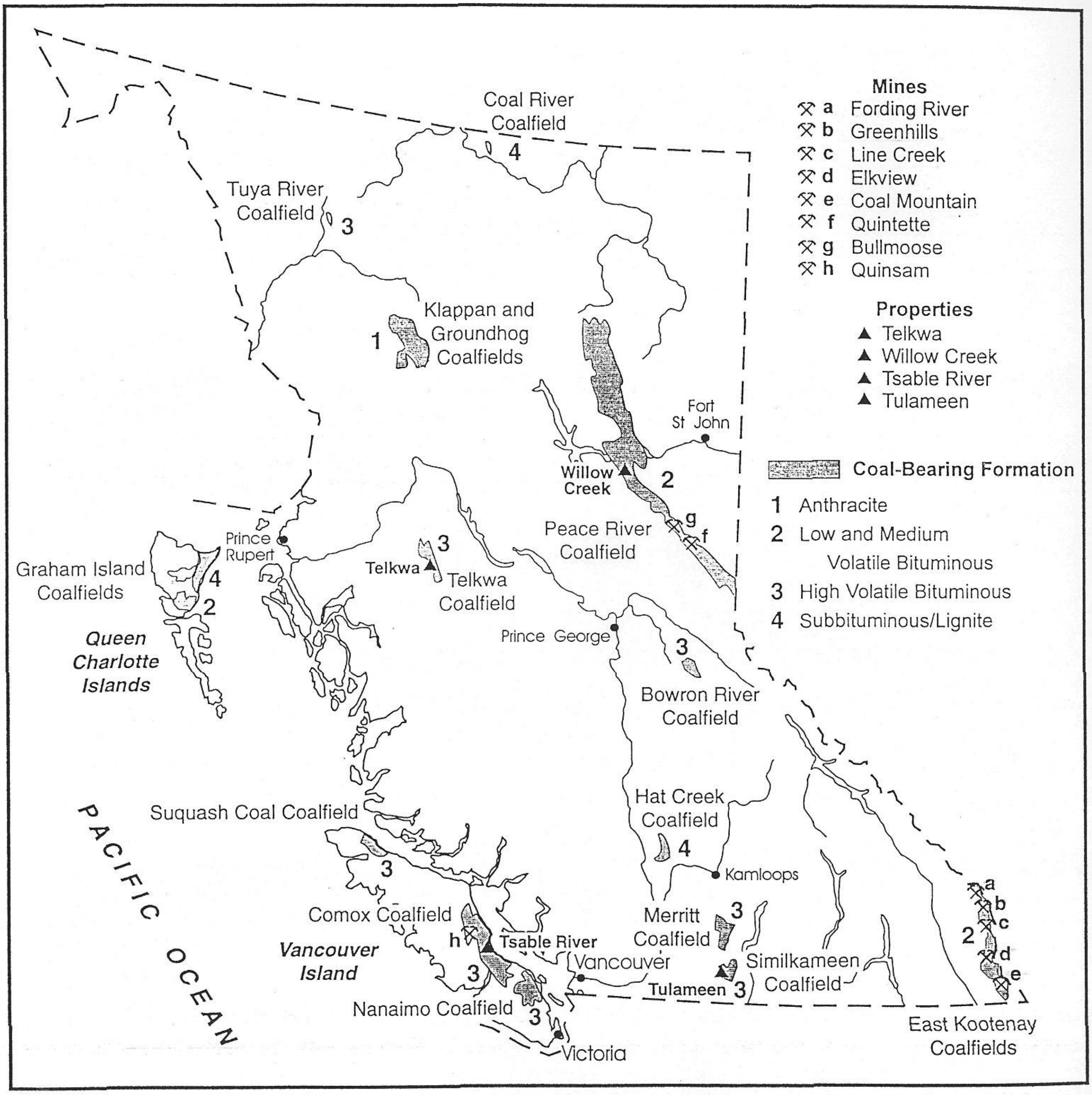
Barry Ryan 23/9/99

PIAPEXP9900

COAL
BARRY RYAN
ESTIMATED AND ACTUAL EXPENSES FOR 99-00 COAL DEPOSITS PIAP

Stob			June	July	August	September	October	November	December	January	February	March	TOTAL EXPENSE	PIAP
10	travel expenses	actual	1218.4	1601.5	0	1187.5							4007.4	
		total est	1300	1500	100	1500	100	200	300	300	0	200	5500	5500
20	contracts	actual											0	
		total est			3000			4000		2000		2000	11000	11000
30	journals	actual											0	
		total est	130	100	870	1000		1200					3300	3300
50	courier miscellaneous	actual											0	
		total est			100			100					200	200
											TOTALS		20000	20000
							additional from ADM							
10	travl expenses						200				300		500	500
20	contracts					3000	3000			3500			9500	9500
											TOTALS		10000	10000

notes budget has been reduced 2.5% I dont know if this also applies to the $10 000 from the ADM
notes lab costs will start accumulating from now to christmas all the money in the budget is committed
and by adjusting the number of samples I expect to zero out as of march 31 /2000



Coal River Coalfield
4
Tuya River Coalfield
3
Klappan and Groundhog Coalfields
1
Fort St John
Willow Creek
2
g
f
Peace River Coalfield
Prince Rupert
Graham Island Coalfields
4
2
Queen Charlotte Islands
Telkwa
3
Telkwa Coalfield
Prince George
3
Bowron River Coalfield
Hat Creek Coalfield
4
Kamloops
Suquash Coal Coalfield
3
PACIFIC OCEAN
Comox Coalfield
h
Tsable River
Vancouver Island
3
Nanaimo Coalfield
3
Victoria
Vancouver
Merritt Coalfield
3
Tulameen
3
Similkameen Coalfield
a
b
c
2
d
e
East Kootenay Coalfields
Mines
a Fording River
b Greenhills
c Line Creek
d Elkview
e Coal Mountain
f Quintette
g Bullmoose
h Quinsam
Properties
▲ Telkwa
▲ Willow Creek
▲ Tsable River
▲ Tulameen
Coal-Bearing Formation
1 Anthracite
2 Low and Medium Volatile Bituminous
3 High Volatile Bituminous
4 Subbituminous/Lignite

SELENIUM IN THE MIST MOUNTAIN FORMATION OF SOUTH EAST BRITISH COLUMBIA

Barry Ryan and Maggie Dittrick
Geological Survey Branch
Ministry of Energy and Mines

INTRODUCTION

This study documents the distribution of Selenium (Se) in the Jurassic-Cretaceous Mist Mountain Formation of southeastern British Columbia and in the various materials segregated by the five coal mines in the area. The study can only be considered a preliminary attempt considering the magnitude of the task. The Mist Mountain Formation outcrops extensively in the east Kootenays and varies in thickness from 25 to 665 metres (Gibsons, 1985). Typically 8% to 12% of the thickness of the formation is coal and in places this is distributed in over 30 seams. The rest of the formation is composed of non marine siltstones, mudstones and sandstones.

The formation outcrops in three distinct coalfields (Figure 1). The Elk valley coalfield in the north hosts three coal mines, the Crowsnest coalfield hosts two mines and there are exploration properties but no mines in the southern most Flathead coalfield. The formation is thinner in the Flathead coalfield and thicker in the other two coalfields though there do not appear to be any consistent regional trends in thickness. The amount of the formation outcropping in each basin varies and is most in the Elk Valley and least in the Flathead.

The paper provides preliminary stratigraphic sections of the Mist Mountain from a number of areas illustrating the major lithologies and coal seams and indicating their Se content. In addition samples of materials disturbed by mining were collected. These included coarse refuse, tailings material and material from settling ponds adjacent to waste rock dumps.

BACKGROUND NOTES ON SELENIUM

Selenium is an unusual trace element in that there is a very narrow band of tolerance for all animals. It is considered to be a trace element of potential environmental concern (Harvey *et al.,* 1983) and a hazardous air pollutant (HAP) (Demir *et al.,* 1998). Cases of natural Se poisoning have been reported in China, but generally more problems result from Se deficiency in diets. In many areas soil is deficient in Se and available Se in vegetation is less than 0.05 ppm. If the diet provides, on average, less than about 0.1 ppm then Se deficiency problems occur that include impaired immunity, hepatic necrosis and cardiac functional changes (Keshan decease). Above about 4 ppm Se toxicity problems occur that in farm animals involve deformities, fertility problems and loss of muscle coordination referred to as the blind staggers. Chronic poisoning occurs in animals if they consistently ingest foods with average Se concentrations between 5 to 20 ppm daily.

In humans it is recommended that the daily Se intake be between 100 and 250 mcg/day (therapeutic dose 400 mcg/day). This amount will usually be found in a normal diet. Foods especially rich in Se include meats, fish, whole grains, brewers yeast and mushrooms. Excess Se in humans may cause dental problems and very high levels reported in Hubei province in China caused hair loss, skin lesions and nerve damage (Zheng *et al.,* 1999). There is therefore a heightened interest in Se levels in the environment and how these levels are effected by human activity.

Selenium is chemically similar to sulphur. It occurs in the forms selenide (-2), elemental (0), selenite (+4), and selenate (+6). Se bearing sulphides oxidize readily to selenite and selenate, which is the most soluble and toxic form. Unless conditions are very oxidizing selenate is easily reduced to selenite. Selenite is easily removed from solution in oxidizing conditions if iron hydroxides such as $Fe(OH)_3$ are available. In non oxidizing conditions Se is reduced to the elemental form, which is insoluble and generally non toxic.

World consumption of Se is probably in the range of 1000 to 2000 tonnes per year (1450 tonnes in 1989, Herring, 1990) . USA consumption in the 1990's has been between 500 and 600 tonnes. Uses for Se include glass making (35%), agriculture and metallurgy (30%) chemical and pigments (20%) and electronics (15%). At present most of the Se is extracted as a bi product when smelting copper ore. In the future the biggest resource of Se may well be world coal deposits and Se may be extracted from fly ash after coal combustion in power plants.

Average crustal abundance of Se is 0.05 - 0.1 ppm (Taylor 1964 and Turekian, and Wedephol, 1961), which is lower than its concentration in the whole earth because of its volatility. The value is usually calculated by dividing the S crustal average by a S/Se ratio. It is concentrated in coal (average abundance about 2.15 ppm) by a factor averaging 82 and ranging from 5 to 300 and rocks rich in phosphate (Table 1). In general Se concentration of sedimentary rocks varies from less than 0.1 ppm in limestones and sandstones to an average of about 0.6 ppm in shales, which have a wide range of contents (0-100 ppm) (Herring, 1990) (Table 2). The content in marine or black shales is higher and shales enriched in organic carbon (TOC) have increased concentrations because the micro organisms responsible for the carbon concentrate Se (Saiki *et al.,* 1993). Under conditions of high pH and salinity, Se in shales is adsorbed onto the clay minerals as selenite. In sea water because of adsorption of Se onto clays and the solubility of SO_4 the S/Se ratio is very high (1.4×10^7) compared to about 2.5 to 3.5×10^3 in coal. During diagenesis, Se in clays may be incorporated into pyrite or remain as a trace element attached to the clay minerals either adsorbed or in the elemental state.

Selenium is released as selenate (SeO_4^{-2}) during weathering when Se bearing sulphides oxidize or when clays are weathered. Once released, in alkaline high pH environments Se remains soluble as $CaSeO_4$ and is available to be taken up by plants. In humid conditions where soil is more acid it is either removed or converted to the less soluble selenite form.

Generally soils contain about 0.4 ppm Se; below 0.1 ppm they are considered to be deficient and above 5 ppm enriched in Se. Soils in large areas of northeastern US and western parts of Washington and Oregon are considered to be Se deficient (Lag and Agic, 1990), probably because of acid soil conditions. In dryer regions to the east (northwestern part of the great plains) Se contents are higher, possibly reflecting concentrations in the bedrock (Shacklette, 1974) or alkali soil conditions. In semi arid regions with impeded drainage Se can concentrate in the soil and in vegetation growing on the soil. crop plants in these areas may have toxic concentrations of Se (Gough *et al.*, 1979), Some countries such as New Zealand add Se to agricultural fertilizers to counter health problems in livestock resulting from Se deficiency in soil and vegetation. Salt licks often contain added Se for the same reason.

Plants generally tolerate Se in amounts above the crustal average, though it is not clear what physiological role Se plays in plant growth. When available in the soil in a soluble form Se is readily absorbed by the plants consequently the concentration in many plants reflects the concentration of soluble Se in the soil and is not particularly characteristic of the species. Generally plant concentration is less than that in soils except for mushrooms and other fungi, which are approximately 100 times better at extracting Se from soils and have contents that range from 0.1 to 16 ppm (Kabata-Pendias and Pendias, 1984): Some plants known as Se accumulators specifically concentrate Se and are toxic to animals; these plants often have a garlicky smell. When they decompose they release Se into the soil in a soluble form available to other species. Se concentrations in plants can range from 0 to 3% dry wt (Table 3). Concentrations in cereals range 0 to 500 ppb and a general range for healthy leaves is 0.01 to 2 ppm. In plants, Se is concentrated in the growing points, seeds and roots

SELENIUM IN COAL

Selenium is enriched in coal compared to crustal average (0.05 to 0.1 ppm). Averages from different areas are hard to determine because of limited data and the range of values, however Table 1 provides approximate average data for a number of areas. The average content in US coals is 1.7 ppm (Coleman *et al.*, 1993), this compares to a world average of 2.15 ppm 6.2 ppm for Chinese coals (Ren *et al.*, 1999) and a value of 0.5 ppm from cleaned coals from Australia (ACARP, 1996). Concentrations vary around the world; some coals in China are reported to have concentrations as high as 8.4% (Yang *et al.*, 1982).

The association of Se in coal is not clear, Gluskoter *et al.* (1977) found that Se in coals from Illinois has an intermediate inorganic association and they found no correlation between organic sulphur and Se. Consequently Se may have a positive correlation with ash or pyrite that tends to be associated with ash. Based on all the data in their paper, Se correlates with pyrite (r^2=0.29), ash (r^2=0.4) and uranium (r^2=0.38). They also indicate that roof rock and parting material often have elevated Se concentrations. A detailed look at four bench samples studied in their paper indicates that Se is often concentrated in the top of seams (Figure 2). This is probably because overlying vegetation is extracting Se from the underlying rotting vegetation. Except for one bench, in which data are biased by a single sample containing a high pyrite concentration, Se tends not to correlate with pyritic or organic sulphur in the incremental bench samples. As with all the data in the paper Se correlates positively with ash and uranium. In fact the best overall correlation is with uranium despite the fact that uranium in contrast to Se has an organic affinity.

Harvey *et al.* (1983) found a mixed association of Se in coals from the Illinois basin. They indicate an ash and pyrite association for the Se with the pyrite connection being the strongest. Finkelman (1994) considered Se to have a mixed association in coal with a significant organic component. Coleman *et al.* (1993) state that Se is associated with the organic fraction probably substituting for organic sulphur, though the correlation of Se with organic sulphur was not always good. Many other workers have found at least a partial association of Se with syngenetic pyrite (Clarke and Sloss, 1992). White *et al.*, (1989) found average concentrations of 97 and 64 ppm Se in pyrite and marcasite from UK coals. Higher concentrations have been found in pyrite and marcasite of higher temperature origin (up to 3% and 80 ppm respectively) (Wedepohl, 1978). Goodarzi and Swaine (1993) report finding Clausthalite (PbSe) and ferroselite ($FeSe_2$) in coals.

In this study the Se concentrations of coals studied by Harvey *et al.* (1983) were predicted by assigning concentrations to ash, coal and pyrite. The best fit of predicted to actual concentrations measured by Harvey *et al.* was obtained by assuming a 1 ppm concentration in coal, 8 ppm in ash and 26 ppm in pyrite (Figure 3). Obviously these solutions are not unique but the analysis is consistent with low concentrations in coal, moderate in ash and higher in pyrite, though not as high as found by White *et al.* (1989).

In the Powder River coals Se correlates positively with ash (r^2=0.62) and to a lesser extent with organic sulphur (r^2=0.4 in the south and 0.81 in the north) and pyritic sulphur (r^2=0.3) (Oman *et al.*, 1988). The correlation with both organic sulphur and ash implies that Se originated from Se rich Cretaceous formations to the south of the basin and was introduced into the coal swamp as detritus and in solution.

The amount of Se in coal is more than can be attributed to the vegetation from which the coal is derived. Most plant species average less than 1 ppm (Table 3) and even after increasing the concentration because of the loss of volatile matter, that occurs when vegetation is converted into coal, Se concentrations in coal are too high to be explained solely by concentrations in plants. It appears that for some coals there has been an addition of Se to the coal swamp. Gluskoter *et al.*, (1977) note the enrichment of Se in coal compared to average crustal abundance and attributed at least some of the Se to the original vegetation. Higher Se contents in seams may reflect acid conditions in the coal swamps and higher contents in provenance rocks. Some of the Se is derived from the vegetation but this Se was previously extracted from the coal swamp and will be returned to it when the vegetation dies, thus there is the possibility that vegetation is not responsible for introducing much new Se into the coal swamp

The strong correlation seen between U and Se in some east Kootenay coals (Figure 4) may indicate a common mode of introduction. The U *versus* Se correlation is not seen in coals with more marine influence for example some Illinios coals (Harvey *et al.*, 1983) and coals from Nova Scotia (Pilgrim and Zodrow, 1990). The correlation of Se with U in east Kootenay coals is difficult to explain in light of the fact that Gluskoter *et al.* (1977) ascribe an organic affinity to U and a largly inorganic affinity for Se. Uranium is probably introduced into the coal swamp in surface or ground water as complex alkali uranyl carbonates (Breger, 1974), which are adsorbed onto organic matter and possibly clays in acid swamp conditions. Some of the Se is probably also introduced in this way being transported to the coal swamps in surface and ground waters with high pH and alkalinity that aid mobilization of Se..

Se concentrations in water can range from below 1 ppb to 1 ppm depending on pH. If the water is acidified after entering the swamp environment, then Se will be reduced and precipitate as a metal, or adsorbed, either onto clays, or iron hydroxides if available. It has been reported (Hayes *et al.*, 1987) that selinite ions can be bonded directly onto goethite surfaces. It may also substitute for sulphur in syngenetic sulphides. It seems to be less common for Se to substitute for organic sulphur. The amount of Se in coal may depend on Se content in bedrocks in the region and on the climate, which influences the ability of water to transport Se..

SELENIUM IN MIST MOUNTAIN FORMATION AND ASSOCIATED COALS EXISTING DATA

Some data exit for coals from the Mist Mountain Formation coals. Goodarzi (1987, 1988 and 1993) studied coals from the Fording River and Coal Mountain mines. Coal samples from a number of mines were analyzed by Grieve (personnel communication, 1999). These data provide an average Se content of raw coals from the Mist Mountain Formation of 1.36 ppm

Analyses of water and sediments in areas adjacent to the coal mines were reported by McDonald and Strosher, (1998) in a study of the potential effects of coal mining on Se concentrations in the Elk River basin. They documented a trend of increasing Se content over time in the Elk River measured at its mouth approximately 80 kilometres down river from the mines. They also documented increased concentrations of Se in tributary creeks draining areas of mining activity compared to concentrations in the Elk and Fording rivers up stream from the mines. Selenium contents of the sediments range up to about 3 ppm except for the Michel Creek area where concentrations are lower. On average concentrations in sediments are higher in creeks draining mine areas (about 2ppm) than in creeks above mining areas (less than 1ppm). Average sediment contents of 2 ppm are high considering average values for rock types. Either there is a predominence of Se rich mudstones in the sediments or they are enriched in Se by another process. The low concentration in Michel area dispite the mining acivity in the drainage may indicate lower Se concentrations in the lower part of the Mist Mountain Formation.

Goodarzi (1987) studied samples of fresh and weathered coal. Though the ash contents of the fresh and weathered samples vary there is no indication that Se concentration decreases in weathered samples. The S/Se ratios for weathered samples are lower than those for fresh samples. This is consistent with the removal from the weathered samples of small quantities of pyrite, which if the concentration of Se in pyrite is about 26 ppm will reduce the S/Se ratio of the samples. Pyrite is susceptible to oxidation, which will release the Se and S in soluble form. Mist Mountain coals generally contain low concentrations of pyrite and may not be susceptible to weathering induced release of most of the Se they contain.

Because of the low total and pyritic sulphur contents in Mist Mountain coals much of the Se must be associated with ash or coal. In fact, at the Fording River mine, Se correlates with ash (R^2=0.65) and U (.R^2=0.93) much better than S (R^2=.0 .39), (data from Goodarzi, 1987). It is difficult to separate the significance of ash and pyrite as hosts for Se because pyrite tends to be associated with the ash. Plots of ash *versus* Se data from four mines in the Elk Valley indicate that at 85% ash (approximately 100% mineral matter) Se concentrations are predicted to be in the range 1.4 to 9.1 ppm and for 100% ash free coal in the range 0.3 to 0.7 ppm (Figure 5). These concentrations agree with the values derived by reinterpreting the data in Harvey *et al.* (1983). The concentrations at 85% ash are influenced by some Se in pyrite but it appears that the ash associated with the coal is enriched in Se more so than the coal and more so than most shale rocks, which average 0.6 ppm. Data from the Fordig River mine (Goodarzi, 1988) indicate that parting and roof material associated with seams constantly has higher Se contents (averaging 4.2 ppm) than the coal (1.65 ppm). It appears that much of the Se in the mine environment may be in coal ash, partings and roof rocks associated with seams. At concentrations in the 3 to 9 ppm this material has 10 to 100 times the Se concentration of interburden rocks.

The ratio S/Se in coal is about 2.5 to 3.5×10^3 . This compares to the ratio in sea water of 1.4×10^7 , which is high because of the solubility of SO_4 and the adsorption of Se onto clays.

if the Se in coal is extracted from sea water then it is a very selective process excluding sulphur. Dry vegetation probably looses about 20 to 60% of its weight as volatile matter when coalified. Therefore vegetation Se contents should be increased by the appropriate amount before estimating the potential Se contribution of vegetation to coal. The S/Se ratio in vegetation is similar to that in coal (in the range 1×10^4). The implication is that much of the Se in coal comes from the vegetation. It may be remobilized during diagenesis and substitute for S in pyrite or remain as organic Se in the coal.

SELENIUM ANALYTICAL TECHNIQUES

Sample preparation for Se is important because it is very volatile and even with low temperature ashing at 200°C 10% to 30% of the Se may lost from the sample. Samples can be dissolved using wet chemical means in sealed containers. Concentrations can be analyzed using atomic adsorption (AA) with hydride generation or a graphite furnace. Alternatively, samples can be analyzed using instrumental neutron activation analysis (INAA), which does not require any sample preparation other than crushing and pulverizing. INAA does take longer than techniques using AA. Both techniques have detection limits of 0.2 to 0.8 ppm. In this study INAA was used partially because of cost and partially because of concerns about Se volatility and chemical interference's.

DATA

Samples were collected from the five coal mines in the east Kootenays identified by the letters A to E in this paper. At each mine if possible the complete exposed Mist Mountain section was sampled though because of mining activity this was not possible at all mines. Interburden rock was divided into simple lithologic units and sampled by collecting chips at approximately 1 to 3 metre intervals along high walls. Coal seams were sampled by channel sampling or by collecting chips. Hangingwall and footwall material was sampled separately as were rock splits within coal seams. In addition samples of coarse and fine refuse were collected. The samples were crushed split and then 100 to 200 grams pulverized to provide samples for INAA and XRF oxide analysis. Splits of crushed material of samples containing coal were kept to be used for coal quality analyses.

DISCUSSION

Selenium in coal

It is obvious from the existing literature that Se has a complicated association with coal. The best correlation is with ash and though it is difficult to separate a pyrite *versus* ash association, however it does appear that ash, minus pyrite, contains elevated Se concentrations ranging up to 10 ppm. How the Se is held in the ash is not clear based on data from Goodarzi, in which Se correlates with Cu, Zn and other metals but not Fe it may occur//

end as of Sept 29/99

Nov. 9/99

Field season summary report: 1999

Trygve Höy
September, 1999

Introduction

The 1999 field season was devoted mainly to assessing the potential for and evaluation of Broken Hill type deposits in southern British Columbia. A secondary objective of the field season was to begin to prepare field trips for the upcoming Geological Association of Canada field trips, scheduled for May, 2000.

All work was concentrated in southern British Columbia, mainly in the Nelson (82F), Vernon (82L) and Revelstoke (82M) map areas.

Field season objectives

- to define BHT deposit targets that would require more extensive work in the future, including mapping by the B.C. Geological Survey Branch,
- to promote this deposit type as a viable exploration target in the province
- to define and outline the two major field trips that I am involved in during the Calgary GAC/MAC 2000 conference

Accomplishments

- visited approximately 12 mineral deposits and occurrences, most notably the Kingfisher and Kneb, both interpreted to be Broken Hill type deposits; note that Kneb is a "new" Cominco discovery, first discovered, identified and described by Höy in the Cottonbelt (No. 80) Bulletin, and credited as such by Cominco.
- approximately 60 samples collected for lab work, including assays of mineralized samples and whole and trace element analyses of metavolcanics
- Client interactions:
  1. led a two day field trip in the Cranbrook area for B.C. college earth science teachers
  2. gave a talk to approximately 25 explorationists and prospectors at the East Kootenay Chamber of Mines meeting in May on Broken Hill type deposits
  3. considerable discussion with BHP promoting the potential for BHT exploration in B.C.; they have decided to start a program with this target, and have asked me to lead a field trip to visit potential sites in late September.
  4. spent several days in field with J. Lydon of GSC (and Derek Brown) to finalize plans for the GAC 2000 field trip.
  5. interaction with company personnel on property site visits, including Cominco, Dickerson Mines (Sylvana), Llyod Addie and others.
- Recognized that two significant occurrences, Kneb and Kingfisher, have characteristics of Broken Hill type deposits with unusual mineralogy, chemistry and host rocks.

- Student training:
  1. gave a lecture to prospectors and others at the East Kootenay Chamber of Mines
  2. spent several days in field with a Memorial graduate student (Sean Bailley) working with S. Paradis in the Eagle Bay assemblage

Safety Record

- Days in field: T. Höy: 42; G. DeFields: 11
- no accidents

Output planned

1. Complete edits for Anderson and Höy Purcell paper (mid October)
2. Write overview paper on Broken Hill deposits for fieldwork (early December)
3. Help with edits/writing/organizing Purcell GAC/MAC trip (ongoing)
4. Poster at Roundup 2000 (Feb., 2000)
5. Complete Rossland metallogeny bulletin draft (spring 2000)
6. GAC/MAC field trip (May, 2000)

Industry Activity

Most significant news is BHP's decision this past May to expand considerably the Vancouver exploration office, making it one of the three main centers worldwide for mineral deposition exploration; this involves mainly bringing in exploration geologists from other international sites. This is a sharp contrast to their major expected and announced cutback in their Vancouver exploration office last winter.

Specifically, BHP have also decided to explore for Broken Hill type deposits in British Columbia, a result, at least in part, of my visits, talks and correspondence with their personnel this past winter and spring. To this end, they have again asked me to give a presentation to their new staff about Broken Hill deposit potential in mid September and to show them deposits and settings in southeastern B.C. later in the month.

Other company activity:

1. Sultan Minerals drilled one hole, with discouraging results, on the True Blue massive sulphide occurrence at Kaslo by Kootenay Lake.
2. Hudson Bay Mining has contacted me regarding VMS exploration potential in the Kootenay Terrane; they report interesting new finds in the Barker Minerals area (Ace prospect) near Likely.
3. Ongoing exploration in the Purcell Supergroup: Eagle Plains, with funding from Billiton, announced a program of mapping and drilling (1800m) on the North Findlay property, and Rio Algom has an option and is drilling on the South Findlay property.
4. Work has commenced on the Ladybug prospect, a Broken Hill type(or skarn) prospect in the Eagle Bay succession.
5. Crest Geological (C. Payne) have picked up the Rift massive sulphide prospect north of Revelstoke and commenced mapping and sampling

Budget

Expenditure summary to Sept. 10, 1999.

Stob 01:	$2812	
Stob 02:	95	
Stob 03:	610	
Stob 10	5700	(includes 500 estimate for truck fuel)
Stob 30	400?	(Estimate for maps, air photos)
Stob 50	2200	(1800 estimate for helicopter)
Total:	$11,817	(analyses, petrography, drafting not included)

Budget status: will probably have a surplus, as season cut short by approximately 10 days

Project status and recommendations

1. Rossland metallogeny bulletin: in preparation, approximately 50 % complete; deadline: this fiscal year

2. Sullivan metallogeny:
Sullivan volume: requires only final edits in one paper; deadline: mid October

3. GAC/MAC Purcell field trip: guidebook coauthored with D. Brown and J. Lydon (December?)

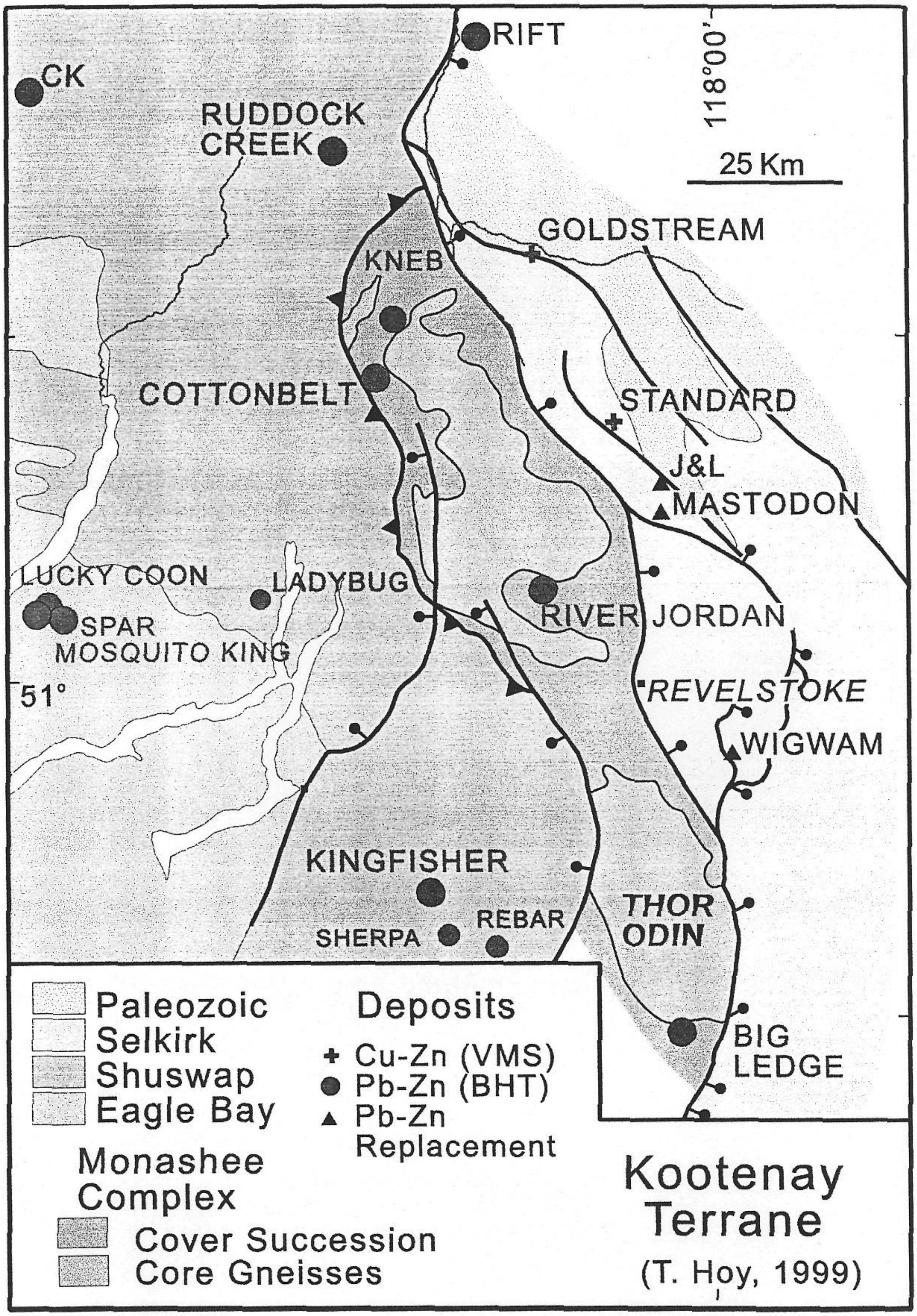
4. GAC/MAC field trip 2: Intrusive related deposits; (December deadline for guide)
   - have decided not to participate;

5. Eagle Bay metallogeny: to be discussed; bulletin planned

6. Broken Hill deposit study: one field season completed
planned output: Overview fieldwork article, Roundup 2000 poster

Proposal: 2000 field season

Proposal for 2000 field season: Continue evaluation of Broken Hill targets, completing mapping of known occurrences. Look into possibility of beginning Manto deposit project in future.



Location of Broken Hill deposits, southern British Columbia

Nov. 9/99

Porphyry / Gibraltar Project

1999 Field Season Summary Report

Chris Ash and Claudia Riveros

INTRODUCTION

Fieldwork in1999 involved a second year of mapping in the Gibraltar mine area in east central British Columbia (Figure 1). Regional 1:20 000 mapping of the Gibraltar area in 1998 (Ash *et al.*, 1999a, 1999b) placed previous interpretations for the setting and origin of the deposit into question. Fieldwork during the 1999 season focused entirely on detailed (1:2000) mapping of the Gibraltar mine open pits. This was conducted over several different periods. Specified time intervals indicated includes both travel and field days.

May 10-12: The Highland Valley deposit was visited with Bill McMillan and Alan Galley (GSC, Ottawa). Following this the Gibraltar mine was visited and a field trip conducted which highlighted results of 1998 mapping. Field trip participants included employees of Hunter Dickinson, former Gibraltar mine geologist as well as research geologist from the University of British Columbia.

May 19-22 This brief phase of fieldwork was conducted in order to capture data along the lower benches of the Gibraltar East pit, before being flooded by waters pumped from the tailings pond. Assistance in mapping during this period was provided by Jennifer Dicus, a B.Sc. candidate with University British Columbia.

July 21-29 Work again focused on detailed pit mapping along the west wall of Gibraltar East and the northeast portion of Pollyanna pits. Alan Galley with the Geological Survey of Canada, Ottawa assisted in mapping. Orientation for Claudia combined with interaction with Alan offered valuable insights. His continued collaboration with the Gibraltar project will be an asset.

Aug 5 - 22 This component of field mapping was supervised and conducted by Claudia Riveros and involved detailed pit mapping of the Gibraltar mine. Assistance was provided by Kris Raffle (University of British Columbia, B.Sc. candidate).

Field Season Objectives

- to produce a geological map and cross section of the mine site;
- to further the understanding of the structural setting origin and distribution of Cu ore distribution.

Accomplishments

The northwest walls of the Gibraltar East and Pollyanna pits were mapped and a cross-section through the mine completed.

A total of 59 samples were collected, including;

17 - ore vein samples for assay;

9 - samples of relatively fresh intrusive rocks from the Granite Mountain and Sheridan Creek intrusions for petrochemical analysis.

2 - Cache Creek limestone samples for conodont analysis.

33 - oriented samples from low and high strain deformation zones for microstructural analysis with accompanying samples for geochemical analysis to assess element mobility related to deformation.

The latter 33 samples were collected by Kris Raffle for his honours thesis, who is working under the supervision of Lori Kennedy at UBC. Both Kris and Jennifer gained valuable experience in open pit mapping techniques and mine safety practices.

Client interactions included geological discussions of the mine and surrounding area with geologists George Barker and Lena Brommeland of Gibraltar Mines Limited, in addition to ongoing interaction with Lori Kennedy regarding the structural development of the mine.

Field mapping resulted in some significant advances in the geological understanding of the Gibraltar mine. Two main sets of copper-molybdenite-bearing vein generations have been demonstrated and atleast one major deformational event affected the veins and ore distribution of the mine. This deformational event is characterized by north-northeast — south-southwest shortening and associated conjugate shears. One set of shears shows an apparent southwest vergence along discrete, shallow east-northeast trending high deformation, schistose zones. The other set of shears shows an apparent northeast vergence along steeply southwest-dipping, vein-parallel shear zones. A pressure solution s-foliation is commonly developed in the shear zones. The regional, open s-folds of the mine phase northwest trending belt are consistent with this deformational event.

Safety Record

A total of 65 person days were spent in the field without any accidents or unusual incidents.

Chris Ash	— 18 days
Claudia Riveros	— 24 days
Kris Raffle	— 15 days
Jenny Dicus	— 4 days
Alan Galley	— 4 days

Output Planned

Paper in 1999 Geological Fieldwork to be submitted by November.
Poster at the Cordilleran Round-Up
Talks as requested.

Industry Activity

Gibraltar Mines Ltd. now owned by Hunter Dickinson is currently initiating an exploration program involving geophysical survey of the mine property and a drilling program that will focus on Gibraltar North mineralization.

Postponed till 2000. TGS

Budget

	Budgeted	Expended	Balance
STOB 01 Salaries	$5,622.48	$8,633.64	$- 3,011.16
STOB 10 Travel	$7,512.50	$3,140.00	$ 4,103.00
STOB 20 Prof. Serv.	$9,750.00	$7,750.00	$ 2,000.00
STOB 50 Matrls & Supls	$7,115.02	$3,115.00	$ 4,000.00
	$29,200.00	$22,638.64	$ 6,561.36

Project Status and Recommendations

- A geological map and cross-section (1:5 000) of the mine and a regional geological map of the surrounding area (1:50 000, Open File 1999-7) have been produced;
- Pb/U age dates are now available of the Granite Mountain batholith and Sheridan stock and will be published in Geological Fieldwork;
- further work needs to address the contact relationships between the Granite Mountain batholith and Sheridan stock;
- further work needs to be done on the relationship between the structural style affecting the mine and the regional deformation affecting the surrounding lithologies.
- A firm Late Triassic age (215 Ma) for the Granite Mountain Batholith suggests that a proposed co-genetic relationship with overlying volcanic rocks can be tested based on the presence or absence of conodonts.

References

Ash, C.H., Panteleyev, A., MacLennan, K.L Payne, C.W. and Rydman, M.O. (1999): Geology of the Gibraltar Mine Area (93B/8&9); *B.C. Ministry of Energ and, Mines,* Open File 1999-7, 1:50 000 scale map.

Ash, C. H., Rydman, M.O., Payne, C.W., Panteleyev, A., Geological setting of the Gibraltar Mine south central British Columbia (93B/8, 9), *B.C. Ministry of Energy and Mines*, Exploration and Mining in British Columbia, pages ??-??.

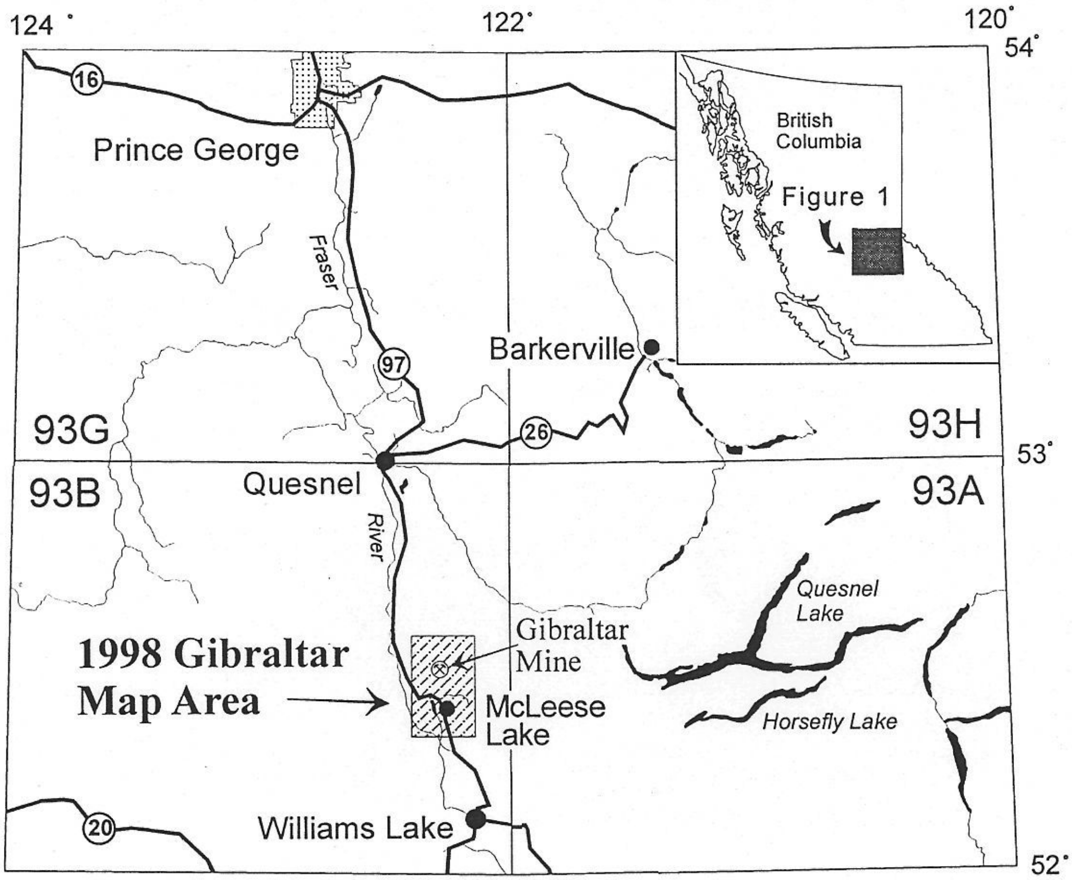


Figure 1. Location of the Gibraltar map area.

Nov. 9/99

PROJECT TITLE: Gemstones and Industrial Minerals

Field Season Summary Report -George, J. Simandl

Introduction:
The field work consisted of documenting and mapping, sampling and analysing new gemstone occurrences and monitoring of the industrial mineral activity in the province.

Field Season Objectives:
Confirm and document the new gemstone discoveries in British Columbia (examples: gem-quality cordierite and precious opal occurrences).
Visit and document selected industrial mineral properties. Assist prospectors.

Accomplishments:
All the occurrences were located and sampled for thin sections and chemical analyses. Some of the occurrences were covered by detailed (deposit scale) mapping.
Client interaction: averaging around 75 client request per month (even during the field period).

Mineral occurrences visited:
2 iolite occurrences, 1 garnet occurrence, 1 graphite occurrence, 2 beryl occurrences in the Slocan Valley area, 2 precious opal occurrences (Burns Lake and Falkland), 3 zeolite deposits (Princeton and Ashcroft), 1 bentonite deposit (Princeton area). c2c zeolite plant near Ashcroft, 2 nephrite deposits (Mount Ogden Area), Garibaldi Granite operation in Squamish, 2 limestone operations on Texada Island.

Advances into geological understanding of iolite and precious opal occurrences in B.C. Independent study of selected zeolite occurrences in terms of mineralogy, physical and chemical properties and their comparison to known standards.

Student training: The project will provide an introduction to applied petrology to one graduate student. Emphasis on nephrite, zeolites, bentonite and other clays.

Safety Record:
About 30 days; no days lost to accidents.

Output Planned is highly dependent on the availability of the support staff.
1) Paper in the Forum on Industrial Minerals (Rhodonite & Jade), for May 1999 (completed, accepted, edits underway) in collaboration with S. Paradis and J. Nelson
2) Fieldwork paper Gem Cordierite Discovery in B.C (in progress) in collaboration with D. Marshall
3) Complete the paper on Gemstones in B.C. a review for 1999 in co-operation with 2 co-authors (in progress).
4)New precious opal occurrences in Burns Lake and Kamloops area. Fieldwork paper and/or presentation (GSA 2000) in collaboration with P. Wojdak and possibly M.Cathro.
5)Mt. Ogden Nephrite deposits. Fieldwork paper and/or presentation (GSA 2000) P. Schiarizza.
6) Fieldwork paper on mineralogy of selected zeolite and clay occurrences in B.C. in collaboration with M. Cathro.
7)2 Posters for Roundup February 2000 (and oral presentation if in Ministry interest)

Industry Activity:
Anglo Swiss (prospecting in Slocan Valley) the progress is hard to document, Texada Quarrying is mining aggregate, chemical grade and filler grade limestone on Texada Island. They lost about 37 000 tonnes of

white limestone in sales to a new Alaska-based producer . Ashcroft Cement is also mining on Texada Island, however its sales are not affected by the Alaskan operation.. C2C is processing stockpiled zeolite near Ashcroft), Garibaldi Granite is mining and processing 3 granite varieties, basalt columns and rhyolite at its small but modern plant near Squamish. Individual prospectors are active throughout the province.

Budget:

I estimate that all the money will be spend well before the end of the fiscal year.
Summary of expenditures by stob:
STOB 10: $ 4500.00 (estimate still active)
STOB 20: $ 4500.00 (much more committed)
STOB 50: $ 2980.00
STOB 80: $ 2500.00

Project Status and Recommendations:
Both gemstone and industrial mineral exploration projects need continuous monitoring. Gemstone exploration is relatively new to B.C. and industrial mineral field is highly market dependent. Number of well constrained industrial minerals and gemstone projects will be needed year after year. In some cases our activity results in expertise transfer to the industry, in other cases we need information in order to make informed decisions. Collaboration with research organisations and industry is essential.

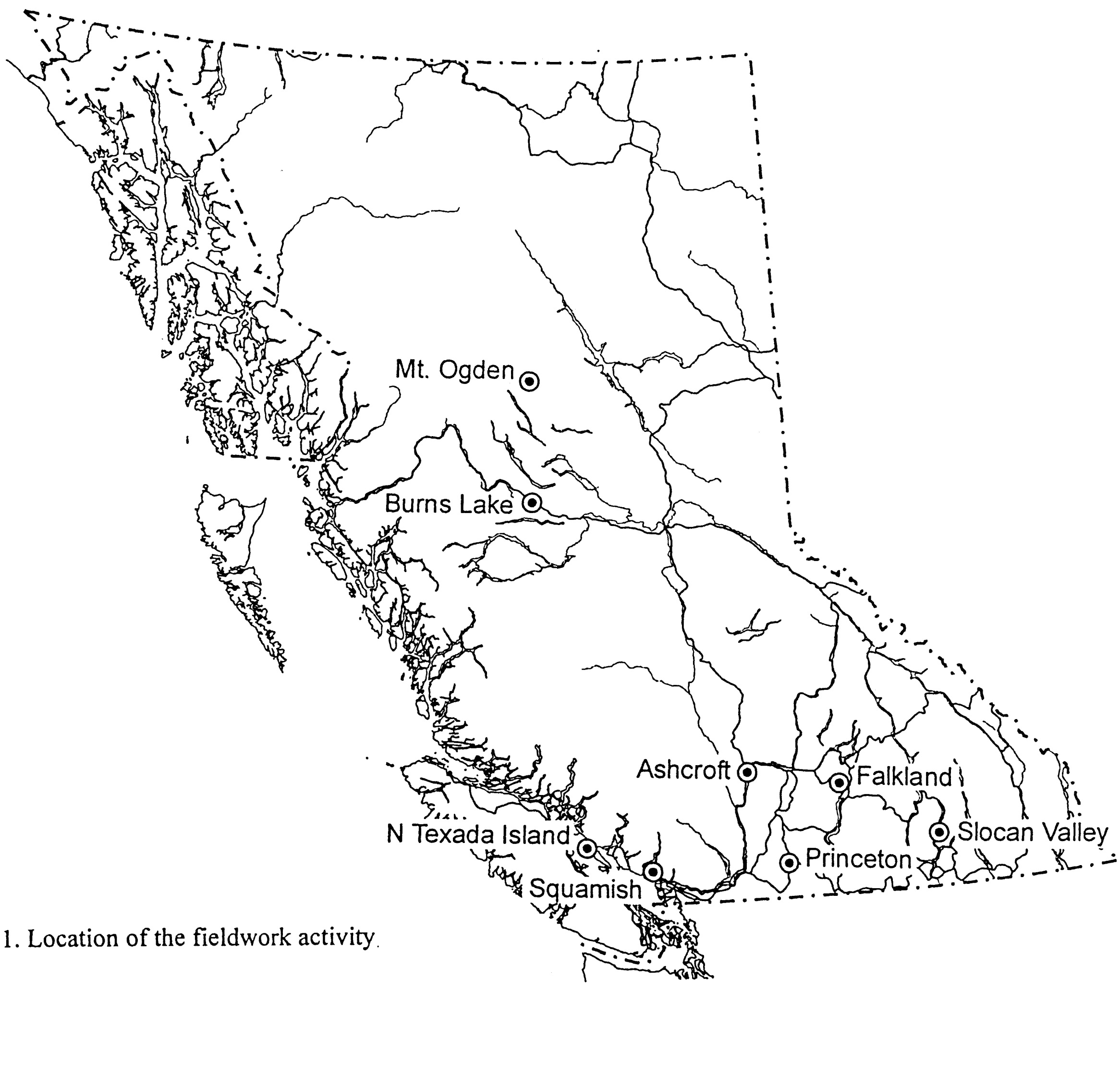


Figure 1. Location of the fieldwork activity.

Nov. 9/99

To: Brown, Derek EM:EX
From: Gerry Ray and Ian Webster
Subject: **End of Season Report - Fe oxide-Cu-Au-REE project**
6th Oct 1999

Summary

In the 1999 summer season, 13 properties with possible Fe-oxide-Cu-Au-REE potential were visited throughout BC. These include the Mesabi (Heffley Lake), Iron Range, Midas and Mag properties, as well as showings or geochemical anomalies in the Burns Lake, Bugaboo Mountains and Smithers areas. 101 whole rock or assay samples were collected together with 18 silt sediment and 4 conodont samples. Assay result for all rock samples have been received. A 38 sq. km area around the Mesabi-Heffley Lake Fe-Cu-Au-REE skarn was mapped at 1:15000 scale and a 2.5 sq. km area with skarn mapped at 1:5000.

Only two areas (Heffley Lake and Iron Range) contain mineralization that undoubtedly fits the Fe-oxide-Cu-Au-REE model. However, some assays from the other properties reveal some interesting geochemistry. Our reconnaissance work in the Bugaboo Mountains suggests that the Windermere metasediments should be prospected for Au and/or carbonatite mineralization.

One of the most significant results of the fieldwork was the recognition, at Heffley Lake, of a large (> 10 sq. km), Alaskan-type ultramafic-mafic pluton. Also, 3 new mineralised occurrences were located in the body, one of which assayed 0.8% Cu. This body should be fully mapped (it's S and E boundaries are still unknown) and prospected for Cu and PGE's.

Introduction:

Between the 20th of July and September 1st, 30 days were spent in the field. At least 13 properties throughout southern and central B.C. were visited and sampled (Fig. 1). In addition, samples previously collected from another 5 properties ranging from Whitehorse in the Yukon to Lamefoot in Washington State were also submitted for assay (Fig. 1). All the properties visited or sampled were selected on the basis of either their high Fe-oxide content combined with the presence of possible Cu-U-F-Au-REE anomalies. They include the Heffley Lake Fe-Cu-Au skarn (near Kamloops: Fig.1), Fe-oxide showings at the Cu mountain, Ajax-Afton, Getty North and Trojan Cu porphyries, and the Iron Range showing near Cranbrook. In addition, visits were made to the Rexspar U-F deposit, to various magnetite-Au-F showings on the Midas property, near Castlegar, to investigate some RGS Fe-U-Au sediment anomalies in the Bugaboo Mountains area, and to several showings near Burns Lake and Smithers (Fig. 1). A total of 101 rock samples were collected for either assay, whole rock and/or thin section, and 4 limestone samples have been submitted for conodonts. 18 silt samples taken from Howser and Tea Creeks (Fig. 2; Bugaboo Mountains) and from the Summerland area; these were follow-up of RGS geochemical Au-Fe-REE anomalies.

Lab work accomplished to date.

Analytical results have been received for all of the whole rock data and for most of the assays. Thin sections and polished sections have been completed by Vancouver Petrographics but no microscope or microprobe work has been started. The silt samples are being sieved and processed in Vancouver. The conodont samples have been forwarded to U. Vic. Arrangements have been made with the UBC microprobe lab to start analyses once the fieldwork articles are written.

Heffley Lake

The bulk of the summer (17 days fieldwork; 21st of July to 7th of August) were spent at Heffley Lake, northeast of Kamloops. Mapping was conducted at two scales:

(a) reconnaissance mapping a 38 sq. km area at 1:15 000, and,

(b) mapping a 2.5 sq. km area over the Heffley Fe-Cu-Au property at a 1:5 000 scale using the 100m spaced grid cut by Echo Bay Mines.

Nearly 70 rock samples were collected.

Rock exposure is probably < 1% in the area. The geology consists of generally steeply dipping, well cleaved tuffaceous siltstones, back argillites, ash tuffs, some substantial units of limestone, and a variety of intrusive rocks. Preliminary interpretation suggests that the rocks in the northern part of the area are Nicola Group whilst those to the south belong to the pre-Nicola basement, the Harpers Ranch. The presumed original stratigraphic contact between these northern and southern packages is now marked by a SE trending structural zone which passes through Heffley Lake and along Armour Creek.

There are some small bodies of megacrystic syenite (feldspars up to 15 cm long), and older swarms of irregular dikes and sills that cut the limestone cliffs immediately north of Heffley Lake. The latter are altered with silica, pyrite and albite. Previously these have been mapped as "dacites" or "rhyolites" but immobile element analyses from our work indicates they were originally dioritic to gabbroic in composition.

The largest and most economically important intrusion in the area is the "Armour Creek Pluton" which is believed to be an Alaskan-type body (hence it may have PGE potential). This intrudes both the presumed Nicola and Harpers Ranch rocks and it covers an area of at least 10 sq. km (it's E, S and N margins have not been delineated). It is a massive, equigranular to moderately porphyritic body that mainly comprises mafic hornblende gabbro and amphibole-pyroxene ultramafic rocks. One to 2% disseminated pyrite is ubiquitous and the ultramafic rocks contain up to 5% magnetite. The latter is responsible for a 6.5 km long airborne magnetic anomaly that trends SE from Heffley Lake. Several previous unreported Cu-bearing occurrences were discovered in the pluton, one of which assayed 0.8 % Cu but low Au. This Alaskan-type body is probably related to both the highly altered (silicified and pyritic) dioritic dike swarm north of Heffley Lake and the Mesabi Fe-Cu-Au-REE skarn. Field evidence shows that the dike swarm, the skarn and by implication the Armour Creek Pluton all predate the major deformation and folding that overprinted the metasediments.

The Mesabi (Heffley Lake Fe-Cu-Au-REE occurrences lie in poorly exposed ground immediately north of the Lake and SW of the limestone cliffs. It comprises pyroxene and garnet-pyroxene skarns with variable amounts of magnetite, pyrite, pyrrhotite and minor chalcopyrite. These skarns appear to be related to the swarm of hydrothermally altered dikes and sill that cut the limestones in the nearby cliffs. It is likely that these swarms originate from the magnetite-rich Armour Creek Pluton, which airomagnetic data suggests underlies the lake adjacent to the Mesabi occurrences. Soil sampling by Echo Bay outlined Au anomalies > 1000 ppb Au on the property.

Other properties.
Details on the other properties visited and sampled, including the Howser and Tea Creek area of the Bugaboo Mountains area (Fig. 2) will be presented in Fieldwork.

Gerry Ray and Ian Webster.

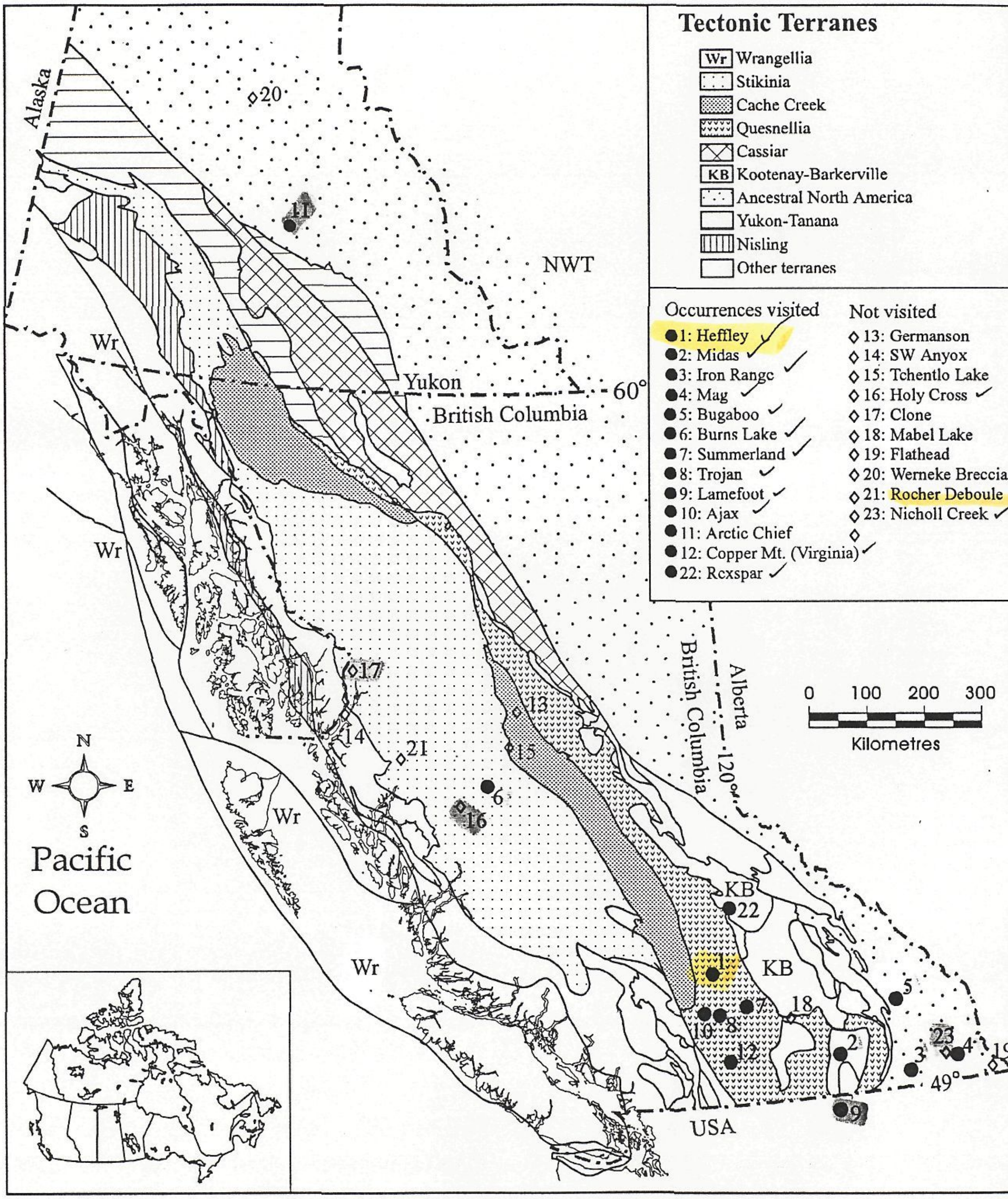


fig1.cdr Figure 1

Properties visited and sampled, 1999

Properties with samples from previous visits.

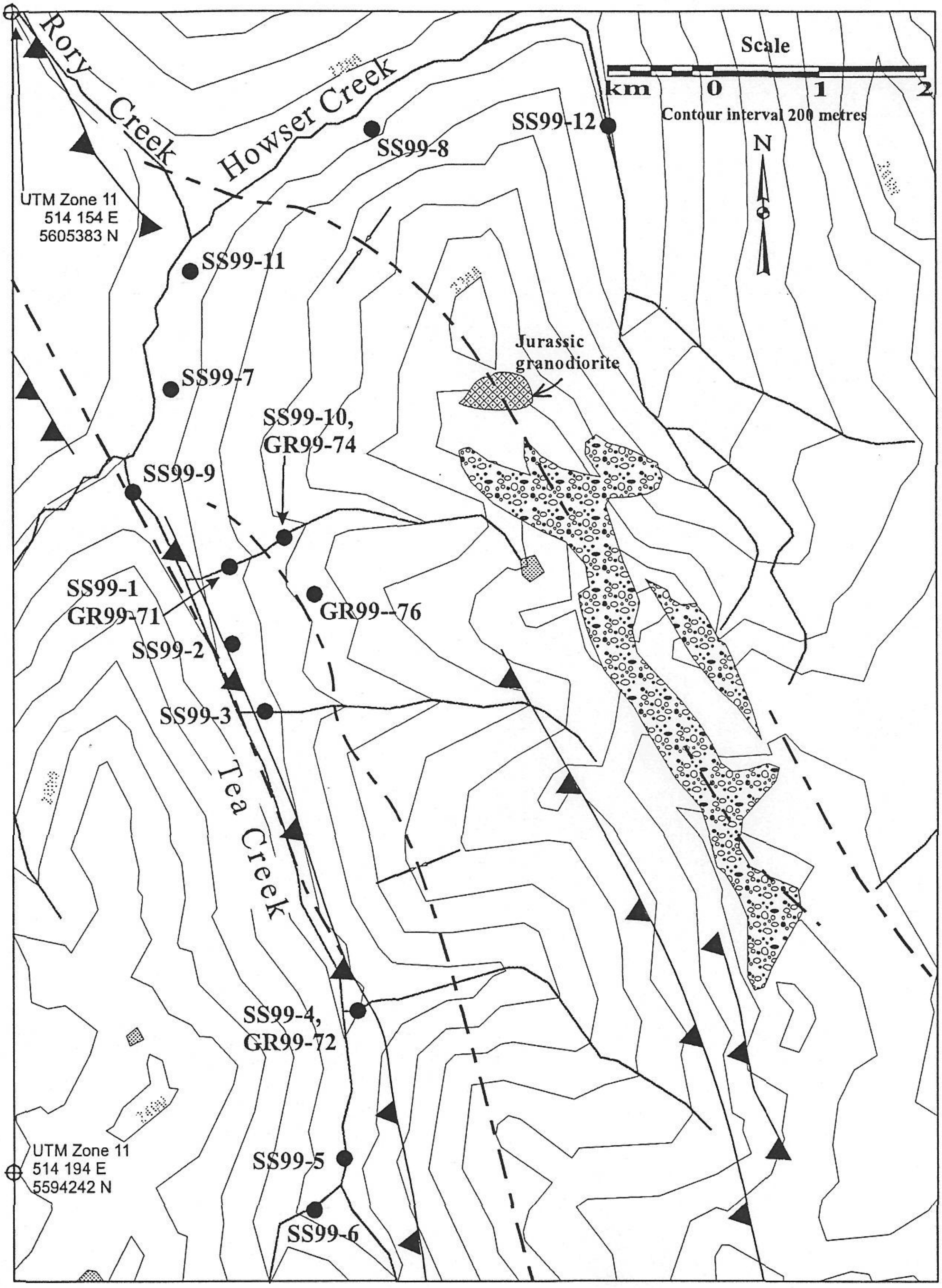


Fig 2

● Location of stream sediment and rock sample sites in the Tea Creek area.

Neoproterozoic Windemere Supergroup rocks include micaceous quartzite, grey slate, phyllite or muscovite schists, dolomitic siltstone and green argillite.

Geology simplified from: Warren, M.J, (1996): Geology of the West-Central Purcell Mountains British Columbia NTS 82K/2,5 & parts of 8, 10: British Columbia Ministry of Employment and Investment, Open File 1996-16, scale 1:75 000, 3 sheets.

G 1b

CC. T.SCHROETER

TGS -> Fieldwork 1999

Field Season Summary Report

Wayne Jackaman

Introduction

Reconnaissance scale drainage sediment and water surveys were conducted in the following areas:

- southern Coast Mountains near Cape Caution (92L/14, 92M/3,4);
- north Moresby Island (103F/1, 103G4) / south Graham Island (103F/7,8,9,10) on Queen Charlotte Island;
- Khutze and the Aaltanhash river drainages in the coast mountains east of Princess Royal Island (103H/1,2,7); and
- south of Bella Coola (93D/2,7).

These surveys will provide baseline regional geochemical data that can be used in the evaluation of the mineral potential of the project areas. Funded under the government's Corporate Resource Inventory Initiative (CRII), these surveys are part of the Ministry of Energy and Mines' contribution to the Central Coast and Queen Charlotte Island Land Resource Planning process.

Field Season Objectives

Based on time and budget constraints, collect drainage sediment and water samples from as many sites as possible within each survey area.

Accomplishments

- Cape Caution (Cook and Jackaman) : lake sediment and water samples were collected from 133 sites covering an area of approximately 800 squarekilometres.
- Khutze River (Jackaman and contractor): sediment and water samples were collected from 111 sites covering an area of approximately 800 squarekilometres.
- QCI (Jackaman and Payie) : moss sediment and water samples were collected from 184 sites covering an area of approximately 1800 squarekilometres.
- Bella Coola (Jackaman, Cook, Pinsent and Ferbey) : moss sediment and water samples were collected from 94 sites covering an area of approximately 800 squarekilometres.

Safety Record

- W. Jackaman 45 days, 0 days lost to accidents
- G. Payie 22 days, 0 days lost
- S. Cook 14 days, 0 days lost
- R. Pinsent 7 days, 0 days lost
- T. Ferbey 5 days, 2 field days lost to accident

Travis was injured in a fall. After being monitored for 24 hrs., he was flown back to Victoria.

Output Planned

- Data packages will be prepared for each project and will include details on survey methodology, listings of field and analytical data, summary statistics, maps of key metals and digital data. Reports are expected to be completed by December.

Industry Activity

- None noted.

Budget

Central Coast CRII - on target

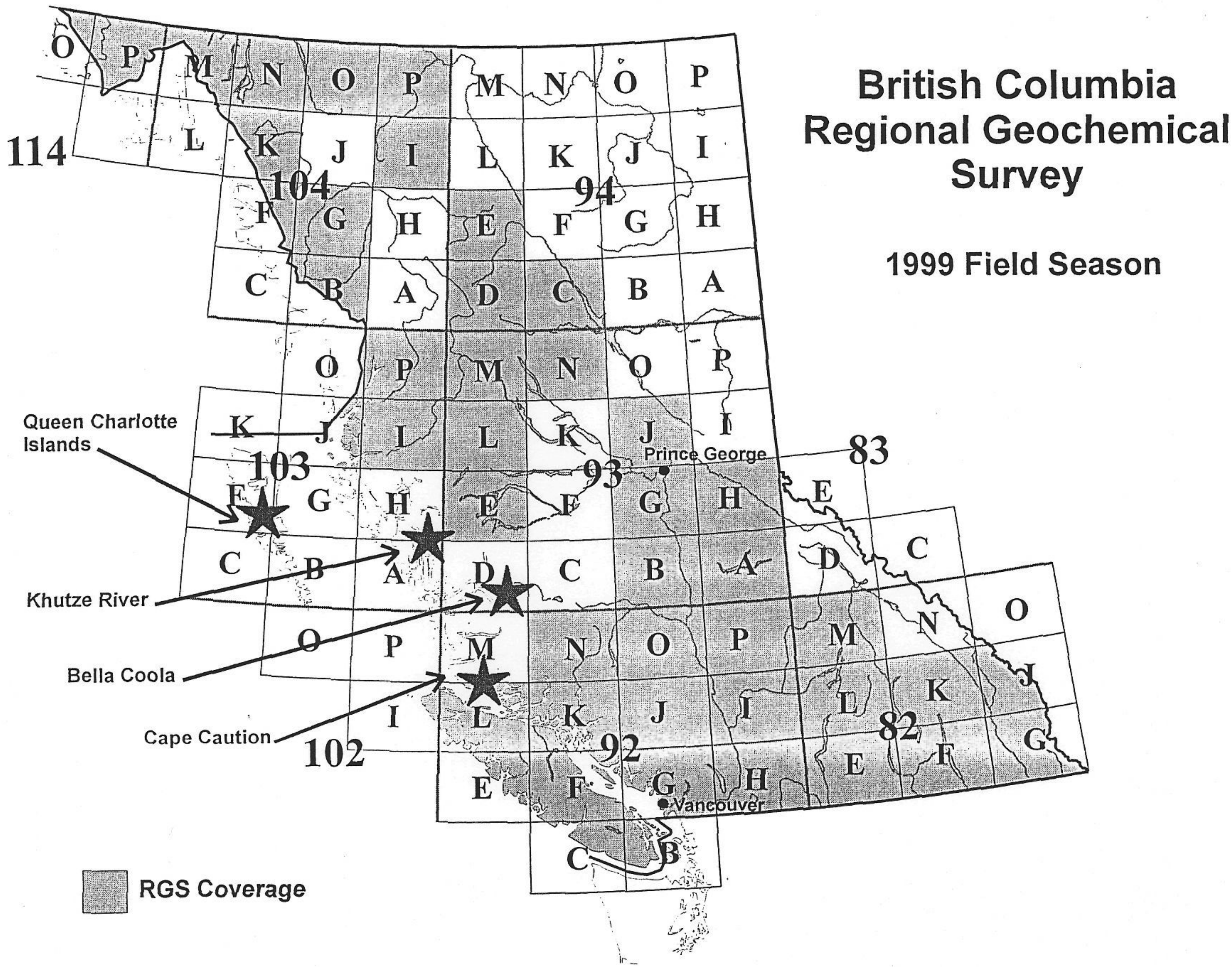
STOB 10	$ 4,000.00
STOB 20	$24,000.00
STOB 50	$40,000.00
TOTAL	$70,000.00

QCI CRII - on target

STOB 10	$ 5,500.00
STOB 20	$16,000.00
STOB 50	$ 0,000.00
TOTAL	$21,500.00

Project Status and Recommendations

- all field activities have been completed


British Columbia
Regional Geochemical
Survey
1999 Field Season
Queen Charlotte Islands
Khutze River
Bella Coola
Cape Caution
Prince George
Vancouver
114
104
94
103
93
83
102
92
82
RGS Coverage

Field Season Summary Report
Stephen Cook

Ancient Pacific Margins NATMAP Project: Geochemistry Component

Introduction

The purpose of this project is to highlight, in conjunction with bedrock and surficial geology mapping programs, the potential for VMS mineralization in Yukon-Tanana correlative rocks. This will be accomplished by compilation and interpretation of available RGS stream and lake sediment geochemical data to identify those areas potentially favourable for VMS mineralization/alteration, characterization of the geochemical responses of known VMS showings and felsic metavolcanic stratigraphic packages in the area, and the subsequent development of recommendations as to the most effective geochemical exploration methods for VMS deposits.

Location: Big Salmon Complex, Teslin Lake area, northern B.C. (NTS 104N/9, 16; 104O/11, 12, 13, 14)

Crew: Stephen Cook (project leader)
Heidi Pass (field assistant)

Field Season Objectives

- pre-season compilation and interpretation of available Regional Geochemical Survey (RGS) stream and lake sediment geochemical data for the Big Salmon Complex to identify those areas potentially favourable for VMS mineralization/alteration

- characterization of the geochemical responses of known VMS showings and felsic metavolcanic stratigraphic packages in the area through a series of case studies.

Accomplishments

Geochemical case study investigations were conducted in three types of areas (see attached Figure):

1) Watershed characterization of anomalous RGS areas
2) Prospective felsic volcanic packages (*e.g.* Mn-Ba crinkled chert)
3) Mineral deposit or prospect case studies (*e.g.* Arsenault VMS prospect)

A wide variety of standard stream sediments and moss mats, -18 mesh sieved sediments, bulk moss mats, soil horizons, stream waters, rocks and vegetation were sampled around several areas over the course of the 1999 field season. A summary table showing the type and number of samples obtained at each site is attached. Most of the field work objectives were achieved over the course of the approximately four week work period.

Heidi Pass, a geology/chemistry student at the University of Victoria, completed field work for her B.Sc. thesis on water and suspended solid chemistry over the course of her employment as field assistant on this project. She will be analyzing the stream water samples for trace elements on the UVic ICP-MS over the autumn.

There was little client interaction with industry geologists over the course of the summer. Some industry geologists were at times present in, or visiting, the Morley Lake base camp. However, the tight work schedule dictated by the limited field budget and helicopter availability did not permit much discretionary time to join in on property visits without affecting the program.

Safety Record

Days in field: 36 days (for each crew member, including travel time)

23/09/99

Number of days lost to accidents: none
Number of days lost to sickness: 4 (Cook)
Unusual incidents: none

Output Planned

Geological Fieldwork 1999 paper	November 1999
Cordilleran Roundup poster	January 2000

Budget

Budget: $30,000 less mid-summer 2.5% clawback: **$29,234**

		Budgeted/Committed	Committed/Expenditures to date
STOB 01/02/03	Student	$ 5623	$6457
STOB 10	Travel	$ 3776	$4569
STOB 20	Prof.Serv.	$ 8310	$8189
STOB 50	Supplies,etc.	$ 11525	$11210
Totals:		***$ 29234***	***$30425***

The present small budget overrun will be eliminated through additional efficiencies in upcoming analytical work and other expenditures. Other than helicopter time, the largest proportion of funds are committed to sample analytical work at various laboratories. This work will be proceeding throughout the fall, and consequently invoices for these services will not be received until later in the year.

Helicopter time (11.2 hours; $8,344) came in about $1600 under budget, but approximately half this savings was lost in the budget clawback.

The field budget allotted for this program was inadequate for geochemical work in such a distant and remote area, particularly for its effect on student assistant time. Geochemical programs, by definition, require considerable funds for analyses, and the poor access here dictated the helicopter budget. Consequently, the field assistant employment period was pared back to eight weeks (4 pay periods) to accommodate, a period insufficient for the project. The field assistant could not be started until just days before leaving for the field, preventing any kind of meaningful assistance with field preparations. Similarly, the student had to leave immediately upon return from the field, preventing the rendering of any assistance with field gear, vehicles, sample prep or office work in the post-field season period.

Probable budget status at end of fiscal year: ***on target***

Project Status and Recommendations

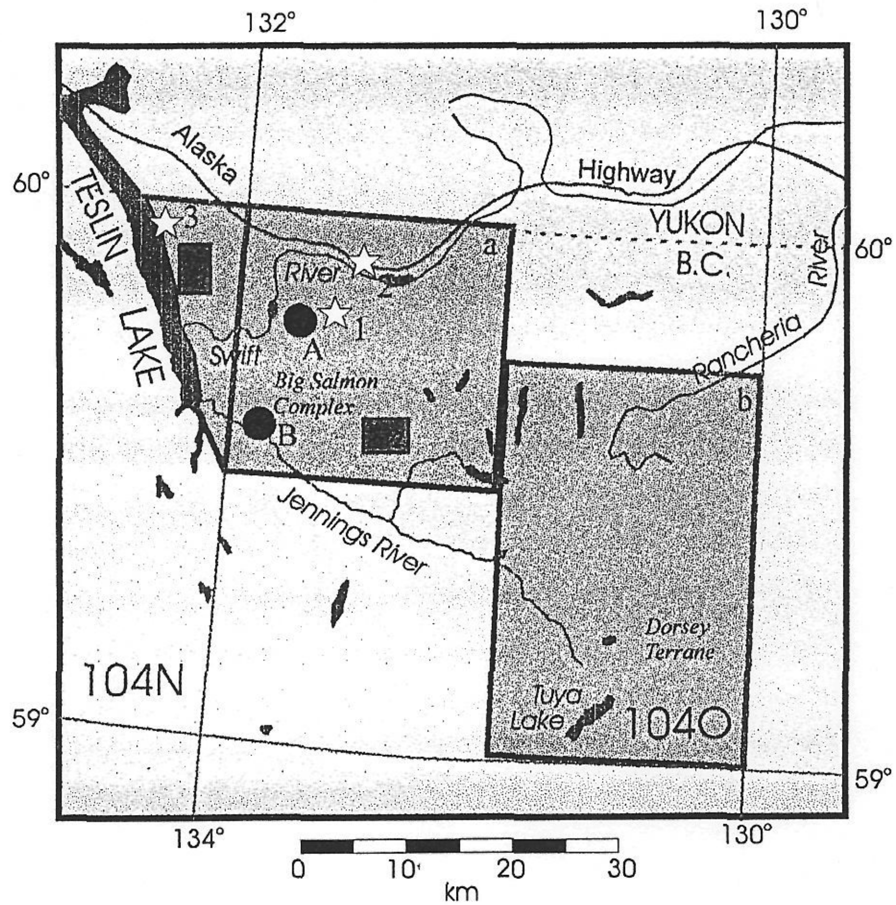
- status: awaiting geochemical results
- detailed recommendations will be made once data has been received and interpreted
- any future field project should be expanded in scope beyond Yukon-Tanana correlative terranes to include VMS prospects and deposits in adjoining terranes of northern B.C

Map

Attached

Other Field Projects

In addition to the foregoing, 7 field days were also spent in the north Vancouver Island area in late June-early July. During this time a lake sediment survey of the Cape Caution region of the mainland was carried out by myself and Wayne Jackaman. The survey was funded under the CRII Mid-Coast project and was based out of Port Hardy. Approximately 150 lake sediment samples were obtained during two days (approx. 15 hours) of helicopter flying.

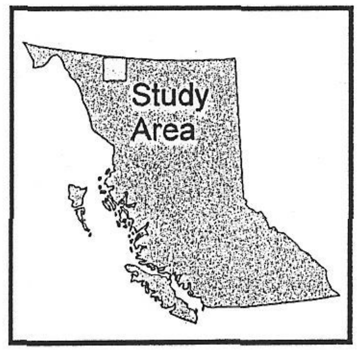


Geochemical Exploration Methods for VMS Deposits

RGS Interpretation Areas: a) 1999 and b) 2000

1999 Fieldwork: Case Studies

- ☆ Mineral Prospects
- ● Felsic volcanic packages
- ■ Watershed Characterization/RGS Infill



Mineral prospects

☆ 1. Arsenault Cu prospect (VMS)
2. Hwy. 97 Cu-bearing gossan
3. Teslin Lake border area

Felsic volcanic units

● A. Mn-Ba crinkled chert sites
B. South Jennings R. qtz-ser schist

Watershed characterization studies

■ *1.* East Teslin Lake area (104N/16)
2. Teh Creek area (104O/11, 12)

SAMPLE MEDIA SUMMARY: 1999 BIG SALMON COMPLEX GEOCHEMICAL STUDIES

		Number of Sites **Watershed Studies** Nisutlin Plateau	Teh Creek area	**Stratigraphic Units** a	b	**Cu Prospects** 1	2	3	*Total Sites*	*Total Samples*
Routine Drainage Sediments	Stream sediments	9	10	4	-	4*	-	-	**27**	29
	Moss mats	8	3	3	-	4*	-	-	**18**	20
Sieved Drainage Sediments	Sieved stream sediments	4	7	3	-	2	-	-	**16**	16
	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	Stream float, pit cobbles, etc.	3	4	8	1	1	2	3	**22**	22

a Crinkle chert localities (see table yy)
b South Jennings R. qtz-ser schist

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

* 6 sites total
** figures do not include underlying till samples of Dixon-Warren

FIELD SEASON SUMMARY REPORT

Project Leader: Antigone Dixon-Warren
Assistant: Adrian Hickin
Date: Sept 22, 1999

INTRODUCTION

The aim of the project was to incorporate surficial mapping with detailed till geochemistry case studies within the Jennings River area, northwestern British Columbia (figure 1). The study area is located within the Ancient Pacific Margin NATMAP project area (NTS mapsheets 104O/NW, 104N/9NE, 104N/16NE), hence Quaternary fieldwork was conducted in conjunction with proposed bedrock mapping and geochemistry studies completed by the BCGS and GSC. This area was selected for investigation given the widespread drift cover, high mineral potential of the Salmon Bay Complex and the need to integrate Quaternary studies with mineral exploration to elucidate exploration models and new targets.

FIELD SEASON OBJECTIVES

The main objectives of the program are:

- to produce a 1:100,000 surficial geology map identifying units suitable for geochemistry sampling and tracing of mineral anomalies to their bedrock sources
- to collect and map ice flow indicators (e.g. striae, fluting, drumlins) to establish paleo-ice flow directions to assist future prospecting activities in the area
- to conduct till geochemical case studies on known VMS prospects to better develop and refine the geochemical response of mineralization
- to further define areas of high mineral potential through geochemical sampling

ACCOMPLISHMENTS

- Area covered by surficial mapping is approximately 4000km2
- Eight stratigraphic sections logged
- Over 100 ice flow indicators (including two till fabrics) mapped characterizing local and regional paleo-ice flow directions
- Six geochemical case studies completed in conjunction with S. Cook
- Fifty-five till samples analyzed (including standards) by ICP and INA (S. Cook also collected soil profiles at many coincident sampling locations)
- Thirty bedrock/rubble samples collected in collaboration with S. Cook
- Visited Logtung and Arsenault properties
- Client Interactions: GSC, Brett Resources, T. Harms (Amherst College)
- Sampling and groundtruthing completed in 24 field days

SAFETY RECORD

- Days in field (2 crew) - 60 person days (including travel time)
- No days lost to accidents

OUTPUTS PLANNED

- Fieldwork paper and Open File
- Round-Up display (if possible)

INDUSTRIAL ACTIVITY

- Steve Traynor manages Arsenault property
- Archer Cathro and Associates holds Logtung property

BUDGET

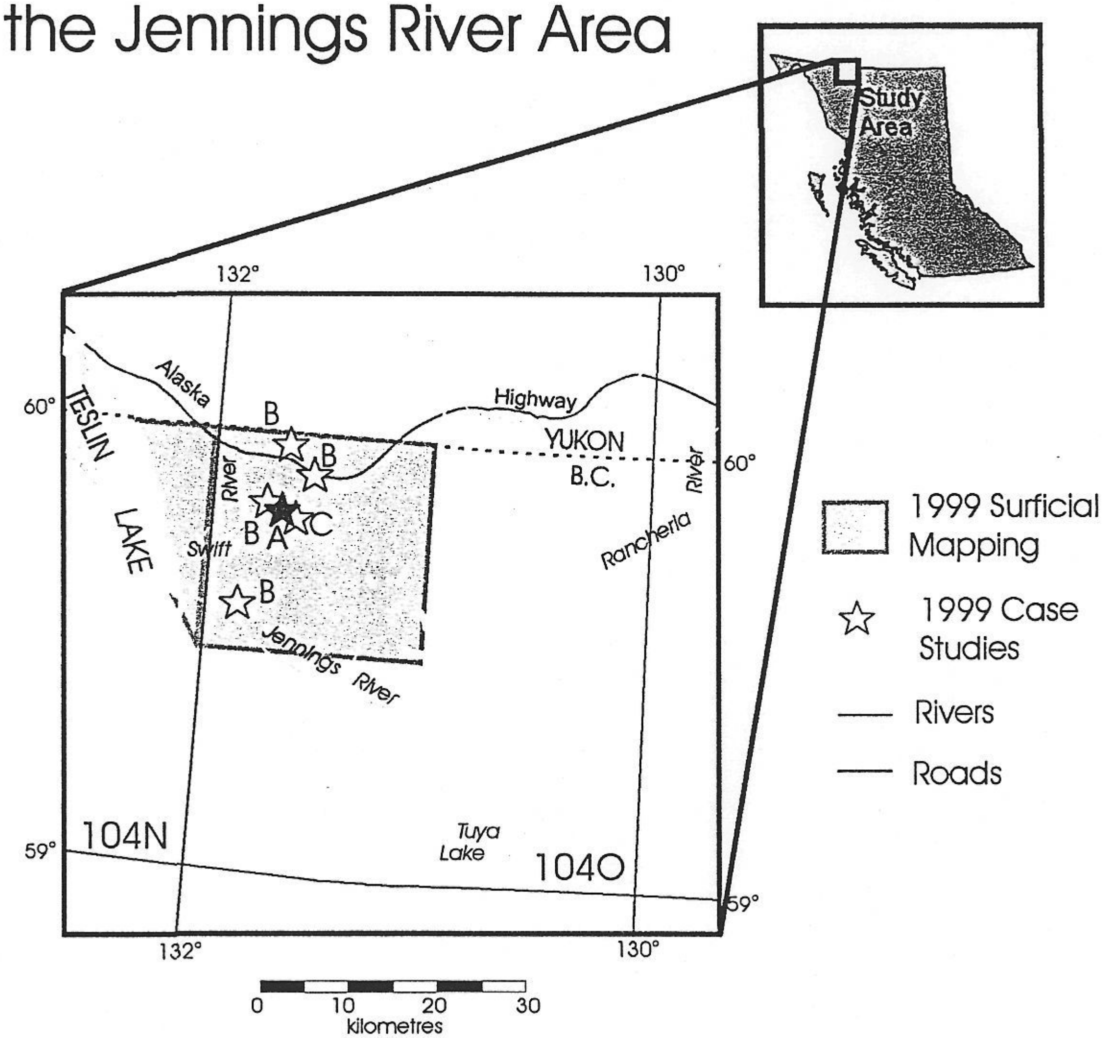
STOB	**BUDGET**	**COMMITTED**	**EXPENDED**	**FORCAST**
1,2,3	12650.00	2503.00	10145.00	2503.00
10	4100.00	1996.00	2007.00	2093.36
20	1330.00	1326.00	0.00	1330.00
30	600.00	160.00	434.00	166.23
50	10550.00	8005.00	1842.00	8707.77
TOTAL	**29230.90**	**13991.00**	**14429.88**	**14801.02**

Estimate of end of fiscal year status: On target

PROJECT STATUS

- Bulk till samples: preparation and lab analysis complete; data analysis and write-up continuing
- Bedrock samples: preparation finished; samples sent for analysis
- Fieldwork paper: in progress; expected completion date Oct 31
- Open File: in progress; expected completion date Nov 21

Surficial Mapping and Till Geochemistry in the Jennings River Area



A	Arsenault Property (VMS)
B	Mafic and Felsic Metavolcanic Packages
C	Geochemically Anomolous Area

FIELD SEASON SUMMARY REPORT

PROJECT: Geochemical Exploration Methods for Intrusion-Related Au-W-Bi Mineralization

PROJECT LEADERS: Wayne Jackaman and Ray Lett

INTRODUCTION:

Recent discoveries of intrusion-hosted sheeted quartz vein gold deposits in Alaska (e.g.Pogo, Fort Knox) and the Yukon has suggested that mid-Cretaceous and other granitic intrusions in B.C. may contain similar Au-Bi mineralization. However, detecting this style of mineralization may be complicated by a weak geochemical expression of the gold in stream sediments and the association of analytically challenged pathfinder metals such as Sn, Bi, and W. Stream sampling was conducted in two areas near granitic hosted Au-Bi-W vein prospects in August 1999 to better understand their geochemical signature and to develop improved sampling, analytical and interpretative methods. The two survey areas are:

The Baldy Batholith, 82M/4, 5 , 6, 92P8
The Bayonne Batholith 82F07E

FIELD SEASON OBJECTIVES:

- Collection of stream sediment, moss mat, stream water, stream suspensate and bulk sediment samples (for preparation of heavy mineral concentrates) from streams draining Au-Bi-W mineral occurrences to provide material for studying the dispersion behaviour of Au and pathfinder elements (e.g. Bi, W, F). The occurrences are Cam Gloria (MINFILE 082M266), Elmo (82FSE137) and German (Gold) Basin (82FSE039).

- Collection of stream sediment, moss mat and stream water from streams draining the Baldy and Bayonne Batholiths and rock samples over a 100-200Km^2 area around known occurrences to establish element backgrounds in different sample media and to identify additional intrusion hosted gold mineralization.

FIELD SEASON ACCOMPLISHMENTS

- Approximate size of area covered by sampling:-
  1. Baldy Batholith - 350 km^2
  2. Bayonne Batholith - 150 km^2
- Number of Samples Collected
  1. Stream sediment - 70
  2. Stream water - 70
  3. Moss - 70
  4. Bulk sediment for heavy minerals - 26
  5. Rock - 15
  6. Suspended sediment - 19
- Mineral Occurrences visited - Cam Gloria
- Client Interactions - Kelly Stashoft, Prospector, Field consultation about German Basin.

Measure of accomplished PIAP goals

- Four mineral occurrences studied (3 in PIAP) including a new vein in 92P8 recently described by Mike Cathro after follow-up of RGS and till anomalies.
- Approximately 400 km2 covered by sampling (200-300 in PIAP).
- Sampling finished in 14 days (28 budgeted).

Safety record

- Days in field (2 crew) - 28 person days (plus mob/demob time).
- No days lost due to accidents.

Outputs planned

- Fieldwork paper and Open File
- Roundup display and talk
- External paper at GSA meeting in April 2000

Industrial activity

New claims (June 1999) staked by C. Burube in Bendelin Creek basin, Baldy Batholith area.
Kelly Stashoft working on German Basin W proposect.

Budget (Sept 1, 1999)

STOB	BUDGET	EXPENDED	BALANCE	FORCAST
10	$5,250	$1,531	$3,719	$3,200
20	$11,635	$0.0	$11,635	$13,200
30	$100	$4	$96	$300
50	$297	$158	$139	$500
Total	$17,282	$1,693	$15,589	$17,200

Estimate of End of fiscal year status: On target

Project status

- **Stream sediment and moss mat samples:** Preparation finished, samples to be sent for analysis by late September.
- **Water samples:** sent for analysis.
- **Bulk sediments:** sent for mineral separation and analysis.

Ray Lett, September, 1999