B.C. REGIONAL GEOCHEMICAL SURVEY PROGRAM: HIGHLIGHTS FROM THE 1993 RELEASE (104M)

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(Contribution to the Corporate Resources Inventory Initiative)

KEYWORDS: Regional Geochemical Survey, reconnaissance, multi-element, stream sediment, stream water, Skagway.

INTRODUCTION

During the 1992 field season the British Columbia Ministry of Energy, Mines and Petroleum Resources conducted reconnaissance-scale stream sediment and water geochemical surveys in the northwest corner of the province (Figure 1). As part of the Ministry contribution to the Corporate Resources Inventory Initiative (CRII), the 1992 Regional Geochemical Survey (RGS) program contributed to the development of a detailed geoscience database. This database is vital to the evaluation of the mineral potential of this under-explored region and has stimulated further exploration and development of the local mineral resources. Prior to the 1992 RGS program, publicly available regional geochemical data for this area was limited to several small-scale surveys conducted by the Ministry as part of a 1:50 000 geological mapping project concentrated in areas adjacent to the Llewellyn fault (Mihalynuk and Rouse, 1988b; Mihalynuk, 1989; Mihalynuk *et al.*, 1990).

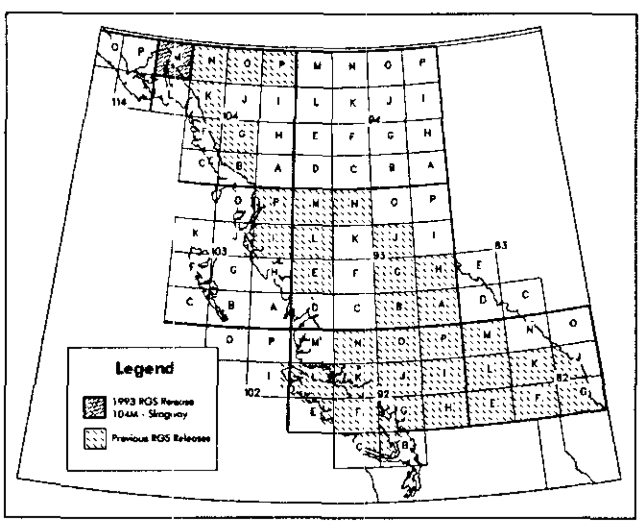

Figure 1. Current status of RGS program.

Results of the RGS program conducted in the Skagway map area (NTS 104M) were released as BC RGS 37 on August 4, 1993. The data package presented field and analytical results for 785 samples located at an average density of 1 sample site every 10 square kilometres. Samples were also collected in the Atlin Provincial Park and Recreation Area as well as in the Tutshi Lake Protected Area Strategy (PAS) study area (Figure 2). Survey results identified high concentrations of both base and precious metals in regions of known mineral potential as well as a number of new areas with little or no recorded exploration activity (Jackaman and Matysek, 1993). This paper will review survey results and highlight exploration opportunities by outlining regions of high mineral potential and identifying top-rated RGS sample sites.

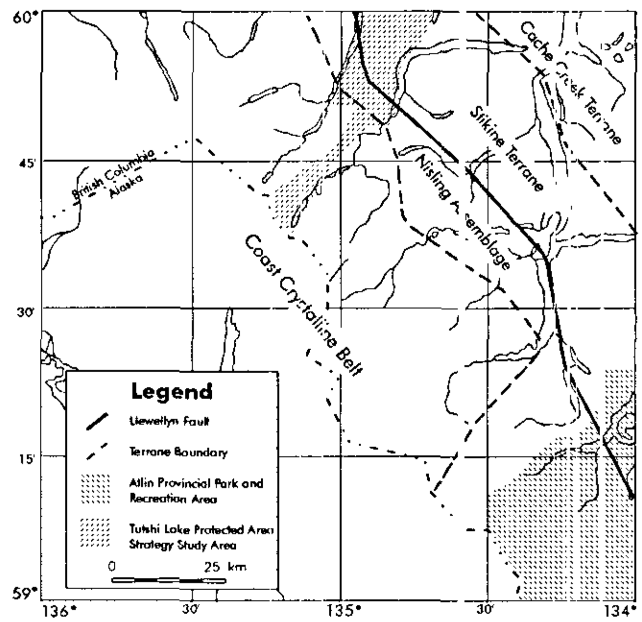

Figure 2. Skagway map sheet (NTS 104M).

REGIONAL SETTING

Situated in the northwest corner of British Columbia, the Skagway map sheet covers about 7500 square kilometres and includes the Coast Mountain and Tagish Highland physiographic subdivisions (Holland, 1976). Trending southeast to northwest, the Coast Mountains extend along the western edge of the map area and are characterized by rugged mountain peaks separated by numerous glaciers and snowfields. Bordering this range to the northeast are the Tagish Highlands which form a transition zone between the Coast Mountains and the Yukon plateaus. This region contains relatively smooth and gently sloping mountains separated by wide, U-shaped valleys.

The Skagway map area straddles the boundary between the Coast and Intermontane tectonic belts (Figure 2). In the west, the Coast crystalline belt is comprised of Late Cretaceous to Tertiary, undifferentiated granitoid rocks. To the east, Permian to Devonian Boundary Range metamorphic rocks and Paleozoic to Late Proterozoic Florence Range metamorphic rocks of the Nisling assemblage (Nisling Terrane?) mark the transition between the major tectonic belts (Mihalynuk and Mountjoy, 1990; Currie, 1990). The Intermontane Belt is dominated by rocks of the Whitehorse trough and includes Lower Jurassic Laberge Group sediments, younger volcanics of the Inklin overlap assemblage, rocks of the Upper Triassic Stuhini Group as well as Boundary Range metamorphic rocks (Mihalynuk and Rouse, 1988a; Mihalynuk *et al.*, 1989; Mihalynuk and Mountjoy, 1990). Mississippian to Upper Triassic Cache Creek Complex and Middle to Upper Triassic Peninsula Mountain volcano-sedimentary rocks are found in the northeast corner of the map area (Mihalynuk and Rouse, 1988a). Cretaceous to Tertiary granitic rocks of the Coast Plutonic Complex intrude rock units throughout the Intermontane Belt (Mihalynuk and Rouse, 1988a). The Llewellyn fault cuts the map sheet from southeast to northwest and marks the western extent of the Whitehorse trough. The Nahlin fault system separates the Whitehorse trough from the Cache Creek Terrane.

Historically, exploration activity has been concentrated in areas adjacent to the Llewellyn fault. This region extends from the Venus mine in the Yukon to the Engineer mine in the southeast corner of the Skagway map sheet. The zone is recognized for its anomalous antimony-arsenic provinces and scattered high gold and silver values (Mihalynuk and Mountjoy, 1990). Known mineral prospects in the region include precious and base metal quartz and quartz-carbonate veins, gold-copper skarns, massive sulphide pods and gold associated with listwanite-altered ultramafic rocks.

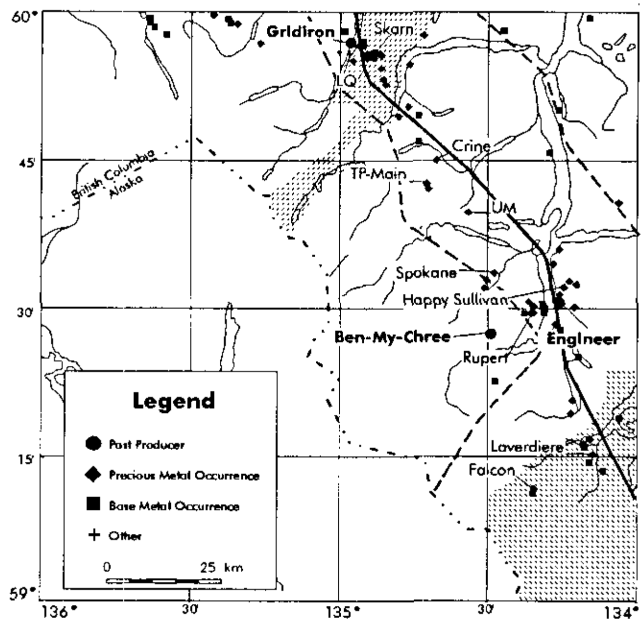

Figure 3. Recorded mineral occurrences.

A total of 87 mineral occurrences have been recorded in the Skagway map area (Jakobsen, 1993). Table 1 details existing past-producers, developed prospects and prospects as recorded in the British Columbia mineral deposits database (MINFILE). Figure 3 illustrates the distribution of these occurrences.

GEOCHEMICAL TRENDS

Several regional trends have been identified utilizing the 104M data set. Figure 4 highlights selected geological units which show elevated mean concentrations for key ore and pathfinder elements relative to the 104M data set as well as to the current RGS provincial data set. These units are primarily located adjacent to the Llewellyn fault zone and the mineralization found in this region is often associated with this structure. Rocks of the Laberge Group (lJLa, lJLg), Stuhini Group (uTsv) and the Boundary Range Metamorphic Suite (PPmb) provide mean concentrations

TABLE 1
SELECTED MINERAL OCCURRENCES

Name	MINFILE Id	Commodities	Status	Type	Geology	Rock Type
Gridiron	104M 001	Ag-Au-Pb-As-Zn	Past Producer	Vein	Boundary Range Metamorphic Suite	gneiss
Spokane	104M 006	Au-Ag-Zn-Pb-Cu	Dev. Prospect	Vein	Boundary Range Metamorphic Suite	schistose gneiss
Rupert	104M 008	Ag-Au-Pb-Zn-Cu	Prospect	Vein	Boundary Range Metamorphic Suite	gneiss
Ben-My-Chree	104M 011	Ag-Au-Cu-Pb-Zn	Past Producer	Vein	unknown	diorite
Happy Sullivan	104M 013	Au-Ag	Prospect	Vein	Laberge Group	greywacke
Engineer Mine	104M 014	Au-Ag-Sb-Te	Past Producer	Vein	Laberge Group	greywacke
Laverdiere	104M 022	Cu-Ag-Au-Mo	Prospect	Skarn	Stuhini Group	limestone
LQ	104M 044	Au-Ag-Zn-Cu-Pb	Prospect	Vein	Boundary Range Metamorphic Suite	gneiss
TP - Main	104M 048	Au-Ag-Co-Cu-Fe	Prospect	Skarn	Boundary Range Metamorphic Suite	marble
Crine	104M 081	Au-Ag-Pb-Zn-As	Prospect	Vein	Boundary Range Metamorphic Suite	schist
UM	104M 084	Au-Ag	Prospect	Vein	unknown	listwanite-altered peridotite
Skarn	104M 085	Au-Cu	Prospect	Skarn	Stuhini Group	porphyritic volcaniclastics
Falcon	104M 087	Ag-Au-Zn-Pb-Cu	Prospect	Vein	Nisling Assemblage	schist

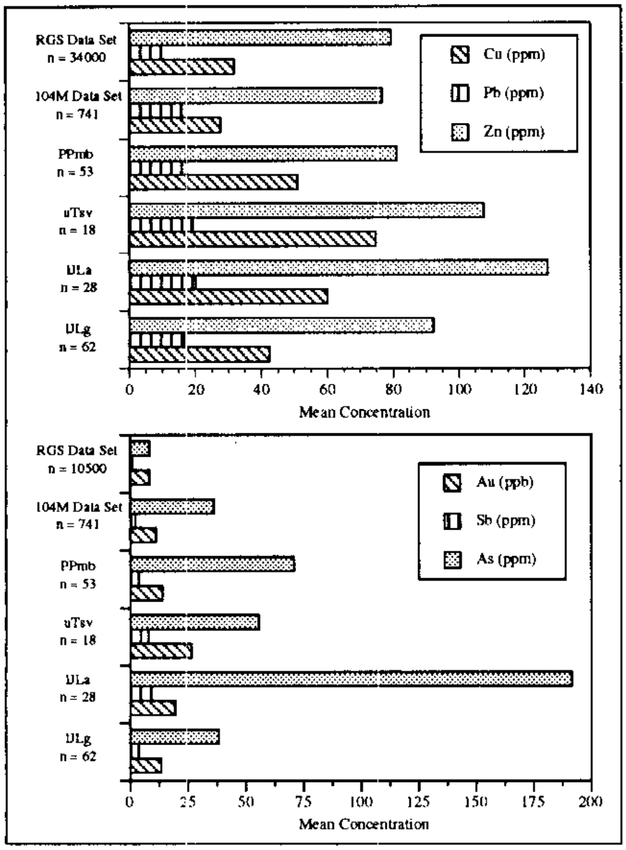

Figure 4. Average concentrations for key elements.

for gold, antimony and arsenic which are significantly higher than both the survey and provincial averages. Average values for copper, lead and zinc show similar results. Lead also returns high average concentrations for several units associated with the Coast Plutonic Complex. These general patterns further define lithological units adjacent to the Llewellyn fault system which have previously been identified as having potential for hosting mineralization (Mihalynuk and Rouse, 1988a; Mihalynuk *et al.*, 1989; Mihalynuk and Mountjoy, 1990).

TOP-RATED RGS ANOMALIES

Utilizing an interpretive technique described in detail by Jackaman and Matysek (1993), samples from the 104M survey which are characterized by anomalous, multi-element signatures have been identified. In general, the technique attempts to distinguish samples which are most likely to reflect mineralized sources from samples affected by lithological units characterized by high background values. Each sample is coded with the predominant lithology found within the drainage basin boundaries upstream from the sample site. The geology base map used to code sample sites is an unpublished compilation by Mihalynuk and Smith (1993). Percentile or threshold values for every element are calculated for each identified lithology. Ratings of 1, 2 or 3 are assigned to each element based on the calculated 90th, 95th and 98th percentile values, respectively. Multi-element anomalies for a base metal suite of elements (Cu-Pb-Zn-Ag) and a precious metal suite (Au-Sb-As-Hg-Ag) are determined by summing the element ratings for each sample. The top 25% of the anomalies determined by this technique are ranked in Table 2 and Table 3. The distribution of these sites is illustrated on Figure 5. The table includes the relationship of the sites to known mineral occurrences and mineral tenure as well as the location relative to the Atlin Provincial Park and Recreation Area and the Tutshi Lake PAS study area

As expected, a large number of the base and precious metal anomalies are concentrated within a zone 10 to 50 kilometres wide adjacent to the Llewellyn fault. This trend extends from Bennett Lake to Willison Bay and into the Atlin Provincial Park and Recreation Area. Several base metal anomalies are also clustered in the Primrose River region. With reference to Table 2 and Table 3, about half of the listed sample sites are associated with intrusive rocks of the Coast Plutonic Complex (eTg, KTg, lKg, Kg). Stuhini Group (uTsv) and Boundary Range metamorphic rocks (PPmb) are represented by over 10% of the sample sites. Five sites list Laberge Group rocks (lJLa, lJLg) as the predominant drainage basin lithology upstream from the sample site. Known mineral occurrences are located within drainage basin boundaries upstream from eleven of the top-rated sample sites. Also identified are a large number of anomalies associated with existing mineral claims, including seven of the top-rated anomalies which were staked in August as a direct result of the 1992 survey. Detailed follow-up work will be conducted on several of these new mineral claims during 1994 (R.H. McMillan, personal communication, 1993). Of the remaining sites open to staking, the most notable are several base metal anomalies including four sites (923200, 925111, 925233 and 921112) which also returned significant precious metal values.

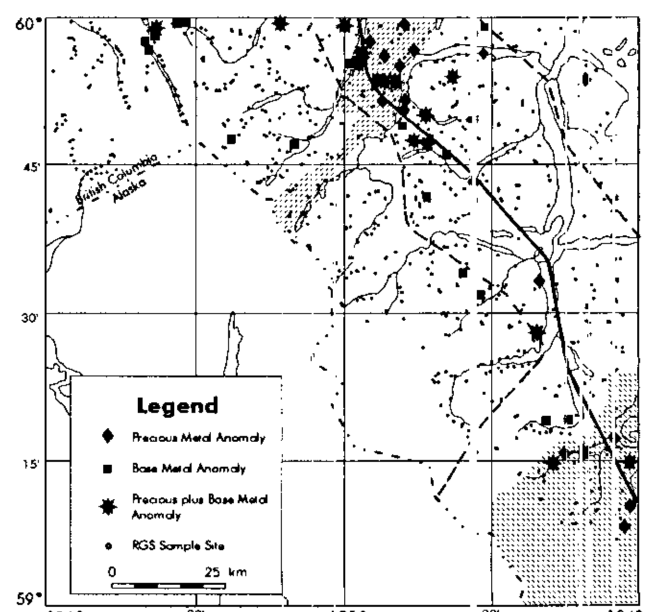

Figure 5. Top-rated multi-element anomalies.

TABLE 2
TOP-RATED BASE METAL ANOMALIES

MAP	ID	FORM	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Anomaly Rating Cu	Pb	Zn	Ag	Total	Status (September, 1993)	Recorded Mineral Occurrences
104M08	925191	eJgd	114	65	268	0.7	3	3	3	3	12	staked (Ice Claims)	none
104M15	923200	lJLa	140	74	498	0.8	3	3	3	3	12	open, PAS	none
104M15	925271	Kg	83	165	129	3.0	3	3	3	3	12	staked August, 1993 (Pen Claims)	none
104M15	925363	lKg	94	65	135	1.4	3	3	2	3	11	staked (Pavey Claims), PAS	Silver Queen (002) - Au,Cu,Ag
104M15	925111	lJLg	132	51	160	0.9	3	3	2	3	11	open	none
104M14	925162	eTg	52	107	386	1.0	2	3	3	3	11	open	none
104M15	923119	lKg	104	35	166	0.7	3	2	3	2	10	open, forfeited tenure	none
104M15	925350	Qal	130	76	286	1.3	1	3	2	3	9	partially staked (Ben Claims), PAS	none
104M15	925349	Qal	230	39	227	1.2	3	2	1	3	9	partially staked (Catfish Claims), PAS	none
104M15	925122	uTsv	100	46	301	0.7	1	2	3	3	9	staked (Tut Claims)	none
104M15	925348	Qal	180	62	178	1.2	2	3	1	3	9	staked (Catfish Claims), PAS	Catfish (074) - Au,Ag,Cu,Pb,Zn,As
104M01	923044	PPgn	82	20	357	0.7	3		3	3	9	mineral and placer reserve	none
104M10	925230	PPmb	76	40	152	0.8	1	2	2	3	8	staked (TP Claims)	none
104M10	925056	eKt	131	18	72	0.2	3	2	3		8	open	none
104M15	923226	lKg	9	127	133	5.0		3	2	3	8	open, PAS	Net 3 (059) - Ag,U,Th,Mo,W
104M13	925138	eTg	33	175	199	1.2	1	3	1	3	8	open	none
104M13	925470	eTg	43	186	407	0.5	1	3	3		7	open	Silt (054) - Mo
104M13	923086	eTg	27	72	252	1.6	1	1	2	3	7	open	none
104M01	925095	Kg	118	28	134	0.5	3	1	3		7	mineral and placer reserve	none
104M08	923010	PPgn	78	75	234	0.6	1	3	1	2	7	open	none
104M15	925365	lmJv	29	115	136	2.3		3	1	3	7	staked (Pavey Claims), PAS	Gaug-West (038) - Au,Ag,Pb,Sb,As
104M08	925004	PPgn	80	9	349	0.6	2		3	2	7	open, forfeited tenure	none
104M15	923208	TP	47	8	113	0.2	3		3		6	open	none
104M15	923196	PPmb	60	43	145	0.6		3	1	2	6	staked August, 1993 (Tutshi Claims)	Jessie (027) - Ag,Au,Cu,Pb,Zn
104M01	925088	lTgd	278	9	59	5.2	3			3	6	Atlin Provincial Park	none
104M14	925127	Es	18	33	106	0.3	3	3			6	staked August, 1993 (Part Claims)	none
104M15	925233	PPmb	82	22	197	0.6	1		3	2	6	open	none
104M15	925362	lKg	43	18	158	0.7	1		3	2	6	staked (Pavey Claims), PAS	Net 6 (058) - U,Th
104M13	925468	KTg	15	33	104	0.7		3		3	6	open	none
104M10	925335	PPmb	74	36	167	0.6		1	3	2	6	staked (TP Claims)	TP (048,049,050) - Au,Ag,Co,Cu,Ma
104M13	921110	KTg	31	38	164	0.4		3	3		6	open	none
104M14	925242	eTg	18	92	165	1.0		2	1	3	6	open	none
104M10	923024	PPmb	103	43	105	0.3	3	3			6	staked August, 1993 (Horn Claims)	none
104M13	921112	eTg	18	120	203	0.8		3	1	2	6	open	Pit Creek (055) - Mo

TABLE 3
TOP-RATED PRECIOUS METAL ANOMALIES

MAP	ID	FORM	Au ppb	Sb ppm	As ppm	Hg ppm	Ag ppm	Anomaly Rating Au	Sb	As	Hg	Ag	Total	Status (September, 1993)	Recorded Mineral Occurrences
104M15	925348	Qal	72	18	1000	960	1.2	3	2	3	3	3	14	staked (Catfish Claims), PAS	Catfish (074) - Au,Ag,Cu,Pb,Zn,As
104M08	925191	eJgd	30	11	190	70	0.7	2	3	3	3	3	14	staked (Ice Claims)	none
104M15	925365	lmJv	287	140	390	20	2.3	3	3	3		3	12	staked (Pavey Claims), PAS	Gaug-West (038) - Au,Ag,Pb,Sb,As
104M15	925271	Kg	217	15	160	20	3	3	3	3		3	12	staked August, 1993 (Pen Claims)	none
104M15	925350	Qal	61	27	670	30	1.3	2	3	3		3	11	partially staked (Ben Claims), PAS	none
104M01	923043	lThg	26	18	32	600	0.3	2	3	2	3		10	Atlin Provincial Park	none
104M15	925363	lKg	41	69	910	50	1.4	1	3	3		3	10	staked (Pavey Claims), PAS	Silver Queen (002) - Au,Cu,Ag
104M15	923200	lJLa	81	71	3200	80	0.8	1	3	3		3	10	open, PAS	none
104M01	925095	Kg	2	31	150	170	0.5		3	3	3		9	mineral and placer reserve	none
104M15	925349	Qal	27	24	320	40	1.2	2	2	2		3	9	partially staked (Catfish Claims), PAS	none
104M15	925362	lKg	41	22	1100	50	0.7	1	3	3		2	9	staked (Pavey Claims), PAS	Net 6 (058) - U,Th
104M15	923119	lKg	32	34	740	50	0.7	1	3	3		2	9	open, forfeited tenure	none
104M01	925088	lTgd	18	4.8	31	40	5.2	1	3	2		3	9	Atlin Provincial Park	none
104M15	925366	PTgd	317	4.3	48	20	0.2	3	3	3			9	staked (Pavey Claims), PAS	none
104M14	925127	Es	170	2.2	36	10	0.3	3	3	3			9	staked August, 1993 (Part Claims)	none
104M15	921004	lTg	363	7.5	160	40	0.2	3	3	3			9	staked August, 1993 (Pad Claims), PAS	none
104M15	925391	eTg	150	1.7	24	20	0.2	3	3	3			9	staked August, 1993 (Pat Claims)	none
104M01	925090	PPgn	4	4.3	34	170	1.4		3		3	3	9	mineral and placer reserve	none
104M15	921006	lTg	94	10	170	30	0.2	3	3	3			9	staked (Catfish Claims), PAS	none
104M15	925122	uTsv	25	16	200	30	0.7		3	2		3	8	staked (Tut Claims)	none
104M15	921005	lTg	30	10	140	30	0.2	2	3	3			8	staked (Catfish Claims), PAS	none
104M15	923240	uTsv	67	12	220	70	0.4	2	1	3	2		8	staked August, 1993 (Wyn Claims), PAS	none
104M15	925233	PPmb	33	19	770	50	0.6		3	3		2	8	open	none
104M15	925384	lJLg	22	18	170	30	0.6	1	3	3		1	8	staked (Willard Claims), PAS	Ben (045,046) - Au,Ag,Pb,Cu
104M15	925364	lmJv	41	13	1100	40	0.5	2	3	3			8	staked (Pavey Claims), PAS	none
104M08	921019	lTgd	5	27	28	340	0.2		3	2	3		8	mineral and placer reserve	none
104M16	921058	MTCl	15	5.6	28	210	0.2	1	3	2	2		8	open	none
104M15	923205	lmJv	34	35	510	40	0.5	2	3	3			8	staked (L-B Claims), PAS	Skarn (088) - Au,Cu
104M10	925227	uTs	12	8.3	79	40	0.3	1	3	3			7	open, forfeited tenure	none
104M15	923242	lKg	208	9.6	200	30	0.5	3	2	2			7	open, PAS	none
104M15	925345	lKg	44	8.3	260	20	0.6	2	2	2		1	7	open, forfeited tenure	none
104M01	923044	PPgn	22	3.4	42	50	0.7	3	1			3	7	mineral and placer reserve	none
104M09	925318	PPmb	39	11	45	70	0.2	2	2		3		7	open	none
104M01	925084	lThg	36	11	20	130	0.3	2	3	1	1		7	Atlin Provincial Park	none
104M15	925103	Qal	27	5.3	81	30	0.6	2	1	2		2	7	open	none
104M15	925111	lJLg	25	3.7	92	50	0.9	2		2		3	7	open	none
104M15	925352	lJLa	46	6.2	260	20	0.7	1		3		3	7	open, PAS	none
104M13	921112	eTg	35	0.6	18	20	0.8	3		2		2	7	open	Pit Creek (055) - Mo

Although this evaluation of the 104M data set has identified many of the top-rated anomalies, some significant results are overlooked. For example, single-element highs for both base and precious metal results are not highlighted by this technique. In terms of precious metal values this includes five unstaked sites returning gold values greater than 100 ppb, three that produced gold values in excess of 50 ppb and one that returned a silver value of 12 ppm. A second limitation of this method is the small number of elements considered. The 104M data set includes analytical determinations for a total of 35 metals in stream sediments and four element determinations in stream waters. Finally, the identification of subtle multi-element highs would also benefit from a more rigorous statistical interpretation which includes detailed background modeling techniques.

CONCLUSIONS

Results of this survey have defined new zones of high mineral potential adjacent to the Llewellyn fault. Anomalous values for gold, antimony, arsenic, copper, lead and zinc are associated with several key geological units including rocks of the Laberge Group, Stuhini Group and the Boundary Range Metamorphic Suite. These units are noted to have potential for precious metal vein deposits, gold-quartz veins, gold-stibnite veins, auriferous quartz-carbonate zones and gold skarns. Although many top-rated RGS anomalies have been staked, several sample sites with significant base and precious metal values remain open to new exploration. In addition, regions previously explored deserve new attention in response to the results of this survey.

ACKNOWLEDGMENTS

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NOTES