Orientation Geochemical Survey over the Jake Gold Prospect, Clearwater (NTS 092J/09), South-Central British Columbia

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KEYWORDS: geochemistry, stream sediments, moss sediments, soil geochemistry, gold occurrence

INTRODUCTION

Mineral deposits in British Columbia usually have a complex surface geochemical expression reflecting bedrock geology, the style of mineralization, the type of surficial sediment and characteristics of the secondary environment such as drainage, topography and climate. Orientation surveys are therefore necessary to assess how these factors control element dispersion. Past case histories have shown localities where geochemical surveys may have been unable to detect mineralization because the influence of the near-surface environment on element migration was not fully appreciated. For example, at a mineral property on Vancouver Island, the high clay content of a consolidated till inhibited Cu and Zn dispersion in B-horizon soil from buried sulphide mineralization, giving rise to a sporadic pattern of B-horizon soil anomalies which were unrelated to the bedrock source. However, more coherent Cu and Zn B-horizon soil anomalies were formed over a more permeable till (Smee, 1987). An orientation geochemical survey was carried out by the authors in 2006 in an area west of Clearwater, BC, around the Jake prospect, to identify

- the main types of glacial sediment and their distribution,
- geochemical sample media most suitable for detecting mineralization, and
- the source of regional stream sediment – water geochemical anomalies.

Preliminary results of the orientation survey are reported in this paper.

SURVEY AREA

Topography and Surface Environment

The orientation survey was carried out within mineral claims covering an area of roughly 300 km^2 along the Mann Creek valley west of Clearwater, BC (Fig 1). Topography is

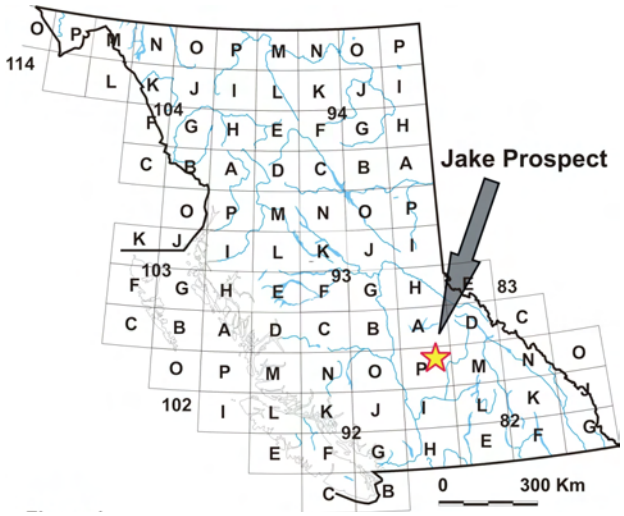

Figure 1. Location of the Jake prospect.

typical of the Shuswap Highland and is characterized by undulating, gently to moderately sloping uplands dissected by steep sided valleys and major rivers (Holland, 1964). Elevations range from about 360 m ASL along the floor of the Thompson River valley near Clearwater to over 2000 m on Grizzly Cub Mountain. Mann Creek, flowing south into the North Thompson River, drains the mineral claims. Upstream, the creek meanders across a broad, often marshy valley, but closer to the North Thompson River, the creek descends by several waterfalls where the channel has eroded flat-lying basalt that is partially infilling the valley. Lakes and small marshy depressions are relatively common through the area, including a small wetland just west of the Jake prospect.

Vegetation on better-drained soils is predominantly subalpine fir, Engelmann spruce, western hemlock and western red cedar, typical of the Interior Wet Belt Region (Gough, 1988). Willow and alder grow along valley floors and in wetlands. The area around the prospect has been logged and mountain pine beetle has damaged much of the timber being harvested.

Undisturbed soil formed on better-drained glacial deposits and colluvium is typically luvisolic with a developed, leached Ae horizon and a pH that is greater than 5.5. Depending on the parent material, soil texture ranges from sandy to gravelly loam. Organic soils (loss-on-ignition [LOI] >30%) and gleysolic soils have formed in poorly drained depressions, such as the marshy area just west of the Jake prospect. The marsh is typical of many small hillside wetlands where there is a thick understorey of cedar, alder and devils club.

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Surficial Geology

Gough (1988) mapped surficial deposits along the Mann Creek valley, including the area around the Jake prospect, as predominantly till with lesser colluvium. A closer examination of surficial geology in the immediate vicinity of the prospect, during the present survey, revealed that colluvium (*i.e.,* sediment transported downslope by gravity) appears to be the dominant surficial sediment. Field observations confirm Gough's mapping that till (*i.e.*, sediment deposited by a glacier or debris-rich ice) also occurs in the immediate vicinity of the prospect. However, the sandy matrix and lack of fines (silt–clay), the high clast content and the abundance of large boulders (0.75 to >1 m) at the surface all suggest that this till is likely an ablation or melt-out deposit. This material was likely released from the melting of stagnant/dead ice, not by mechanisms active at the ice/substrate contact, such as lodgment processes, that produce material types such as basal till. Figure 2 shows a typical sandy diamicton at the Jake prospect, interpreted here as a colluvium.

Near the Jake prospect, weathered bedrock appears to be close to surface, sometimes within 1 m, and is directly overlain by colluvium. Given the irregular topography, relative changes in elevation and observed bedrock outcropping locally in the area, bedrock is likely within metres (approx. 1–10 m) of the surface beneath the hill where the showing is located and under the hill west of the swampy depression. Bedrock might be more deeply buried down-ice from the showing or in the lee of the high point of land where a greater thickness of till may have been deposited. Local ice-flow directions were not investigated during the present fieldwork, but Paulen *et al,* (2000) report that regional ice-flow was toward the south to southeast.

Basal till does occur in the region. One basal till sample, collected directly north of the Jake prospect near Clearwater Peak, has abundant volcanic rock clasts of the Fennell Formation. Other basal till samples were collected in the northwest part of the mineral property and, in contrast, have a higher content of granitic clasts.

Bedrock Geology and Mineralization

The geology of the area surrounding the Jake prospect has been mapped and described by Schiarizza *et al.* (2002a, b). Much of the mineral claim area, including the Jake prospect, is underlain by pillowed and massive basalt with lesser chert and gabbro representing the upper structural division of the Carboniferous to Permian Fennell Formation. To the east, a lower division of the Fennell Formation has a greater abundance of metasedimentary rocks in the volcanic sequence. Phyllite and slate, interbedded with quartzite and siltstone lamellae representing the Lemieux Creek succession of the Middle and Upper Triassic Nicola Group, outcrop west of the Fennell Formation. The Lemieux Creek fault forms a contact between the Fennell Formation to the east and the Lemieux Creek succession to the west. Further west, sedimentary units within the Lemieux Creek succession are separated from Nicola Group volcanic breccia, tuff, basalt, sandstone and conglomerate by the Taweel Lake fault. Partially infilling the Mann Creek valley and outcropping north of the Jake prospect are flat-lying Quaternary alkaline olivine basalt flows. North and east of Surprise Lake is Jurassic to Cretaceous granite and granodiorite forming part of the Raft batholith.

The Jake property consists of 21 000 ha of contiguous mineral claims, wholly owned by Rimfire Minerals Corporation, centred on the Jake prospect. Rimfire optioned the prospect from M. Kaufman, the prospector who made the original discovery in 2005. Kaufman was alerted to the showing by the gossanous nature of the soils and weathered bedrock exposed in a new forestry access road. In March of 2006, Rimfire excavated trenches centred on the discovery outcrop and oriented parallel to the established road on the basis of the existing exploration permit. The north-south oriented trench cut across multiple steeply dipping veins over a trench length of 75 m. Bedrock in the trench consists of chlorite-altered, pillowed basaltic flows and lapilli tuff and contains 1 to 3% disseminated pyrrhotite and pyrite. Veins have average widths of approximately 50 cm, but swell to widths of up to 100 cm. Individual veins are composed of quartz, pyrite, pyrrhotite, chalcopyrite and bismuthinite. Significant Au mineralization occurs in three separate clusters of quartz veins over a 36 m length of trench (approximately 20 m true thickness). As an example of mineralization, four composite samples across veining over a 4 m strike length returned an arithmetic average of 9.9 g/t Au over an average width of 0.8 m (Rimfire press release, 2006). Up to 10 ppm Au was detected in grab samples of the vein material collected as part of the orientation survey.

There is no record of regional scale exploration for discrete Au-quartz vein deposits in the Fennel Formation within the Jake property, although several Cu-Zn mineralized quartz vein occurrences have been noted on the property, *i.e.*, Mann Creek (MINFILE 092P 029) and CP (MINFILE 092P 116, 117, 118). The most similar style of Au mineralization to the Jake prospect in the region is the Windpass deposit east of the North Thompson River and approximately 24 km south of Clearwater. At Windpass, mineralization occurs within relatively shallowly dipping, north-striking Au-bearing quartz veins (typically about 40 cm wide) hosted by rocks of the Fennell Formation. Vein mineralization contains variable amounts of pyrite, chalcopyrite, bismuth sulphide, free Au, magnetite and Au tellurides. Mining between 1934 and 1939 extracted 93 425 t of rock yielding 1 071 684 g of Au, 53 469 g of Ag and 78 906 kg of Cu. The Windpass deposit is considered a proximal intrusion-related Au deposit associated with the Baldy batholith (Logan, 2001).

Figure 2. Sandy deposit exposed in a trench at the Jake prospect. The deposit is interpreted as colluvium.

The Cam-Gloria Au prospect, a pyrrhotite-pyrite quartz vein occurrence, is located 9 km from the southeast margin of the Baldy batholith (Cathro *et al.,* 2000). The vein has a Au-Bi-Cu-Pb-Mo-Te-W-As geochemical association resembling the Windpass deposit suggesting that the Baldy batholith could be a driver for mid-Cretaceous intrusion-related Au systems (Logan, 2002).

SAMPLE COLLECTION AND ANALYSIS

Overburden (till, colluvium and soil), stream sediment, moss and streamwater samples were collected during a visit to the Jake property in June 2006. Overburden samples were collected from vertical profiles along the south side of a trench crossing the main showing, from a wetland on the north side of the trench and from roadcuts north and northwest of the showing. Stream sediment, moss sediment and streamwater samples were taken from drainages within the property (Fig 3). Bulk stream sediment for heavy mineral concentration was taken from several of the streams. Water sample preservation was carried out in the field; sediment and rock samples were prepared in the BC Geological Survey Laboratory, Victoria, BC. Water samples were analyzed for elements by the Geological Survey of Canada Methods Development Laboratory, Ottawa, Ontario. Pre-preparation (*i.e.,* field) and post-preparation duplicate samples and standard reference materials were included with the samples sent for analysis to commercial laboratories. The –230 (<0.063 mm) fraction of overburden samples was analyzed at ASL Chemex for Au by lead collection fire assay – ICP-ES (inductively coupled plasma emission spectroscopy) and for trace elements by aqua regia digestion – ICP-MS (inductively coupled plasma mass spectrometry). The –80 (<0.177 mm) fraction of stream sediment and moss sediment samples was analyzed for Au and trace metals by the same methods as overburden samples. There is less than 10% difference between pathfinder element (*e.g.,* Cu, As and Bi) analyses of duplicate field and duplicate analytical samples. Gold, arsenic, bismuth and silver analyses of a standard reference material differ by less than 25% of the recommended value for the standard.

RESULTS

Stream Sediment, Moss Sediment and Water Geochemistry

Most Au and pathfinder element (*e.g.,* As, Sb, Hg, Cu, Pb and Zn) values in moss and sediment samples collected as part of the present orientation survey are below thresholds calculated at the 95 percentile from regional stream sediment data for NTS 092P map sheet RGS (Matysek *et al.,* 1992). Values at the 95 percentile are commonly used to define anomaly thresholds for larger datasets, whereas quartiles are more realistic for small sample groups. The third quartile value thresholds (Table 1) calculated from the moss and stream sediment data generated from the present geochemical sampling reveal several subtle multi-element anomalies. Most elements (*e.g.,* Au, Ag, As, Bi, Cd, Cu, Pb, V, and Zn) are higher in moss sediment compared to stream sediment. This enhancement could reflect discrete silicate, oxide or sulphide grains rather than the adsorption of metals to clay-sized minerals and/or secondary oxides. Heavier grains would be captured preferentially from the suspended load in a stream by moss, thereby depleting the sediment in

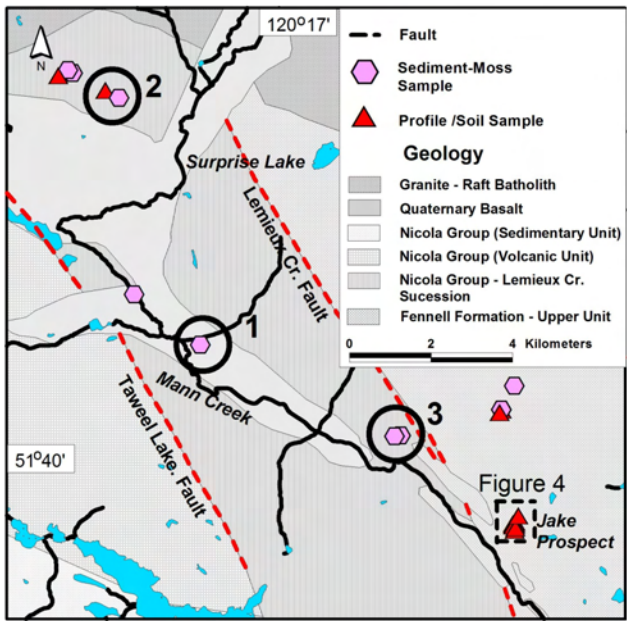

Figure 3. Regional geology, prospect location and geochemical sample locations. Bedrock geology has been summarized from the digital map published by Massey *et al.* (2005).

smaller, heavier grains. This might explain the presence of a moss sediment Au anomaly and the absence of Au in drainage sediment at the same site. While moss sediment clearly increases Au anomaly contrast, the routine use of this media for geochemical surveys is limited by the absence of moss in some streams. Previous drainage surveys on Vancouver Island and in the Adams Lake area have demonstrated the advantages of moss sediment geochemistry in exploration for Au (Matysek and Day, 1988; Lett *et al.,* 2000).

Element anomalies are identified by number on Figure 3. The highest Au value (762 ppb) detected is in moss sediment from a stream draining the area south of Surprise Lake (Anomaly 1). No other anomalous elements occur in either the moss or stream sediment at this site and no visible Au grains were identified in a heavy mineral concentrate prepared from a bulk sediment sample. Other sites with lower Au in drainage sediment and moss sediment have elevated levels of associated pathfinder elements. For example, a stream draining the area underlain by the Raft batholith in the northwest part of the mineral claims has anomalous Au (24 ppb), As, Sb, Bi, Cd, Se, V and Zn in moss with a similar multi-element signature in sediment (Anomaly 2). The streamwater has elevated Cu (3.9 ppb) and Rb. Till exposed in a roadcut near the stream has elevated Bi, Be, Rb, Sr and U, suggesting that the source of the anomalous metal in till and sediment is the granite. Closer to the Jake prospect, a creek draining from the north has detectable, but background Au in sediment and moss with anomalous As, Cd, Cu, Ni, Sb, Se, Tl and Zn (Anomaly 3). There is no obvious source for the anomaly, but the multi-element association could reflect vein-type mineralization in the drainage basin.

Till, Colluvium and Soil Samples

Median value thresholds have been used to identify Au and pathfinder elements in till, colluvium and soil. Median

TABLE 1. MEDIAN, 3RD QUARTILE (QUART) AND MAXIMUM (MAX) VALUES FOR ELEMENTS DETERMINED BY AQUA REGIA DIGESTION – ICP-MS AND AU BY LEAD COLLECTION FIRE ASSAY – ICP-MS IN STREAM SEDIMENT (10 SAMPLES) AND MOSS SEDIMENT (8 SAMPLES). ABBREVIATION: SED, STREAM SEDIMENT.

Element	Sediments			Moss		
	Median	Quartile	Maximum	Median	Quartile	Maximum
Au (ppb)	9	11	22	13	20	762
Ag (ppb)	20	25	33	31	36	49
Al (%)	1.54	1.72	1.99	1.65	1.83	1.92
As (ppm)	6.20	6.90	11.40	7.05	9.35	16.20
Ba (ppm)	100.00	110.00	140.00	75.00	102.50	150.00
Be (ppm)	0.56	0.61	0.84	0.53	0.68	0.94
Bi_ppm	0.13	0.37	0.50	0.16	0.25	0.58
Ca (%)	0.53	0.68	0.75	0.80	0.90	1.40
Cd (ppm)	0.46	0.56	2.88	0.61	0.95	4.90
Ce (ppm)	31.50	42.70	58.20	26.90	42.18	52.50
Co (ppm)	8.00	12.20	21.30	10.70	13.73	15.30
Cr (ppm)	27.00	31.00	51.00	26.00	30.00	42.00
Cs (ppm)	2.06	2.53	3.06	2.01	2.74	3.21
Cu (ppm)	22.5	35.6	39.6	30.1	49.1	65.3
Fe (%)	1.78	2.25	2.88	2.06	2.41	2.71
Ga (ppm)	3.51	4.53	5.15	3.56	4.24	5.10
Hg (ppb)	50	70	90	90	10	130
K (%)	0.05	0.14	0.16	0.09	0.11	0.21
La (ppm)	18.60	28.90	39.10	17.75	27.75	44.30
Li (ppm)	10.40	17.00	18.80	10.15	14.88	18.70
Mg (%)	0.38	0.42	1.00	0.41	0.51	0.79
Mn (ppm)	543	613	1320	741	866	968
Mo (ppm)	2.33	2.92	6.37	0.96	2.08	6.94
Nb (ppm)	2.04	2.32	2.46	1.64	2.60	2.85
Ni (ppm)	18.20	22.80	39.40	17.90	30.35	36.60
P (ppm)	720	780	1290	1020	1070	1140
Pb (ppm)	6.40	8.00	10.20	6.55	8.35	11.40
Rb (ppm)	5.90	19.70	26.00	7.30	11.93	30.80
S (%)	0.04	0.06	0.07	0.10	0.12	0.13
Sb (ppm)	0.26	0.31	1.01	0.35	0.49	1.32
Sc (ppm)	2.90	3.30	4.70	2.85	3.18	3.90
Se (ppm)	1.10	1.30	3.10	1.60	3.08	5.70
Sr (ppm)	25.20	29.00	49.30	33.25	50.93	57.20
Te (ppm)	0.02	0.02	0.03	0.02	0.02	0.04
Th (ppm)	3.60	4.60	7.40	1.85	2.83	6.50
Ti (%)	0.08	0.10	0.17	0.08	0.08	0.17
Tl (ppm)	0.13	0.20	0.30	0.14	0.28	0.46
U (ppm)	1.98	3.16	6.63	2.48	3.26	5.53
V (ppm)	49.00	59.00	74.00	44.50	57.50	77.00
W (ppm)	0.97	1.80	5.83	0.20	1.35	3.52
Y (ppm)	9.50	12.30	15.25	13.15	16.76	21.30
Zn (ppm)	49.00	58.00	146.00	53.00	70.50	140.00

values are those reported by Paulen *et al.* (2000) from data for a regional till geochemical survey in the Chu Chua – Clearwater area. The survey covered a region immediately south of the Jake prospect. Thresholds are 36 ppb Au; 28 ppm As; 1 ppm Bi; 111 ppm Cu; 30 ppb Hg; 1.2 ppm Sb; 1.2 ppm Se; 0.2 ppm Tl; and 89 ppm V. Till samples taken at sites remote from the Jake prospect are shown on Figure 3. Two of the samples have detectable background levels of Au and in the northwest part of the mineral property the till has elevated Bi, Be, Rb, Sr and U.

Locations of vertical sediment profiles east and west of the Jake prospect are shown on Figure 4. Element variations down the vertical profiles reveal that high Au (10 ppm), As (36 ppm), Ag (2.5 ppm), Bi (823 ppm) and Cu (2250 ppm) in quartz vein material are reflected in anomalous metal values in colluvium immediately above the bedrock surface. Increased Se, Tl and V accompany the high metal values, but there are no anomalous elements in the overlying B-horizon soil. Only V is elevated in the deeper sediments from Profile 2, located 20 m to the south of Profile 1, but there are anomalous Au, As, Bi and V in deeper sediments from Profile 4, located 50 m south of Profile 1. The only anomaly present in bedrock and deeper colluvium from Profile 3, located 100 m south of Profile 1, is V and there are no anomalous elements in the overlying B-horizon soil. At Profile 5, located 200 m north of Profile 1, a lower, clay-rich, more dense diamicton (possibly basal till) has anomalous Au, As, Cu and V. Again, these higher values are not reflected in the overlying more sandy sediment or the B-horizon soil. The Au-As-Cu-V association in the lower sediments could reflect another more remote, mineralized source to the north, since Profile 5 may be up-ice relative to Au-Bi-Cu-Ag-As mineralization at the Jake prospect. The absence of Bi, but anomalous V, in the till from Profile 5 could reflect a mineralized source that is different from the Jake prospect.

The spatial variation of elements in soil and glacial sediment over mineralized bedrock at the Jake prospect is summarized in Figure 5 by a series of block prisms. Anomalous element associations down each profile distinguish between Au, As, Bi and V in profiles south of the prospect, compared to Au, As, V to the north. All of the profiles show that anomalous element concentrations are confined to the sediment immediately above the bedrock and that they decrease sharply within more shallow soils.

Wetland Samples

Only the surface, fibrous layer on the wetland just west of the Jake Showing has been sampled and only Se is anomalous in the material. The presence of anomalous Se can be explained by the higher S content of the organic matter. No elements appear to have accumulated in the organic sediment.

CONCLUSIONS

- Much of the Mann Creek valley, including the area of the Jake prospect, is covered by sandy glacial

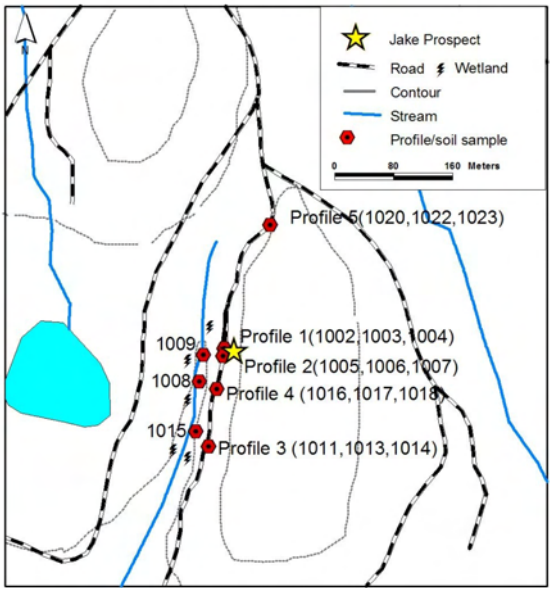

Figure 4. Vertical sediment profile locations around the Jake prospect.

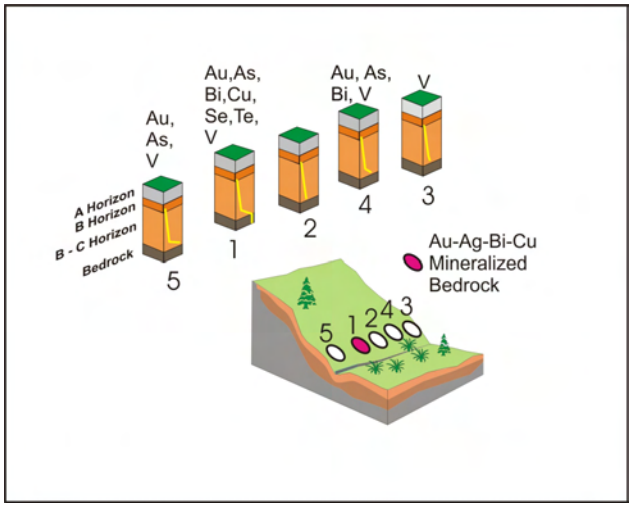

Figure 5. Model showing variation of metals in soil profiles around the Jake prospect.

sediment interpreted as colluvium with perhaps a minor component of melt-out till. Basal till appears to be a common glacial deposit at higher elevations and more stable, less steep slopes in the valley. Element variations in vertical sediment profiles over Au-Bi-Ag-Cu mineralization demonstrate that only samples collected close to bedrock would identify the presence of mineralization. Since basal till (typically a first derivative of bedrock) is the target sediment type for a till geochemical survey, the colluvium and soil (and possibly melt-out till) occurring at the Jake prospect would not be effective media for geochemical surveys. However, basal till surveys could be conducted at a more regional scale. Ideally, in combination with collecting basal till samples, the ice-flow history of the area would have to be investigated so that the transport direction of basal till, and ultimately trace element determinations, could be more accurately interpreted.

- Moss sediment is generally more effective for detecting Au, especially in steeper, high-energy streams where the amount of fine-textured bottom sediment is small. However, the significance of high Au in moss sediment combined with the absence of other typical Au pathfinder elements (*e.g.,* As) in both moss sediment and steam sediment should be treated with caution. One creek northwest of the Jake prospect containing anomalous Au, Ag, As, Sb, Bi, Cd, Se, V and Zn in moss and stream sediment with higher metal in nearby till could indicate vein-type Au mineralization in the granite of the Raft batholith.

ACKNOWLEDGMENTS

The authors very much appreciate the assistance and support from Rimfire Minerals during fieldwork on the Jake prospect and with the subsequent sample analysis. Paul Schiarizza very kindly provided advice on geology of the area around the Jake prospect and identified clast types in the till samples. Gwendy Hall, head of the Environmental Geochemistry Laboratory, Geological Survey of Canada, Ottawa, is sincerely thanked for analyzing the water samples.

REFERENCES

Cathro, M.S. and Lefebure, D.V. (2000): Several new plutonic related gold, bismuth and tungsten occurrences in southern British Columbia; *in* Geological Fieldwork 2001, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 1999-1, pages 207–224.

Gough, N.A. (1988): Soils of the Bonaparte River–Canim Lake map area (92P East Half); *BC Ministry of Environment and Parks,* BC Soil Survey Report 24, 229 pages.

Holland, S.S. (1964): Landforms of British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources,* Bulletin 48, 138 pages.

Lett, R.E.W., Jackaman, W. and Englund, L. (2000): Stream sediment exploration for pluton related quartz-vein gold deposits in southern British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources,* Open File 2000-23, 34 pages.

Logan, J.M. (2002): Intrusion-related gold mineral occurrences of the Bayonne magmatic belt; *in* Geological Fieldwork 2001, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2002-1, pages 237–246.

Logan, J.M. (2001): Prospective areas for intrusion-related gold-quartz veins in southern BC; *in* Geological Fieldwork 2000, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2001-1, pages 231–252.

Massey, N.W.D., MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital map of British Columbia: tile NM 10 southwest BC; *BC Ministry of Energy, Mines and Petroleum Resources,* Geofile 2005-03.

Matysek, P.F. and Day, S.J. (1988): Geochemical orientation surveys: northern Vancouver Island, fieldwork and preliminary results; *in* Geological Fieldwork 1987, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 1988-1, pages 493–502.

Matysek, P.F., Jackaman, W. and Cook, S.J. (1992): British Columbia Regional Geochemical Survey–Bonaparte Lake (NTS 92P); *BC Ministry of Energy, Mines and Petroleum Resources*, RGS 36.

MINFILE (2005): MINFILE BC mineral deposit database; *BC Ministry of Energy, Mines and Petroleum Resources*, RGS 35, URL <http://www.em.gov.bc.ca/Mining/Geolsurv/Minfile/> [November 2006]

Paulen, R.C., Bobrowsky, P.T., Lett, R.E., Jackaman, W., Bichler, A.J. and Wingerter, C. (2000): Till geochemistry of the Chu Chua – Clearwater area, BC (parts of NTS 92P/8 and 92P/9); *BC Ministry of Energy, Mines and Petroleum Resources,* Open File 2000-17, 233 pages.

Rimfire (2006): Jake Trenching Exposes Gold Mineralization; Further Exploration Planned; Rimfire Minerals press release, May 24, 2006.

Schiarizza, P., Heffernan, S. and Zuber, J. (2002a): Geology of the Slide Mountain Terranes, west of Clearwater, south-central British Columbia (92P/9,10,15,16); *in* Geological Fieldwork 2001, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2002-1, pages 83–108.

Schiarizza, P., Heffernan, S., Israel, S. and Zuber, J. (2002b): Geology of the Clearwater – Bowers Lake area; *BC Ministry of Energy, Mines and Petroleum Resources,* Open File 2002-15.

Smee, B.W. (1987): Soil sampling strategies in an area with alpine glaciation, British Columbia, Canada; *in* Practical Problems in Exploration Geochemistry, Levinson, A.A., Bradshaw, P.M.D. and Thomson, I. Editors, *Applied Publishing Limited*, pages 78–82.