Innovative Gold Targets in the Pinchi Fault/Hogem Batholith Area: The Hawk and Axelgold Properties, Central British Columbia (94C/4, 94N/13)

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INTRODUCTION

The Pinchi Fault and Hogem Batholith are major geological elements of central British Columbia (Figure 1).

Both have been long known to localize significant mineral deposits, such as the Lorraine porphyry copper-gold deposit in the Hogem Batholith, and mined mercury deposits such as Takla Bralorne and the Pinchi Mine along the Pinchi Fault. Traditional models for mineralization, derived from past exploration successes and the general geological history of the area, have focused on porphyry copper-gold in the Hogem Batholith, and precious metal and mercury vein and stockwork styles along the Pinchi Fault. Two novel mineral deposit models are currently being tested on the Hawk and Axelgold properties, intrusion-related and alkalic-related styles of gold mineralization respectively. This project, a partnership between the B.C. Ministry of Energy and Mines, Redcorp Ventures Ltd. and Rubicon Minerals Corporation, aims at substantiating the validity and applications of these innovative exploration concepts to other prospects in the area.

REGIONAL GEOGRAPHY AND GEOLOGY

The Hawk and Axelgold properties are located in central British Columbia, about 150 km northeast of Smithers and 300 kilometres north of Fort St. James (Figure 1). Hawk is either ATV or helicopter accessible from a secondary branch of the Thutade-Osilinka road, which departs the Omineca Mining Road 16 kilometres south of the Osilinka Camp; and Axelgold is a short helicopter flight from a logging spur road west of Mt. Ogden. The two properties lie on opposite sides of the Omineca River, which has developed a deep valley in shattered bedrock around the main strand of the Pinchi Fault. The Axelgold is located west of the river, in the Axelgold Range, next to a subsidiary strand of the Pinchi system shown as the Axelgold Fault on Figure 1. The Hawk lies east of the river, in the prominent mountains underlain by granitoids of the northern Hogem Batholith.

The Pinchi Fault, one of the major structural lineaments of the Cordillera, separates the arc terrane, Quesnellia, with its Triassic/Jurassic volcanic and epiclastic strata and related plutons, from the oceanic Cache Creek accretionary complex to the southwest. The fault has had a protracted, complex and still imprecisely constrained history of displacement. Some strands, such as the Pinchi Fault near Pinchi Lake, may be remnants of the southwest-vergent mid-Jurassic collision that trapped the Cache Creek complex between Quesnellia and the outboard Stikinia arc terrane (Struik *et al.*, 2001). The main strand truncates Cretaceous and even Tertiary units. Based on offsets to the north on the Finlay and Kutcho faults (Gabrielse, 1985), the Pinchi probably accommodated on the order of a hundred kilometres of dextral motion in Cretaceous-Early Tertiary time. The Pinchi Fault and its splays, as well as zones of distributed strain in the rocks around it, provide likely structural controls for mineralization. A number of mineral prospects are localized along and near the main fault, including the Pinchi and Takla Bralorne mercury mines, and gold-bearing quartz-stibnite veins at the Snowbird and Indata prospects. The Lustdust skarn-manto system lies 4 kilometres west of the fault (Figure 1).

The Hogem Batholith is a northwest-elongate composite body 160 kilometres long and up to 35 km wide, that intrudes Mesozoic arc-related strata of Quesnellia. It is truncated to the southwest by the Pinchi Fault (Figure 1). It comprises a highly variable Early Jurassic suite of plutons (Hogem intrusive suite; Nelson and Bellefontaine, 1996) that range in age from 206 to 171 Ma by K-Ar methods, (Garnett 1978; converted to new decay constants), and a set of later, cross-cutting granite bodies that are identical in texture and composition to the mid-Cretaceous Germansen Batholith. K-Ar ages of 120 to 100 Ma (Figure 1; Woodsworth *et al.*, 1991, Garnett, 1978) evidence this younger intrusive event. The Early Jurassic phases tend to mildly alkalic, shoshonitic compositions, equivalent to coeval volcanic units of the Quesnellia arc (Nelson and Bellefontaine, 1996). The Lorraine porphyry copper-gold deposit is hosted by one of the youngest Jurassic phases, the Duckling Creek syenite. Similar in style and age to

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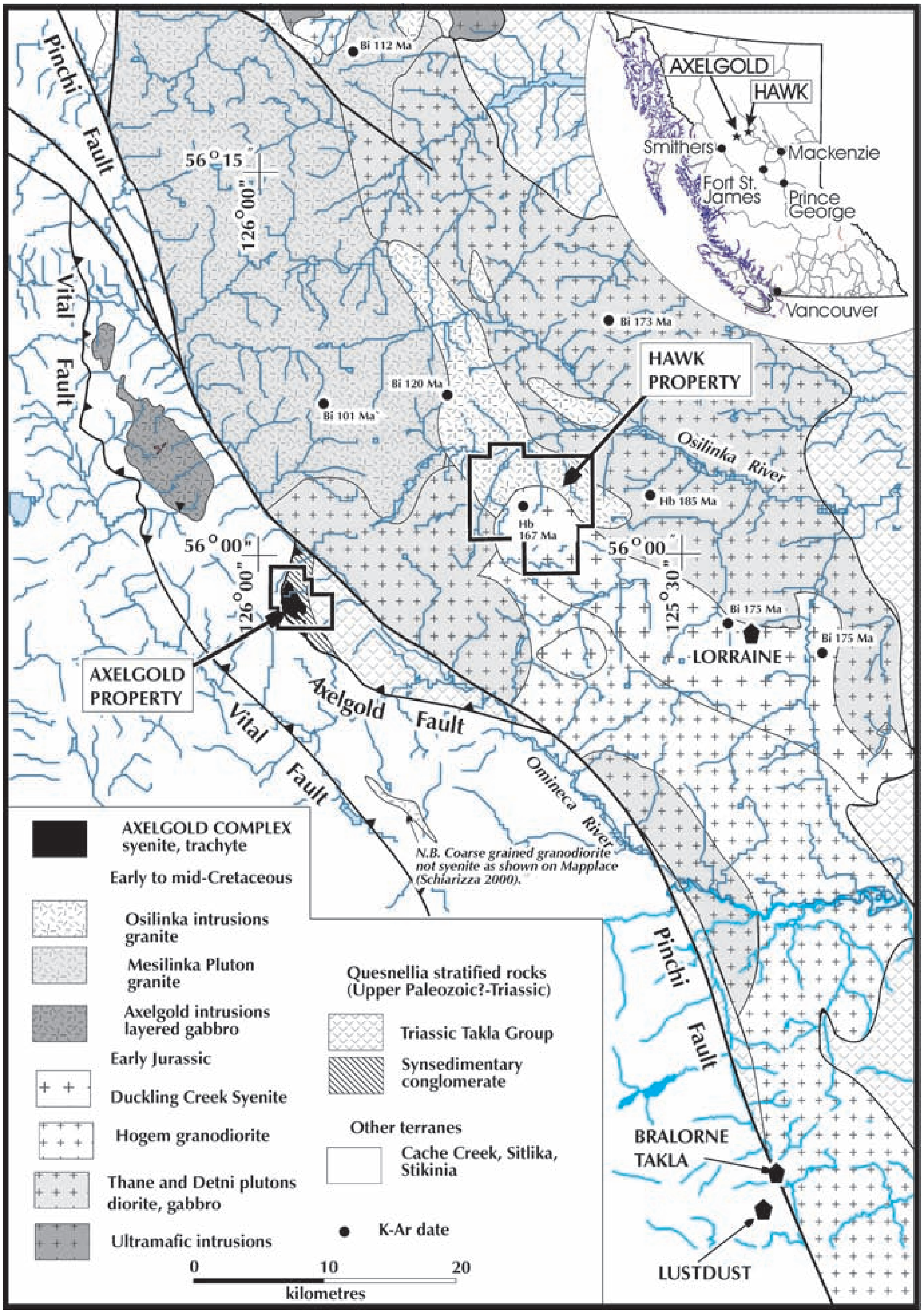


Figure 1. Regional geology of the Omineca River area; location of the Hawk and Axelgold properties, the Hogem Batholith and Pinchi Fault. Sources: Woodsworth (1976), Garnett (1978), Irvine (1976), Paterson (1974), Schiarizza (2000).

Lorraine, the Mt. Milligan porphyry system is associated with a small crowded porphyry monzonite stock southeast of the Hogem Batholith.

THE HAWK VEIN SYSTEM: PERIPHERAL TO PROPHYRY, OR INTRUSION-RELATED AU?

The Hawk property was originally explored for porphyry-style mineralization in the early 1970's by Amoco, and for porphyry-related vein targets by Cyprus and Castleford in the 1990's (Stevenson, 1991). The Hawk veins are roughly centered on the contact between the Duckling Creek syenite to the south and a granite body to the north (Figure 2). They cut both syenite and granite. Woodsworth (1976; Woodsworth et al, 1992) considered the granite body to be of mid Cretaceous age, based on textures, field relationships and K-Ar dating (Figure 1). If correct, this interpretation implies that the Hawk veins are mid Cretaceous or younger, and thus unrelated to Jurassic porphyry-style mineralization in the syenite.

The veins are quartz-rich, with pyrite, chalcopyrite, galena, sphalerite, rare large clumps of scheelite in the Zulu vein and in a few instances, visible gold; elevated gold values are accompanied by silver, bismuth, and tungsten (Redcorp internal report). This geochemical signature, along with the possible Cretaceous host granite, suggests that this may be an intrusion-related Au system, with parallels in the Tombstone plutonic suite in Alaska and the Yukon. One goal of this study is to test the applicability of intrusion-related models to the Hawk veins.

THE AXELGOLD PROPERTY: ALKALIC-RELATED, BUT WHICH INTRUSIVE SUITE?

Geological maps of the Axelgold property show polymetallic mineralization hosted within and adjacent to a small syenite body, which intrudes mixed volcanogenic and sedimentary hosts (Jiang and Hurley, 1996, McInnis, 1998; Figures 1, 7). The intrusion and its country rocks are cut off by the Axelgold fault to the southwest, which juxtaposes them with the oceanic Cache Creek complex. To the northwest, in the northern Axelgold Range, the Cache Creek rocks are intruded by the Axelgold layered gabbro body (Irvine, 1976), which Armstrong *et al.* (1985) assigned a mid Cretaceous age, based on K-Ar and Rb-Sr dating. Irvine (1976) mapped very small syenites and trachytes within the Axelgold gabbro. However, the felsic intrusion on the Axelgold property is separated from the gabbro complex by a major fault, and its host rocks, conglomerate, siltstone, wacke, and lapilli tuff, are considered part of Quesnellia rather than the oceanic Cache Creek Terrane (Paterson, 1974; Taylor, 1987). The Axelgold syenite, described as a multiphase fine grained to Kspar megacrystic body, could be part of the 175 Ma (Garnett, 1978) Duckling Creek syenite on the Lorraine property (G. Nixon, personal communication August 2002; Nixon, this volume). A third possible correlation is with the Eocene monzonite of the Glover Stock on the Lustdust property, which like the Axelgold syenite is a composite of dikelike phases with strong structural control, and is associated with gold mineralization (Ray et al, 2002). Each of these three possible ages, Jurassic, Cretaceous and Eocene, suggests a different exploration strategy for regional equivalents.

GEOLOGY AND MINERALIZATION ON AND NEAR THE HAWK PROPERTY

GRANITOID HOST ROCKS

The Hogem Batholith in the vicinity of the Hawk property, as elsewhere, is highly heterogeneous, comprising a range of compositions from ultramafic to syenitic and alaskitic (Figure 2). The northern part of the property is underlain by a distinctive mafic-poor granite. This body, one of the Osilinka intrusions of Woodsworth (1977), is unusual within the Hogem intrusive suite. It is a pale pink to pale greenish, white weathering, medium grained, equigranular to somewhat inequigranular granite that is homogeneous over tens of kilometres. Sparse mafic minerals in it include biotite and euhedral sphene. Near its southern contact with the Duckling Creek syenite, the granite contains very sparse pink Kspar megacrysts, possibly xenocrysts derived from the syenite. A decrease in grain size towards the contact suggests that it is chilled.

In contrast to the homogeneity of the granite, the Duckling Creek "syenite" is characterized by a plethora of textures and compositions, including Kspar megacrystic and crowded-megacrystic, trachytic phases, as well as phases containing abundant mafic inclusions and/or mafic schleiren, and equigranular granodiorites and monzonites. The degree of foliation ranges from strong to weak. Most foliation textures - crystal alignment and flattening of mafic inclusions - reflect magmatic flow and/or ballooning. Thin local zones of subsolidus deformation occur, with west-northwesterly orientations parallel to the contact with the granite.

Figure 3 shows rare earth element signatures from five samples of the Osilinka granite (Table 1), plotted with a local granodiorite and the data of Barrie (1993) for the southern Hogem batholith. The mainly intermediate Hogem phases, which are moderately LREE-enriched and generally similar to average upper continental crust. The Osilinka granite, although showing relative LREE enrichment with respect to chondrite, is markedly depleted in all REE compared to average upper crust, with a strong negative Eu anomaly that reflects the fractionation of plagioclase. The rare earth elements were probably depleted during extensive fractional crystallization of phases such as titanite.

GOLD-BEARING QUARTZ VEINS

The Hawk property contains gold-bearing quartz veins of several orientations. Originally explored in the early 1970's by Amoco, it was later surveyed and drilled for vein targets by Cyprus and Castleford in the 1990's (Stevenson,

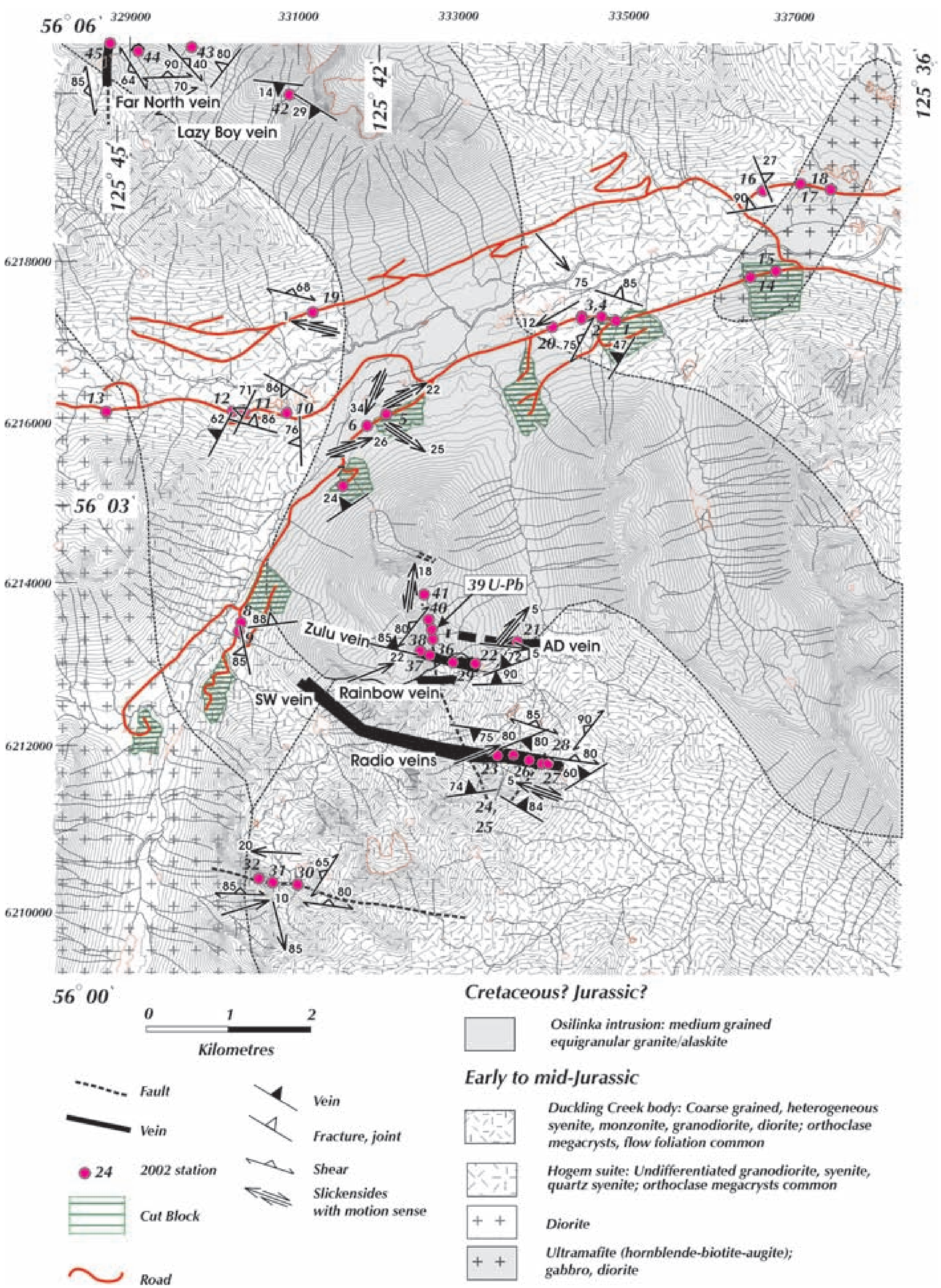


Figure 2. Geology on and near the Hawk Property. 2002 field data, J. Nelson and R. Carmichael; compilation from Woodsworth (1976) and Stevenson (1991).

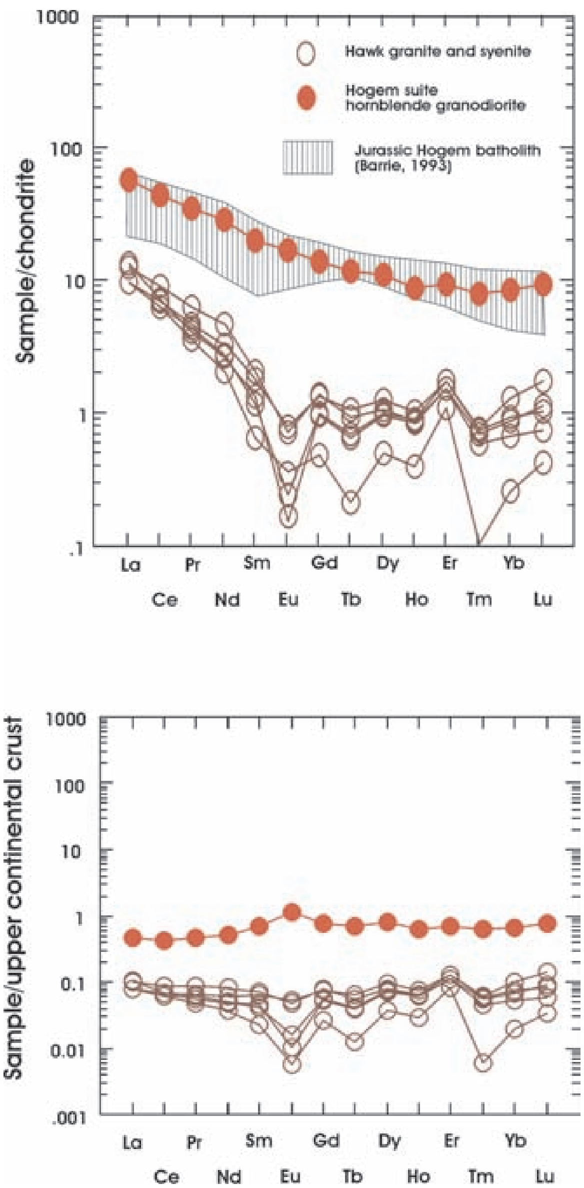


Figure 3. Petrochemistry of the host granite for the Hawk veins.

1991). This work defined three zones of economic interest, the AD, Radio and SW zones. These zones were described as mineralized quartz veins, oriented at 280^{o} to 290^{o} with a maximum exposed strike length of about 100 meters. Reinterpretation of previous results by Redcorp in 2001and 2002 showed a set of linear geochemical anomalies and recognized the potential for:

I) Undiscovered parallel veins;

II) Strike extensions to the known veins, and;

III) A second set of mineralized structures oriented at 250^{o} to 260^{o}.

Prospecting, trenching and diamond drilling in 2002 was designed to test this potential and to evaluate and characterize the known mineralization. The program was successful in confirming all three ideas, resulting in a better appreciation for the economic potential of the Hawk property.

Two new veins, the Zulu vein and the Rainbow vein (Figure 2), were discovered in 2002. The Zulu vein has a minimum strike length of 450 meters, an average width of 0.75 meters and an average grade of 9.69 gpt gold (based on 6 surface chip samples), ranging up to 46.8 gpt gold (assay results from Eco-Tech Laboratories, Kamloops, B.C.). The Rainbow vein has a minimum strike length of 350 meters, an average width of 0.29 meters and an average grade of 10.29 gpt gold (based on 6 surface chip samples). The Zulu vein strikes 280^{o} and dips steeply to the south; the Rainbow vein strikes 017^{o} and dips 24^{o} to the northeast, a new mineralized structural orientation.

The 2002 work program was successful in tracing the Radio veins along strike to the SW vein and establishing that both zones occur on one mineralized structure with a minimum strike length of 3,000 meters. Mineralized float found 1,000 meters along strike to the northwest of the AD vein showing indicates significant strike potential for this vein as well.The soil geochemical compilation indicated several distinct linear gold-in-soil anomalies trending 260^{o} immediately north of the AD vein. An important result of the 2002 work program was the discovery of several mineralized splay veins off the Zulu vein, which also trend 260^{o}. These untested soil anomalies may derive from undiscovered splay veins off the AD structure.

STRUCTURAL SETTING OF THE HAWK VEINS

Sets of fractures and shears, visible on air photos, cut across both intrusive bodies and the contact between them. They strike at 280-290^{o}, 250-265^{o}, 215-220^{o}, and 160-170^{o}, with very steep dips (Figure 4).

There are also gently-dipping joints. The 280^{o} set is of particular importance, as it hosts the main veins on the property. A 170^{o}-striking shear zone 6 kilometres north of the property hosts a quartz vein with a minimum strikelength and local thickness up to 15 metres. In general, the granite-hosted veins occupy comparatively broad, relatively complex, sheared and/or brecciated zones, with selvages of strong sericite alteration up to several metres thick. Exceptions to this include "flat" veins and local splays from the major veins, which occupy simple, joint-like fractures. The syenite-hosted veins, the Radio and SW veins, are typically much narrower structures with very little shearing, brecciation or alteration. Both the 220^{o} and the 160-170^{o} structures offset veins.

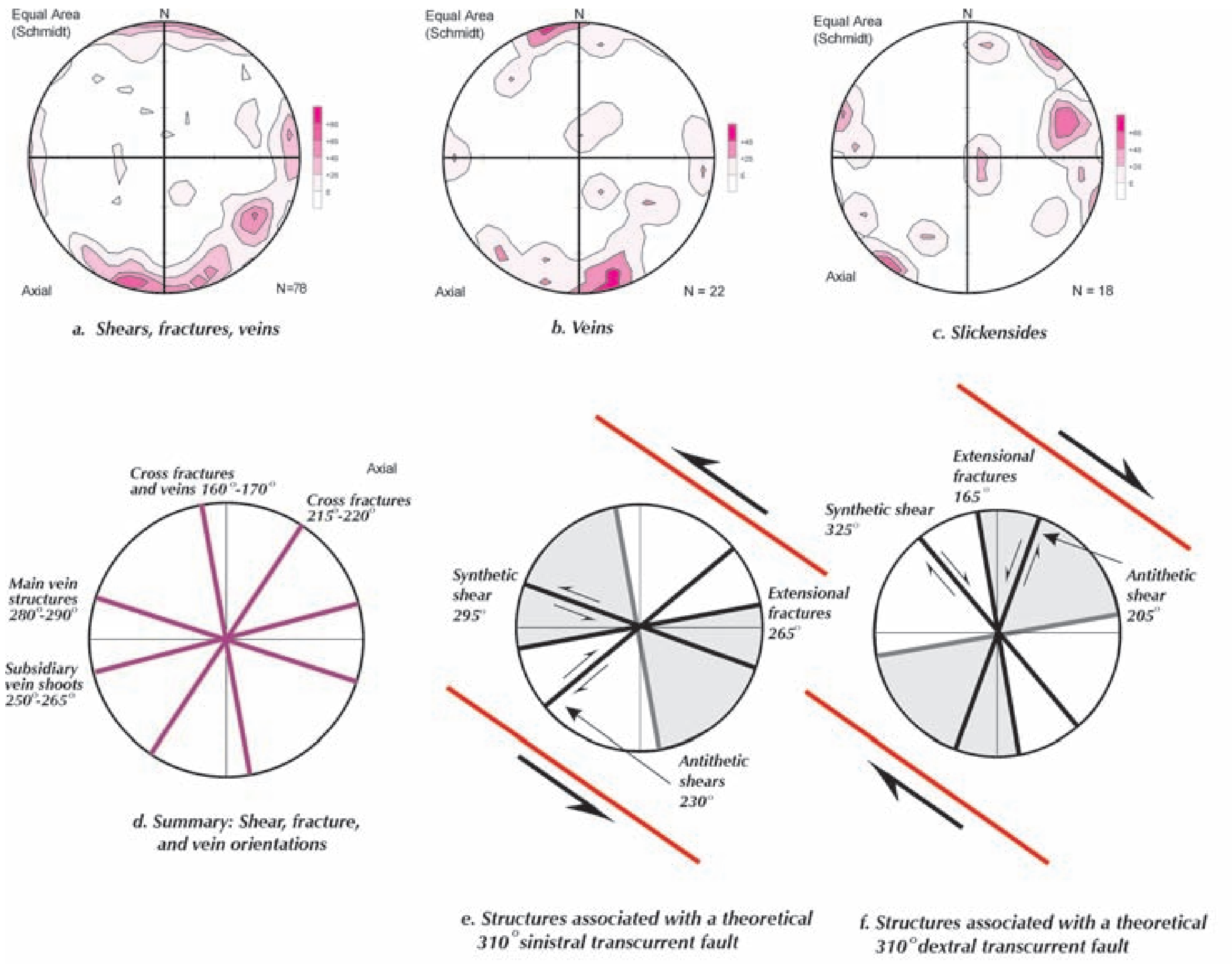
The various fractures and shears have complex, although minor, motion histories, with opposite senses of shear expressed on structures of similar orientation (Figure 4). Features used to determine sense of shear include deflected local foliations, which develop in the granite within the sericite-altered envelopes of veins; slickensides, offsets, deflection of fracture sets, shear bands, and lineation of cataclastic fabric. As shown by gently plunging slickensides (Figure 4c) and other indicators, the motion sense on

TABLE 1
PETROCHEMICAL DATA FROM OSILINKA GRANITE AND HOGEM GRANODIORITE

Sample	Description	UTM-east	UTM-north	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	SUM	Y*	Zr*	Nb*	V*
02JN-HK-01	Granodiorite - coarse, 25%hb	334712	6217085	54.52	0.7	17.77	7.65	0.15	3.03	7.73	3.69	2.4	0.25	1.46	99.48	17	74	3	166
02JN-HK-05	Granite - mg, alaskitic	331975	6216058	71.9	0.14	15.46	1.17	0.02	0.18	1.27	5.13	2.91	0.02	0.87	99.28	4	76	<3	23
02JN-HK-10	Quartz syenite	330785	6216113	73.65	0.07	14.67	0.93	0.02	0.09	1.2	5.09	3.25	0.01	0.46	99.59	<3	56	<3	17
02JN-HK-39	Granite - mg, alaskitic	332550	6213240	72.29	0.1	15.18	0.93	0.02	0.07	1.1	5.23	3.33	0.01	0.8	99.25	3	80	<3	19
02JN-HK-41	Granite - mg, alaskitic	332500	6213750	72.66	0.1	15.05	0.87	0.02	0.15	1.28	5.17	3.4	0.01	0.46	99.37	5	85	4	16
02JN-HK-42	Granite - mg, alaskitic	330900	6219500	70.31	0.14	16.43	1.2	0.02	0.23	1.72	5.63	2.71	0.01	0.95	99.58	3	107	<3	19

Sample	Ba	Y	Zr	Hf	Nb	Ta	Th	La	Ce	Pr	Nd	Sm	Eu	Gd160	Tb	Dy	Ho	Er	Tm	Yb	Lu
02JN-HK-01	1545.794	13.595	109.961	2.396	9.346	0.419	4.671	13.559	26.407	3.247	13.18	3.004	0.977	2.826	0.437	2.751	0.49	1.53	0.2	1.43	0.24
02JN-HK-05	1551.293	2.151	78.964	1.675	3.695	0.128	0.226	2.296	4.211	0.45	1.538	0.28	0.045	0.277	0.04	0.322	0.06	0.29	0.02	0.159	0.03
02JN-HK-10	1411.634	1.161	50.162	1.202	3.14	0.092	0.143	2.335	3.902	0.34	0.955	0.101	-0.01	0.1	0.008	0.128	0.02	0.19	0	0.044	0.01
02JN-HK-39	1688.25	1.958	83.783	1.973	5.006	0.166	0.509	2.309	3.911	0.42	1.31	0.204	0.009	0.201	0.025	0.244	0.05	0.26	0.02	0.147	0.03
02JN-HK-41	2143.571	2.225	76.763	2.571	4.969	0.222	1.817	3.16	4.36	0.395	1.246	0.18	-0.01	0.206	0.026	0.254	0.05	0.29	0.02	0.223	0.04
02JN-HK-42	2304.38	1.88	86.019	1.999	4.256	0.098	0.373	3.042	5.502	0.609	2.159	0.315	0.041	0.288	0.034	0.272	0.05	0.26	0.02	0.112	0.02

Oxides: Fused Disc - X-ray fluorescence; Cominco Laboratories   * = Pressed pellet-XRF; Cominco Laboratories   Other traces: Peroxide fusion-ICPMS; Memorial University



	Shear sense (number of measurements)	Shear sense pre-mineralization	Shear sense syn-mineralization	Shear sense Post-mineralization
Main vein structures 280°-290°	Sinistral (2) Dextral (3) Downdip JN 31	Dextral Splays in dextrally deflected 240 foliation JN 28 Zulu vein JN 29	Dextral South vein JN 25	
Subsidiary vein shoots 250°-265°	Sinistral (1) Dextral (3)			
Cross fractures 215°-220°	Sinistral (3) Dextral (2)			Sinistral Offsets Radio vein Jn27, 28
Cross fractures and veins 160°-170°	Sinistral (2) Dextral (2)		Sinistral Vein-bearing structure offsets 220 cross fractures JN 40	Dextral Dextral shear bands offset vein shoots JN 45

Figure 4. Structural analysis of veins, shears and fractures on and near the Hawk property.

shears is predominantly transcurrent, except for downdip catalastic fabric lineation on one prominent 280° shear south of the main vein system.

The Hawk vein set is located 10 kilometres from the Pinchi Fault: sets of local shears may have developed as subsidiary structures to it. Figures 4e and 4f show the predicted orientations and offsets of shears and extensional fractures associated with, respectively, sinistral and dextral transcurrent motion on a 310 degree-striking master fault such as the Pinchi. Each accounts for part but not all of the observed features. Given this, and the observed opposite senses of motion on each shear set, a model of fault reactivation is reasonable. Fault reactivation occurs when new motion takes place on a pre-existing shear plane which is near but not at the ideal orientation for failure in the ambient stress field. The main 280-290° vein-hosting shears could have initially formed as sinistral faults related to sinistral motion on the Pinchi, because they closely correspond to the 295° predicted orientation of synthetic shears. This would explain the sinistral sense of motion on them. During later dextral motion, they could have been reactivated as dextral faults proxying for the ideal 325° synthetic shears. Similarly, northeast-striking shears show both sinistral and dextral motion. The sinistral motion, which post-dates veining, corresponds to antithetic shears in a dextral system (Figure 4f). The north-northwesterly shears correspond best to extension features developed in a dextral system (Figure 4f); there is also minor dextral motion on them.

The veins post-date most, but not all, offsets on shears. For instance, in the Radio vein, undeformed 250° splays feather into dextrally deflected shear fabric in the main 290° structure (Figure 4). On the other hand, sinistral motion on the 220° shear set (resulting from dextral motion on the 310° master fault) postdates mineralization, because it offsets the Radio vein; and shear bands related to dextral motion on the 160-170° set offset vein shoots. This suggests that veining took place after the transition from sinistral to dextral regional shear couples, but before dextral motion on the Pinchi Fault ceased.

INTRUSION-RELATED GOLD MODELING: GEOLOGICAL, GEOCHEMICAL AND ISOTOPIC INDICATORS

The apparent localization of the Hawk gold-quartz veins along the margins of the Osilinka pluton is an indirect argument for relating mineralization to the granite. On the other hand, a direct connection cannot be demonstrated. None of the mineralized veins grade into pegmatites. White, flat-lying, barren quartz veins do show this relationship, but they may belong to an earlier generation. The strong structural control of the gold-bearing veins could indicate that they formed significantly later than the intrusive bodies that host them. Unlike many deposits of the Tombstone belt and Fairbanks district, fracture-controlled sheeted veins are not observed.

Intrusion-related gold mineralization is associated with a characteristic suite of elements, including Bi, W, As, Mo, Te, Sb and low concentrations of base metals (Lang and Baker, 2001). Bismuth, molybdenum and tungsten in particular may indicate the role of high-temperature magmatic fluids. In Figure 5, log-log cross-plots based on analyses from quartz veins on the Hawk property show that Ag, Bi, and Pb correlate positively with Au. Copper, tungsten, molybdenum and tungsten are elevated but do not correlate with gold. This is probably due to the uneven distribution of mineral phases in the veins. For instance, scheelite has only been recognized in a single clot 10 cm across in the Zulu vein. Arsenic and antimony occur only in trace amounts. Significantly, the field of Au/Bi values from the Hawk veins overlaps the field of analyses from gold-bearing, plutonic related quartz veins in southern B.C. (Logan, 2001).

Lead isotopic analyses were performed on two galena samples from the Hawk veins by Janet Gabites at the University of British Columbia Geochronological Laboratory (Table 2). Figure 6 shows this data. Also plotted are fields for the Cretaceous, continental, intrusion-related(?) gold vein system at Cassiar (Bradford, 1988), feldspar leads from the mid-Cretaceous Tombstone intrusive suite (J. Mortensen, unpublished data), Jurassic veins of Stikinia and the Copper Mountain copper-gold porphyry deposit of southern Quesnellia (Godwin *et al.*, 1988). The lead in the Hawk veins is most similar to that from Jurassic Snip and Sulphurets veins. It is more radiogenic than Copper Mountain, but considerably less radiogenic than leads associated with the Cretaceous, continental gold deposits of the Tombstone suite and at Cassiar. This signature is consistent with 1) a Jurassic age for the Hawk veins and 2) their location within the Intermontane belt, which is partially underlain by thick, pericontinental crust. The unradiogenic Copper Mountain leads may reflect more mantle input.

A uranium-lead date for the host granite is now in progress.

Hart *et al.* (2002) divided the deposits of the Tintina gold province, which includes both the Fairbanks and Tombstone districts, into three end-member types: intrusion-related, such as Fort Knox, epizonal, such as Donlin Creek, and shear-related, such as Longline and Pogo. The shear-related deposits, because they are structurally focussed, contain much higher gold grades than the other categories. They tend to have equivocal or distal relationships with causative plutons, although they may have plutonic hosts. Their location within shear zones, and features such as tensile vein arrays and ductile shears, ally them with orogenic vein deposits. The Hawk veins fit most closely into this class.

ARE THERE OTHER HAWK VEIN SYSTEMS IN THE NORTHERN HOGEM BATHOLITH?

Regional prospecting in 2002 led to the discovery of two significant, previously undocumented veins hosted by granite of the Osilinka pluton, in a cirque 5 kilometres north of the Hawk property, the Lazy Boy and Far North veins (Figure 2). The Lazy Boy vein strikes 100-125 degrees and

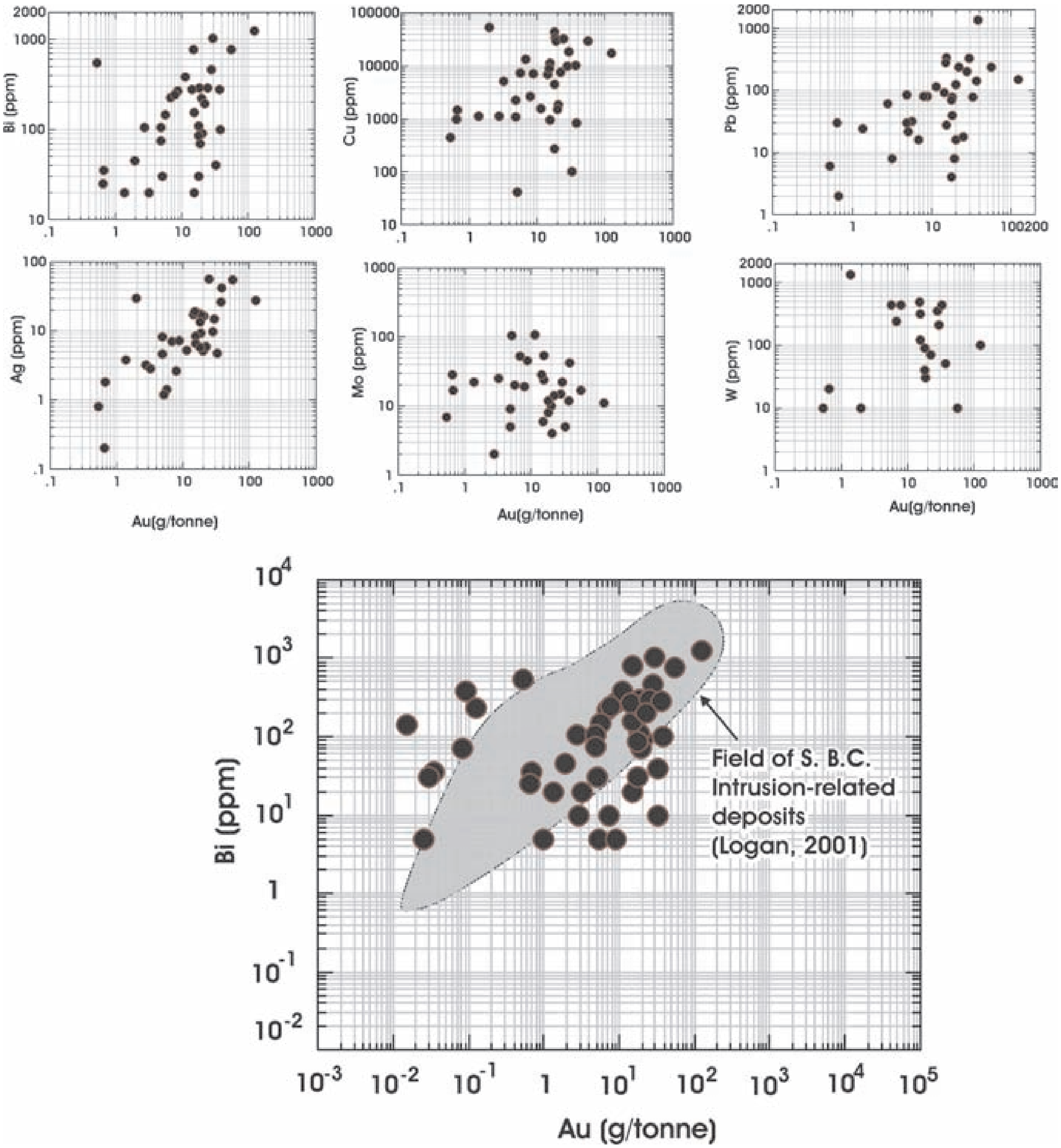


Figure 5. Geochemical correlation diagrams: Hawk vein samples: plotted vs. Au. Data from Redcorp Ventures Ltd.; Eco-Tech Laboratories analysis.

dips gently at 15 to 30 degrees to the south. It forms a low knob in the flat bottom of a subsidiary cirque with a total exposure of approximately 15 by 25 metres and a thickness of between 0.50 and 0.75 metres. White quartz in the vein contains pyrite and traces of galena. The highest grab sample assay from this vein returned 1.78 g/tonne Au and 10.4 g/tonne Ag. The Far North vein occupies a prominent 170° striking shear zone that can be traced over a kilometre. In its main exposure, the quartz vein attains widths of 15 metres, and contains streaks and laminae of pyrite. Extensions can be seen in the cirque floor to the south, and in the headwall of the adjacent cirque to the north. Although only containing trace amounts of gold, a few samples from this outcrop contain anomalous Bi (to 140 ppm) and W (to 340 ppm).

So far, all known vein occurrences are located either within or near one of the granitic Osilinka plutons (Figure 2). This setting may or may not stand up as a “hard” constraint on their distribution. Further exploration should employ air-photo analysis for identifying possible vein-hosting linear structures, in combination with detailed geochemical sampling and prospecting. In comparison to copper-gold porphyry systems, Hawk-type gold-quartz vein systems, with their spatially limited geochemical ha-

TABLE 2
LEAD ISOTOPIC DATA FROM HAWK VEINS

Sample Number	UTM East	UTM North	Mineral	206Pb/ 204Pb	Pb64 %err	207Pb/ 204Pb	Pb74 %err	208Pb/ 204Pb	Pb84 %err	207Pb/ 206Pb	Pb76 %err	208Pb/ 206Pb	Pb86 %err
Flat Vein	332432	6212856	galena	18.8793	0.045	15.6511	0.066	38.6353	0.087	0.8290	0.022	2.0465	0.044
BCR-003	330783	6216117	galena	18.8385	0.043	15.6248	0.065	38.5162	0.087	0.8294	0.022	2.0446	0.043
HK-42	329803	6220532	sphalerite?	18.8940	0.043	15.7579	0.065	38.9881	0.087	0.8340	0.022	2.0635	0.044

Analyses by Janet Gabites, Geochronology Laboratory, Department of Earth and Ocean Sciences, The University of British Columbia.
Results have been normalized using a fractionation factor of 0.15% based on multiple analyses of NBS981 standard lead.

loes and negligible alteration effects, may have been overlooked.

GEOLOGY AND MINERALIZATION ON AND NEAR THE AXELGOLD PROPERTY

On the Axelgold property, disseminated and vein-style, gold-enhanced polymetallic mineralization coincides with a small syenite body. The syenite and its country rocks are bounded to the southwest by the Axelgold Fault (Figures 1, 7). Geological mapping in 2002 focussed on three issues: the extent and nature of the syenite body, the nature and regional correlations of its host rocks, and the displacement history of the Axelgold Fault and its relation to the syenite.

STRATIGRAPHIC FRAMEWORK

The southern Axelgold Range northeast of the Axelgold Fault is underlain by a three northwesterly-elongate fault slivers, each of which comprises a distinct rock unit (Figure 7).

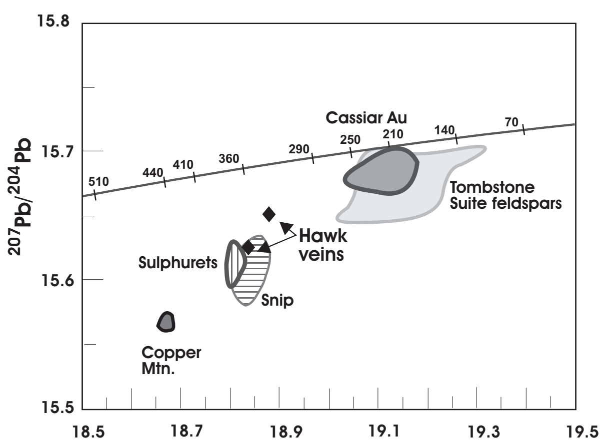


Figure 6. Pb isotopic analyses from Hawk veins. Data sources: Table 2; Bradford (1988), Godwin *et al.* (1988), Mortensen (unpublished data).

They are: 1) synsedimentary breccia, which hosts the syenite; 2) regularily bedded, grey shale and siltstone and green volcanic sandstone and 3) grey, brachiopod-bearing siltstone/shale/pebble conglomerate. All of these units have analogues within Quesnellia. As first noted by Paterson (1974), they do not belong within the Cache Creek Terrane.

The synsedimentary breccia unit is coarse, immature, matrix-supported in areas of relatively low clast density, and rarely bedded. Clasts of grey radiolarian chert and black radiolarian-bearing argillite, limestone, volcanics and ultramafites, occur in a dark grey, graphitic matrix. Sparse, bright green micaceous clasts are probably fuchsite. The argillite clasts tend to be subangular, irregular and flattened, features that suggest they are intraclasts. In one area this sediment-dominated unit grades into a volcanic-dominated facies, in which green and red volcanic and orange-weathering carbonate clasts are surrounded by a green to maroon, tuffaceous matrix. The sedimentary breccia is characterised by significant ductile strain throughout, with strong flattening and elongation of the clasts. Its affinity is uncertain. It differs from the Triassic units of Quesnellia in several significant respects. Most notable is the presence of ultramafic clasts. Some of these are quartz-carbonate altered. Others are remarkably fresh, with clinopyroxene(-spinel) cumulate textures and serpentinized interstitial olivine. They could be derived from the Cache Creek Terrane, as could the radiolarian cherts. Ultramafic clasts occur in the Triassic Tezzeron succession near Pinchi Lake, which Struik *et al.* (2001) included within the Cache Creek Terrane. The volcanic clasts include plagioclase-phyric and equigranular, plagioclase-rich lithologies. Although of probable intermediate island arc affinity, they lack the augite and hornblende phenocrysts that are nearly ubiquitous in the Takla Group. No clasts similar to Cache Creek basalts were seen.

The degree of penetrative strain displayed in the sedimentary breccia unit exceeds both that of the Takla Group regionally, and the degree of strain in the other

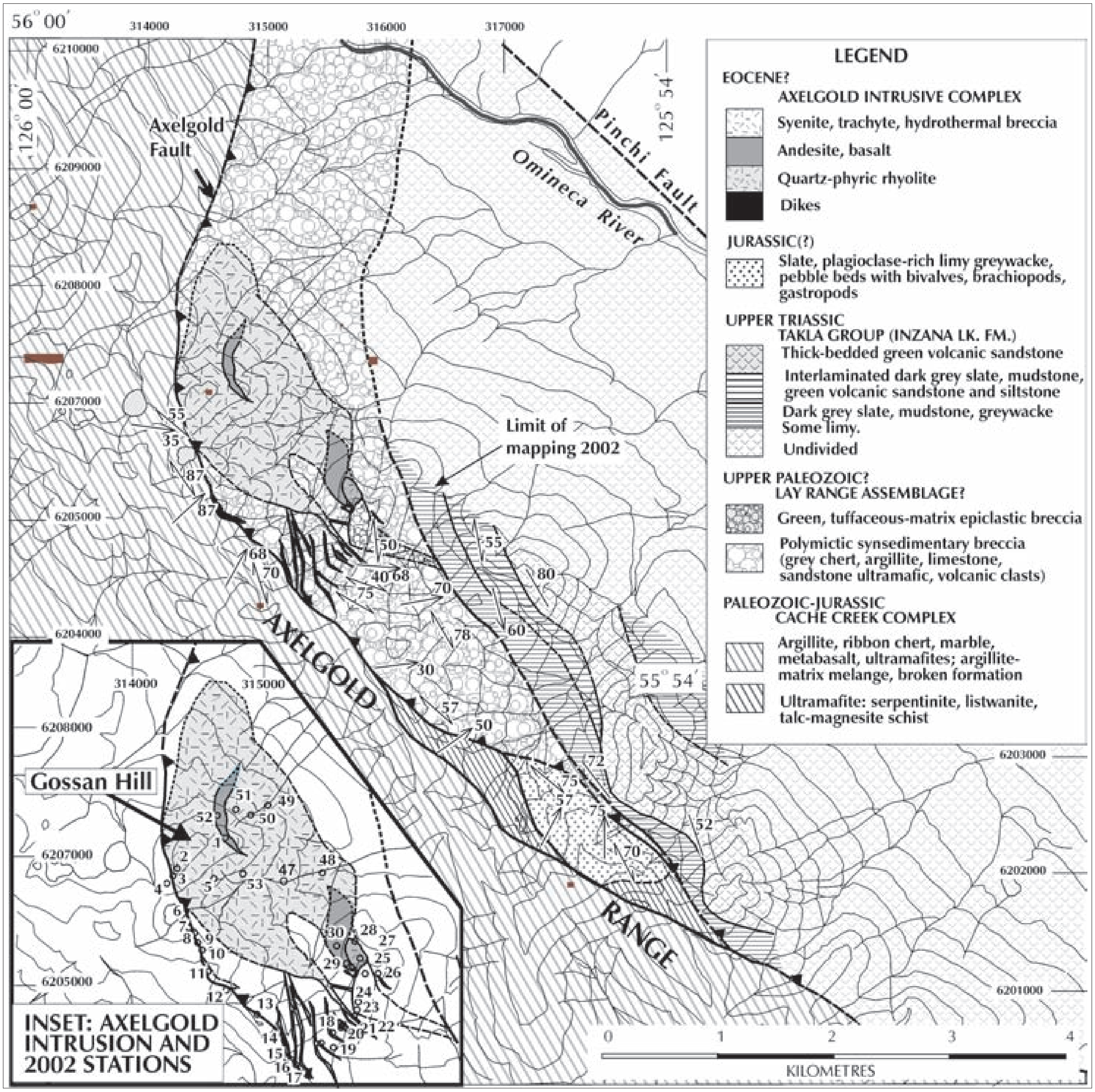


Figure 7. Geology on and near the Axelgold Property. Mapping by J. Nelson 2002.

fault-bounded units locally. It may be of Paleozoic age, part of the Harper Ranch subterrane of Quesnellia. Its provenance requires proximity to sources of oceanic detritus: perhaps it represents the Paleozoic forearc region of Quesnellia, as the Tezzeron succession represents the Triassic forearc.

The second unit is identical to the Inzana Lake formation, the lower unit of the Takla Group in the Nation Lakes area of central Quesnellia (Nelson and Bellefontaine, 1996). Interbedded dark grey shale, siltstone and limy siltstone at its base coarsen upward through thinly interbedded green volcanic sandstone and grey siltstone, into a resistant, cliff- and summit-forming unit dominated by thick-bedded volcanic sandstone (Figure 7). In marked contrast to the homogeneous synsedimentary breccia unit, this sequence is very well bedded. The volcanic sandstones are in places graded, and some of their bases show load casts. They are turbiditic in origin, as evidenced by the incorporation of wispy black shale intraclasts as well as sparse pebble-sized volcanic detritus. They are rich in plagioclase, with fresh, black hornblende and augite grains visible in some samples. Although cleaved, this unit does not show penetrative ductile deformation.

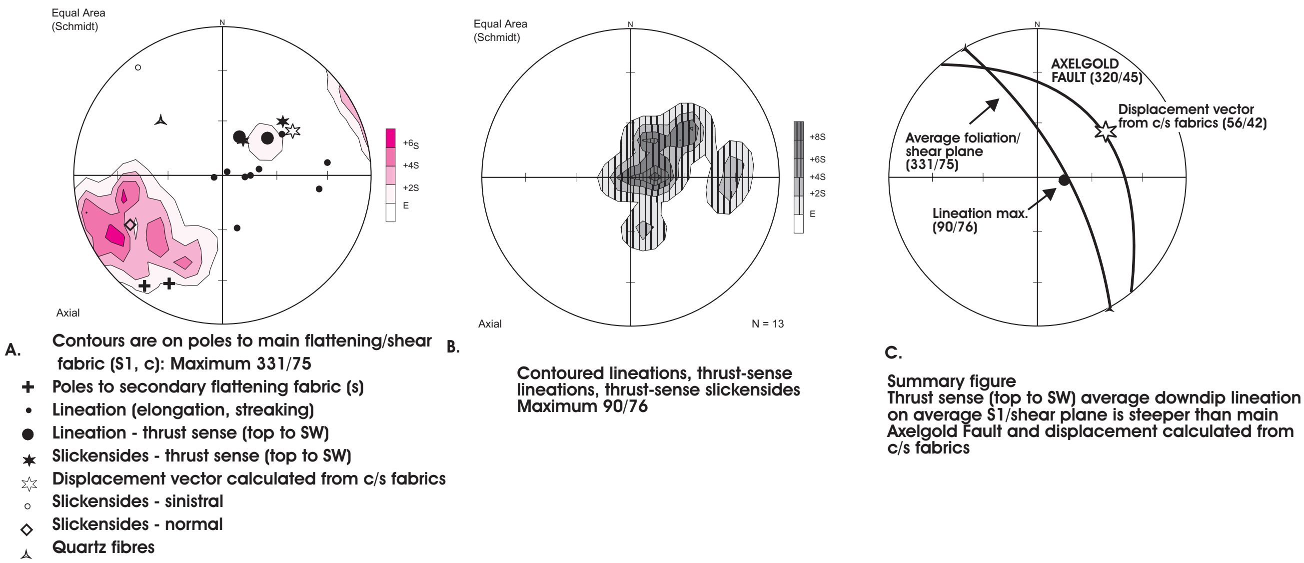


Figure 8. Structures on and near the Axelgold property.

The third unit is entirely sedimentary, with no volcanogenic detritus. It comprises limy shale, siltstone, sandstone/greywacke and sandstone with rounded chert pebbles. Fragments of bivalves, brachiopods, and gastropods are very common in parts of this unit, particularily in the coarser, sandy beds. It is cleaved, but neither fossil fragments nor clasts show any flattening. T. Poulton (personal communication, October 2002) notes that the brachiopods, probably rhynchonellids or spiriferids, appear to be generalized, non-diagnostic forms; however a Lower or Middle Jurassic age is reasonable. In central Quesnellia and the Cache Creek Terrane, pre-Jurassic shallow-water shelly faunas are rare. This unit occurs in a structural panel with Cache Creek ultramafic rocks, west of the main Axelgold Fault (Figure 7). It could be a late-stage, syn-accretionary overlap sequence similar to the Bowser Lake Group, or Toarcian sedimentary rocks of central Quesnellia (Nelson and Bellefontaine, 1996).

STRUCTURE

The most prominent structure in the southern Axelgold Range is the steeply northeast-dipping Axelgold Fault, which here separates Quesnellia from the Cache Creek Terrane. Numerous shear and subsidiary faults imbricate the rocks on both sides of the main fault. Regional geological relationships (Figure 1) imply that the Axelgold Fault is an early structure, cut off by the main strand of the Pinchi Fault.

Small-scale linear features range from ductile to brittle in origin. They include clast elongation in the synsedimentary breccia, mineral lineations in carbonatized ultramafites, and slickensides. With rare exceptions, these lineations plunge steeply to the northeast, indicating primarily dip-silp movement (Figure 8).

Where motion sense indicators are present, such as steps on slickensided surfaces, c-s fabrics and shear bands, they indicate top-to-the-southwest, thrust-sense motion on the Axelgold Fault and within the rock masses around it. A few shallowly-plunging sinistral, and no dextral indicators were observed. Given that the Cretaceous-Tertiary history of the Pinchi Fault involved regional dextral motion (Gabrielse, 1985), it is reasonable that the Axelgold Fault and its surrounding rocks preserve the record of an earlier, proto-Pinchi thrust motion history, perhaps analogous to the area around Pinchi Lake (Struik *et al.*, 2001).

Rocks of the Axelgold intrusive complex are unfoliated and unsheared. Dikes of the complex follow and fill shears developed within the synsedimentary breccia unit (Figure 9).

On the other hand, the complex is confined to the panel northeast of the Axelgold Fault. Dikes approach the fault but do not cross it. This may be due to late reactivation of the fault, rock competency contrasts between the Cache Creek argillites and serpentinites *versus* the brittle synsedimentary breccia, or both.

THE AXELGOLD INTRUSIVE COMPLEX AND ITS ASSOCIATED ALTERATION AND MINERALIZATION

The Axelgold intrusion is a northwesterly-trending, composite intrusive body, 3 kilometres long by over a kilometre wide, centred on a ridge informally called "Gossan Hill", where spectacular iron-streaked ridge-top exposures rise out of heaps of orange talus. The margins of the body dip steeply northeast, controlled by the structural fabric of its country rocks. Dike swarms both cut and extend southeastward from the main body, in some cases following shear planes in the host synsedimentary breccia. Syenitic phases are predominant, ranging from porphyryitic with Kspar megacrysts, through finer grained to aphanitic. Small biotite books distinguish the later dikes from the main intrusion. One unusual phase, a quartz-phyric rhyolite with square to rounded, embayed phenocrysts, forms a small pluglike body in the southeastern part of the complex (Figure 7).

Intrusive rocks tend to be strongly altered, with abundant secondary sericite, ankeritic carbonate and Kspar (C. Leitch, petrographic report for Rubicon Minerals, October, 2002). Green microporphyritic andesite or trachyandesite phases show comparatively weaker alteration. A significant proportion of the intrusion shows breccia textures, in which intrusive fragments are surrounded by a clastic matrix. The breccias range from coarse-textured (fragments > 10 cm) to very finely comminuted. Some are monolithologic; others are polymictic, containing a mixture of clasts from different intrusive phases, for instance megacrystic and fine grained equigranular syenites and trachytes. Crystal clasts of Kspar and lesser embayed, igneous quartz are also present, particularily in the finer grained breccias. Multi-episodic brecciation is shown by breccia clasts surrounded by breccia matrix.

The microscopic textures of these breccias are compatible with either an intrusive-hydrothermal, or alternatively a surface, pyroclastic origin (C. Leitch, petrographic report for Rubicon Minerals, October, 2002). Field characteristics and relationships of the breccias clearly favor the hydrothermal, intrusive option. The breccias occur wholly within the Axelgold intrusive complex, and their clasts are solely derived from syenites, trachytes and rhyolites of the complex. They share alteration assemblages with the rest of the complex. Overall morphologies of the breccia bodies are roughly tabular and steeply northeast-dipping, similar to the shapes of individual intrusions of the complex (Allen, 2002). In detail, breccia zones in core cut across unshattered syenite. So far, the only dikes that have been observed to cross-cut the breccias belong to the late-stage, relatively unaltered andesite group; although the biotite-phyric trachytes do not appear to be brecciated. These characteristics suggest that hydrothermal brecciation occurred within the syenite complex, probably during the later stages of its emplacement.

Gold mineralization within the Axelgold syenite complex is of disseminated to stringer, and rarely vein style. Higher gold values tend to be associated with the Kspar-biotite-plagioclase monzonite dikes. Mineralization comprises quartz, carbonate, fluorite, pyrite, chalcopyrite, chalcocite, ?tetrahedrite, galena, stibnite, and a bright green micaceous mineral that has not yet been positively identified. Microscopically, it consists of fine grained, greenish sericite-like masses that in some cases surround

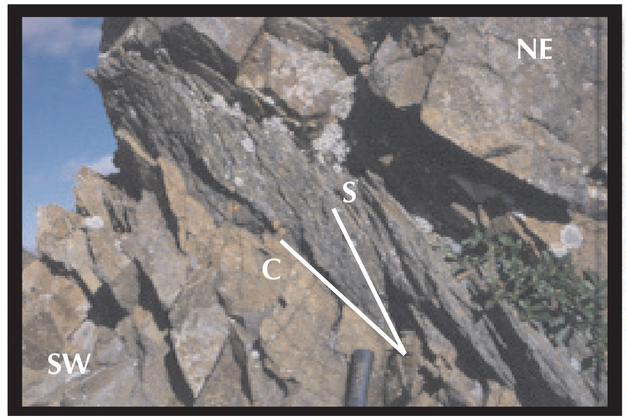


Figure 9. Trachyte dike cutting c-s fabrics in the sedimentary breccia unit, Axelgold property.

opaque material, possibly magnetite replacing chromite grains. A rock sample containing roughly 5% of this mineral returned low values of vanadium (9 ppm) and chromium (68 ppm). These low abundances fail to support identification of either the vanadium mica roscoelite or the chromium mica fuchsite. On the other hand, anomalous gold values in surface rock samples correlate with vanadium (*see* below).

PETROCHEMISTRY OF THE AXELGOLD INTRUSIVE COMPLEX

Because of the intense, pervasive alteration within the Axelgold complex, whole-rock analytical data is of little use for igneous rock characterization. Mineralogically, the complex is dominantly syenitic with subordinate monzonite and granite phases. Relict igneous features indicative of felsic alkalic composition include the predominance of orthoclase phenocrysts with little quartz and plagioclase; and trachytic as well as equigranular, Kspar-rich matrix textures. However , to characterize these rocks in detail, immobile trace element chemistry is the tool of choice. Five representative samples were analysed for immobile elements, including rare earths (Table 3). Key plots are shown on Figure 10.

On the Zr/Ti vs. Nb/Y discrimant diagram of Winchester and Floyd (1977), Axelgold syenites plot in the alkalic, comendite-pantellerite field. They contrast with the mildly alkalic, shoshonitic arc rocks of Quesnellia, which plot in the subalkaline field on this diagram. The Axelgold syenites are highly enriched in light rare earths (Figure 10). They are similar to monzonites of the Eocene Glover stock on the Lustdust property, but unlike the more mildly LREE-enriched Jurassic Hogem batholith. This evidence, although not conclusive, suggests that the Axelgold complex and Glover stock are part of an Eocene alkalic belt that parallels the Pinchi Fault.

DEPOSIT MODELLING

Gold mineralization within the Axelgold syenite complex offers intriguing parallels with other alkalic-related

TABLE 3
PETROCHEMICAL DATA FROM AXELGOLD SYENITE

Sample	Description	UTM-east	UTM-north	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	SUM	Y*	Zr*	Nb*	Rb*	Sr*
AX02-11-22.86 m	Syenite; medium to coarse-grained porphyry	314607	6206694	69.50	0.30	14.69	2.24	0.03	0.89	0.32	4.29	4.63	0.08	2.53	99.83	19	230	20	150	600
AX02-14-25.91 m	Syenite intrusion breccia	314375	6206680	63.03	0.63	15.06	4.36	0.08	1.76	0.73	1.65	6.81	0.29	5.03	99.44	36	370	30	244	600
AX02-14-174.69 m	Syenite; medium to coarse-grained porphyry	314391	6206784	71.22	0.29	14.44	2.01	0.01	0.31	0.24	4.31	4.72	0.09	2.09	99.90	20	240	20	137	700
AX02-09- 56.2 m	Orthoclase-plagioclase-biotite porphyry	315589	6206006	56.86	0.68	14.48	5.79	0.08	3.09	4.49	4.16	5.18	0.48	4.32	99.22	30	230	20	140	1200
AX02-13- 53.5 m	Syenite; megacrystic	314336	6206955	59.19	0.51	16.76	3.93	0.07	1.15	1.79	3.74	7.56	0.16	4.51	99.38	40	620	40	196	1600

Sample	Ba*	Y	Th	La	Ce	Pr	Nd	Sm	Eu	Gd160	Tb	Dy	Ho	Er	Tm	Yb	Lu
AX02-11-22.86 m	2800	11.4	20	51.5	93.9	9.7	34.8	5.9	1.7	5.4	0.6	2.3	0.3	1	0.1	0.8	0.1
AX02-14-25.91 m	3700	24.9	28	82.5	156.5	17.1	65.2	11.5	3.3	10.6	1.2	5.1	0.8	2.3	0.3	1.8	0.3
AX02-14-174.69 m	2500	10.3	19	41.6	75.2	7.7	27.7	4.6	1.3	4.3	0.5	2	0.3	0.9	0.1	0.7	0.1
AX02-09-56.2 m	3300	22.2	19	67.1	134	15.6	62.1	11.6	3.1	9.6	1.1	4.8	0.7	2.1	0.2	1.5	0.2
AX02-13-53.5 m	3200	27.7	61	104.5	183	19.3	68.8	11.6	3.1	10.1	1.1	4.9	0.8	2.5	0.3	2.2	0.3

Oxides: X-ray fluorescence, ALS CHEMEX Laboratories * = Pressed pellet-XRF; ALS CHEMEX
Other traces: Lithium metaborate fusion, Mass spectrometer, ALS CHEMEX

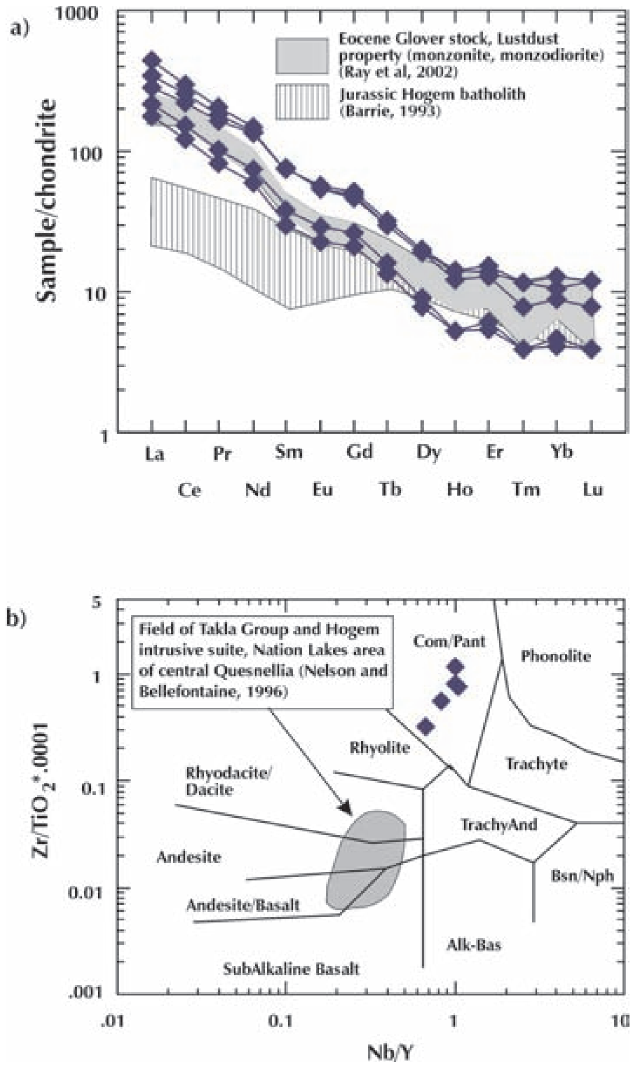


Figure 10. Petrochemical characterization of the Axelgold syenite complex. b) Winchester and Floyd, 1977.

Au deposits worldwide (Mutschler and Mooney, 1993; Schroeter and Cameron 1996). Most important are the well-developed hydrothermal breccias, similar to those described in the Tertiary epithermal systems at Cripple Creek (Thompson *et al.*, 1985), Golden Sunlight (Porter and Ripley, 1985), and Montana Tunnels (Sillitoe *et al.*, 1985). Additional features include widespread carbonate alteration (Taylor, 1987); the presence of green sericite, which may be in part the vanadium mica roscoelite; Au associated with quartz, carbonate, fluorite, pyrite, chalcopyrite, tetrahedrite, galena and stibnite; and a geochemical association with Sb, As, Cu, Zn, Mo, and Pb (Kaip, 2002; and this paper). The geochemical signature of the Axelgold system shows moderately anomalous gold correlating with V, Sb, As, Cu, and Zn (Figure 11).

The alkalic-related suite embraces a wide variety of deposit types and associations, from epithermal mineralization at Lihir, the Emperor Mine (Anderson and Eaton, 1990), Porgera (Richards, 1992) and Cripple Creek, to mesothermal Au-quartz veins at Kirkland Lake (Cameron, 1990), to a possible linkage with Au-Cu porphyries. The locus of mineralization may be within intrusive rocks, as at Porgera, in calderas as at Lihir , the Emperor Mine, and Cripple Creek; or along regional structures, as at Kirkland Lake. Evaluation of exploration parameters rests entirely on the geological setting of the individual deposit: the alkalic association alone is not predictive in terms of local controls on mineralization or the discovery of additional prospects.

Petrochemical affinities between the Axelgold syenite and Glover stock suggest that they could represent a belt of small, high-level intrusions, possibly a previously-unrecognized eastern, alkalic extension of the Babine porphyry belt (Ray *et al.*, 2002; J. Oliver, personal communication, August 2002). A number of small felsic and porphyritic intrusions near Humphrey Lake (*see* Schiarizza, 2000) may also belong to this group. Two known prospects establish the gold potential of the belt: Au skarns and mantos at the Lustdust (Ray *et al.*, 2002), and diffuse, low-grade gold at Axelgold. Given the small footprints of the host intrusions, it is entirely possible that others may be found.

CONCLUSIONS: NEW IDEAS, NEW DIRECTIONS

This project has added to the repertoire of gold exploration target types in central British Columbia. A series of vein discoveries on the Hawk property in 2002 demonstrates the potential of the northern Hogem batholith for high grade, gold-only, in addition to porphyry-style copper-gold targets. The geochemical character of the veins, for instance the gold-bismuth correlation, suggests that they may fit broadly into the category of intrusion-related gold occurrences. Significant differences between the Hawk and well-documented Cretaceous deposits of the Fairbanks and Tombstone districts, for instance location within a primarily Jurassic batholith, lack of associated arsenic and strong structural control, may expand the search parameters for intrusion-hosted gold in the Canadian Cordillera.

The dating of the Glover stock as Eocene (Ray *et al.*, 2002) and the recognition in this study of affinities between it and the Axelgold syenite offers a new potential belt of Au-enriched alkalic intrusions west of the Pinchi Fault.

ACKNOWLEDGEMENTS

Gord Allen and Dave Kamisi, consulting geologists for Rubicon, contributed significantly to the development of ideas on the Axelgold property, particularily the extent and significance of the intrusive breccias. We thank Janet Gabites for timely and important lead isotopic analyses that have advanced our knowledge of the Hawk vein system. Wes Luck, third generation pilot, provided safe, efficient helicopter service between clouds and crags.

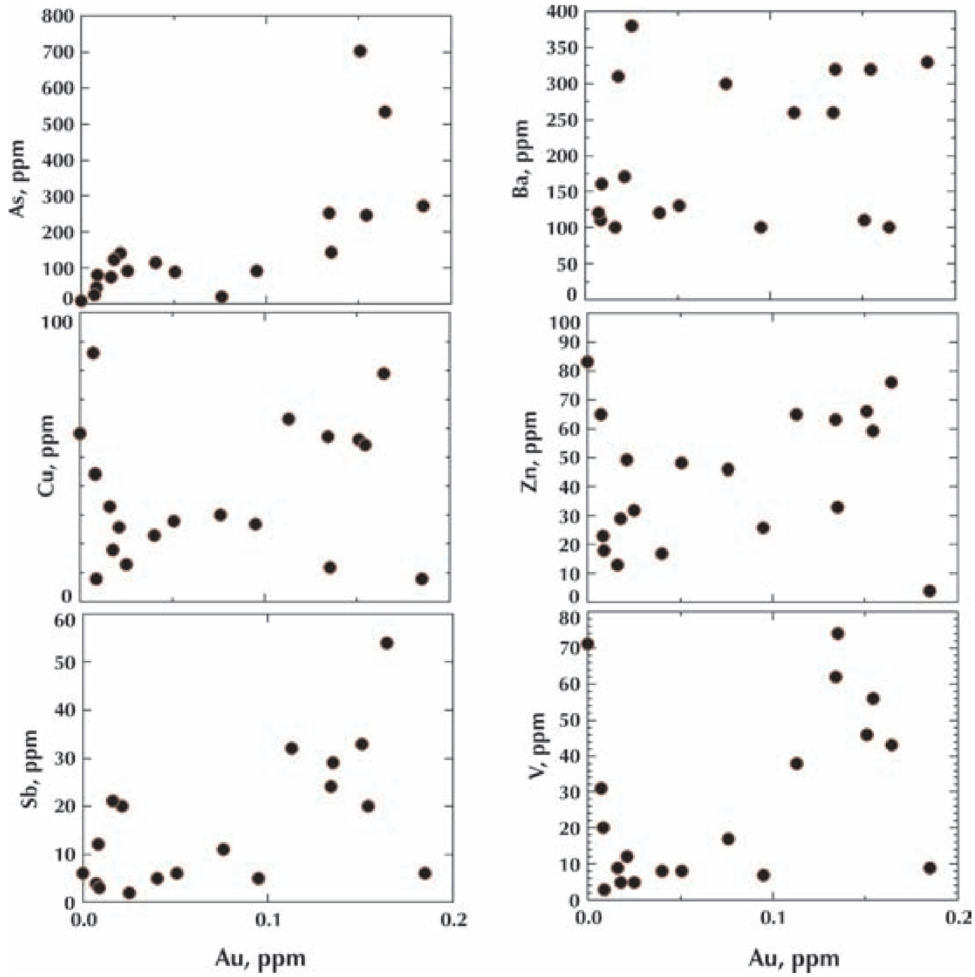


Figure 11. Geochemical correlation diagrams: Axelgold vein samples: plotted vs. Au. Data from surface grab samples, Rubicon Minerals Corp. Intermediate values only plotted; actual gold values up to 8.95 ppm (analyses by ALS CHEMEX).

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