Regional Studies of VMS Mineralization and Potential within the Early Jurassic Hazelton Group, British Columbia

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INTRODUCTION

Eskay Creek type (ECT) volcanogenic massive sulphide (VMS) deposits within the Early and early Middle Jurassic Hazelton Group are currently the focus of a considerable amount of mineral exploration effort because of their substantial tonnage potential and high precious metal content. A project was begun in 2003 with the goal of identifying the specific controls that lead to formation of an ECT deposit instead of a more typical polymetallic, "Kurokotype" VMS deposit. Both of these types of VMS deposits are known to exist within the Hazelton Group in Stikinia (Massey, 1999; Massey et al., 1999); however, deposits in the immediate area of Eskay Creek are the only significant ECT deposits that have been discovered thus far in British Columbia. Funding for the project derives in part from the Rocks to Riches Program, which is administered by the BC & Yukon Chamber of Mines, and by a consortium of mining and exploration companies, with matching funds from the Natural Sciences and Engineering Research Council of Canada (NSERC).

Work during the 2003 and 2004 field seasons included 1) a detailed study of upper Hazelton Group strata in the northern Bella Coola and southern Whitesail Lake area in southern Stikinia known to host VMS occurrences that display some ECT characteristics (Mortensen et al., 2004; Gordee et al., 2005; Mahoney et al., 2005); and 2) a regional investigation of key features, such as crystallization age, geochemistry and eruption temperature of volcanic rocks that host known VMS occurrences within the Hazelton Group, as well as water depth and paleotopography of the immediate area in which the mineralization formed (Mortensen et al., 2004).

Results of the 2004 field work in the Bella Coola and Whitesail Lake areas are summarized by Gordee et al. (2005). This paper reports the results of field studies, as well as U-Pb dating and Pb isotopic studies of the Hazelton Group and contained mineralization from several parts of Stikinia, including the northern Bella Coola and southern Whitesail Lake areas, the southern Babine Range east and southeast of Smithers, the Homestake Ridge area southeast of Stewart, and the Forrest Kerr Creek area (RDN property) north of the Eskay Creek mine (Figure 1). Mineral occurrences that have previously been interpreted to be syngenetic (VMS) in character are present in each of these areas.

NORTHERN BELLA COOLA AND SOUTHERN WHITESAIL LAKE AREA

The regional setting and local geology of the southern Stikinia Terrane in the northern Bella Coola and southern Whitesail Lake area (Figure 1) are described by Gordee et al. (2005) and Mahoney et al. (2005). Previous workers have provided brief descriptions of VMS mineralization at the Nifty occurrence (Ray et al., 1998; Diakow et al., 2002), which is hosted in felsic volcanic rocks of early Middle Jurassic age and hence roughly age equivalent to the Eskay Creek deposit. Other mineralization presently known within this part of Stikinia includes disseminations and veins of specular hematite (locally associated with minor malachite; Gordee et al., 2005) and several small chalcopyrite-bearing quartz-vein breccia zones in the Mt. Preston area.

Lead isotopic compositions determined for galena from four samples of the Nifty mineralization (Table 1) fall within the general field of Pb isotopic values for mineralization of Early to Middle Jurassic age in northwestern Stikinia ('Jurassic cluster' in Figure 2) and closely overlap the field of Pb compositions from the Eskay Creek deposit itself (Childe, 1996). This is consistent with the interpreted syngenetic character of the Nifty mineralization and its coeval relationship with the Eskay Creek deposit. A single Pb analysis of chalcopyrite from a mineralized quartz-vein breccia from southeast of Mt. Preston also falls within the Jurassic cluster, but is distinctly less radiogenic than the Nifty sulphides. Nonetheless, the isotopic composition suggests that the vein breccias formed as part of an Early or Middle Jurassic metallogenic event, possibly analogous to epigenetic mineralization of Early Jurassic age in the Iskut River area in northwestern Stikinia.

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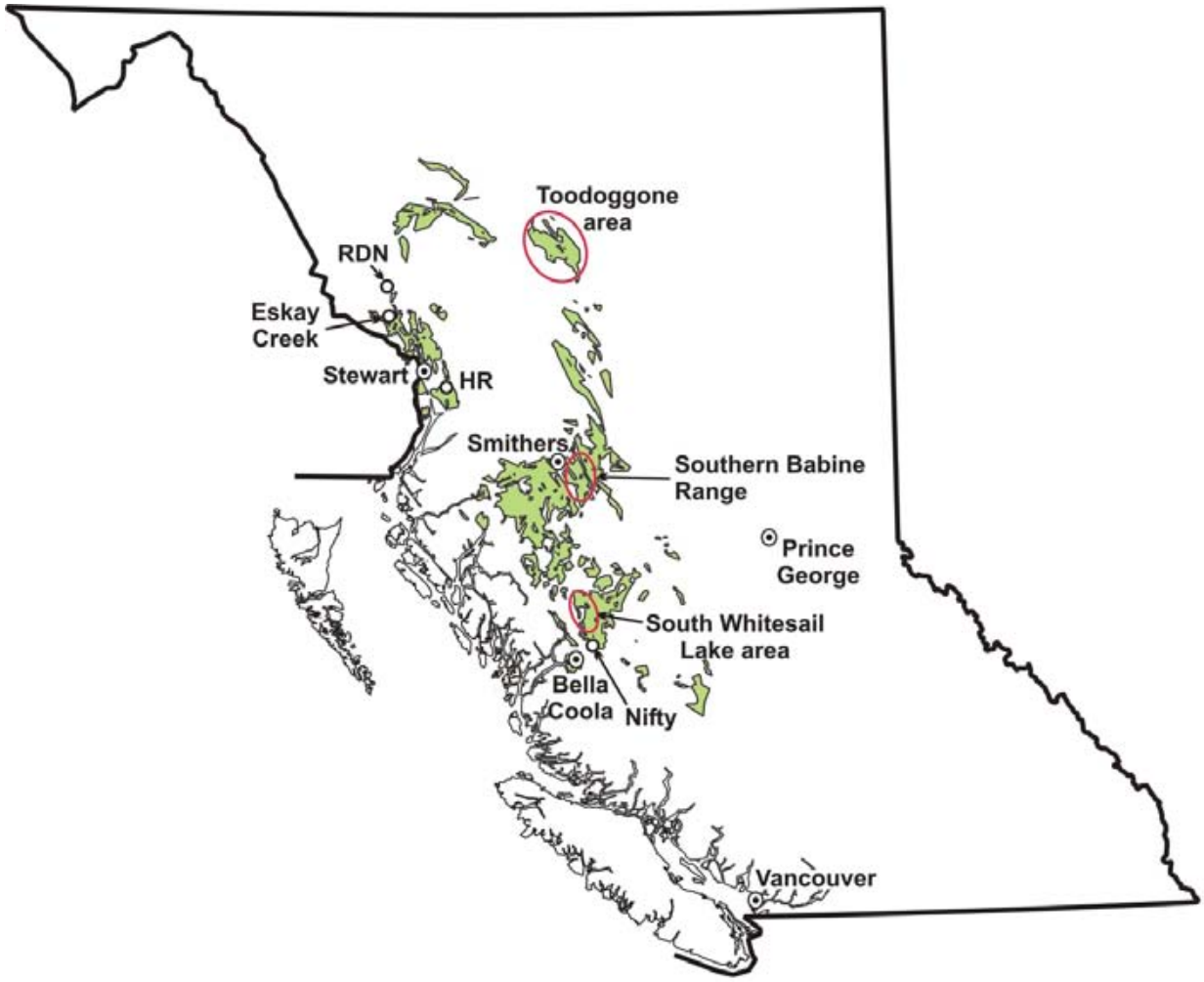

Figure 1. Distribution of Early and Middle Jurassic volcanic and sedimentary strata of the Hazelton Group within the Stikine Terrane of British Columbia.

SOUTHERN BABINE RANGE

Several mineral occurrences hosted by Hazelton Group volcanic strata in the southern Babine Range east of Smithers (Figure 1) were interpreted by Wojdak (1998) to be potentially syngenetic in origin. MacIntyre (1989) assigned volcanic and sedimentary strata in this area to the Telkwa and Nilkitkwa formations based on overall lithology and sparse Late Sinemurian to earliest Toarcian fossil ages. This suggests an age of ~195–180 Ma for the host rocks to mineralization; hence, syngenetic (?) mineralization in the area would appear to be somewhat older than that at Eskay Creek.

One of these prospects (Harry Davis; BC MINFILE 093L 203, 204, 205 and 214) includes several individual occurrences located near the summit of Mt. Harry Davis, north of Houston. It consists mainly of disseminated and fracture-filling sphalerite, chalcopyrite, galena and locally fluorite, although, in one instance (the "Hilltop showing"), sphalerite occurs as disseminations along bands in massive to laminated chert. The upper portion of Mt. Harry Davis is underlain by a thick section of flow-banded, quartz- and feldspar-phyric rhyolite that is associated with bedded red and maroon lapilli tuffs which locally contain accretionary lapilli. A sample of the rhyolite is calc-alkaline in composition, with a volcanic-arc signature (Mortensen et al., 2004). Four fractions of zircon recovered from a sample of the massive rhyolite give concordant analyses (Table 2; Figure 3a), and the oldest two concordant analyses (C and E, Figure 2a) give overlapping $^{206}Pb/^{238}U$ ages of 179.3 ± 0.8 Ma (Late Toarcian), which is taken as the crystallization age of the sample. This age is near the upper age limit for Hazelton Group strata that had been recognized in this area on the basis of fossil age constraints. It is also similar to the age of the Salmon River Formation that hosts the Eskay Creek deposit; however, the rhyolite at Mt. Harry Davis is geochemically distinct from that at Eskay Creek (calcalkaline vs. tholeiitic).

The Lakeview prospect (BC MINFILE 093L 030), located approximately 6 km northeast of the Harry Davis occurrence, was visited briefly during 2004. Mineralization comprises medium- to coarse-grained, massive to crudely banded specular hematite, chalcopyrite, pyrite and sphalerite. It appears to be roughly stratabound, and associ-

ated with a limy horizon within steeply northwest-dipping felsic pyroclastic rocks (Wojdak, 1998). The immediate wallrocks for the sulphides are strongly hematized and epidotized. The overall character of the mineralization, including the mineralogy, relatively coarse grain size of the sulphides, and association with carbonate rocks, is most reminiscent of a skarn, although the possibility that the occurrence comprises Early or Middle Jurassic syngenetic (?) mineralization that has been strongly recrystallized in the contact aureole of a younger intrusion (not presently exposed) cannot be ruled out.

One day was spent examining and sampling the Ascot prospect (BC MINFILE 093L 024), which comprises several individual occurrences near the head of Canyon Creek, approximately 30 km east of Smithers (Figure 1). The property is underlain by a package of mixed sedimentary rocks (mainly thinly bedded limestone, carbonaceous argillite and argillaceous wacke) and intermediate to felsic breccias, all of which are cut by widely spaced andesite dikes. The rock units in this area have been variably deformed, and weaker lithologies (e.g., limestones and argillites) show a moderate to strong foliation and locally abundant minor folding (e.g., Figure 4a). Two distinct styles of mineralization were observed: 1) disseminations and bedding-parallel stringers of fine-grained sphalerite and galena in impure argillaceous limestones, and 2) galena in fine quartz stringers and disseminations in a felsic breccia unit (Figure 4b). The mineralized stringers in this latter style of mineralization are truncated at the margins of the clasts, indicating that the veining predated brecciation and the mineralization therefore must be broadly syngenetic with respect to the felsic volcanic event.

Lead isotopic compositions have been determined for sulphide samples from all of the potentially syngenetic occurrences in the southern Babine Range and are shown in Figure 2. Although there is some scatter in the data, all anal-

TABLE 1. PB ISOTOPIC COMPOSITIONS OF SULPHIDE MINERALS FROM OCCURRENCES IN THE NORTHERN BELLA COOLA–SOUTHERN WHITESAIL LAKE AREA AND SOUTHERN BABINE RANGE.

Occurrence	Mineral	$^{206}Pb/^{204}Pb$	Error (abs.)	Error (%)	$^{207}Pb/^{204}Pb$	Error (abs.)	Error (%)	$^{208}Pb/^{204}Pb$	Error (abs.)	Error (%)
Northern Bella Coola/southern Whitesail Lake area										
Nifty	sl	18.8094	0.0277	0.15	15.6009	0.0238	0.15	38.543	0.0647	0.17
03M-01 Nifty	py	18.8018	0.0082	0.04	15.6131	0.0102	0.07	38.5262	0.0334	0.09
03M-01a Nifty	py	18.8107	0.013	0.07	15.5789	0.0109	0.07	38.3262	0.0435	0.11
03M-01a Nifty	py	18.8089	0.0155	0.08	15.6075	0.0116	0.07	38.4445	0.0486	0.13
03M-05	cp	18.7266	0.0093	0.05	15.5958	0.0108	0.07	38.4479	0.0352	0.09
Southern Babine Range										
Del Santo-1	py	18.6942	0.0106	0.06	15.592	0.0108	0.07	38.3059	0.0373	0.1
Lakeview 2	py	18.8699	0.0184	0.1	15.6703	0.0158	0.1	38.6114	0.0737	0.19
Lakeview-2	py	18.8329	0.0104	0.05	15.5823	0.0105	0.07	38.4059	0.0397	0.1
Lakeview-3	py	18.7949	0.0104	0.06	15.5978	0.011	0.07	38.4427	0.0365	0.09
Su	py	18.7183	0.0226	0.12	15.6213	0.0142	0.09	38.2534	0.0634	0.17
Su	py	18.7529	0.012	0.06	15.6406	0.0122	0.08	38.4829	0.0385	0.1
HD	py	18.7918	0.0141	0.07	15.6642	0.0138	0.09	38.6877	0.0415	0.11
Ascot	sl	18.7192	0.0286	0.15	15.6187	0.0206	0.13	38.3998	0.0743	0.19
Del Santo-2	py	18.6965	0.0185	0.1	15.5905	0.0152	0.1	38.2679	0.0548	0.14
Homestake Ridge										
03M-100 Myborg adit	gl	18.9478	0.0083	0.04	15.6773	0.0102	0.07	38.7255	0.0337	0.09
03M-101 Myborg adit	cp	18.8793	0.0228	0.12	15.6657	0.0104	0.07	38.5461	0.0553	0.14
03M-101 Myborg adit	cp	18.8166	0.0262	0.14	15.5736	0.0227	0.15	38.4641	0.0617	0.16
03M-102 Myborg adit	cct	19.8714	0.0526	0.26	15.6951	0.0418	0.27	39.2944	0.1085	0.28
03M-105 vein in seds adjacent to South Dome rhyolite	cp	18.9611	0.0141	0.07	15.6418	0.0118	0.08	38.647	0.0419	0.11
03M-107a Dilly Zone	py	18.7506	0.0112	0.06	15.625	0.0111	0.07	38.7768	0.0376	0.1
03M-108 Dilly Zone	gl	18.9137	0.0084	0.04	15.6255	0.0102	0.07	38.5199	0.0337	0.09
03M-110 Dilly Zone	gl	18.9072	0.0086	0.05	15.6089	0.0103	0.07	38.5437	0.0342	0.09
03M-111 Dilly Zone	gl	18.9535	0.0082	0.04	15.6692	0.0102	0.06	38.7193	0.0335	0.09
Vanguard Cu	cp	18.9132	0.0261	0.14	15.6552	0.0182	0.12	38.5787	0.0718	0.19
Vanguard Cu	cp	18.9158	0.0094	0.05	15.6362	0.0107	0.07	38.5963	0.0351	0.09
Silver Crown	py	19.1597	0.0115	0.06	15.6415	0.0109	0.07	38.6905	0.0376	0.1
RDN Property										
RDN01-19 94.0	gl	18.826	0.0294	0.16	15.6883	0.0247	0.16	38.506	0.0687	0.18
RDN01-20	gl	18.8837	0.0091	0.05	15.612	0.0104	0.07	38.5669	0.0345	0.09
RDN99-01	py	18.8383	0.0094	0.05	15.6051	0.0102	0.07	38.4062	0.0349	0.09

All errors given at the 2 sigma level.

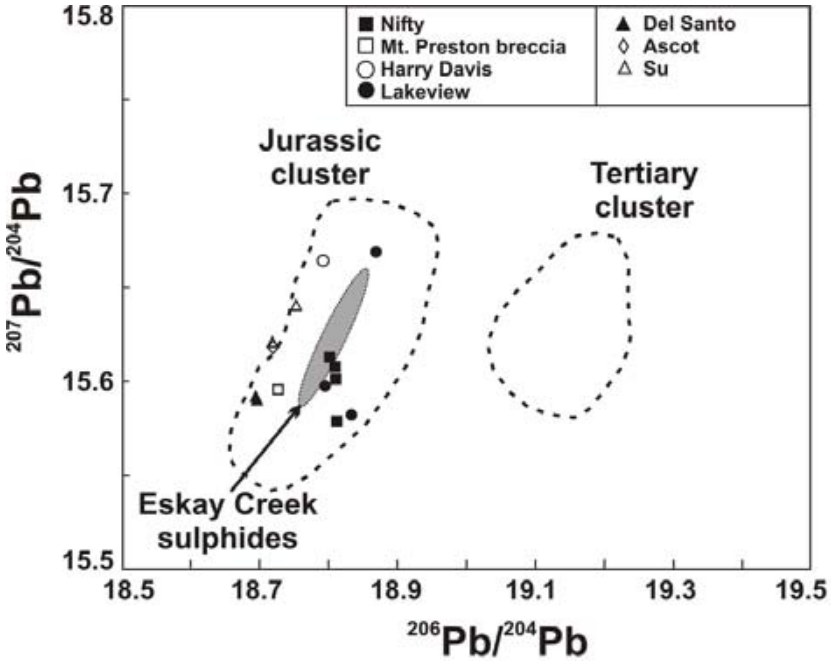

Figure 2. Lead isotopic compositions of sulphide minerals from occurrences in the northern Bella Coola–southern Whitesail Lake area and southern Babine Range. Fields for Jurassic and Tertiary sulphide Pb compositions are from Rhys et al. (1995). Field for Eskay Creek sulphide Pb compositions is from Childe (1996).

yses fall within the 'Jurassic cluster', suggesting that mineralization in all cases is of Early or Middle Jurassic age. In particular, three analyses from the Lakeview prospect overlap completely with analyses from the Nifty occurrence. These results are somewhat surprising, especially because the mineralization at the Del Santo prospect (BC MINFILE 093L-025) has been interpreted by most previous workers as a skarn, possibly associated with an Early Tertiary diorite intrusion on the property (M. Marchand, pers. comm., 2004).

HOMESTAKE RIDGE AREA

The Homestake Ridge property, approximately 32 km southeast of Stewart (Figure 1), which is currently being explored by the Bravo Ventures Group Inc., comprises over 80 individual base and precious metal occurrences. The property is underlain by a Late Triassic to Early and Middle (?) Jurassic package of basaltic, andesitic and rhyolitic volcanic and volcaniclastic and clastic sedimentary rocks (Figure 5). The property hosts more than 80 individual mineral occurrences, some of which have been worked since 1914. Previous work on the property by Noranda Exploration Ltd. and TeckCominco Ltd. identified several highly prospective targets, including shear-hosted veins hosting high-grade precious metals, broad areas of gold-enriched, quartz-sericite-pyrite mineralization with bulk tonnage potential, and a volcanic-sedimentary stratigraphy with precious metal–enriched VMS potential.

Hazelton Group rocks on the property consist of basaltic, andesitic and dacitic volcanic and volcaniclastic rocks that are equated to the Early Jurassic Betty Creek Formation, as well as fine-grained clastic sedimentary rocks that may correlate with the early Middle Jurassic Salmon River Formation. Mineralization and alteration is focused around subvolcanic hornblende-feldspar porphyry intrusions that resemble and are believed to be equivalent in age to the Goldslide intrusions at Red Mountain, located approximately 25 km northeast of the property (Rhys et al., 1995). These porphyry intrusions occur along structural breaks in the rock package and are associated with broad areas of rocks with locally intense sericite-quartz-pyrite alteration. Two large accumulations of flow-banded rhyolitic volcanics, tuff and coarse fragmental rocks are present on the property and are referred to as the North Dome and South Dome. The felsic units were previously equated with the Mt. Dilworth Formation, which served to highlight the potential of the property for ECT-type VMS mineralization.

The property displays a relatively complex structural history. Northwest- and northeast-trending fault-bound rifts appear to have controlled the deposition of the Early Jurassic sequence and localized the emplacement of porphyry intrusions. Large-scale, southwest-directed, open to isoclinal, disharmonic folds and thrusts likely formed in the Cretaceous, but were strongly controlled by the earlier basin geometry. East-west extension and dextral strike-slip faulting of probable Tertiary age produced block faulting and minor lateral offsets on numerous, highly visible, northeast-trending fault structures.

The Homestake Ridge property hosts a very large number of precious and base mineral occurrences. Mineralization is typically structurally controlled, with some of the occurrences having a close spatial association with variably altered hornblende-feldspar porphyry. Brief descriptions of some of the individual occurrences shown on Figure 5 are given here to highlight the diverse nature of mineralization present.

The Homestake Crown Grant area covers an epithermal vein system hosted by an upper unit of massive to coarse fragmental andesitic volcanics and lower units of heterolithic to monolithic debris flows, dacitic fragmentals and feldspar-hornblende porphyry, and andesitic to dacitic volcanic rocks. High-grade gold-silver shoots are localized near the intersection of the main mineralized shears. Mineralization is hosted within pyritiferous quartz stockworks and breccias with trace to several percent chalopyrite, sphalerite and galena in a hostrock that is intensely altered to sericite and K-feldspar. Drilling during 2003 intersected broad zones (up to 43 m thick) of highly anomalous gold (0.7 g/t) and silver (10.2 g/t) mineralization with several >1 m wide intervals of 6–13.9 g/t Au and up to 2 oz./t Ag.

TABLE 2. U-PB ZIRCON AGES FOR FELSIC VOLCANIC AND PLUTONIC ROCKS, SOUTHERN BABINE RANGE.

Sample Description[1]	Sample weight (mg)	U (ppm)	Pb^2 (ppm)	$^{206}Pb/^{204}Pb$ (meas.)[3]	Total common Pb (pg)	% $^{208}Pb^2$	$^{206}Pb/^{238}U^4$ (± % 1)	$^{207}Pb/^{235}U^4$ (± % 1)	$^{207}Pb/^{206}Pb^4$ (± % 1)	$^{206}Pb/^{238}U$ age (Ma; ± % 2)	$^{207}Pb/^{206}Pb$ age (Ma; ± % 2)
Sample 03M-113 (rhyolite on Mt. Harry Davis; UTM zone 9, 641824E, 6035173N)											
A: N5,+74	0.013	193	5.6	1242	3	14.7	0.02710(0.38)	0.1846(1.20)	0.04921(1.10)	173.1(1.3)	159.1(51.3)
C: N5,+74	0.03	146	4.4	2661	3	16.1	0.02825(0.15)	0.1947(0.46)	0.04997(0.42)	179.6(0.5)	193.6(19.7)
D: N5,+74	0.021	128	3.8	1758	3	15.5	0.02781(0.20)	0.1903(0.55)	0.04962(0.52)	176.8(0.7)	177.3(24.3)
E: N5,+74	0.029	240	7.5	3783	3	18	0.02818(0.16)	0.1924(0.33)	0.04952(0.28)	179.1(0.6)	172.7(12.9)
Sample 03M-106 (South Dome rhyolite; UTM zone 9, 463288E, 6177315N)											
A: N2,+104	0.01	219	7.6	1698	3	10.3	0.03452(0.16)	0.2385(0.53)	0.05010(0.48)	218.8(0.7)	199.6(22.2)
C: N2,+104	0.007	344	11.9	2934	2	8.3	0.03489(0.18)	0.2463(0.44)	0.05120(0.38)	221.1(0.8)	249.8(17.6)
D: N2,+104	0.005	104	3.9	511	2	12.3	0.03594(0.44)	0.2830(1.68)	0.05709(1.60)	227.6(2.0)	495.1(71.2)
Sample RDN-01-16-85.34m (RDN property, Boundary Zone, K-feldspar-phyric monzonite; UTM zone 9, 399935E, 6311081N)											
A: N2,+134	0.031	407	12.7	4184	6	12	0.03049(0.11)	0.2102(0.20)	0.05000(0.13)	193.6(0.4)	195.0(5.9)
B: N2,+134	0.033	435	13.6	8338	3	11.6	0.03048(0.13)	0.2096(0.20)	0.04986(0.11)	193.6(0.5)	199.6(5.3)
C: N2,+134	0.037	396	12.5	17960	2	12.8	0.03049(0.12)	0.2111(0.35)	0.05021(0.31)	193.6(0.5)	204.7(14.3)
D: N2,+134	0.044	445	14	7982	5	12.4	0.03048(0.10)	0.2108(0.21)	0.05015(0.16)	193.5(0.4)	201.9(7.3)
E: N2,+134	0.41	388	12.1	18600	2	12.1	0.03034(0.24)	0.2103(0.27)	0.05028(0.11)	192.7(0.9)	207.7(5.3)
Sample RDN-01-19-94.0m (RDN property, Wedge Zone, Gossan Creek porphyry; UTM zone 9, 399971E, 6319397N)											
A: N2,+134	0.027	269	8.1	4005	3	7.4	0.03079(0.17)	0.2133(0.28)	0.05027(0.20)	195.5(0.6)	207.3(9.1)
C: N2,+134	0.02	359	11.1	3240	4	10.7	0.03050(0.15)	0.2095(0.30)	0.04987(0.22)	193.7(0.6)	189.0(10.3)
D: N2,+134	0.023	493	15.4	487	44	12.4	0.03034(0.25)	0.2087(2.05)	0.04989(1.94)	192.7(1.0)	189.7(90.2)
E: N2,+134	0.027	352	10.7	5186	3	10.4	0.03016(0.13)	0.2074(0.23)	0.04986(0.16)	191.6(0.5)	188.6(7.2)
Sample RDN-01-20-23.2m (RDN property, Wedge Zone, plagioclase-phyric dacite; UTM zone 9, 399997E, 6319193N)											
A: N2,134-149	0.014	303	9.1	2841	3	8.8	0.03049(0.30)	0.2084(0.64)	0.04957(0.57)	193.6(1.1)	175.1(26.5)
B: N2, 134-149	0.009	436	13.2	2918	3	11	0.02981(0.16)	0.2075(0.38)	0.05043(0.32)	189.6(0.6)	214.6(14.7)
E: N2, 134-149	0.014	152	4.8	2010	2	14.3	0.02974(0.17)	0.2053(0.62)	0.05007(0.57)	188.9(0.6)	198.2(26.4)

[1] N2 = non-magnetic 2 degrees side slope on Frantz isodynamic magnetic separator; grain size given in microns.

[2] radiogenic Pb; corrected for blank, initial common Pb, and spike

[3] corrected for spike and fractionation

[4] corrected for blank Pb and U, and common Pb

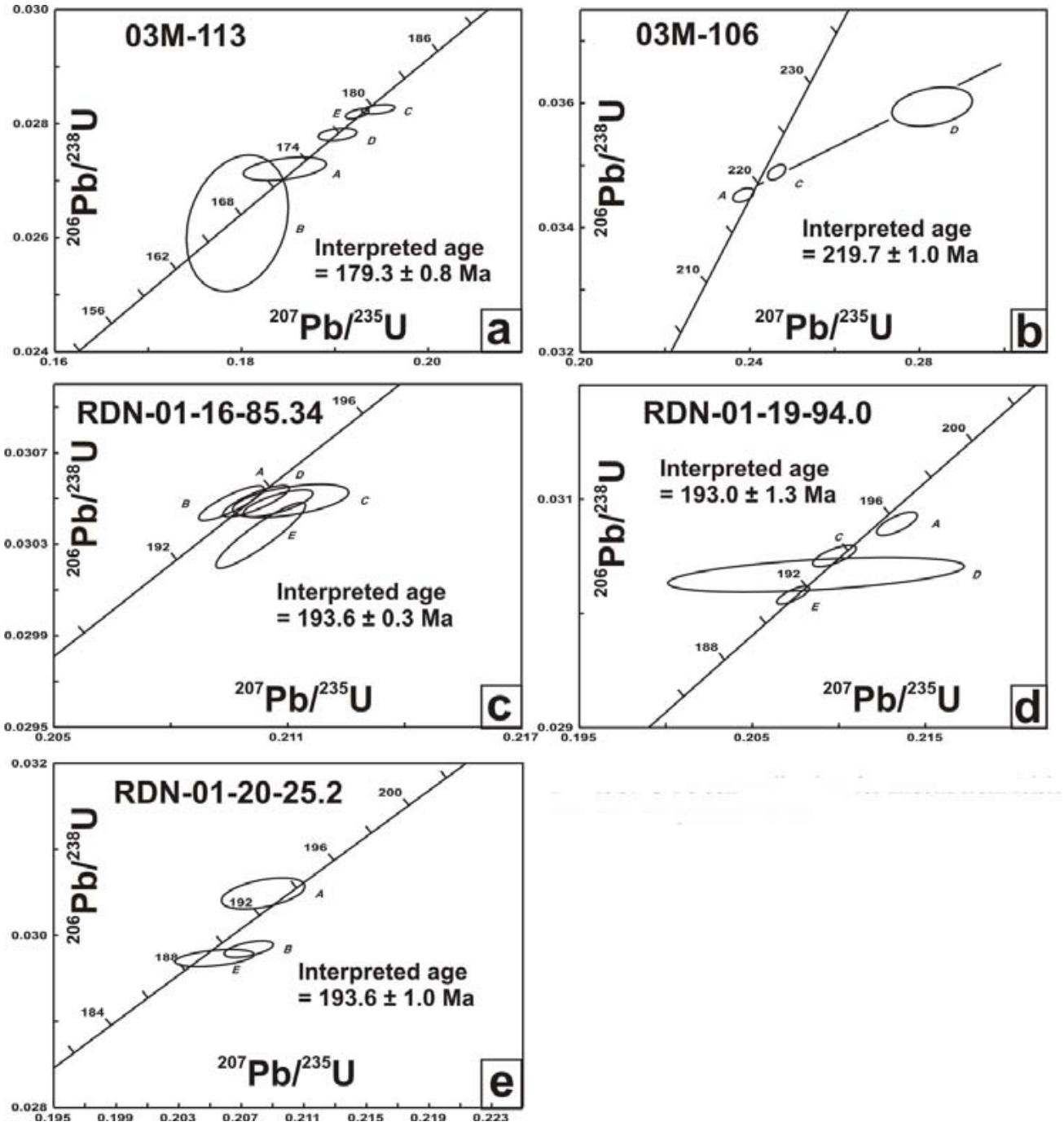

Figure 3. U-Pb concordia plots for zircons from felsic volcanic and plutonic rocks.

Calcite-barite veins exposed in historical trenches at the Vanguard gold showing run up to 9.56 g/t Au and 10.5 g/t Ag over 6.0 m. The zone dips steeply to the northeast and can be traced on surface for about 200 m.

The Dilly and Dilly west zones comprise a series of north-northwest–trending precious and base metal mineral occurrences that form two subparallel linear trends with strike lengths of 1500 m and 600 m, respectively. The occurrences are found at or near the contact between a felsic volcanic package and a bedded, fine-grained clastic succession. Styles of mineralization include massive sulphide base metal showings, semimassive to massive arsenopyrite showings, massive laminated galena-sphalerite showings and sulphide stockworks within felsic volcanic pyroclastics. Bravo Venture geologists interpreted the western rhyolite-sedimentary contact as predominantly a structural feature with mineralization occurring in northwest- to west-northwest-directed shears along the contact zone.

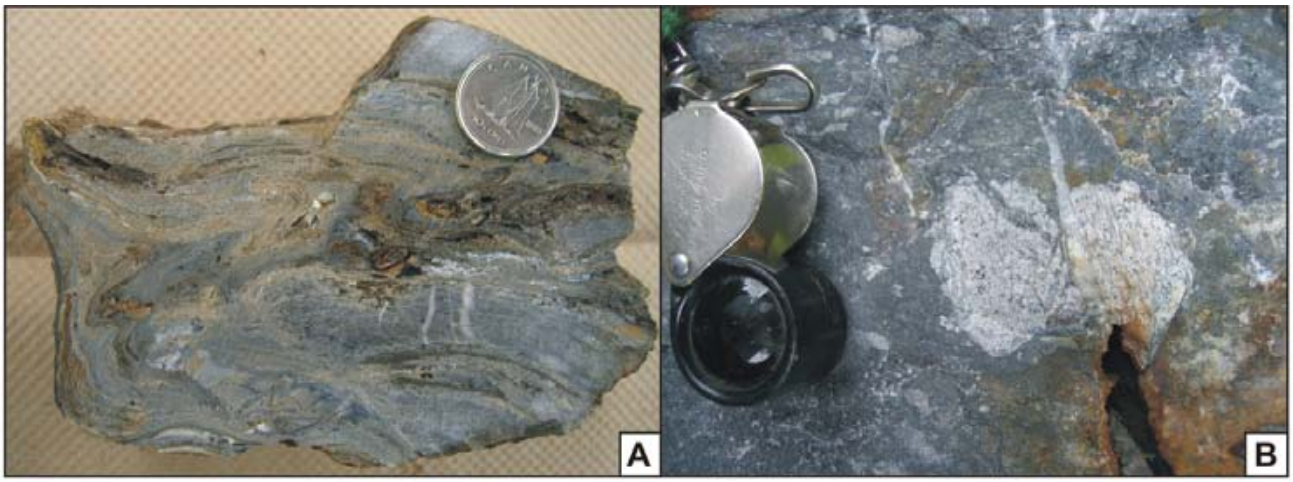

Figure 4. Mineralized specimens from the Ascot occurrence: A) deformed argillaceous limestone and disseminated galena; B) felsic fragmental rocks with fine, galena-bearing quartz stringers that predate brecciation and deposition.

In the south end of the Dilly zone, galena-rich, banded massive sulphide mineralization was observed in several surface occurrences along a 300 m strike length. This mineralization is hosted in a chlorite-sericite–altered felsic volcanic rock and includes a 6–10 cm wide zone of massive galena and sphalerite.

The Silver Crown occurrence is located within a sediment-sill complex and is marked by a collapsed adit in argillaceous sedimentary rocks. Massive sphalerite-galena-(tetrahedrite) sulphide boulders occur in a waste pile near the mouth of the adit. Sampling of the boulders by TeckCominco Ltd. returned values of up to 14.15 g/t Au, 5740 g/t Ag, 11.55% Pb and 3.3% Zn. Mineralization cannot be traced beyond the immediate vicinity of the adit.

Lead isotope analyses were carried out on a number of samples from several of the zones of mineralization on the RDN property. All but one of the analyses fall well within the field of compositions for Early and Middle Jurassic mineralization in northwestern British Columbia (Figure 6). The only exception is galena from the Ag-rich Silver Crown vein, which yields a composition that falls within the Tertiary cluster of isotopic compositions (Figure 6). This indicates that at least some of the Ag-rich veins in the area represent an Early Tertiary metallogenic event that overprints the main Early and Middle Jurassic mineralization.

A sample of the South Dome rhyolite (Figure 5) was sampled for U-Pb zircon dating. This body appears to be intrusive into dacite and basalt, as well as fine-grained sedimentary rocks that were thought to be part of the Hazelton Group. Three fractions of zircon from the South Dome sample were analyzed. Two fall on or near concordia at about 219 Ma and a third analysis falls well to the right of concordia, indicating the presence of a significant inherited zircon component (Figure 3b). A regression through the three analyses yields calculated lower and upper intercept ages of 219.7 ± 1.0 Ma and 2.85 Ga, indicating a Late Triassic (early Norian) crystallization age and Late Archean inheritance. This result is very surprising, since it indicates that at least some of the stratigraphic units on the Homestake Ridge property actually form part of the Stuhini Group rather than the Hazelton Group. The implications of this age for the structure and stratigraphy on the property are still being assessed.

FORREST KERR CREEK AREA

The RDN property of Rimfire Minerals Corp. (BC MINFILE 104G 144; Figure 1), located in the Forest Kerr Creek area approximately 40 km northeast of the Eskay Creek mine, covers a package of felsic volcanic rocks overlain by mafic volcanic rocks and carbonaceous argillites that are thought to correlate, at least in part, with the early Middle Jurassic Salmon River Formation that hosts the Eskay Creek deposit (Figure 7) Although most of the mineralization located on the property thus far consists of structurally controlled mineralized veins and breccias, strong precious and base metal geochemical anomalies within argillite sections are very reminiscent of that associated with ECT mineralization. Diamond-drilling has intersected a thick section of dacitic to rhyolitic flows, domes and volcaniclastic rocks in the stratigraphically lower part of the section.

Three felsic units from the lower felsic sequence were dated using conventional U-Pb zircon methods. Sample RDN-01-16-85.34m is a weakly foliated, very strongly sericitized and clay-altered K-feldspar–phyric monzonite from the Boundary Zone in the southern part of the RDN property (Figure 7). Five strongly abraded fractions of zircon were analyzed (Table 2; Figure 3c). Four of these fractions give overlapping concordant analyses with a total range in $^{206}Pb/^{238}U$ ages of 193.6 ± 0.5 Ma, which is taken as the crystallization age of the sample. The fifth fraction falls slightly below the concordia and appears to have suffered minor Pb loss. A second sample (RDN-01-19-94.0m) consists of massive, plagioclase-phyric porphyry of the 'Gossan Creek porphyry' unit from near the northern end of the Wedge Zone (Figure 7). The porphyry is strongly car-

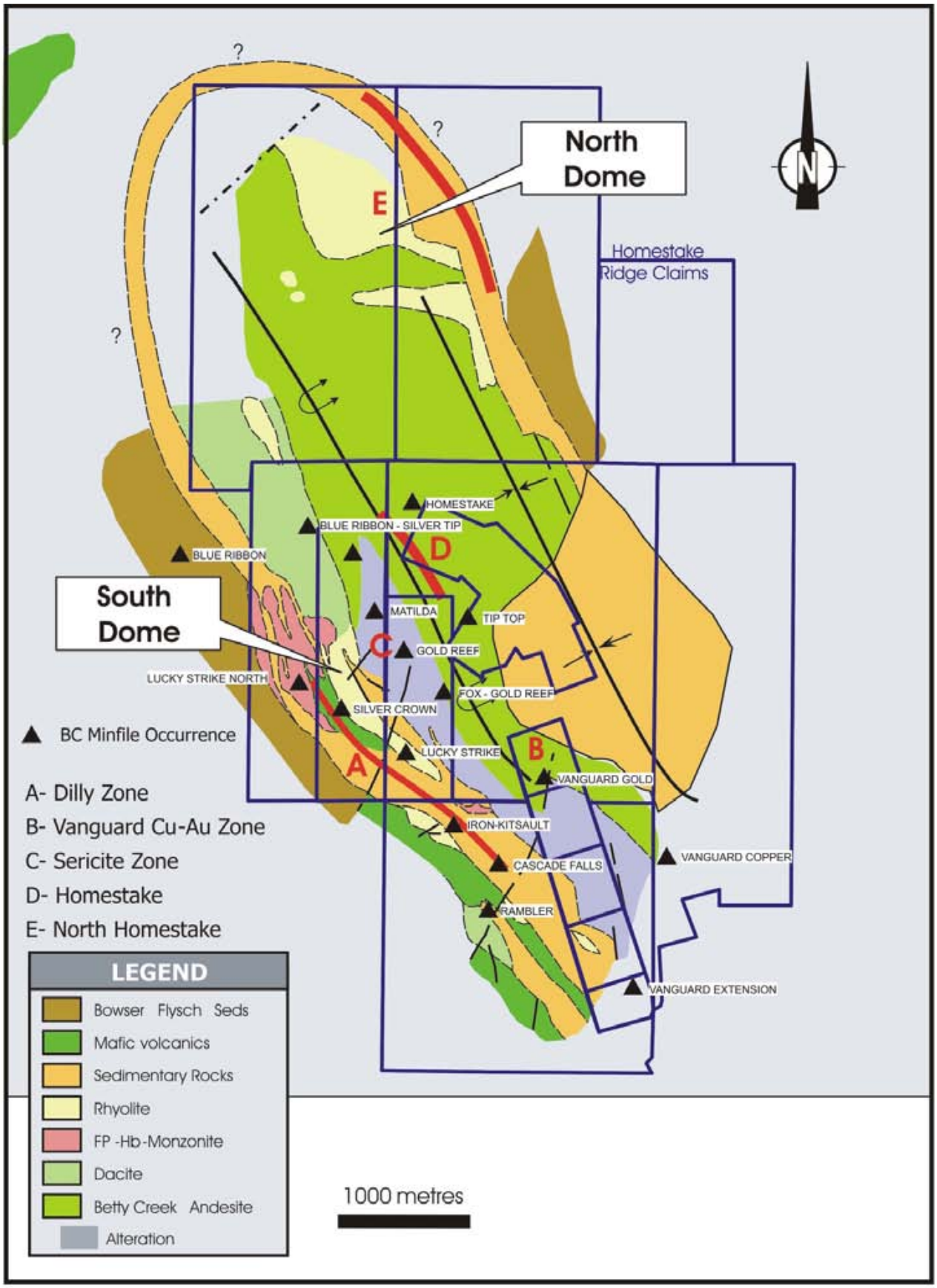

Figure 5. Simplified geology of the Homestake Ridge property (courtesy of TeckCominco Ltd.).

bonate altered and contains abundant fine stringers of carbonate. Three fractions of abraded zircon yield concordant analyses but with some scatter along the concordia (Figure 3d). The best estimate for the crystallization age of this sample is considered to be given by the total range of $^{206}Pb/^{238}U$ ages for the oldest two concordant fractions, at 193.0 ± 1.3 Ma. Fraction E has suffered minor Pb loss and fraction A appears to contain a minor component of older, inherited zircon. The third sample (RDN-01-20-23.2m) was from massive feldspar-phyric dacite from the central part of the Wedge zone (Figure 7). Three fractions of strongly abraded zircon were analyzed. All three analyses fall on or near concordia (Figure 3e), and the best estimate for the crystallization age of the sample is given by the oldest $^{206}Pb/^{238}U$ age of 193.6 ± 1.1 Ma.

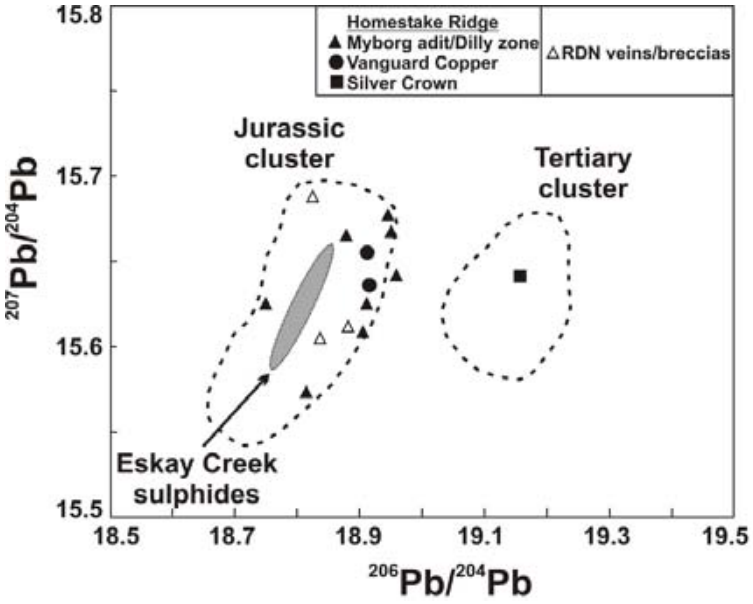

Figure 6. Lead isotope compositions of sulphide minerals from occurrences in the Homestake Ridge area and from the RDN property. Fields for Jurassic and Tertiary sulphide Pb compositions are from Rhys et al. (1995). Field for Eskay Creek sulphide Pb compositions is from Childe (1996)

These new data indicate that the lower felsic volcanic package on the RDN property is Late Sinemurian in age and thus significantly older than either the Eskay rhyolite or the footwall dacite in the immediate Eskay area. Fossil ages from locally tuffaceous argillite in the overlying argillite-basalt sequence in the vicinity of the RDN range from Toarcian to as young as Bathonian (Logan et al., 2000), indicating that strata that are age equivalent to the Salmon River Formation in the Eskay Creek area are indeed present on the RDN property. These results raise the possibility that a significant unconformity may separate the lower felsic package from the overlying argillite-basalt sequence in the RDN area.

Three samples of galena from crosscutting veinlets in argillite in drillcore on the RDN were analyzed for Pb isotope composition. All three analyses fall well within the field of Jurassic Pb dates (Fig. 6), confirming that the epigenetic mineralization in this area is part of the Early to Middle Jurassic mineralizing event in northwestern British Columbia.

DISCUSSION AND CONCLUSIONS

Results of the study provide new constraints on the nature of base and precious metal mineralization within the Hazelton Group in several parts of Stikinia, and specifically on the potential for some of the known occurrences to represent ECT mineralization. The Nifty occurrence in the Bella Coola map area closely resembles Eskay Creek in terms of age and Pb isotopic composition, although the geochemistry of the hostrocks at Nifty is calcalkaline as opposed to the tholeiitic hosts for the Eskay Creek deposit itself. Although the Nifty shares some of the geochemical traits of ECT mineralization (Ray et al., 1998; Diakow et al., 2002) it does not appear to have the strong gold enrichment that is seen at Eskay Creek. The only other mineralization identified thus far within the Hazelton Group section in northern Bella Coola and southern Whitesail Lake map areas consists of small, chalcopyrite-bearing quartz-vein breccias. Lead isotopic compositions of this style of mineralization indicate that it also represents part of an Early or Middle Jurassic metallogenic event, and is not related to Early Cretaceous and younger intrusions in the area. Despite the limited evidence for additional VMS occurrences within the Hazelton Group in this area, widespread semiconformable epidote alteration within the section, association with a coeval subvolcanic (?) felsic intrusion and the presence of significant synvolcanic fault structures (Gordee et al., this volume; Mahoney et al., this volume) suggest that the area has very high potential for hosting additional VMS occurrences.

The nature and age of several mineral occurrences in the southern Babine Range that were identified by Wojdak (1998) as possible VMS targets remains partially unresolved. Lead isotopic compositions from all of the occurrences are consistent with an Early or Middle Jurassic age of mineralization; however, at least two of the occurrences (Del Santo and Lakeview) appear in the field to be either skarns or possibly syngenetic mineralization that has been strongly recrystallized and overprinted in the contact aureole of intrusions. At least some of the mineralization at the Ascot occurrence predates brecciation and subsequent deposition of felsic volcanic units, and must therefore be broadly syngenetic. Although none of the various styles of mineralization at the Harry Davis occurrence is conclusively syngenetic in character, a U-Pb age of 179.3 ± 0.8 Ma for a flow-banded rhyolite unit indicates that volcanic rocks in this area are age equivalent to the Salmon River Formation that hosts the Eskay Creek deposit.

Mineralization in the Homestake Ridge area is mainly structurally controlled and many occurrences have a close spatial association with hornblende-feldspar porphyry dikes and sills of presumed Early Jurassic age. These occurrences yield Pb isotopic compositions that are consistent with an Early or Middle Jurassic age, and this style of mineralization appears to be analogous to that at the Red Mountain and/or Silbak Premier deposits to the north and west. Other Ag-rich vein occurrences such as Silver Crown have Pb isotopic compositions that indicate they are Early Tertiary in age and represent a younger, superimposed metallogenic event.

The Late Triassic U-Pb zircon age reported here for the South Dome rhyolite indicates that not all of the supracrustal units in the Homestake Ridge area belong to the Hazelton Group, but at least some of them are part of the underlying Stuhini Group. This suggests that there may be major, previously unrecognized structural complexities in this region. None of the mineralization in the Homestake Ridge area has been proven to be syngenetic; however, VMS mineralization does occur at the Sault occurrence (BC MINFILE 103P 233), approximately 6 km east of the Homestake Ridge property. The Sault occurrence is hosted within felsic volcanic rocks that have given a U-Pb zircon age of 193.5 ± 0.4 Ma (Late Sinemurian; Mortensen and Kirkham, 1992), and is one of several Ag-rich VMS occurrences that have been identified in the upper Kitsault River valley (e.g., Dolly Varden, Torbrit; Pinsent, 2001). The Sault occurrence is therefore approximately equivalent in age to some of the intermediate-composition maroon and green volcanic breccias that underlie parts of the Homestake Ridge property and are thought to correlate with the Betty Creek formation, as recognized farther to the north (Lewis and Tosdal, 2001). There does appear to be some potential for VMS mineralization on the Homestake Ridge property, although it would likely be at a lower stratigraphic level than that at the Eskay Creek deposit.

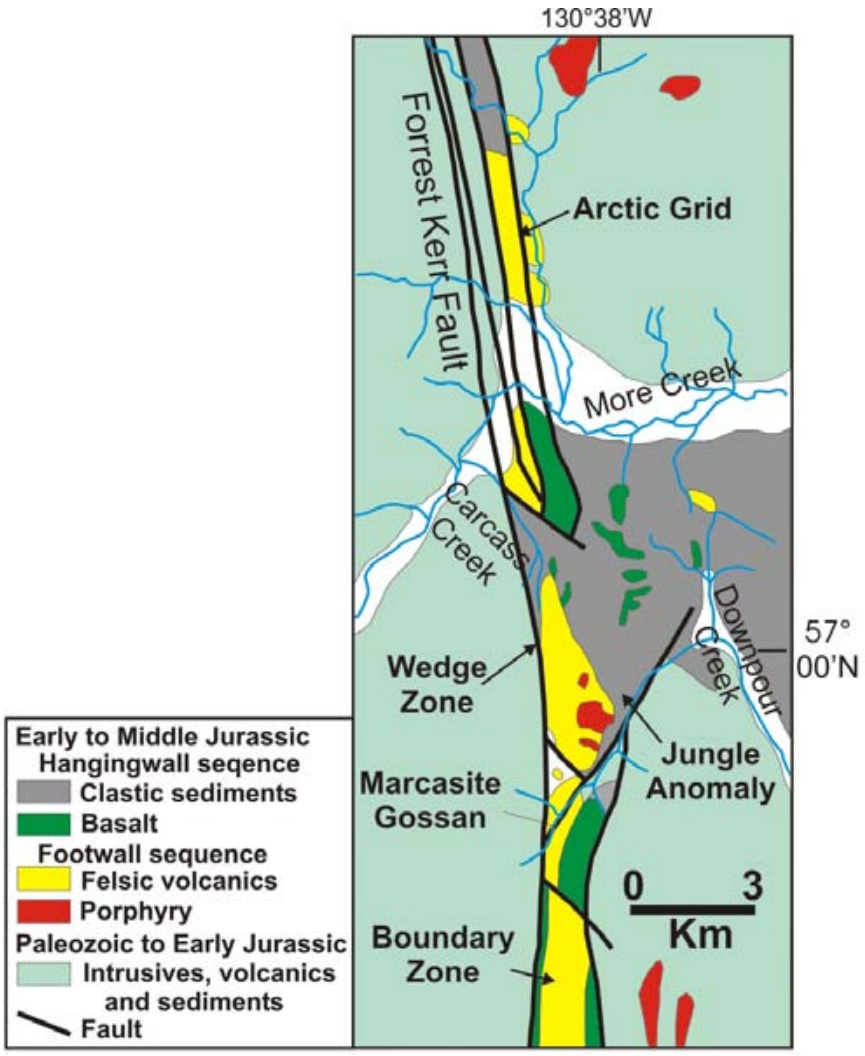

Figure 7. Simplified geology of the RDN property (from Rimfire Minerals Corporation website, http://www.rimfire.bc.ca/Home.asp).

Studies of the RDN property in the Forrest Kerr Creek area support the suggestion that geochemical anomalies and scattered base and precious metal occurrences there are potentially close analogues of the Eskay Creek deposit. Felsic volcanic and volcaniclastic rocks that make up the lower part of the stratigraphic sequence on the RDN property are ~193 Ma in age, and therefore equivalent in age to host rocks for the Sault VMS occurrence (see discussion above). Laminated pyrite was intersected in one drillhole within this package of felsic rocks on the RDN property (M. Jones, pers. comm., 2004), suggesting that an older VMS horizon may be present on the property. Most of the geochemical anomalies that are thought to be more analogous to the Eskay Creek deposit on the RDN occur within the overlying argillite-basalt package, which contains fossils indicating that the units are correlative with the Salmon River Formation.

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