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METALLOGENIC IMPLICATIONS OF GALENA LEAD ISOTOPE DATA, EQUITY SILVER AND SILVER QUEEN DEPOSITS, CENTRAL BRITISH COLUMBIA

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ABSTRACT

Deposits in the Buck Creek Basin of Central British Columbia include the Silver Queen epithermal Au-Ag-Zn-Pb-Cu veins near Owen Lake, B.C. and the Equity Silver Cu-Ag-Sb-As-Au mine at Goosly Lake. These deposits, separated by about 30 km, are enclosed by mainly subaerial continental volcanic rocks of probable Cretaceous age. Lead isotope ratios for galenas from these two mineralized areas are uniform in composition within each area but differ significantly between the two areas. Independent isotopic data indicate ages of 51 Ma and 58 Ma for Silver Queen and Equity respectively. The clustering of lead isotopic data is interpreted to reflect large scale homogenizing processes during mineralization and to have resulted from small but real geochemical differences in U-Th-Pb environments in which the two lead compositions evolved just prior to mineralization. Provenance for both lead compositional clusters could be early Jurassic basement rocks in the area.

INTRODUCTION

The Silver Queen (Nadina, Bradina) vein deposit, a past producer, and the producing Equity Silver mine, are in the Buck Creek Basin (Church, 1973) near Houston, 100 km southeast of Smithers in the Bulkley Valley region of central British Columbia (Fig. 1). A genetic relationship between the two deposits has been suspected because of proximity, similar hosts and comparable time of mineralization; we undertook a lead isotope study as part of a comprehensive investigation of

mineral deposits in the Owen Lake area of central British Columbia in order to examine this possible relationship in more detail.

General Geology

West-central British Columbia is part of the accreted Stikine terrane, a sequence that includes submarine calc-alkaline to alkaline immature volcanic island-arc rocks of the Late Triassic Takla Group (Stuhini assemblage) and subaerial to submarine calc-alkaline volcanic, volcaniclastic and sedimentary rocks of the Early to Middle Jurassic Hazelton and Takwahoni assemblages. These are overlain by several post-accretionary volcanic and sedimentary sequences including the Skeena, Carmacks and Kamloops assemblages (Dawson et al., 1990). Late Cretaceous to Tertiary calc-alkaline continental volcanic arc rocks of the Carmacks and Kamloops assemblages include the Kasalka, Ootsa Lake and Endako groups (Fig. 1), which occur sporadically throughout the terrane, mainly in downthrown fault blocks and grabens (MacIntyre and Desjardins, 1988). Plutonic rocks of Jurassic, Cretaceous and Tertiary ages form distinct intrusive belts (Carter, 1981), with which porphyry copper, stockwork molybdenum and mesothermal and epithermal base-precious metal veins are associated.

Buck Creek basin is interpreted as a resurgent caldera (Church, 1985); the important Equity Silver mine is in a window eroded into the central uplifted core of the basin. Silver Queen mine is on the caldera rim which is delineated roughly by a series of rhyolite outliers and semi-circular alignment of

Upper Cretaceous and Eocene volcanic centers scattered between Francois Lake, Houston, and Burns Lake (Fig. 1; see also figure 59 of Church, 1985). A prominent 30 km long lineament, trending east-northeasterly from the Silver Queen mine towards the central uplift hosting the Equity mine, appears to be a radial fracture coinciding with the eruptive axis of Upper Cretaceous volcanics and a line of syenomonzonite stocks and feeder dykes to an assemblage of Tertiary "moat volcanics" (Church, 1985). Block faulting is common in the basin, locally juxtaposing the various ages of volcanic rocks.

Local Geology

The area including the Silver Queen mine is dominated by calc-alkaline volcanics of the Upper Cretaceous Tip Top Hill Formation (Leitch et al, 1990). In the mine area, the rocks are subdivided into five stratigraphic units and three dyke types. A basal reddish-purple polymictic conglomerate is overlain by a felsic fragmental unit ranging from thick crystal tuff to coarse lapilli tuff and breccia, and this is succeeded upwards by a thick feldspar porphyritic andesite flow unit, intruded by microdiorite sills and other small porphyry bodies. The stratified rocks form a gently northwesterly-dipping succcession, with the oldest rocks exposed in the south. The Cretaceous rocks are cut by Eocene dykes that can be divided into three groups: pre-mineral amygdaloidal dykes, post-mineral bladed feldspar porphyry dykes, and later diabase dykes. These dykes may have been feeders for trachyandesitic to basaltic volcanic rocks that unconformably overlie the Cretaceous

succession to the south, and probably correlate with the Eocene Goosly Lake Formation (Church 1973).

Polymetallic (Ag-Zn-Pb-Cu-Au) veins cut the amygdaloidal, fine-grained plagioclase-rich dykes and are cut, in turn, by the bladed plagioclase dykes. Premineral dykes generally are strongly altered, whereas postmineral dykes are unaltered; the two dyke series are indistinguishable in whole rock K-Ar ages at 51.3 ± 1.8 and 51.9 ± 1.8 Ma respectively (Leitch et al., in prep.). Errors on ages here and elsewhere in this paper are one standard deviation analytical errors. The bladed feldspar porphyry dykes, some of which also contain pyroxene phenocrysts, correlate with the 50 Ma Goosly Lake volcanics (these volcanics are divided into two groups, one with and one without pyroxene in addition to the ubiquitous bladed plagioclase: Wetherell, 1979). The Nadina Mountain quartz monzonite stock, one of the Nanika intrusions, has a K-Ar model age for biotite of 53.8 ± 2.2 Ma (Carter, 1981). The intrusion lies 5 km to the east of the Silver Queen deposit and the two may be related genetically.

MINERAL DEPOSITS

Mineralization at Silver Queen deposit is restricted mainly to 0.1 to 2 meter thick quartz-carbonate-barite-specular hematite veins that contain disseminated to locally massive pyrite, sphalerite, galena, chalcopyrite, tennantite and argentian tetrahedrite. Minor sulfides include marcasite, arsenopyrite, wurtzite, bornite, covellite and chalcocite; oxides, in addition to hematite, are magnetite, rutile, anatase, ilmenite and goethite. Locally, in chalcopyrite-rich samples,

there is a diverse suite of Cu-Pb-Bi-Ag sulfosalts (Hood et al, 1991). Gold occurs as electrum, with a fineness of 510-620, throughout the veins. Carbonates include Mn-siderite, rhodochrosite, ankerite and calcite. Alteration of wallrock (Cheng et al, 1991) comprises quartz, sericite, clay (illite and kaolinite) and several phosphates including apatite. From 1972 to 1973 the mine produced 3160 oz Au, 168 000 oz Ag, 893 000 lbs Cu, 1.55 million lbs Pb, 11.1 million lbs Zn and 34 800 lbs Cd from 210 185 tons of ore. Reserves currently stand at about 500 000 tonnes averaging 3 g/t Au, 200 g/t Ag, 6.2% Zn, 0.92% Pb and 0.23% Cu.

The Equity Silver property has been described by Wetherell (1979), Wetheral et al (1979), Cyr et al. (1984) and Wojdak and Sinclair (1984). Deposits occur in a homoclinal Mesozoic inlier consisting of sedimentary and volcanic rocks plus intrusions surrounded and unconformably overlain by younger Tertiary volcanic rocks. The mine sequence includes a basal clastic sedimentary division, an intercalated subaerial pyroclastic division, interbedded volcanic sediments, and bedded andesitic to dacitic flows. These rocks are cut by a pre-mineral quartz monzonite stock (58.5 ± 2.0 Ma by K-Ar on biotite), belonging to the Nanika intrusions, and a post-mineral gabbro-monzonite complex (dated at 49.7 to 48.8 ± 1.9 Ma by K-Ar on biotite: Church, 1973 and Carter, 1981). Dykes of quartz latite and andesite, similar to those at Silver Queen, cut the Equity deposit and are dated at 50.7 ± 1.8 to 48.3 ± 2.0 Ma by K-Ar on whole rock (Cyr et al., 1984).

Equity Ag-Cu-Au-Sb-As deposit occurs as zones of disseminations, open-space fracture fillings, veins, and crackle breccia zones that are roughly tabular and have attitudes grossly conformable with the enclosing rocks. Production has come from the Main and Southern Tail zones, which are characterized by pyrite, chalcopyrite and tetrahedrite, plus minor marcasite, arsenopyrite, sphalerite, pyrrhotite, galena, a variety of sulfosalts and rarely chalcocite-covellite and molybdenite-wolframite. The Main zone is larger and lower grade (26 million tonnes of 109 g/t Ag, 0.85 g/t Au, 0.35% Cu), whereas the Southern Tail zone, now mined out, was smaller but higher grade (4.3 million tonnes of 135 g/t Ag, 1.3 g/t Au, and 0.45% Cu).

Alteration and gangue minerals at Equity include quartz, sericite, kaolinite, chlorite, carbonate, albite, epidote, and an unusual advanced argillic suite of andalusite, blue scorazalite, tourmaline, corundum and dumortierite in the Main zone, and andalusite and pyrophyllite in the Southern Tail zone.

SAMPLING AND ANALYTICAL METHOD

Samples taken from the Silver Queen (Owen Lake) property for lead isotope analysis were fist-sized specimens of galena-rich material either from diamond drill core or from freshly broken outcrops. Samples were selected to represent widespread geographic positioning of veins as well as to examine possible vertical variations in lead isotopic abundances within the main No. 3 zone. Equity Silver samples were mostly large but

included one sample with minute amounts of galena as well as samples of float above the orebody. Both of the producing zones (Main and Soutern Tail) were sampled.

Galena lead isotope data reported in Table 1 have been obtained by various workers at The University of British Columbia. Early analyses by B. Ryan were done on a solid source mass spectrometer using standard, single filament, silica gel techniques; procedural details are in Godwin et al. (1982). Recent analyses by J.E. Gabites and A. Pickering were done as follows (cf. Andrew and Godwin, 1989): hand-picked galena crystals (0.5 mg) were converted to pure lead chloride solution by dissolution of the galena in pure 6N HCl and evaporation to dryness. Lead chloride crystals so formed were cleaned by washing several times in 4N HCl, and the cleaned chloride crystals were dissolved in ultrapure water. One microgram of lead in the solution was loaded with phosphoric acid and silica gel onto a cleaned rhenium filament (cf. Cameron et al., 1969). Lead isotope ratios were measured on a Vacuum Generators Isomass 54R solid source mass spectrometer linked to a Hewlett-Packard HP-85 computer. Within run precision, expressed as a percentage standard deviation, is better than 0.01 %, and the variation observed in duplicate analyses is less than 0.1 %. Isotope ratios are normalized to the values of Broken Hill Standard Lead (BHS-UBC1) given in Richards et al. (1981): $^{206}Pb/^{204}Pb$ = 16.004, $^{207}Pb/^{204}Pb$ = 15.390, and $^{208}Pb/^{204}Pb$ = 35.651. Analytical precision is monitored by repeated measurement of BHS-UBC1 and systematic duplicate analyses. Fractionation error

and ^{204}Pb error trends are shown on data plots so that trends in data can be assessed.

RESULTS

Data given in Table 1 and plotted in Figs. 2 and 3 show two distinct clusters, one for Silver Queen data, the other for Equity data. The apparent trends in the data in the $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ plot (Fig. 2) are due in part to fractionation and ^{204}Pb error, although they also reflect the vertical exaggeration on the $^{207}Pb/^{204}Pb$ scale used in plotting. The Equity data are complicated by two outlying points, one of which is supported by duplicate analysis; no sample remains of the other (30409-102), thus, we were unable to reanalyze it. In the $^{208}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ plot (Fig. 3), the trends are more nearly parallel to established growth curves. Our sampling has not allowed us to investigate the significance of the limited amount of more radiogenic Equity data and we confine our interpretation to the more abundant data of uniform composition.

DISCUSSION

The Silver Queen (No. 3 vein) deposit was sampled in detail over a strike length of 2 km and a vertical extent of 300 m. There is no apparent spatial variation of the isotopic ratios either in plan or section, a result anticipated from the tight clustering of the data (Figs. 2 and 3); the variation in the data falls within the limits of analytical error and encompass lead isotopic compositions of other veins in the area (Table 1).

A comparable homogeneity of isotopic composition is evident in much of the Equity data as well. We interpret these uniform isotopic compositions to reflect highly effective homogenization of lead from large but different source rock volumes (provenances) during collection and transport of metals, with, for the most part, negligible contamination by lead from other sources during transport to depositional sites. The two Equity samples that are slightly enriched with radiogenic Pb may be the product of minor natural contamination during ore fluid transport.

Several classical growth curve models give negative model ages for both clusters of data. For example, application of the Stacey-Kramers model gives model ages of -185 Ma and -257 Ma for Silver Queen and Equity respectively. Consequently, the isotopic compositions are anomalous in the sense defined originally by Russell and Farquhar (1957) and the Stacey and Kramers model is unsuitable for modelling evolution of the observed compositions.

However, using average compositions of the two clusters it is possible to simulate and test two extreme hypotheses in the light of independent constraining information viz. (1) the two compositions were generated from the same source, and lead was separated at slightly different times (i.e. they lie along a common growth curve, with the Equity deposit being slightly younger); or (2) the two leads evolved in source areas with different Pb-Th-U characteristics and both deposits were formed at about the same time.

By forcing a single growth curve through the median compositions for the two data clusters (Table 2) we can estimate the difference in ages implicit in assumption (1) above. Such a calculation for various mu values (mu is the present day value of $^{238}U/^{204}Pb$) gives age differences of about 45 Ma (mu = 14) and 60 Ma (mu = 10). An age difference of this magnitude is inconsistent with independent geochronological data which show Equity mineralization to be about 58 Ma (Wojdak and Sinclair, 1984) and Silver Queen mineralization to be 51 Ma (Leitch et al, in prep.). The assumption of evolution of the two lead isotope ratio clusters from a common source requires that Equity be at least 45 Ma younger than Silver Queen instead of 7 Ma older. We conclude that the two lead compositions cannot have evolved in a common reservoir that was tapped at separate times to produce the observed lead isotopic compositions. In fact, the two sources are necessarily different in both U/Pb and Th/Pb ratios in order to produce the observed isotopic clusters. This example provides some insight into the small physical distances over which quite different evolutionary paths are reflected in lead isotopic compostions of deposits of comparable age and indicates that caution is necessary in the definition of local metallogenic areas.

In the second hypothesis above, the two isotopic clusters can be modelled as resulting from lead evolution in two reservoirs of different mu (i.e. different uranium/lead ratios). Such evolution was necessarily along two separate growth curves for which we have assumed mu values of about 10

and 14 for the Silver Queen and Equity leads (kappa values of 30 and 37.5 respectively). Both of these environments might have been in the early Jurassic sequence of about 200 Ma (the age of probable basement rocks at both deposits) with possible initial isotopic ratios of $^{206}Pb/^{204}Pb$ = 18.61, $^{207}Pb/^{204}Pb$ = 15.57, $^{208}Pb/^{204}Pb$ = 38.11. These initial isotopic ratios were estimated by trial and error by projecting the Silver Queen and Equity median isotopic values backwards along growth curves, characterized by mu values of 10 and 14.1 respectively, to the common point of intersection.

The observed lead isotopic compositions lie between the average curves for upper mantle and upper crustal sources (Godwin and Sinclair 1982). The shale curve may be appropriate to represent lead isotopic evolution in an upper crustal setting (cf. Doe and Zartman, 1979) in the part of the northwestern Canadian Cordillera containing the Buck Creek basin but we are unable to define the upper mantle growth curve in this locale. Consequently, we are unable to model mixing of crustal and mantle lead in detail for the area. The difference in lead abundance in these two ultimate sources is roughly an order of magnitude (0.5 ppm Pb for the mantle source, 5 ppm for the shale, based on Doe and Zartman, 1979 estimates for mantle and orogene sources, respectively). Thus, the mantle lead component must have been accumulated from a volume about 10 times that of the crustal component. This mixing could have been achieved within a volcanic pile formed largely of volcanic material (about 90 percent by volume) derived from the upper mantle, with

a less abundant (10 percent by volume) upper crustal component. Mixing is assumed to have taken place physically when hydrothermal solutions circulated through the pile at ca. 50 Ma. One can speculate that early Jurassic rocks in the area are an appropriate source of lead for these deposits but no independent evidence exists to prove this suggestion.

CONCLUSIONS

Lead from Silver Queen and Equity deposits is remarkably uniform locally but differs significantly in composition between the two deposits. The difference is somewhat anomalous in that the older deposit (Equity) is more radiogenic than the younger (Silver Queen). The mineralizing system in both cases, however, seems to have effectively homogenized lead from large but different volumes of source rocks (provenances).

Both the Silver Queen and Equity lead isotope clusters are roughly midway between the mantle and shale curves indicating about equal contributions of lead from both mantle and crustal sources. Because of large differences in absolute abundances of Pb in these two environments the volume of crustal provenance is about one-tenth that of mantle provenance.

At a more detailed level the galena lead isotope ratios of the Silver Queen and Equity deposits appear to be explained best by a multistage history involving evolution along a growth curve of approximate μ = 9.74, prior to 200 Ma, with the spread between the two analytical clusters (see Table 1) due to a later stage of lead evolution in two different environments

characterized approximately by mu = 10 and 14.1, respectively, both extending from 200 Ma until mineralization (ca. 50 Ma). Geologic observations suggest that the deposits are related metallogenically (i.e. spatially related, in the same age host and of similar age of mineralization), but deposits could have been derived from hydrothermal solutions that extracted metals from different rock volumes (perhaps mainly lower Jurassic volcanic rocks) with significantly different uranium-thorium-lead characteristics.

The negative model ages obtained by using world average lead evolution curves such as those of Stacey and Kramers (1975) and Cummings and Richards (1975) clearly demonstrates that world average curves cannot be used with confidence to date mineral deposition unless independent evidence exists to support their use; in fact, lead-lead model ages based on galena lead isotopes can be wrong by several hundred million years if based on world average models.

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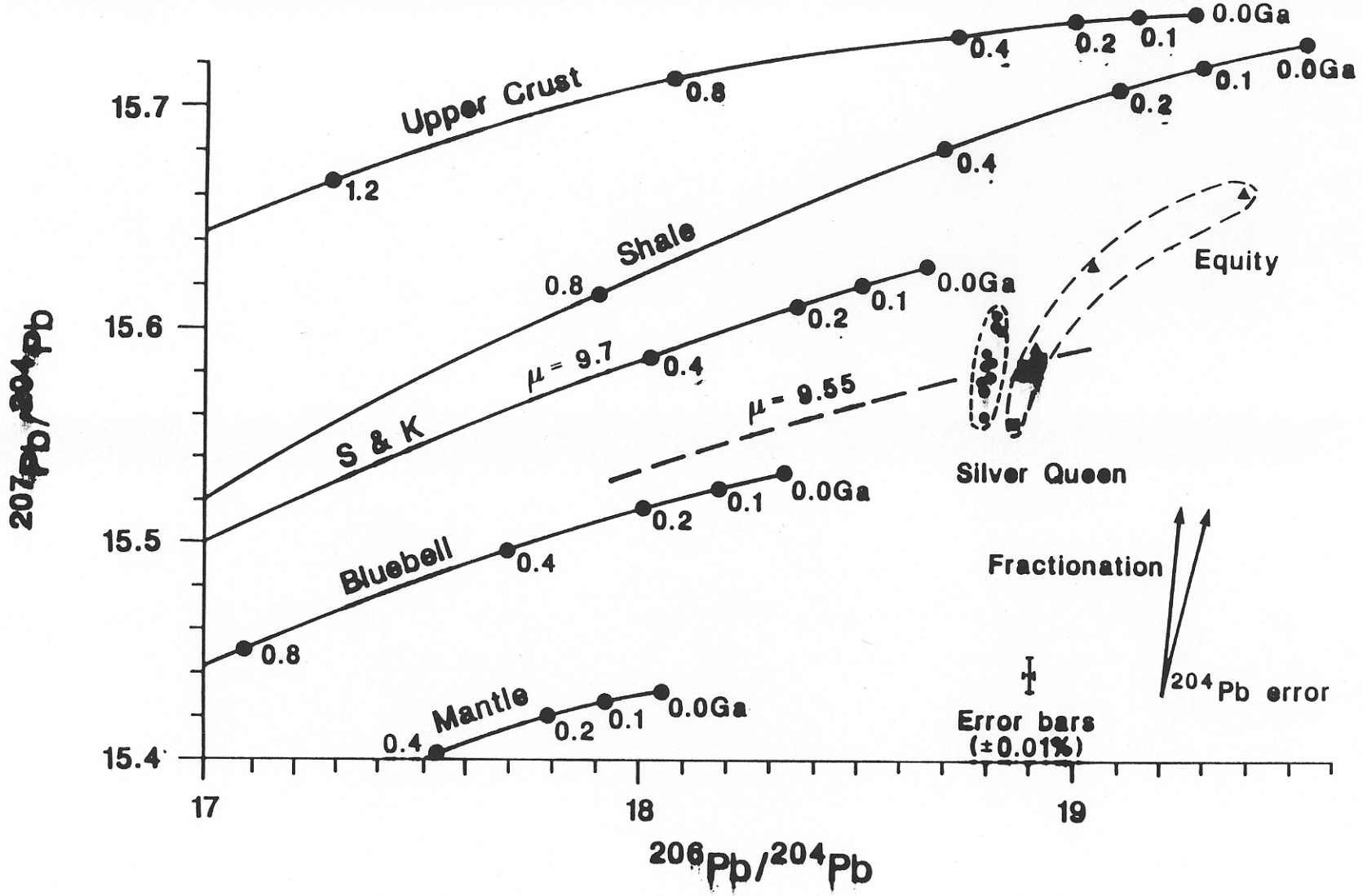
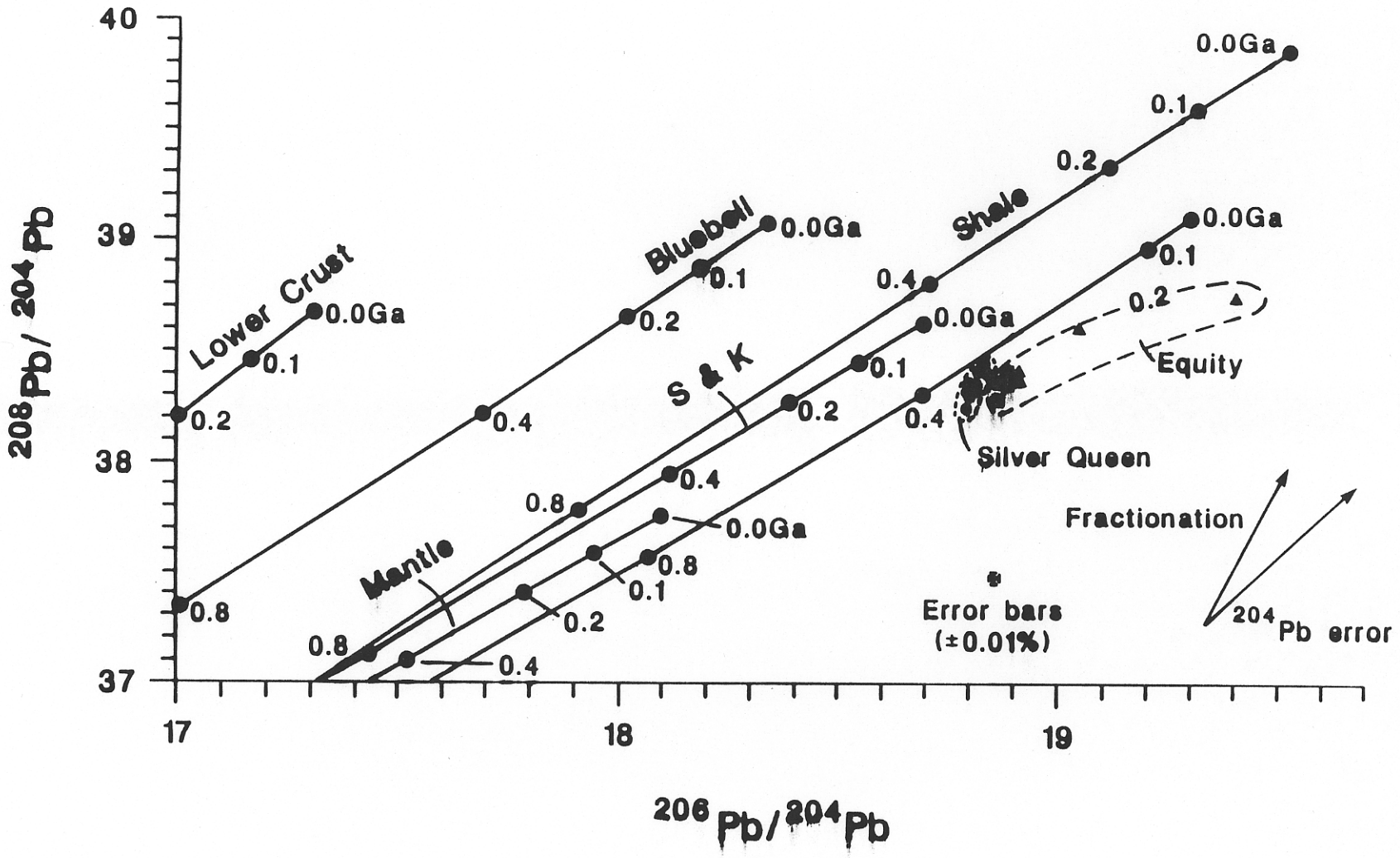
Figure Captions

Figure 1. General geology of west-central British Columbia showing location and regional setting of the Silver Queen and Equity deposits. After MacIntyre (1985).

Figure 2. Plot of $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ for data from the Equity (Main Zone = triangles; Southern Tail Zone = squares), and Silver Queen (circles) deposits. Mantle and upper crust curves are from Doe and Zartman (1979); Bluebell (lower crustal) curve from Andrew et al. (1984); S & K curve from Stacey and Kramers (1975); shale curve from Godwin and Sinclair, 1982. Error bars are one standard deviation analytical error. Arrows in lower right are error trends for ^{204}Pb error and fractionation during analysis.

Figure 3. Plot of $^{208}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ for data from the Equity and Silver Queen deposits; symbols and curves as for Figure 2.


Upper Crust
1.2
0.8
0.4
0.2
0.1
0.0Ga
Shale
S & K
μ = 9.7
μ = 9.55
Bluebell
Mantle
Equity
Silver Queen
Fractionation
204Pb error
Error bars
(±0.01%)
15.7
15.6
15.5
15.4
17
18
19
207Pb/204Pb
206Pb/204Pb


40
39
38
37
17
18
19
$^{208}Pb/^{204}Pb$
$^{206}Pb/^{204}Pb$
Lower Crust
0.0Ga
0.1
0.2
0.4
0.8
Bluebell
0.0Ga
0.1
0.2
0.4
Shale
0.0Ga
0.1
0.2
0.4
S & K
0.0Ga
0.1
0.2
0.4
0.8
Mantle
0.0Ga
0.1
0.2
0.4
0.8
Equity
0.2
Silver Queen
Fractionation
Error bars
(±0.01%)
^{204}Pb error

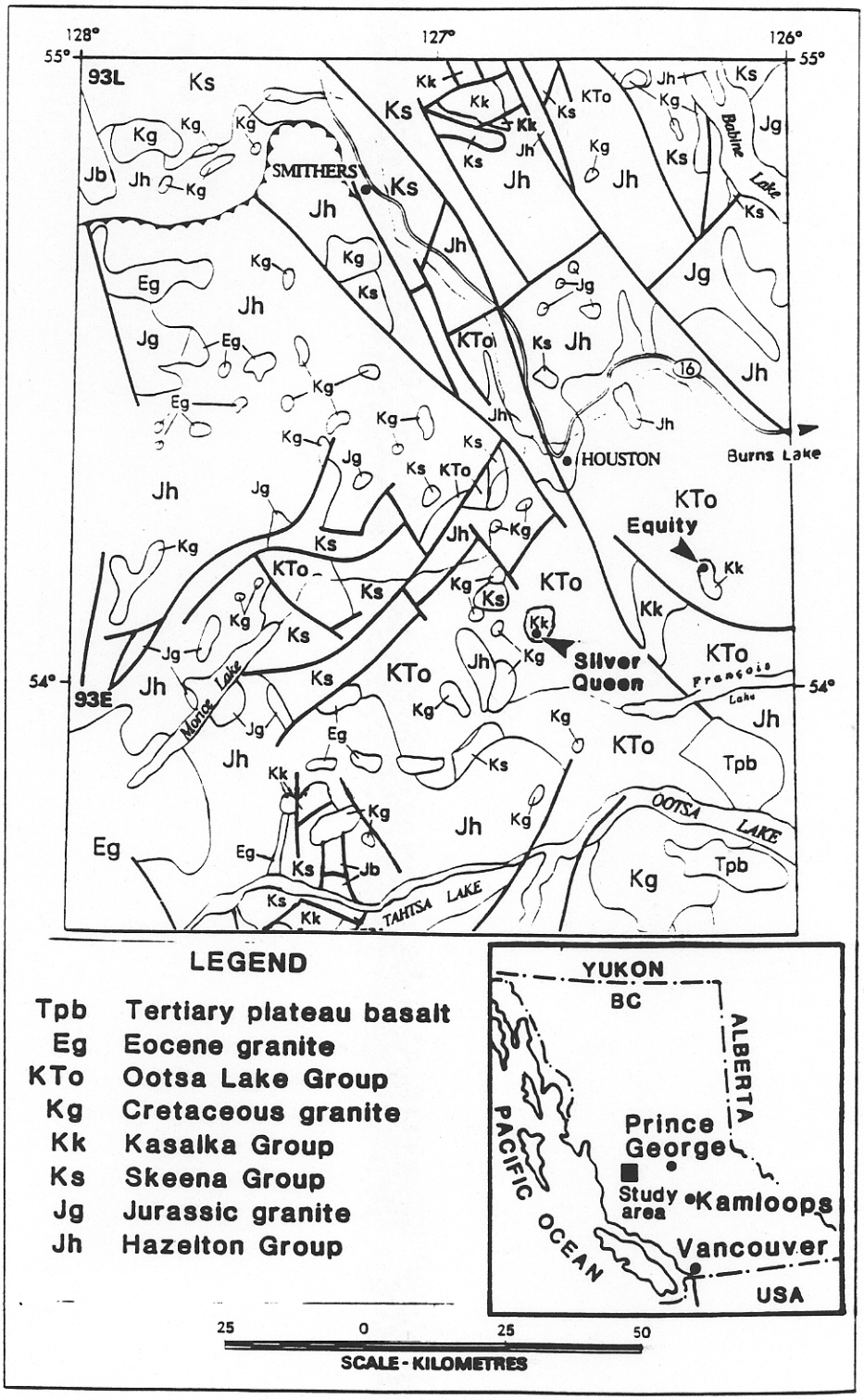

128°
127°
126°
55°
54°
93L
93E
SMITHERS
HOUSTON
Burns Lake
Equity
Silver Queen
Morice Lake
François Lake
OOTSA LAKE
TAHTSA LAKE
Babine Lake
16
Ks
Kk
KTo
Jh
Kg
Eg
Jg
Jb
Tpb
LEGEND
Tpb Tertiary plateau basalt
Eg Eocene granite
KTo Ootsa Lake Group
Kg Cretaceous granite
Kk Kasalka Group
Ks Skeena Group
Jg Jurassic granite
Jh Hazelton Group
YUKON
BC
ALBERTA
PACIFIC OCEAN
Prince George
Study area
Kamloops
Vancouver
USA
25 0 25 50
SCALE - KILOMETRES

TABLE 1. Galena lead isotope analyses from the Silver Queen and Equity deposits, west-central British Columbia.

Sample No.[a]	Location[b]	Lat. (°N)	Long. (°W)	Lead isotope ratios (1σ uncertainty) $^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$
			Silver Queen deposit			
30800-501[1]	Unlocated	54.09	126.73	18.790	15.578	38.317
30800-001[3]	Unlocated	54.09	126.73	18.792 (0.003)	15.568 (0.03)	38.320 (0.01)
30800-002[3]	#3 vn C Adit 2590 el.	54.09	126.73	18.833 (0.02)	15.598 (0.015)	38.467 (0.045)
30800-008[3]	HW vn C Adit 2590 el.	54.09	126.73	18.798 (0.003)	15.581 (0.003)	38.366 (0.011)
30800-009[3]	#3 vn C Dump 2590 el.	54.09	126.73	18.822 (0.004)	15.600 (0.004)	38.422 (0.012)
30800-012[3]	#7 vn Surf 2650 el.	54.09	126.73	18.818 (0.005)	15.606 (0.004)	38.436 (0.014)
30800-013[3]	178'core	54.09	126.73	18.809 (0.004)	15.576 (0.003)	38.351 (0.011)
30800-014[3]	181.5'core	54.09	126.73	18.804 (0.003)	15.583 (0.003)	38.362 (0.011)
30800-015[4]	#2 vn N Adit 2590 el.	54.10	126.73	18.802 (0.003)	15.579 (0.003)	38.355 (0.008)
30800-016[4]	#3 vn S Decl 2400 el.	54.08	126.73	18.808 (0.004)	15.581 (0.004)	38.371 (0.013)
30800-017[4]	#3 vn S Surf 2780 el.	54.08	126.73	18.791 (0.003)	15.571 (0.004)	38.334 (0.012)
30800-018[4]	NG-6 vn Surf 3000 el.	54.10	126.72	18.803 (0.008)	15.575 (0.007)	38.336 (0.019)
30800-018[c4]				18.812 (0.003)	15.584 (0.003)	38.380 (0.009)
30800-019[4]	#5 vn C Surf 2600 el.	54.09	126.74	18.806 (0.004)	15.588 (0.003)	38.397 (0.010)
30800-019[c4]				18.797 (0.004)	15.575 (0.003)	38.339 (0.010)
30800-020[4]	Cole vn Surf 2800 el.	54.08	126.71	18.803 (0.003)	15.583 (0.003)	38.368 (0.008)
30800-021[4]	NG-3 vn core 1300 el.	54.07	126.72	18.809 (0.003)	15.585 (0.003)	38.374 (0.008)
30800-022[4]	Cole vn core 2300 el.	54.08	126.71	18.831 (0.011)	15.604 (0.003)	38.427 (0.037)
30800-022[c4]				18.833 (0.006)	15.617 (0.005)	38.482 (0.016)
30800-022[d4]				18.805 (0.005)	15.581 (0.005)	38.348 (0.013)
30800-023[4]	#3 vn N X-Cut 2590 el.	54.08	126.73			
30800-024[4]	George L. vn 2590 el.	54.09	126.72	18.787 (0.003)	15.566 (0.002)	38.307 (0.010)
30800-024[d4]				18.798 (0.003)	15.574 (0.003)	38.337 (0.009)
30403-001[3]	Chisholm Surf 2400 el.	54.08	126.73	18.790 (0.004)	15.575 (0.004)	38.303 (0.011)
30403-002[3]	Chisholm Surf 2400 el.	54.08	126.73	18.795 (0.003)	15.578 (0.003)	38.388 (0.010)
			Equity Silver deposit			
30409-001[2]	DDH 133-382'	54.18	126.26	19.047 (0.07)	15.628 (0.11)	38.649 (0.08)
30409-001[c4]				19.048 (0.003)	15.632 (0.003)	38.676 (0.009)
30409-001[d4]				19.028 (0.003)	15.612 (0.003)	38.613 (0.010)
30409-005[2]	Unlocated	54.18	126.26	18.911 (0.006)	15.584 (0.005)	38.467 (0.014)
30409-005[c4]				18.922 (0.004)	15.602 (0.004)	38.484 (0.011)
30409-006[3]	Main pit 1290 bench	54.18	126.26	18.889 (0.01)	15.578 (0.04)	38.399 (0.01)
30409-006[c4]				18.904 (0.003)	15.586 (0.003)	38.437 (0.009)
30409-007[3]	87 South Main 1	54.18	126.26	18.900 (0.003)	15.588 (0.003)	38.437 (0.01)

30409-008[3]	DDH87-366 113-121 m	54.18	126.26	18.889	(0.003)	15.581	(0.003)	38.409 (0.01)
30409-009[3]	Main pit 1290 bench	54.18	126.26	18.902	(0.003)	15.583	(0.003)	38.423 (0.011)
30409-101[2]	S78GS-001 (float)	54.18	126.26	18.863	(0.06)	15.577	(0.13)	38.387 (0.26)
30409-102[2]	G87GS-002 Main pit	54.18	126.26	19.402	(0.06)	15.661	(0.12)	38.772 (0.18)
30409-103[2]	G78GS-003 S. Tail	54.18	126.26	18.860	(0.05)	15.553	(0.09)	38.301 (0.10)

[a] Analyses quoted in Thorpe (1972) denoted by [1]; analyses by B. Ryan denoted by [2]; analyses by J. Gabites denoted by [3]; analyses by A. Pickering denoted by [4].
[b] Abbreviations are: vn = vein; Surf = surface; el. = elevation in feet; N = northern part of vein, S =southern part, C = central part.
[c] Analytical duplicate (repeat analysis on separately picked galena from the hand specimen).
[d] Analytical replicate (repeat mass spectrometry on same solution).

TABLE 2: Summary of median lead isotope values and parameters for Silver Queen and Equity deposits.

	x	y	z
Silver Queen median Pb isotope values	18.803	15.581	38.367
Equity median Pb isotope values[1]	18.900	15.583	38.423
Assumed common composition at 200 Ma[2]	18.566	15.567	38.143

1. Median values based on omission of 2 abnormally radiogenic samples.
2. mu and kappa values are 10 and 30 respectively to generate Silver Queen median values, and 14.1 and 37.5 respectively to generate Equity median values.