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COMPOSITION OF GOLD FROM SOUTHWESTERN BRITISH COLUMBIA: A PROGRESS REPORT

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INTRODUCTION

This account gives new data on the composition of gold from various lodes and placers in southwestern British Columbia. This research is a continuation of work reported in a 1986 paper (Knight and McTaggart, 1986). This account repeats some of the introductory material of the earlier paper in order to clarify the present report.

A main objective of this work is to characterize gold by its suite of minor elements; with gold from different sources thus fingerprinted, one can attempt to trace the path of gold from lode to placer. In addition, the composition of lode gold is a parameter which may be used in the genetic classification of gold deposits. The study of placer gold textures is expected to yield information on conditions and distance of travel.

Placer and lode gold are rarely if ever pure, but are alloyed with other elements such as silver, copper and mercury. Early studies on gold composition and its significance were made before the electron microprobe was developed and Boyle (1979) provides an exhaustive account of this research. One of the early studies is that of Warren and Thompson (1944) who spectrographically analysed gold from many areas, mainly British Columbia. Holland (1950) lists gold-silver ratios for many placers in the province. Microprobe studies include those of Desborough (1970) who has studied placer gold from many localities in the United States and Giusti (1983) who reported placer gold compositions from Alberta, Canada.

This paper presents new compositional data on eight lodes and eight placer deposits and the reader may find it useful to compare these results with those of the earlier work (Knight and McTaggart, 1986).

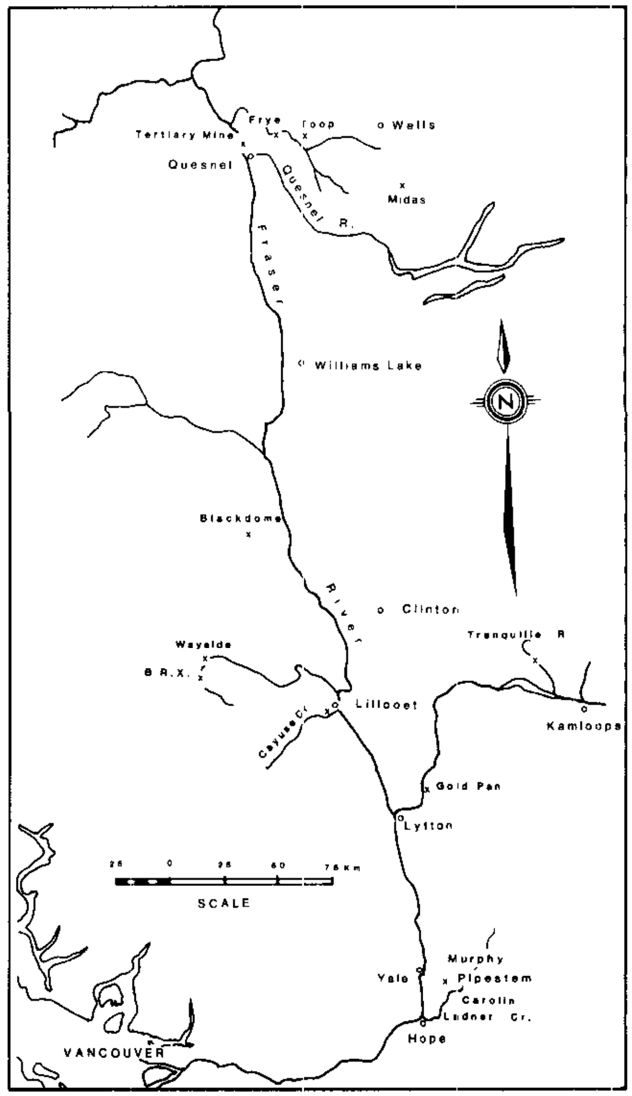

Figure 2-4-1. Location of gold samples.

METHOD

Samples (Figure 2-4-1) were obtained in various ways; some were donated and many were collected by the authors. Vein quartz was crushed and the gold recovered by panning or, in one case, by dissolution in cold hydrofluoric acid. The number of gold particles ranged widely from sample to sample.

Gold particles for analysis must be large enough to be manipulated by needle or tweezers; this means the practical lower size limit is about 0.2 millimetre. All placer particles are photographed so that grains of anomalous composition can be examined for unusual textural features.

Particles are embedded in plastic cylinders, ground and polished. Before being carbon-coated, the gold is examined with an ordinary microsope for contamination, inclusions, heterogeneities and so on. Most gold grains appear to be homogeneous except for rimming (*see* below). Many copper-rich grains show regular two-phase patterns resembling exsolution textures. Analyses were made using an SX-50 Cameca microprobe which has a practical detection limit for most elements of about 0.05 per cent.

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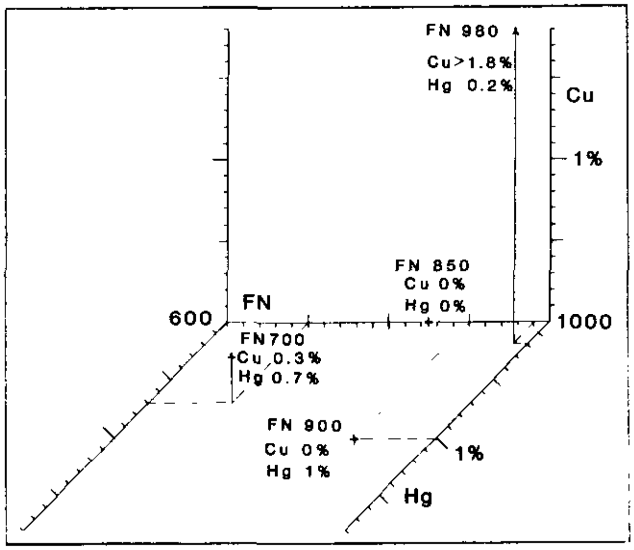

Figure 2-4-2. Explanation of composition diagrams.

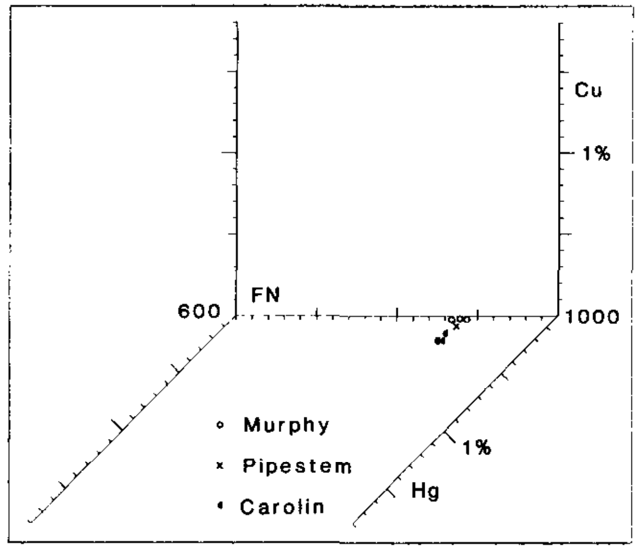

Figure 2-4-3. Lode samples, Coquihalla gold belt.

Preliminary testing indicates that only three elements, silver, copper and mercury, occur at greater than detection limits in gold from southwestern British Columbia. Testing for other elements is being done on a reconnaissance basis, rather than routinely, in order to save time and money. Early, pre-microprobe studies suggested that gold commonly contains a large variety of elements in easily measurable amounts but that work, mainly spectroscopic, was done necessarily on large specimens which held other mineral inclusions. The microprobe, allows an investigator to examine gold under high magnification and thus avoid mineral inclusions.

The analytical results are plotted as in Figure 2-4-2 which shows how they are to be read. Each cross or other symbol represents the composition of a single gold particle.

"NEW" GOLD

Some gold in certain placer deposits may not be detrital in origin but rather formed by precipitation from groundwater or low-temperature hydrothermal solutions at that site. Such gold is said to be of high fineness [fineness, abbreviated FN, = 1000 × %Au/(%Au + %Ag)]. Furthermore, gold particles deposited from solutions within a limited area should show a similarity in composition (compare gold from Blackdome mine, described following). No placer deposit has been sampled in this work in which all of the gold is of consistent high fineness or uniform composition. In addition, most of the gold has the form of clastic grains that have been more or less abraded, flattened or otherwise modified during water transport. For these reasons it is believed that nearly all of the placer gold is detrital in origin.

A few particles, much less than 0.5 per cent of the placer grains, show a thin coating of microcrystalline gold or are agglomerations of particles cemented by coatings of finely crystalline gold. These rare coatings appear to be "new" gold, precipitated on detrital gold.

TEXTURAL FEATURES OF GOLD PARTICLES

Gold grains show much variety in shape. Gold released from lodes is extremely angular, consisting of aggregates of blebs, intersecting flakes, crystals and wires. Much placer gold from the study area consists of subcircular or elliptical discs with regular outlines, and mean dimension up to 40 times thickness but averaging about 15 times thickness. It is assumed that this flattening is the result of fluvial transport. Some of these discs have been wrinkled, folded or torn. Coarse grains greater than 1.5 millimetres are more flattened than small grains of about 0.4 millimetre, which, on average, are less flattened, more elongate, show more re-entrants and have less regular outlines than the larger grains.

A placer sample from Frye Creek shows two quite different textural types which also differ in composition.

GOLD RIMS

Every placer sample includes gold grains with complete or partial rims of gold of high fineness. In an earlier account Knight and McTaggart (1986) reported that rimming was not found in samples from the Bridge River or Cariboo districts. New samples from the Cariboo show rimming and, after careful repolishing of original samples, rimming and partial rimming were found in nearly all placer samples. The nature and origin of rimming are discussed in the earlier paper so only a brief note is given here. Rims are outer zones or coats that enclose the placer grain. They range in thickness from a few microns to 25 per cent or more of the grain diameter. They are invariably of high fineness, 970-999, and are devoid of copper and mercury. No evidence has been found to contradict the conclusion that rims from this region are probably the result of leaching of silver and other metals from the placer grains.

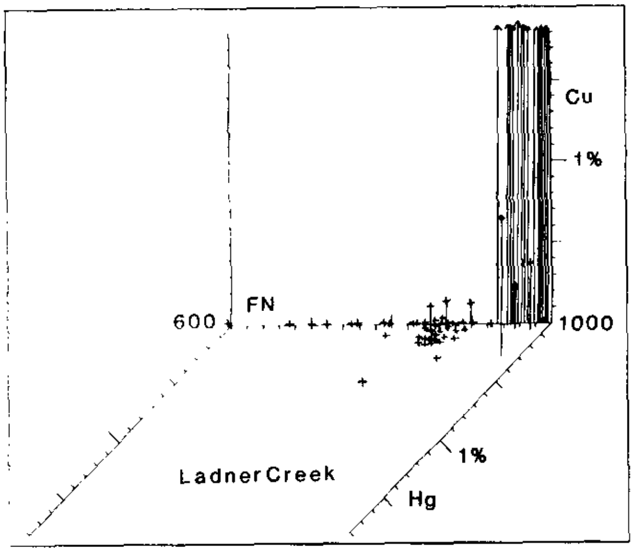

Figure 2-4-4. Placer sample, Ladner Creek.

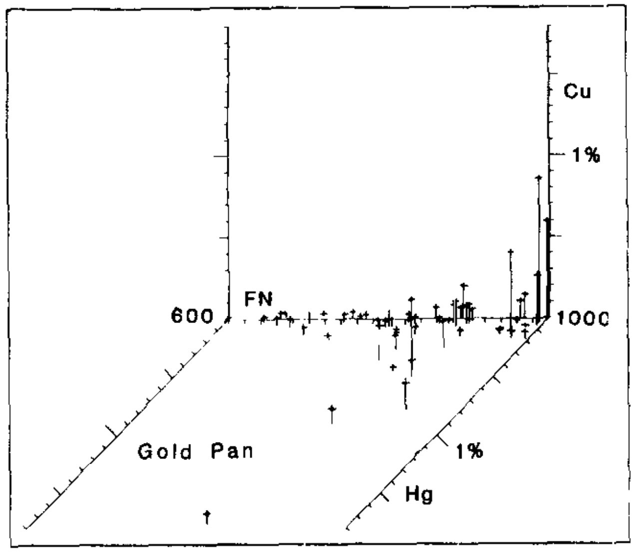

Figure 2-4-5. Placer sample, Gold Pan Park.

MERCURY AND COPPER IN GOLD

Many of the placer gold particles contain mercury and the maximum value found is approximately 10 per cent. It is believed that the mercury in placer gold reported here is primary and is not the result of contamination. The presence of mercury in lode gold that has not been exposed to contamination, for example Wayside (Figure 2-4-8) and Bralorne mine (Knight and McTaggart, 1986) shows that mercury in placer gold derived from these lodes can be primary.

A few grains with thin mercury-rich rims and rare aggregates of gold grains held together by mercury were found in this study. They were easily recognized by their silvery colour and are almost certainly the result of contamination. They were not analysed.

It has been generally observed that high-copper gold has a high fineness and this is borne out in the present study. Mercury is generally low or near the detection limit in such gold. Cupriferous gold is slightly redder than pure gold. Although it is said to be harder than pure gold, copper-rich placer grains do not seem to have distinctive textural features. Cupriferous gold is reported (Knight and McTaggart, 1986) from Relay Creek (north of Bralorne), Bridge River and Fraser River. It also occurs in the Coquihalla River (Figure 2-4-4) and is presumeably derived from the lodes of the Coquihalla gold belt.

RESULTS

COQUIHALLA GOLD BELT AND LADNER CREEK

Deposits of the Coquihalla gold belt, northeast of Hope, have been described by Cairnes (1924, 1930) and by Ray (1984). The present writers have analysed gold from three lodes and from gravels in Ladner Creek, some 4 kilometres downstream from the Carolin mill.

The scanty lode samples (*see* Figure 2-4-3) are from the Carolin and Pipestem mines and the Murphy prospect. The Pipestem and Murphy samples, fineness about 880, lack both copper and mercury. The Carolin sample contains up to 0.2 per cent mercury.

The placer sample (Figure 2-4-4) from Ladner Creek shows a wide range of compositions. Of 81 gold particles, 21 contain abundant copper. The maximum copper value found is near 24 per cent (3 grains) and most of the rest contain well over 2 per cent copper. These copper-rich particles have a fineness greater than 930. Much of the gold with more than 10 per cent copper consists of a copper-rich and a copper-poor phase forming an irregular exsolution intergrowth with alternating layers less than 10 microns wide. Most of these analyses represent bulk compositions. The copper-poor particles of the sample show a strong concentration between 830 and 900 fine, with up to 0.2 per cent mercury, which easily includes the compositions of the lode samples already described.

Clearly a lode source has not been identified for the copper-rich grains which make up a quarter of the placer sample. Such compositions appear to be restricted to gold deposits in ultramafic rocks. A clue to the nature of the source is provided by Cairnes (1930) who describes the Fifteenmile group of claims which lie along the western side of the "Serpentine Belt" in the headwaters of Fifteenmile Creek. Gold occurs on this property in narrow talcose zones, associated with serpentine, diorite, "white rock" (rodingite) and chalcocite. Cairnes states that "the colour of the gold is distinctly reddish as contrasted with other properties where it has a more normal appearance". He suggests "that its colour may be due to the presence of a small proportion of copper as an alloy with the gold". The Fifteenmile showing is situated so that it could not supply material to the Ladner Creek drainage by normal fluvial processes. Unless glaciation rearranged some of the residual or placer deposits, it seems likely that the copper-rich gold in Ladner Creek originated in some other lode, probably of the Fifteenmile type, in the upper Ladner drainage.

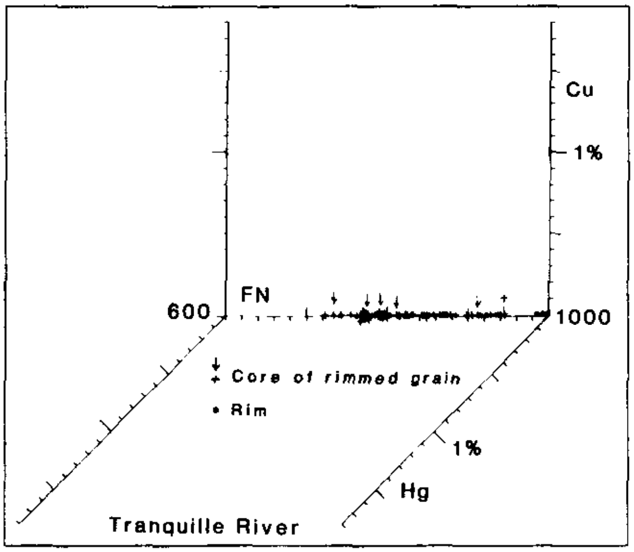

Figure 2-4-6. Placer sample, Tranquille River.

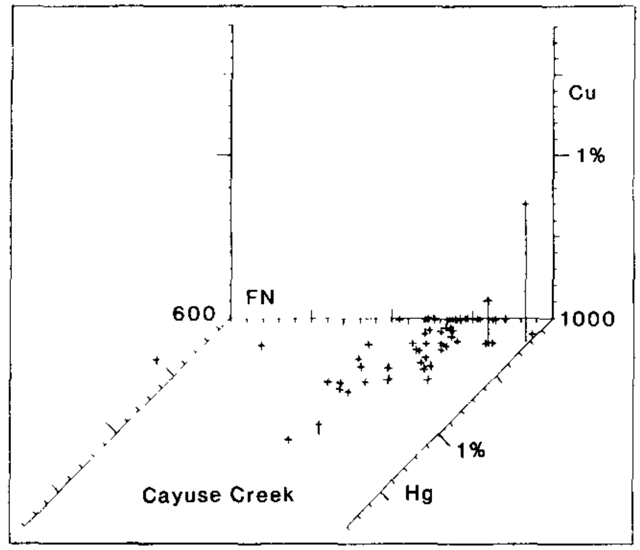

Figure 2-4-7. Placer sample, Cayuse Creek.

THOMPSON RIVER, GOLD PAN PARK

A sample from the Thompson River at Gold Pan Park, about 18 kilometres northeast of Lytton, shows a wide range in fineness and in amounts of mercury and copper (Figure 2-4-5). It resembles a sample taken at Lytton (Knight and McTaggart 1986) and is probably a mixture of contributions from many sources, including glacial drift.

TRANQUILLE RIVER

A sample from Tranquille River is unusual in its wide range of fineness and the almost complete absence of mercury and copper. Five analysed, rimmed grains are indicated in the diagram (Figure 2-4-6). Rims are greater than 980 fine.

CAYUSE CREEK

A placer sample from Cayuse Creek, at a point some 13 kilometres southeast of Lillooet, was taken almost directly below the Golden Cache lode. In general, a placer sample taken close to a productive lode shows a narrow range of compositions reflecting the compositions of the parent lodes; examples are found in diagrams for placers near the Bralorne, Blackdome and Coquihalla gold belt lodes. Unexpectedly, for a placer so close to a lode, the diagram (Figure 2-4-7) for Cayuse Creek shows a relatively wide dispersion in fineness and also in mercury content. The general pattern resembles, in part, that of some Bridge River samples (Knight and McTaggart, 1986).

WAYSIDE PROSPECT

This lode sample is reported to be from the Zero adit, also called the Paxton adit, from a 45-centimetre quartz vein. For this sample, gold was released by dissolution in cold hydrofluoric acid.

The diagram (Figure 2-4-8) is notable for a strong concentration at 770 fine and 1.3 per cent mercury. Three grains in this vicinity show measurable copper. None of this gold is recognizable in samples from Bridge River.

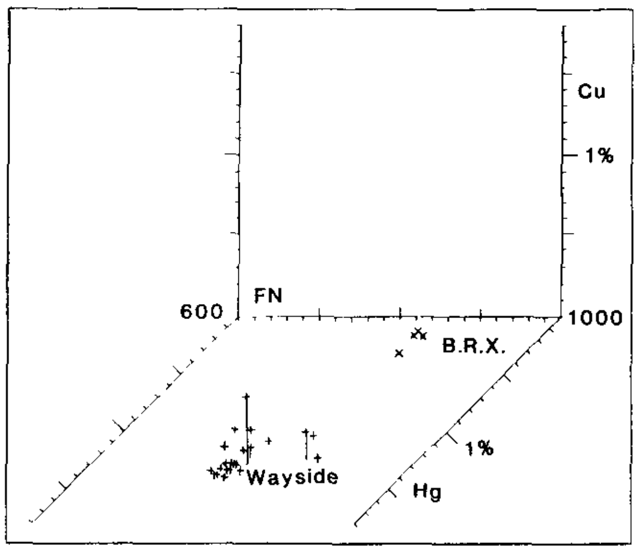

Figure 2-4-8. Lode samples, B.R.X. and Wayside veins.

B.R.X. PROPERTY

This small sample (Figure 2-4-8) from the Whynot vein on the B.R.X. property in the Bridge River area, closely resembles the Bralorne mill sample reported by the authors in an earlier paper.

BLACKDOME MINE

Gold from the Blackdome mine (Faulkner, 1986) has a fineness near 600, which is markedly lower than that of other lode gold so far analysed. Such low average fineness is one characteristic of epithermal deposits.

Gold-quartz samples, collected from exploration trenches, were crushed and panned. Samples 126 and 129 (Figures 2-4-9 and 2-4-10) from No. 1 vein differ slightly in that measurable mercury occurs in the latter.

Samples 127 and 128 (Figures 2-4-9 and 2-4-11) are from No. 2 vein and differ slightly in fineness.

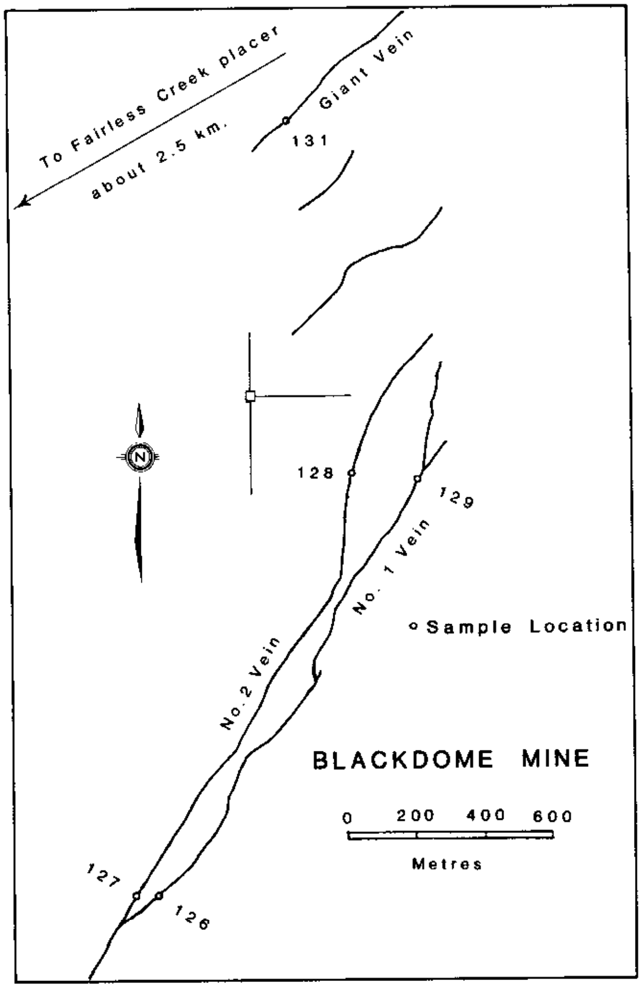

Figure 2-4-9. Blackdome mine, sample locations.

Sample 131 (Figure 2-4-11) from the Giant vein is interesting in that gold-coloured and silver-coloured grains could be distinguished during picking and mounting. The gold-coloured grains have normal cores (fineness about 600) but marginal parts of high fineness (~990). The analyses shown in Figure 2-4-11 are from the cores.

A sample from underground, a polished section with only four grains of gold, has a fineness of 650 and some grains contain a little mercury. This sample is significant in connection with the Fairless Creek placer, described below.

FAIRLESS CREEK PLACER

The Fairless Creek placer is a small inactive operation, about 2 kilometres downhill and west of the Blackdome veins.

Fifty particles (Figure 2-4-12) were recovered by sluicing and panning. Compositions show a wide range. Samples of 580 to 610 fineness are easily related to the No. 1, No. 2 and Giant veins at Blackdome. The strong concentration at about 630 fineness is close in composition to the sample from underground. Two particles of 980 fine may be marginal parts of the gold-coloured grains from the Giant vein. Grains of fineness 700-900 are of unknown provenance.

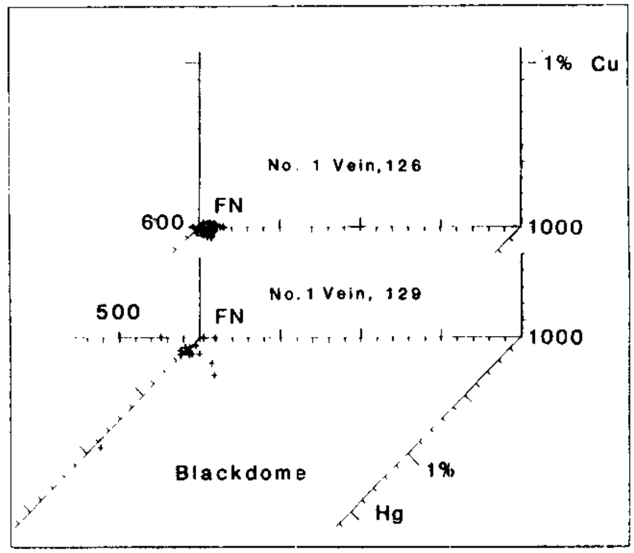

Figure 2-4-10. Lode samples, No. 1 vein, Blackdome mine.

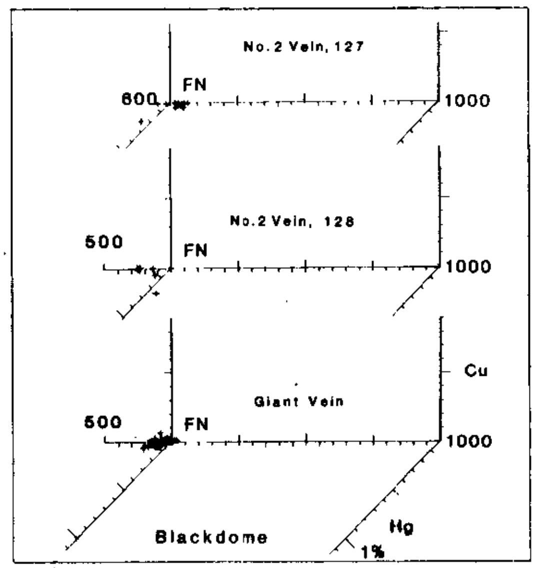

Figure 2-4-11. Lode samples, No. 2 and Giant veins, Blackdome mine.

CARIBOO DISTRICT

The authors report on five new samples from the Cariboo district: a lode sample from the Midas lode on the Snowshoe property in the Yanks Peak area; a placer sample from the Toop placer near Cottonwood House; a placer sample from Frye Creek, a tributary of Cottonwood River; a sample from the Tertiary mine just north of Quesnel; and a placer sample from the Fraser River at the Tertiary mine.

MIDAS LODE

The sample from the Midas lode (Figure 2-4-13) (Holland, 1953) shows a tight concentration at about 860 fine. In the absence or near absence of copper and mercury the sample is similar to earlier reported lode and placer samples (Knight and McTaggart, 1986) from the Cariboo district. Samples

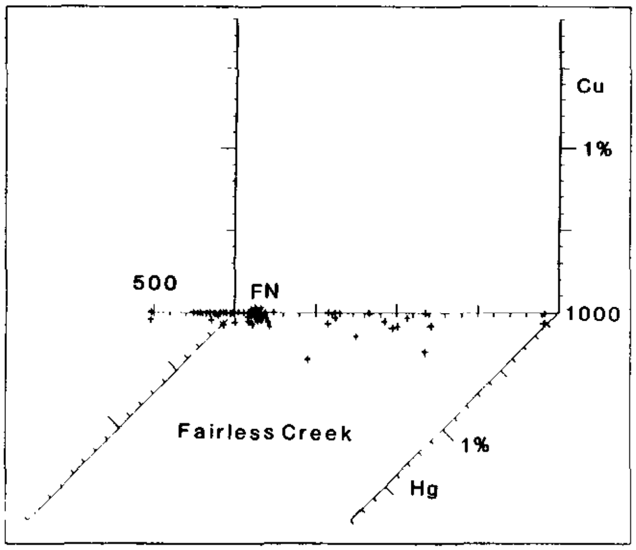

Figure 2-4-12. Placer sample, Fairless Creek, near Blackdome mine.

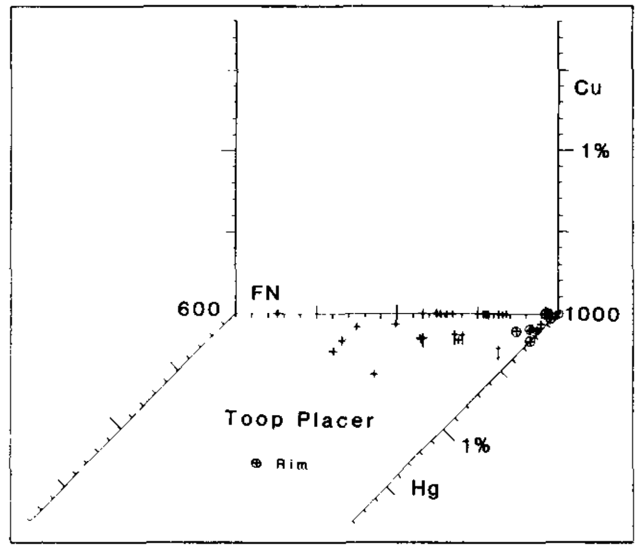

Figure 2-4-14. Placer sample, Toop placer mine.

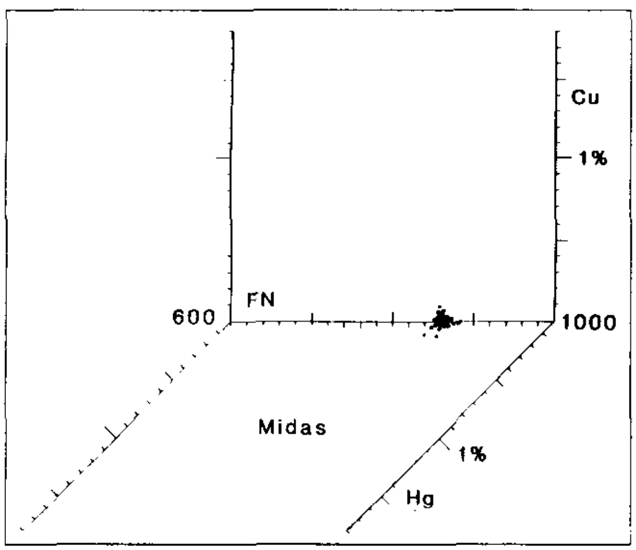

Figure 2-4-13. Lode sample, Midas showing, Cariboo district.

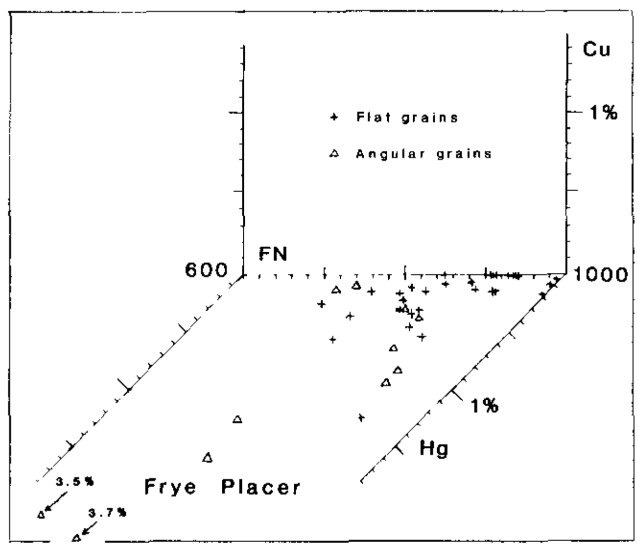

Figure 2-4-15. Placer sample, Frye Creek placer mine.

from the western part of the area, however, (*see* below) show abundant mercury. The concentration at fineness 860 has not been identified in any of the Cariboo placers.

Toop Placer

The Toop placer is some 8 kilometres northeast of Cottonwood House. Particles show well developed rims of nearly pure gold (Figure 2-4-14). The sample shows a higher mercury content than the gold from the four Cariboo placers reported on earlier.

Frye Placer

The Frye placer is near the confluence of Cottonwood River and Frye Creek. The sample has several features of interest (Figures 2-4-15 and 2-4-16). Firstly, the compositions of the thick rims and cores of several grains are shown in Figure 2-4-16; tie lines join rim and core. Rim formation, if the result of leaching, clearly involved removal of mercury as well as silver. Secondly, the sample consists of two very distinct textural types: highly angular grains, many with quartz attached, and strongly flattened grains. These types are distinguished in Figure 2-4-15. The first appear to be little travelled and the second much travelled. These two populations overlap a little in composition but the angular grains show a wide range in mercury content, up to 3.7 per cent, and a slightly lower average fineness. One might speculate that a nearby lode contributed the angular particles.

Much of Fraser River placer gold has appreciable mercury. In the first four samples from the Cariboo district (Knight and Mctaggart, 1986) mercury was very low and the origin of mercury-bearing gold from the upper Fraser River was a

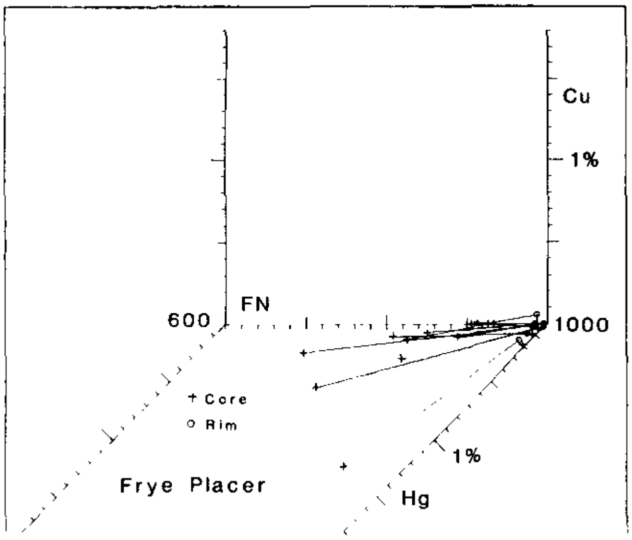

Figure 2-4-16. Placer sample, Frye Creek, showing compositions of cores and rims.

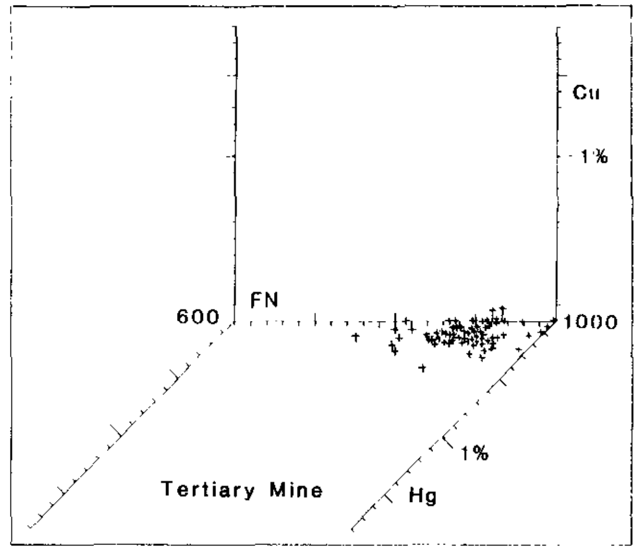

Figure 2-4-18. Looe sample, Tertiary mine.

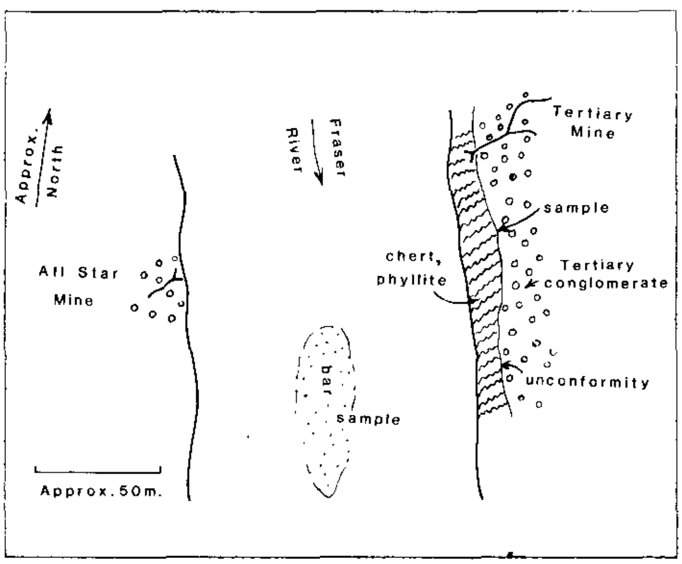

Figure 2-4-17. Sample location sketch map, Tertiary mine.

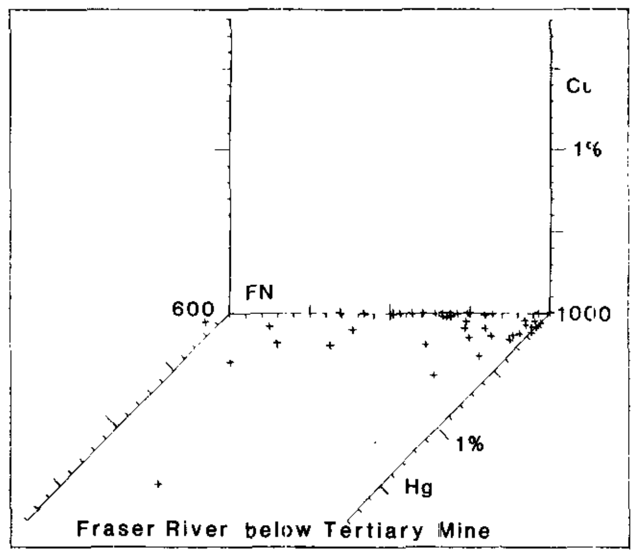

Figure 2-4-19. Placer sample, Fraser River just below Tertiary mine.

mystery. It now appears that some Cariboo placers (*see also* the Toop placer sample), carry appreciable mercury and could have contributed mercury-bearing gold to the Fraser River placers.

Tertiary Mine

The Tertiary mine is about 8 kilometres north of Quesnel, on the east side of Fraser River (Figure 2-4-17). It produced about 31 kilograms of gold and closed in 1926 (Lay, 1940). The stopes and portal are partly caved. The stopes were developed in a fossil placer that lies along an unconformity between Cache Creek pelite and chert, and a well-cemented Tertiary conglomerate. The All Star mine was developed in similar rocks on the west side of the river. The sample (Figure 2-4-18) consists of 75 grains panned from material dug from along the unconformity. Many of the grains are rimmed with almost pure gold and show no exceptional textural features. Mercury is mostly under 0.2 per cent, the gold thus differs markedly from the angular grains of the Frye Creek sample which was taken only a few kilometres away.

Fraser River Placer, at Tertiary Mine

This sample (Figure 2-4-19) is from a river bar less than 500 metres downstream from the adit of the Tertiary mine. It includes compositions that could be from the Tertiary mine deposit, which possibly extended across the Fraser River to the All Star mine, but clearly includes other gold of low fineness. It lacks the high mercury "plume" that is present at Chimney Creek and Fountain on the Fraser River (Knight and McTaggart, 1986). The wide scatter of compositions is seen in other samples from the Fraser River and seems typical of placers some distance from their sources.

DISCUSSION

The main objectives of this continuing work have been realized in a preliminary way. Fingerprinting placer and lode gold has allowed identification of certain placer gold as coming from specific sources. For example, it appears that the high-copper gold of Ladner Creek comes from a type of lode referred to as the Fifteenmile type, and certainly much of the gold in Fairless Creek comes from the Blackdome veins. When a large proportion of placer gold in an area cannot be related to any lode it seems reasonable to conclude that there is an undiscovered lode in that area. This kind of clue could be useful to the prospector. For example, gold samples from the few analysed Cariboo lodes (Cariboo Gold Quartz, Midas) do not appear to contain mercury, but gold from placers in the western Cariboo (Toop, Frye Creek, Fraser River) have significant mercury. Where does this mercury-bearing gold come from?

A study of the textural features of placer gold provides a clue to the distance the gold has travelled. The composition of lode gold helps to distinguish or confirm the genetic type of the deposit. For example, the relatively low fineness (about 600) of gold from Blackdome mine is typical of epithermal deposits whereas the moderate fineness of Bralorne and Pioneer gold (880-850) is typical of mesothermal veins.

There is, of course, no end to this kind of study because samples from new localities continue to provide data that demand modification of earlier tentative conclusions. The authors would welcome well-documented gold samples from British Columbia, both lode and placer, for eventual analysis. They are particularly interested in "new" gold.

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