Composition of placer and lode gold as an exploration tool in the Stewart River map area, western Yukon

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ABSTRACT

A reconnaissance study of the composition of gold from several placer streams in the Stewart River map area was carried out to characterize the likely style(s) of lode mineralization from which the placer gold in each stream was derived. Results of the study indicate that placer gold from Eureka and Black Hills creeks, as well as gold grains from colluvium in exploration pits at the head of Eureka Creek, have relatively low fineness, low copper contents and high mercury contents. These compositions are consistent with both the gold in colluvium and most of the placer gold having been derived from epithermal sources in the Eureka Dome or Henderson Dome area. Gold in placers in the Moosehorn Range is likely derived from intrusion-related, gold-bearing quartz veins exposed in the headwaters of the placer creeks, and is characterized by relatively high fineness, high copper contents and low mercury contents. Placer gold in Thistle, Kirkman and Blueberry creeks is very similar to that from streams in the Moosehorn Range, suggesting that an undiscovered intrusion-related gold deposit is present within the Thistle/Kirkman drainage basin.

RÉSUMÉ

Une étude de reconnaissance de la composition de l'or placérien de plusieurs des cours d'eau de la région de la carte Stewart River a été effectuée afin de déterminer de quel type de minéralisation filonienne provient l'or placérien de chaque cours d'eau. Les résultats de l'analyse ont révélé que l'or placérien des ruisseaux Eureka et Black Hills, ainsi que les grains d'or colluviaux relativement grossiers extraits de fosses d'exploration situées sur le cours supérieur du ruisseau Eureka, renferment relativement peu de cuivre et beaucoup de mercure. Cette composition suggère que l'or colluvial et la majeure partie de l'or placérien proviennent de sources épithermales localisées dans la région du dôme d'Eureka ou du dôme d'Henderson. L'or placérien de la chaîne Moosehorn provient vraisemblablement de veines de quartz aurifère associées à des intrusions, qui affleurent sur le cours supérieur des ruisseaux placériens; il est caractérisé par des grains relativement grossiers ainsi que par des teneurs en cuivre élevées et des teneurs en mercure faibles. L'or placérien des ruisseaux Thistle, Kirkman et Blueberry est très similaire à celui des cours d'eau de la chaîne Moosehorn, ce qui suggère qu'un gisement d'or non découvert associé à une intrusion serait présent dans le bassin versant des ruisseaux Thistle/Kirkman.

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INTRODUCTION

Exploration for lode gold in the unglaciated parts of western Yukon is complicated by poor exposure and an incomplete understanding of the bedrock geology of the area. Soil, silt, and heavy mineral geochemistry are the main exploration tools employed. Advanced stages of exploration involving trenching and/or drilling, however, can be expensive, and harmful to the environment. A technique applicable to gold anomalies in soil, silt or heavy mineral samples is the classifcation of mineralization style using geochemical 'fingerprinting'. Development of such a technique is the main goal of this study and it should allow companies to target their exploration efforts and expenditures more efficiently.

Placer gold occurrences, including several major placer gold-producing streams, are widespread in western Yukon; however the source(s) from which the gold in these deposits was derived is in most cases unknown. A study of the composition of placer and lode gold in the Klondike District in west-central Yukon by Knight et al. (1999a) showed that placer gold in that area displays a distinctive geochemical signature that allows it to be related directly to local bedrock occurrences. In this study, we have taken a similar approach to that of Knight et al. (1999a), but have applied the geochemical fingerprinting of gold on a reconnaissance scale in several localities throughout the Stewart River map area in western Yukon. Placer gold samples from Eureka Creek, Kirkman Creek, Black Hills Creek, Thistle Creek, Blueberry Creek, Swamp Creek, Mine Creek and Roo Pup have been investigated in this study, along with gold from lode occurrences near the head of Eureka Creek.

PREVIOUS WORK ON GOLD COMPOSITION

Workers such as Knight (1985), Morrison et al. (1991), Knight et al. (1991, 1994, 1999a), Palacios et al. (1999a,b,c,d), Chapman et al. (2000), among others, have investigated the geochemical compositions of gold particles in various placer and lode occurrences. Results of these studies indicate that it is possible to characterize the geochemical composition of a gold particle and relate that composition with a specific style of mineralization.

Palacios et al. (1999a,b,c,d) studied concentrations of As, Ag, Au, Cu, Hg and Bi in native gold from epithermal and porphyry deposits. They determined that copper contents of natural gold in such occurrences vary with vertical position within certain deposit types, and that epithermal deposits are depleted in Cu and relatively rich in Ag. Gold-rich copper porphyry deposits, in contrast, were determined to have a relatively high Cu content and variable Ag concentrations. Chapman et al. (2000) investigated the compositions of alluvial gold in the Irish and Scottish Caledonides. They grouped gold samples into ten different compositional populations on the basis of Au, Ag, Cu, Hg and Pd contents, and correlated each population with a specific host rock or probable source rock assemblage.

Morrison et al. (1991) examined the fineness values for gold from different deposit classes. They determined that fineness values were in the range of (and average) 780-1000 (940) for Achaean lode gold deposits, 800-1000 (920) for mesothermal 'Slate Belt'-type deposits, 650-970 (825) for 'plutonic' deposits, 650-1000 (700-1000) for porphyry deposits, 520-870 (650-850) for volcanogenic deposits, and 0-1000 (440-1000) for epithermal deposits.

Knight (1985) studied placer gold from the Fraser River drainage and concluded that it was possible to characterize lode gold deposits and to recognize gold from these lodes in nearby placers using variations in Ag, Cu and Hg contents in the gold. High Cu and high Hg contents were found in gold that appeared to be associated with ultrabasic rocks, and high Hg contents in gold was found to be typical of lode gold associated with major faults.

Knight et al. (1994, 1999a, b) studied the variation in composition and shape of placer gold found in the Klondike District of western Yukon. Concentrations of Ag, Au, Cu and Hg were determined for a large number of samples of placer and lode gold from the area. Results of this study showed that Klondike gold has a considerable compositional range, but much of it is characterized by low fineness, low Cu content and relatively high Hg content. This study showed that by geochemically characterizing gold from specific lode sources, placer deposits can be related to individual types of lode sources, and that the point of entry from each new lode source into a placer stream can be determined. Knight et al. (1999b) also found that the shape and other physical properties of placer gold in the Klondike can be used to estimate the distance the gold has been transported from its source.

GEOLOGICAL SETTING

The Stewart River map area is underlain mainly by rocks of Yukon-Tanana Terrane, comprising polydeformed metasedimentary, metavolcanic and metaplutonic rocks. These rocks are intruded and overlain by a variety of Early Jurassic to Early Tertiary plutons, and are locally overlain by mid-Cretaceous to Early Tertiary volcanic and sedimentary rocks. The study area is located within the 'Tintina Gold Belt', which hosts a wide range of mainly intrusion-related gold deposits (British Columbia and Yukon Chamber of Mines, 2000). Most gold deposits within the Tintina Gold Belt are thought to be genetically related to mid- and Late Cretaceous intrusive rocks (e.g., Mortensen et al., 2000).

A wide variety of gold-bearing lode occurrences is known or inferred to exist in the Stewart River map area. These include mesothermal ('metamorphogenic') quartz veins such as those in the Klondike District (Fig. 1; Rushton et al., 1998), intrusion-hosted veins such as the Longline occurrence in the Moosehorn Range (southwest corner of Fig. 1; MacDonald, 2001), epithermal vein systems (Glasmacher and Friedrich, 1992), gold-bearing skarns, gold in carbonate-altered ultramafic rocks such as those found in the Sixtymile District (west of the Yukon River on Fig. 1; R. Hulstein, pers. comm., 1999), and precious-metal enriched volcanogenic massive sulphide deposits. Known and inferred ages for intrusion-related gold mineralization in the study area range from Early Jurassic to Late Cretaceous or Early Tertiary.

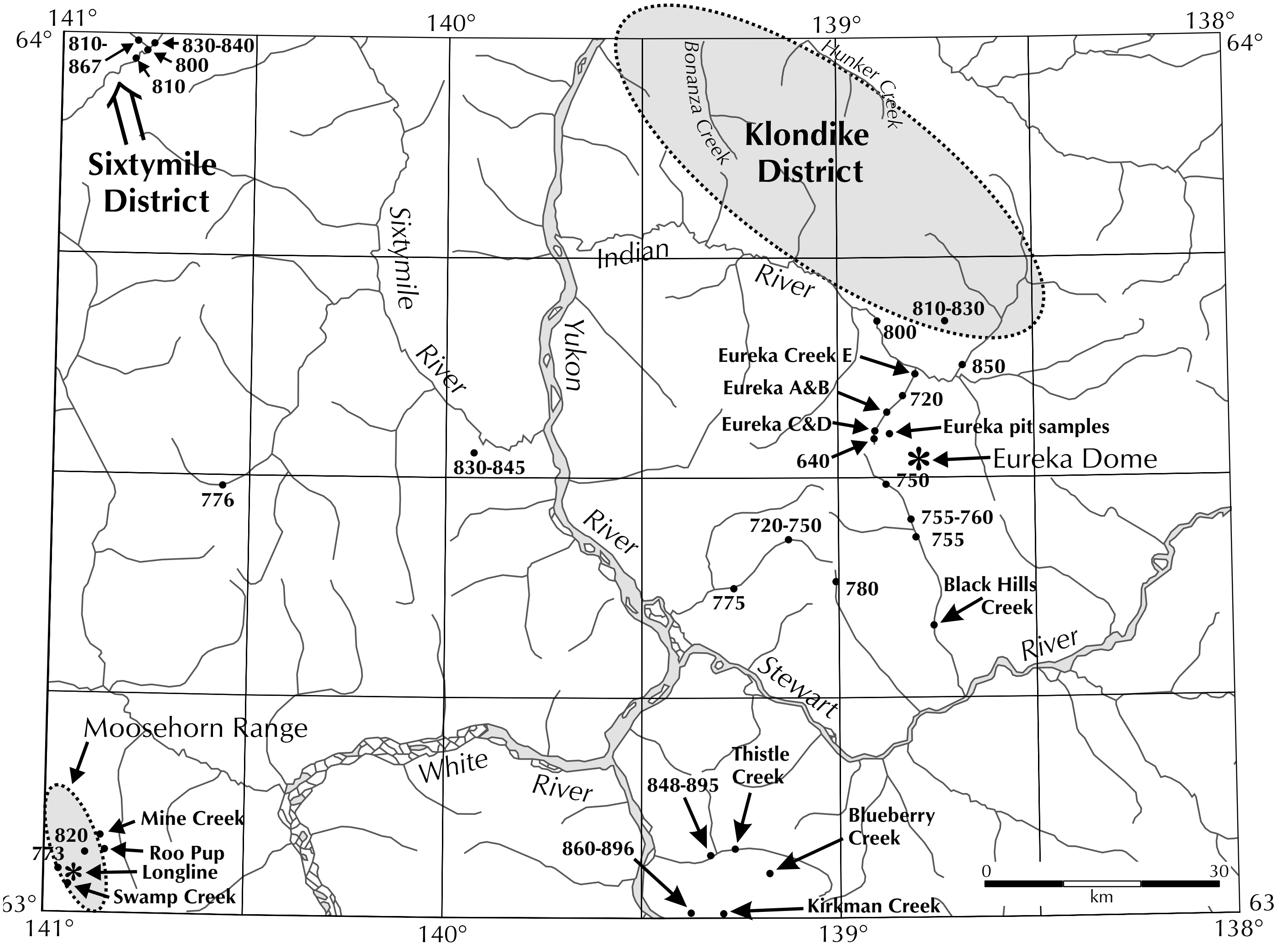

Figure 1. *Map of the Stewart River area displaying locations of the samples investigated in this study, as well as reported bullion fineness values from some of the major placer streams in the area (data from Debicki, 1982, 1983; Debicki and Gilbert, 1986; Lebarge and Morison, 1990).*

Placer gold is present in streams throughout the Stewart River map area. Major placer deposits occur in the Klondike and Sixtymile districts, as well as the Indian River, tributaries of the lower Stewart River (including Black Hills and Scroggie creeks), and Thistle and Kirkman creeks (Fig. 1). Minor placer gold producers include Eureka Creek as well as Mine Creek and Swamp Creek in the Moosehorn Range (Fig. 1).

PLACER GOLD FEATURE DEVELOPMENT

Both chemical and physical processes affect a gold grain between the time it is liberated from its lode source and the time it is recovered from a placer deposit. At the source, a gold particle is still attached to the host rock and the composition of the gold at the source is essentially unchanged from its composition at the time of formation. During transport downstream, silver is leached from the rim of the placer gold grain, leading to an increased bulk or 'bullion' gold fineness in the placer gold with increasing distance from the source. (Gold fineness refers to the relative amounts of silver and gold present; it is given as a number out of 1000 and is defined by Au/(Ag+Au)x1000, where Au and Ag are the weight percentages of Au and Ag present.) This leaching only occurs along exposed surfaces of the grain; therefore, a leached rim with a high fineness forms along the outer surfaces of the sample, leaving an unaltered core (Knight et al., 1994, 1999a). The thickness of the leached rim is a function of the distance (or length of time) the particle has traveled from the source. Gold located at or close to its original source can be expected to have at most, a very thin leached rim, and bulk or 'bullion' fineness of placer gold from such a region closely reflects that of the source.

Many physical processes also affect a gold particle during its transport downstream. As the particle travels downstream it is beaten by stream action, causing flattening, rounding, abrasion, and in some cases, folding of the grain. The surface appearance of the particles is thus affected by the time the grain has spent in transport (Knight et al., 1994). At the source, gold grains typically have an angular or hackly appearance. As stream processes work on the grain, the edges of the particle become more rounded, and, overall, the grain becomes more rounded in appearance. The particle will also be hammered as it travels down the stream, causing it to flatten and in some instances even fold over. Roundness and flatness increase dramatically within the first 5 km from the source, after which the roundness remains relatively unchanged (Knight et al. 1994, 1999b). Flattening of a gold particle requires a relatively large amount of transport, whereas rounding of a particle requires less transport and is commonly noticeable before much flattening is observed. Knight et al. (1994, 1999b) argued that grain roundness is a more sensitive measure for distances under 5 km, but grain flatness is a more reliable indicator of transport distances greater than 5 km. The original shape of the grain is also a factor in how the particle will be altered by the transport. A small flat grain will respond differently to these processes than a larger more equant grain.

The thickness of the leached rim on a placer gold grain is not an entirely effective method for gauging the distance from the source, since the abrasive action of the stream is also at work, and some of the rim will be removed. The leached rim can, however, provide a rough estimate of the minimum time since it has been liberated from its source, and an approximate distance from the source.

METHODOLOGY

Most impurities in pan concentrates were removed using a Franz magnetic separator. The gold grains were then separated from other non-metallic minerals by hand. Samples were examined, and the habits of representative grains were documented.

Plexiglass disks 1 in. (2.5 cm) in diameter, each with three 3/8 in. (9.5 mm) diameter holes, were used as mounts for the gold grains. Double-sided tape was placed on a glass plate and the plexiglass disk placed on top of the tape. Representative grains from each of the sample sites were carefully placed into the mount with the aid of a binocular microscope. Each mount contained grains of equal size such that grains requiring similar amounts of grinding and polishing in order to expose the core were grouped together. Flat and elongated grains were placed on end so that when the mount was ground down and polished, the grain was not plucked out or ground away.

After the grains were carefully placed, each hole was carefully filled in with epoxy. Buehler epoxy resin was used in this study. A toothpick was used to drop in the epoxy. Care was taken to avoid disturbing the grains and to exclude air bubbles in the epoxy. A fine piece of wire was used to gently ease out any major bubbles.

Once the epoxy hardened, 600-grit wet-dry sandpaper was used to grind the mounts down to the desired level. One-micron diamond paste was then used to remove the major scratches from the surface of the mount and a final polish was done using a 0.05-micron alumina powder. An ultrasonic scrubber was used to clean each sample mount between each of the polishing stages. Once the mounts were polished and cleaned using an ultrasonic scrubber, they were carbon coated for examination with the scanning electron microscope (SEM) and electron microprobe (EMP). The SEM was used in backscatter mode to examine each particle to identify weathered zones, leached rims, internal structure, and other important features. Photographs were taken using the SEM to help select specific sample sites for EMP analysis.

Concentrations of Au, Ag, Cu and Hg in the gold were determined using the EMP. A spot size of 1 micron was used. Count time for Au was 20 000 ms, and count time for the remaining elements was 150 000 ms each. A minimum of two points were selected on each grain, taking care to avoid pores, weathered surfaces, scratches, and other deformities that could affect the results. In total, 228 points were analysed from 77 different grains. Three measurements of a standard were made, at the beginning, midpoint, and end of the analytical run. From these 228 sample points, 195 had a total weight percent of 95 or higher, and were considered to be within the acceptable limits. Points totaling less than 95% were likely situated over a piece of gangue, or a pore, and are not included in the following discussion.

The standard consisted of 80% Au and 20% Ag. It was analysed three times and determined to have 20.1445, 20.1159 and 20.0959 wt% Ag, and 79.2806, 78.8039 and 79.3642 wt% Au, respectively, for the three analyses. Copper and mercury were measured at 0.0001 and 0.0002, respectively for each analysis, which is well below the detection limit and well below the standard deviation. Although the standard was not considered to be in the best condition, all of these analyses fall within two standard deviations of the accepted value. For all of the analyses of unknown gold, average detection limits were as follows: Cu=0.02 wt%, Ag=0.04 wt%, Au=0.2 wt%, Hg=0.08 wt%. The average overall standard deviation for each element was as follows: Cu=0.018 wt%, Ag=0.208 wt%, Au=0.991 wt%, and Hg=0.052 wt%.

RESULTS

Gold grains from eight different creeks from the study area, Eureka Creek, Black Hills Creek, Thistle Creek, Blueberry Creek (tributary to Thistle Creek), Kirkman Creek, Swamp Creek, Mine Creek, and Roo Pup (tributary to Mine Creek; Fig. 1) were analysed. Individual grains analysed varied in size between 0.5 mm and 5 mm.

In general, leached rims on gold particles closer to the headwater of streams (closer to the source) are thin or absent in backscatter images. Leached rims were not visible in the majority of the grains examined in this study. A large number of grains, however, show very high porosity. It is uncertain whether this was primary porosity or was caused by the plucking of inclusions during the polishing process. Gold from all of the sample locations, except for the pit samples on Eureka Dome, showed some porosity, and some grains also showed a rim of very low porosity with a highly porous core. A backscatter image of a grain of placer gold from lower Eureka Creek with a well-developed leached rim and high porosity is shown in Figure 2.

EUREKA CREEK PLACER AND COLLUVIAL GOLD

Eureka Creek placer gold samples were collected from three different locations along the creek (Eureka A & B, Eureka C & D, and Eureka E; Fig. 1). Gold grain samples closer to the headwaters, and at a midpoint in the creek, were thick, with uneven surfaces and minor evidence of hammering. Bits of wallrock were attached to some of these particles. There was some variation in surface colour among these samples, varying between a silvery to a golden colour. Grains further down Eureka Creek were flattened with well-rounded edges and a pitted surface. Gold grains from hand trenches in colluvium on Eureka Dome (considered to be representative of underlying lode sources) were very angular with rough edges. Some surfaces were very smooth. One particular sample was an extremely thin flake with no evidence of hammering.

Grain mounts of placer gold from Eureka Creek show significant variations in gold composition within the grain in back-scatter images. This internal variation is interpreted to be a primary feature within the grain, and not related to alteration of the grain during or after transport. Deformation of the grain is quite evident. Some particles from Eureka C also show an apparent silver enrichment along fractures. Some samples from Eureka Creek had a 'granular' appearance with gold-rich zones present throughout the entire grain. The processes that formed the silver-enriched zones and granular texture are not completely understood, but are thought to be late- or post-mineralization due to their association with fractures and grain boundaries. Grains from the Eureka Creek placer gold samples show well-developed leached rims (Fig. 2).

A total of 123 points were analysed from the Eureka Creek samples, including Eureka A (12 grains, 30 points), Eureka B (9 grains, 22 points), Eureka C (11 grains, 54 points), Eureka E (6 grains, 11 points) and Eureka Pit samples (5 grains, 6 points). A few of the grains from Eureka C were analysed using seven to nine points, compared to the average of two for all other samples. This caused the data to be more heavily weighted towards the trends of those few grains rather than an average of all the grains. These grains were analysed more extensively as an attempt to determine the nature of unusual internal grain structure found only in grains from Eureka C.

Grains from Eureka Creek (including those from the hand pit) have fineness values less than 800, with a significant number less than 700 (Appendix 1). Many of the points from the Eureka C grains, which were re-analysed several times, had fineness values below 500, and should therefore be termed electrum. For all but two points, Cu values were below the detection limit (Appendix 1). A large number of measured Hg values in the Eureka Creek gold are relatively high (greater than 1.7 wt%), although the average value of 0.04 wt% is actually below the detection limit (Appendix 1).

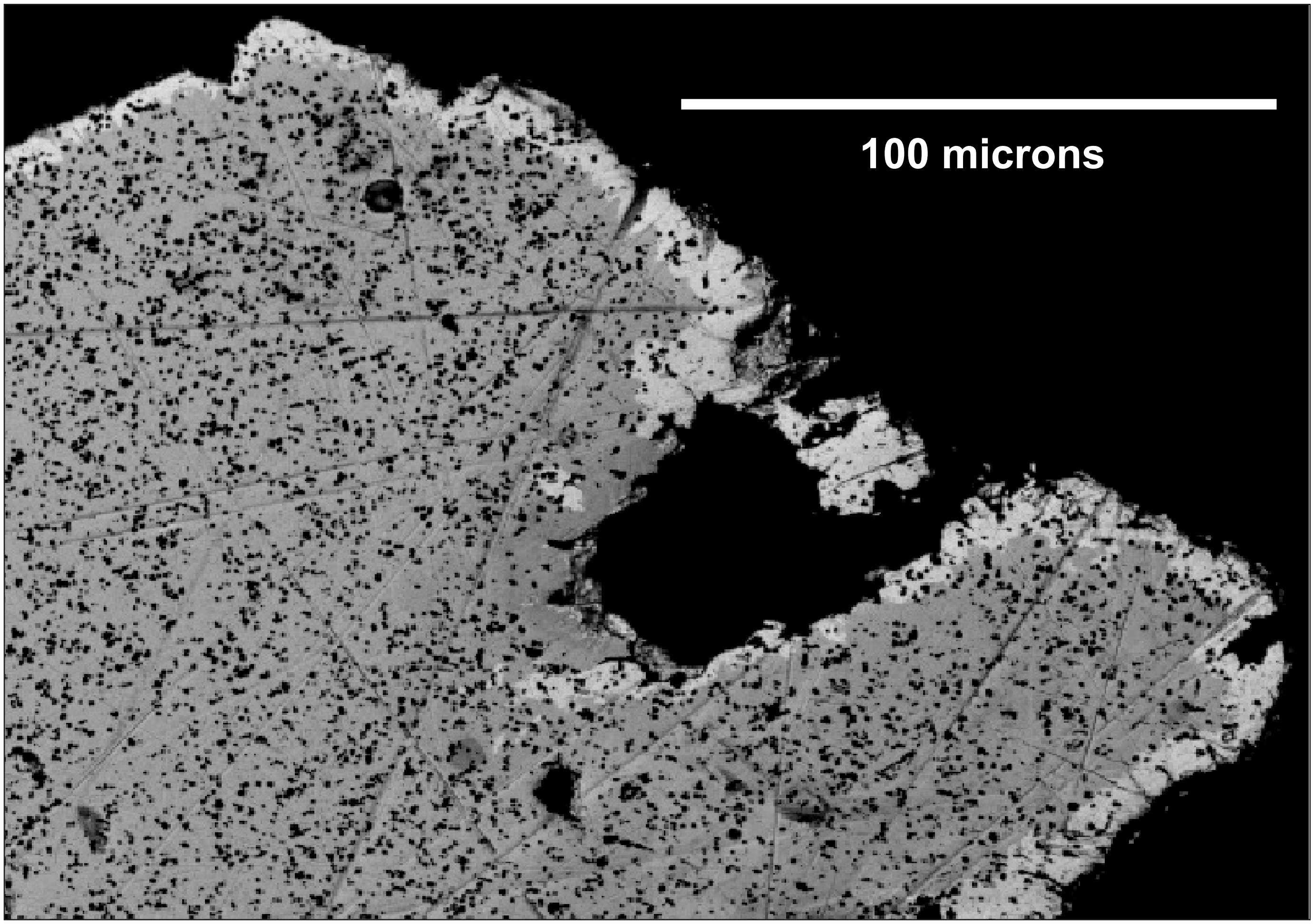

__Figure 2.__ Back-scatter image of part of a placer gold grain from lower Eureka Creek, showing a well-developed leached rim (pale grey) surrounding an unleached core (darker grey). Note the irregular nature of the contact between the rim and core, and the high degree of porosity in the grain.

Black Hills Creek

Grains collected from Black Hills Creek were very fine with rounded edges. All of these grains showed signs of hammering. The grain shape was commonly thin and flaky, or pebbly in appearance, although a few grains were very long and slender.

Five grains from Black Hills Creek were analysed for a total of six points. The fineness values from these points ranged from 666-753. None of the points had Cu contents over the detection limit. Two of the points had Hg levels below the detection limit, two points had values around 0.28 wt% and another two had values of 0.63 wt% and 0.89 wt%.

Mine Creek, Swamp Creek and Roo Pup

Mine Creek and Roo Pup in the Moosehorn Range (Fig. 1) produced grains with well-rounded edges and grains in many different shapes, ranging from long and slender to very thin. Some inclusions of wallrock were present, and most grains were thick. Only minor colour variations were observed. Swamp Creek placer gold forms very angular grains with uneven surfaces, attached wallrock, and little evidence of hammering. Gold from Swamp Creek varies in colour from pale brassy colour to a more golden colour.

Eighteen points from eight different grains were analysed from Swamp Creek. All of the fineness values were above 800, except for two at 687 and 739. All but one of the Cu values were below the detection limit. The Hg values were all lower than the detection limit, except for three points. Eleven points from five different grains were analysed from Mine Creek; these yielded fineness values between 750 and 900. Six points yielded Cu values below the detection limit, whereas the remaining averaged around 0.032 wt% Cu. The Hg values were all below the detection limit, except for three points, which had values between 0.21 and 0.27 wt% Hg. Eight points from four different grains from Roo Pup were analysed, and yielded fineness values between 790 and 900. All but two of the Cu values were below the detection limit. Most of the Hg values were around 0.10 wt%, with two below the detection limit, and two around 1.5 wt%.

Thistle, Blueberry and Kirkman creeks

Placer gold grains from Thistle Creek were mostly flattened with rounded edges, and minor inclusions of wallrock. Some grains appeared to be folded flakes. Blueberry Creek produced flat grains with angular to rounded edges. Only small amounts of wallrock inclusions were present, and almost all of the grains show signs of hammering. Grains from Kirkman Creek were flattened with rounded edges and minor inclusions of wallrock. Some grains from Kirkman Creek were elongated, and some showed signs of folding. All grains showed signs of hammering. Grains from Kirkman Creek showed particularly well-developed leached rims.

Four grains from Kirkman Creek were analysed with eleven points. All of these points had fineness values greater than 730. Three points had Cu values above the detection limit, ranging from 0.025-0.032 wt%. Mercury levels were all below 0.75 wt%, with an average around 0.23 wt%. Four grains from Blueberry Creek were analysed with eight points. All of the fineness values were between 735 and 910. Four of the copper values were below the detection limit, and three were around 0.044 wt%. One point had a Cu value around 0.031 wt%. Mercury levels were all below 0.044 wt%, with four points below the detection limit. Four grains from Thistle Creek were analysed with ten different points. Fineness values were between 825 and 925. Four of the Cu levels were below the detection limit, while six fell between 0.02 and 0.03 wt%. Mercury levels averaged around 0.4 wt%, with three values around 0.6 wt%, and two values below the detection limit.

DISCUSSION

Compositions of placer and colluvial gold analysed in this study, together with the main fields of data previously published from the Klondike District (Knight et al., 1999a) are shown on fineness vs. Cu and fineness vs. Hg in Figures 3 and 4. Compositions of gold from Eureka Creek are distinct from most other samples analysed in the study. Copper concentrations in this gold are low with almost all analyses below the detection limit of 0.02%. Mercury values, on the other hand, are relatively high with a wide range of values, averaging about 0.45%. Fineness values are low, mainly below 800. In terms of physical characteristics, samples collected near the headwaters of these streams showed relatively minor physical alteration, whereas samples from further downstream showed considerable alteration and development of leached rims. There was no noticeable change in the composition of the core of the gold relative to the sample location. Gold grains found in exploration pits dug in colluvium near

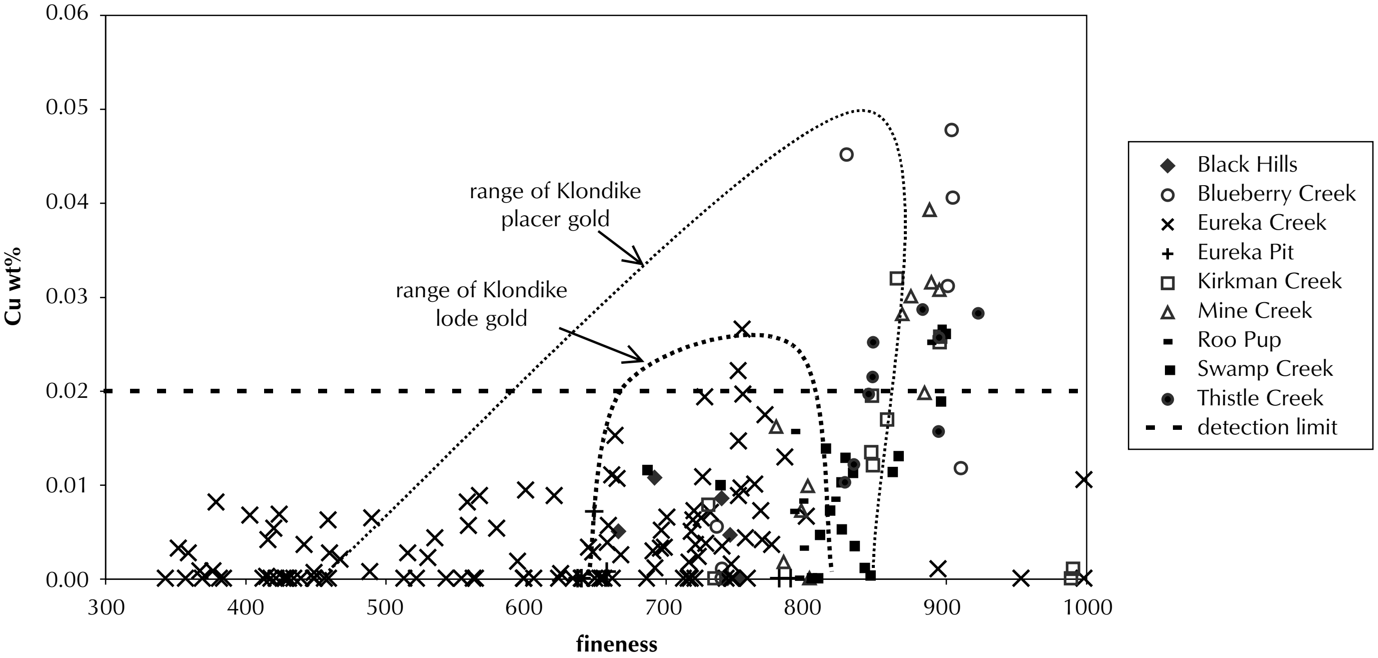

Figure 3. *Plot of measured Cu wt.% against fineness for gold analysed in this study. Also shown are the compositional fields for Klondike District lode and placer gold from Knight et al. (1999a). Detection limit is shown by the dashed line. Copper contents shown for analyses that plot below the detection limit are based on total counts obtained during each analysis.*

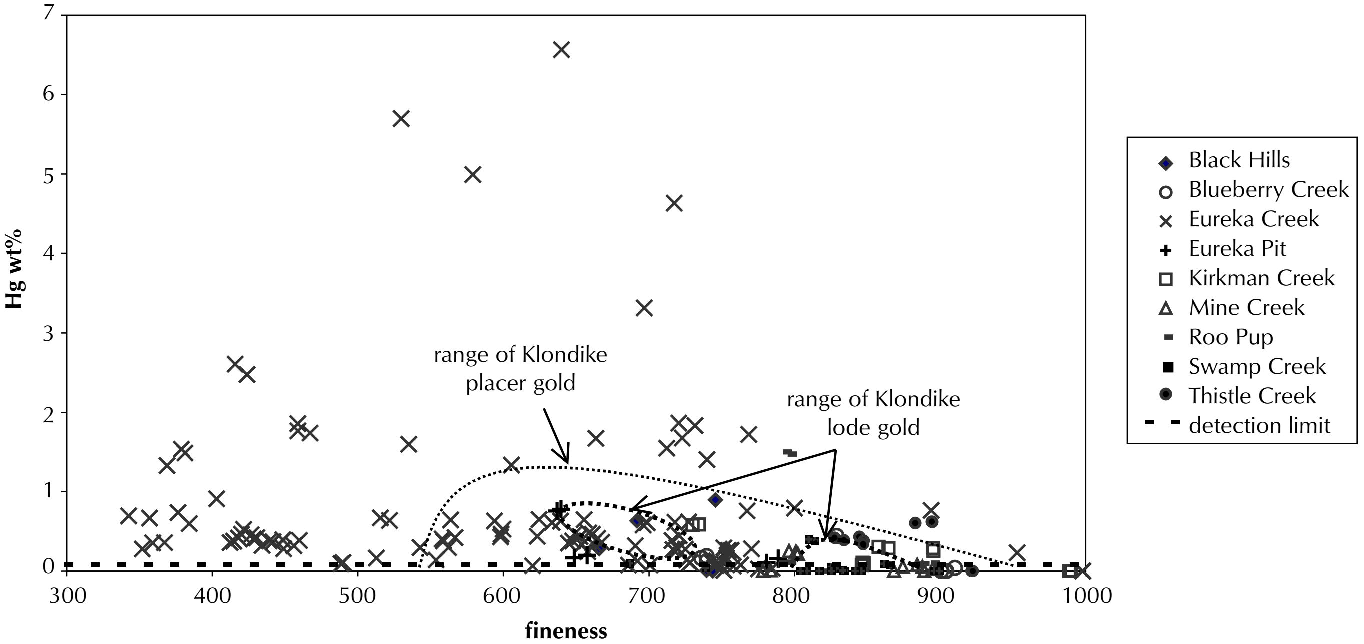

Figure 4. *Plot of measured Hg wt.% against fineness for gold analysed in this study. Also shown are the compositional fields for Klondike District lode and placer gold from Knight et al. (1999a). Detection limit is shown by the dashed line. Mercury contents shown for analyses that plot below the detection limit are based on total counts obtained during each analysis.*

Eureka Dome are thought to be close to the lode source due to the fact that they are located near a topographic high point, are very rough and angular, and apparently have not been transported. Eureka Dome is located near the headwaters of Eureka Creek, and it is likely that the pit samples are representative of the source of at least some of the placer gold in these creeks. Analyses of these colluvial gold samples showed them to be compositionally similar to the placer gold from Eureka Creek, supporting this interpretation. Placer gold in Black Hills Creek is similar to that in Eureka Creek (see later discussion).

Although no definite lode gold occurrences have been identified thus far in the Eureka Dome area, there are abundant Late Cretaceous volcanic rocks with associated high level porphyry dykes in the area, and the composition of the pit and placer gold are typical of samples from epithermal vein sources (e.g., Morrison et al., 1991). It is therefore suggested that significant epithermal vein system(s) exist in the area and supplied gold to the placer deposits.

In contrast, gold from streams draining the Moosehorn Range (Swamp Creek, Mine Creek and Roo Pup) has a compositional range that is quite distinct from placers in the Eureka Dome area. Swamp Creek drains the southwestern side of the Moosehorn Range, whereas Roo Pup and Mine Creek drain the northeast side of the Moosehorn Range. All of the placer samples were taken from near the headwaters of the creeks. The grains were mainly angular in shape, showed little hammering, and were commonly still attached to pieces of wallrock. The source of gold for all three creeks is believed to come from a similar source(s) along the upper part of Moosehorn Range. Gold compositions for all of these creeks are generally similar, as expected for gold coming from the same source. Measured fineness for Moosehorn Range placer gold is high, mostly above 750. Copper values from these creeks are noticeably higher than values from the Eureka Dome area, although a very small proportion of grains from Eureka Creek also had copper contents well above the detection limit. Mercury values in the Moosehorn Range placer gold are generally distinctly lower than those from the Eureka Dome area.

Placer gold in streams draining the Moosehorn Range is thought to come from lode sources at the top of this range. The Longline occurrence comprises intrusion-related, mesothermal, gold-bearing quartz vein systems that occur along the crest and on the western side of the Moosehorn Range (MacDonald, 2001). Although compositions of lode gold from the Longline occurrence were not determined, it is reasonable to conclude that the placer gold in this area was derived from Longline-type veins, and measured compositions are therefore representative of the gold in the veins themselves. The relatively high fineness, moderate to high Cu contents, and low Hg contents in the gold is consistent with derivation from an intrusion-related source.

Placer gold in Thistle, Blueberry and Kirkman creeks shows generally similar compositions to that from the Moosehorn Range, suggesting derivation from a similar type of lode mineralization.

Results of this study, together with previous published results from the Klondike District (Knight et al., 1999a), therefore provide distinct compositional ranges for gold from each drainage area. These compositional ranges are consistent with gold derivation in each drainage from epithermal veins, intrusion-related mesothermal veins, or metamorphic gold-bearing veins.

Fineness values determined in this study are similar to bulk fineness values found by previous workers. Figure 1 shows the locations of placer gold samples investigated in this study and previously reported bulk fineness values for some of the placer creeks in the study area. Bulk fineness values reflect a combination of high fineness leached rims and unleached cores; thus bulk fineness values represent a maximum fineness for the core compositions and therefore the lode source(s) from which the gold was derived. Most placer gold grains examined in this study had relatively thin leached rims, and fineness values determined for cores of grains are therefore similar to reported bulk fineness values in the same area.

APPLICATION OF THE GOLD COMPOSITION MODEL TO EXPLORATION

Although our study was somewhat limited both in scope and in the total number of analyses carried out, several significant first-order implications for gold exploration in the area can be derived from the data.

1. Gold from Black Hills Creek shows low Cu concentrations, high Hg, and fineness values below 800, and is very similar to gold from Eureka Creek. Black Hills Creek drains the southeast side of Eureka Dome, and the gold compositional data can be interpreted to suggest that the source of the gold in Eureka Creek and

Black Hills Creek consists of epithermal vein occurrences in the Eureka Dome area.

2. Measured fineness values for gold from Blueberry Creek were all above 700, with a large number of analyses around 900. Similarly, gold from Thistle Creek yields fineness values between 825 and 925. Gold from both streams also shows relatively high Cu values, and gold from Thistle Creek has somewhat higher Hg contents than that from Blueberry Creek. Compositions of placer gold from these two streams is similar to that from creeks in the Moosehorn Range, suggesting that the lode source for gold in Thistle Creek and its tributaries is similar to that in the Moosehorn Range. The higher Hg levels in Thistle Creek may indicate that there is more than one lode source contributing gold to Thistle Creek and its tributaries. Gold from Blueberry Creek and Thistle Creek both appeared to have traveled some distance based on grain shape, although that from Blueberry Creek is less-traveled than that from Thistle Creek. This helps constrain the location of the lode source(s) to near the headwaters of these creeks.
3. Kirkman Creek gold all has a fineness greater than 700. Mercury values were moderate, and most measured copper contents were below the detection limit, except for some significantly high points. The presence of scattered high Cu concentrations and high fineness values are similar to what is observed in Moosehorn Range samples. Gold samples from Kirkman Creek were flat and showed a significant leached rim development, suggesting that the gold has traveled a considerable distance. Kirkman Creek and Thistle Creek are approximately 8 km apart, and are located on either side of a drainage divide. Blueberry Creek also drains this same divide. The gold compositional data from these three creeks is consistent with all the gold having been derived from a similar source, and perhaps from a single lode occurrence. The data further suggests that the lode source(s) is likely to be similar to the intrusion-related gold-quartz veins in the Moosehorn Range.
4. Distinct, although partly overlapping, compositional fields can be derived for placer gold from each creek studied in the Stewart River area, using a combination of fineness, Cu wt% and Hg wt%. Plots of Cu wt% and Hg wt% vs. fineness (Figs. 3 and 4), when superimposed on compositional ranges for gold from the Klondike District (from Knight et al., 1999a), also show considerable overlap. The Klondike study demonstrated that Klondike placer gold was derived largely, if not entirely, from mesothermal gold-quartz veins of 'metamorphogenic' origin (Rushton et al., 1998; Knight et al., 1999a). It appears that gold sources for such veins cannot be conclusively distinguished from gold from epithermal or intrusion-related sources using only elements that are detectable by EMP methods.

Western Yukon contains many placer gold deposits; however the ultimate lode source(s) for this placer gold has not yet been identified for most placer streams. Gold exploration in the region over the past decade has also identified a very large number of gold anomalies in soil, silt and heavy mineral surveys. Many different styles of lode gold are known to exist in the region, but only a small number of these are likely to have economic potential. In view of the poor exposure in the region and the still relatively poor understanding of the geology and mineral deposits of the area, it would therefore be very useful to be able to classify gold anomalies (and sources of placer gold) in terms of the likely style of lode gold in the source. This would allow follow-up exploration work to be focused on anomalies that were related to potentially economic sources, and would thus make exploration programs considerably more time- and cost-effective. The results of our study suggest that gold compositional data can provide such a geochemical 'fingerprint' for constraining the likely lode source(s) of placer and colluvial gold, and thus evaluating anomalies.

FUTURE WORK

This study comprised a relatively small number of analyses from a limited sample suite. However, the data clearly demonstrate that a relationship exists between the composition of placer gold and the style of lode mineralization from which the placer gold was derived. A larger data set for the deposits used in this study would be needed before this relationship can be widely applied to gold exploration in the region. A larger data set would create a more defined statistical range of compositions for each deposit type, and create a more specific geochemical fingerprint for these deposits. Work should also be done to characterize gold from other styles of lode mineralization over a larger study area.

This and previous studies in the region have used electron microprobe (EMP) methods to determine gold compositions. EMP analytical capability is widely available and the method is relatively inexpensive; however, it is limited to elements that are present at a level of at least a fraction of a percent. Application of more sensitive analytical methods such as laser ablation, high resolution

ICP-MS would make it possible to determine the concentrations of a much wider range of elements (including Bi, As, Te, etc.) down to extremely low concentrations (sub-ppb). This would allow a much more complete and specific geochemical signature to be established for different lode and placer deposits and therefore a more efficient geochemical 'filter' to be applied for gold anomaly evaluation purposes.

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APPENDIX 1. ELECTRON MICROPROBE ANALYSES OF GOLD FROM THE STEWART RIVER MAP AREA.

Location	Sample	Label	wt%(Cu)	wt%(Ag)	wt%(Au)	wt%(Hg)	Total wt%	Fineness	Comments
Black Hills Creek	B61-1	121	0.0051	33.0565	65.8841	0.2821	99.2278	666	
Black Hills Creek	B61-2	122	0.0108	30.327	68.0415	0.6301	99.0094	692	
Black Hills Creek	B63-1	119	0.0086	25.574	72.6265	0.0065	98.2156	740	
Black Hills Creek	B63-2	120	0.0001	25.7951	74.9958	0.0002	100.7912	744	
Black Hills Creek	B64-1	117	0.0001	24.0108	70.2388	0.3235	94.5732	745	
Black Hills Creek	B64-2	118	0.0001	23.7912	72.5753	0.2867	96.6533	753	
Black Hills Creek	B65-1	115	0.0067	17.8754	75.7641	0.7002	94.3464	809	
Black Hills Creek	B65-2	116	0.0047	24.7398	72.5193	0.8943	98.1581	746	
Blueberry Creek	BL412-1	161	0.0154	11.5705	73.1558	0.1148	84.8565	863	
Blueberry Creek	BL412-2	162	0.0118	8.8298	89.4832	0.0395	98.3643	910	
Blueberry Creek	BL412-3	163	0.0062	12.1037	75.743	0.1491	88.002	862	
Blueberry Creek	BL44-1	158	0.0452	16.9353	81.962	0.4406	99.3831	829	
Blueberry Creek	BL44-2	159	0.0173	13.9772	72.2925	0.4595	86.7465	838	
Blueberry Creek	BL44-3	160	0.1583	16.2542	73.5348	0.948	90.8953	819	
Blueberry Creek	BL46-1	155	0.0011	25.4025	72.2542	0.1263	97.7841	740	
Blueberry Creek	BL46-2	156	0.0001	25.9478	73.716	0.189	99.8529	740	
Blueberry Creek	BL46-3	157	0.0056	25.9285	72.2916	0.1643	98.39	736	
Blueberry Creek	BL47-1	152	0.0312	9.5868	87.1051	0.0002	96.7233	901	
Blueberry Creek	BL47-2	153	0.0478	9.6251	90.3232	0.0002	99.9963	904	
Blueberry Creek	BL47-3	154	0.0406	9.5614	90.5075	0.0002	100.1097	905	
Eureka A	EA41-1	138	0.0037	27.7033	71.5273	0.4427	99.677	721	
Eureka A	EA41-2	139	0.0194	27.2009	72.5891	0.6185	100.4279	727	
Eureka A	EA42-1	135	0.0011	10.5026	88.5586	0.7633	99.8256	894	
Eureka A	EA42-2	136	0.0054	40.5154	55.6893	4.9956	101.2057	579	
Eureka A	EA42-3	137	0.0023	44.0119	49.6139	5.6998	99.3279	530	
Eureka A	EA43-1	132	0.0001	33.1876	58.9802	6.5669	98.7348	640	
Eureka A	EA43-2	133	0.0153	33.0263	65.1166	1.6726	99.8308	664	
Eureka A	EA43-3	134	0.0026	32.5716	65.3651	0.3612	98.3005	667	
Eureka A	EA45-1	124	0.0156	22.0504	72.5024	0.3	94.8684	767	
Eureka A	EA45-2	125	0.0097	24.415	74.559	0.1643	99.148	753	
Eureka A	EA45-3	126	0.0001	20.1857	67.9107	0.1915	88.288	771	
Eureka A	EA46-1	127	0.0001	38.3207	58.7876	1.3319	98.4403	605	
Eureka A	EA46-2	128	0.0029	34.4636	63.3305	0.3787	98.1757	648	
Eureka A	EA46-3	129	0.0001	4.6393	94.2369	0.2287	99.105	953	
Eureka A	EA47-1	130	0.0057	33.5499	64.7491	0.4779	98.7826	659	
Eureka A	EA47-2	131	0.0111	33.363	65.0891	0.4625	98.9257	661	
Eureka A	EA51-1	177	0.0001	39.4004	58.6173	0.4306	98.4484	598	
Eureka A	EA51-2	178	0.0001	39.2774	58.5177	0.4658	98.261	598	
Eureka A	EA51-3	179	0.0095	39.3824	59.0048	0.5258	98.9225	600	
Eureka A	EA52-1	174	0.0175	22.711	76.2937	0.2795	99.3017	771	
Eureka A	EA52-2	175	0.0042	22.2436	73.8917	1.722	97.8615	769	
Eureka A	EA52-3	176	0.0073	22.8723	75.4993	0.7552	99.1341	768	
Eureka A	EA53-1	170	0.0044	23.998	74.5884	0.2594	98.8502	757	
Eureka A	EA53-2	171	0.0197	24.0547	74.0605	0.2565	98.3914	755	
Eureka A	EA53-3	172	0.0147	24.7135	74.7927	0.2924	99.8133	752	
Eureka A	EA53-4	173	0.0266	24.2574	74.3936	0.2543	98.9319	754	
Eureka A	EA54-1	168	0.0065	49.9837	47.9719	0.1065	98.0686	490	
Eureka A	EA54-2	169	0.0008	49.9375	47.6639	0.0912	97.6934	488	
Eureka A	EA55-1	166	0.013	21.4004	77.9871	0.0358	99.4363	785	
Eureka A	EA55-2	167	0.0037	22.4378	77.3999	0.0251	99.8665	775	
Eureka A	EA56-1	164	0.0089	24.5026	74.1425	0.0066	98.6606	752	
Eureka A	EA56-2	165	0.0222	24.6193	74.4335	0.0945	99.1695	752	
Eureka B	EB210-1	92	0.0056	10.1897	83.301	0.0117	93.508	891	apparent high fineness zone
Eureka B	EB210-2	93	0.003	30.5071	68.1082	0.3183	98.9366	691	
Eureka B	EB210-3	94	0.0107	33.1343	65.7022	0.4088	99.256	665	
Eureka B	EB21-1	81	0.0035	25.7178	73.1064	1.4029	100.2306	740	

Location	Sample	Label	wt%(Cu)	wt%(Ag)	wt%(Au)	wt%(Hg)	Total wt%	Fineness	Comments
Eureka B	EB21-2	82	0.0071	26.0642	71.0795	1.8322	98.983	732	
Eureka B	EB21-3	83	0.0106	0.2085	101.7449	0.0002	101.9642	998	
Eureka B	EB23-1	84	0.0001	33.9145	64.5252	0.6456	99.0854	656	non porous rim
Eureka B	EB23-2	85	0.0001	34.0763	64.3886	0.3317	98.7967	654	non porous rim
Eureka B	EB23-3	86	0.0001	33.6481	65.7676	0.3503	99.7661	662	
Eureka B	EB25-1	87	0.0109	27.0076	71.5542	0.1399	98.7126	726	non porous rim
Eureka B	EB25-2	88	0.0044	14.6799	53.5989	0.1352	68.4184	785	
Eureka B	EB27-1	89	0.0019	39.2067	57.3121	0.6327	97.1534	594	
Eureka B	EB27-2	90	0.0001	41.4151	53.5232	0.6409	95.5793	564	
Eureka B	EB27-3	91	0.0044	45.3771	52.1863	1.5979	99.1657	535	
Eureka B	EB32-1	15	0.0018	27.999	70.6941	0.2721	98.967	716	
Eureka B	EB32-2	16	0.0001	28.1248	70.8061	0.3863	99.3173	716	
Eureka B	EB32-3	17	0.0051	27.9543	71.1281	0.6154	99.7029	718	
Eureka B	EB33-1	20	0.0012	30.5388	68.6153	0.1234	99.2787	692	
Eureka B	EB33-2	21	0.0039	33.9782	65.3188	0.2427	99.5436	658	
Eureka B	EB33-3	22	0.0034	35.092	63.641	0.349	99.0854	645	
Eureka B	EB36-1	13	0.0001	27.036	68.5753	4.6321	100.2435	717	
Eureka B	EB36-2	14	0.0052	29.3352	67.3682	3.3143	100.0229	697	
Eureka B	EB38-1	18	0.0033	30.2587	69.2431	0.5813	100.0864	696	
Eureka B	EB38-2	19	0.0034	29.4626	68.3247	0.6069	98.3976	699	
Eureka C	EC110-1	203	0.0001	47.916	50.4128	0.1627	98.4916	513	
Eureka C	EC110-2	204	0.0001	54.6545	44.5311	0.2824	99.4681	449	
Eureka C	EC110-3	205	1.1994	70.7129	1.0019	0.0001	72.9143	14	
Eureka C	EC110-4	206	0.0001	55.7306	42.7809	0.3232	98.8348	434	apparent low fineness zone
Eureka C	EC110-5	207	0.0001	56.7407	41.3486	0.5252	98.6146	422	apparent low fineness zone
Eureka C	EC110-6	208	0.0054	57.1608	41.398	0.4611	99.0253	420	apparent low fineness zone
Eureka C	EC110-7	209	0.0089	37.7129	61.5227	0.0661	99.3106	620	
Eureka C	EC11-1	219	0.0101	23.3535	75.233	0.0777	98.6743	763	
Eureka C	EC11-2	220	0.0001	44.1172	54.754	0.1403	99.0116	554	apparent low fineness zone
Eureka C	EC11-3	221	0.0061	22.7457	69.0457	0.0522	91.8497	752	apparent low fineness zone
Eureka C	EC11-4	222	0.0001	24.0322	75.2617	0.0602	99.3542	758	
Eureka C	EC11-5	223	0.0001	40.6123	49.9337	0.176	90.7221	552	apparent low fineness zone
Eureka C	EC11-6	224	0.0001	30.6173	66.869	0.0718	97.5582	686	
Eureka C	EC14-1	210	0.0007	53.6973	43.7068	0.3871	97.7919	449	
Eureka C	EC14-2	211	0.0001	55.3421	43.3427	0.3791	99.064	439	
Eureka C	EC14-3	212	0.0028	53.0426	45.1445	0.3844	98.5743	460	apparent high fineness zone
Eureka C	EC14-4	213	0.0033	63.8096	34.6371	0.2787	98.7287	352	apparent low fineness zone
Eureka C	EC14-5	214	0.0001	45.0384	53.4669	0.2935	98.7989	543	apparent high fineness zone
Eureka C	EC14-6	215	0.0001	58.4793	41.0188	0.3561	99.8543	412	
Eureka C	EC14-7	216	0.0028	63.3957	35.5142	0.3534	99.2661	359	apparent low fineness zone
Eureka C	EC14-8	217	0.0003	58.0284	41.1341	0.3735	99.5363	415	apparent high fineness zone
Eureka C	EC14-9	218	0.0001	56.226	42.1127	0.4023	98.7411	428	
Eureka C	EC16-10	188	0.0001	5.1358	82.2321	0.0002	87.3682	941	apparent high fineness zone
Eureka C	EC16-11	189	0.001	6.5999	83.6255	0.0113	90.2377	927	apparent high fineness zone
Eureka C	EC16-12	190	0.0009	62.5167	36.2876	0.3583	99.1635	367	apparent low fineness zone
Eureka C	EC16-13	191	0.0001	56.4232	41.9928	0.454	98.8701	427	
Eureka C	EC16-14	192	0.0001	53.7948	45.1017	0.3195	99.2161	456	
Eureka C	EC16-2	180	0.0001	56.3395	42.5876	0.421	99.3482	431	
Eureka C	EC16-3	181	0.0001	54.4016	44.2276	0.3911	99.0204	448	
Eureka C	EC16-4	182	0.0001	56.9745	40.906	0.4176	98.2982	418	
Eureka C	EC16-5	183	7.1248	60.6203	0.0356	0.0001	67.7808	1	dark inclusion
Eureka C	EC16-6	184	0.9954	80.5636	0.0416	0.0001	81.6007	1	dark inclusion
Eureka C	EC16-7	185	0.0001	64.5939	33.6624	0.6958	98.9522	343	apparent low fineness zone
Eureka C	EC16-8	186	0.0001	62.4505	34.6841	0.6678	97.8025	357	apparent low fineness zone
Eureka C	EC16-9	187	0.0037	55.5269	43.9045	0.3673	99.8024	442	
Eureka C	EC18-1	193	0.0021	51.1991	44.9088	1.7376	97.8476	467	
Eureka C	EC18-10	202	0.0069	55.6354	40.9148	2.4729	99.03	424	
Eureka C	EC18-2	194	0.0042	56.6073	40.2823	2.607	99.5008	416	

Location	Sample	Label	wt%(Cu)	wt%(Ag)	wt%(Au)	wt%(Hg)	Total wt%	Fineness	Comments
Eureka C	EC18-3	195	0.0001	37.0573	61.2832	0.4386	98.7792	623	
Eureka C	EC18-4	196	0.0001	59.7751	37.2897	0.5984	97.6633	384	apparent low fineness zone
Eureka C	EC18-5	197	0.0009	61.2038	36.9557	0.7346	98.895	377	apparent low fineness zone
Eureka C	EC18-6	198	0.0001	52.8345	44.7961	1.7678	99.3985	459	apparent low fineness zone
Eureka C	EC18-7	199	0.0063	52.2884	44.3163	1.8576	98.4686	459	apparent low fineness zone
Eureka C	EC18-8	200	0.0001	60.9166	35.6184	1.3257	97.8608	369	apparent low fineness rim
Eureka C	EC18-9	201	0.0068	57.6464	38.9087	0.911	97.4729	403	apparent low fineness zone
Eureka C	EC21-1	51	0.0082	42.8388	54.0743	0.4012	97.3225	558	
Eureka C	EC21-2	52	0.0089	42.7896	55.9925	0.4203	99.2113	567	
Eureka C	EC23-1	48	0.0001	27.1708	70.0304	1.8644	99.0657	721	
Eureka C	EC23-2	49	0.0024	27.0635	70.5767	1.6746	99.3172	723	
Eureka C	EC23-3	50	0.0001	28.141	69.6634	1.5488	99.3533	712	
Eureka C	EC24-1	53	0.0001	25.2172	72.842	0.1158	98.1751	743	
Eureka C	EC24-2	54	0.0001	25.0333	73.7363	0.1276	98.8973	747	
Eureka C	EC24-3	55	0.0001	25.3562	74.9986	0.0946	100.4495	747	
Eureka C	EC24-4	56	0.0016	25.1687	74.0406	0.0707	99.2816	746	discoloured area
Eureka C	EC25-1	62	0.0028	47.1933	50.2076	0.6698	98.0735	516	
Eureka C	EC25-2	63	0.0001	46.9067	51.1791	0.636	98.7219	522	
Eureka C	EC26-1	60	0.0001	59.7083	36.7888	1.4865	97.9837	381	
Eureka C	EC26-2	61	0.0082	60.7464	37.0495	1.5323	99.3364	379	
Eureka C	EC27-1	57	0.0063	27.8172	71.1757	0.2934	99.2926	719	
Eureka C	EC27-2	58	0.0065	27.0256	71.3076	0.2732	98.6129	725	discoloured area
Eureka C	EC27-3	59	0.0073	27.7891	71.4157	0.2741	99.4862	720	
Eureka E	ECR21-1	64	0.0057	43.6994	55.3569	0.3779	99.4399	559	
Eureka E	ECR21-2	65	0.0001	43.2948	55.6023	0.2937	99.1909	562	
Eureka E	ECR22-1	66	0.0001	19.8473	70.4067	0.7136	90.9677	780	
Eureka E	ECR22-2	67	0.0067	19.9955	79.988	0.7927	100.7829	800	
Eureka E	ECR23-1	70	0.0066	29.7232	69.5414	0.0716	99.3428	701	
Eureka E	ECR23-2	71	0.0044	1.04	106.7786	0.0002	107.8232	990	
Eureka E	ECR24-1	72	0.0001	34.3376	59.188	0.6568	94.1825	633	
Eureka E	ECR24-2	73	0.0006	37.2338	61.9338	0.6473	99.8155	625	non porous rim
Eureka E	ECR24-3	74	0.0001	35.5365	61.4073	0.6091	97.553	633	non porous rim
Eureka E	ECR24-4	75	0.0001	35.6024	63.0836	0.6277	99.3138	639	
Eureka E	ECR26-1	68	0.0043	23.163	65.4338	0.1004	88.7015	739	
Eureka E	ECR26-2	69	0.0038	26.7552	71.7163	0.1092	98.5845	728	
Eureka E	ECR27-1	76	0.0001	0.1981	101.2947	0.0002	101.4931	998	leached rim
Eureka E	ECR27-2	77	0.0001	34.5927	63.9519	0.4721	99.0168	649	non porous rim
Eureka E	ECR27-3	78	0.0001	20.9961	52.2343	0.187	73.4175	713	leached rim
Eureka E	ECR27-4	79	0.0001	34.1077	64.0432	0.4331	98.5841	653	non porous rim
Eureka E	ECR27-5	80	0.0101	0.1267	56.871	0.0002	57.008	998	porous core
Eureka Pit	EPA1-1	108	0.0072	33.7783	62.3452	0.1679	96.2986	649	
Eureka Pit	EPA2-1	106	0.0001	21.3845	76.1589	0.1057	97.6492	781	
Eureka Pit	EPA2-2	107	0.0001	20.7408	77.502	0.1567	98.3996	789	
Eureka Pit	EPB-1	109	62.6228	0.0135	0.0002	0.0002	62.6367	15	
Eureka Pit	EPB-2	110	62.7491	0.0143	0.0002	0.0002	62.7638	14	
Eureka Pit	EPB-3	111	59.5423	0.0226	0.0706	0.0002	59.6357	758	
Eureka Pit	EPC-1	112	0.0001	36.347	63.7347	0.7583	100.8401	637	
Eureka Pit	EPC-2	113	0.0001	35.0884	62.2482	0.7778	98.1145	640	
Eureka Pit	EPD-1	114	0.0008	34.2047	65.6553	0.198	100.0588	658	
Kirkman Creek	K35-1	10	0.0011	0.975	98.6065	0.0002	99.5828	990	
Kirkman Creek	K35-2	11	0.017	14.0759	84.8735	0.3042	99.2706	858	
Kirkman Creek	K35-3	12	0.032	13.4753	86.1109	0.2875	99.9057	865	
Kirkman Creek	K36-1	2	0.0079	26.6696	72.1117	0.5784	99.3676	730	
Kirkman Creek	K36-2	3	0.0001	26.5498	73.3883	0.5877	100.5259	734	
Kirkman Creek	K36-3	4	0.0001	1.1267	100.4156	0.0002	101.5426	989	
Kirkman Creek	K37-1	5	0.0258	10.4684	89.7602	0.2542	100.5086	896	
Kirkman Creek	K37-2	6	0.0252	10.4276	89.0346	0.2881	99.7755	895	
Kirkman Creek	K38-1	7	0.0135	15.2787	84.1345	0.0723	99.499	846	

Location	Sample	Label	wt%(Cu)	wt%(Ag)	wt%(Au)	wt%(Hg)	Total wt%	Fineness	Comments
Kirkman Creek	K38-2	8	0.0121	15.2831	84.9732	0.1017	100.3701	848	
Kirkman Creek	K38-3	9	0.0195	15.2989	84.6022	0.1025	100.0231	847	
Mine Creek	M1_-1	228	0.0001	19.6056	79.5554	0.2174	99.3785	802	
Mine Creek	M1_-2	229	0.0099	19.7723	79.5969	0.2418	99.6209	801	
Mine Creek	M1_-3	230	0.0073	19.8971	77.805	0.2508	97.9602	796	
Mine Creek	M24-1	33	0.0316	11.0932	89.0289	0.0002	100.1539	889	non porous rim
Mine Creek	M24-2	34	0.0198	11.521	88.0436	0.0759	99.6603	884	
Mine Creek	M25-1	31	0.0282	12.6252	83.354	0.0002	96.0076	869	
Mine Creek	M25-2	32	0.0301	12.5095	87.1935	0.0522	99.7853	875	
Mine Creek	M26-1	37	0.0018	21.6471	78.5043	0.0081	100.1613	784	non porous rim
Mine Creek	M26-2	38	0.0162	22.0024	77.301	0.0002	99.3198	778	
Mine Creek	M27-1	35	0.0393	11.0079	87.1669	0.0532	98.2673	888	
Mine Creek	M27-2	36	0.0308	10.6252	90.5433	0.0241	101.2234	895	
Roo Pup	R11-2	225	0.0083	20.2528	79.0478	0.1103	99.4192	796	
Roo Pup	R11-4	226	0.0157	20.7475	78.2012	0.1037	99.0681	790	
Roo Pup	R11-5	227	0.0072	20.5459	77.1724	0.0867	97.8122	790	
Roo Pup	R22-1	46	0.0001	11.3257	56.6972	0.0002	68.0232	834	
Roo Pup	R22-2	47	0.0077	10.5621	76.624	0.0049	87.1987	879	
Roo Pup	R23-1	44	0.0001	20.1886	77.3295	1.4992	99.0174	793	
Roo Pup	R23-2	45	0.0033	19.5444	76.465	1.4712	97.4839	796	
Roo Pup	R25-1	42	0.0268	10.1824	86.5844	0.0994	96.893	895	
Roo Pup	R25-2	43	0.0252	11.2316	88.555	0.0946	99.9064	887	
Roo Pup	R27-1	39	0.0001	9.5213	41.3648	0.0002	50.8864	813	non porous rim
Roo Pup	R27-2	40	0.0085	17.9392	81.1917	0.0002	99.1396	819	non porous rim
Roo Pup	R27-3	41	0.0134	8.6459	54.6138	0.0002	63.2733	863	
Swamp Creek	S210-1	97	0.01	25.8041	73.0054	0.0371	98.8566	739	
Swamp Creek	S210-2	98	0.0116	30.8435	67.5814	0.0977	98.5342	687	
Swamp Creek	S211-1	103	0.0001	0.98	87.2088	0.0002	88.1891	989	apparent high fineness zone
Swamp Creek	S211-2	104	0.0114	13.8506	86.2736	0.0893	100.2249	862	
Swamp Creek	S211-3	105	0.0131	13.3214	86.0048	0.0775	99.4168	866	
Swamp Creek	S22-1	101	0.0103	17.3756	82.0233	0.0516	99.4608	825	
Swamp Creek	S22-2	102	0.0129	17.0807	82.2481	0.0362	99.3779	828	
Swamp Creek	S23-1	99	0.0035	16.4334	82.8393	0.0029	99.2791	835	
Swamp Creek	S23-2	100	0.0113	16.689	83.3921	0.0077	100.1001	833	
Swamp Creek	S29-1	95	0.0053	17.3445	81.9638	0.0002	99.3138	825	
Swamp Creek	S29-2	96	0.0073	17.8731	79.7841	0.0002	97.6647	817	
Swamp Creek	S34-1	23	0.0139	18.4154	80.6337	0.3807	99.4437	814	
Swamp Creek	S34-2	24	0.0189	10.4241	89.8392	0.0002	100.2824	896	
Swamp Creek	S34-3	25	0.0261	10.0604	89.9649	0.0002	100.0516	899	
Swamp Creek	S35-1	26	0.0004	15.4613	84.8864	0.0002	100.3483	846	
Swamp Creek	S35-2	27	0.0012	15.8516	84.3385	0.0002	100.1915	842	
Swamp Creek	S37-1	28	0.0001	18.9519	80.0133	0.0002	98.9655	809	
Swamp Creek	S37-2	29	0.0001	19.5936	80.4232	0.0002	100.0171	804	
Swamp Creek	S37-3	30	0.0047	18.7612	79.9007	0.4004	99.067	810	
Thistle Creek	T410-1	146	0.0122	16.4388	82.5962	0.3879	99.4351	834	
Thistle Creek	T410-2	147	0.0103	17.0131	81.5868	0.4197	99.0299	828	
Thistle Creek	T410-3	148	0.0197	15.4376	83.8467	0.4291	99.7331	845	
Thistle Creek	T412-1	140	0.0088	10.312	69.5651	0.1099	79.9958	871	
Thistle Creek	T412-2	141	0.0252	14.902	82.9216	0.3819	98.2307	848	
Thistle Creek	T412-3	142	0.0215	14.9953	83.1564	0.341	98.5142	847	
Thistle Creek	T45-1	149	0.0257	10.3849	88.299	0.619	99.3286	895	
Thistle Creek	T45-2	150	0.0287	11.3179	85.4118	0.6047	97.3631	883	non porous rim
Thistle Creek	T45-3	151	0.0157	10.3516	87.6619	0.6224	98.6516	894	
Thistle Creek	T49-1	143	0.026	7.6273	89.6418	0.0002	97.2953	922	
Thistle Creek	T49-2	144	0.0283	7.7078	91.9233	0.0002	99.6596	923	
Thistle Creek	T49-3	145	0.0006	1.3794	90.7548	0.0002	92.135	985	
Standard	S254	1	0.0001	20.1445	79.2806	0.0002	99.4254	797	standard
Standard	S254A	123	0.0001	20.1159	78.8039	0.0002	98.9201	797	standard
Standard	S254B	231	0.0001	20.0959	79.3642	0.0002	99.4604	798	standard