

Placer Gold Discussion

By Chris Ash, May 16, 2002

As an introduction several points from the 1933 Lindgren volume, which summarizes the nature and character of placer gold mining in Sierra Nevada metamorphic belt of California are presented. This is because it is the richest and most productive placer field in the North American Cordillera and is also well documented (at least relative to the Canadian examples).

Ore deposits of the Western United States (Lindgren Volume, 1933)

Chapter 10 - Placer Deposits of the Western United States by J.T. Pardee

The great California gold rush of 1849 was initiated by Marshall's discovery of placer gold on the South Fork of American River at Sutter's Mill, Coloma, in northern California. Prior to this, gold was mined by Mexican and Spanish priests in the first half of the 19th century or earlier in the southern states of the western US including southern California. This most likely reflects the origin of the term,

"PLACER: a Spanish word, the definitions of which include "an extensive bank of sand or gravel" and "a place where currents of water deposit particles of gold" (Zero et al., 1885). Most likely first used by Spanish or Mexican gold miners. Now generally applied to all detrital deposits that yield valuable minerals by washing."

Due mainly to the huge yield in the Sierra Nevada region, the western United States has exceeded all other parts of the world in the placer gold production. To the end of 1931 the total is about (1933 dollars) \$1,600,000,000 (*94 117 647 oz). In 1952 alone nearly \$81,300,000 (*4 782 352) was washed from California placers (this more than the total production from Barkerville). Bulk of placer production was recovered before 1875 – annual production in the following 30 years was \$8 000 000 (*470 588 oz.) - \$9 000 000 (*529 411 oz)] roughly half a million ounces per year.

*Using \$17.00 value for gold conversion, based on a value of 860 as average fineness.

Under the section "Origin of Placers", J.T. Pardee writes:

The general distribution of placers considered herein indicates definitely that the source of their gold was lodes. In many instances the pay streak leads directly to a lode; in others the two may be widely separated but the path the gold has traveled can generally be determined. In a few, however, for example the 'flour' gold deposits of Snake River, the source remains obscure. As a rule, quality of gold varies with texture. The smaller particles being the more pure. In a given deposit the purity of gold increases somewhat downstream or away from the source. Suggesting refinement is due to a very slow solution of the silver or other impurity.

As you are all aware my position on the origin of the gold at Barkerville is detrital. I do not profess to be a placer gold expert. My views are based on an evaluation of the available data relating to the subject.

Possibly the most powerful argument in favor of a detrital origin was that expressed by Dale Sketchny during the discussion following the presentation, i.e., the lack of inclusion of foreign material within the placer nuggets. All reported large nuggets often contain quartz and possibly carbonate or albite, which is characteristic of the lode source, but little else. It seems very difficult to rationalize how something can grow in gravel and not encapsulate the surrounding material. One could use as an analogy the character of cumulate textures in igneous rocks or paragenetic succession of metallic minerals in ore deposits and how they convey relative timing of crystallization.

The following points were provided by Vic Levson and also support a detrital origin for Barkerville placer gold.

1. nuggets occur in specific sedimentary (high energy) facies and stratigraphic units - if they are chemical precipitates, why would there be any stratigraphic or facies control on their distribution?
2. placer gold consistently occurs with high concentrations of other heavy minerals that are clearly detrital.
3. mineral inclusions within placer gold correlate strongly with mineral inclusions in source area terrains and specific host rocks.
4. gold composition in placers correlates strongly with gold composition in source area lodes.
5. individual streams have distinctive gold compositions.
6. the cores of compound nuggets (i.e. those with >1 core surrounded by pure gold) are geochemically identical.
7. placer nugget roundness and flatness increase downstream from source areas.
8. placer nugget size decreases downstream from source areas.
9. the thickness of high fineness rims on individual nuggets increases downstream.
10. there is a decrease in size of gold particles in placers with time (Boyle, 1979); If grains grow in place, should not the oldest placers be the biggest?

McTaggart and Knight (1993) state on page 7:

"Knight and McTaggart (1990) concluded from observation and experiment, that rims on gold in the Cariboo are the result of removal of silver and other metals from the margins of the placer grains."

Attempts to find any hard data to support growth of placer nuggets in the creeks has been difficult.

Vic provided the following comment when requested to provide evidence for in-situ placer gold growth.

"haven't been able to find much on this, possibly because not much hard data exists! I tried a couple of geochem texts - Levinson in his textbook says that native gold, "for all practical purposes", is only mechanically mobile in the surficial environment. Rose et al. and Boyle refer mainly to some old Russian literature. Au in tropical soils can be useful for finding weathered Au-bearing deposits but the gold may just be detrital. Boyle says that gold in laterites is certainly residual but some may also be chemical in origin (pg 57) but cites no reference for that."

The argument for in situ gold growth to explain the contradiction between the style of coarse placer nugget gold, that is uncharacteristic of the fine lode gold, appears to have been promoted by Eyles and Kocsis (1988). The following extracted quote from these authors present a hypothesis that is either anecdotal or entirely suggestive (underlined and **bold**) with no hard data to support the proposed view. Importantly, this topic was not even the objective of the work conducted by these authors. They do however, state that "*Further work is clearly needed ...*". It is significant to note that this model does not imply that placer grains grow in the creeks. It appears to suggest concentration by growth within the lode, which has been affect by supergene enrichment to subsequently eroded (at least as I read it).

Eyles and Kocsis (1988, Page 73)

Under "Origin of Placer Gold in the Barkerville Area".

..... It may be that the present vein exposures are remnants of a previously larger system that has been eroded and redeposited as rich placers. However the weathering of auriferous sulphides and supergene enrichment may provide an alternate source of placer gold. Sulphides such as pyrite and arsenopyrite,

commonly associated with gold, liberate sulfuric acid upon weathering. In the Cariboo district, there are reports of gold films and minute crystals attached to pebbles, suggesting that solution and redeposition of gold is possible. Gold will dissolve in an acidic solution, will oxidize to Au^{3+} which can then combine with chlorine ions to form the stable complex (AuCl_4^-), but only in the presence of a strong oxidizing agent, such as MnO_2 (Guilbert and Park, 1986, p. 812). In the study area, it is possible evaporite-carbonate sequences, which include salts, could provide chlorine which is necessary in forming the gold-chloride complex. The abundant manganese sericite could provide the necessary manganese dioxide. Deep weathering and supergene reprecipitation of gold above the water table may have occurred during a lengthy episode of Tertiary weathering prior to the onset of Quaternary glaciations and erosion by ice sheets. Further work is clearly needed to establish the precise origin of placer gold in the Cariboo district but the close association of historic and current placer operations with the outcrop belt of the Downey Creek Succession in the Barkerville area indicates that the placer gold is of local derivation.....

Likewise, in the Klondike where no coarse lode source for the placers have been found, Tyrrell (1907) concluded that

"the rich gravels were the result of such continuous uninterrupted stream concentration of rock detritus containing a very minute amount of gold."

This detrital origin is also consistent with recent work on placer grain shape and chemistry by Knight et al. (1999a and b).

Barkerville:

Clague, J.J. (1989): Placer gold in the Cariboo district, British Columbia; in Current Research, Part E, , Geological Survey of Canada, Paper 89-1E, p. 243-250.

Eyels, N. and Kocsis, S.P. (1988): Gold Placers in Pleistocene glacial deposits; Barkerville, British Columbia; CIM Bulletin, p. 71-79.

Knight J. and McTaggart, K.C. (1990): Lode and placer gold of the Coquihalla and Wells areas, British Columbia (92H, 93H); in Exploration in British Columbia 1989, B.C. Ministry of Energy, Mines and Petroleum Resources, Paper 1990-1, pages 105-118.

Levson, V.M. and Giles, T.R. (1993): Geology of Tertiary and Quaternary gold-bearing placers in the Cariboo region, British Columbia (93A, B, G, H); , B.C. Ministry of Energy, Mines and Petroleum Resources, Bulletin 89, 202 pages.

McTaggart, K.C. and Knight, J. (1993): Geochemistry of Lode and Placer Gold of the Cariboo District, BC; BC Ministry of Energy and Mines, Open File 1993-30, 26 pages.

Klondike:

Knight, J.B., Mortensen, J.K. and Morison, S.R. (1999a): The relationship between placer gold particle shape, rimming, and distance of fluvial transport as exemplified by gold from the Klondike District, Yukon; *Economic Geology*, v. 94, no. 5, p. 635-648.

Knight, J.B., Mortensen, J.K. and Morison, S.R. (1999b): Lode and placer gold composition in the Klondike district, Yukon Territory, Canada: Implications for the nature and genesis of Klondike placer and lode gold deposits; *Economic Geology*, v. 94, no. 5, p. 649-664.

Tyrrell, J.B. (1907): Concentrations of gold in the Klondike; *Economic Geology*, vol. 2, p. 343-349.

Following is a brief summary relating to the origin of placer gold, their tectonic setting and their spatial relationship to ophiolitic rocks. This information was generated following initial review of Chapter 6 in Bulletin 108 when the "origin issue" was previously challenged. It also includes a number of examples of high-grade, gold-rich pockets mined from lodes. These are extracted from the "Ophiolite gold vein Bulletin" where complete references can be found.

Placer Gold Source

All placer gold deposits in the North America Cordillera consistently show an immediate spatial relationship with ophiolitic crustal rocks within and marginal to terrane collisional boundaries. Placers with significant production in the Canadian Cordillera; Barkerville, Atlin, Klondike all display remarkably consistent lithotectonic relationships in that gold resides immediately below a flat-lying collisional suture zone to depths of within 300 meters. Suture zones are everywhere characterized by the presence of listwanite-altered ultramafic rocks usually as isolated klippa above the basement rocks on which the placers reside. Footwall gold veins characteristic of high pyrite content with associated fine flower gold and restricted vertical extent are commonly developed where the suture rests above predominantly metamorphosed limey shales and siliceous mudstones (Barkerville, Klondike). The textural features of the placer nuggets, particularly the larger ones, consistently indicate that it has not traveled any significant distance yet the source has alluded gold seekers for over a century.

The answer to this question is relatively straight forward when one steps back from the immediate deposits scale features with understanding that:

1. Every significant occurrence of very-rich coarse nugget gold ever mined in the North American Cordillera; Grass Valley, Bralorne-Pioneer, Alleghany, Mother Lode, Cassiar, IXL-Midnight (Rossland) was from a quartz vein hosted by listwanite altered mafic igneous crustal lithologies in close proximity to listwanite altered ultramafic rocks within or marginal to a terrane bounding thrust fault. There are few, if any, exceptions to this general rule. *(Would appreciate it if someone could indicate a deposit where this is not the case?)*.
2. Ophiolitic mafic igneous lithologies which are the host to coarse, native gold can be shown to have existed immediately above the carbonate-altered collisional suture zone.
3. The erratically distributed coarse, lode gold mineralization is concentrated by erosion and as a function of gravity currently must reside below its point of origin. Gold is eroded and therefore the rocks that initially hosted it must have experienced a similar erosional fate. The only rocks that host such styles of coarse native gold are the ones that have been eroded. A relatively straightforward relationship.

Atlin

This relationship suggests that gold-rich deposits of this type will be found where ophiolitic crustal mafic igneous lithologies in tectonic contact with listwanite altered ultramafic rocks have not been removed by erosion. It is evident that exploration efforts for the source of placer gold deposits is better expended on the basis of an understanding of the regional litho-tectonic setting of the placer camp. History has proven that the mere presence of gold-rich gravels has no bearing on their source being immediately beside or below them. The consistent vertical depth of the richest placers below the sutures suggests that within this limited distance placers still remain near surface and thus have been identified. The question of undiscovered significant placers in similar geological settings, that may be buried, is an intriguing one.

High Grade Gold and ULTRAMAFIC ROCKS In Lode Mines

Bralorne;

Cairnes (1937, page 123) writes when describing the occurrence of high-grade ore shoots at the Pioneer Mine.

Gold is the mineral of chief economic importance. Mostly it occurs free and either

separate from other metallic constituents or minutely associated with them. Much free gold occurs along partings between ribbons of quartz and is associated with finely crystalline sulphides. It may however occur in massive, white quartz or coarsely crystalline calcite and rich pockets of such material have been found in the western mine workings close to the serpentinite contact.

"Altogether, four principal ore shoots are referred to by James, namely, a west-end shoot, a west shoot, and two easterly shoots. The west-end shoot takes approximately with the intersection of the vein fissure and the serpentinite and extends back for several 100 feet from this intersection. This is a high grade shoot and has provided exceptionally rich pockets. In a stope from 8-level, two tons alone produced \$200 000.00 (9685 ounces) worth of gold. Another pocket yielded 400 pounds of gold from 900 pounds of ore.

Rossland Gold Quartz Veins

Appreciable gold (1060 kilograms) has also been recovered from gold-quartz veins associated with ultramafic rocks on the O.K., IXL and Midnight Crown-granted claims to the west of the massive sulphide vein system of the Rossland camp. All three mines are situated along a faulted contact between massive basalt/diabase and talc carbonate altered ultramafic rocks.

Fyles (1984) reported that between 1899 and 1974, 10492 tonnes of ore were mined from these veins with an average grade of 101 grams per tonne gold and 14 grams per tonne silver. Some of the veins have exceptionally high reported gold grades, the Snowdrop vein, for example produced only 6 tonnes of ore with an average grade of 1150 grams per tonne gold.

Mother Lode, California

A mass of gold illustrated in a photo by Leicht (1982) measures 6 x 13 inches and weighs 67 troy ounces (5.5 pounds) was found at the Eureka mine, Tuolumne County on the Mother Lode belt. (Resides in the Smithsonian Institute).

A photo of a second mass of crystalline gold the 'Fricot Nugget', found in 1865 at the Grit mine, El Dorado County, weighs 201 troy ounces (close to 17 lbs) is characterized as the finest ever found in California. Resides in California Division of Mines and Geology collection, Ferry Building, San Francisco.

Alleghany, California

Ferguson and Gannett (1932) estimated that over 80% of the production of the district has come from portions of the quartz veins with 80 to 100 feet of serpentinite bodies intersected by the veins. In some mine all ore was found only adjacent to serpentinite (Coveney, 1981).

Ferguson and Gannett (1932, page 76):

"...At Alleghany the ore shoots almost without exception are small but of exceedingly high gold content, whereas in the neighboring districts such as Grass Valley, large bodies of relatively low grade are the rule, although both at Grass Valley and on the Mother Lode small "bunches" of ore of astonishing richness are sometimes found."

Ferguson and Gannett (1932, page 27):

"A single slab of gold-bearing quartz recovered from Bald Mountain, calculated to contain \$20,486 (423 oz) in gold was exhibited in San Francisco in 1882."

New Fork Mine in 1875

"The harder ore was so rich that two men working with hand mortars pounded out \$8000 (390 ounces) in gold in a week, and on one occasion over 20,000 (close to 1000 ounces) is said to have been recovered in a single days work."

Johnson, 1940:

*"Ore of astonishing richness at **Grass Valley** is associated with the Idaho-Maryland vein, with a serpentinite footwall, in which "specimen rock" was particularly abundant."*

The point of all this and underlying point of my CIM presentation is that these types of gold-rich deposits exist. They are spatially associated with listwanite altered ultramafic rocks. This is only one, of a combination of observable geologic features that can be used to potentially isolate similar deposits.

Hope this is helpful, and leads to a constructive conclusion, or at least helps generate some consensus on how to arrive at one. The point is clearly an important one in helping to understand the origin and settings of both lodes and placers and ultimately find others.

Schroeter, Tom EM:EX

From: Schroeter, Tom EM:EX
Sent: Thursday, May 16, 2002 12:01 PM
To: Ash, Chris EM:EX
Subject: RE: Placer Gold Source Discussion

Good on 'ya, Chris! Tom.

-----Original Message-----

From: Ash, Chris EM:EX
Sent: Thursday, May 16, 2002 11:04 AM
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Subject: Placer Gold Source Discussion

Good Day Ladies and Gentlemen,

The following is intended to help clarify the discussion relating to the origin of placer gold in the Barkerville camp, which ensued following the "Exploration criteria for gold-quartz veins..." presentation given at the recent CIM meeting.

The two possibilities discussed were:

- 1) The gold nugget size is due to in situ gold growth within the gravels, or
- 2) It is detrital and derived from a lode source

In light of the significance of this question, I thought it important to generate a discussion as to the available evidence or arguments, for or against the two alternate proposals for nugget gold formation. I have included the people involved in the discussion at the meeting (for whom I have an e-mail address). Currently included are: Gerry Ray, Dale Sketchly, Tom Schroeter, Jennifer Pell, Godfrey Walton, Mike Hibbitts and Nick Carter. Also Vic Levson, our resident placer expert, and Dani Alldrick who has also worked in the Barkerville camp. In addition, Ian Webster, Brian Grant and Ron McMillan have expressed an interest in being included. If you know of others that may be interested in contributing, feel free to forward this e-mail.

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