ORIGIN AND CHARACTERISTICS OF PLACER GOLD

The origin of placer gold appears, at first glance, to be relatively simple, but there remain several enigmas which require satisfactory explanation. They are :

1. The difficulty of relating placer gold, both in quality and quantity to the possible original source.
2. The common occurrence of alluvial gold at or near bedrock or false bottoms often beneath vast quantities of barren alluvium.
3. The size and frequency of nuggets relative to such sizes in lode gold. (In Victoria, Australia, however, 1327 nuggets from placer sources weighing 0.62 Kg or more have been reported, as against 118 lumps of this weight or more from lodes (Bowen and Whiting).
4. The formation of a large number of commercial gold placers during the tertiary period.

Chemical Phenomena

In general most evidence tends to support the obvious origin from lode sources, by weathering, degradation, transport and concentration. There are sound reasons to consider chemical phenomena may also be responsible. The most salient of these are :

1. In addition to the nuggets, placer gold in general is considered to be coarser than lode gold. It could have become larger by chemical precipitation as much as by mechanical aggregation and hammering. (This explanation for this observation, if indeed it is true, is harder to accept than the other chemical phenomena).
2. Gold is undoubtedly dissolved by humic waters and reprecipitated. The fascinating 'pinta que paga' in Brazil described by Freise bear testimony to that. Similar small pay streaks have been worked intermittently in Korea and the USSR too. The precipitated gold, however, is very fine and can be green.

3. Some nuggets have concentric structures which bespeak of an accretionary process, which is better explained by chemical rather than mechanical phenomena.

4. Crystallinity is encountered more often in placer rather than lode gold.

5. Thin deposits and films of high purity gold have formed on rounded particles of osmiridium and platinum (Syrovatskii).

6. Films, threads, wires, dendrites and paint gold are not uncommon in placers in or organic material, such as wood, that has exerted a reducing action. Gold can also be contained within pyrite or pseudomorphs of pyrite replacing such structures.

7. The fineness of gold increases and the gold particle size decreases with increasing distance from 'source'. This is usually attributed to the preferential leaching of the other elements, notably silver, which is made easier as the greater surface area per unit of mass increases. There are instances where the phenomenon is attributed to further additions of gold of greater fineness along the main channel (Fisher). The work of Desborough has shown conclusively the common, but not exclusive, presence of a leached rim on alluvial gold.

Undoubtedly, therefore, chemical phenomena contribute to the origin of placer gold, but, except in particular instances, the origin must be largely due to physical phenomena.

CHARACTERISTICS

Particle Size

In general placer gold is considered to be more coarse than lode gold (consider for instance the physical versus the chemical method of recovery respectively). This may reflect the practice rather than the reality. Most commercial placer operations are only viable if cheap and simple physical recovery methods can be used. Fine gold, therefore if present, is of no commercial interest and may not be looked for or reported. Fine gold may not be deposited with the coarse gold but may

have been transported with finer sediments further downstream or offshore.

Gold will abrade quite readily to form fine particles (Yeend, Shilo) and forms colloidal gold which may account for a readiness for chemical reaction and precipitation in favourable circumstances. Indeed there is a large deltaic deposit of colloidal or absorbed gold (about 300 mg/t) in Burma (Bensusan) which is totally unamenable to physical processing.

Gold in placers can in fact range up to 2 mm in size, and coarser. Placer gold may be very finely divided (flour, float or flood gold) which is very difficult to recover by physical means and therefore often ignored. Any one particular occurrence may contain gold which is very fine, or may be all quite coarse, or a mixture of coarse and very fine, or may be present at all sizes.

It is now commonly regarded that the gold of the Witwatersrand conglomerate is of alluvial origin. Although no doubt remobilised to some extent, it still retains some of the features of alluvial gold (Pretorious). The gold particles within these conglomerates are fine (in placer gold terms) - around 80 microns. A content of around 2000 mg/t of gold would be regarded as marginal for an opencast mining and milling operation today. The placer industry therefore should not disregard an occurrence of fine placer gold of around 1000 mg/t, since milling is not involved.

Alluvial cassiterite similarly can be fine, but the industry has largely been unaware of its presence. The prospecting techniques, like those for placer gold, attempt to simulate the commercial recovery practices. It is only in the last 20 years that the presence of fine cassiterite has been reported. Prospecting techniques now tend to measure all the tin present but still distinguish between conventionally recoverable and non-recoverable tin.

Dalton-Browne in 1958 claimed the industry was recovering only about one half of the cassiterite present. Fontein's work with hydrocyclones and sieve bends indicated about 25% of the cassiterite was less than 50 microns and had previously been unreported. The dredges claim to recover +90% of the recoverable cassiterite as determined by field

concentration techniques (Anglo-Oriental). This recoverable cassiterite is more or less devoid of minus 50 microns cassiterite, as is the hydrocyclone underflow of Fontein's work. Fontein's work therefore implies - the classification effected by hydrocyclone is comparable to the unconscious classification within the field techniques.

To date however, that minus 50 micron cassiterite is not being - recovered whereas cassiterite down to 2 microns is avidly sought at some lode tin mines.

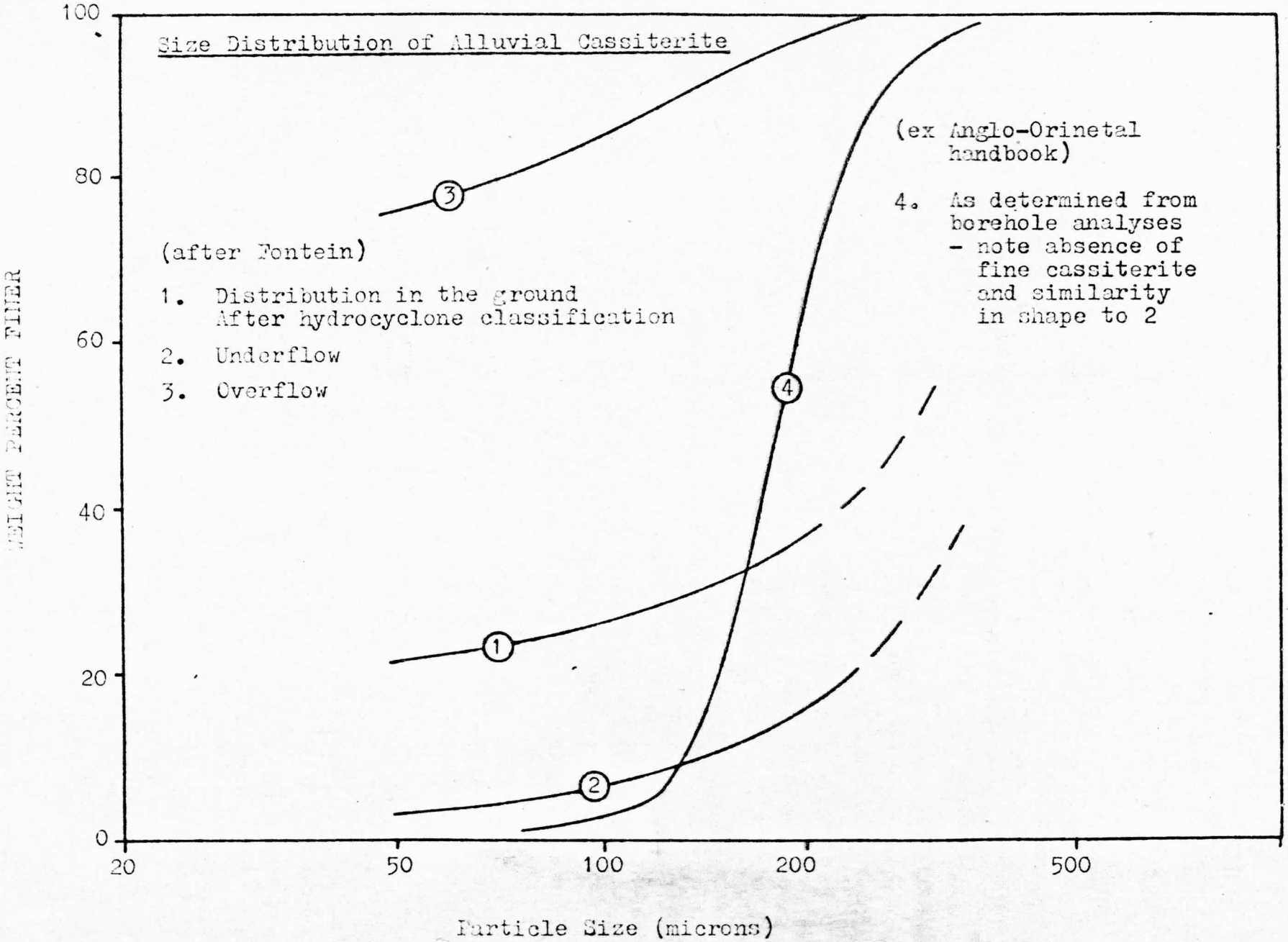
We should therefore be conscious of the probable existence of gold to very fine sizes which should be reported and characterised, even if we must distinguish it from conventionally recoverable gold.

Particle Shape

Alluvial gold tends to be flat, possibly because of the hammering it receives as it is transported. The gold in eluvial and deluvial - deposits has not been similarly flattened. The aspect ratio (projected area diameter : thickness) decreases with decreasing size. A large particle tends to remain in one piece as it is flattened. As it gets thinner small pieces tend to break off.

At around 2 mm an aspect ratio of 10:1 is typical. Tishchenko - reports a range of 1 to 22, and Kisterov a range of 1 to 10. The ratio is controlled by mode and distance from source. Kisterov claims that the particle size does not reflect the migration pattern during placer - deposition.

The flatness of a gold particle will certainly affect the manner in which it is transported and processed. Once a flat gold particle rests on a stable base (like bedrock or a shaking table) it will be much harder to re-suspend, relative to a round particle of the same mass. A flat - particle, once suspended, will however be more mobile than a round particle of the same mass. It falls with its flattened surface perpendicular to the flow, and thus tends to be carried along and buffetted by other - particles in a moving suspension. Flat gold particles therefore relative to round ones, have more difficulty penetrating through a jig bed. Thus other things being equal, the tailings from a shaking table are much less likely to contain gold than those from a jig.


Size Distribution of Alluvial Cassiterite
(after Fontein)
1. Distribution in the ground After hydrocyclone classification
2. Underflow
3. Overflow
(ex Anglo-Orinetal handbook)
4. As determined from borehole analyses - note absence of fine cassiterite and similarity in shape to 2
WEIGHT PERCENT FINER
100
80
60
40
20
0
20
50
100
200
500
Particle Size (microns)

Surface Properties

Placer gold can be coated with iron or manganese oxides, organic substance (c.f. thucolite of the Rand), etc, which prevent or make difficult amalgamation. Some circuits therefore lightly mill the gold.

Gold is naturally hydrophobic, which property alone or in conjunction with a (hydrophobic) coating prevents the particle wetting. If that particle is small enough or has a large surface area to mass ratio it may float away, despite the high density of gold.

Fineness

Placer gold is generally finer than lode gold, ranging from 500 to 999, but is isually greater than 850. The major alloying element is silver. Individual particles of the same size and at the same location can have markedly different fineness. In general fineness increases with decreasing particle size, largely due to the preferntial leaching of the alloying elements. The fineness of gold from the Witwatersrand on the other hand is remarkably consistent from one particle to another in the same deposit.

In recent months the presence of around 2% mercury has been discovered in South African gold, which hitherto has gone unnoticed. It is also suspected of being in placer gold, but it too would have gone unnoticed as mercury is used to recover the mineral.

Gold in any one placer may be derived from several different lode sources. Each lode source can have a characteristic group of minor alloying elements within the gold. Such information may assist in identifying the lode sources if known, or may assist exploration for the unknown gold source or sources (Desborough).

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