1 oro aluvial -

INCEMMET
BIENES CULTURALES
54.810 05063
INVENTARIO 1996

GESEPI S.R.L. INVENTARIO 2003

INVENTARIO 1997

SAMPLING OF ALLUVIAL GOLD DEPOSITS

(A. G. Fricker)

SAMPLING THEORY

Before embarking on the sampling of an alluvial gold deposit it is well to first consider the problems that it presents. The samples have to be chosen to represent a position in space and a relationship with space.

Parameters relevant to a position in space

- value mineral
  - concentration
  - particle size, size distribution and shape
  - distribution within the sample uniform, random, etc.
- associated mineral
  - particle size (particularly the largest size) and size distribution
  - physical characteristics (clay, sand gravel, etc)

Parameters relevant to relationship with space

- lateral dispersion
  - confined to river channels etc.
  - uniformly distributed in a flood plain etc.
- vertical dispersion
  - confined to bedrock etc.
  - presence of false bottom etc.

Most sampling theory addresses itself to selecting a suitable sample to be representative of its position in space. Most theories derive a sample size inordinately large for deposits of low grade high value minerals. Some compromise is called for and hence experience. To some extent that compromise is catered for in the next part of the programme, i.e. the distribution of values in space.

Even so some of the problems of sampling and evaluating gold alluvials have arisen through insufficient consideration of sampling theory, particularly in regard to large gold particles and small diameter drillholes.

SAMPLING METHODS

The method has to be appropriate to the stage of the investigation. The methods are :

Existing exposures
- largely reconnaissance
- can be misleading (beware old tailings)

Excavations
- hand-dug
  - freestanding and shallow - reconnaissance
  - boarded and deep - final proving stage
- machine dug
  - shallow - reconnaissance?
  - deep - final stage

Drilling
- small diameter
  - initial and/or final evaluation
  - to define physical limits of deposits as well as to collect samples.
- large diameter
  - confirmatory evaluation
  - to obtain data for selection and design of mining method.

Gold occurrences likely to lead to drift mines or hydraulic mines present sampling difficulties. Buried leads may have to be sampled from adits, shafts and cross cuts. Hydraulicking may be better evaluated from trial pits, since the costs of proving such ground may be less than - "having a go".

If the initial reconnaissance has been encouraging, the evaluation stage will normally consist of drilling. If that in turn proves a viable deposit, shafts or large diameter holes may be sunk to select and design the mining method.

DRILLING METHODS

Churn Drills	Dia (mm)	Max depth (m)
Empire or Banka	100	20
Ward	100 or 150	30
Millman Airplane Drill	100	
Keystone	190 mm shoe 150 mm casing	130

Cyclone	)	150 mm casing
Star	)	
Bucyris-Erie	) Comparable to the	
Hillman Prospector	) Keystone	

Churn drills drive a casing ahead of an internal cutting bit which is dropped from a cable. The cuttings are periodically withdrawn, replacing the cutting bit with a cylindrical pump with a klack valve. The smaller ones are manually driven in low labour cost countries using several men on an elevated platform. The larger ones are mechanically driven. All churn drills are slow and can therefore be costly. They are never-the-less the preferred type.

Because the churn drill can be costly, alternative drills have been developed, usually successfully in specific situations. The Becker hammer drill has proved itself in the eyes of at least one Alaskan placer miner (Colp) but some uncertainty exists whether it is suited for coarse gravels (Breeding). It is some five times faster than churn drilling. Rotary drills are very fast but have only been used for qualitative work, such as defining the limits of a deposit (Breeding). Bucket and auger drills are largely successful in unconsolidated material such as beach sands and loose fine gravels.

The Caldwell bucket drill has been successfully used ahead of the Keystone in Central Otago in New Zealand. An uncased 600 mm diameter Caldwell drilled to near water table was followed by a Keystone drill from the water table to basement. The Keystone cost 2.2 times more than the Caldwell on a linear basis, but admittedly the Keystone started deeper and therefore at a disadvantage. The Caldwell is suitable for semi-consolidated sands with little or no clay, but above the water table. Casing below the water table is possible but is expensive. The Caldwell is limited to about 27 metres depth even when cased.

The KLAM drill is similar to the Caldwell (Colp). Both drills have large diameters and therefore provide large samples. The bucket drills do appear to be restricted by the nature of the ground. An alternative to these is the caisson shaft. There is no doubt the BADE rig can sink a shaft from 500 to 2000 mm in diameter to a depth of 100 m or more, and is not restricted by the type of ground (Breeding). The technique proved itself in 13 m of gravel and broken rock in Nevada (Hildebrand). It was about three times more expensive than a Keystone or a linear basis, but nine times less expensive on a volume basis.

The Churn drill can be used in any type of ground, which perhaps accounts for its preference. There are other faster or larger diameter drill but which have their limitations. As drilling costs rise, improvements to reduce the cost must come, which may mean selecting a particular alternative for a particular situation, or using a combination as was used in Central Otago.

THE PROCESSING OF SAMPLES

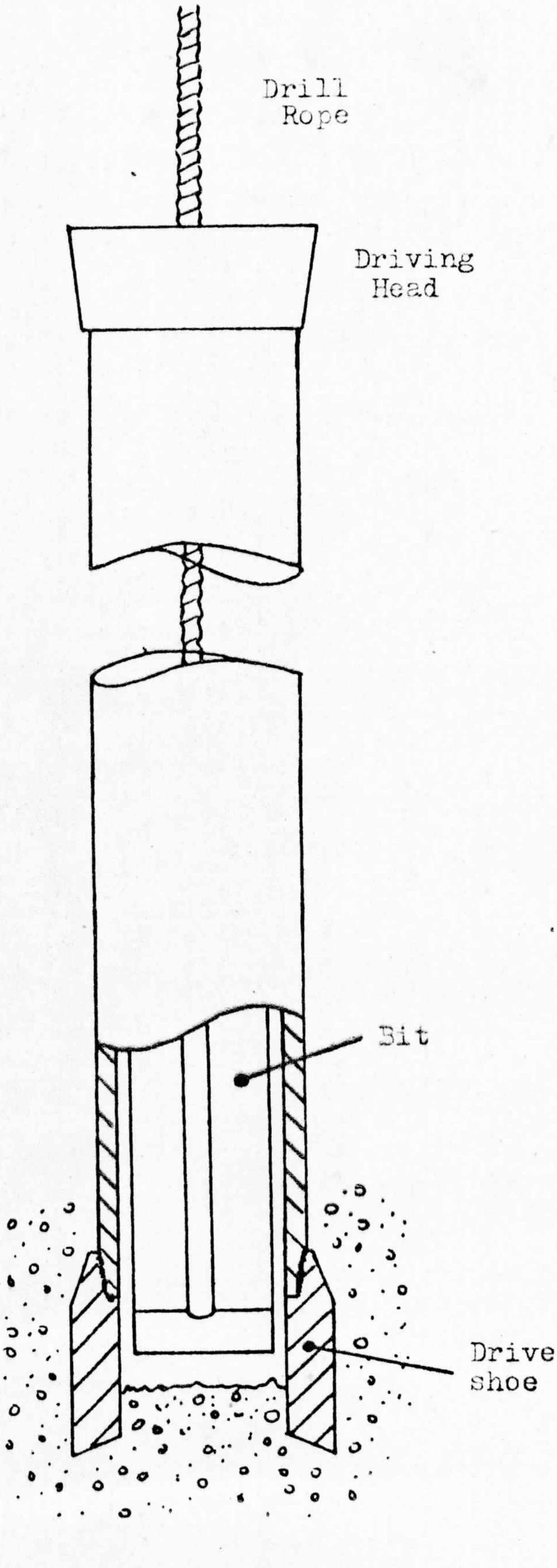
Volume Measurement

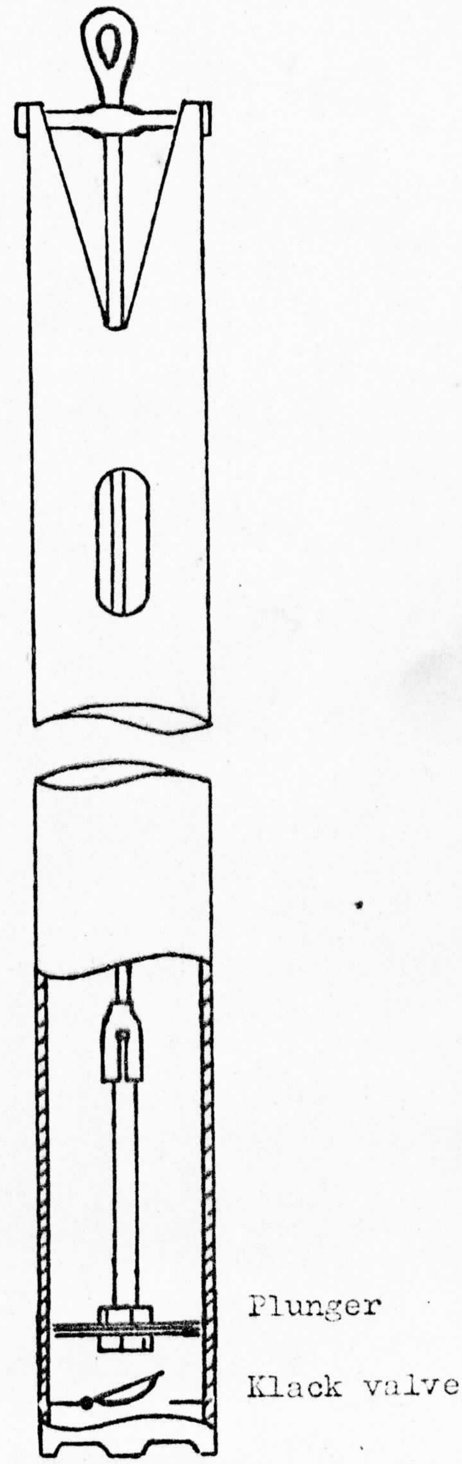
Volume from excavations, large diameter holes and shafts present no problem to measurement. Volumes from small diameter holes do. The length of drive is kept fairly short, particularly in rich ground. The actual recovered volume is compared to the theoretical volume. If the drillhole increment contains too much core, its value is down-graded. If the increment contains too little core its value is up-graded. (Some conservative engineers never upgrade).

Arriving at the theoretical volume is also a bit of an art, for it endeavours to take into account the space occupied by the casing. For instance, the standard Keystone drill has an external area of 0.0286 m^2 (0.3068 ft^2) but it is usual to reduce this to allow for shoe wear to 0.025 m^2 (0.27 ft^2) - some 12%. This is known as the Radford factor and is based on experience. (Nevertheless the cynical are bound to question the fortuity of 100 ft corresponding to 1 yd^3 of material).

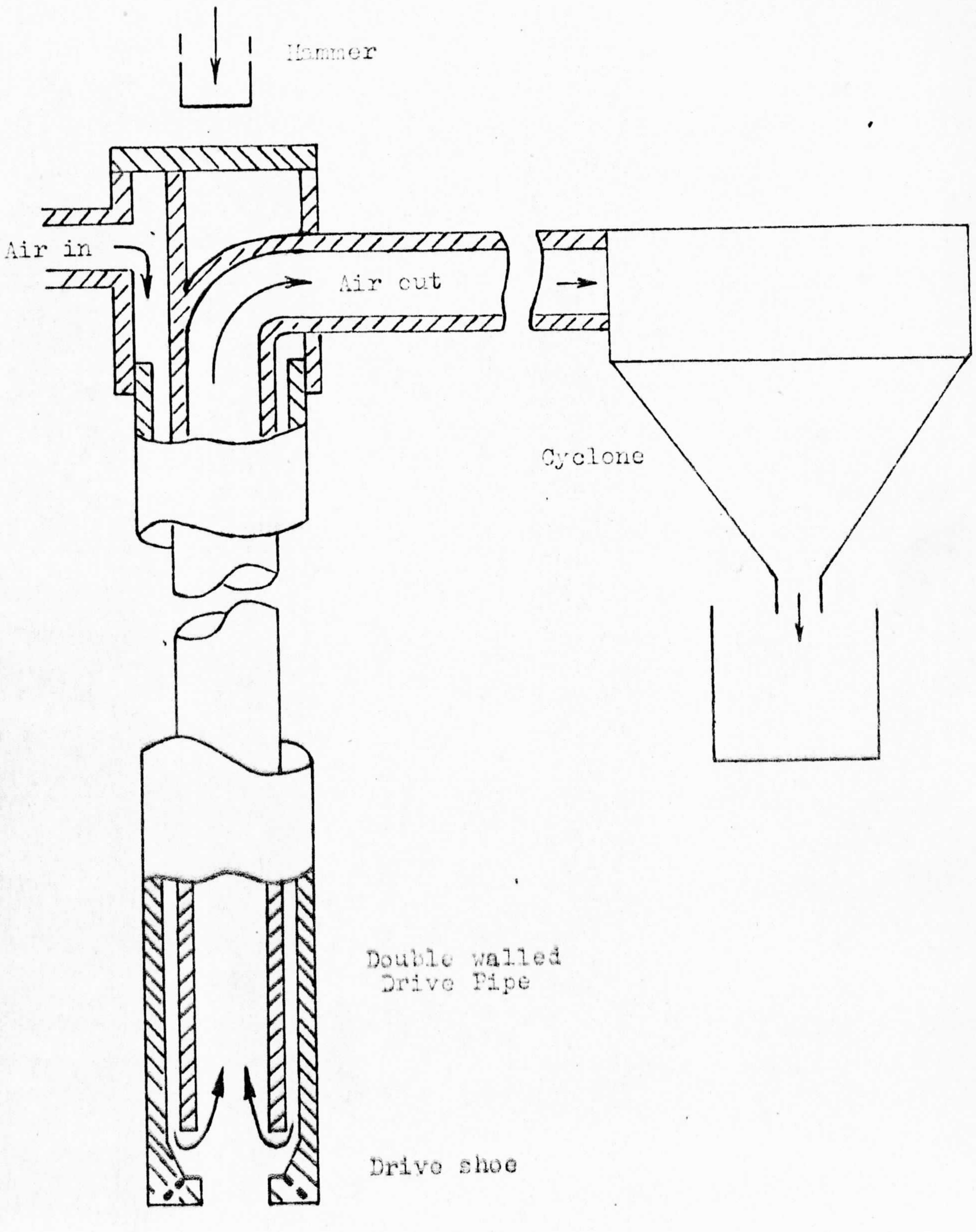
In comparing a Becker and a KLAM drill, Colp found that he had to considerably modify the shoe factor of the Becker drill for the results to correlate with the KLAM results. A shoe factor of 0.0143 m^2 had to be reduced to 0.00890 m^2 to obtain correlation. This reduction is substantial - some 37%.

KEYSTONE DRILL





PUMP


Hammer
Air in
Air out
Cyclone
Double walled
Drive Pipe
Drive shoe

Gold Measurement

The gold content is obtained by washing, screening and gravity concentration, followed by amalgamation to simulate the processes likely to recover the gold on a commercial scale.

These methods will be dealt with later but include

- panning
- the rocker or cradle
- the sluice box (2 to 4 m long by 0.2 to 0.3 m wide by 0.2 m high)
- the Denver gold saver, and the Denver mechanical gold pan
- the Pan-o-Matic
- the Kower separator

A colour count of the gold in the concentrate is first made :

a number 3 colour weighs less than 1 mg - about 0.5 mm

a number 2 colour weighs between 1 and 4 mg

a number 1 colour weighs over 4 mg - about 1 mm

Gold particles weighing over 10 mg are individually weighed and recorded.

Coarse gold is separated from the concentrate by hand, and the fine gold with mercury. The mercury is subsequently dissolved in dilute nitric acid, and residual mercury driven off at a dull red heat before weighing.

Gold determinations by assay can be erroneous and should only be made when physical separation is impractical.

COMMENTS ON THE METHODS

Small Diameter Holes

The possibility of gold preferentially migrating into or out of the core volume is real. If all the gold within 37 mm of the periphery of a Keystone drill was to be drawn into the core, the hole would be over valued by 100%.

The effect that the accidental loss or addition of a single particle of gold on the valuation of an increment of a drillhole can be quite dramatic. For example the effect of a 1 mg gold particle is 55 times greater for a 75 mm drillhole relative to a 600 mm hole.

The Measurement of Volumes

The use of correction factors when measuring is justified by placer engineers on the basis of experience and confirmatory production results. Production results do not appear to confirm their use in my opinion, as will be developed later. Indeed the factors also appear to have a retrospective element too.

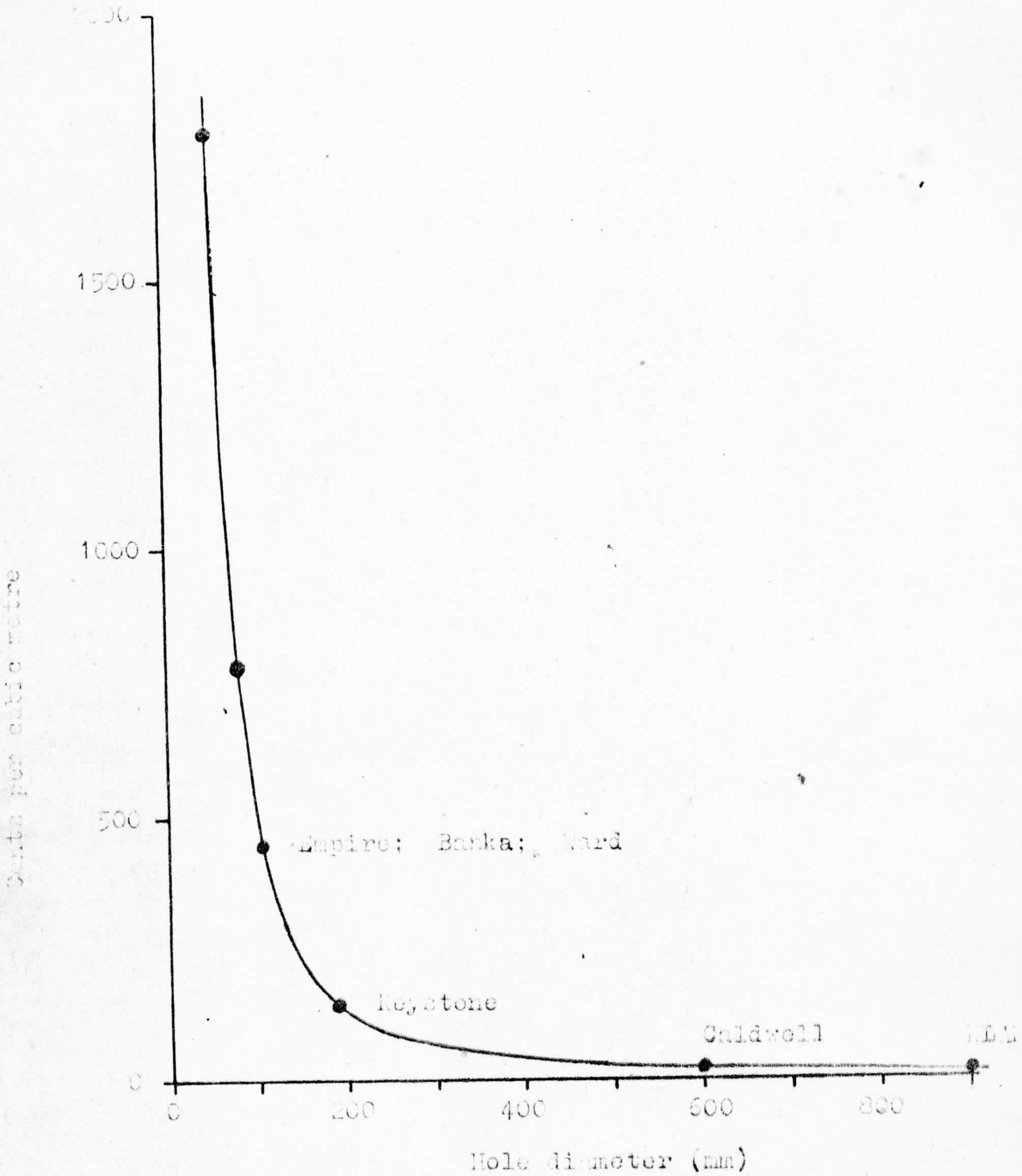
The Processing of Samples

Field processing devices should be checked for suitability and reliability each time and tailings should be reprocessed. Colp has shown that the Denver gold saver may only recover 30% of the gold if it is too fine.

My own work indicates losses of 85% on a particular increment, but which reduced to 5% for the hole.

Whereas methods to simulate commercial practice is admirable, the philosophy is self defeating. It allows no room for improvements in recovery practices. The field practice should also examine whether gold too fine for the assumed commercial processes is present and how much. Such information may present the industry with a challenge it cannot afford to ignore. Similarly other economic minerals should be searched for.

The recording of the gold in terms of colours and weight is totally inadequate. The gold should be sized far more meaningfully, and its shape and other physical characteristics should be determined. Laboratory separating procedures, such as magnetic and electrostatic separation could be used.



Effect of a 1mg gold particle accidentally lost from or added to a 0.5m increment of core from drillholes of different diameter on the valuation of that increment. (Gold at $20 per gram, $620 per ounce)

BIBLIOGRAPHY

Ottley, Gy's sampling slide rule. World Mining 1966, August 40-44.

Clifton et al, Sample size and meaningful gold analyses. USGS Prof. Paper 625 C, 1969.

Fricker, The sampling of low grade ores of high value minerals (unpublished).

Wells, Placer examination: principles and practice. US Dept. Int., Bur. of Land Management, Tech. Bull. 4, 1969.

Breeding, The evaluation of placer deposits. Course on Placer Explorat_ ion and Mining, Nevada 1976.

Colp, A placer gold evaluation technique comparison between Becker and KLAM drill. Course on Placer Exploration and Mining, Nevada 1976.

Hildebrand, New technique enhances the art of bulk sampling of placer deposits. Eng. Min. J. 1976, July, 76-78.

Fricker, The evaluation and processing of alluvial cassiterite and gold deposits. DSIR Chemistry Division, report 5609, 1976.