

### 11: Froth floatation – 1930s research in Idaho and USSR

Froth floatation of gold is possible due to gold's surface hydrophobicity – “the antithesis of gravity concentration” [27] and therefore froth floatation can recover up to 100% of very fine to moderately fine gold (<150μ), much the same as cyanide leaching.

The first paper on froth floatation of gold appeared as late as 1914 [49]. Today froth floatation is a widely used method for recovering many types of minerals including gold, platinum, chromite, flourspar and coal.

Regarding placer gold, deterrents are the cost of reagents, the need to recycle effluent and the challenge of floating placer gold due its depressed hydrophobicity, buoyancy and floatability due to impurities and coatings. But placer gold is often irregular in shape (due to natural leaching) – even porous – and is often remarkably flat, and paradoxically it is these factors that make gravitational settling difficult yet froth floatation easier.

#### Operation

For placer ore, the process is most appropriate to gold recovery from fine tailings or from concentrate.

The feed consists of finely milled hardrock ore, or else fine tailings or placer concentrate.

Slurry is made by adding water, and fed continuously into a floatation tank.

In the floatation tank, the slurry is agitated and air bubbles injected. The gold particles attach themselves to the meniscus of the rising bubbles. This is due to gold being hydrophobic – and by selectively enhancing this tendency by adding chemicals known as ‘collectors’; by controlling the collectors using ‘conditioners’; by stimulating wetting by ‘wetting agents’; by stimulating frothing by ‘frothing agents’ and by controlling pH.

The resulting froth is then removed and the gold recovered by either gravity settling or chemical means.

#### Adoption by placer gold miners

In 1916 Lang suggested that the platy shape of placer gold in black sand of the Pacific Coast of North America should make it amenable to recovery by floatation [50]. The first research report on placer gold floatation was by Arthur Fahrenwald in 1933 [51] and 1937 saw publication of floatation recovery of placer gold on Idaho gold dredges [3,52]. Reagents were amyl xanthate and Aerofloat-15 plus either pine oil or cresylic acid frother. Gold recoveries were 47-76% – the less slimes then the better the floatation [3]. Contemporary tests in the Soviet Union with similar reagents on clean-up tailings and <150μ fraction of placer ores yielded 75-90% recovery at concentration ratios of 25:1 to 42:1 [3,53,54].

Research resumed in the 1970s in China [27] where 78-99% recovery was attained with rougher concentration ratios of several hundred [3].

Floatation tests of Soviet Union coastal marine sands achieved 70-100% recovery of 75-125μ gold [2,27]. A graph by Wang and Poling shows >95% recovery was possible for “coastal type gold” <150μ with a retention time of 15 minutes, and 100% recovery possible for <120μ with a retention time of only 5 minutes.

The Soviet Union appears to have operated the world's only full-scale floatation circuit for placer gold, a six-cell floatation circuit in the 1930s that scavenged both ‘fine’ and ‘minute’ gold from gravity tailings aboard a bucket-line dredge [2,27]. It processed 300 tons of solids per day and although the gold recovery was “satisfactory” the floatation circuit was deemed uneconomic at the then prevailing low gold price.

Today, froth floatation is a neglected method for recovering placer gold and the author is unaware of any commercial placer operations using this method.

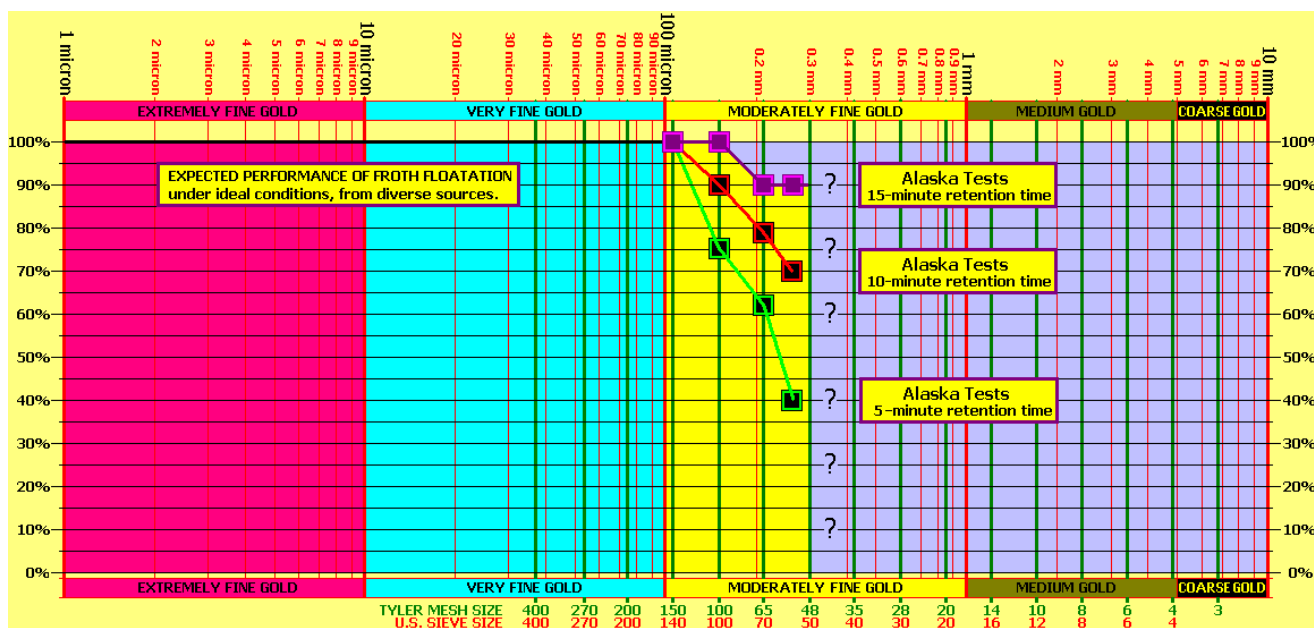


Figure 27. GOLD RECOVERY BY FROTH FLOATATION  
Froth floatation can separate >90% of gold <150μ, but is too slow for leaching >300μ gold. (compiler: Robin Grayson)