

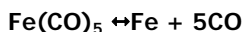
34: Magnetic coated gold – 1980s research in Colorado

A rather unexpected way to recover placer gold is, having first removed magnetite and other magnetic minerals to then selectively make the gold particles magnetic and remove them by magnetic means.

James K. Kindig and Ronald L. Turner of Golden, Colorado gained patents in clean coal technology having discovered that by warming coal with iron carbonyl vapour the pyrite became magnetic and could then be removed more easily (US #3,938,966 and #4,175,924).

Kindig and Turner then adapted the method for placer gold with good results and they were awarded a patent in 1980 (US #4,229,209) and assigned it to Hazen Research Inc. First they removed the magnetite and suchlike using magnetic separators. Next they put the non-magnetic placer into a rotating kiln with iron carbonyl vapour in an inert nitrogen atmosphere. Important variables include the temperature, pressure, type of carbonyl used, gas composition etc.

The iron carbonyl selectively attaches itself to the gold particles and decomposes to make a magnetic coat of iron for the gold particles.



Iron carbonyl $\text{Fe}(\text{CO})_5$ is a straw-yellow liquid that is cheap, but unfortunately it requires special precautions as it is not only flammable but is also toxic if inhaled.

The inventors recovered 93.3% of placer gold from Clear Creek, Colorado; then 76.5-93.3% of placer gold from the Vulture placer in Arizona, and later on their tests were getting 99.98% gold recovery.

Of interest is that the Kindig and Turner method requires no water at all, making it of potential value in enabling large-scale placer gold recovery in arid regions. However, the method has not been tested on gold <100µ and therefore further research is warranted.

Operation

This text is based on the Kindig and Turner method presented in US patent #4,229,209.

Iron carbonyl liquid is sourced from specialist suppliers and stringent precautions are applied during transport, storage and use regarding risk of fire and risk of acute poisoning.

The placer ore is either dry-screened or else wet-screened and then dried. Magnetic minerals are removed as fully as possible.

The dry non-magnetic fraction is fed to a rotating kiln serving as a reaction vessel to bring the material into direct contact with iron carbonyl vapours in the presence of a gas such as nitrogen that is inert to the reaction.

The objective is to cause the decomposition of the iron carbonyl to form a magnetic skin on the gold particles but not on the other particles present. Typically about 0.5 to 4 kilos of carbonyl are added per ton of feed.

Generally a reaction time of from half an hour to an hour is adequate, at 110-130°C. The higher the temperature the more complete is the gold recovery, but at higher temperatures the iron carbonyl is liable to coat other minerals beside gold particles.

After the treatment, the magnetic coated gold is removed by dry magnetic separators such as a low to medium separator with a magnetic drum having field strengths of up to about 2,500 gauss, electromagnetic drum separators up to about 7,000 gauss or induced roll separators up to about 11,000 gauss.

Adoption by placer gold miners

This 'making gold magnetic' process unsuitable for artisanal miners, but seems to have merit for large-scale placer mining operations – particularly in dry deserts as the process requires no water.

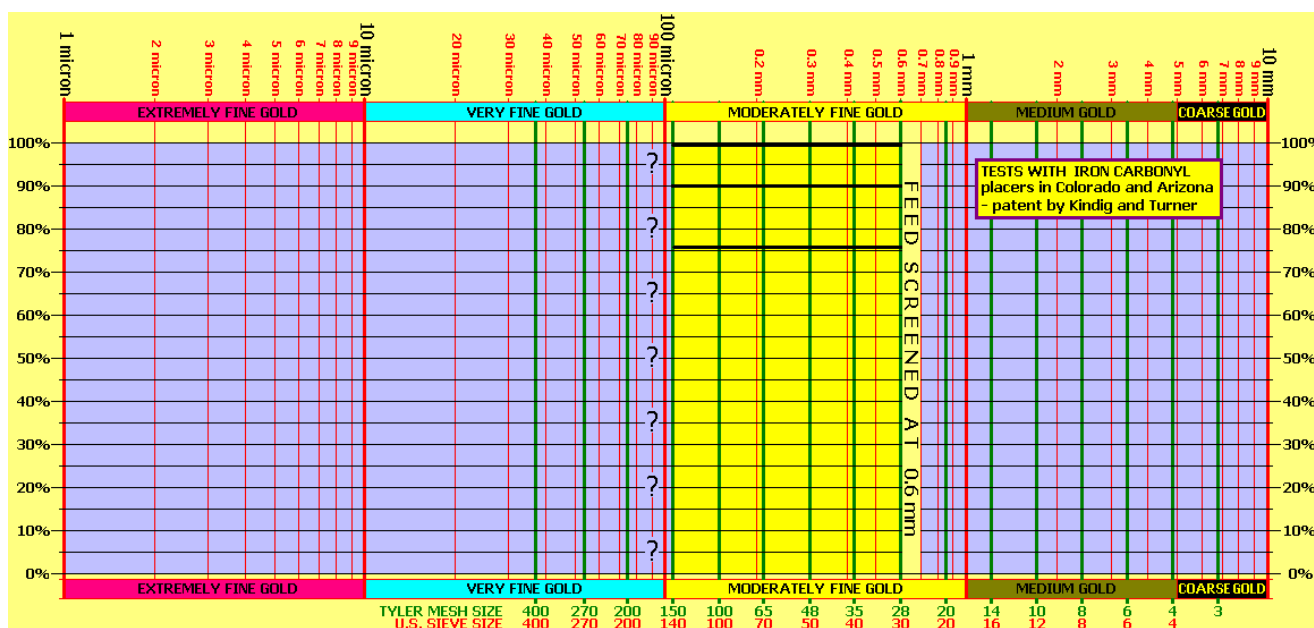


Figure 71. GOLD RECOVERY BY MAGNETIC COATING GOLD PARTICLES
 Recovery of placer gold by the iron carbonyl method according to the original patent. (compiler: Robin Grayson)