Consulting Analytical Chemists and Geochemists

AN ILLUSTRATION OF THE EFFECT OF SINGLE GOLD GRAIN ON THE GRADE OF A 50- AND 100-GRAM ASSAY SAMPLE

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ABSTRACT

Gold is particularly prone to a nugget effect, making the collection of representative samples of gold ores, tailings and treated materials difficult to obtain. In a hypothetical situation it was demonstrated by way of calculation that an assay sample of 0.15 g/t contaminated by a rogue gold particle of 45 µm would significantly add to the grade of the sample.

1 Introduction

1.1 Sampling

Gold is particularly prone to a nugget effect (Carrasco, 2010), making the collection of representative samples of gold ores, tailings and treated materials difficult to obtain. Therefore, it is imperative in any sampling situation, that best practices are applied so that samples taken are similar in particle distribution to the main bulk. This should be done in such a manner that the gold composition and its distribution is representative of the larger amount but also to any sub-sample taken.

1.2 Milling of Samples

Gold is metallic and malleable and is practically impossible to pulverise. If milled incorrectly, or over milled, it is smeared forming small platelets which is a worse scenario, than if it had been under-milled.

The acceptable particle size values to which gold bearing materials should be milled vary in the literature. Lenahan & Murray-Smith (1986) states that particle size for fire assay of gold ores should be 85 % passing 150 µm. ASTM E 1568-03 recommends a value of 90% passing 150 µm for gold in activated carbon. For platinum group metal ores (including gold), a criterion of 90% passing 75 µm is used. To produce gold ore CRMs, AMIS requires candidate material to be milled and air-classified to 95% passing 54 µm. An assay laboratory may choose a larger particle size if there is no confidence in their ability to achieve 75 µm without making matters worse, in which case a 100 to 150-gram assay sample is recommended.

The factors that affect the split accuracy is the mass of the sample, sample top size, intensity of vibrations and speed of splitter cups. Therefore, the higher the top size the larger the sample mass required in order to obtain an accurate split. Large assay portions (100 to 150 g) do minimise sampling uncertainty and multiple replicates (minimum of duplicate) increase confidence in results.

2 Effect of Gold Nugget Contamination

2.1 Mass of Gold Particle

Assuming that a particle of gold is spherical with a diameter of 45 µm, and having a purity of 100 %, the mass of such a particle would be:

$$Volume\ of\ sphere(cm^3) = \frac{4}{3}\pi r^3$$

$$Volume\ of\ sphere(cm^3) = \frac{4}{3}\ x\ 3.14\ x\ 0.00225\ cm^3$$

$$Volume\ of\ sphere(cm^3) = \ 4.7678\ x\ 10^{-8} cm^3$$

$$Density\ of\ gold\ x\ Volume\ of\ gold\ sphere\ = mass\ of\ gold\ sphere$$

$$19.391\ g/cm^3 x\ \ 4.7678\ x\ 10^{-8} cm^3 = 9.201\ x\ 10^{-7}\ g$$

$$Therefore\ a\ gold\ particle\ of\ 45\ \mu m\ would\ weigh\ 9.201\ x\ 10^{-7}\ g$$

2.2 100 Gram Assay Sample at 0.15 g/t

For a 100 g assay sample of 0.15 g/t of gold, the mass of gold in 100 g is 0.000015 g:

$$Gold\ (g)\ in\ 100\ g = \frac{0.15\ x\ 0.001}{10} = 0.00015\ g$$

If the sample becomes contaminated by a single particle of gold of 45 µm, this will add to the existing gold mass of 0.00015 g, *i.e.*, $1.5\ x\ \ 10^{-4}\ +\ 9.201\ x\ 10^{-7}\ g$ = $2.4201\ x\ 10^{-5}\ g$.

Therefore, the increase in the grade of the assay sample will be:

$$2.4201\ x\ 10^{-5}\ g \text{ in 100 g}$$

Converting to g/t:

$$2.4201\ x\ 10^{-5}\ g\ x\ 10\ 000 = 0.24\ g/t$$

Therefore, the unintentional introduction of a 45 µm gold particle into a 100 g assay sample through sample carry-over as a single nugget, increases the grade by 0.09 g/t or a 60% increase!

2.3 50 Gram Assay Sample at 0.15 g/t

The unintentional introduction of a 45 µm gold particle into a 50 g assay sample through sample carry-over as a single nugget, increases the grade to 0.18 g/t, a 120% increase!

3 Conclusion

It was demonstrated by way of calculation that an assay sample of 0.15 g/t contaminated by a rogue gold particle of 45 µm would significantly add to the grade of the sample.

REFERENCES

ASTM Standard Test Method for the Determination of Gold in Activated Carbon by Fire Assay. ASTM E 1568: 2003 – R 2008. Assay Gravimetry. American Society for Testing and Materials. 01-11-2008.

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