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Developing a Commercial Facility for Rapid Assay of Gold and other Elements in Mineral Ores Using Gamma Activation Analysis

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The global mining industry relies on elemental analysis throughout their value chain. The development of near real-time analysis techniques such as on-stream and hand-held X-ray fluorescence allows assay data to be used for process control and optimisation.

Unfortunately, current methods have insufficient sensitivity to measure metals such as gold, which are mined at concentrations of a few parts-per-million (ppm) or less. Gold is currently measured commercially using the process of fire-assay, a laborious, time-consuming, manually intensive and hazardous process. Extensive sample preparation requirements mean that analysis turn-around times are typically at least 24 hours, precluding the use of the results for control purposes.

We have been developing gamma activation analysis (GAA) as an alternative approach. GAA mimics the more conventional neutron activation analysis (NAA), using a high-intensity radiation source to activate target elements in samples, and then measuring characteristic gamma-rays emitted from activated radioisotopes. Unlike the nuclear reactor commonly required for NAA however, GAA uses a high-energy X-ray beam produced using an electron accelerator.

GAA is particularly well-suited to the analysis of gold via excitation of the 409 keV, 7.73 s half-life meta-state of 197Au. The short half-life of the meta-state, and the fact that it can be excited using X-rays with energies below the activation thresholds of major rock-forming elements, make the method particularly rapid and sensitive. Notwithstanding these potential benefits, the GAA method has found only very limited commercial application, with only one industrial facility operating worldwide to our knowledge.

In this paper we report developments in several areas:

• Our work to better understand the physics of GAA and significantly improve sensitivity and accuracy. We demonstrate how a novel correction method allows accuracies of better than 1-3% to be achieved (figure 1).

• Optimisation of a practical system for round-the-clock commercial operations, including design of the X-ray source, shielding, detector systems, and automated sample handling.

• Safety and regulatory approval. We discuss the development and use of advanced Monte Carlo software tools for shielding design and evaluation of residual activity.

• A profitable facility model and effective industry engagement strategy. We report on experiences setting up our first commercial GAA facility and our strategy for engaging with industry partners and customers to build acceptance of a new analysis method.

• Planning for a containerised GAA facility, suitable for rapid deployment on mining and mineral processing sites to facilitate provision of near real-time analysis data.

The new facility is currently in the advanced planning stage and is scheduled to start operations in mid-2017.

[Figure 1 goes here]

Caption: Comparison of GAA and lab grades for a large suite of gold samples; results for samples below 3 ppm gold (linear scale, left-hand plot) and all samples (log scale, right-hand plot).

Country/Organization invited to participate

Australia

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