INDUSTRIAL PHOTONUCLEAR PHYSICS: ASSAY OF GOLD AND OTHER ELEMENTS IN MINERAL ORES USING GAMMA ACTIVATION ANALYSIS

James Tickner[1], Chanel Tissot[1] and Justin Delaney[1,2]
[1]Commonwealth Scientific and Industrial Research Organisation, Australia
[2]University of Wollongong, Australia

Gamma activation analysis (GAA) relies on the production and detection of selected radionuclei using photonuclear reactions. In particular, the excitation of isomeric states using Bremsstrahlung produced from a high-power electron linear accelerator provides an effective method for measuring a number of commercially important metals. The formation and decay of the 409 keV ($t_{1/2}$ = 7.73 s) isomeric state of ^{197}Au allows gold to be rapidly and non-destructively measured in bulk mineral samples.

We describe a facility, currently under construction, that will provide a commercial assay service to mining and mineral processing companies with an anticipated throughput of at least 300,000 samples per year. We discuss advances in the GAA method that lower detection limits for gold to the low parts-per-billion range, and improve absolute analysis accuracy to better than 1-2%.

Achieving high accuracy in a fully automated facility relies on being able to correct for source and detector instability, sample positioning errors and matrix effects. These corrections rely on a detailed physical model of the isomeric photoactivation process.

We present results that disagree with the common model for isomeric excitation, namely strongly resonant absorption of incident photons via a small number of ‘gateway levels’ with subsequent cascade decay to the isomeric state. Instead, a quasi-continuum model of excitation via a very large number of weak gateway levels is favoured.

These results have important practical benefits in better understanding the consequences of source instability and ore particle size on analysis accuracy.