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A New LA-ICP-MS Approach to Quantifying Variable Gold Deportment within Pyrite for Complex Orebodies

Angela J. Escolme, Leonid V. Danyushevsky
CODES - University of Tasmania, Sandy Bay, TAS, Australia

Variable Au content in pyrites from complex orebodies presents opportunities for mineral processing optimization. In this study we establish a routine method for laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) analysis of pyrite to quantify the proportion of pyrite with high Au and the distribution of Au within pyrite grains (e.g., high Au-bearing pyrite rims) in mineral processing samples.

Pyrite can host a wide range of trace elements, including Au, in variable concentrations reflecting formation temperature, absorption properties, grain size, fluid composition, and availability of Fe and/or S. In overprinted porphyry systems, pyrite grains may reflect a complex history of pyrite precipitation and dissolution under changing conditions. As a result, the Au content of pyrite may be highly variable both between grains and within individual grains. Three end members are recognized, early porphyry-stage pyrite with low Au, late epithermal-stage pyrite with high Au, and composite pyrite grains with low-Au cores and high-Au rims (Sykora, 2018). This phenomenon provides opportunities to optimize mineral processing for refractory Au if the distribution of Au in pyrite can be quantified at various stages of mineral processing.

We present a new method for routine LA-ICP-MS analysis of pyrite in order to quantify variable Au deportment in pyrite using a case study of crushed and size-sorted samples from mineral processing samples from an overprinted porphyry system. In this method, two perpendicular ablation lines are run from core to rim on each pyrite grain/fragment using a 4-µm beam, moving at 3 µm/sec, firing at 20 Hz with a resulting in the line depth of ~2.5 µm. The ICP-MS signals for Fe (2 ms), As (5 ms), and Au (20 ms) were measured with a total sweep time of 37 ms. Line data was interpreted assuming a simple cuboid model to estimate the volume of Au-rich pyrite and low-Au pyrite as well as the proportion of Au contained in outer rims of pyrite.

Results were validated against diagnostic leach data for each size fraction. Data sets collected using the method described were interrogated for the following information: a) pyrite grain/fragment size, b) presence of Au-rich rims, c) Au concentration in high-Au pyrite, c) thickness of Au-rich rims, and d) variability in all the former by size fraction. We propose that this method can be applied to assess the characteristics of ore feed as well as gauge processing efficiencies in the treatment of refractory Au in pyrite and could be adapted to rapidly review the deportment of critical metals (e.g., Co, Te) in pyrite in crushed materials.