Mapping Speciation and Trace Metal Content of Gold-Bearing Pyrites at the Dome Mine: Mine- to Micron scale Characterization of Whole Rock Samples using Synchrotron X-ray Spectroscopy

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Synchrotron micro X-ray fluorescence (μXRF) provides quick and effective micron scale, quantitative trace element analysis and mapping of minerals with ppm detection limits. Additionally, speciation of trace elements and gold can be probed using X-ray absorption near-edge structure (XANES) spectroscopy. This provides critical insights into trace element associations within ore minerals. The historic Dome mine in Timmins, Ontario has produced over 16 million ounces of gold to date, of which ~20% has been mined from its massive ankerite veins. These veins represent the earliest stage of mineralization at the deposit, and are overprinted by main stage veining. Gold is intimately related to pyrite mineralization, as inclusions, fracture fill, as well as nanoparticles and/or in the pyrite crystal lattice. Cut slabs from hand samples and drill core, as well as thin sections and their corresponding offcuts have been mapped in their entirety at 20μm resolution. This provided unprecedented contextual trace element information which can be tied to mineralogy; something lacking in conventional bulk rock analysis. In addition, it aided the selection of pyrite grains and samples for higher resolution μXRF and XANES analysis (<5μm). μXRF mapping has identified multiple generations of gold mineralization with variable trace element associations and gold content, representing at least 3 distinct fluid events. Using the fundamental parameters based spectral deconvolution (fitting) and dynamic analysis capabilities of GeoPIXE™, quantitative composition analysis for individual samples and mineral grains (including gold) was ascertained. In addition, large mineralized regions were mapped using XANES to identify variability and correlations in As and Au speciation. This information provides a new framework for investigating mineralizing fluids, fluid evolution, and depositional mechanisms. Samples do not require extensive preparation or characterization prior to analysis, only a good understanding of their geologic context, and a relatively smooth surface. This represents a paradigm shift in the application of high resolution analysis for exploration. The trace element information gained from synchrotron X-ray spectroscopy can be applied to the development of trace element exploration vectors, and provides valuable information on local redox conditions responsible for mineralization.