Trace Element Content and Speciation in Gold-bearing Pyrite Grains: Characterizing "Invisible" Gold and Redox Conditions in the Dome Mine Ankerite Veins, Timmins, Ontario

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The Dome mine, located in the prolific Porcupine gold camp of the Abitibi Greenstone belt is characterized by multiple generations of gold mineralization of which the youngest is a unique set of massive 2,679-2,960 Ma ankerite veins. These veins were subject to multiple mineralization events, and have been subsequently overprinted by later main stage quartz veining and mineralization. Gold is primarily hosted within or associated with pyrite as inclusions, along grain boundaries and fractures, and as "invisible" gold. Characterizing the associations between trace metals and gold, as well as the nature of the invisible gold and trace metal speciation is integral to understanding mineralization history of the ankerite veins. Synchrotron X-ray spectroscopy has been used to characterize the trace element content of a suite of gold bearing pyrite grains from these veins. Using a synchrotron X-ray source provides unprecedented collection speeds and spatial resolution with low detection limits. Both micro X-ray fluorescence (uXRF) (mapping and point analysis) and X-ray absorption near edge structure (XANES) spectral data were collected at the Canadian Light Source, Advanced Photon Source and Cornell High Energy Synchrotron Source. Additionally, secondary ion mass spectrometry (SIMS) and high-resolution transmission electron microscopy (HRTEM) were used to better constrain the nature of the "invisible" gold. Multiple generations of gold mineralization have been identified with variable trace element associations, and in general, gold content as "invisible" gold correlates with pyrite As content. The speciation of Cu, Ni, Au and As have been characterized and variability is seen in As speciation within the growth haloes of individual grains. "Invisible" gold occurs both as metallic gold nanoparticles in pyrite grains as well as bound in the crystal lattice of arsenopyrite inclusions. This information provides insights into fluid evolution and mineralization history at the Dome mine and is contributing to a better understanding of early gold mineralization in the Timmins camp.