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The Importance of Bi-Te Nanoparticles in the Remobilization of Polymetallic (Au-Ag-Te-Bi) Orogenic Gold Mineralization

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Recent petrographic and microthermometric observations in orogenic gold systems imply that low-melting-point chalcophile elements can co-exist in the form of liquid-polymetallic Au-Ag-Te-Bi-melt-droplets with hydrothermal fluids to temperatures down to 135°C. These melts can efficiently scavenge Au from Au-undersaturated fluids through adsorption-reduction mechanisms along the polymetallic droplet-surface-area and, on further cooling, form Au-Ag-Te-Bi-minerals, visible as solid inclusions in pyrite, observed in various orogenic gold districts. Orogenic gold deposits commonly experience multiple hydrothermal events, which have the potential to remobilize polymetallic inclusions. However, their remobilization potential, mode of transport and chemical evolution remain elusive. Orogenic gold mineralization in the Abitibi (Canada) is distributed along the E-W striking Larder-Lake-Cadillac-fault-zone and hosted in lower-order structures that cut volcanic rocks and intrusions of the greenstone belt. These lower-order structures comprise brittle-ductile reverse shear zones and sub-horizontal tension veins, composed of quartz-tourmaline-carbonate. The shear-zones record two hydrothermal events 1) at ~2643 Ma, introducing the majority of gold as native Au and Au-Ag-Te-Bi-inclusions within pyrite; 2) a younger event at ~2607 Ma replaces sulfides and precipitates carbonate-chalcopyrite-native Au and carbonate-Au-Ag-Te-Bi-phases in pyrite fractures.

Here, we investigate the mineral-scale gold distribution of the Goldex deposit (Abitibi) by examining the potential of Au-Ag-Te-Bi-remobilization from pyrite-hosted, µm- to nm-sized polymetallic inclusions into texturally late sulfide fractures. Preliminary transmission electron microscopy (TEM) and nano-scale energy dispersive spectroscopy of two foils, extracted from texturally late pyrite fractures, hosting calcite-Au-Ag-Te-Bi-assemblages, reveal that infill of amorphous carbon forms layers, <300 µm-thick, at the interface between Te-Bi-phases, adjacent Au, calcite and pyrite host. The amorphous carbon phase contains sub-angular to rounded inclusions of Te-Bi nanoparticles between 10 to 50 nm. This suggests that late, reduced hydrothermal fluids dissolved pyrite-hosted Au-Ag-Te-Bi-inclusions and were remobilized along pyrite fractures. Our data imply that naturally occurring Te-Bi nanoparticles play a crucial role during the hydrothermal remobilization of already-present Au-Ag-Te-Bi-inclusions.