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Orogenic Gold Grain Coarsening from Colloidal Precursor by Ostwald Ripening

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The growth of large gold grains within a hydrothermal ore forming system is difficult to reconcile with the relatively low solubility of gold in most crustal fluids. The presence of gold colloids within the hydrothermal fluid can help to explain this dilemma. Several workers have demonstrated the presence of colloid-sized gold in vein material from both epithermal and orogenic gold forming systems. However, the mechanisms by which these colloids overcome their electrostatic repulsion to coalesce and form large grains remain incompletely understood. A recent sampling campaign in a tectonically late and highly auriferous black quartz vein in the Archean Barberton greenstone belt has unveiled unique gold textures comprising a dispersion of gold-silver colloids and nanoparticles in close association with coarse gold grains. These coarse gold grains were liberated using a non-destructive SELFRAG sample preparation technique, and the colloidal gold was imaged using high-resolution scanning electron microscopy. The observed individual gold spheroids range in diameter between < 5 nm and > 1 μm, and some of the best-preserved spheroids are found in association with micrometer-scale botryoids and conical protrusions growing from the adjacent coarse gold grain surface. Raman spectroscopy revealed the presence of both graphitic carbon and amorphous shungite carbon in association with these gold textures. Based on these results, we suggest that a viscous hydrocarbon phase was instrumental during the transient stages of gold grain growth, which occurred by an Ostwald ripening mechanism. Arrestation of the Ostwald ripening process, due to increasing viscosity of the hydrocarbon phase, resulted in a ‘freezing in’ and fortuitous preservation of the observed spheroids and protrusions. This novel mechanism for gold grain growth may serve as one explanation for the formation of anomalously gold-enriched ore shoots in some hypogene gold deposits (i.e., those running at 100s of ppm Au).