Nanoparticles and Gold Deposit Formation

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Gold concentrations in gold deposits are several orders of magnitude higher than in aqueous ore-forming fluids, and five orders of magnitude higher than in typical crustal rocks. Gold deposit formation therefore requires concentration of gold from large volumes of fluid or rock at some point during transport or deposition. Microstructural analysis of alteration around gold grains increasingly shows that the alteration intimately associated with gold is incompatible with large fluid volumes. Nanoparticulate suspensions, or colloids, present an alternative transport medium to the aqueous ionic gold complexes that are typically considered to have formed gold deposits. Whilst colloidal transport of gold and silica is observed in epithermal gold systems, and nanoparticulate gold is present in most deposit types, colloidal transport is rarely considered in orogenic gold systems. We present the first direct evidence that large, high economic grade, orogenic gold deposits form from gold nanoparticles.

Electron backscatter diffraction (EBSD) of gold grain aggregates from Plutonic Gold Mine shows micron-scale domains of orientation variation within the grains. These domains are comprised of 100 nm nanoparticles of gold that have a strong crystallographic preferred orientation. In between the gold nanoparticles are zoned nanoparticles of platinum-iron alloy. The large gold aggregates also contain 10 micron-scale inclusions of euhedral calcium-aluminium silicate. Nanoscale chemical maps show that the inclusions contain silica and gold nanoparticles The silica and gold nanoparticles in the silicate inclusions indicate that the two phases were transported together with the silica stabilised colloids stable at temperatures in excess of 350°C. Given the large quantities of gold that can be transported in relatively small volumes of colloid, this result means that fluid fluxes and formation timescales of orogenic gold deposits may be greatly overestimated.