Colloidal Processes in the Formation of Bonanza-Grade Gold Ores

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The idea that colloids may play a role in the formation of naturally occurring solids is two hundred years old and can be traced back to the great German mineralogist, August Breithaupt. By the early 20th century, textures described as botryoidal, reniform and mammillary were widely considered to be the results of colloidal processes, and grouped under the term colloform in recognition of their colloidal origin. The hypothesis of colloidal ore formation was widely embraced to explain the genesis of a variety of mineral deposits, including many epithermal gold deposits. In a landmark paper, however, Roedder (1968) provided compelling evidence that colloform ores are not the products of colloids but instead grow "directly as minute druses of continuously euhedral crystals projecting into an ore fluid". Since then, the idea that colloidal processes may play a role in ore genesis has received only limited attention.

Although epithermal gold ore formation is generally attributed to direct deposition of the gold in crystalline form as a result of the saturation of the ore fluid, the very low concentration of gold raises the question of how it is possible to form bonanza-type gold ores. In some deposits, centimetre-thick gold veins extending for metres are observed. This is the case for the Brucejack gold deposit, B.C., Canada. Here we describe textures from this deposit, which provide little doubt that colloidal processes played a central role in ore formation. Images are presented showing spherical 1 to 5 nm gold particles embedded in a cryptocrystalline matrix of carbonate and silica. In places, these nanoparticles have coagulated to form larger particles containing hundreds of nano-particles. Finally, the margins of adjacent gold masses are observed to comprise nano-particulate gold partially crystallised to massive monocrystalline gold.

A model is proposed, in which the gold deposited as nano-particles owing to an unusually high degree of boiling-induced supersaturation of the fluid. These particles flocculated due to fluctuations in pH, producing larger particles that were mechanically transported into narrow fractures, which they blocked and, with the aid of boiling-promoted seismic pumping, transformed into veins of gold.