Gold grain structure and chemistry: Relics of biogeochemical processes

J. SHUSTER[1]*, F. REITH[23] AND G. SOUTHAM[1]

[1]The University of Queensland, St. Lucia, Queensland 4072, Australia (*correspondence: j.shuster@uq.edu.au)
[2]The University of Adelaide, Adelaide, South Australia 5005, Australia
[3]CSIRO Land and Water, Contaminant Chemistry and Ecotoxicology, Glen Osmond, South Australia 5064, Australia

The structure and chemistry of gold grains represents the dynamic balance between the dissolution and reprecipitation, i.e., cycling, of gold. Under near-surface environmental conditions, these processes are catalysed by the biosphere and result in the formation of nanometer- to micrometer-size particles including colloids, bacteriomorphic and isotropic structures. Accumulation of these secondary gold structures can contribute to the 'growth' of grains while dispersion can result in the loss of gold to the surrounding environment. Using an experimental system to represent a simplified weathering environment, we have demonstrated that gold grains can be liberated from a gold-bearing, polymetalic sulphide via oxidation catalysed by an acidic, iron-oxidising bacterial consortium. These 'synthesized' grains contained characteristic structures that were similar to gold grains obtained from a natural weathering environment. Secondary gold particles occurred on the surface of all grains and were closely associated with topographical concavities filled with clay-size minerals and residual organic material. Bacteriomorphic structures represented the (bio)geochemical process of electrum dissolution that intuitively formed soluble gold thiosulphate complexes through leaching. However, the close association of colloids and octahderal platelets indicated that reprecipitation processes also occurred and conterbalanced the loss of gold from the surface of the grain. The bacterial contribution to the weathering of primary, gold sources can lead to the release of gold grains and highlights the potential for how gold can be mobilised under near-surface environments. Implications of grain structure and the biogeochemistry involved in creating various textures on gold grain surfaces can be applied to mineral exploration, specifically in reducing the nugget effect in geochemical exploration surveys. The comparison of these nanophase particles demonstrates the link between biogeochemical weathering of primary gold sources, transportation and the formation of secondary gold enrichment.