Gold Biogeochemical Cycling Promotes the Enrichment of Metallophilic Bacteria Living on Placer Gold Particles

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Bacteria contribute to gold biogeochemical cycling by transforming placer gold particles through the gold oxidation and reduction, which leading to its dissolution and precipitation, respectively. Gold particles were obtained from a historic mine in Western Australia. To understand how bacterial communities are influenced by gold biogeochemical cycling. An aliquot of sampled particles was used for comparative biomolecular studies. Bacteria detected on the surface of gold particles included Proteobacteria (42.5%), Bacteroidetes (20.1%), Acidobacteria (19.1%), Firmicutes (8.2%), Actinobacteria (3.7%), and Verrucomicrobia (3.6%). These microbes were interpreted to be capable of biofilm establishment, nutrient cycling, and heavy-metal transformation/detoxification. Comparatively, bacteria were directly enriched from additional aliquot of gold particles. This bacterial community 60.0% similar (e.g., phyla level) in composition to that which was detected directly from particles. When this bacterial community was exposed to increasing gold(III)-chloride concentrations, bacterial diversity decreased. However, metal-resistant species were selected and confirmed by the whole genome analysis of gold tolerant isolates. Particles were characterized using high-resolution micro-analytical techniques. Nanometer- to micrometer-scale structures (e.g., porous texture and aggregates of nano-phase secondary gold) were observed on the surface of particles. These features were interpreted to be structures attributed to biogeochemical gold dissolution and reprecipitation processes. Using micro-analytical data, the amount of secondary gold, i.e., gold which was biogeochemcially dissolved and subsequently re-precipitaed, was estimated. On average, 0.2 μmoles of pure secondary gold (or 10.4% of a gold particle) was biogeochemically transformed. When this gold was solublized, it would have likely provided selective pressure for increased gold-tolerance of the microbial community, which would have further contributed to the biogeochemical transformation of the gold particles.