Bioaccumulation and secondary gold nugget formation

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Experimental evidence suggests that microorganisms are important in the cycling of Au (1). Recent microcosm studies with auriferous soils from Australian mine sites have shown that the resident microbiota are capable of solubilising up to 80 wt.% of the Au contained in these soils (1). A number of common soil bacteria, actinomycetes, archaea, and fungi have been shown to precipitate Au(I/III)-complexes under a wide range of experimental conditions (2). Morphological evidence for the occurrence of micrometre sized bacterioform structures on secondary Au grains has been reported in earlier studies (3). However, neither the biological origin of these structures nor associated organisms or processes have been identified. Gold grains for this study were obtained from the auriferous soils overlying mineralisation at the Tomakin Park- and the Hit or Miss Gold Mine in moderate New South Wales and tropical Queensland, respectively. The grains were 200 to 2200 µm in diameter and generally showed little sign of physical transport. Analyses of gold grain digests that amounted to an average fineness of 99.2% established their secondary origin. Scanning electron microscopy (SEM) revealed bacterioform on untreated grains from both sites. The presence of active bacterial biofilms on the surface of Au grains was confirmed using confocal stereo laser microscopy (CSLM) combined with nucleic acid staining. Isolation, amplification and separation of 16S ribosomal DNA from these biofilms and identification of the organisms present using DNA sequence analysis showed that unique, site-specific bacterial communities are associated with these Au grains that differ from those dominating the surrounding soil. 16S ribosomal DNA clones bearing 99 % similarity to a known metallophilic bacterium are present on all 16S rDNA positive grains from both locations. The ability of this metallophilic bacterium to accumulate $AuCl_4^-$ complexes was tested under in-vitro conditions, and biologically active cells typically accumulated twice as much Au as lysed cell preparations. These results indicate that bacteria that are associated with Au grains may be able to actively reduce $AuCl_4^-$ and accumulate metallic Au, and thus contribute to the authigenic formation of secondary Au nuggets in the regolith.

References

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