The effect of iron-oxidizing bacteria on the stability of the gold-thiosulfate complex

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Acidophilic iron oxidising bacteria, enriched from a Rio Tinto river sample collected approximately 7 km SW of Nerva, Spain, precipitated colloidal gold when exposed to 2 μM to 20 mM Au $(S_2O_3)_2^{3-}$. Growth of the consortium produced soluble ferric iron and colloidal, ferric iron-oxide mineral precipitates. A range of gold (I) thiosulfate solutions reacted with the whole cultured system and with each component system separately (i.e. bacteria, spent media, mineral precipitates) immobilized gold from solution within several hours. Transmission electron microscopy and scanning electron microscopy demonstrated that the immobilization of gold occurred differently by the three components in the microbial system. When each separate constituent was exposed to 20 mM gold: bacteria precipitated 30.78% gold in the form of 5 nm colloids concentrated along the cell envelope; the colloidal, iron-oxide minerals precipitated 26.26% gold as 5 nm colloids that reduced and replaced the acicular iron-oxide filaments extending outward from the particles; and spent media, devoid of residual organics and solid iron oxides precipitated 99.51% gold as 200 nm to 2 μm gold sulfide colloids and aggregates. In a chemical control experiment, gold did not react with soluble ferrous iron under the same experimental conditions. This suggests that stripping electrons from organic material and a role for ferric iron in destabilising the gold thiosulfate complex were critical to colloidal gold formation. Analysis of whole culture systems exposed to 2 mM gold using XANES/EXAFS demonstrated that gold (I) was immobilized and reduced to a gold sulfide and elemental gold, respectively. The direct immobilisation of gold by these iron oxidising bacteria and the indirect immobilization of gold by biologically-mediated, iron oxide precipitates suggests an active and passive role the biosphere has in influencing the mobility of gold as soluble complexes or as colloids. Understanding the biogeochemistry of gold interception and accumulation within a geologic temporal setting would provide insight into dispersal of gold in natural weathering systems where weathering of gold bearing metal sulfides occurs.

Mercury stratigraphy: A proxy for volcanogenic CO_2 buildup in Neoproterozoic snowball Earth and volcanism in the K-T transition

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Mercury tends to concentrate in sediments deposited right after major glacial events [1] as a result from leaching of volcanogenic Hg from land surface and accumulation along argillaceous sediments. Wherever geological background of Hg is negligible, its concentration in sediments may be useful for investigation of climatic changes.

Volcanism is assumed to be responsible for CO_2 build up in the atmosphere during Snownall Earth event with subsequent greenhouse effect, ice melting and cap carbonate deposition [2]. Intense volcanism witnessed the Cretaceous-Tertiary transition [3] and was, perhaps, responsible for dramatic climatic change.

We have used Hg as a proxy of volcanism intensity and CO_2 buildup during snowball events in Neoproterozoic cap carbonates in NE Brazil. Localities where carbonates are in sharp – but not erosional – contact with basal diamictites (earliest stages of aftermath of glacial events) and show $\delta^{13}C$ values ~ –5‰ were analyzed. Hg contents are usually over 10 times higher than background values (<1 ngg^{-1}), occasionally reaching values > 200 ng g^{-1}. Hg contents in cap carbonates of the Sergipano Belt and Ubajara Basin are similar to those in carbonates deposited coevally to volcanic activity elsewhere. This study supports mantle-origin for the CO_2 in cap carbonates, transferred to the atmosphere by volcanism.

In three drill-hole cores in carbonate rocks that register the K-T transition (KTB) in the Paraiba Basin, NE Brazil, Hg increases (4 ngg^{-1}) in the early Danian right after the KTB. Hg spikes predating the KTB register volcanism before this transition. Hg shows stratigraphic variation synpathetic with $\delta^{13}C$ and $\delta^{18}O$ stratigraphies.

This study supports Hg stratigraphy as possible tracer of dramatic climatic changes as those in Neoproterozoic snowball Earth events and in the KTB.

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