

The biogeochemical cycling of silver in acidic surface environments

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The movement of precious metals within natural environments is enhanced by their dissolution and re-precipitation. These processes are attributed to direct microbial action and metabolically/abiotically-induced changes to physicochemical conditions. Contemporaneous to the biogeochemical cycling of Au, little is known about the 'fate' of Ag mobilized from natural Au/Ag-grains and the kinetics of Ag-turnover. Using a combination of Ag-bearing materials from laboratory experiments and mine sites, we present data for biogeochemical Ag-cycling under Fe-rich, acidic conditions. An acidophilic, Fe- and S-oxidising bacterial consortium weathered polymetallic sulfides resulting in the 'liberation' of Au/Ag-grains and the dissolution of Ag. This bacterial consortium also promoted the formation of argentojarosite when exposed to higher concentrations of dissolved Ag-ions. A range of Ag concentrations occurred in various transported materials, such as gossans, terraced Fe-formations and soils, collected from abandoned mines in Spain and Australia. Within gossan, Ag occurred within pore spaces in close association with μm -size structures interpreted as microfossils of mineralised biofilms, which likely contained Fe- and S-oxidising bacteria. Thiosulfate-leaching of Ag has been suggested as a leaching mechanism resulting in the secondary enrichment of Au on the surface of Au/Ag-grains. Using this model in the context of Ag mobility, it was estimated that the biogeochemical cycling of Ag within gossan could range from seasons to centuries. These studies highlight the importance of structural and physicochemical characterization of secondary Ag structures to understand how bacteria contribute to the biogeochemical cycling of Ag.