Development and implementation of a gold mobility model

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Gold (Au) plays an important role in many societies across spatial, temporal and cultural boundaries. Increasing fundamental knowledge of Au biogeochemical cycling and transport behaviour in the unsaturated zone, also increases the appeal to utilise this knowledge for e.g. mineral exploration. However, the underlying mechanisms of gold solubilisation, transport, dispersion and eventual precipitation in secondary enrichment zones are complex and involve numerous (hydro)geological and (bio)geochemical processes, which often have not been quantitatively investigated. In this situation, numerical models are useful tools in summarizing the existent knowledge and being able to quickly test hypotheses arising from new experimental results. The present study is the first attempt at creating a conceptual model for the (bio)geochemical Au solubilisation, transport and re-precipitation in shallow subsurface environments. It is composed of a minimal set of components and reactions necessary to describe Au cycling under subsurface conditions. These components and processes include: Au in various states (*i.e.*, large native particles, dissolved complexes, (im)mobile nanoparticles); bacteria producing ligands assisting Au dissolution and stabilizing nanoparticles; bacteria precipitating Au from soluble complexes; s; a generic substrate component used for bacterial growth; and ligands forming complexes with the dissolved Au and stabilizing nanoparticles, thereby increasing their mobility. For each process, kinetic rate equations are established with rate coefficients fitted to or estimated from experimental or environmental data. A first test case for the model are the conditions at an archaeological site, where increased Au concentrations around buried artefacts are observed. Comparing the time the artefact has been buried with the travel time predicted by the model will help determine the authenticity of the artefact. In addition, the model can also be used in mineral exploration or for assessment of environmental mobility of anthropogenic Au nanoparticles.