Source rocks for sediment-hosted orogenic Gold deposits

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Currently accepted ore genesis models for orogenic gold deposits consider that the gold is sourced from deep below the deposits, in the lower crust or mantle, and transported upwards, along major crustal fractures or shear zones, during metamorphism and deformation, to become concentrated in second order structures during the peak, or post-peak, of metamorphism. However, recent LA-ICPMS studies of pyrite in a number of gold provinces (Victoria Australia, Sukhoi Log Siberia and Carlin Nevada) supports a two-stage process of gold ore genesis in these districts. The first stage involves development of favourable source rocks, by pre-concentration of gold and arsenic during sedimentation and diagenesis in black mudstone facies of continental margin sedimentary basins. In the sediments, the gold is present as either, invisible gold trapped in diagenetic arsenian pyrite or, micro-nuggets (< 2 microns) of free gold associated with fine-grained clays and organic matter. These gold-bearing, organic-rich, sedimentary rocks are also enriched in a characteristic suite of elements, particularly V, As, Mo, Se, Te, Ni, Ag, Zn and Cu. Gold contents of these source rocks commonly range from 5 to 100 ppb, with arsenic from 10 to 100 ppm, and organic carbon from 0.2 to 2 wt %.

The second stage, of the two-stage process, occurs during late diagenesis and metamorphism of the sediments, associated with deformation, basin inversion and/or granite intrusion. Gold is released from the arsenian pyrite and from clay-organic matter intergrowths, associated with low-grade metamorphic reactions in the sediments. Progressive recrystallisation of sedimentary arsenian pyrite, releases not only gold, but other trace elements, in particular, Cu, Zn, Pb and Te. Conversion of gold-bearing arsenian pyrite to pyrrhotite at higher grades of metamorphism (lower-greenschist to upper-greenschist and amphibolite facies) is the ultimate process to release all the contained gold and arsenic to the metamorphic fluid. This late stage release may be responsible for the Au-As-rich rims on ore pyrites in some districts (e.g. Carlin and Bendigo). The H_2S-CO_2-CH_4-bearing metamorphic fluid formed in this way, transports the gold and arsenic, through the permeable silt and sand facies sedimentary rocks, to become concentrated in zones of intense fluid flow and related pressure release, such as anticlinal fold axes, shear zones or dilatant quartz-vein reefs and stock-work zones, to form orogenic gold deposits.

Modeling horizontal gene transfer in porous media: Implications for contaminated ground waters

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Horizontal gene transfer (HGT), the process whereby one organism acquires genetic material from another without being its offspring, is now recognized for its significant role in shaping the speciation, adaptation and diversification of microbial communities. Because the genes that are responsible for heavy metal resistance and xenobiotic degradation are among the most laterally mobile, HGT has great implications for the natural attenuation and bioremediation of contaminated soils and ground waters. However, the extent, frequency and regulation of HGT in the subsurface remains largely unexplored. Here, we present a reaction transport model (RTM) describing the coupled propagation of genetic information via HGT and pollutant degradation in subsurafce environments.

The RTM explicitly accounts for the kinetics of HGT by representing donor (B^+) and recipient cells (B^-), as well as cels that have recently received and donated the genes of interest (B^T and B^X, respectively). Transconjugant (B^T) and exhausted (B^X) states are included as state variables because of the observation that, following successful HGT events, both newly enabled microbes and the ones donating the mobile genetic element enter into a state in which neither can act as donor for a characteristic time period. For each biomass, conservation equations describe their distribution in time and space due to HGT, attachment to and detachment from solid phases, and advection plus dispersion.

The HGT-explicit RTM is applied as a sensitivity tool in the context of a virtual aquifer contaminated from a single point source. Microbes carrying genes that enable degradation of the pollutant of interest are released by the same point source. The model simulations illustrate the dependence of the spatio-temporal evolution of the contaminant plume on the HGT kinetics and the transport properties of the gene carriers, as these determine how fast the native biomass acquires the ability to degrade the pollutant. Overall, the results emphasize the need to recognize and quantify HGT in the risk assessment and remediation of contaminated aquifers.