Roles of humic substances in biological reduction, precipitation, and mobilization of uranium

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Biological reduction and immobilization of uranium have been proposed as one of the promising remediation technologies to sequester uranium *in situ* in the subsurface. Humic substances (e.g., humic and fulvic acids) occur ubiquitously in soil and groundwater and have been known to play multi-functional roles in these processes. Humics may enhance the biological reduction and immobilization of urnaium but, on the other hand, they may form complexes with reduced U(IV), promote its dissolution and mobilization, and thereby impact on the long-term stability of uranium in the subsurface. We found that, in the presence of the dissimilatory metal reducing bacterium *S. putrefaciens* CN32, humic mateirals enhanced the reduction of U(VI) under anaerobic, circumneutral pH conditions. Humics enhanced the reduction rates up to ~10 fold and alleviated the toxicity effect of Ni^{2+} ions to microorganisms. Among various humic materials, soil humic acid is the most effective in mediating the biological reduction of U(VI) as compared with fulvic acid with a relatively low aromatic content. However, humics were also found to form complexes with reduced U(IV), preventing it from precipitation in solution. When exposed to oxygen, humics increased the oxidation rates of reduced U(IV), rendering it soluble and mobile as U(VI)-carbonate or U(VI)-humic complexes. Evaluation of the dissolution and mobilization of bioreduced U(IV) in a contaminated sediments confirmed that humics can cause the dissolution and mobilization of U(IV) although the dissolution rate appeared very slow, especially when fulvic acid was used at relatively low concentrations. This study emphasizes the importance of considersing site geochemistry (such as the presence or absence of humics) in designing bioremediation strategies for the long-term stabilization of uranium-contaminated sites.

Organic ore-forming fluids in the Youjiang basin, South China and their linkage to the hydrocarbon accumulation and gold mineralization

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The Youjiang sedimentary basin is situated on the early Paleozoic basement at the south margin of the South China plate. Since the late Paleozoic the Youjiang basin has experienced a three-stage evolution: passive margin rift basin (D_1-P_1), back-arc rift basin (P_2-T_2), and foreland basin (T_3). The Carlin-like disseminated gold deposits hosted in the Permian to middle Triassic sedimentary rocks are widespread in the basin and spatially closely related to the paleo-hydrocarbon reservoirs that mostly occur in the Permian carbonate rocks. Fluid inclusion studies on the gold deposits and associated paleo-hydrocarbon reservoirs indicate that the hydrocarbon-bearing ore-forming fluid in the basin is an immiscible system of multicomponents and multiphases. The reservoir-forming fluid is characterized by a low temperature (typically between 90~160℃) and a low salinity (mostly below 6 wt % NaCl), with main components of hydrocarbon, CO_2, and H_2O. The ore-forming fluid of gold deposits has a medium to low temperature (typically between 150~250℃) and a low salinity (0.4~6.7 wt % NaCl) and is composed mainly of H_2O and CO_2 and subordinately of hydrocarbon. The timing of the hydrocarbon charge in the paleo-reservoirs is estimated to be 238-182 Ma, while the activation of the ore-forming fluids for gold deposits is determined to be 267-172 Ma [1]. The spatially close association of paleo-hydrocarbon reservoirs and gold deposits, the contemporaneous activity of reservoir fluid and ore-forming fluid, and the intimate relationship in reservoir and ore genesis suggest that both the hydrocarbon reservoirs and the gold deposits are products of organic ore-forming basinal fluids.

[1] Gu X.X., Li B.H., Xu S.H., Fu S.H. & Dong S.Y. (2007) *Acta Petrologica Sinica* **23**, 2279-2286.