Nanoscale structural variation in pyrobitumen of the 2.0 Ga Zaonega Formation, Karelia, Russia

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Alteration and especially remobilization of organic material and carbonic fluids in Archean rocks has led to many controversies regarding early life. It is therefore important to establish the detailed changes that occur when carbonaceous materials are affected by metamorphism. A case study is presented here of carbonaceous matter that occurs in sediments of the 2.0 Ga old Zaonega Formation, Karelia, Russia. Petroleum generation and contact-metamorphism caused by intersecting magmatic bodies, regional greenschist-facies metamorphism, and circulation of silicate-saturated fluids, led to complex mixtures of silicious and bituminous materials. Raman spectroscopy and transmission electron microscopy on pyrobitumen-rich samples revealed two significantly distinct carbon allotropes; 1) graphitic films representing highly ordered carbon, and 2) variously oriented nm-scale crystallites representing strongly disordered carbon that comprises the bulk pyrobitumen matrix. This clear bimodal distribution in structural order cannot be related to a simple temperature- or pressure-induced graphitization process, and requires additional effects that caused annealing of sp2-bound carbon crystallites. Potential effects include variations in graphitizing precursor materials, local stress and strain caused by mineral authigenesis or gas bubble growth, and reorganization of graphitic clusters by hydrothermal fluid circulation. The details of these effects and their implications for the general alteration and remobilization process of organic structures in the Archean rock record will be discussed.

Evaluation of chromium reductive immobilization and oxidative re-mobilization in flow-through aquifer sediment columns

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Remediation of chromium contamination typically involves reducing the toxic and soluble hexavalent form, Cr(VI), to the relatively harmless and mostly immobile trivalent state, Cr(III). The objective of the overall project is to identify the biogeochemical mechanisms that control *in situ* chromium reduction and oxidation.

In the initial phase of the experiment, reduction under anaerobic conditions was observed for over 12 months by subjecting flow-through columns containing homogenized sediments from the Hanford 100H site to different dominant electron acceptors, i.e. NO_3^-, Fe(III), and SO_4^{2-}, in the presence of Cr(VI) and lactate. Cr(VI) was depleted in the effluent solutions of the nitrate-treated columns, all of which exhibited denitrifying conditions, as well as in some of the sulfate-amended columns where fermentative conditions were dominant. However, only a small amount of Cr(VI) was removed under other electron-accepting conditions. Spectroscopic analysis of the column sediments showed that most of the chromium was precipitated as mixed phase Cr-Fe hydroxides.

In the second phase of the study, the denitrifying and fermentative columns were subjected to oxidizing conditions that are expected to be prevalent once the bioremediation is completed (with nitrate and O_2 present). Preliminary results show that the chromium precipitated in the denitrifying columns was more readily mobilized under the oxidizing conditions, suggesting that fermentative conditions promote more sustained Cr(VI) remediation.