Stability of natural bacteriogenic iron oxides (BIOS) and their role in Sr cycling

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Bacteriogenic iron oxides (BIOS), composed of a mixture of poorly ordered hydrous ferric oxides and intact and partially decomposed bacterial cells, are thought to play an important role in regulating aqueous trace element concentrations in groundwater-supplied wetland environments. We have initiated a study examining the seasonal variation in the biogeochemistry of BIOS and its role in contaminant sequestration in a wetland site at Chalk River, Ontario, Canada, an area that hosts an exceptional abundance of BIOS. We have also carried out Sr sorption experiments with fresh and aged BIOS in order to assess the long-term stability of the Sr-bacteria-iron oxide composite under reducing conditions. SEM observations of representative BIOS samples found a predominance of a sheathed bacterium resembling *Leptothrix ochracea*, an Fe(II)-oxidizing organism known to thrive under circumneutral pH, high dissolved Fe(II) and low dissolved oxygen concentrations. The BIOS mineralogy was dominated by 2-line ferrihydrite, although some samples collected further downstream from the groundwater discharge zone appear more closely related to 6-line ferrihydrite. Iron reduction was noted at depth in both the sedimentary and porewater profiles, with the dissolved Fe(II) peak in the latter occurring at shallower depths in summer compared to the spring. Strontium, a contaminant of concern at this site, showed little seasonal variation, but its concentration was broadly correlated with that of dissolved iron and manganese. In addition, porewater strontium concentrations were 2-3 fold higher at a nearby control site where BIOS was absent, indicating the likely importance of BIOS in attenuating migration of this contaminant. On the other hand, reduction experiments showed that BIOS was easily reduced by *Shewanella putrefaciens* CN32, a common iron-reducing bacterium. Calculated reduction rates for BIOS were significantly higher than those reported for synthetic ferrihydrite. During the reduction experiments, Sr release mirrored that of Fe(II) release into solution, suggesting that it was likely sorbed onto the iron oxides and not the bacterial surface.

Plutonic Imaging: A Key to Understanding Crustal Evolution

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Plutonic imaging refers to the extraction of a diverse array of information from metaluminous plutonic rocks in complex orogenic settings. Previous workers have utilized the secondary isotopic systematics of young metaluminous rocks to define isotopic/age provinces in the North American Cordillera. The ability to extract discrete elemental and isotopic information from individual zircons, however, provides a critical complement to secondary isotopic systematics that are strongly influenced by elemental abundance ratios between mantle derived magmas and older lithosphere. The ability to use in situ measurement techniques such as ion probe and LA-ICP-MS to measure age, Hf isotopic ratios, O isotopic ratios, and trace element abundances in magmatic and xenocrystic zircons is critical to this approach. Plutonic imaging, therefore, allows much more useful constraints to be placed on the distribution of older crust, the role of younger magmatism in the chemical and structural maturation of the lithosphere, and the extent of transfer of new lithiosphere from the asthenospheric mantle. As a consequence, plutonic imaging also provides a crital complement to geophysical studies (e.g. seismic velocity models and potential field measurements) that yield estimates of density, rigidity, thermal conditions, compositional or structural boundaries, etc., but no estimates of crustal age diversity and true composition. These deficiencies can be addressed by studies of crustal xenoliths in some locations, but xenoliths are relatively rare compared to plutons and not all xenoliths provide the necessary P-T-t information to construct crustal models. We are applying the plutonic imaging approach to the widespread Late Cretaceous plutonic rocks emplaced along the boundary between the Archean Wyoming craton and accreted Proterozoic terranes within the Great Falls tectonic zone. These plutons record the presence of a diverse Archean to Proterozoic lower crust and mantle lithosphere in areas where secondary isotopic systematics of Pb and Nd, for example, suggest a homogeneous source. Our data strongly suggest that the area is at least partly underlain by an inverted crustal section with Proterozoic crust and/or lithosphere underlying Archean crust.