Arsenic association with secondary iron phases on ferroan micas: Implications for ground water quality in South Asia

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We analyzed a variety of fresh (river) and ancient (aquifer) sediments from Nepal and Bangladesh using chemical extraction, electron microbeam and synchrotron X-ray techniques in order to track the evolution of arsenic (As) speciation from recent to buried sediment and to determine the predominant geochemical reactions controlling As solubility in Bangladesh ground water. The sediments represent a range of weathering states and redox conditions, and were collected from several sites.

We and others have previously reported that mica separates from the study area contain 2-3 times more As than the bulk sediment [1, 2]. μ-XRF analysis further indicates that As is almost always associated with iron-rich micas (biotite, altered biotite, and chlorite) rather than muscovite. However, the apparent As enrichment of iron micas is largely due to secondary As-bearing phases that coat mica surfaces or penetrate prominent clevage planes, rather than direct incorporation of As into the mica structure.

In oxidized river sediments and shallow soil, As^{5+}-bearing ferric (hydr)oxides form within and on micas; gray, reducing sediment contains As^{3+}-bearing siderite and vivianite on micas. Growth of arsenian pyrite on/in ferroan micas occurs in sulfidic sediment [3]. The transformation from ferric to ferrous As-bearing phases could have implications for As release to ground water. The preferential formation of As-bearing, Fe-rich secondary phases on Fe-micas over other minerals also needs investigation; Fe-micas may posess favorable electrochemical properties, for example. We conclude that the stability of both ferric and ferrous iron phases must be considered when modeling the release of As to ground water in South Asia.

[1] Foster *et al.* (2000) *EOS Trans. AGU Fall Mtg. Suppl.* **81**, absract H21D-01. [2] Dowling *et al.* (2002) *Wat. Res. Research* **38**, 1173–1190. [3]. Lowers *et al.* (2007) *GCA* **71**, 2699–2717.

Plutonic imaging of two Proterozoic underplating events in the NW Wyoming Province from Hf-Isotopes of zircon from Cretaceous Batholiths

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Plutonic imaging refers to the extraction of discrete elemental and isotopic (U-Pb, Hf, O, etc.) information from *in situ* measurements of individual zircons and other accessory minerals as a complement to secondary isotopic systematics of plutonic rocks. It can provide critical constraints on crust-mantle intereactions and an image of the distribution of temporally and compositionally distinct lithospheric components. Plutonic imaging provides a critical complement to geophysical studies that cannot provide estimates of crustal age diversity and true composition.

The Late Cretaceous (*ca.* 70 Ma) Pioneer, Philipsburg, and Mt. Powell batholiths were emplaced along the boundary between the Archean Wyoming craton and Proterozoic-Archean Great Falls tectonic zone. Hf-isotopes of magmatic zircons from granodiorite and tonalite from the Pioneer batholith give εHf values for most grains of -28 to -32 with depleted mantle model ages of 1.8-2.0 Ga. The dominant population of magmatic zircons from the Mt. Powell and Philipsburg plutons gives εHf of -16 to -20 along with a few grains that extend the overall range from -12 to -30. Single stage model ages for the -16 to -20 group are 1.4-1.6 Ga, other grains range from 1.1 to 1.9 Ga. These data are consistent with derivation of these metaluminous batholiths from partial melting of two discrete, but likely mafic, lower crustal sources, one that is mainly Paleoproterozoic (*ca.* 1.9 Ga) and the other Mesoproterozoic (*ca.* 1.5 Ga). The Pioneer batholith plutons were largely derived from partial melting of Paleoproterozoic crust similar in age to the Little Belt magmatic arc of the Great Falls tectonic zone, whereas the Philipsburg and Mt Powell batholiths were derived mainly from mafic rocks emplaced during the formation of the *ca.* 1.47 Ga Belt Basin.

These data suggest that the thick (~20 km) mafic (P-wave velocities >7 ms^{-1}) lower crust of the Wyoming province and Great Falls tectonic zone is diachronous and significantly younger than the Archean-Paleoproterozoic upper crust. This implies that the lower crust along the northwestern margin of the Wyoming craton was underplated (either tectonically or magmatically) subsequent to the formation of the Archean upper crust of the Wyoming craton.