Boron isotope systematic of marine hydrothermal fluids: New insights from the Lost City Hydrothermal System (MAR 30°N)

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Marine hydrothermal fluids from Pacific Ocean (i.e. fast-spreading ridges) display a very regular array of data points in a δ^{11}B–B diagram, resulting from a simple mixing process between boron of seawater modified at low-T, and boron leached from MORB at higher T. However, hydrothermal fluids at slow-spreading ridges, such as the Mid-Atlantic Ridge (MAR), do not plot on the Pacific array and show systematically lower boron contents and isotope compositions. Our study of the ultramafic-hosted Lost City Hydrothermal Field (LCHF; MAR 30°N) identifies a new end-member marine hydrothermal fluids characterised by a high pH (10-11), low T (55-90°C), δ^{11}B = 25‰¸ and very low boron contents (0.34 ppm), defining the most extremely boron-depleted composition among the MAR hydrothermal fluids. The extremely depleted composition of LCHF fluids can be explained by massive brucite deposition (B up to 140 ppm, δ^{11}B up to 53‰) in the serpentinite substratum. The systematically lower B contents and isotope compositions typical of MAR hydrothermal fluids reflect variable reaction with mafic and ultramafic rocks along its flow path at varying temperatures, and the key role of brucite in the boron geochemical cycle of ultramafic-hosted marine hydrothermal systems. Finally, boron compounds have been recently observed to enhance the thermo-stability of ribose and other carbohydrates opening new scenarios for the high-temperature origin of life at the interface of ultramafic-hosted hydrothermal systems and seawater in the early oceans.

Effect of organic matter quality on iron and sulfate reduction and the expression of groundwater arsenic

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Arsenic contamination in drinking water wells in south and Southeast Asia poses a major health risk for many people. This contamination is generally attributed to the reductive dissolution of arsenic-bearing iron oxides by iron reducing bacteria; however, other biological and chemical processes also may play important roles in arsenic release and sequestration in sediments. Here, we examine the effect of depositional environment on organic matter deposition and form, and the possible effects of this deposition on the extent and spatial distribution of groundwater arsenic concentrations in the Mekong River delta, Kandal province, Cambodia. Much of the groundwater in the region contains elevated iron and arsenic, suggestive of iron-reducing conditions. Organic matter composition and isotopic composition (δ^{13}C) was examined within drilled cores, suspended sediments and surface waters collected during the monsoon season in Fall, 2007. X-ray absorption spectroscopy (XAS) was used to determine iron and arsenic speciation in fresh sediment collected from drilled cores.

Organic matter quantity, chemical composition and reactivity is impacted by depositional environment. Deposition of labile organic matter in rapidly depositing geomorphic features facilitated the development of extensive Fe-reducing conditions, and arsenic release into the aquifer. In some older features organic carbon levels are sufficiently high to sustain extensive iron and sulfate reduction. This sulfate reduction sequesters arsenic in sulfide minerals and effectively removes arsenic from groundwater. Other older features do not contain sufficient labile organic carbon to undergo sustained iron reduction and groundwater thus is largely devoid of arsenic. Regions of rapid deposition are particularly likely to contain elevated groundwater arsenic because reactive carbon can be buried quickly to aquifer-bearing depths where *in situ* redox processes regenerate aquifer arsenic. These data indicate that heterogeneities in organic matter deposition may lead to heterogeneity in the expression of groundwater arsenic in the Mekong delta and other similar sedimentary environments.