

Contrasting behaviour of arsenic, iron, manganese and uranium during anaerobic incubation of aquifer sediments from Nadia, West Bengal

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The critical role of indigenous metal-reducing bacteria in mediating the mobilisation of arsenic from shallow sediments in Bengal has been widely muted, however, there remains debate over the mechanistic details of the mobilisation processes, including the relative importance of enzymatic and abiotic processes. Observing, in suitable microcosm experiments, the behaviour of trace elements with contrasting biogeochemistries might provide some further insight.

Using sediment from 20 m depth from Chakdaha Block, Nadia, West Bengal, we conducted microcosm experiments under anaerobic conditions with 15 g sediment / 30 mL synthetic model Bengali groundwater (after Islam *et al.*, 2004) amended with sodium acetate (as a proxy electron donor) to 0, 0.1, 1 or 10 mM at an initial pH of 7.0, 20°C & 1 atm. Triplicate microcosms were sampled after 1, 3, 7, 10, 14, 22 and 29 days. Trace elements were determined by HR-ICP-MS, As speciation by IC-ICP-QMS, Fe(II) by the UV-Vis based ferrozine method and H₂ by GC-RCD.

Reduction of As(V) to As(III) was observed within 7 days, followed by the mobilisation of As, Fe and Mn and the immobilisation of U mostly within 14 days suggesting increasingly reducing conditions. Release of Mg, Ca, Sr and Ba may be due to dissolution of carbonate phases consistent with increasingly acidic conditions that would be expected. Amendment with acetate made no systematic significant difference to the rate or magnitude of As, Fe or Mn release – this is consistent with large amounts of H₂ generated during the microcosms and the presence of highly reactive organic matter within the sediments. Null results from sterile controls confirmed the overall critical role of microbes. Work is ongoing to characterise the bacterial communities and the nature of the reactive organic components in the sediments.

Magmatic processes and the evolution of crust: Insights from the New Zealand/Kermadec subduction system

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It is now well established that andesitic magmas have an ultimate origin in the mantle wedge but the extent to which erupted compositions are modified through crustal interaction is still being defined. Subduction-related volcanic rocks are commonly identified by their textures and by specific trace element characteristics. The textures reflect complex crustal level processes that include assimilation and crystal fractionation (ACF) and magma mixing or mingling. Although commonly interpreted to reflect slab fluid influences, the trace element characteristics are also specific to continental crust. Detailed studies (stratigraphy, major and trace element chemistry, Sr-Nd-Pb isotopes, U-series disequilibria) of andesitic eruptive sequences in New Zealand's North Island indicate that they represent magmas that evolved through ACF processes operating on variable time scales in complex storage and feeder systems dispersed throughout the crust. Contrasts between individual volcanoes arise because of variations in storage and feeder systems and because, in the more extreme cases, for example Ruapehu and Taranaki, both mantle sources and the crustal assimilants are compositionally different. In the Taupo Volcanic Zone, the principal locus of volcanic activity in the North Island, rhyolitic magmatism marks the onset of rapid extension and high heat flow and is preceded by andesitic volcanism. The change from andesitic to dominantly rhyolitic eruptives reflects progressive thermal evolution of the lithosphere and a shift from mantle and lower crustal dominated genetic and evolutionary processes to those dominated by crustal melting and lower pressure crystal fractionation. These processes occur in both continental and oceanic segments of the New Zealand-Kermadec system demonstrating that it is the thermal evolution of the crust rather than its thickness or composition that controls the mix of lithologies in arc-type volcanoes.