

## U(VI) reduction by *Desulfotomaculum reducens* MI-1

PILAR JUNIER<sup>1</sup>, MANON FRUTSCHI<sup>1</sup>,  
NICHOLAS S. WIGGINTON<sup>1</sup>, ELENA DALLA VECCHIA<sup>1</sup>,  
JONATHAN O. SHARP<sup>1</sup>, ELENA SUVOROVA<sup>1</sup>,  
ELEANOR SCHOFIELD<sup>2</sup>, JOHN R. BARGAR<sup>2</sup>,  
AND RIZLAN BERNIER-LATMANI<sup>1\*</sup>

<sup>1</sup>Environmental Microbiology Laboratory, Ecole  
Polytechnique Federale de Lausanne, Switzerland  
(\*rizlan.bernier-latmani@epfl.ch)

<sup>2</sup>Stanford Synchrotron Radiation Laboratory, USA

We investigated U(VI) reduction by the sulfate-reducing spore-forming bacterium *Desulfotomaculum reducens* MI-1 in the presence of pyruvate as the electron donor. We found that growth was decoupled from U(VI) reduction, with reduction occurring after depletion of pyruvate. This decoupling can be explained by the fact that spores, rather than vegetative cells, were responsible for the reduction and that H<sub>2</sub> (a product of pyruvate fermentation) served as electron donor for U(VI) reduction. Furthermore, we observed that a small extracellular factor produced during growth is required for the process. The identity of this factor is currently under investigation. Growth and sporulation occurred in the presence of the competing electron acceptors sulfate and nitrate, but neither affected U(VI) reduction by spores. Respiration of Fe(III) by cells inhibited both sporulation and U(VI) reduction.

Another novelty of U(VI) reduction by *D. reducens* is that the U(IV) produced lacks the characteristic U-U peak at 3.86 Å typically observed in Fourier transforms of EXAFS spectra of the mineral uraninite. This suggests that unlike the majority of bacteria studied thus far, uraninite may not be the dominant product of U(VI) reduction. Transmission electron microscopy revealed that U(IV) accumulates as amorphous solid-phase products in the exosporium of spores and at the envelope of the cells. Interestingly, U(VI) reduction appears to have a deleterious effect in the development and morphology of spores.

In summary, *D. reducens* displays a unique mechanism of U(VI) reduction (involving spores) that does not result in uraninite production. Relatives to the *Desulfotomaculum* spp. have been found in microbial communities of uranium contaminated sites, and appear to dominate under high U concentrations. Thus it is possible that metabolically dormant spores could play a role in U(VI) reduction in contaminated subsurface environments.

## Metal transport by geothermal and volcanic vapour

H. KAASALAINEN<sup>1,2\*</sup>, A. STEFÁNSSON<sup>2</sup>, N. GIROUD<sup>2</sup>  
AND S. ARNÓRSSON<sup>2</sup>

<sup>1</sup>Nordic Volcanological Center, Institute of Earth Sciences,  
Sturlugata 7, 101 Reykjavik, Iceland  
(\*correspondence: hannakaa@hi.is)

<sup>2</sup>Institute of Earth Sciences, Sturlugata 7, 101 Reykjavik,  
Iceland (as@hi.is)

Volatile species provide important information on physical and chemical origin and processes in volcanic geothermal systems. Significant amount of metals and metalloid species are known to be transported by geothermal and volcanic fluids. Until recently, the role of the vapour phase as a media for metal and metalloid transport has been largely ignored. However, analysis of vapour rich fluid inclusions, samples of volcanic vapour and geothermal steam as well as experiments have recently pointed out the importance of vapour as a transporting media.

Samples were collected of steam and volcanic gas fumaroles and two-phase well discharges from five volcanic geothermal systems in Iceland, and Vulcano Island and Solfatara in Italy and analysed for major and trace elements. The sample pressures and temperatures were in the range 1-42 bars and 100-407°C, respectively. The fluids consisted of 85-100 mol% H<sub>2</sub>O, <0.01-14.5 mol% CO<sub>2</sub>, <0.01-0.17 mol% H<sub>2</sub>S, 0.00-0.30 mol% SO<sub>2</sub>, 0.00-0.58 mol% Cl, 0.00-0.01 mol% F. Metal and metalloids were observed to be depleted in geothermal vapour compared to the water phase in two phase well discharges at *t* <300°C. Nonetheless, volatiles including B were observed in elevated concentrations (5.5-345 ppb), and others including As, Hg, Cu, were found in significant measurable concentrations (0.01-2 ppb) in the steam phase. B and As were enriched in the water phase (20-2000 times), whereas Cu and Hg either show similar concentrations in the steam and water phase, or are enriched in the steam. In the single phase volcanic vapour discharge at 100-420°C, metals and metalloids are found in much higher concentrations, typically in the range 0.1-50 ppm, the sources being magma degassing and gas-rock interaction. Enrichment compared to the host rock of some elements including B, As, Cu, Hg etc indicate true volatile nature of these gases. Based on thermochemical modelling, the trace elements may be transported as simple chlorides, oxychlorides sulphides, fluorides and elemental gas. Hydrated species are also considered important in some cases. Modelling of boiling and phase segregation in volcanic geothermal systems indicate equilibrium distribution of some trace elements like B between the liquid and vapour phase.