

D₂O as tracer to study diffusion processes through the quartz crystal

M. BAUMGARTNER, G. DOPPLER AND R.J. BAKKER

University of Leoben, 8700 Leoben, Austria

(*correspondence: miriam.baumgartner@unileoben.ac.at)

Laboratory synthesised fluid inclusions in natural quartz are used to study diffusion processes of H₂O and D₂O molecules through the quartz crystal. Feedstock of re-equilibration experiments are pure H₂O inclusions synthesised at 600°C and 337 MPa which correspond to a molar volume of 25 cm³/mole of the liquid phase. Those inclusions are exposed to a D₂O fluid at equal experimental conditions. Due to the concentration gradient (chemical potential) diffusion is induced and fluid exchange between the “pore fluid” and the fluid inclusions is expected. D₂O is used for re-equilibration experiments because it is easily identified in the inclusions due to the increase of the melting temperature of ice (pure D₂O at +3.8 °C) and its typical Raman spectrum between 2200 – 2800 cm⁻¹. After five days of re-equilibration the inclusions shapes are strongly modified and ice melting temperatures up to +1.8 °C are observed, which corresponds to about 47 mass% D₂O. In addition, Raman spectra taken from those inclusions reveal high amounts of D₂O (see Figure below). Nevertheless, the concentration of D₂O vary significantly and inclusions with low and high contents can be found. This variation is mainly caused by the position of the inclusion in the quartz sample (3-dimensional distance from the quartz surface) and the total volume of the inclusion itself. In addition structural effects, like nano cracks and crystal defects affect the fluid flow through the quartz crystal.

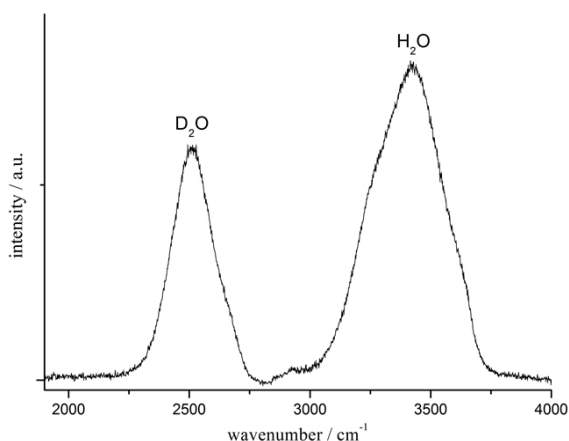


Figure 1: Raman spectrum of a fluid mixture of H₂O and D₂O measured in an inclusion after re-equilibration.

Microbially induced corrosion of depleted uranium metal in oxic soil

A.C. BAXTER^{1,2} S. SHAW³ M.N GARDNER¹ AND I.P. THOMPSON⁴

¹Department of Earth Sciences, University of Oxford, UK

²AWE, Aldermaston, UK

³School of Earth and Environment, University of Leeds, UK

⁴Department of Engineering, University of Oxford, UK

To determine the environmental impact of corroding depleted uranium (DU) munitions in oxic soils, fundamental information regarding the mechanisms and kinetics of DU breakdown are required. In particular, the key geochemical and microbiological factors which control the rate of corrosion. Previously, a study was conducted on DU metal pieces left *in situ* in two soil types (quartz rich dune sand and organic rich clay) for ≈8 years [1]. This concluded that a significant biological response, e.g. oxalate production, was instigated from the indigenous microbes in response to the DU corroding in the soil, suggesting that microbes may have a significant influence on DU breakdown.

To determine the microbial impact on the corrosion of DU metal, microcosm experiments were set up containing DU metal piece in a slurry containing either sterile soil or soil with the intact indigenous microbial communities.

After 5 months *in situ* corrosion had only occurred in the microcosms containing the viable indigenous microbes (Figure 1).

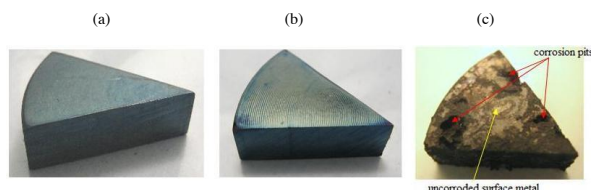


Figure 1: Digital photograph of the DU metal pieces (a) before addition to the microcosms, and after 5 months *in situ* in (b) sterile soil and (c) soil with viable indigenous microbial communities.

Imaging the DU metal pieces showed considerable pitting corrosion had occurred on the surface. Within these pits bubble-like structures were observed which may have been caused by hydrogen generation at the metal surface. Fluorescent staining of the DU metal demonstrated diverse microbial communities had colonised within the corrosion pits.

[1] S. Shaw, *et al.* (2007) Geochemical and microbiological controls on the corrosion and transport of depleted uranium in soil. *Geochim. Cosmochim. Acta* **71**(15) A925