Marysvale (USA)

Description: The Marysvale analogue site in Utah, USA is located in a mining area with abundant mineralisation in the form of a networking of hydrothermal veins containing uraninite, pyrite and fluorite. These veins cross-cut both volcanic rocks (ash flows, breccias and tuffs) and intrusive rocks (quartz monazite and granite). Mineralisation took place around 19 million years ago, at a depth of approximately 450 m. The hydrothermal fluids were acidic (pH 2 to 4), with a temperature of around 200ºC, and the duration of the hydrothermal event was around 10 000 years.

The objective of the analogue study was to investigate the mobilisation of uranium and other elements into the host rocks from the mineralised veins, see Figure 1. To this end, a number of elemental and isotopic profiles were determined in the rocks adjacent to the mineralised veins (Shea, 1984; 1987; 1990). It was found that sodium, magnesium, potassium, calcium, rubidium, barium, rare-earth elements and uranium all exhibited concentration gradients which could be modelled for coupled advective-diffusive transport. The depth into the rock through which transport could be identified on the basis of the profiles was 10 to 20 mm for the rare-earth elements, and 20 to 50 mm for uranium.

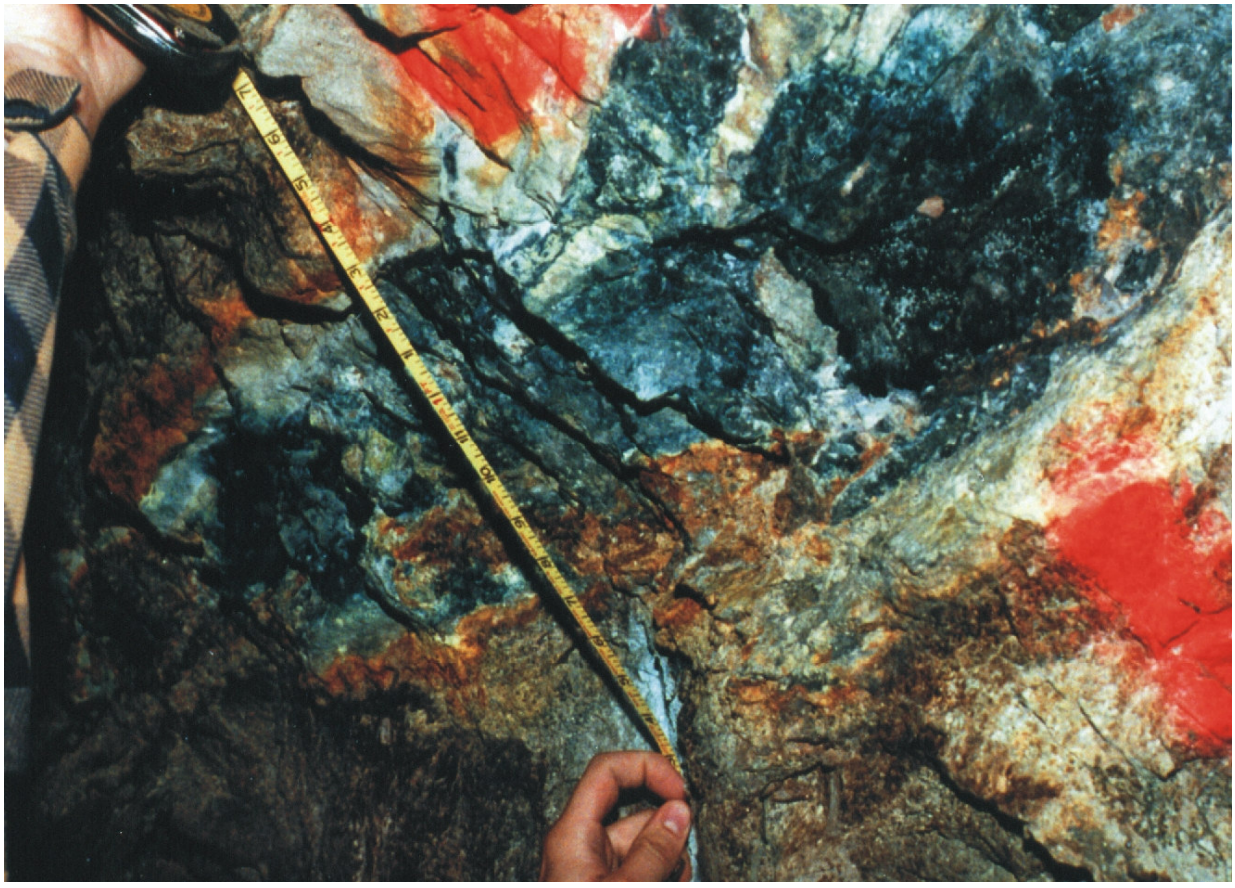

Figure 1: Photograph of one of the mineralised veins in the Central Mining Area of Utah, and investigated in the Marysvale analogue natural analogue study. Uranium and rare-earth element profiles into the rock were modelled using coupled advective-diffusive transport estimates. (From Miller et al., 2000. Photograph courtesy of Mike Shea).

The data also showed that uranium concentrations in the mineralised veins exceeded 50,000 mg/kg but dropped to below 50 mg/kg in smaller veins and fracture coatings. The distance away from the veins at which uranium concentrations (due to mobilisation into the rock) are half of the concentration in the vein (the source) were determined and, on this basis, the mass of uranium mobilised into the bulk rock was determined to be 5.7×10^5 kg around the major veins and

$6.8x10^2$ kg around the smaller veins. This highlights the very large potential for the rock matrix to retard radionuclides released from a repository.

Position(s) in the matrix tables: Far-field processes, saturated media, diffusion

Limitations: However, care needs to be exercised in extrapolating these data directly to typical repository host rocks because these are unlikely to have been substantially affected by large-scale hydrothermal processes.

Quantitative information: Diffusion coefficients for crystalline rocks $3.3x10^{-16}$ m^2/s (Shea, 1998).

Uncertainties: Uncertainties in boundary conditions and assumptions used in deriving diffusion coefficients.

Time-scale: Geological

PA/safety case applications: None known

Communication applications: None known

References:

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Added value comments: None known

Potential follow-up work: None identified

Keywords: far-field, migration, matrix diffusion, diffusion coefficients

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