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Letter Report

TITLE: Review of: Migration of trace elements into water-exposed natural fissure surfaces of granitic rock, Chemical Geology 49, 31-42, 1985, by B. Allard, T. Ittner and B. Torstenfelt.

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The subject report documents a study in which granites and granodiorites were exposed to solutions containing the radionuclides Cs, Am and Tc and, using autoradiographs, both the depth of penetration of these radionuclides and their mineral specific associations were determined. The granites and granodiorites used in the study were obtained from several drill cores from depths of 72-526 m, from three locations in Sweden, Stripa, Studsvik, and Finnsjon. The samples were chosen specifically to contain fissure minerals, as the determination of the effect of these minerals on radionuclide migration was a major purpose of the study. Cs ($\sim 10^{-6}$ M) was added in the Cs^+ form, Am ($\sim 10^{-8}$ M) as a mixture of hydroxy and carbonate complexes, and Tc ($\sim 10^{-6}$ M) as the TcO_4^- anionic complex to water compositions representative of those found at the depth from which the specific drill core sample had come. Thus several different groundwater compositions were used in the experiments. The exposure times of the rock to the solutions varied from 3 to 12 months.

The results of the study show that most of the Am was sorbed onto the exposed rock surfaces with very little penetration ($\leq$0.5 mm)into the rock. The absence of penetration is partially a result of the shorter exposure time (3 months) used in the single reported Am experiment. Both Cs and Tc showed significant penetration into the rock (>1 mm for Tc and $\geq$4 mm for Cs), although the mechanism of their penetration differs. Cs is associated primarily with veins or large grains of high cation exchange capacity minerals, while Tc shows no specific associations.

Although the reported experiments are specific to granites the results are more general and can probably to applied to other rock types which contain a similar mineralogy. Cs was strongly sorbed onto smectite, chlorite, biotite, laumontite and some of

the feldspars. Except for biotite, all of these minerals are also found in altered basalts. Several of these minerals are solid solutions, and it is not clear from the present study if variations in their composition would affect the observed results, as these minerals may have different compositions in a basaltic versus granitic regime. Thus Cs might be expected to behave similarly in fissures in basalts and granites. Am was sorbed most strongly onto biotite, next strongly onto feldspars, and slightly onto quartz. Since biotite is uncommon in basalts, the retardation of Am in basaltic terrains would probably be less than that occurring in granitic terrains as a result of interactions with specific minerals. Since Tc was not observed to be associated with specific minerals, no tentative conclusions can be drawn for this element.

This study should be considered preliminary in nature as it leaves many questions unresolved. The authors used several groundwater compositions, yet no comment is made as to whether this had any affect on the results. Groundwater compositions in general may have a large affect on the results. Also the experiments were performed at 22°C and atmospheric pressure, while a repository would presumably operate at a higher temperature and pressure. A change in the pressure and temperature from the experimental conditions could potentially cause a great difference in the results. Similarly, the experiments were run in an oxygenated environment, and an anoxic environment, and/or one containing a significant partial pressure of CO_2, could potentially yield very different results as well.

The experimental methods used in this study can provide much information on the relationship between radionuclide adsorption and fracture minerals, and the depth and mechanisms by which these elements penetrate rocks. The study also has applicability to other rock types besides granites, because many alteration mineralogies are similar. Its results should, however, be viewed as preliminary in nature because many of the potentially important parameters affecting radionuclide adsorption in a repository environment were not examined.