A coupled ion exchange, surface complexation, calcite dissolution, and mass transfer model to describe uranium(VI) desorption and reactive transport at the Rifle (USA) field site

J.A. DAVIS[1]*, M. HAY[2], P.M. FOX[1] AND K. WILLIAMS[1]

[1]Lawrence Berkeley National Laboratory, Berkeley, CA, 94720, USA (*correspondence: jadavis@lbl.gov)
[2]U. S. Geological Survey, Menlo Park, CA 94025, USA (mbhay@usgs.gov)

Predicting uranium mobility in the subsurface requires detailed knowledge of geochemical processes controlling the sorption dynamics of U(VI). This is a particular challenge in cases where aqueous solution conditions are highly variable. Desorption of U(VI) from mineral surfaces is strongly dependent on aqueous chemistry (e.g., pH, HCO_3 and Ca concentrations). Further, kinetic processes such as intragranular diffusion affecting U(VI) desorption equilibrium may become increasingly important under conditions where changing solution chemistry causes relatively steep U(VI) concentration gradients.

In this research we have quantified the effects of aquifer sediment properties on the transport dynamics of U(VI) under variable chemical conditions and developed a reactive transport model that can be applied to field settings. An ion exchange model was calibrated first in experiments conducted with the aquifer sediment <2 mm fraction with calcite removed. This was then applied in combination with a surface complexation model to describe U(VI) transport in laboratory columns. Chemical conditions within the columns were varied through the injection of influent solutions with differing pH, bicarbonate, and major ion concentrations. Initial conditions within the columns were impacted by slow calcite dissolution. Stopflow events during column elution demonstrated U(VI) desorption was not at local equilibrium, and U(VI) elution data were used to calibrate a distributed rate mass transfer model for U(VI) desorption, at flow rates and alkalinity concentrations relevant to the Rifle site. Oversaturation with respect to calcite was observed in this column experiment and in the Rifle aquifer. In a column experiment with high influent bicarbonate, calcite oversaturation exceeded one order of magnitude, suggesting calcite nucleation and precipitation and U(VI) co-precipitation within the column. The model was successfully applied to describe field injection experiments after correction for local surface sediment properties (surface area, ion exchange capacity, and initial adsorbed U(VI)).

Geochemistry of granites from magmatic-metamorphic complex of Boein-Miandasht, Sanandaj-Sirjan Zone, Iran

A.R. DAVOUDIAN[1]*, N. SHABANIAN[1] AND F. PANAHDAR[2]

[1]Faculty of Natural Resources and Earth Sciences, Shahrekord University, Shahrekord, Iran (*correspondence: alireza.davoudian@gmail.com)
[2]Islamic Azad University- Khorasgan Branch, Isfahan, Iran

Geological Setting and sample description

The granitic plutons crop out the north of the Boein – Miandasht city: they intruded into the metamorphic rocks. Various ages have been assigned to the metamorphic complex: Precambrian [1], Paleozoic and Mesozoic [2]. Metamorphic rocks in the study area comprise phyllite, mica schist, amphibolite, marble and meta-rhyolite with minor quartzite. Alkali granite is the major rock type in the plutons. It is composed of quartz, K- feldspar, plagioclase, biotite, amphibole, epidote, allanite, zircon, sphene, magnetite, tourmaline and apatite.

Discussion and Results

The granites have contents of SiO_2, ranging from 68.7 to 73.3%. They have high alkalis, with K_2O= 2.3 to 5.01% and Na_2O =3.75 to 5.0%, but low Fe_2O_3 (0.8 - 1.7%), FeO (1.1-1.9%), MnO (<0.1%), MgO (0.4-0.7%), CaO (0.9-1.8%), TiO_2 (0.3-0.5%) and P_2O_5 (0.1-0.2%). Al_2O_3 ranges from 13.8% to 14.9%.

Similarly the trace element compositions exhibit significant variations, particularly in the case of Rb (146.7–212.8 ppm), Y (32.1–40.2 ppm), Sr (65.3–153.0 ppm), Ba (400–633ppm), Ga (18.0-20.0 ppm) and high field-strength elements (HFSE) (Nb: 15.6–27.4 ppm; Ta: 1.5– 2.4ppm; Zr: 184.3–346.0 ppm; Hf: 5.2–10.1 ppm). The granites displays the characteristics of A-type grnitoids. According to a geochemical classification scheme for granitoids, proposed by Frost *et al.* [3], the granitic rocks belong to ferroan, alkali-calcic, mildly peraluminous granites. The plot of Zr + Nb + Ce + Y vs. 10000*Ga/Al suggest an A-type to fractionated granites character for the rocks. The granites show A2 field on ternary diagrams from Eby [4].

[1] Thiele *et al.* (1968) *G.S.I.* [2] Mohajjel *et al.* (2003) *J. Asian Earth Sci.* **21**, 397-412. [3] Frost *et al.*(2001) *J. of Petrology* **42**, 2033–2048. [4] Eby (1992) *Geol.* **20**, 641–644.