Evaluation of crystalline rock pore water geochemistry in DGR conditions

Václava Havlová, Milan Zuna, Anna Pecková, and Filip Jankovský
UJV Rez a.s., Department of Fuel Cycle Chemistry, Hlavní 130, Řež, 250 68 Husinec, Czech Republic (vaclava.havlova@ujv.cz)

Geochemistry of groundwater within the host rock is one of the most crucial boundary conditions for radionuclide speciation and migration.

The typical porosity of crystalline rock is less 0.5 wt%. In addition to the circulation of groundwater in the cracks, different types of fluids may be present in the pore space. Total porosity $\varepsilon_T$ corresponds to the volume of rock not filled with mineral grains. It is often defined by the relation: $\varepsilon_T = \varepsilon_F + \varepsilon_D + \varepsilon_R$, where $\varepsilon_F$ stands for effective porosity (the dominant fluid transport is advective flow), $\varepsilon_D$ represents diffusive porosity (the predominant transport in water-filled pores is diffusion) and $\varepsilon_R$ represents residual porosity (discontinuous pores in which no transport takes place), in which solutions may also be present in closed inclusions.

Most of the solutions contained in the pore space, the "pore fluid of the rock matrix", cannot be collected using conventional groundwater sampling techniques. Only limited number of techniques has been reported, e.g. Smellie et al., (2003); Waber and Smellie (2008) and Eichinger et al. (2008).

Therefore, determination of pore water chemistry in crystalline rock from underground laboratory Bukov (SÚRAO) in at least 500 m depth was in focus, testing different laboratory and in-situ techniques. Fresh crystalline rock samples from the 12th (-550 m) and 24th (-1000 m) horizon of Bukov URL were used for the laboratory experiments. In-situ sampler was installed at undisturbed section of the borehole at URL Bukov.

Firstly, leaching experiments, inspired by methods mentioned above were performed.

Secondly, high pressure techniques were used in order to extract pore water from the rock samples.

Finally, in-situ extraction of rock fluids, using a sampling packer system, installed into the undisturbed rock section, was applied.

Parallelly, geochemical modelling, using PHREEQC code, considering long-term interaction of main rock constituting minerals with solution in pores, was ongoing.

The results of in-situ sampling, lab leaching and modelling indicated that the determination of the
pore water composition of crystalline rocks is still an open issue, since only about 1.5 ml of groundwater was present in approximately 20 cm of drill core (porosity below 0.5%).

Its composition will be significantly influenced by the equilibration of the solutions, entering pores, with the main and minor rock components (e.g. sulphites). The composition will most probably move towards the Na-HCO$_3$-Cl type with increasing chloride component with increasing depth. Here close communication with depth specific groundwater can be found. However, chlorine source within quartz – plagioclase – biotite – amphibolites rock type is not clear. Geochemical modelling showed that Cl source other than rock forming minerals might have an influence, either residual solutions or fluid inclusions (containing NaCl according to the analyses).

References:

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