An experimental vs. numerical approach to determine capability of Archie's law to explain impact of evolving porosity on diffusivity

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In France, clay formations are proposed to host the future deep geological radioactive waste disposal facility. Some of these wastes may release soluble salts generating precipitation/dissolution in rock porous matrix. Such a generation could locally change the rock porosity, modifying the diffusive properties of radionuclides. To mimic this situation, chemistry transport codes can be used. However, such "Representative Elementary Volume" codes rely on relationships between diffusion and the evolution of the material, usually empirical, such as Archie's law.

Experimental data were acquired to investigate the pore and diffusion evolution in a model porous medium. Experimentally, a through-diffusion experiment was carried out, to allow for barite or gypsum precipitation in chalk matrix. Our experiments showed that barite and gypsum precipitation decreased the HTO (tritiated water) diffusivity D_e ($\times 10^{-10}$ $m^2 s^{-1}$) from 4.15 to 1.1 and 2.2, respectively. This distinct impact is due to difference in the structure of the pore filling by the two minerals even within the same porous matrix. This can be seen from µCT images of gypsum (Figure-1A), showing spherules creation with connecting nodular lines and barite (Figure-1B) with a dense planar shaped evolution.

We are now reproducing all the results using HYTEC and CRUNCH codes. First results underline the limitation of the empirical Archie's law; alternative approaches are now under investigation.

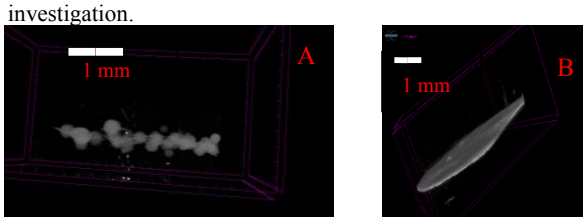

Figure-1. (A): µCT of gypsum and (B) µCT of barite in chalk matrix