

## CO<sub>2</sub> sequestration in olivine rich basaltic aquifers: A reactive percolation experimental study

S. PEUBLE, M. GODARD, P. GOUZE AND L. LUQUOT

Géosciences, CNRS-Université Montpellier 2, France

Injection of CO<sub>2</sub>-rich fluids into basaltic aquifers is one of the methods envisaged for mitigation of increasing atmospheric CO<sub>2</sub>. Basalts are rich in Mg, Fe and Ca and have a high potential to trap CO<sub>2</sub> as carbonate minerals. However, the role of reaction-transport processes has yet to be investigated in order to predict the capacity and sustainability for CO<sub>2</sub> storage of these highly reactive systems.

We present the results of three percolation experiments performed on the ICARE-2 experimental bench at 180°C and total pressure of 12 MPa. NaHCO<sub>3</sub> rich water (0.5 mol/L) mixed with CO<sub>2</sub> (P<sub>CO<sub>2</sub></sub> = 10 MPa) was injected through sintered analogues of olivine-accumulation zones in basaltic flows (~95% olivine Fo<sub>87</sub>, MORB glass, minor chromite). The injection rate was 1 mL/h for exp. 1 and 2, and 0.1 mL/h for exp. 3. The initial porosity and permeability of samples ranges from 4 to 7% and 30x10<sup>-18</sup> to 400x10<sup>-18</sup> m<sup>2</sup> respectively.

All experiments show a strong permeability decrease (down to 10<sup>-18</sup> m<sup>2</sup>) after 90 hours for exp. 1 and 2, earlier for exp. 3. Yet dissolution occurs: high concentrations of Zr and Al and of Co in the outlet fluids indicates dissolution of basaltic glass and olivine respectively. Si concentration changes reveal a more complex system with olivine dissolution and the precipitation of Si rich phases. We observed the growth of relatively large (up to 5 microns) Mg-Fe rich phyllosilicates perpendicular to (at the expense of ?) olivine surface. This reaction is typically associated to hydration of (ultra-)mafic rocks and may explain the decrease in permeability during experiments. Finally, the low Ca and Mg fluid concentrations suggests trapping by Ca-Mg rich phases. Ankerite and dolomite were identified by Raman spectrometry in the samples of exp. 1 and 2, while exp. 3 was characterised by precipitation of well developed and abundant magnesite (Mg<sub>0.88</sub>Fe<sub>0.11</sub>Ca<sub>0.01</sub>CO<sub>3</sub>) replacing dissolved olivine. Carbonation appears to be an efficient process: ~ 0.015g of CO<sub>2</sub> per gram of sample is stored as carbonates during exp. 1, that is, if these results were directly upscaled to the size of an injection site, an average yield of ~45 kg/m<sup>3</sup>/day. Our results indicate a strong control of flow rates on carbonation, but also on hydration reactions. This implies not only variations of the CO<sub>2</sub> storage capacity of the basaltic aquifer with distance to the injection well, but also that controlling the injection rate could allow to enhance the efficiency of *in situ* carbonation.

## Diffusion of nanoparticles in waters and biofilms-implications for bioavailability

T.-O. PEULEN<sup>1</sup>, R.F. DOMINGOS<sup>2</sup>, D.F. SIMON<sup>3</sup> AND K.J. WILKINSON<sup>3</sup>

<sup>1</sup>Institute of Molecular Physical Chemistry, Heinrich-Heine-University Düsseldorf, Building 26.32.02,

Universitätsstraße 1, 40225 Düsseldorf, Germany

<sup>2</sup>Centro de Química Estrutural, Instituto Superior

Técnico/Universidade Técnica de Lisboa, Torre Sul lab

11-6.3, Av. Rovisco Pais # 1, 1049-001 Lisbon, Portugal

<sup>3</sup>Département de Chimie, Université de Montréal, C.P. 6128, succursale Centre-ville, Montréal QC, H3C 3J7, Canada

In order to properly assess the environmental risk of engineered nanoparticles (ENP), it is necessary to determine their fate (including dissolution, aggregation and bioaccumulation) and mobility under representative environmental conditions. While the mass transport of nanoparticles in the environment is necessarily lower than that of ions, it is not clear that reduced mobility will result in reduced bioavailability. In this study, two lines of study were examined to determine the effect of increased particle size on the mobility and bioavailability of nanoparticles. The bioaccumulation (and biological effects) of CdTe/CdS quantum dots (QD) was compared with that of free Cd<sup>2+</sup>. While the bioaccumulation of the QD was largely accounted for by dissolved Cd, whole transcriptome screening using RNA-Seq analysis showed that the free Cd and the QD had distinctly different biological effects. In a second line of experiments, the diffusion of several model nanoparticles (dextrans, fluorescent microspheres, Ag nanoparticles) were studied *in situ* using confocal microscopy and fluorescence correlation spectroscopy in a biofilm. For the most part, relative self-diffusion coefficients decreased exponentially with the square of the radius of the nanoparticle. The nature of the biofilm was also shown to be an important parameter controlling the diffusion of the nanoparticles. Finally, the charge of the nanoparticles also appeared to be important – a greater than predicted decrease in the self-diffusion coefficient was observed for the negatively charged nano Ag, especially in dense biofilms. In order to understand the role of nanoparticles in the environment, it is necessary to understand the important factors affecting their mobility.