



## **Assessing the potential consequences of CO<sub>2</sub> leakage to freshwater resources: a batch-reaction experiment with isotopic monitoring program (Albian formation, Paris Basin)**

Pauline Humez (1), Julie Lions (1), Philippe Négrel (1), Vincent Lagneau (2), and Pascal Audigane (1)

(1) BRGM, Water Department, Orleans Cedex 2, France (p.humez@brgm.fr), (2) MINES ParisTech, geosciences department, Fontainebleau Cedex, France

This study focuses on open questions linked to the assessment of potential impact of CO<sub>2</sub> leakage from a CO<sub>2</sub> geosequestration site into freshwater resources: Can changes in water quality provide evidence of CO<sub>2</sub> leakage? Which parameters can we use to assess impact on freshwater aquifers? What is the time scale of water chemistry degradation in the presence of CO<sub>2</sub>?

Batch experiments were conducted in order to obtain a better understanding of rock-water-CO<sub>2</sub> interactions with two main objectives:

- To study the evolution of formation water chemistry and mineralogy of the solid phase over time during CO<sub>2</sub>-water-rock reactions. This implies periodic sampling during the experiments.
- To develop an isotopic monitoring program for freshwater resources potentially concerned by CO<sub>2</sub> leakage. The main focus is to select suitable environmental isotope tracers to track water rock interactions and changes in redox conditions associated with small quantities of CO<sub>2</sub> leaking into low salinity aquifers.

Effects of CO<sub>2</sub> on groundwater quality will be controlled by water-rock interactions, which will depend on aquifer mineralogy. The Albian aquifer of the Paris Basin is our study object because the Paris Basin contains deep saline formations identified as targets by the French national program of CO<sub>2</sub> geological storage. The Paris Basin also relies heavily on freshwater aquifers for its drinking-water supply including deep freshwater resources of strategic importance like the Albian aquifer. Sampling campaigns including water from the Albian aquifer, fresh outcrops of Albian sands, drilling cuttings, were led throughout the Paris Basin region to select representative samples for the experiments. The Albian sands are a multi-layered aquifer, confined in the central part of the Paris basin. Albian groundwater is anoxic with high concentrations of Fe, a pH of around 7 and low mineral content (0.3 to 0.6 g/L). All things considered, a weakly oxidized sand sample from the outcrop was preferred for the experiments over the in situ but more disturbed cuttings; macroscopic and microscopic analyses showed a quartz-rich sample with presence of illite/smectite, microcline and glauconite, an iron rich phyllosilicate, which provides a characteristic dark green colour to the sand. Mineralogical, chemical and isotopic determination of aquifer sample constituted a zero state for experimentation.

The experimental approach including fluid-mineral-CO<sub>2</sub> reactions, leading to hazardous trace elements transport and to geochemical evolution of the groundwater, is assessed through a multi-isotope approach including  $\delta^{44}\text{Ca}$ ,  $\delta^{56}\text{Fe}$ ,  $\delta^{7}\text{Li}$ ,  $\delta^{11}\text{B}$ ,  $\delta^{34}\text{S}$ ,  $\delta^{13}\text{CDIC}$ ,  $\delta^{18}\text{OH}_2\text{O}$ ,  $^{87}\text{Sr}/^{86}\text{Sr}$ .

The initial set-up consisted of 40 g of greensands and 400 ml of formation water collected on the south of Paris at 600 m depth (i.e. a liquid-solid ratio of 10) which were introduced in PTFE reactors (batch system) equipped with a PTFE tube connected to a valve to introduce aqueous fluid and CO<sub>2</sub>. A second valve was installed as a blowhole and for pressure monitoring. The experiment was conducted at room temperature and atmospheric pressure. Ten reactors containing sample of aquifer rocks and a blank (deionized water with sodium chloride only) were run simultaneously. One reactor was equipped for continuous pH measurements under the same conditions than all others ten reactors. We present the evolution of concentrations of anions, cations and trace elements (Ca, Mg, Na, K, Cl, SO<sub>4</sub>, F, Ag, Al, As, B, Ba, Be, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, SiO<sub>2</sub>, Sr, U and Zn ) derived from aquifer minerals in function of pH, over a duration of the batch-reactions ranging from one week to six months, together with first results of the multi-isotope approach (change in isotopic ratios with time).