



**HAL**  
open science

## Comparison of shallow aquifer and soil gas monitoring approaches for detecting CO<sub>2</sub> leakage at a natural analogue site in France

David Widory, Frédéric Gal, Eric Proust, Bernhard Mayer

► **To cite this version:**

David Widory, Frédéric Gal, Eric Proust, Bernhard Mayer. Comparison of shallow aquifer and soil gas monitoring approaches for detecting CO<sub>2</sub> leakage at a natural analogue site in France. AGU Fall Meeting, Dec 2011, San Francisco, United States. hal-00631773

**HAL Id: hal-00631773**

**<https://brgm.hal.science/hal-00631773>**

Submitted on 13 Oct 2011

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Comparison of shallow aquifer and soil gas monitoring approaches for detecting CO<sub>2</sub> leakage at a natural analogue site in France

D. Widory<sup>1</sup>, F. Gal<sup>1</sup>, E. Proust<sup>1</sup> & B. Mayer<sup>2</sup>

<sup>1</sup>Bureau de Recherches Géologiques et Minières (BRGM), 3 Avenue Claude Guillemin, BP 36009, 45060 Orléans Cedex 2, France

<sup>2</sup>Department of Geoscience, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada T2N 1N4

Natural analogue sites where geologic CO<sub>2</sub> is leaking to the surface provide excellent opportunities to test approaches suitable for monitoring for potential CO<sub>2</sub> leakage at carbon capture and storage sites. We tested isotope monitoring approaches for CO<sub>2</sub> detection in shallow aquifers and the overlying soil zone at a CO<sub>2</sub> analogue site near Sainte-Marguerite in the Massif Central (France). The Sainte-Marguerite area is located in the southern part of the Limagne graben (French Massif Central). The basement, composed of highly fractured granite, outcrops toward the west of the study area, notably around the Saladis spring. An intercalated arkosic permeable interval between fractured granite and Oligocene marls and limestones acts as a stratiform drain for fluid migration while the overlying thick Oligocene interval is impermeable and acts as a seal. The Allier river bed is located near the contact between the basement and the sedimentary rocks. Deep CO<sub>2</sub>-laden fluids migrate through the arkose interval toward the Sainte-Marguerite area and sustain a number of local springs. The Sainte-Marguerite area is known for the travertine deposits associated with the CO<sub>2</sub>-rich natural springs.

We collected water samples and effervescent gases at the springs as well as soil gases for chemical and isotopic analyses. The analytical parameters included major anions and cations,  $\delta^{13}\text{C}$  &  $\delta^{18}\text{O}$  of CO<sub>2</sub>,  $\delta\text{D}$  &  $\delta^{18}\text{O}$  of H<sub>2</sub>O and  $\delta^{13}\text{C}$  of dissolved inorganic carbon (DIC). Preliminary results revealed that  $\delta^{13}\text{C}$  values of CO<sub>2</sub> in most groundwater and soil samples were similar. Oxygen isotope measurements revealed equilibrium between CO<sub>2</sub> and H<sub>2</sub>O-oxygen in most samples, but except for a limited number of samples,  $\delta^{18}\text{O}$  values of water did not deviate significantly from the local meteoric water line. Our preliminary results suggest that both the groundwater and the soil sampling approaches should be capable of detecting leakage of CO<sub>2</sub> provided that the leaking gas has a distinct isotopic composition. The thresholds of leakage detection are currently determined in laboratory column experiments, where CO<sub>2</sub> of known isotopic composition is bubbled through a water-saturated sand at different rates and continuously measured for its  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  isotope composition using laser spectroscopy. The potential for isotope exchange between oxygen from water and oxygen from bubbling CO<sub>2</sub> is also evaluated.