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Dissolved Trace Metals dynamics during a rich-CO_2-water leakage in a near-surface carbonate freshwater aquifer

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The present work is part of the "Aquifer-CO_2-Leak" project funded by ADEME, which evaluates the impacts of CO_2 leakages from a geological storage site on aquifers and develops new monitoring tools and methodologies. This study is focused on the characterization and the quantification of dissolved metallic trace elements (MTE) releasing in the context of a leak towards a shallow freshwater aquifer and relation to the CO_2-water-carbonate interactions.

An experimental leak “simulation” was carried out at the Saint-Emilion experimental site (France) which is located in an Oligocene carbonate formation of around 25-meter-thick. The near-surface freshwater aquifer shows wackestone to grainstone facies, which are associated with values of porosity from 25 to 45% and permeability between 5 and 20 D. A volume of 200 liters of gasified water (CO_2 (90%), He (9%), Kr (1%)) was injected into the aquifer during low water table periods. To follow the plume, eight boreholes lined up the hydraulic gradient, of approximately 6 m deep, were fitted with CO_2 probes, multi-parameters probes, and gas sampling probes. Water has been sampled at regular intervals to determine the concentrations of major ions by ionic chromatography and dissolved MTE by ICP-AES.

During the experiment, concentrations of dissolved CO_2 calcium, and electrical conductivity were shown to increase as the pH values decreased, which can highlight the calcite dissolution. Three main types of MTE behavior stand out during the increase in dissolved CO_2. As, V, Cu, Se, Ga, Co, Li, Fe, Sr, Mo, Mn, and Cd have shown a speedy response consisting of an increase in their concentrations followed by a rapid return of the geochemical background. On the contrary, Cr, Ni, and Pb showed a major decrease in their concentration immediately after injection. Thirdly, Zn and Si concentrations didn’t seem to be affected by the arrival of $CO_{2(aq)}$. Only As, Ba, and Se exceed WHO/UE drinking water standards but they return to background concentrations in approximately 20 hours. The returns to normal conditions are fast showing that the carbonated system has great resilience.

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