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Carbon stable isotopes to monitor the reactivity of injected CO_2, in geological reservoirs

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This work was undertaken with the aim of evaluating the response of the carbonate system, the Dissolved Inorganic Carbon = $[H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$ (DIC), to a natural or artificial injection of CO_2 in geological reservoirs. The possible causes of the DIC evolution are: carbonate precipitation, gas or carbonate dissolution, mixing of fluids, organic matter oxidation, or biological activity. All these processes, which increase or decrease the DIC, are associated with symptomatic isotopic characteristics (isotopic fractionations for DIC sinks and isotopic compositions for DIC sources). Thus, coupling the $\delta^{13}C_{DIC}$ and the DIC forms a very efficient tool to monitor the reactivity of the carbonate system, in a geological system.

As a preliminary study, to validate our $\delta^{13}C_{DIC}$-DIC tool, we have focused our attention on the carbon cycle of the Pavin Lake (Massif Central, France). Because of its limnologic characteristics, it can be viewed as a natural analogue of a "geological reservoir". Large amounts of carbon dioxide are stored in the bottom of the lake, due to volcanic CO_2input from the lake basement (Camus et al., 1993, Aeschbach-Hertig et al., 1999). Our results emphasize large variations of the $\delta^{13}C_{D.I.C}$ and DIC with depth and allow a good understanding and modelisation of processes, in which DIC is involved (photosynthesis, degradation of organic matter, methane oxidation and mixings).

Subsequently, the $\delta^{13}C_{DIC}$-DIC tool was used in a CO_2 geological sequestration experimental test site, located at the Lamont Doherty Observatory of Earth (NY, U.S.A), where CO_2high pressure equilibrated fluid injection tests are conducted in basalt and

sandstone aquifers. The evolution of the $\delta^{13}C_{DIC}$ vs. DIC of the aquifer fluids can be explained by CO_2 degassing, mixing with the original aquifer fluid and carbonate precipitation. This diagnostic will be confronted to other chemical data (Ca^{2+}, Cl^- $\ldots$).

References

Aeschbach-Hertig et al. 1999 *Geochimica et Cosmochimica Acta*, 63, 3357-3372.

Camus, G., et al., 1993 *Bulletin de la Société Géologique de France*, 164, 767-781.