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CO_2 storage monitoring using noble gas geochemistry

E. Jeandel (1,2), A. Battani (1), P. Sarda (2)

(1) IFP, Rueil-Malmaison, France, (2) University of Paris Sud, Orsay, France
(Elodie.JEANDEL@ifp.fr / Fax: 33 1 01 47 52 70 19 / Phone: 33 1 01 47 52 63 89)

Because of their chemical inertness, noble gases are one of the tracers proposed to monitor CO_2 behavior in natural or industrial CO_2 storage. As there is no pilot field available to date in France, we first tested our methodology on a commercialized natural gas storage located in the Paris basin, operated by Gaz de France. Our aim is to validate this methodology for future CO_2 industrial storage sites.

Gas samples were collected several times from the injection well in summer 2006, and then every month from producing-wells during winter 2007 (January to April).

We performed major compounds (C_1-C_5 and CO_2) analyses by Gas Chromatography as well as noble gas concentrations (He, Ne, Ar, Kr and Xe) and isotopic ratios ($^3He/^4He$, $^{20}Ne/^{22}Ne$, $^{21}Ne/^{22}Ne$, $^{38}Ar/^{36}Ar$, and $^{40}Ar/^{36}Ar$) analyses on the 25 gas samples.

We observe important variations of noble gas abundances, as well as isotopic ratios:

^4He concentration ranges from 94 to 248 ppm, and tends to increase with time during production before returning to the initial value of injection. A similar behavior is also noticeable for the $^3He/^4He$ and $^{40}Ar/^{36}Ar$ isotopic ratios, as well as for $^{20}Ne/^{36}Ar$ and $^4He/^{40}Ar$* elemental ratios. Variations of the elemental abundances are probably related to changes of the gas to water volume ratio, while for isotopic ratios, mixing processes must certainly be invoked.

To our knowledge, this is the first time that noble gas isotopic variations are measured at such a very small, human – type, time scale. This study thus provides an exceptional opportunity to check for processes operating in crustal fluids at the scale of a geolog-

ical reservoir, but at an extremely small time scale, while we generally only see them after geological time periods.

We shall compare this noble gas monitoring with noble gas results obtained on CO_2 natural accumulations (Colorado plateau and french carbo-gaseous province) which provide on the contrary a natural laboratory for studying the effects of long-term, subsurface storage of CO_2.