Tracing Injected CO_2 in the Olla Oil Field, Louisiana using Noble Gas Isotopes.

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The possible impacts of unintended CO_2 leakage into aquifers from primary storage reservoirs during or after geological carbon sequestration is of increasing concern. Groundwater monitoring could identify when CO_2 is leaking from the primary reservoir. However, one factor that is not well constrained is the amount of CO_2 loss from the system or dissolution in to formation water. Understanding the amount of dissolution could also provide information on the efficiency of CO_2 flooding in the hydrocarbon industry. Noble gases are effective tracers for assessing subsurface fluid flow, and are unique in their ability to constrain fluid interactions in the subsurface. Noble gas isotope and bulk chemical composition data from the Olla oil field (n=7), Louisiana, which was CO_2 flooded during the mid-1980's, will be compared to the nearby Nebo-Hemphill oil field (n=7), which has never undergone any enhanced oil recovery and is considered pristine.

Although $\delta^{13}C$ of the injected CO_2 does not have a magmatic signature [1], we show that fluids from the Olla oil field have a high R/R_A, ($1.7\text{-}2R/R_A$) and $^{20}Ne/^{22}Ne$ (0.037-0.045) ratio indicating that the injected CO_2 has a magmatic source. This is also observed in the $^{136}Xe/^{130}Xe$, $^{134}Xe/^{130}Xe$, $^{132}Xe/^{130}Xe$ and $^{129}Xe/^{130}Xe$ isotopic ratios, which correlate with a magmatic CO_2 signature. In contrast, there is no evidence for a mantle component in the Nebo-Hemphill oil field. Therefore, we suggest that noble gases can be used to trace injection fluids, even if CO_2 itself has not been preserved.

In the Olla oil field, correlations of the $CO_2/^3He$ ratio to the ^{20}Ne and ^4He concentrations show an order of magnitude loss of CO_2 with increasing contact and dissolution to groundwater. In contrast, the Nebo-Hemphill oil field does not show any relationship between $CO_2/^3He$ and ^4He or ^{20}Ne and is homogenous in its noble gas composition, as well as in its major chemical constituents. Noble gas data will be used to investigate CO_2-water interactions and model loss of the injected CO_2 within the Olla reservoir system.

[1] Shelton et al., (2014) *Applied Geochem.,* 51, 155-169.