The Use of Noble Gases as a Tracer in Carbon Dioxide Sequestration

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A viable option currently being explored to counteract the effects of global warming is the geological sequestration of anthropogenic CO_2.

The benefits of CO_2 sequestration into stable geological structures such as oil and gas fields include: 1) The structures are natural underground fluid traps; 2) They have trapped fluids over geological time; 3) The structure, lithology and fluid environment are typically well characterized; and 4) The technology and infrastructure required for sequestration is already available. However, using expended oil and gas reservoirs also presents some potential problems. For example, leakage of CO_2 to overlying trapping structures, or even the surface may occur. Furthermore, transfer of CO_2 into associated aquifers may result in an additional sink for CO_2, but may also provide a mechanism for significant lateral migration that must be controlled.

In order for sequestration to be sucessful it is vital to gain a better understanding of subsurface processes once the CO_2 is injected. Noble gases provide an ideal tracer. They are chemically inert and therefore reflect the physical processes occuring. For example, isotopic changes can be used to trace the physical processes of transport and mixing of these fluids within the reservoir, allowing the pathways of the CO_2 injection fluid to be identified. Changes in the elemental compositions reflect the gas partitioning between the different phases and can be used to quantify this interaction.

We use noble gases to investigate the relationship between oil, water and gas phases at Salt Creek. This is a >$750m CO_2 EOR (Enhanced Oil Recovery) project in Wyoming, USA owned by Anadarko Petroleum. We have sampled injection fluid (CO_2), background fluid composition and fluid return at various stages of CO_2/water/oil evolution. We present preliminary data that show changes in noble gas concentrations and isotopic ratios that we interpret to reflect fluid phase mixing and phase interaction.

Teapot Dome is a US government owned oil field structurally related and adjacent to Salt Creek and the target for long term CO_2 storage. This provides additional samples to develop the noble gases as a tracer of real time CO_2 injection, migration, precipitation and phase interaction. The combination of Salt Creek and Teapot present a unique opportunity to compare EOR approaches that are currently being carried out at Salt Creek to maximise oil return with those aimed at maximising carbon storage at Teapot.