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What we have learned over 20 years of CCUS projects

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Summary

A primary mode of Carbon Capture and Sequestration (CCS) is geologic sequestration in which carbon dioxide (CO_2) is injected into underground geologic sinks. Critical to the success of geologic sequestration is the need to ensure that underground storage sinks have adequate seal and to monitor those seals over time to ensure there is no threat to human health and the environment.

Ultrasensitive passive geochemical surveys have been used in CCUS projects for 20 years. Passive geochemical detection was first used to assess reservoir seal integrity in the Dutch North Sea in 2002, and later in Australia and Oman. In 2015 an ultrasensitive geochemical survey was used to monitor CO_2 leakage over reservoirs, faults, and natural fractures in Algeria.

Method/Novel Technology

Passive geochemical samplers (Figure 1) contain a specially engineered oleophilic (i.e. oil loving) adsorbent encased in a microporous membrane. These membrane pores are small enough to prevent soil particles and water from impinging on the adsorbents but are large enough to allow microseepage hydrocarbon and CO_2 molecules to pass through and concentrate on the adsorbents within (Price, 1986; Klusman, 1993; Klusman and Saeed, 1996; Jones and Burtell, 1996).

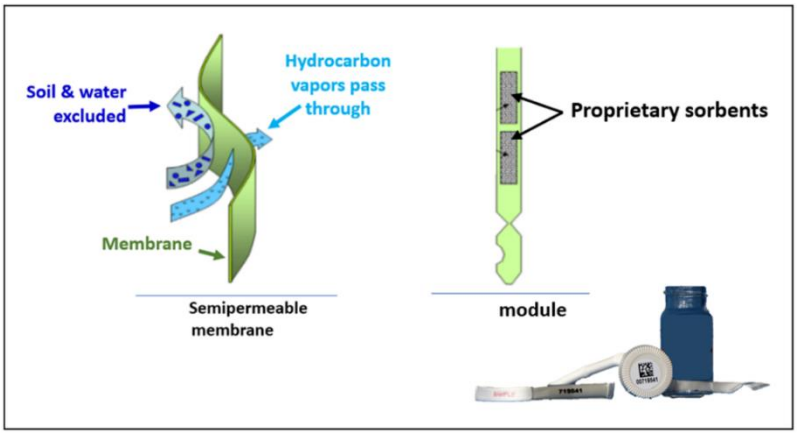

Figure 1. Schematic of the geochemical sample device (module), which incorporates engineered adsorbents for hydrocarbon collection.

Results, Observations, Conclusions

The first case study took place in the Yibal field located within the Fahud Salt Basin in northwestern Oman. The purpose of the survey was to map elevated hydrocarbon compound response along faults in the Natih A reservoir prior to CO_2 injection.

Samples were deployed at the surface along transect over structural closures at depth to monitor indications of natural leakage pathways. After deployment, collection, and analysis, hydrocarbon signatures were detected, at parts per billion (ppb) levels, and differentiated along fault trends (Figure 2). Elevated hydrocarbon signatures, noted by red dots, were mapped along coherent segments of fault projections inferring reservoir leakage along specific fault traces.

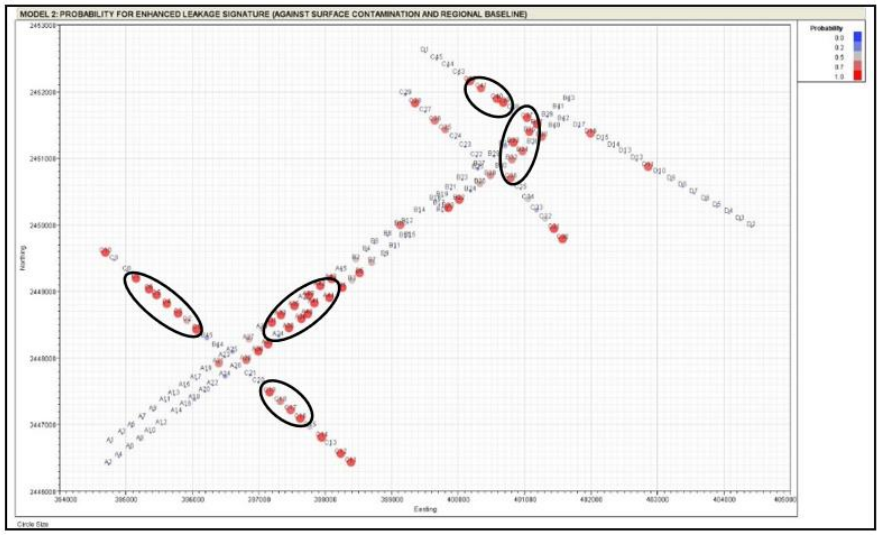

Figure 2. Geochemical probability results map. Red dots indicate elevated hydrocarbon levels along fault lines. Gray dots indicate background hydrocarbon levels.

The second case study involves the In Salah CCS program in the Algerian Krechba Field (Figure 3). Gas with high amounts of CO_2 was produced from a ~20 m thick reservoir at ~1850–1900 m. The reservoir is overlain by ~950 m carboniferous mudstones, siltstones, and limestones, which in turn is overlain by ~900 m of Cretaceous sandstone deposits (Ringrose, 2009). The AGI survey utilized fluorinated CO_2 tracers to evaluate subsurface leakage. No CO_2 tracers or elevated *in situ* reservoir hydrocarbons were detected at the surface above fractures or around injection wells, indicating no reservoir leakage of CO_2. This field is still being monitored to this day.

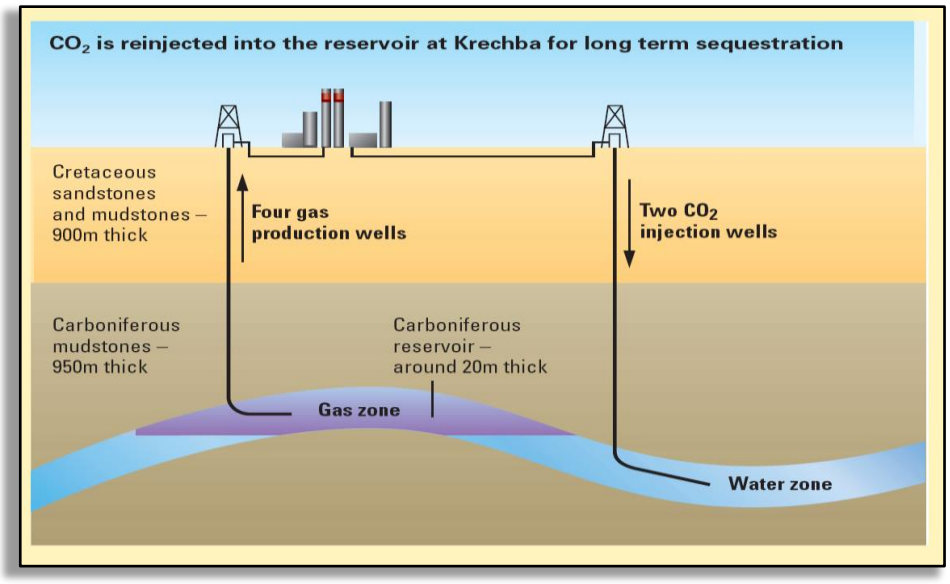

Figure 3. Illustration of the Krechba Field CCUS project. Gas is produced from the 20 m thick reservoir and brought to the facilities at the surface. CO_2 is tripped from the natural gas and then reinjected into the water leg in the reservoir.

Novel/Additive Information

The presentation will also discuss recent breakthroughs in the use of passive geochemical monitoring since these case studies were performed, such as:

- Tracerless *in situ* chemical markers for mapping and monitoring CO_2 leakage;
- Identification of compartmentalization in reservoirs that can affect reservoir filling capacity.

The presentation will close with seven lessons learned over 20 years of CCUS projects.

Acknowledgements

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