Using Geochemical Surface Detection to Perform Reservoir Characterization and Monitoring of CO_2 Sequestration Sites

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Summary

A primary mode of Carbon Capture Utilization and Sequestration (CCUS) is geologic sequestration in which carbon dioxide (CO_2) is injected into underground geologic sinks. Critical to the success of geologic sequestration is reservoir characterization prior to the injection of CO_2.

The ability to determine if these subsurface structures have adequate seal prior to CO_2 injection and that those seals remain leak-proof is difficult since there are not many highly sensitive CO_2 monitoring technologies available to cover an entire field. Ultrasensitive passive geochemical sorbers placed at the surface can provide the ability to determine adequate seal containment, evaluate potential leakage of plugged and abandoned wells, and monitor possible CO_2 leakage once CO_2 injection has begun.

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).

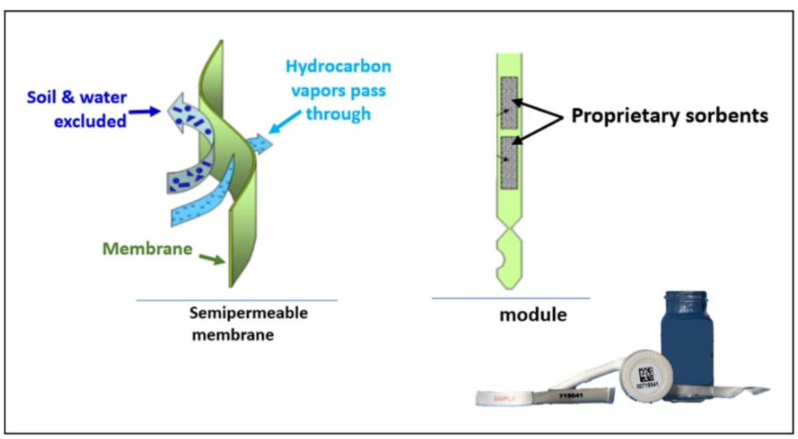

Figure 1. Schematic of the geochemical sample device (module), which incorporates engineered adsorbents for hydrocarbon collection.

Case Studies, 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 ground-truth the ability of surface geochemical imaging 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.

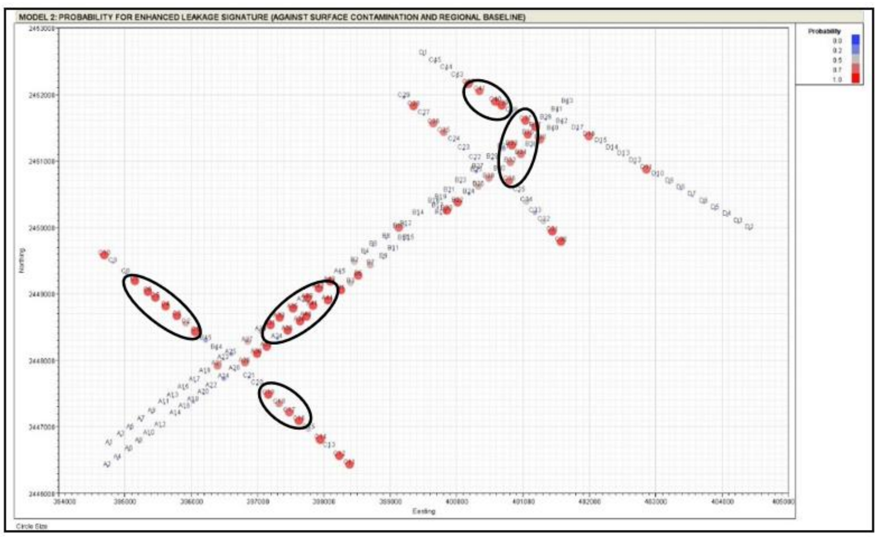

Figure 2. Geochemical probability results map. Red dots indicate elevated hydrocarbon levels along fault lines. Gray dots indicate background hydrocarbon levels.

The second case study involved the In Salah CCS program in the Algerian Krechba Field. The reservoir was overlain by ~950 m carboniferous mudstones, siltstones, and limestones which were then overlain by ~900 m of Cretaceous sandstone deposits. CO_2 was injected into the~20m thick down-dip water leg of the gas reservoir at ~1.9 km depth.

Response of the reservoir to CO_2 injection was detected using geophysical technologies such as InSAR, 3D seismic and microseismic. Surface deformation was observed above each injection well.

An AGI survey, using fluorinated CO_2 tracers was employed to evaluate subsurface leakage. No CO_2 tracers or elevated hydrocarbons levels were detected above the reservoir, along fractures, or around the injection wells. Thus, the study demonstrated the ability of the geochemical method to monitor baseline levels of hydrocarbons and potential leakage of perfluoronated tracers, used as a proxy for CO_2.

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