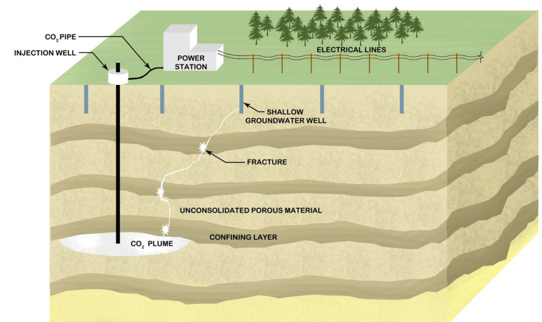
Analog Studies: Gas Migration Through the Overburden

Project Description

Less is known about CO_2 behavior in the overburden than about behavior of CO_2 in the reservoir and in the near-surface. The large areal extent of the overburden, the expense of its characterization, and the historic lack of interest by industry has left this geologic zone as a "black box" of unknown characteristics.

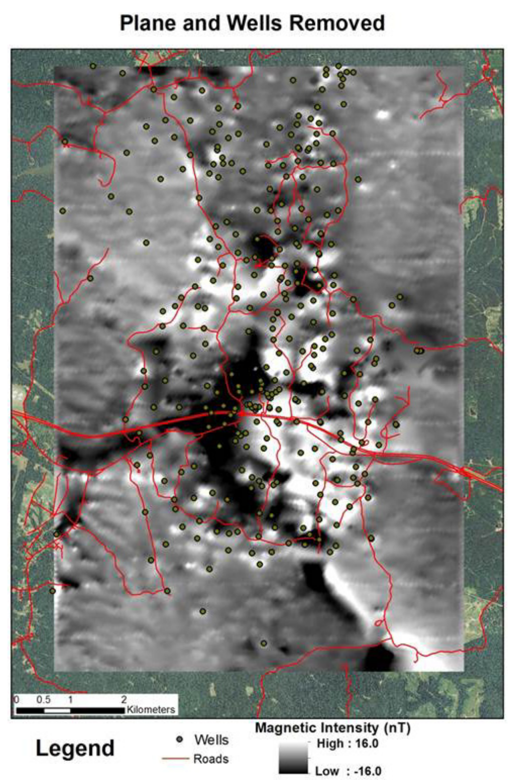
Recent near-surface controlled releases such as at ZERT and CO_2FieldLab, and other smaller experiments at the Brackenridge Field site in Austin Texas, Kyushu University in Japan, and Center of Excellence in Research and Innovation in Petroleum, Mineral Resources and Carbon Storage (CEPAC) in Brazil all indicate difficulty in predicting where a leak may manifest at ground surface.



Schematic of gas migration through the overburden

Impact

Understanding how CO_2 that escaped from the reservoir would migrate through the overburden is essential to predicting if it could reach groundwater or atmosphere, the possible migration path, the time required for migration, the potential impacts to resources, and how to recognize and attribute fluids that have undergone this migration should they be detected in near-surface environments. Information about migration paths is important for designing robust monitoring and for assessment should leakage quantification and remediation be needed. During 2011-14, significant progress was made toward characterizing overburden and field data was collected about fluids that have interacted with the overburden.



Aeromagnetic survey of a CO_2-EOR site. It is possible that hydrocarbon migration can cause the deposition of magnetic minerals. The small signals must be separated from infrastructure noise and regional trends using data processing techniques.

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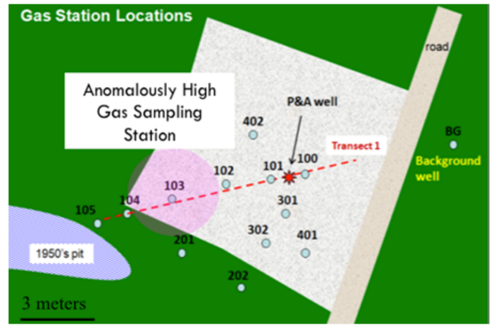
Accomplishments

- Collected and analyzed seal core (Jiemin Lu, Cranfield, and West Ranch).
- Identified a possible microseep at a field prior to and during progress of a CO_2 flood and collected 5 years data on change in fluids composition and isotopes.
- Collected data on ambient gas characterization in the intermediate zone, groundwater, and soil gas at several locations (Cranfield, Hastings, and West Ranch).



Soil gas sampling at CO_2-EOR site contains anomalously high concentrations of CO_2 and methane. The source of this gas (natural versus reservoir) and the migration mechanism are still uncertain.

We have developed a new model to consider methane as a proxy for CO_2. Methane is a preferable tracer than CO_2 because (1) methane is more commonly accumulated in reservoirs (2) many cases of methane migration through the overburden to near surface environments exist and (3) methane is less attenuated by dissolution into water than CO_2. Methane may be more easily detected using several methods and methane interactions with ecosystems are less widespread than CO_2 interactions.

Several students have made notable contributions to the development of this model. Mary Hingst completed a master's thesis showing that oxidation-reduction potential is more sensitive than pH to CO_2 and CH_4 leakage in near surface sediments. Jacob Anderson has separated potential microseepage-induced magnetic signals from infrastructure noise using data processing techniques. Anderson plans to continue studying methane migration through the overburden while pursuing a PhD.

Next Steps

- **Field Work.** Geochemical parameters collected through the entire overburden from natural seeps and controlled release experiments will be complied using GCCC collected field data and published literature. Potential "data gaps" will guide future work.
- **Modeling.** A conceptual model of subsurface processes will be used to develop numerical simulations and sensitivity analysis to assess the importance of specific reaction rates and directions.
- **Lab Work.** Experiments to identify the effects of individual processes on gas compositional changes under site-specific conditions will be performed. Masters student Michael Patson is conducting batch experiments to determine the sensitivity of dissolved inorganic carbon to CO_2 leakage. The results of lab work and modeling will direct future data collection at CCS sites.

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