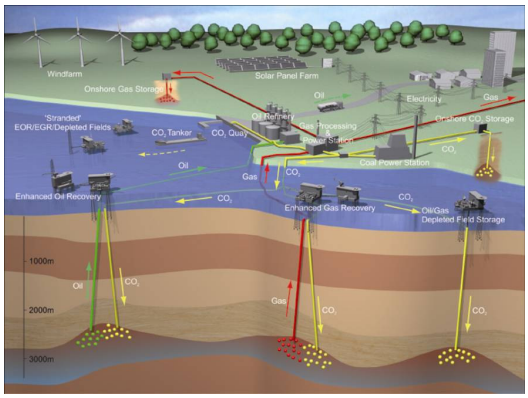
# Theme Overview: Analog Studies

## 2011–14 Goal

Improve understanding of the long-term fate of $CO_2$ through examination of analogs, especially the $CO_2$–enhanced oil recovery (EOR) sites to (1) assess environmental impacts of $CO_2$ leakage from the storage formations and (2) test and validate monitoring tools and strategies for $CO_2$ leakage detection in near-surface environments.




**$CO_2$-EOR site is an example of an analog used to study the fate of carbon dioxide in the environment.**

## Accomplishments

- Conducted groundwater chemistry survey at two $CO_2$-EOR industrial analog sites: Cranfield site, Mississippi, and Hastings site, Texas, for understanding the complexity of geochemical processes dominating groundwater quality.
- Conducted a set of laboratory experiments with groundwater and sedimentary samples collected from various major aquifers in Texas to study the effects of $CO_2$ leakage on groundwater quality.
- Developed numerical models to simulate the laboratory experiments and field tests.
- Conducted controlled-release tests at the ZERT site, Montana, for validating the process-based approach and applied this approach to $CO_2$ leakage detection at the Cranfield and Weyburn sites in Texas and Canada.
- Completed a preliminary study of gas migration through the overburden, including
  - Identification of a possible microseep at a field prior to and during progress of a $CO_2$ flood and collection of five years of data on changes in fluid composition and isotopes.
  - Implementation of aerial magnetic and conductivity surveys and initialization of laboratory simulations of gas migration.

## Methodology Development

Studies of analogs have resulted in the development of the following new geochemical methods:

- An integrated approach combining numerical simulations, laboratory experiments, and field single-well push-pull tests to assess potential impacts of $CO_2$ leakage on groundwater quality and test groundwater chemistry monitoring for $CO_2$ leakage detection.
- A process-based approach that can promptly identify a leakage signal using three simple relationships among coexisting gases ($CO_2$, $N_2$, $O_2$, and $CH_2$) to distinguish processes acting in the near surface.
- A novel methodology using light hydrocarbon as a potential proxy for $CO_2$ leakage detection. Methane migration through overburden to near-surface environments is well known, and methane is less attenuated by dissolution into water than $CO_2$ is.

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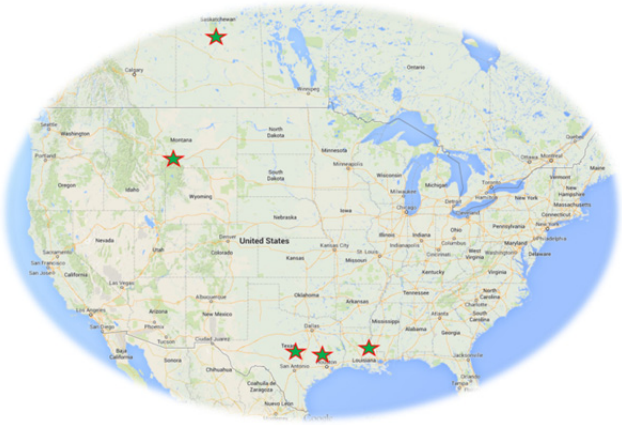
## Major Field Sites

**Brackenridge Field Laboratory (BFL).** An important research site in Austin, Texas, where various controlled-$CO_2$-release tests can be conducted in the shallow aquifer and also the vadose zone.

**Cranfield site, Mississippi.** An active industrial site with significant EOR activity where we studied groundwater and soil gas chemistry.

**Hastings site, Texas.** An oil field near Houston undergoing EOR where GCCC has helped develop a monitoring plan for the field.

**ZERT site, Montana.** A research field site where the process-based approach was validated for the detection of $CO_2$.




Field sites in North America.

**Kerr Farm, Weyburn, Canada.** Adjacent to a field undergoing EOR where the process-based approach was applied to investigate a suspected $CO_2$ leak.

## Personnel

- Changbing Yang
- Katherine Romanak
- Susan Hovorka
- Patrick Mickler
- Rebecca Smyth
- Brad Wolaver
- Mary Hingst
- Jacob Anderson
- Michael Patson

## Contact

Dr. Changbing Yang
changbing.yang@beg.utexas.edu, (U.S.) 512-471-4364
www.gulfcoastcarbon.org