Baseline Soil Gas Monitoring at the Bell Creek Combined CO_2 Enhanced Oil Recovery and CO_2 Storage Project

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Abstract

The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center (EERC) at the University of North Dakota, is working with Denbury Resources Inc. (Denbury) to evaluate the efficiency of a large-scale injection of carbon dioxide (CO_2) to study CO_2 enhanced oil recovery (EOR) and long-term incidental CO_2 storage at the Bell Creek oil field (Gorecki and others, 2012). The PCOR Partnership is using an iterative approach to site characterization, modeling and predictive simulation, monitoring, and risk assessment to demonstrate that incidental CO_2 storage can be safely and permanently achieved on a commercial scale in conjunction with EOR.

Soil gas monitoring is being carried out as one component of a CO_2-monitoring, verification, and accounting (MVA) program. The MVA program includes a wide variety of monitoring efforts covering surface water, groundwater, and a variety of deep subsurface monitoring techniques in addition to the soil gas program. The primary objectives of baseline soil gas monitoring at Bell Creek are to 1) establish baseline concentrations and seasonal variations in soil gas chemistries across the Bell Creek Field, 2) generate a scientifically defensible data resource to evaluate any deviation from baseline conditions, and 3) aid in characterizing the source and location of an anomaly to guide remediation efforts should a significant out-of-zone migration be detected.

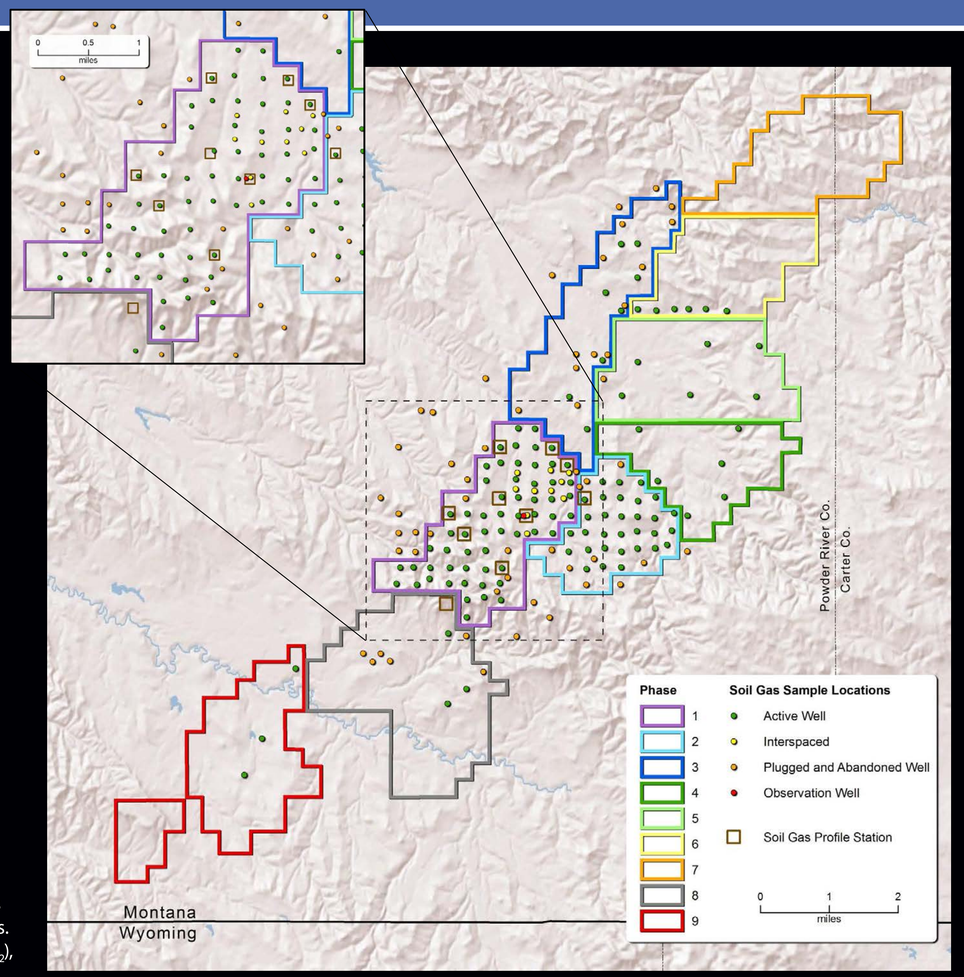
Soil gas probe sampling

Soil gas sample collection at a fixed-location soil gas profile station

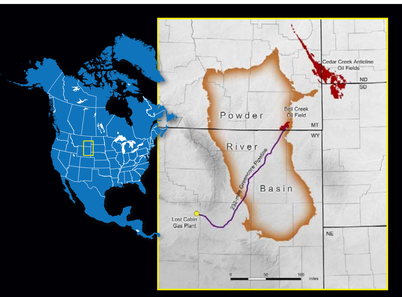
Handheld field meter analysis for soil gas survey

Field laboratory gas chromatography analysis for soil gas survey

A soil gas survey was conducted to establish and provide baseline values for several specific components naturally found in the vadose-zone gases. These components included CO_2, oxygen (O_2), nitrogen (N_2), hydrogen (H_2), carbon monoxide (CO), methane (CH_4), ethane (C_2H_6), and ethylene (C_2H_4). A sudden change in one or any combination of these components will trigger additional characterization efforts to determine the source and magnitude of the anomaly.



Baseline soil gas samples were collected and analyzed fieldwide from November 2011 to April 2013 focused on the Phase 1 development area near the first stage of injection activities.



Conclusions

The baseline soil gas characterization data will be used for assurance monitoring during the CO_2 injection phase of the project to help identify and scientifically evaluate the significance and source of anomalies (if present). Continued monitoring may provide additional insight into interannual variations of soil gas concentration changes during drought/wet cycles and provide a valuable data set that can be used to enhance future CO_2 EOR- and CO_2 storage-monitoring efforts throughout the region.

A process-based approach in conjunction with isotope analysis has been utilized to characterize near-surface seasonal soil gas concentration changes throughout the Bell Creek oil field and surrounding area. The process-based approach, developed by Romanak and others (2012), is based upon observing the naturally occurring processes that impact soil CO_2 concentrations, such as biological respiration and methanogenesis. This is accomplished by directly comparing the relative concentrations of major fixed gases in the soil to one another. This method is simple to employ, effective, and allows for immediate interpretation of sampling event results, as it does not rely upon direct comparisons of previously recorded concentrations. Isotopic analysis is also being performed on a subset of soil gas CO_2 samples. Baseline isotopic measurements are indicative of a natural environment. Additionally, all data sets are undergoing routine statistical analysis to identify trends and anomalies detected during the sampling program.

References

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