Practical Application of Stray Gas Investigation Methodologies to Monitoring of Carbon Dioxide Retention in Geologic Sequestration Reservoirs

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Background/Objectives. New incentives for carbon sequestration in the form of federal tax credits (Section 45Q) or California Low Carbon Fuel Standard (LCFS) credits are anticipated to drive the rapid implementation of carbon capture and storage (CCS) projects by means of geological sequestration or enhanced oil recovery (EOR) practices. To receive these credits, monitoring is required to verify that the injected carbon dioxide (CO_2) remains within the intended reservoir. Guidelines for verifying sequestration commonly require monitoring of transmissive zones immediately overlying the targeted reservoir, shallow underground sources of drinking water (USDWs), the vadose zone (i.e., soil gas), and/or gas emissions at the ground surface. Where elevated CO_2 concentrations are detected, regulatory agencies and industry alike recognize the need to distinguish natural versus anthropogenic sources of CO_2. To date, research has focused on methods to discriminate these two sources, particularly in soil gas samples and air emissions. However, there is still little consensus on how to best detect elevated CO_2 concentrations across a large area. In addition, there is a paucity of information on how dissolved gas concentrations in groundwater may be utilized for this purpose. To this end, several relevant lessons can be applied from the investigation of stray hydrocarbon gas (i.e., methane) migration in oil and gas fields.

Approach/Activities. This presentation reviews current monitoring requirements and guidelines set forth in tax incentive or offset credit programs for CCS projects and discusses how best to apply streamlined strategies for investigation and management of CO_2 sequestration in this context. In addition, we explore the use of dissolved gas data, including non-hydrocarbon and hydrocarbon gas concentrations, for detecting and identifying the sources of CO_2 in groundwater. Data are presented from case studies that utilize a closed-system sampling device that allows for the collection of dissolved gas samples without the potential escape of gases into the atmosphere. The utility of groundwater monitoring at hydrocarbon gas release sites is compared to other approaches that focus on monitoring soil gas or air emissions.

Results/Lessons Learned. As with stray hydrocarbon gas releases, the pathway for upward CO_2 migration from deep CCS reservoirs may be via the annular space of active or abandoned injection or production wells. In addition, natural preferential pathways (e.g., more transmissive zones, fractures, faults, or bedding planes) can create a discontinuous spatial pattern of gas migration in the subsurface. Dissolved hydrocarbon and non-hydrocarbon gas concentration data, which is standard at hydrocarbon gas release sites, can serve to both identify and discern the origin and migration of CO_2 and other gases and support the design and implementation of a reliable monitoring network.