

# Process-based approach to CO<sub>2</sub> leakage detection by vadose zone gas monitoring at geologic CO<sub>2</sub> storage sites

GCCC Digital Publication Series #12-15

K. D. Romanak  
P. C. Bennett  
Changbing Yang  
Susan D. Hovorka



**Keywords:**

Vadose; Process-based; Leakage; Sequestration

**Cited as:**

Romanak, K.D., Bennett, P.C., Yang, C., and Hovorka, S.D., 2012, Process-based approach to CO<sub>2</sub> leakage detection by vadose zone gas monitoring at geologic CO<sub>2</sub> storage sites: *Geophysical Research Letters*, 39, L15405, doi: 10.1029/2012GL052426, 6 p. GCCC Digital Publication #12-15.

**Abstract:**

A critical issue for geologic carbon sequestration is the ability to detect CO<sub>2</sub> in the vadose zone. Here we present a new process-based approach to identify CO<sub>2</sub> that has leaked from deep geologic storage reservoirs into the shallow subsurface. Whereas current CO<sub>2</sub> concentration-based methods require years of background measurements to quantify variability of natural vadose zone CO<sub>2</sub>, this new approach examines chemical relationships between vadose zone N<sub>2</sub>, O<sub>2</sub>, CO<sub>2</sub>, and CH<sub>4</sub> to promptly distinguish a leakage signal from natural vadose zone CO<sub>2</sub>. The method uses sequential inspection of the following gas concentration relationships: 1) O<sub>2</sub> versus CO<sub>2</sub> to distinguish in-situ vadose zone background processes (biologic respiration, methane oxidation, and CO<sub>2</sub> dissolution) from exogenous deep leakage input, 2) CO<sub>2</sub> versus N<sub>2</sub> to further distinguish dissolution of CO<sub>2</sub> from exogenous deep leakage input, and 3) CO<sub>2</sub> versus N<sub>2</sub>/O<sub>2</sub> to assess the degree of respiration, CH<sub>4</sub> oxidation and atmospheric mixing/dilution occurring in the system. The approach was developed at a natural CO<sub>2</sub>-rich control site and successfully applied at an engineered site where deep gases migrated into the vadose zone. The ability to identify gas leakage into the vadose zone without the need for background measurements could decrease uncertainty in leakage detection and expedite implementation of future geologic CO<sub>2</sub> storage projects.

**To access full text, please contact the author or visit:**

<http://onlinelibrary.wiley.com/doi/10.1029/2012GL052426/pdf>