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BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

DRINKING WATER RESEARCH PROGRAM

USE OF SOIL-GAS, GAS FLUX, AND GROUND-WATER MONITORING TO EVALUATE POTENTIAL LEAKAGE TO UNDERGROUND SOURCES OF DRINKING WATER, THE ATMOSPHERE, AND BUILDINGS DURING GEOLOGICAL SEQUESTRATION OF CARBON DIOXIDE

Issue:

Geological sequestration (GS) is recognized as the injection and subsequent long-term trapping of gaseous, liquid, or supercritical carbon dioxide (CO_2) in subsurface media – primarily saline formations, depleted or nearly depleted oil and gas reservoirs, and coal seams. Carbon capture, transport, and storage via GS from stationary sources of CO_2 such as refineries, and coal-fired electric, ethanol, cement, and fertilizer plants could allow continued use of fossil fuels in a manner that greatly reduces CO_2 emissions until alternative energy sources are deployed on a large scale in the coming decades.

It is widely acknowledged that leakage through transmissive faults (and associated fractures) and well penetrations (operational, non-operational, and abandoned wells) are the most likely potential pathway for CO_2 release from a storage formation at a properly selected site for GS. Leakage through transmissive faults and well penetrations could result in intrusion of CO_2 or brine into underground sources of drinking water (USDWs), release of CO_2 to the vadose zone and the atmosphere, and intrusion of CO_2 into buildings. Release of CO_2 or brine into a USDW could be accompanied by measurable alteration in pH, major ions, and mobilization of hazardous inorganics. Release of CO_2 into the vadose zone could be accompanied by compositional changes in soil gas and flux to the atmosphere. Release of CO_2 into buildings could result in increased CO_2 and potential reduction in oxygen in indoor air.

Scientific Objective:

The U.S. Environmental Protection Agency's (EPA) Water Research Program in the Office of Research and Development is conducting research to better detect and quantify leakage into USDWs, the vadose zone, the atmosphere, and buildings.

Research in this initiative is focused in three topical areas:

- **Evaluation of Leakage through Well Penetrations** Soil-gas, gas flux, and ground-water monitoring will be conducted at an enhanced oil recovery site and/or a site where CO_2 will be injected into a saline aquifer to assess the potential for leakage from well penetrations, especially abandoned wells. Measurements will be conducted near and away

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from well penetrations to detect "spot anomalies" prior to and during injection of CO_2. This concept is similar to the use of soil-gas surveys to locate gas release from faults and fractures in volcanic or geothermal areas where magna degassing or thermo-metamorphic alteration of carbonates produces large volumes of CO_2 and the use of soil-gas surveys for mineral or petroleum/natural gas exploration.

- **Gas Intrusion**
  Intrusion of sub-surface gases into buildings will be evaluated at a housing division near Wichita, Kansas where depletion of oxygen and buildup of CO_2 has been documented in indoor air after a heavy infiltration event. This study will serve as a natural analogue to evaluate potential CO_2 intrusion into buildings due to GS. During commercial application of GS, it will be necessary to have a protocol to discern the cause of elevated levels of CO_2 to avoid an unnecessary shut down of a GS system and potential public overreaction.
- **Soil-Gas Method Development**
  Despite the long-term use of soil-gas sampling to support resource exploration and hazardous waste investigations, quality assurance and control measures are poorly documented or lacking. Research on leak, purge, and gas permeability testing, will be conducted to support application of GS.

The National Risk Management Research Laboratory (NRMRL) has a long history of conducting research on subsurface gas flow (DiGiulio and Varadhan, 2001), gas and vapor intrusion (DiGiulio et al., 2006a), and soil-gas sampling (DiGiulio et al. 2006b).

Application and Impact:

The outcomes of this research, conducted through the Drinking Water Research program, will be used to develop cost-effective protocols for monitoring GS systems. Decreased cost will lead to increased implementation and protection of public health and the environment.

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