Roles of Tracers in Assuring Storage of Carbon Dioxide

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To avoid releasing carbon dioxide into the atmosphere, facilities that produce large volumes of the greenhouse gas are beginning to use carbon capture and geologic storage (CCS). Capture is currently conducted where natural gas is prepared for sale, at power plants where coal is combusted, and at refineries where CO_2 is a by-product of hydrogen production. Geologic storage at depths below and isolated from potable groundwater and land surface is a well-known and highly secure method of isolating captured CO_2 from the atmosphere for long periods of time. Storage can be coupled with current uses of CO_2 for enhanced oil recovery. However, expansion of this technology in terms of prospective large volumes and into areas where deep well injection has not been widely used raises research questions about how storage permanence can be assured.

Tracers have played an important role in addressing these questions. Natural and introduced gas- and water-soluble tracers have been effective in assessing trapping processes that assure permanence, including capillary trapping, dissolution of CO_2 into water and into hydrocarbons, and mineral trapping. Tracer breakthough curves allow assessment of fluid-flow processes through heterogeneous media and interactions with flow rate. Tracers have been used to understand leakage mechanisms both in analog and controlled release conditions to provide confidence that leakage out of storage, should it occur, can be detected.

A number of complexities and limitations in tracer performance have been identified, including nonconservative tracer behavior and other interferences among constituents in the earth system and tracers. Introduction of tracers can have downsides, including cost, difficulty in handling and sampling, and the fact that some useful tracers are themselves strong greenhouse gases. Approaches seem to require site-specific evaluation. Lastly, it is important to separate high-value approaches needed to solve problems in a research context from those to be deployed at commercial sites. Use of tracers to answer key questions surrounding disposal implies that applications must be conservative so good-quality tracers are available when needed; thus, advances in tracer science continue to be important.

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