

## Experimental Analysis and Modeling of PFT and SF<sub>6</sub> Transport in Organic Rich Vadose Zones: Implications for Monitoring CO<sub>2</sub> Leakage at CCS Sites

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Perfluorocarbon tracer compounds (PFTs) and sulfur hexafluoride (SF<sub>6</sub>) are commonly proposed tracers for use in carbon capture and sequestration (CCS) leak detection and vadose zone monitoring programs. During a tracer test, tracers are co-injected with supercritical CO<sub>2</sub> and monitored in the vadose zone to calculate leakage rates. These calculations rely on the assumption that tracers exhibit “ideal” tracer behavior- i.e. the tracer is conservative, is inert and not partitioned into or sorbed onto geologic media. This assumption has been brought into question by lab and field evaluations- e.g. Zhong and Amonette (2012) showed PFT retardation in smectite-rich sediments while Deeds et al. (2000) showed that four perfluorocarbon tracers (C<sub>7</sub>F<sub>14</sub>, C<sub>8</sub>F<sub>16</sub>, C<sub>9</sub>F<sub>18</sub>, C<sub>10</sub>F<sub>18</sub>) partitioned differentially into an unidentified LNAPL in contaminated soil in column studies with partition coefficients ranging from 8.8 +/- 0.6 to 71 +/-3. SF<sub>6</sub>, in contrast, is shown to be an ideal tracer in many different substrates. The objective of this study is to identify substrates and applications where PFT and SF<sub>6</sub> behave conservatively. We compare tracer break-through curves for PFT and SF<sub>6</sub> in one-dimensional flow through columns packed with acid-washed silica beads, calcite or organic carbon-rich soils. Based on previous studies, we expect both tracers to behave conservatively in columns packed with silica beads or calcite and but only SF<sub>6</sub> to behave conservatively in columns with added organic carbon. Dry nitrogen is used as the carrier gas and constant flow rate (2 mls/min) and temperature (26°) are maintained. A known mass of tracer is injected at the head of the 1 m-long column (1.27 cm diameter) and the effluent analyzed at regular intervals for tracers at picogram levels by a gas chromatograph with an electron capture detector. Preliminary results of laboratory column experiments are consistent with analytical modeling and confirm the conservative behavior of the control tracer, SF<sub>6</sub>, in columns packed with silica beads, calcite or left empty and conservative behavior of C<sub>6</sub>F<sub>12</sub> in columns packed with silica beads or left empty.

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