The U-Tube: A Novel System for Sampling and Analyzing Multi-phase Borehole Fluid Samples during the Frio Brine Pilot Test

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Abstract

A novel system has been deployed to sample and analyze multiphase fluids during a geologic CO_2 sequestration experiment conducted in the Frio brine aquifer in Liberty County, Texas. Project goals required high frequency recovery of representative and uncontaminated aliquots of a rapidly changing two-phase (supercritical CO_2-brine) fluid from 1.5 km depth. The data sets, collected using both the liquid and gas portions of the downhole samples, provide insights into the coupled hydro-geochemical issues affecting CO_2 sequestration in brine formations. The U-tube consists of a continuous loop of tubing open to the formation using a check valve. High purity compressed nitrogen is used to close the downhole check valve and drive the sample to the surface. The sample is collected at formation pressure, preventing degassing and contamination with outside gases, which would lead to rapid changes in sample chemistry. While the basic premise underlying the U-Tube sampler is not new, the system is unique because careful consideration was given to the processing of the recovered two-phase fluids. More specifically, strain gages mounted beneath the high-pressure surface sample cylinders measure the ratio of recovered brine to supercritical CO_2. A quadrupole mass spectrometer provided real-time gas analysis for perfluorocarbon and noble gas tracers that were injected along with the CO_2. The U-Tube successfully acquired frequent samples, allowing accurate delineation of the arrival of the CO_2 plume, and on-site analysis revealed rapid changes in geochemical conditions.

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