Establishing high resolution chemical and isotopic baseline conditions in a shallow bedrock aquifer in southern Alberta, Canada

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Geological storage of CO_2 and hydraulic fracturing associated with shale gas development have the potential to cause mobilization of entrapped gases and subsequent leakage into shallow groundwater. To detect gas migration and determine impacts on shallow aquifers from anthropogenic activities, a scientifically reliable baseline assessment of subsurface gas distributions is required in the fresh groundwater zone. This study has the objective of developing depth-resolved chemical and isotopic baseline assessments of the shallow groundwater in an area where potential gas migration will be investigated in the future.

CMC Research Institutes Inc. has established a multi-disciplinary field research site dedicated to advancing state-of-the-science approaches for monitoring gas migration. The site is comprised of one 300m deep gas injection well, two 350m deep monitoring wells, a 65m deep domestic water well and a depth-discrete multi-level Westbay™ system with 26 sampling ports distributed throughout the uppermost 106 m. Carbon isotope ratio depth-profiles for methane were determined in the uppermost 106 m of the silty sandstone/ coal bedrock using 15 mud gas samples, 300 cuttings and crushed rock core samples in Isojars and VOA vials and 14 intact rock cores in degassing cells. Bi-annually Westbay and bi-monthly domestic well groundwater samples have also been collected and analyzed. The C isotope ratios and trends were consistent between all methods and reveal $\delta^{13}C$-CH_4 values for the upper 106 m range naturally from -85‰ to -65‰, indicating a biogenic origin of the methane. Aqueous geochemistry data suggest that the shallow aquifer is at favourable redox conditions for in-situ methanogenesis. The outcome of this research will be an unprecedented depth-resolved baseline characterization of the shallow groundwater, against which future fugitive gas migration impacts can be tested.