Establishing chemical and isotopic baseline conditions in a shallow bedrock aquifer at a gas migration field research station in south-eastern Alberta, Canada

T. Cheung, B. L. Parker, J. A. Cherry, L. Halwa
G360 Centre for Applied Groundwater Research, University of Guelph, Ontario, Canada (Email: terri.cheung@g360group.org)
B. Mayer, M. Nightingale, M. Shevalier, S. Taylor
Applied Geochemistry Group, Department of Geoscience, University of Calgary, Calgary, Alberta, Canada
W. Kloppmann
Bureau de Recherches Géologiques et Minières, Orléans, France
D. Lawton
CMC Research Institutes Inc., Alberta, Canada

ABSTRACT
Subsurface storage of CO_2 and hydraulic fracturing of shale gas has the potential to cause adverse environmental impacts due to mobilization of entrapped gases into shallow groundwater. To detect gas migration and determine impacts from anthropogenic activities, a scientifically reliable baseline assessment of subsurface gas distribution is required. The objective of this ongoing study is to develop depth-resolved chemical and isotopic baseline assessments of the fresh groundwater zone in an area where gas migration will be investigated in the future.
CMC Research Institutes Inc. (CMC) has established a multi-disciplinary field research site dedicated to advancing state-of-the-science approaches for gas migration monitoring. Currently 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. From borehole drilling, methane depth-profiles of C isotope ratios were determined using multiple approaches: (1) mud gas samples in Isotubes, (2) outgassing of cuttings and crushed rock core in Isojars and VOA vials and (3) intact rock cores in degassing cells. The C isotope ratios and trends were consistent between methods and reveal $\delta^{13}C$-CH_4 values for the upper 106 m range naturally from -85‰ to -65‰, indicating a biogenic origin. Additionally, quarterly Westbay and bi-monthly domestic well groundwater samples have been collected and analyzed. The Westbay well $\delta^{13}C$ values of dissolved methane in samples follow a similar trend to rock core sample results, although some samples were enriched in ^{13}C. Aqueous geochemistry data from the Westbay ports and the landowner well samples suggests the groundwater 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.

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