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Geochemistry of groundwater in the Saint-Édouard area, Quebec, Canada, and its influence on the distribution of methane in shallow aquifers

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Abstract

Shale gas and tight oil production has undergone a tremendous increase in the last decade in North America, which was accompanied by animated scientific debate and local public uproar concerning environmental issues, especially the risks of contamination for shallow groundwater resources. In Québec (eastern Canada), public concerns led to a *de facto* moratorium on hydraulic fracturing in 2010 for the St. Lawrence Lowlands, where the underlying Utica Shale is known to contain significant gas resources. As only a few exploration gas wells have been drilled, this vast area may still be considered “virgin”. In 2012, a 4-year project was initiated by the Geological Survey of Canada, which aimed at characterizing aquifer vulnerability to deep industrial activities in the Saint-Édouard region, located close to Quebec City in the St. Lawrence Lowlands. As part of this project, a baseline study of hydrocarbons and other geochemical parameters was conducted in shallow aquifers. This paper presents groundwater geochemical characteristics in the region and assesses the geological, hydrogeological and geochemical controls on methane distribution.

Results show that methane is present in 96% of the 48 sampling points over the 500 km² study area, and that concentrations are highly variable (from undetected (<0.006 mg/L) to above 80 mg/L), sometimes over short distances and through time. Methane concentrations appear to be related to bedrock geology and to specific hydrogeochemical conditions, such as those found below the active groundwater flow zone (0-30 m within bedrock), where relatively old, chemically evolved water is found under semi-confined to confined conditions. Two main fault zones are well documented in the area, and there is clear evidence that some deep formation brines, in addition to marine water originating from the Champlain Sea, are migrating into shallow aquifers in the vicinity of one of them. This saline groundwater contribution is

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