The geochemical characterization of shallow groundwater flow systems for identifying fugitive methane and potential water quality impacts

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There is significant concern over the potential impacts of methane migration to shallow groundwater systems from thermogenic sources at depth in areas of hydrocarbon production. Identifying fugitive methane that has migrated from depth and discerning it from local or shallow sourced biogenic methane is important for identifying cause and attributing impacts. In northeast British Columbia significant conventional and unconventional gas devlopment has been conducted and continues to be a major resource exploitation factor in the region. The unconventional production is largely through fracking of horizontal wells and because the area has a long history of hydrocarbon extraction there are many abandoned wells. These two factors have lead to the allocation of substantial resources for flow and geochemical characterization, development of monitoring infrastructure and identifying potential water quality impacts. In this study we report on the geochemical characterization of the groundwater flow systems to establish baseline conditions and define both the fugitive and local methane impacts on water chemistry. Over 300 groundwater wells and springs were sampled for chemical and isotopic composition. Of those, over half have been sampled for dissolved gas chemistry and the $\delta^{13}C$ as well as $\delta^{2}H$ of methane where present in sufficiently high concentrations. Groundwater from the shallow unconsolidated glacial and interglacial sediment flow systems tends to be of a higher oxidation state with a Ca-Mg-HCO_3-(SO_4) type composition and low to no methane. The Cretaceous shale and sandstone bedrock sourced groundwater is of a lower oxidation state, is a Na-HCO_3-(SO_4) type and commonly contains methane. Isotopes suggest that the majority of the methane is local with a shallow biogenic origin.