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Composition and origin of gas associated with high pH waters within the Mid-Continent Rift in Minnesota (USA)

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H_2 emissions have long been studied at plate boundaries, in contexts where serpentinization of ultramafic to mafic rocks is believed to be dominant. Several studies have shown that occurrences of H_2 emissions are also recorded within intracratonic areas where the origin of the gas has yet to be determined.

The Mid-Continent Rift extends from Kansas to the Lake Superior region. It is a Precambrian aborted rift from 1.1 Ga composed of a multi-kilometric scale accumulation of mafic rocks. The southernmost part of the rift has been studied in Kansas because of occurrences of H_2 emissions in old wells. Water and gas associated with this H_2 have been analyzed and show that pH is almost neutral (7.4), the Fe content in the fluid is high (1.1mM) and He from crustal origin is present up to 2.9% (Guélard et al., 2016). The northernmost part of the rift, in Minnesota, is outcropping and no gas wells have been studied so far. Only a few public water wells have been analyzed which showed the pH was highly basic. Such pH is known to be typical of H_2 production by serpentinization of mafic rocks and is a key parameter in hydrogen exploration.

Following a field sampling survey within the mafic rocks of Minnesota, wells presenting free gas or water with dissolved gas were sampled. Characterizing natural gas associated with intracratonic areas and being able to identify the origin of these gas are of major importance to provide key information for future natural gas exploration. The gas collected and analyzed by GC are composed of CH_4 (up to 10%), CO_2 (up to 2500 ppm), and C_2H_6. No H_2 was detected in the gas phase. However, high pH (up to 11.4) and very low Eh (down to -300 mV) suggest redox reactions may have taken place. Isotopic compositions in $\delta^{13}C$ of CO_2, CH_4, and C_2H_6 and in δD of CH_4 were characterized by GC-C-IRMS. These analyses associated with noble gas studies and water chemistry will allow us to discuss the origin of these gases and to determine if there might have been a past presence of H_2.