Native H_2 generation by alteration of Fe-rich olivine within the Precambrian granitoid crust in Kansas (USA)

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Studies of natural hydrogen generation have until now been mainly focused on ultramafic to mafic rocks at mid-oceanic ridges and their onshore equivalent, ophiolitic complexes, that may produce H_2 during serpentinisation processes. Nevertheless, several studies have shown that hydrogen occurrences also appear at the center of continents, in geologic formations with underlying cratonic basement. The aim of this study is to better understand the role of basement rocks in producing native H_2 through redox reactions.

Drill cores were obtained from the H_2-emitting DR1-A well, located in Kansas (USA). In this area the basement is mainly composed of Precambrian granite. The Mid-Continent Rift System, a 1.1 Ga crustal fracture filled with basalt and gabbro, is part of this Precambrian basement.

Petrographic observations of samples from a depth of 452 m within the basement show fractured olivine associated with amphibole, pyroxene, feldspar, quartz and oxide. Scanning Electron Microscopy allowed us to identify fractured and altered Fe-rich olivine (fayalite, Fe_2SiO_4), filled with two types of phyllosilicates, and iron oxide. Focused Ion Beam (FIB) thin sections were cut into the samples and analyzed with Transmission Electron Microscopy. Results show that both phyllosilicates have high Fe/(Fe+Mg) ratio, with one being enriched in Fe compared to the other. A more precise characterization of secondary minerals and Fe-valence characterization with STXM is in progress.

Although atypical in such geological context, the presence of fayalite and its alteration products, correspond to a good candidate for local generation of H_2. Furthermore, Precambrian granites, rich in ferromagnesian minerals, are present on every continent. They could correspond to potential mineral sources for native hydrogen production through redox reactions.

Mots-Clés : Hydrogen, Precambrian, granite, fayalite

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