

A multiscale petrology study on Fe-rich clays minerals in fayalite-bearing gabbros within the Kansas (USA) Precambrian basement: an attempt to quantify natural hydrogen generated

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Natural hydrogen (H₂) generation has long been believed to only occur during the serpentinization of ultramafic to mafic rocks at mid-oceanic ridges. Nevertheless, several studies have shown that natural H₂ could also be generated within ancient cratonic basements located in the middle of continents. To date, the mechanisms, and quantities of H₂ generated within basements remain poorly understood. Here, we report the study of drill cores from the DR1-A well which reaches the Kansas (USA) Precambrian basement, where high concentrations of native H₂ emissions have been detected^[1].

The studied area consists of iron-rich monzo-gabbro. A multi-scale petrological study, including SEM, TEM, and STXM-XANES performed on FIB-thin sections of two samples (K1, K2) shows that the DR1-A well reaches a part of the Mid-Rift System, a Precambrian aborted rift from 1.1 Ga. The monzo-gabbro is composed of feldspars, fayalite (the iron-rich end-member of olivine), ferrosilite (the iron-rich end-member of orthopyroxene), iron-rich amphiboles, and iron-rich clays minerals. This study has shown these clay minerals might have been formed during two distinct events: 1) a late magmatic event, a process called deuteric alteration, leading to the metasomatic replacement of fayalite by a first generation of clay minerals enriched in ferric iron, and 2) a post deuteric alteration at lower temperatures and new redox conditions leading to the formation of a second generation of clay minerals enriched in ferrous iron.

In order to establish a link between these clay minerals and the documented hydrogen emissions we performed quantitative compositional mapping of the K2 sample by EMPA. Data were processed using XMaptools 4.1^[2,3]. The two primary iron-rich minerals are replaced specifically: (i) olivine by serpentine (ii) orthopyroxene by amphibole. For each reaction, respective mass transfer and associated solid volume variation were obtained to estimate element behavior and redox conditions. Results show that both reactions have similar redox conditions

[1] Guélard et al (2017) *G³* **18(5)**, 1841-1865. [2] Lanari et al (2014) *Comput Geosciences*, **62**, 227-240. [3] Lanari et al (2019) *Geological Society, London*, **478(1)**, 39-63.