

Catalytic role of minor phases from ultramafic environments on the H₂ production by serpentinization: Electrochemical tests and hydrothermal experiments

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One of the key solutions for our energetic transition is based on the utilization of the di-hydrogen (H₂) as an energetic vector. Carbon-free H₂ is currently principally provided by water electrolysis from renewable electricity and is still very expensive and energy-intensive to produce. Alternatively, natural sources of H₂ exist all around the earth and are mainly associated with the serpentinization of (ultra)mafic-rocks. These natural H₂ fluxes are observed in a large range of temperature (50 – 400 °C) pressure (atm – 3 kbar), and pH (3-11) fluid conditions. H₂ concentrations can be highly variable from one place to another, even if the observed conditions seem similar.

To be able to plan native H₂ exploitation (in situ or ex situ), we need to understand the origin of these concentration variations, and a privileged track may be linked to the presence of secondary phases with catalytic effect.

In this study, we investigate the potential role of natural minerals presents in the ultramafic environment, as catalysts of H₂ production. We used an electrochemical approach, based on cyclic-voltammetry to identify and compare the catalytic efficiencies of a selected mineral list at ambient conditions. Voltammograms show a catalytic efficiency for H₂ formation of several phases with the strongest efficiency for magnetite, chalcopyrite, and hematite. Magnetite and chalcopyrite (10 g) were selected to be tested at 300 °C-300 bars with peridotite (30 g from Borée) fine powder (150-40 microns) in a 0.5 M NaCl solution into a titanium cell during 4 months. Fluids analysis shows an enhanced H₂ production (one of the highest disponible in the literature at this duration and grain size) with magnetite (16 mmol/kg) compared to magnetite-free experiments (3 mmol/kg), while in presence of chalcopyrite H₂ production is lowered (1.6 mmol/kg). Solids analysis showed in both cases an indurated rocky powder with petrological texture and serpentinization fronts displaying multi-scaled spherical porosities mostly associated with the location of catalysts clusters. Deeper solid analyses are in progress, notably to estimate the potential alteration of catalysts during the experiments.

Mots-Clés : Native Hydrogen, catalyze, serpentinization

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