The role of metallic cation in H_2 production during hydrothermal reactions

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Serpentinisation reaction is well known to produce large amounts of H_2 venting from hydrothermal chimneys via the coupled Fe(II) oxidation / water reduction. This H_2 production has important consequences since, for example, it is responsible for the reduction of carbon, providing methane and other reduced carbon compounds, but also can feed some microbial communities at depth. Discovery of hydrogen seepages within the continental lithosphere away from ophiolitic systems has opened a lot of questions concerning the origin of this gas and the mechanisms at the origin of such a production. It also points to possibilities for native H_2 exploration.

Fe-rich olivine is so far the best candidate to allow H_2 production during hydrothermal Fe alteration. Zn incorporated into spinel (gahnite) phases has shown a catalytic potential for H_2 production (Mayhew et al., 2013). In order to understand the role of some metallic cations, that can be incorporated into olivine and spinel phases, we have performed analogic water-rock interactions experiments using transition metal oxides as starting material. Multiple runs mixing various amounts of FeO and MnO, NiO or ZnO were conducted in gold tubes placed within a batch reactor for 1 and 3 weeks, at 300°C, and 300 bar. Analyses of the gases, extracted from the capsule under vacuum, were performed after the reaction by gas chromatography. Solid sample were then recovered and analysed by SEM and XRD. While some metallic cations do not affect significantly H_2 production by FeO oxidation (Mn for example), others (such as Ni) have a strong effect. The mechanisms implied will be discussed.