

## Serpentinization and potential for natural hydrogen in North-Western Pyrenees

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Interest for natural hydrogen (H<sub>2</sub>) is increasing with the development of renewable energies to reduce carbon emissions. Natural H<sub>2</sub> produced from hydrothermal alteration of ultramafic rocks is a well-known process at mid-ocean ridges. Recent studies indicate the potential production of large volumes of H<sub>2</sub> in continental settings (e.g., [1]), yet the PTX conditions at which these H<sub>2</sub>-forming reactions take place are still poorly understood. We studied serpentinites and their protolith from three spinel-bearing lherzolite massifs located in the North-Western Pyrenees, Montaut, Urdach and Turon de la Técoüère (Turon), to assess their potential H<sub>2</sub> production, using a combined mineralogical (Raman, XRD, magnetic susceptibility), petro-structural (EBSD) and geochemical (EPMA, XRF, ICP-MS) approach.

Studied peridotites have olivine Fo contents ranging from 89 (fertile lherzolites) to 91 (clinopyroxene-poor lherzolites) and TiO<sub>2</sub> <0.2 wt% in the three massifs, suggesting a similar protolith. The three massifs are however distinguished by their degree of serpentinization and by the morphology and composition of serpentines. Turon comprises variably serpentinized (10-100%) and mylonitized lherzolites, Montaut presents highly serpentinized (60-80%) and variably weathered peridotites, while Urdach is 100% serpentinized except for ophicalcites from the south of the massif (60% serpentinization). Bastite and mesh serpentine are ubiquitous except in the ultramylonites from Turon. Montaut is distinguished by multiple generations of serpentine veins whilst veins observed in Urdach and Turon are smaller and less diverse. The most striking feature is the difference in the distribution of Fe between serpentine and magnetite from one massif to the other, independently of their degree of serpentinization: (1) Montaut lherzolites and Urdach ophicalcites have Fe-poor (<5 wt%) serpentines but contain abundant magnetite (up to 2-3% for Montaut), (2) Turon mylonites and Urdach serpentinites contain Fe-rich (>5 wt%) serpentines but little magnetite. Low temperature (< 200°C, e.g., [2]) hinders the formation of magnetite. The variable distribution of Fe suggests distinctive thermal regimes of (incipient) serpentinization/exhumation between the three massifs: hot for Montaut, transitional for Urdach and cold for Turon. These preliminary results suggest also different reaction paths and efficiency for H<sub>2</sub> production.

[1] Sherwood Lollar et al, *Nature*, 516: 379-382, 2014; [2] Klein Frieder et al, *Lithos*, 178: 55- 69, 2013.