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Exploring for natural H_2 in the North Western Pyrenean foothills

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The existence of geological fluids rich in hydrogen (H_2) raises the question about the energy potential of this carbon-free resource (Truche et al., 2020). However, to date there is no exploration strategy based on robust methodologies and pathfinders. Therefore, it is important to develop an exploration guide that is not only focused on surface gas monitoring, but that also considers the local deep geological setting integrating the entire hydrogen system from source to trap or leakage into the atmosphere.

We present new geochemical and geophysical data recorded at both the regional (7500 km^2) and local (1 km^2) scales in the North Western Pyrenean foothills (France). This region is under post-orogenic extension and may serve as a natural laboratory to developpe the technologies required for natural hydrogen exploration. The presence of i) an ultramafic mantle body located less than 10 km depth and under pressure-temperature conditions favorable to serpentinization; ii) major faults such as the North Pyrenean Frontal Thrust constituting large-scale fluid flow convergence and drainage; iii) hydraulic gradients due to the presence of strong reliefs, combined with temperature and pressure gradients that trigger fluids migration; and iv) impermeable sedimentary formations or caprocks such as evaporites or claystones overlying porous reservoir rocks , may constitute a fertile geological settings with respect to deep-seated H_2 generation, migration and entrapment. Thanks to an extensive soil gas (H_2, CH_4, CO_2, H_2, ^{222}Rn) exploration survey, we have discovered several hotspots along the North Pyrenean Frontal Thrust where H_2 is enriched at > 500 ppm together with high CO_2 (> 10 vol%) and ^{222}Rn (> 50 kBeq/m^3) concentrations in soils (Lefeuvre et al., 2021).

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