Integrated Petro-physical Modeling of Serpentinized Mantle: Implications for Natural Hydrogen Generation

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Résumé

Among the key mechanisms identified for natural hydrogen production, active serpentinization of shallow mantle rocks is considered a major contributor. This process requires both the hydration of peridotitic rocks and favorable temperatures with maximum rates of H2 generation from 200 to 300∘C, where serpentinization reactions are thermodynamically favorable. Constraining the hydrogen production potential of a mantle body therefore requires first estimating both its degree of serpentinization and the temperature conditions to which it is subjected. To address this, we use LitMod2D_2.0, a forward modeling software that integrates geophysical and petrological data to simulate the thermal structure, density distribution, and seismic wave velocities in 2D. Mantle properties are calculated based on bulk rock compositions, allowing us to account for possible hydration and serpentinization. Mineralogical assemblages and physical properties of the mantle are computed using the Generator_Mantle module, which incorporates Perple_X thermodynamic modeling. We applied this integrated petrophysical modeling approach to two collisional orogens where the presence of a shallow mantle body has been demonstrated: the Taiwan and the Pyrenean collision zones. These case studies illustrate how such modeling can provide valuable insights into the processes controlling natural hydrogen production and help assess the hydrogen potential in collisional settings where mantle rocks are present at shallow depth (_˜10km depth).

Mots-Clés: Taiwan, Pyrénées, collision, hydrogen emanations, serpentinized mantle

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