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Estimation of Orange Hydrogen Production from Basalt rock formation based on the Mineral Powder Experimental Results

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Natural hydrogen refers to hydrogen generated through the decomposition of high-temperature water within underground rock formations via various mechanisms. Orange hydrogen, on the other hand, is produced artificially by inducing serpentinization reactions in ultramafic rock formation rich in olivine. Since ultramafic rocks comprise diverse minerals, including olivine, it is essential to consider the effects of individual minerals on serpentinization to accurately predict hydrogen production.

This study estimates the hydrogen production from orange hydrogen based on the mineral composition of basalt, a representative ultramafic rock, using experimental data from published literature. The experiments measured hydrogen yields by reacting powdered olivine, silica, and spinel with water under conditions of approximately 300°C and 3 kbar. The results indicated that spinel increased hydrogen production, whereas silica significantly reduced it. In experiments involving olivine, pyroxene, and spinel, 119 mmol/kg of hydrogen was produced

Using these results, hydrogen production from basalt was estimated. The basalt core from Idaho, USA, consisted of plagioclase (48.5%), olivine (13.8%), pyroxene (24.9%), and orthoclase (4.7%). Applying experimental findings, the estimated hydrogen yield per unit volume of rock was approximately 180 g/m^3, while estimates based on the serpentinization reaction formula suggested a yield of about 400 g/m^3. Assuming orange hydrogen production from a basalt formation being analogue to a SAGD well pattern size of 1000 m × 100 m × 50 m, a typical steam injection oil recovery process with the same mineral composition, the hydrogen yield is estimated to be 900 tons based on experimental data and 2000 tons using the reaction formula.

The differences in hydrogen yield arise from the exclusion of effects from other minerals and considering only the olivine-water reaction during serpentinization. Additionally, since the experimental analysis utilized powdered minerals, the broader contact area with water might have led to overestimated hydrogen production compared to actual field conditions. Therefore, future studies should not only account for the rock-forming mineral composition but also consider factors like rock permeability and potential clogging phenomena during hydrothermal reactions to evaluate the reliable prediction of hydrogen production.