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Geospatial Assessment of Geologic Hydrogen Resources in non-Felsic Igneous and Metamorphic Rocks of the United States

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Recent prospectivity mapping by USGS [1] identified promising regions for geological hydrogen exploration across the conterminous US, delineating where hydrogen-generating rocks may exist. Estimating hydrogen production potential, however, requires coupling rock geochemistry to local pressure, temperature, and brine composition. We present a novel workflow integrating geochemical modeling with geostatistical interpolation to constrain hydrogen generation potential across ultramafic, mafic, and metamorphic formations.

We compiled mineral major oxide compositions (olivine, clinopyroxene, orthopyroxene, feldspar, ilmenite, chromite, spinel, garnet, and glass) from PetDB, GEOROC-GeoReM, and in-house Twin Sisters dunite measurements [2], together with reservoir bulk compositions, water chemistry, and depositional environment data to characterize the subsurface redox conditions controlling hydrogen solubility in brine. Mineral formula recalculation in MinplotX [3],[4] provides endmember distributions feeding into Reaktoro [5] batch simulations of serpentinization under varying pressure-temperature-composition conditions. Subsurface temperatures come from the Stanford Thermal Earth Model [6], while pressure estimates draw on density profiles from state land commission well logs and USArray seismic data. Sample locations are overlaid onto USGS State Geologic Map Compilation polygons, with kriging constrained by lithologic boundaries used to interpolate compositions spatially. The resulting maps yield probabilistic estimates of hydrogen solubility and thermal energy released during serpentinization. This framework offers a path toward ranking prospective plays and guiding exploration decisions.

References

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