Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29089

Geomagnetic field induced anisotropic hydrous texture at Earth's lowermost mantle

SHICHUAN SUN[1], SIMON REDFERN[1], HEPING LI[2] AND YU HE[3]

[1]Nanyang Technological University
[2]Key Laboratory of High Temperature and High Pressure Study of the Earth's Interior, Institute of Geochemistry, Chinese Academy of Sciences
[3]Institute of Geochemistry Chinese Academy of Sciences

We combine *Ab Initio* Molecular Dynamics (AIMD) and machine learning-based potential modeling to investigate the seismic and geodynamic roles of superionic py-FeO_2H_x and δ-AlOOH under D″ conditions. By simulating a range of pressure–temperature regimes relevant to the lowermost mantle, we reveal that superionic py-FeO_2H_x exhibits notable velocity softening and high density, providing new clues to the low shear-wave speeds observed in Large Low Shear Velocity Provinces (LLSVPs) and Ultra-Low Velocity Zone (ULVZ). Meanwhile, δ-AlOOH displays faster-than-average wave speeds and strong shear-wave anisotropy, providing a plausible explanation for the distinct D″ anisotropy signals. Remarkably, our results also show that external electromagnetic fields induce anisotropic proton diffusion in δ-AlOOH, hinting at a potential mechanism for hydrous texture formation and water transport deep within the mantle. Taken together, these findings suggest that a py-FeO_2H_x–δ-AlOOH assemblage may account for key seismic signatures and guide our understanding of the compositional evolution of upwelling plumes in the D″ region. By integrating first-principles calculations, machine learning potentials, and electromagnetic field effects, our study establishes a framework for linking hydrous phase transitions, deep water cycling, and geophysical observations in the lowermost mantle.