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Mineral reservoirs and behaviors of hydrogen in Earth's lower mantle

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The incorporation of H into minerals imposes profound effects on their physicochemical signatures of the solid Earth. The locations of hydrogen reservoirs are detected by seismology. However, the mineral responsible for storing large quantity of hydrogen, particularly in Earth's lower mantle is still controversial. Combining a set of in-situ probes at high pressure-temperature and first principles simulation, we investigated the solubility and behaviors of H in silica and hydroxide up to the conditions found at the core-mantle boundary. The solubility of hydrogen keeps high in those minerals even along the mantle geotherm. Under deep lower mantle pressures, hydrogen atoms are free from the hydroxyl bonding and becomes highly diffusive. The swift diffusion of hydrogen ions induces soaring electrical conductivity when the sample is laser heated. Those exotic properties indicate novel transport mechanisms for both charge and mass at Earth's deep lower mantle. The potential of hydrogen enriched volatile reservoirs may carry major impacts on the electrical and magnetic behaviors, as well as redox, H isotopic mixing, and other geochemical processes in the Earth's deep interiors.