

Experimental Determination of Hydrogen Solubility in Silicate Magma Oceans

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To interpret and contextualize atmospheric spectra of exoplanets collected by JWST, understanding how solid/liquid planets and their atmospheres co-evolve is crucial. However, geochemical models that are applied to exoplanets are based on chemistry and petrological relationships calibrated on Earth-like systems, many of which are still not well understood. Notably, H_2 is the most abundant species in primary (nebula-derived) planetary atmospheres that may be in direct contact with magma oceans for an extended time. The models needed to interpret exoplanet atmospheric data depend on the solubility of H in molten rock, but studies of such reduced volatiles in high-pressure and high-temperature silicate liquids are scarce. We present the results of hydrogen solubility experiments performed on silicate compositions at high and ambient pressures and in multiple apparatuses to help improve our understanding of the water (*sensu lato*) budgets of terrestrial planets. Through Fourier-Transform infrared spectroscopy (FTIR) analysis of quenched glasses, we determined that OH^- is the dominant species in equilibrium with $H_2(g)$ at 1-bar conditions and that the amount of dissolved H-bearing species increases with the square root of H_2O fugacity. We show that extrapolating an existing model of hydrogen solubility relationships in more evolved silicate liquids to mantle-like compositions is likely not valid. We use Bayesian parameter estimation to derive a robust hydrogen solubility law for low pressures and use it to estimate the amount of hydrogen that can dissolve into rocky planets that form in the presence of the nebular disk.