Coupling Geochemistry to Magnetic Induction, Gravity, and Seismology in Icy Ocean Worlds

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In icy ocean worlds the hydrosphere comprises a major fraction of the bulk volume. For example, Ganymede’s H_2O-rich shell occupies about 75% of its total volume. To understand the global geophysical properties of such worlds thus requires information on the petrology and geochemistry of ices and fluids in detail commensurate to the sensitivity of planned geophysical investigations. However, with the planned implementation within less than 16 years of the *Europa Clipper*, *JUICE*, and *Dragonfly* missions to Europa, Ganymede, and Titan, respectively, key information is almost entirely absent. Electrical conductivity data to significant pressures are only available for aqueous $MgSO_4$, but NaCl may be a more likely main component of the oceans. Most available data extend only to very low salinity and modest temperatures. Adding to this difficulty, ice hydrates are likely to trap significant amounts of ionic material, but the thermodynamic and seismic properties of such materials have not been studied extensively. We have developed geophysical models for icy ocean worlds that incorporate available thermodynamic data, allowing us to evaluate the radial structures for different assumed compositions and thermal states. By exploring the bounds placed by available and yet-to-be-obtained geophysical data, this forward modeling approach helps to identify which experimental measurements are most needed.

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