Evolution of volatiles from Europa's interior into its ocean

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Introduction and Methods

Jupiter's moon Europa hosts a >100 km deep ocean beneath its 3 – 30 km ice shell [e.g. 1]. Key to understanding the habitability of Europa's ocean is its composition and origin. We explore an endogenous origin for Europa's earliest ocean. Specifically, we consider ocean build-up by volatile exsolution from volatile-bearing mineral destabilization, caused by thermal metamorphism during planetary differentiation and Europa's tidal-orbital evolution in the Jovian system. We use Gibbs energy minimization program `Perple_X` [2] to model the stability of minerals and fluids, and quantify the mass and composition of exsolved volatiles.

Results and Discussion

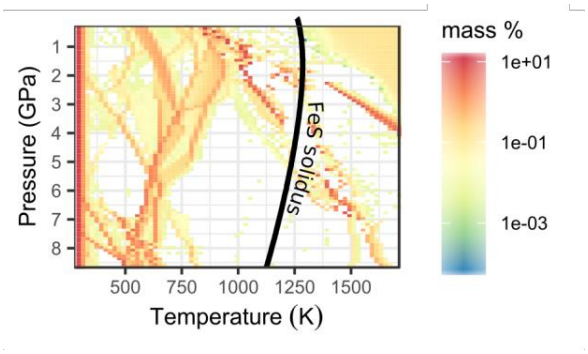

Figure 1: Mass percent of fluid and melt extracted from the rocky interior of Europa as a result of isobaric heating in the interior. The minimum temperature achieved in Europa's interior is the FeS solidus, because Europa is differentiated; thus, we constrain a minimum mass of exsolved fluid.

Testing different initial chondritic compositions and retained-to-extracted fluid ratios, we find that Europa's ocean could be entirely built from volatile (mainly H_2O) exsolution, and may have evolved from sulfate- to chloride-rich from accretion until the present day. *[JPL-Caltech under contract from NASA. Government sponsorship acknowledged.]*

[1] Hendrix, A. R. et al. (2018). The NASA Roadmap to Ocean Worlds. *Astrobiology*, **19(1)**, 1–27. [2] Connolly J. A. D. (2009) *G*^{3} **10**, Q10014.