Modelling the Rock-Water Interactions in the Sub-surface Environment of Enceladus

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Understanding the geochemical cycles occuring at the rock-water interface on Enceladus is crucial in establishing the potential habitability of the sub-surface environment. The work to be presented focuses on the early ocean's interaction with the silicate interior, with future work exploring the modern-day sub-surface environment on Enceladus.

In preliminary studies we have used thermochemical modelling (CHIM-XPT) [1] to determine the chemical composition of the sub-surface ocean. The modelling focuses on the interaction of an 'initial' ocean chemistry with a defined silicate interior [2] to generate a modern ocean composition. We have defined the chemistry for the silicate interior based upon the chemical composition of a CI carbonaceous chondrite [3].

In the preliminary modelling we have used two different 'initial' compositions for the sub-surface ocean that represent different theories on its origin. The first uses a dilute sodium chloride solution, based upon the assumption that the sub-surface ocean originated as almost pure water [4]. The second is based upon the assumption that the water originated from melted cometary ice [5], with a cometary composition based upon data collected from 67P [6]. We have explored the full temperature and pressure ranges anticipated at the rock-water interface. We will present the results from this preliminary modelling, the output of which will generate a modern-day ocean composition. This will be used in subsequent modelling and simulation experiments.

We then plan to model the modern-day sub-surface environment to understand the full range of chemical cycles occurring at the rock-water interface. We will use the sub-surface ocean composition determined by the preliminary modelling and the chemistry for the silicate interior that has already been defined. This work will have a specific focus on carbon cycling occurring within the sub-surface environment, gaining a better understanding about the potential habitability of this environment.

References: [1] Reed, M. H., Spycher, N. F., Palandri, J., (2010) User guide for CHIM-XPT, University of Oregon, Oregon [2] Hamp R. E. et al., (2019), 50th LPSC 2019, Abstract **1091** [3] Zolotov, M., (2007) *Geophys Res Let*, L23203 [4] Brown R. H. et al, (2006) *Science*, **311**, 1425-1428 [5] Neveu, M., et al., (2017) *Geochim et Cosmochim*, **212**, 324-371 [6] Hertier K. H., et al., (2017) *RAS monthly notices*, **469**