



## Modelling the volatile and organic content of Enceladus' ocean

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A variety of Cassini data on Enceladus suggest that the jets of material spraying out of the south polar region of this Saturnian moon are connected to a regional or global ocean below an icy crust—an ocean in contact with a rocky core [1, 2, 3]. In this study we construct models of the mineralogical and elemental composition of Enceladus' rocky core so as to predict the abundance of species that may provide more detail on the extent of hydrothermal evolution of the ocean and its interaction with the rocky core. Using equations of state of the relevant material, the models are made consistent with the values of the gravity coefficients [1]. We investigate the amount of organic molecules (amino acids and fatty acids) as well as the amount of  $^{40}\text{Ar}$  that could be present in Enceladus' deep ocean and, therefore, in the icy grains expelled into space.

Some models show that the conditions in Enceladus rocky core can be very similar to those existing in the Earth's oceanic crust, suggesting that all of Enceladus rocky core would have been leached over the age of the solar system. The amount of  $^{40}\text{Ar}$  dissolved in the ocean provides constraints on the amount of K in the building blocks of Enceladus, the amount of leaching of the silicate fraction, and the extent of the ocean. Based on chondritic abundances for K, we have calculated that the total potential of  $^{40}\text{Ar}$  is about  $5.6 \times 10^{12}$  kg. We also investigate the amount of organic material that would have been concentrated in the ocean. The Murchison meteorite contains about 60 ppm of amino acids, mainly glycine [4]. Assuming that all the rocky core has been leached by water, the modelled concentration of amino acids exceeds 150 ppm. Carboxylic acids were detected in the Asuka carbonaceous chondrites in Antarctica with values, for example, of 90 nmol/g of benzoic acid. Assuming this value, about 35 ppm of benzoic acid would be present in Enceladus' ocean. The concentrations are larger if the ocean is not global, but rather limited to the South Pole [1], and assuming that all the leached material is concentrated in the regional ocean (and not partially trapped elsewhere in ice). A future mission to Enceladus could eventually measure these quantities in order to assess the extent of evolution of Enceladus, and the potential presence of the building blocks of life in its ocean.

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[1] Iess L. et al. (2014) *Science*, 344, 78. [2] Porco C. et al. (2014) *The Astronomical Journal*, 148:45. [3] Hedman M. M. et al. (2013) *Nature*, 500, 182-184. [4] Sephton M.A. (2002) *Nat. Prod. Rep.*, 19, 292–311.