Geophysical Research Abstracts, Vol. 8, 09655, 2006
SRef-ID:

Hydrothermal Processes in Enceladus

D. Matson (1), J. Castillo (1), T. Johnson (1) and J. Lunine (2, 3)

(1) Jet Propulsion Laboratory / California Institute of Technology, Pasadena, California, USA, (2) Lunar and Planetary Laboratory, Tucson, Arizona, USA, (3) ITA-ISFI, Roma, Italy (Contact: Dennis.L.Matson@jpl.nasa.gov)

We consider possible hydrothermal processes taking place inside Enceladus. The temperatures for the hydrothermal environment are calculated from the thermal evolution model developed by Matson *et al.* (2006). We are especially interested in the characteristics and long-term evolution of the hydrosphere in which hydrothermal processes involving water in its supercritical state are likely to take place. The ejecta in the eruptive plumes in Enceladus' South Polar geyser field include a number of molecular species: $91 \pm 3\%wt.$ H_2O, $3.2 \pm 0.6\%wt.$ CO_2, $4 \pm 1\%wt.$ N_2, and $1.6 \sim 0.4\%wt.$ CH_4 (Waite *et al.* 2006). The observed molecular nitrogen can be formed by the high-temperature dissociation of ammonia, $2NH_3 \rightarrow 3H_2 + N_2$. This decomposition is expected to occur at temperatures in the range of 550 to 700 K. Methane can be produced in the same environment, at somewhat lower temperatures, via Fischer-Tropfsch reactions, but can also come from other sources (e.g., accreted from the Saturnian subnebula).

Such hydrothermal geochemistry has terrestrial analogs (*e.g.*, Broadlands, New Zealand (Giggenbach 1980); Matsukawa, N-E Japan (Yoshida 1984)).

Also, from the amount of N_2 observed, and assuming that its source is fully saturated with nitrogen we can infer the characteristics (*e.g.*, pressure and temperature) of the reservoir in which the solution last equilibrated, with implications for the geyser's mechanism. For example, from the solubility saturation data for N_2 in water, the observed value corresponds to a temperature of $\sim 25^oC$ and a pressure of $\sim$ 2 MPa. On Enceladus this would occur at a depth of $\sim$ 20 km. This would make Enceladus the home for the first extraterrestrial bathymetric "spa".

References: Giggenbach *GCA* 44, 2021-2032 1980); Matson *et al.*, LPSC XXXVII

(2005); Waite, *Science* in print (2006) ; Yoshida, *Geoch. J.* 18, 195-202 (1984).

Acknowledgements: This work was carried out at the Jet Propulsion Laboratory-California Institute of Technology, under contract to NASA.