



The Possibility of Serpentinization on Enceladus

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Enceladus, an icy moon of Saturn, is considered a potential place for a second genesis of life in a rather easy accessible environment for future space missions. Plumes erupting material out to Saturn's E-ring have been detected. This and the latest gravity data received by NASA's Cassini probe highly suggest a regional subsurface water reservoir to exist. The Cassini mission has detected all the necessary elements for life in these plumes and few ecosystems known from the Earth could in theory exist on this moon. These ecosystems rely on a sufficient hydrogen source. On Earth, this molecule is known to be produced when the oceans interact with silicates in the mantle through a geochemical process called serpentinization.

The aim of this work is first of all to determine whether serpentinization is possible on Enceladus at an assumed pressure range of 25–50 bars and a temperature range of 0–50 °C. If it is possible, then the second aim is to estimate the hydrogen production rate. Therefore, geochemical modeling with the EQ3/6 software package has been applied and thermodynamic databases have been created with the use of the DBCreate program. Due to the present lack of data on the chemical composition of the subsurface sea it is assumed to be equal to the chemical composition of the plumes. Finally, the importance of the pH value (7–9) is studied.

Models based on Enceladus being a captured comet or aggregated ring material are used to specify the core composition. These are different combinations of pyroxenes and olivines or no silicates, respectively. The results show that serpentinization is ongoing in all models with silicates at these low pressure and temperature ranges. Hydrogen is only produced in the presence of an iron-rich end-member of either pyroxene (ferrosilite) or olivine (fayalite). In these cases, the dihydrogen concentration is estimated to be around 2.0 mg/kg solution. Changing the pH value did not make any differences to the results.

It is discussed how the complex aqueous solution assumed (based on the composition of the plumes) affect the serpentinization process on Enceladus. In addition, it is discussed if the pressure and temperature ranges are too small to make a significant change on the dihydrogen concentration.

This work shows that serpentinization seems to be possible at the low pressure and temperature values found at the water/rock boundary on Enceladus. To improve the estimate of the hydrogen production rate, measurements for the silicate ions in the aqueous solution on Enceladus are needed.

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