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Silica nanoparticles in E ring ice grains as an indicator for hydrothermal activities at Enceladus

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Abstract

Since 2004 the Cosmic Dust Analyser (CDA) on board the Cassini spacecraft detects nano-meter sized dust particles, so called stream particles, in the Saturnian system. Recently it has been shown that they are released from E ring ice grains in which they were previously embedded [1]. As a consequence the nanograins must have been generated at Saturns active moon Enceladus which feeds the E ring by its spectacular jets of vapour and ice grains. Liquid water below the moons icy crust is known to be the dominant source of these jets [2, 3].

New results from CDA presented here indicate that stream particles actually are nano-silica grains. The most prominent geological process which produces nano-phase silica are hydrothermal rock-water interactions. This process has recently been intensely studied for hydrothermal systems on Earth [e.g. 4, 5]. The measured concentration, composition and size range observed at in the Saturnian system precisely matches a hydrothermal synthesis origin. Thus, we propose nano-colloidal silica to be present at mMol concentrations in Enceladus' subsurface waters.

We were able to reproduce the proposed hydrothermal serpentinisation processes in a geochemical long term experiment in the laboratory. As there are no alternative formation scenarios which are in agreement with the CDA observations our results indicate ongoing rock-water interactions inside Enceladus at temperatures clearly exceeding 100°C. We discuss implications for Enceladus geochemistry, like salinity, possible ranges of temperature and pH, as well as the mineral composition of the Enceladian rock core.

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