Volatile and refractory organic material from the hydrothermal depths of Enceladus' subsurface ocean

NOZAIR KHAWAJA[1*], FRANK POSTBERG[1], JON HILLIER[1], FABIAN KLENNER[1], LENZ NÖLLE[1]

[1]Free University, Berlin, Germany
(*correspondence: nozair.khawaja@fu-berlin.de)

The south pole of Saturn's moon Enceladus emits a plume of gas and ice grains whose source is a global subsurface [1] salty ocean, in contact with the moon's water percolated porous rocky core. On-going hydrothermal activity demonstrates intense water-rock interaction and exothermic serpentinization reactions on or below the sea floor of Enceladus [2].

Cassini's mass spectrometers found concentrations of many organic species in the ~ 15 — ≥ 200 u range [2,3] within the plume. Here we focus on Cosmic Dust Analyzer (CDA) mass spectra from ice grains that show organic signatures. Complex organic material has been found [4] in a subgroup of these grains. The spectra exhibit mass lines corresponding to aromatic and aliphatic fragments, possibly possessing O- and N-bearing functional groups, from larger (m > 200 u) insoluble organics.

We also analyze and interpret the spectral features of volatile organic compounds (VOCs) found at mmol concentrations in many ice grains [5]. We show that these VOCs are soluble low mass N-bearing and O-bearing compounds, plus less soluble aromatic compounds, that may have evaporated from Enceladus' subsurface waters at 272 K and then adsorbed onto pre-existing water ice grains as the gases cool upon rising through ice vents towards the surface of Enceladus. Polar VOCs are preferentially adsorbed onto ice grains [6] and detected by CDA whereas less polar VOCs remain unaltered in the gas phase and are detected by INMS [3]. The soluble, polar nature and low masses of the VOCs detected by CDA indicate that they could take part in Friedel-Crafts-type reactions in Enceladus' hydrothermal systems, perhaps producing biologically relevant compounds such as amino acids [7].

References: [1] Thomas et al.(2016) *Icarus*264, 37-47 [2] Postberg et al. (2018a) *Uni. of Arizona*, 129-162 [3] Waite et al.(2017) *Sci*.356, 155-159 [4] Postberg et al.(2018b) *Nat*.558, 564-568 [5] Khawaja et al.(2019) *MNRAS* (under review) [6] Bouquet et al.(2019) *TAJ* 873, 1-28 [7] Menez et al.(2018) *Nat*.564, 59-63