

Possible sources for methane and C2 – C5 organics in the plume of Enceladus

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Abstract

In this paper we consider six possible sources of CH₄ and other low-mass (C₂ – C₅) organics in the plume of Enceladus: initial endowments of cometary organics or Titan-like tholin, in situ production by Fisher-Tropsch type reactions, water-rock reactions, or microbiology, and thermogenesis from heavier organics already present. We report on new laboratory results C₂ hydrocarbons released on thermogenesis of laboratory tholin and Fisher-Tropsch type synthesis. Tholin heating produced ratios of CH₄/C₂H₄ and CH₄/C₂H₆ of about 2 for temperatures up to 450°C and about 6 for a temperature of 650°C. Low pressure Fisher-Tropsch type experiments produced CH₄/C₂H₄ of ~1.5, similar to previous results. No C₂H₂ was produced by either process. Tests of gas production by four strains of methanogens confirmed the absence of any detectable production of non-methane hydrocarbons. Cometary endowment, Fisher-Tropsch type synthesis, and Titan-like tholin incorporation could be primary inputs of organics and subsequent thermal processing of any of these all are possible sources of low mass organics in the plume. Biological production and water-rock reactions are an alternative source of CH₄. Neither water-rock reactions or thermal processing of biomass could be a source C₂ – C₅ organics due to the low interior pressures. The confirmed detection of CO and C₂H₂ in the plume of Enceladus would provide an important constraint on sources as we have identified no process – other than the initial volatile component of cometary organics which can supply these gases. Precise determination of the relative concentrations of C₁ – C₅ hydrocarbons may provide additional constraints on sources but a detailed isotopic analysis of C and H in these organics and a search for amino acids constitute the next important steps in resolving the sources of the organics in Enceladus' plume.