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Laboratory Investigation of Potential Chemical Pathways for the Formation and Degradation of Organics Relevant to Outer Planets and Satellites

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The recent discovery of water vapor plumes ejected from fissures near the south pole of Saturn's satellite Enceladus has generated considerable excitement and interest throughout the planetary science community. Present evidence suggests that the combination of a hydrological cycle, chemical redox gradient and a geochemical cycle exists on Enceladus that could provide favorable conditions for life under an ice-covered ocean (Parkinson et al., Astrophysical Journal, in review, 2006). We have initiated a laboratory based investigation to identify and confirm the potential chemical pathways for the formation and degradation of organic compounds on Enceladus. The surface of Enceladus is about 70 K, in equilibrium with the solar energy it receives. In the hot fissures, above where the water plumes arise, the temperature could be as high as 180 K. The surface is exposed to solar UV and energetic particles from Saturn's magnetosphere. Our approach is to study mixtures of water ice and species that have been identified or believed to be present on or near the surface of Enceladus (e.g., CO_2, N_2, CH_4 C_2H_2, C_3H_8, NH_3, SO_2 etc.,; Hansen et al., Science, 311, 1422, 2006) Using a combination of analytical techniques (Fourier Transform Infrared Spectroscopy and Mass Spectrometry), we will monitor chemical evolution in the ices as a function of simulated surface conditions such as temperature and irradiation dose (i.e.,

UV, electrons). Among the key questions we seek to address in the research program are, for instance, whether the observed chemical species are the end products of the degradation of biochemical molecules, and which compounds will be formed from the species known to exist on or near Enceladus when embedded within a crystalline water ice matrix. Preliminary results of these experiments will be presented.