Compositional heterogeneity amongst salt-rich grains emitted from Enceladus' subsurface ocean

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Salt-rich icy particles within Saturn's E-Ring are relatively young (\(<\sim\)200 years), and originate from frozen aerosolized droplets of the salty seawater of Enceladus' subsurface ocean, ejected into space, through fractures in the moon's south polar region, within a plume of gas and ice particles. The salt-rich grains are therefore believed to reflect the composition of the ocean water. In situ mass spectra of the plume and E-ring icy particles, obtained by the Cosmic Dust Analyzer (CDA) impact ionization mass spectrometer onboard the Cassini spacecraft, indicate significant compositional diversity within the salt-rich population. Understanding the compositions of dissolved salts within the grains, and thus the ocean, can provide important constraints for geochemical models of Enceladus' core/ocean environment.

To investigate and quantify variations in grain composition, a Laser Induced Liquid Beam Ion Desorption (LILBID) technique has been used to desorb and ionize a wide range of Enceladean ocean-like solutions containing dissolved salts. The resulting ions were then measured by a reflectron-type time of flight mass spectrometer. As the laser desorption mechanism simulates the ice grain impact process occurring on the CDA target, spectra produced in the laboratory from a large range of well-characterized salt solutions can be used to determine the CDA-applicable spectral appearances of substances within the ice grains emitted from Enceladus' ocean.

Here we present the results of an investigation of CDA E-ring spectra, supported by laboratory analogue experiments, which show significant compositional heterogeneity within the salt-rich grains originating from Enceladus' subsurface ocean. Two main spectral subtypes, representing endmember compositions within the salt-rich grains, are identified. These mass spectra are dominated by features from chloride-rich or carbonate-rich compounds and the laboratory detectability of other, additional, compounds within these brines is discussed.