

Availability of nutrients in the Enceladus ocean: Implications for habitability - *F.W. Clarke Award Lecture*

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Enceladus, a small icy satellite of Saturn, was found to have a subsurface water ocean and evidence of ongoing hydrothermal activity in the seafloor. The ocean water, sampled via a plume, was inferred to contain substantial levels of inorganic and organic carbon as well as ammonia. However, there are very few constraints on the availability of other bio-essential nutrients, including phosphorus, sulfur, iron, and other enzyme-supporting metals. This talk will summarize our current understanding and report some ongoing research about the availability of these nutrients. Briefly, I will cover theoretical and observational evidence on high contents of dissolved inorganic orthophosphate in Enceladus ocean water and discuss organic-P as potential biosignatures. Moreover, I will report some new constraints on the availability and speciation of sulfur, iron, and several other transition metals. Furthermore, I will discuss the limiting nutrient and possibly additional limiting factors for the origin and survival of life in the Enceladus ocean. These considerations can help in defining future astrobiology missions to Enceladus.