Oxidants and Ocean Worlds: Radiolytic Production of Electron Acceptors in Ice

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Ocean worlds of the outer solar system, such as Europa Enceladus, and Titan, harbor liquid water oceans beneath their icy lithospheres. These oceans may be in contact with silicate seafloors capable of providing significant fluxes of reductants, resulting from tidal energy dissipation and radiogenic decay within rocky mantles [1, 2]. Geochemical, and possibly biochemical, reactions may be limited by the availability of oxidants

The ice-covered surfaces of many of the moons of the outer Solar System are processed by energetic ions and electrons [3]. In the simplest case of pure water ice, hydrogen peroxide is produced via radiolysis and has been observed on Europa [4, 5] and studied extensively in the lab [6, 7, 8, just to cite a few]. The oxidant products of radiolysis may be of importance to sub-surface habitability, if geological activity permits exchange of material between the surface and ocean then some of the radiolytically produced oxidants could help maintain a chemically rich and potentially habitable subsurface liquid water environment [9, 10].

We have conducted laboratory experiments extending our earlier work on neat 100 K ice irraidated with 10 keV electrons to water ices with a variety of salts and cations that efficiently yield, or bind with, radiolytically produced anions that could serve as useful oxidants (SO_4^{2-}, OH^-). We also examined the stability and radiolytic modification of oxidants that could be expected on radiolytically modified icy surfaces (NaOH, NaOCl). Results of these experiments, and their implications for the oxidant concentrations and fluxes on ocean worlds will be presented.

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