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Thermal Reactions of H_2O_2 on Icy Satellites and Small Bodies: Descent with Modification?

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Magnetospheric radiation drives surface and near-surface chemistry on Europa, but below a few meters Europa's chemistry is hidden from direct observation. As an example, surface radiation chemistry converts H_2O and SO_2 into H_2O_2 and $(SO_4)^{2-}$, respectively, and these species will be transported downward (Greenberg, Astrobiology, 2010, 10, 275) for possible thermally-driven reactions. However, while the infrared spectra and radiation chemistry of H_2O_2-containing ices are well documented, this molecule's thermally-induced solid-phase chemistry has seldom been studied. Here we report new results on thermal reactions in H_2O + H_2O_2 + SO_2 ices at 50 - 130 K. As an example of our results, we find that warming H_2O + H_2O_2 + SO_2 ices promotes SO_2 oxidation to $(SO_4)^{2-}$. These results have implications for the survival of H_2O_2 as it descends, with modification, towards a subsurface ocean on Europa. We suspect that such redox chemistry may explain some of the observations related to the presence and distribution of H_2O_2 across Europa's surface as well as the lack of H_2O_2 on Ganymede and Callisto. [This work was supported by NASA's Exobiology, Outer Planets, and Planetary Geology and Geophysics programs, and The Goddard Center for Astrobiology.]