Heavily Hydrated Salts on Europa

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Recent laboratory studies have quantified the infrared spectral character of heavily hydrated sulfates and other salts proposed as major surface components on Europa. At temperatures relevant to the surface of Europa, the spectral signatures of these materials are markedly different than at room temperature. Comparison to Galileo Near Infrared Mapping Spectrometer (NIMS) observations indicate that heavily hydrated sulfate salts, such as mirabilite ($Na_2SO_4 \bullet 10H_2O$) and magnesium sulfate dodecahydrate ($MgSO_4 \bullet 12H_2O$), provide a better explanation of the unique infrared signature observed in the reddish, disrupted terrains than less hydrated salt compounds under consideration, such as bloedite ($Na_2Mg(SO_4)_2 \bullet 4H_2O$) and epsomite ($MgSO_4 \bullet 7H_2O$). However, slight discrepancies which may go unnoticed in room temperature laboratory measurements are magnified at Europa temperatures, and suggest that the surface spectra cannot be explained by a single compound.

The infrared signature of hydrated sulfate salts arises from the waters of hydration and is not intrinsic to the host compound. Therefore, alternative materials bearing waters of hydration must also be considered. Some of the materials considered thus far include sulfuric acid hydrate, chloride, carbonate, and sulfide hydrates, and hydrated metabolites in extremophile organisms trapped in ice or evaporite mineral crystals. Each material has separate implications for the formation and evolution of the near-surface environment, with ramifications for the evaluation of astrobiological potential at Europa from current and planned spacecraft observations. Consideration of the chemical, physical, and infrared behaviors of these materials leads to specific questions concerning acceptable definitions of biosignatures to be applied in the search for life in the Solar System.