

## The Composition of Europa's Triple Bands: Clues for the Chemistry of a Subsurface Ocean

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Recent work regarding lineament development suggests that pre-existing cracks in Europa's icy crust may broaden by upwelling liquid water [1], much as sea-floor spreading occurs on Earth. Triple band composition, then, may be a surface expression of subsurface ocean chemistry. Europa experiences magnetospheric ion bombardment, which may modify the surface through implantation of exogenous species as well as by decomposition of endogenous material. Thus the recently-observed CO<sub>2</sub> may be a decomposition product of either organics or carbonates [2, 3]. The effect of ion bombardment on triple band composition must therefore be considered. Instruments on the Galileo spacecraft have partially constrained surface composition; spectral features have been attributed to hydrated carbonates and sulfates [3]. Combining surface measurements with equilibrium aqueous speciation calculations for Europa's hypothetical ocean places theoretical constraints on the presence of biotic or pre-biotic compounds. Use of a similar method to make realistic speculations about conditions on early Mars [4] indicated that SO<sub>2</sub> levels must have been lower than predicted to maintain stable solution pH. As suggested by [3], preliminary water chemistry calculations for Europa begin with an alkaline initial water chemistry due to high CO<sub>2</sub> partial pressures from dissolved carbonate species.

[1] Greenberg *et al.*, 1998. *Icarus* **135**, 79-94.

[2] Delitsky and Lane, 1997. *J. Geophys. Res.* **102**, 16385-16390; Johnson *et al.*, 1998. *Geophys. Res. Lett.* **25**, 3257.

[3] McCord *et al.*, 1998. *Science* **280**, 1242-1245; Kargel, 1998. *Science* **280**, 1211-1212.

[4] Murphy and Bass, 1998. *Bull. Amer. Astron. Soc.* **30**, 1030.