Surface Expression Models for Aqueous Oceanic Activity on Titan

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Drawing upon analogs from the rocky planets with geological features, subsurface acquifers and magmatism, the range of surface manifestations of a subsurface ocean on Titan comprise a series of models. Cryovolcanism of aqueous eutectics will produce flows which may be detectable as sporadic outcrops from the hydrocarbon-rich regolith, exhumed by aeolian and/or fluid processes. Solidification of extruded cryomagma, especially if containing a significant water component, should exhibit fractional crystallization of solutes in late-freeze ponds and flow fronts. Abundant higher-Z elements such as Si, S and Fe, as influenced by the Eh-pH field of the liquid phase, might be in evidence, demonstrating communication among the principal mantle components of such bodies. Consequent availability of potential nutrients and chemical energy sources would be a key indicator for habitability by chemoautolithotrophs on Titan.

With near-surface mobility and sensing, LIBS as well as active and passive IR mapping spectrometry are all possible in the environment of Titan's lower atmosphere. Although some remote measurements are infeasible because of the atmosphere, near-surface naturally radioactive rock-forming elements such as K, U, and Th could be detected with gamma ray spectrometry. Touch-and-go techniques developed for small-body sampling can provide material for onboard GC, MS, XRD, microscopy and other miniaturized analytical techniques. Surface dwell times of minutes would enable contact XRF with detection of critical element ratio's such as S/Cl, K/Ca, and Mg/Si/Fe, and Raman spectroscopy for organic and mineralogical analysis, . Longer contact times would permit electromagnetic depth sounding. Many IR and particle-detection sensors operate ideally at or near the low temperatures intrinsic to the Titan atmosphere, simplifying those aspects of instrument development. Exploration of Titan by in situ and mobility techniques would capitalize on the investments and lessons-learned from the robotic exploration of Mars and other planetary bodies.