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Assessing Cryovolcanic Resurfacing of Titan: Implications for Detection of Active Cryolavas

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Cryovolcanism has been proposed for resurfacing Saturn's moon Titan (see references in [1]). We have quantitatively examined the constraints on cryovolcanic resurfacing, and the likelihood of detection of active flows by instruments on the Cassini spacecraft. If the surface of Titan has an age of order 0.5 Ga, then the entire satellite is resurfaced in this time by a net rate of areal coverage of only 0.17 km^2 $year^{-1}$ (53 cm^2 s^{-1}), erasing most impact craters. In comparison with Earth, this coverage rate is less than the average rate for many contemporaneous terrestrial volcanic flows. For example, at Kilauea volcano, Hawai'i, the average coverage rate for a flow is of order $\sim$1 m^2 s^{-1}: on Titan, this rate would cover the entire surface $\sim$200 times in 0.5 Ga, if the activity was distributed evenly. If the flows were 1 m thick, the total volume erupted in this time would still only be 0.4% of the volume of a 50 km thick crust. At the other end of the flow effusion-rate scale, the largest eruptions on Earth emplaced massive basalt flows, each $\sim$10-100 m thick (e.g., Deccan Traps, India). Areal coverage rates would have been of order $\sim$1000 m^2 s^{-1}. This coverage rate would cover the entire surface of Titan in less than 3000 years, an unfeasible scenario. The analogue comparisons suggest that only a relatively very small amount of effusive activity (e.g., much less than current activity at Kilauea) is required to resurface Titan in 0.5 Ga. If so, the detection of active eruptions may be very difficult with the Cassini Visible-Infrared Mapping Spectrometer (VIMS) and the Composite Infrared Spectrometer (CIRS). If activity is confined to specific locations, then the chances of detection increase: our modelling of cryolavas [2] suggests that the signature of such activity can be detected by CIRS (and possibly VIMS) if the extent and areal coverage rates are high enough. This work was performed at the Jet Propulsion Laboratory-California Institute of Technology, under contract to NASA, with support from the NASA Outer Planets Research Program. References: [1] Davies et al., 2009, LPSC-40 abstract 1906. [2] Davies et al., 2008, DPS-40 abstract 34.05 (BAAS vol. 40, no. 3, 2008).