Geophysical Research Abstracts
Vol. 12, EGU2010-5647-1, 2010
EGU General Assembly 2010

Determining Io's Lava Eruption Temperature: Strategies for a New Mission to the Most Dynamic Satellite in the Solar System

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Spacecraft observations of lava fountains [1, 2] and skylights (holes in the roof of a lava tube) [2, 3] offer the best opportunities for determining eruption temperature of Io's dominant lavas, probably the most important unanswered science question in the wake of the *Galileo* mission. Determining if Io's lavas are predominantly mafic ($<$1550 K) or ultramafic ($>$1850 K) immediately applies strong constraints to composition and state of Io's mantle [1]. To answer this question we have evaluated the best observations to be made from an Io-dedicated mission, such as the proposed Discovery-class *Io Volcano Observer* (*IVO*) [4] or a mission including a close Io flyby, as well as what is required to determine eruption mode using the most efficient selection of imager wavelengths [2]. Episodes of lava fountaining during fissure eruptions are the cause of large thermal outbursts from Io. The magnitude of the thermal emission means that this mode of eruption has the advantage of being easily detectable from great distances, allowing identification during Io monitoring phases of spacecraft missions. Variability in fountain activity and the need to isolate fountain thermal emission from that of associated lava flows requires detailed modelling of clast cooling and the integrated fountain and flow thermal emission. Also required is the almost contemporaneous ($<$0.1 s) acquisition of unsaturated multi-spectral data [2]. In addition to rare lava fountains, skylights provide another opportunity to constrain eruption temperature. Models of skylight thermal emission reveal that a narrow range of high temperatures are exposed. The resulting thermal emission spectrum should be diagnostic of lava eruption temperature [3]. Probably common on Io, skylights are very small and so will have to be searched for in data acquired during Io flybys. An advantage is that they do not have to be resolved in imaging data, especially if the surrounding area is relatively cool (and therefore contributing little thermal emission at short wavelengths). In all cases, to avoid complications created by the need to remove sunlight, the most valuable data would be obtained at night or with Io in eclipse. The requirements to make these observations are being used in designing instruments for *IVO* [4]. Part of this work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA, and is supported by the NASA OPR and PG&G Programs. References: [1] Keszthelyi et al., 2007, Icarus, 192, 491-502. [2] Davies et al., 2010, JVGR, submitted. [3] Davies, 2008, Fall AGU Abstract P43A-1389. [4] McEwen et al., 2009, LPSC-40 abstract.