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TI: Lava Lakes in Io's Paterae: Surface Expressions of Subsurface Processes

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AB: Recent analyses of morphologies and temperatures of paterae (volcanic depressions) on Io reveal strong connections to well-supplied magma source regions in Io's interior. The uniformly dark, warm floors of many paterae are best explained as newly emplaced crusts of active lava lakes that periodically overturn as the lakes are recharged with new lavas [1,2]. One patera, Pele, is analyzed both for its similarities to and differences from other paterae. This volcano is the source of a consistently active giant plume eruption, and appears to contain a large, actively overturning, fountaining lava lake [3,4]. The 60 m/pixel, 2-filter Galileo SSI nighttime observations allow us to calculate color temperatures as high as 1620+-100K, in a few locations in the most active region in 3x3 pixel areas. Ultramafic silicates (primarily Mg-rich ol, px) have melting temperatures in this range and may be the primary component of many lava flows on Io [5,6]. Even if we assume that the source has a bulk composition on an undifferentiated Io, this would require on the order of 50% partial melting. To analyze eruption style, we calculated the fractional area of hot material across the Pele region, and determined that its highest concentration occurs in a central region about 60-80 km2, while the material in the rest of the 600 km2 region remains remarkably cool. Thus, fountaining and overturn at the lava lake in Pele Patera (and other paterae) may occur in small, localized regions, while the majority of the lava lake remains insulated under a cool crust. The thermal output from the high temperature components of the Pele eruption is 280 GW, and indicates a mass flux into the volcano of 6.44-8.89 x10^5 kg/s [7]. As there is no evidence of large lava flows emerging from Pele, all of this material is confined to the patera, or is recycled back into the source region. This is true for most paterae, since they have insignificant to inexistent shields, and thus no flank eruptions. Thus the large disparity between the tremendous mass flux into Pele and other paterae and observed

erupted material is best explained if there is access to a global, subsurface, magma ocean that is continually being partially melted due to tidal heating [8]. This way, well established magma conduits are fed by an essentially inexhaustable magma supply, which can explain why most large volcanic centers on Io appear to persist over long periods of time. These paterae, with strong subsurface connections, appear to be the primary conduits for heat to escape to Io's surface, which implies that the heat flow through this energy-laden body is spatially discrete.

References: [1] Radebaugh et al. (2002) AGU 83. [2] Rathbun et al. (2002) GRL 29. [3] Davies et al. (2000) AGU 81. [4] Radebaugh et al. (2001) DPS 33. [5] McEwen et al (1998) Science 281. [6] Williams et al (2001) JGR 106. [7] Davies et al. (2001) JGR 106. [8] Keszthelyi et al (1999) Icarus 141.

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