A DEEP LAVA CHANNEL ON IO: P.M. Schenk[1] and D.A. Williams[2], [1]Lunar and Planetary Institute, Houston, TX 77058 (schenk@lpi.usra.edu), [2] Arizona State University, Tempe AZ 85287 (David.Williams@asu.edu).

Introduction: Lava channels are an important aspect of effusive volcanism on any planet, and Io should be no exception. Due to mechanical failure, Galileo's imaging coverage of Io was severely limited and few lava channels were observed at high resolution or even identified. We have identified a lava channel on Io in images acquired during Galileo orbit I25 and obtained at low sun, allowing us to characterize its morphology in unprecedented detail.

The channel was observed at 0°N, 73°W and lies ~225 km east of Hiiaka Montes in relatively flat volcanic plains (Fig. 1). Imaging coverage at 260 m/pixel was obtained for some of this channel at >80° incidence angle, but neither the origin or terminus of the channel were included. Tawhaki Patera, a 60 km wide dark-floored caldera located ~100 km to the northwest is the nearest volcanic features and is plausibly the source for the lava channel but a gap in image coverage prevents confirmation.

The observed length of the channel is ~190 km, but is certainly much longer. Channel segments appear to the south of the main feature (broken by the terminator), suggesting a total length in excess of 250 km. Channel width varies considerably from >500m to 6 km, including several points where the channel narrows abruptly from 4-5 km to <1 km over distances of <0.5 km, suggesting inpediment due to topographic undulations. This is narrower than most venusian lava channels [1]. The southernmost observable section appears to expand into a ~20 km wide fan or delta, but this portion of the imaging is relatively noisy (due to the tendency of radiation hits to accumulate during top-to-bottom readout of the Galileo Solid-State Imager CCD), and may be several individual channels. Topographic islands are apparent in some of the wider portions of the channel, producing an appearance of braiding in some sections.

High-sun imaging at 1.4 km/pixel show a nearly-featureless bright plain in this region, and do not reveal any albedo features in association with this channel, suggesting that it and any (presumably dark) lava flows that may have been associated with it have been subsequently covered by ballistic plume or other deposits. No changes were detected during the Voyager or Galileo missions in this region, although Tawhaki Patera is a known hotspot [2] and may be silicate in composition [3].

Lava channels have been resolved in only a few locations on Io (eg. Emakong Patera [4]) due to imaging constraints. The uniqueness of this channel is the low sun illumination, which allows us to use shape-from-shading (i.e., photoclinometry [aka PC]) to estimate channel depth for the first time (Fig. 2). The lack of contrast in low-phase-angle images indicates there are no significant albedo variations associated with this channel, removing one of the major sources of error in this technique. The Galileo images are subject to varying degrees of radiation-induced noise but the technique [5] we use is robust against noise, unless the signal-to-noise ratio deteriorates to extreme levels.

The observed depth of the channel is remarkably uniform over most of its observed length (Fig. 2). Measured depths range between 40 and 65 m, with most between 50 and 60 m. Measured depths drop below this in the narrowest sections of the channel but we suspect this may be a resolution effect.

Many of the sample profiles across the channel show evidence of raised rims (Fig. 3), which could indicate marginal levees. These levee-like margins are 10-20 m high, but this is similar to topographic variations seen elsewhere in the DEM. Levees are not immediately evident from visual inspection of the DEM or image and are considered possible but unconfirmed in this case.

Our PC DEM is not considered reliable over long wavelengths and we cannot ascertain regional or along-track slopes. We infer that regional slopes are slight but cannot have been negligible otherwise a long channel would not have formed. Slopes on

shield volcanoes and volcanic plains in general on Io are generally no more than 0.5° or so [6], however.

The sinuosity of the channel and evidence for topographic islands within it suggests formation by flowing lava, rather than a tectonic origin. The only other channel where we have observed islands (and perhaps the only other channel where we have sufficient resolution) is at Emakong Patera [4], although that example was significantly smaller and narrower than the channel described here. We do not see at the observed resolution any evidence for pit chains.

The channel appears to have been open and continuous for at least 190 km. This may indicate that the lava was superheated, not allowing a solid crust to form. This channel is likely to have been erosional. Modeling [4] suggests that ultramafic lavas eroding into ultramafic substrates have low erosion rates (<0.1 m/day), whereas sulfur eroding into sulfur substrates is faster (1-4 m/day), depending on conditions. Thus either "long" eruptions would be required to erode a 40-60 m deep channel in similar composition substrates (400-600 days for ultramafics, 10-60 days for sulfur), or a high-T lava flowed over a substrate of drastically lower melting temperature. Candidates include ultramafic lava over sulfur substrate (now buried) or sulfur lava over SO_2-rich sulfurous substrate.

References: [1] Baker, V., et al., JGR, 97, 1341, 1992. [2] Lopes, R., et al., JGR, 106, 33053, 2001. [3] Geissler, P., et al., Icarus, 140, 265, 1999. [4] Williams, D., et al., JGR 106, 33161, 2001; Williams et al., JGR 106, 33,105, 2001. [5] Schenk, P., Nature, 417, 419, 2002. [6] Schenk, P., R. Wilson, and A. Davies, Icarus, in press, 2004.

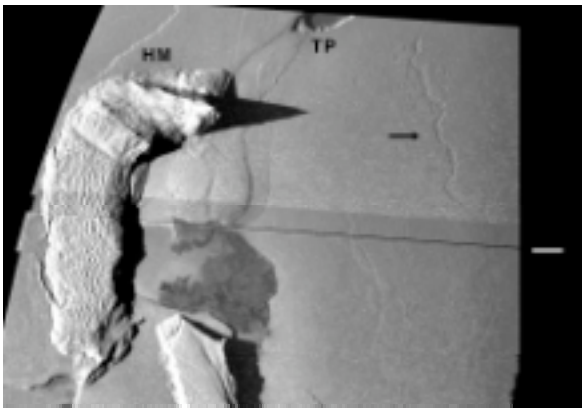

Figure 1. Galileo I25 mosaic of Hiiaka Montes (HM) region, featuring 250 km long lava channel (arrow). Oblong caldera (Tawhaki Patera, TP) is ~ 60 kom long. Scale bar is 25 km.

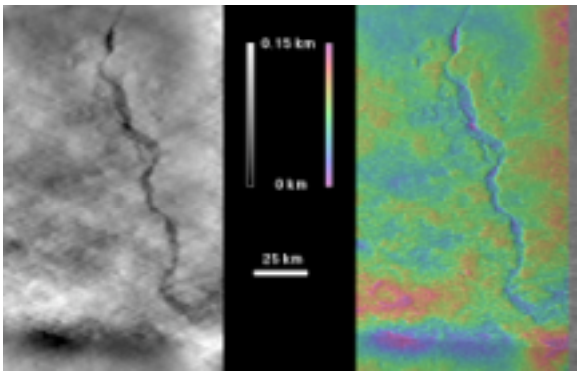

Figure 2. Digital Elevation Model (DEM) of lava channel. Gray-tone version (left) and color-coded (right) overlain on original image mosaic. Note small islands and apparent braiding of channel. Elevation data from photoclinometry and may not be reliable over large distances.

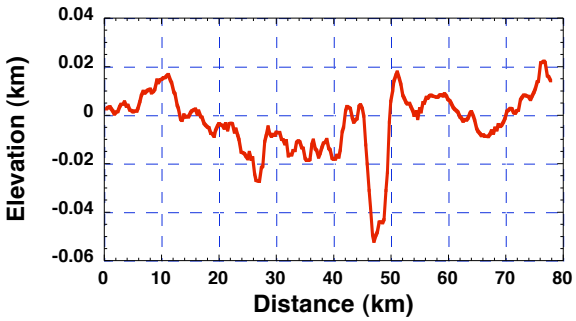

Figure 3. Topographic profile across channel, derived from data in Figure 2.