ERUPTION CHARACTERISTICS OF LONG LAVA FLOWS ON THE NORTHERN FLANK OF ELYSIUM MONS, MARS; Michelle J. Tatsumura and Peter J. Mouginis-Mark, Hawaii Institute of Geophysics and Planetology, SOEST, University of Hawaii, Honolulu, Hi 96822.

Introduction. High resolution Viking images of long lava flows on the northern flank of Elysium Mons present an opportunity to examine and constrain eruption characteristics through observations of flow lengths, widths, thicknesses, and general morphologies (Figure 1). Because of the long lengths of the flows (in excess of 300 km for the whole flow field) which is somewhat unusual for Mars, we consider whether the flows represent vigorous and voluminous eruptions or alternatively, were slowly emplaced over years to decades [1]. Previous work has also suggested that the eruptions were "pulsing" so as to produce lava flow segments that emerge from the upslope segment before it [1]. In this work, we present flow data, from which we derive possible eruption characteristics that formed this flow field and conclude that the lavas were emplaced at relatively high effusion rates.

Observations. Over 20 photoclinometric measurements of the long Elysium flows were made from orbit 651A (~50 m/p resolution) to determine lava flow thicknesses. The flows have generally uniform widths of 4-10 km and thicknesses that range from 40-100 m on a regional slope of ~0.5°. The entire flow field is at least 300 km long (the source area is obscured younger deposits) and covers an area of approximately 30,000 km^2. These yield an estimated total flow field volume of ~1800 km^3 (for an average flow field thickness of 60 m). The majority of individual flows are relatively featureless. A lava channel is associated with at least one of the flows and is ~100 m wide and approximately 20 m deep based on photoclinometric measurements. A series of individual lava flow segments are observed within several lava flows in this area [1]. In each case, a downslope lava flow segment underlies the upslope segment before it with a typical area of 20-100 km^2 [1].

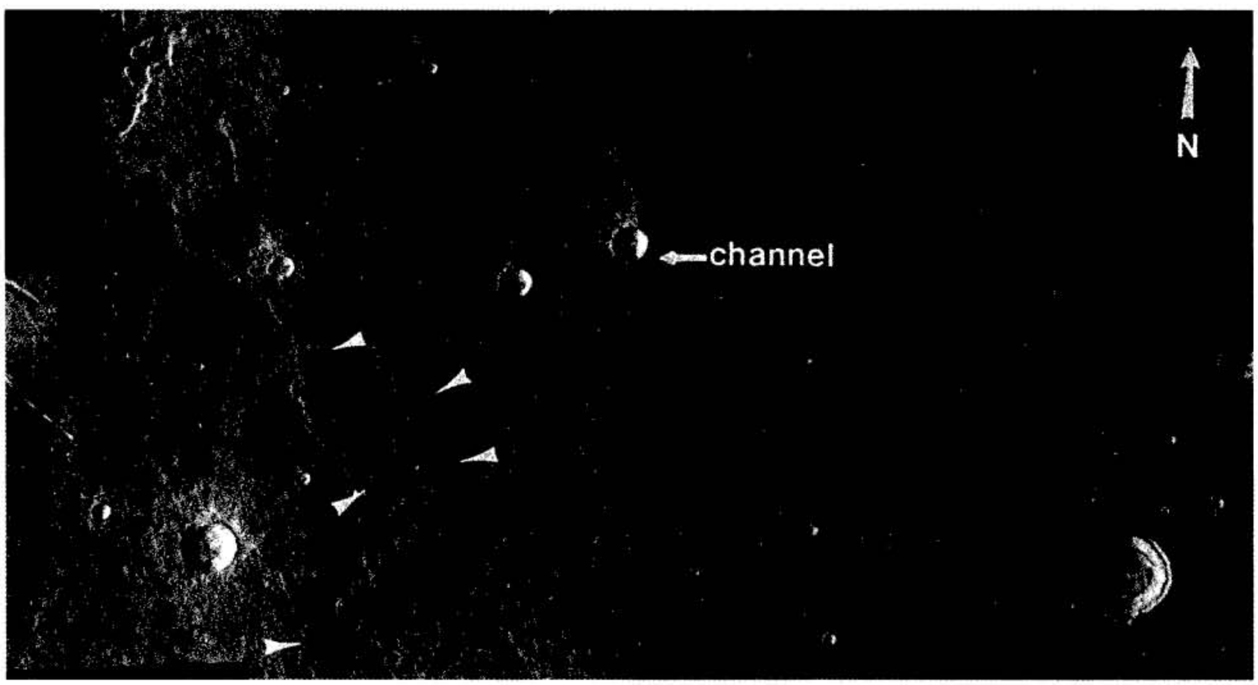

Figure 1. Distal portion of Elysium long lava flows. Flow direction to top. Arrowheads represent margins of individual flow segments. Viking images 651A7-14, ~50 m/p. Original digital mosaic by Mark Robinson.

ERUPTION OF LAVA FLOWS ON ELYSIUM MONS: Tatsumura M.J. and Mouginis-Mark P.

Discussion. Several lines of morphologic evidence suggest these lava flows were erupted at high eruption rates. First, large lava channels are observed on some of the lava flows. Lava channels generally indicate high volumetric flow rates on terrestrial basalts. Second, a separate investigation of the planimetric shapes of several lava flows in this flow field found them to have fractal measurements that suggest these are similar to terrestrial basaltic a'a lava flow morphologies [2]. If this is correct, this also suggests relatively high eruption rates. In Hawaii for example, a'a morphologies form at eruption rates of >5-10 m^3/s, as high as 1000m^3/s, whereas pahoehoe forms at lower eruption rates (<5-10m^3/s) [3].

We estimate the average volumetric eruption rate of a single Elysium Mons flow utilizing the method of Crisp and Baloga [4] which takes into account initial and final flow temperatures, flow dimensions, density, specific heat, etc. of the lava. We obtain average eruption rates of between 20-2000 m^3/s. For a single lava flow, 300 km long, 5 km wide, and 60 m thick this implies an emplacement time of 1-140 years with an advance rate of 2-200 km/year. The critical factor in our calculation (which provides the range of values) is the fractional amount of core material that is exposed during emplacement. The fraction of core exposed is a direct relation to the vigor and amount of disruption with which the lava flow is moving [4]. The fraction exposed is very small (0.001) if the eruption rate was relatively low because a significant and sturdy crust insulates the bulk of the core. If the lava was flowing at a very high rate, much of the interior core would be exposed as crust is being disrupted (which corresponds to an exposed fraction of 0.01). If however, the entire flow field was being emplaced contemporaneously, say from a 100 km fissure, eruption rates would be significantly higher, easily an order of magnitude.

We determined above that eruption rates were fairly high and if the volcano had maintained a constant effusion rate for the emplacement times derived, we would expect well-defined channels with few breakouts. The presence of lava channels in some of the flows then supports the relatively high eruption rates we derived here. But what were the conditions that produced the individual lava flow segments in these flows? To address this issue, there lies our future work. Do the well-preserved lava flow segments represent a volume-limited system [5] where supply of fresh lava is a key factor in their emplacement? Or alternatively, are the flow segments a result of a cooling-limited situation where crusts and flow fronts cool and thicken sufficiently so that the flow stop even though lava continues to be added [5]?

References. [1] Mouginis-Mark, P.J. (1992) *Lunar Planet. Sci. Conf.* ***23rd*** *(Abstract)*, 939-940. [2] Bruno B.C. et al. (1994) *Bull Volcanol.*, 193-206. [3] Rowland, S.K. and G.P.L. Walker (1990) *Bull Volcanol.* **52**, 615-628. [4] Crisp, J. and S. Baloga (1990) *Icarus* **85**, 512-515. [5] Guest, J.E. et al. (1987) *Bull Volcanol.* **49**, 527-540.