
INTRODUCTION:
The existence of several unusually long (>100 km) lava flows to the north of Elysium
Mons, Mars, has been previously reported (1). Further mapping of the same flow field is
reported here, since it is now seen to include a total of 59 individual lava flows that range in
length from 12 to 246 km. These flows are located predominately to the north and west of
Elysium Mons, in the region between 26° - 34°N, 207° - 224°W. The flows are of interest
for several reasons: a) they can be used to infer the distribution of dikes within the perimeter
of Elysium Mons; b) some flows are very long compared to Quaternary terrestrial lava flows
(2) and so provide morphologic clues to the emplacement process of these unusual terrestrial
examples; and c) they may place real-life constraints on recent numerical models that predict
the formation of long lava flows via tube-fed eruptions (3).

FLOW DIMENSIONS:
Flow area, flow length, and vent distance from the summit of Elysium Mons have been
measured for each flow (Figs. 1 - 3). These data show a slight increase in flow size (length
and area) for flows that originate at greater distances from Elysium Mons. The largest flows
("A" and "B" Fig. 1) originate at ~300 km from the summit and have lengths >200 km. Short
(<20 km), small-area (<10 km²) flows can occur at any distance from the summit, while all flows that originate within 200 km of the summit are linear, small-area (<200 km²) flows. Typical flow widths range from 4 - 7 km, with the maximum width of 38 km.
Surface areas of the flows can be used to infer the relative total volume of lava erupted at
each vent. Although some flow thicknesses in the range of 50 - 80 m have been measured
using photclinometry on the distal portions of the flows west of Hecates Tholus (4), these
values may not be representative of the entire flow field. Surface areas of the flows described
here range from ~20 - 4,100 km², which would imply volumes in the range of 1 - 205 km³
if the flows have an average thickness of 50 m.

Fig. 1: Plot of flow length vs. distance
of vent from the summit of Elysium
Mons. Note that due to poor image
resolution, these values may under-
estimate the length and over-estimate
the distance to vent, since no vents
could be identified in any Viking
image. The vents for the labeled flows
are located as follows: "A" 29.7°N,
213.6°W; "B" 30.0°N, 214.2°W;
"C" 32.2°N, 218.6°W.

Fig. 2: Plot of area vs. distance from
the summit of Elysium Mons. Area
values assume that the boundaries of
individual flows have been correctly
identified, which may not be the case
in area where image resolution is
poor. In these cases, area is most
likely to be over-estimated as intra-
flow boundaries were not mapped.
Fig. 3: Plot of flow area vs. flow length. A general correlation can be seen, but it is clear that area can vary by a factor of ~5 - 10 for a flow of a given length, indicating that some flows spread more in a lateral direction than do others. This may indicate multiple tubes within a single flow or a compound flow field.

FLOW MORPHOLOGY:

The well-preserved surfaces of these Elysium lava flows may help constrain the mode of emplacement of long planetary lava flows. For instance, using a numerical model for flow emplacement via tube-fed eruptions, Keszthelyi (3) has predicted that tube-fed flows with effusion rates ~20 - 100 m$^3$ s$^{-1}$ could produce lava flows several hundreds of kilometers in length provided that they had active tubes with diameters of ~10 - 20 m in diameter. Stable eruption conditions that preserve the geometry of the tube over timescales that might span years to decades are also required if the same flow is to remain active. The lack of multiple break-outs along the length of most of the Elysium flows supports such an idea of stable flow conditions. For the 59 flows identified here, only two flows (including flow “A”) show major bifurcations into discrete flow segments, while seven others have short (< 10 km) secondary lobes. Only flows “C” and one other display any significant increase in width at their distal ends; the remainder of the flows are typically ~4 - 7 km in width. Although Wilson and Head (5) predict that long lava flows form due to high effusion rates, there are no sheet-like flows within Elysium Planitia that could be associated with large-volume, high effusion rate fissure-fed flows analogous to flood basalts on Earth.

Lava channels are very rare in these Elysium flows, and there are no examples of collapse pits or crestal rises that could be indicative of lava tubes. Nor is the occurrence of the flow segments as common as was previously reported (1). Very few of the longer lava flows (i.e., those > 50 km in length) possess individual flow segments, and none of the shorter flows are segmented. This distribution may possibly be a function of image resolution (much of the area was only imaged at ~150 m/pixel), although even where image resolution is ~50 m/pixel this segmentation is rarely observed outside the original study area (1).

CONCLUSIONS:

The distribution of lava flows tens to hundreds of kilometers in length over much of the NW flank of Elysium Mons testifies to the late-stage existence of a well developed dike system associated with the volcano, capable of erupting large volumes of lava more than 500 km from the volcano. Contrary to previous work (1), the occurrence of flows with discrete segments (formed by pulsing eruption rates?) appears to be unusual in Elysium Planitia, although several flows have unusually large surface areas that suggest either a different mode of formation (perhaps as a series of fissure fed a’a flows) or very high eruptions volumes.

REFERENCES:

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System