

PROFILES OF LAVA FLOWS AT ALBA PATERA, MARS

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Well-defined and prominent lava flows are evident in the Viking images of Alba Patera, Mars. Dimensional and topographic data, supplemented by morphological analysis, provides the opportunity for deriving inferences about the nature of eruptions and flow emplacement. Specifically, the application of the simple physical models to such data provides estimates for eruption rates, eruption durations, Reynolds numbers and crude constraints on the bulk composition of the lava.

Lava flows are ubiquitous at Alba Patera, appearing in both the central region near calderas and on the flanks. Many of the flows have been classified generically as "undifferentiated" because they cannot be traced or mapped with certainty. Other flows, however, are more pristine and clearly exposed with solitary lobes that extend up to several hundred kilometers.

We have mapped and measured the planimetric dimensions of two sets of flows at Alba Patera, one set in the central region near the caldera and another on the southeast flank. We have also used photogrammetry to construct longitudinal profiles of these flows. Figure 1 shows some representative profiles that we believe estimate flow depth as a function of distance for these flows. It is difficult or impossible to unambiguously determine the exact source of the flows, so the horizontal origins in the figure represent the location of the first photogrammetric measurement for each profile. Perhaps the most remarkable feature of the profiles we have studied is their flatness. Except for some unusual local variations that are still under study, typical depth increases tend to be less than a meter per kilometer of distance along the path of the flow.

The application of some basic fluid dynamic considerations [Baloga and Pieri, 1986; Baloga, 1986; Williams and McBirney, 1979] to the profiles and dimensions lead to interesting geologic conjectures. First, the apparent viscosity of the lava, where the flows are clearly defined, is more like that seen for Etnean eruptions than for Hawaiian lavas. Had Alba Patera continued to produce such flows for a geologically significant period, it is likely that Alba would have manifested more topographical relief than we see in the Viking images. Second, the eruption rates appear to have been in a range from 10^3 to 10^5 m^3/sec . Although such rates are large by terrestrial standards, they are not unreasonable considering the high volumes of the Alba flows. Corresponding eruption durations range from tens of days to a few years, depending on the (presently unknown) extent of levees on these flows. Third, the Alba eruption rates and viscosity estimates imply flow Reynolds numbers in a range from about one to a few hundred, again depending on the nature of the levee-building process. These values are again completely consistent with terrestrial experience with the larger eruptions at Mt. Etna and Hawaii.

Although there remain a number of unresolved issues and points for further investigation, these preliminary analyses encourage further study of Alba flows in parallel with more detailed terrestrial analog investigations.

References

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