MORPHOLOGY OF LAVA FLOWS AT ALBA PATERA; David Pieri and Dale Schneeberger, Jet Propulsion Laboratory, California Institute of Technology Pasadena, California 91109

Alba is distinguished by many large radially-oriented lava flows. These flows exhibit a range of morphologies (1, 2, 3, 4, 5). While they have often been alluded to, particularly because of their remarkable dimensional characteristics (>500km long, up to 250m thick) previous attention has been focused on important overall planimetric characteristics. Here we draw attention to important morphological attributes and suggest a more consolidated nomenclature.

We have divided the lava flows at Alba into two major morphological groupings: tabular flows and crested flows. Tabular flows are characterized mainly by their flat, smooth-appearing upper surfaces and their steep-sided margins. Previous workers have called these features "sheet flows" or "flat-topped flows". We prefer the "tabular" designation, first invoked by (6) because it unifies the terminology and connotes the thick, confined, mono-layered appearance of individual flow units. These flow units are almost certainly not strictly "flat-topped", although admittedly, any relief is likely to be low (< 10 meters). Scrutiny of medium and high resolution Viking images show an undulating softened upper surface, however, there are hints of flow-related morphology. Tabular flows are highly lobate, exhibiting at least 3 different kinds: marginal, distal, and internal lobes. The character of these lobes may be related to: (a) past flow front positions, (b) levee forming processes, (c) arrested and propagating instabilities at flow fronts, or (d) waning stage instabilities within lava channels.

There appear to be two general styles of tabular flows: solitary and intercalated. Solitary tabular flows generally emerge from an undifferentiated zone surrounding the central calderas, are well defined, and can be quite long (up to 500km). They tend to be clustered into about 3 or 4 major parallel groupings. Intercalated tabular flows tend to occur in intimate association, in complex superposition relationships, giving them a stacked or layered appearance.

We have identified about 25 major tabular flows on the flanks of Alba Patera. Because of their emphatic morphologies it is unlikely that more undetected examples at these scales exist. Thus the apparent 5% areal distribution of these large features as a class on Alba is likely to be close to their true volumetric distribution. This observation is consistent with the Alba's low overall relief. Tabular flows appear to occur over in a variety of sizes. Large solitary or intercalated tabular flows occur in all mapped quadrants of Alba, with their mapped proximal reaches generally coinciding with the circumferential horst and graben field that characterizes Alba. In addition, smaller, generally solitary flows with gentle medial swales appear superimposed over undifferentiated areas surrounding late stage collapse calderas within the graben swarms.

The composition and rheological regimes of the tabular flows appear somewhat problematical. The longitudinal profiles of these flows are much flatter than, for instance, typical Hawaiian flows. Their overall thicknesses tend to argue against low viscosity (e.g., ultramafic or mafic) lavas. Best fit viscosities assignable to the first discernable upstream manifestation of a discrete flow tend to hover around 10^5 poise, suggesting basaltic-andesite or andesite compositions (7,8), for reasonable effective radiation temperatures. Such compositions are more silicic than have been suggested previously for Alba (9) however, they may be more consistent with current suggestions of evidence of pyroclastic activity (10).

Crested flows are our second major flow class. These flows are generally equivalent to the "ridge flows", "tube-fed flows", and "tube-channel" flows described by other workers (4, 9). We use the term "crested" to denote the major morphological attribute of these features, namely that they typically possess positive relief with an axial, often medial, apex. Such axial apices often (but may not necessarily) coincide with axial longitudinal valleys or longitudinally-aligned pits. We feel that the evidence as to whether these longitudinal valleys represent true lava channels or whether the aligned pit chains represent true collapsed lava tube/channel systems, while adequate to support such a working hypothesis, is not generally unequivocable. Data with spatial resolution adequate to resolve their interior morphologies is not available for more than one example. Crested flow margins appear to smoothly grade into the surrounding terrain, although in a few cases marginal ramparts can be discerned.

Overall, crested flows are remarkably uniform in plan width, as are their axial troughs, where they exist. As with tabular flows, discrete source regions cannot be distinguished for these flows. Often they emerge from undifferentiated flow fields, and appear to occupy radially arrayed topographic lows provided by pre-existing topography. At this point, there is little that can be inferred about the relief of these flows, except that they appear to be thicker than their apical channels (>10 meters) and typically do not overtop adjacent tabular flows (<~50-100m). It does not appear likely that crested flows make up a substantial part of the shallow Alba shield. These features appear to be highly local, and this style of morphology appears to occur at only one size scale.

The genesis of crested flows is problematical. A logical terrestrial analog would appear to be flows with collapsed lava tube-lava channels (e.g., Snake River Plain, Hawaii) (9, 11, 12). Disparities of channel width vs. flow width and flow scale compromise such straightforward comparisons when rheological and thermal aspects are considered. The emplacement mechanisms, rheological and compositional regimes of crested flows remain unclear.

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REFERENCES:
(1) Carr, M.H., et al., 1977, Jour. Geophys. Res., 82, p. 3985-4015. (2) Carr, M.H., and Greeley, Ronald, 1980, NASA SP-403. (3) Carr, M.H., 1981, The Surface of Mars: New Haven, Yale University Press, 232p. (4) Greeley, R. and P. Spudis, 1981, Rev. Geophys. Space Phys., 19, 13-41. (5) Cattermole, P., 1987, Jour. Geophys. Res., 92, B4, E553-E560. (6) Carr, M.H., 1980, Space Science Reviews, 25, pp. 231-284. (7) Baloga, S.M., et al., 1987, Proc. LPSC XVII, p. 42-43. (8) Pieri, D.C. and S.M. Baloga, Jour. Volc. Geotherm. Res, 1986, 30, 29-45. (9) Greeley, R. 1977, in Greeley and King, eds., NASA CR-154621, 308 pp. (10) Mouginis-Mark, P.J., et al., 1987, submitted to Bulletin of Volcanology. (11) Greeley, R., 1987, USGS Prof. Paper 1350, Decker et al., eds., 1667 pp. (12) Green, J. and N.M. Short, 1971, Volcanic Landforms and Surface Features, Springer-Verlag, New York, 519 pp.