THE CRUSTAL DICHOTOMY BOUNDARY WEST OF TEMPE TERRA: SPECULATION ON WHERE IT LIES BENEATH ALBA PATERA BASED ON MOLA TOPOGRAPHY.

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Summary: MOLA gridded data based on profiles collected during the Aerobraking Hiatus and Science Phasing Operations suggest the crustal dichotomy boundary west of Tempe continues beneath Alba volcanics, at least to 105W at about 50N. A broad shelf-like region in the Alba units is continuous with a similar region of Tempe in which Hesperian volcanics overlie Noachian cratered terrain. Perspective views show significant changes in the sloping character of the flanks of Alba east and west of 105W, with much more continuous steep topography to the west. We suggest that Alba sits astride the ancient crustal dichotomy boundary, not adjacent to it, and that its eastern half lies on old cratered terrain. If true, this would significantly affect the estimate of Alba volcanics volumes, and might also explain some of the observed asymmetries in the structure and the distribution of faults associated with this immense feature.

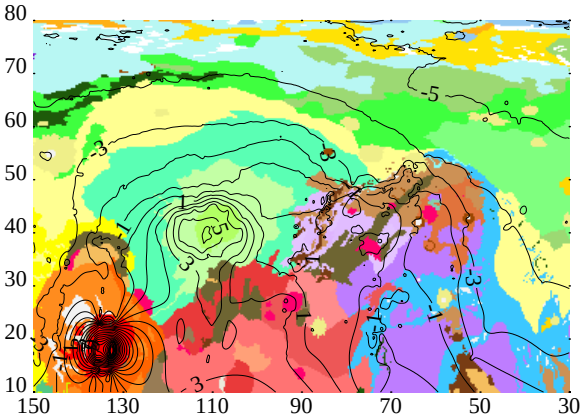

Figure 1. Contoured topography based on a gridded data set (Neuman, personal communication) that combines MOLA data from 30N and higher with a low resolution spherical harmonic representation of occultation-derived heights [5] (30N and south). Contour interval 1 km. Elevation contours are shown superimposed on a slightly modified geologic map. Note the change in direction the -1 km contour.

Data collected by MOLA during the Aerobraking Hiatus and the Science Phasing Operations 1 & 2 provide good coverage over the northern hemisphere of Mars, and in particular over the Tempe Terra - Alba Patera region. This area has some of the most dramatic elevation and geologic contrasts on Mars, from the volumetrically largest volcanic edifice to some of the oldest and most fractured terrain on the planet. Alba stands some 6 km above the MOLA reference level and over 9 km above the Amazonian lowland plains that surround its northern and northwestern flanks. Portions of the cratered terrain in Tempe rise 5 km from northern lowlands through a narrow transition zone of less than 300 km [1], generally having greater relief over a shorter distance than found at the dichotomy boundary in eastern Mars [2]. The outer Middle and Upper Hesperian volcanics (unit *Hal*) from the eastern portion of Alba embay Middle and Upper Hesperian Tempe volcanic plains (*Htm*, *Htu*) superimposed on and isolating old basement complex (*Nb*) and cratered terrain (Npl_1) in western Tempe. The inner and younger Alba plains (*Aam*) are intensely fractured by two large sets of faults. Alba Fossae form a relatively narrow band diverting around the main caldera to the west on what MOLA shows to be the steeper and higher side of the structure (see below). The Tantalus Fossae form a broader band on the eastern side of the caldera, extending to the NE across what topographically is a broad shelf region (see below).

As portrayed on the USGS geologic map [3], the dichotomy boundary at about 50N terminates near 90W where it runs into Alba, then resumes at 5S near 145W. In the Tharsis-Alba region between there is little old terrain and no obvious continuation of this boundary in either image or old topographic data. In particular, the features which characterize the dichotomy boundary zone (knobs, mesas separated by relatively smooth plains but located close to old cratered terrain) are not apparent in this area.

Figure 1 shows MOLA-based topography for the Alba-Tempe region, superimposed on a slightly simplified geologic map adapted from the original by Scott and Tanaka [3,4]. Elevation contours are from a gridded data set (Neuman, personal communication) that combines MOLA data from 30N and higher with a low resolution spherical harmonic representation of occultation-derived heights [5] (30N and south). The elevation of the central portion of Alba is very impressive, rising to a peak of about 6 km above the MOLA reference level in the western portion of the central caldera. Overall Alba stands about 9 km above the lowland Amazonian plains which surround its northern and northwestern flanks. By contrast, Tempe Terra reaches elevations of only about 0 km (except for localized volcanic features which stand about 1 km higher) but can be more than 4 km above the lowland plains. The character of the topography at the boundary between cratered highlands and lowland plains in Tempe varies along the boundary [1], but is well described as a step function like that in eastern Mars [2]. The slope breaks and elevations that mark the transition between lowlands and cratered uplands in Tempe (approximately -2 and -1 km) continue in a slightly subdued form westward into the Alba units to about 105W, where the -1 contour bends southward. The area of outer and inner Alba volcanics (*Hal*, *Aam*) between 90 and 105W lies on a topographic platform

or shelf with similar elevation and slopes as the adjacent cratered terrain in Tempe. West of 105W the shelf-like structure disappears with elevations dropping steadily to more flat-lying units west of 120W.

Figure 2 provides a perspective view (with great vertical exaggeration) of the Tempe Terra - Alba region from the north. The shelf-like region appears continuous with the Tempe units to the east (left in Figure 2) and decays steadily to the west (right in Figure 2).

We suggest on the basis of the topography of this region that the crustal dichotomy boundary continues westward at about 50N to approximately 105W before turning SW. The broad shelf-like region may represent old Tempe Terra terrain thinly mantled by Alba volcanics, which elsewhere may be significantly thicker. We note the fractures of Tantalus Fossae extend throughout the width of this area more so than in the NW portion of Alba. Perhaps thinner volcanics in this region were more easily fractured than those in regions not underlain by old cratered terrain. It is particularly interesting to consider that the old terrain underlying the NE portion of Alba may themselves have been fractured, like some of that to the east (Mareotis and Tempe Fossae), and that the Tantalus Fossae in part represent reactivation of these.

It may be that Alba sits astride the dichotomy boundary zone and not adjacent to it. The boundary west of 105W may trend SW through the area now occupied by the caldera of the volcano. If true, approximately 40% of the Alba volcanics may overly old cratered terrain, and that cratered terrain may contribute to some 4 km of the elevation (and thickness) of eastern Alba.

References. [1] Frey et al., this volume.[2] Frey et al., GRL 24, 4409-4412, 1998. [3] Scott, D. H. and K. L. Tanaka, 1:15M Geol. Ser. Map I-1802-A, 1986. [4] Tanaka, K. L. et al., Proc. Lunar Planet. Sci. Conf. 18, 665-678, 1988. [5] Smith, D. E. and M. T. Zuber, Science 271, 184-188, 1996.

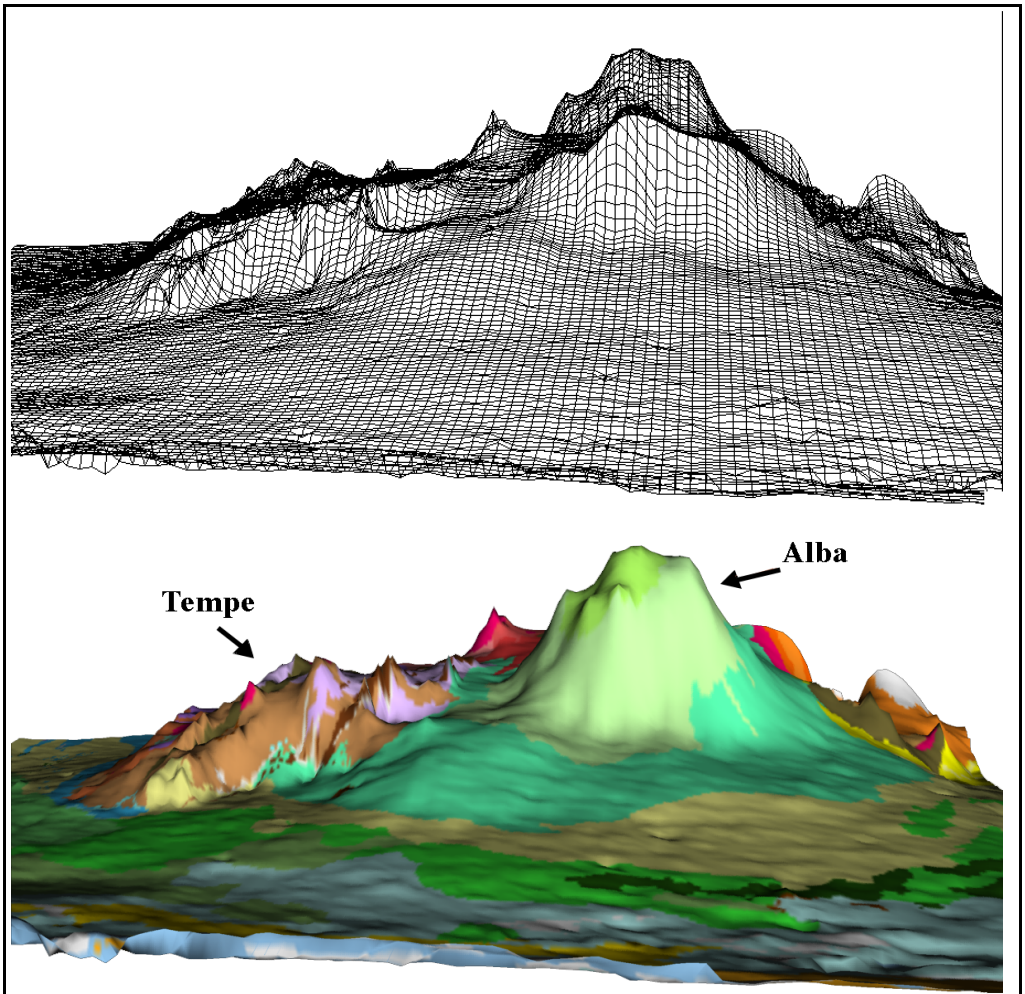

Figure 2. Perspective view from the north of Tempe Terra - Alba topography alone (top) and with superimposed geologic units (bottom). The vertical exaggeration is approximately 110:1 and the illumination is from the west (right). Note the shelf-like portion of the Alba volcanic units (blue-green) immediately adjacent to the Tempe Terra (browns, lavender).