A TALE OF TWO CRATERS: MOLA CONSTRAINTS ON TIMING OF THE FORMATION OF THE CRUSTAL DICHOTOMY BOUNDARY ZONE AND ITS ASSOCIATED TOPOGRAPHY ON MARS. H. V. Frey[1], S. E. H. Sakimoto[2], and J. H. Roark[3], [1]Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, frey@denali.gsfc.nasa.gov, [2]USRA at the Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, sakimoto@denali.gsfc.nasa.gov, [3]Science Systems & Applications, Inc., Lanham, MD 20706, roark@denali.gsfc.nasa.gov.

Summary: Three MOLA passes cross the crustal dichotomy boundary zone in the Aeolis portion of eastern Mars. Two of these profiles pass through craters that are of similar large (~150 km) diameter but very different preservation states, and are located at the contact between the cratered terrain (CT) and the transition zone (TZ) of mesas and knobs. The N and S rims of the more degraded crater (north of Knobel, hereafter Knobel-N) are at the same high elevation; just north of the crater the elevation drops by ~3.4 km to the plains in the TZ. Gale crater appears better preserved, but the northern rim is nearly 2 km lower than the southern. Gale seems to overlap the CT/TZ boundary, whereas Knobel-N lies at the edge of the CT. From the topography and degradation states of the craters and their surroundings we conclude that Knobel-N formed *before*, and Gale formed *after* (at least some of) the CT/TZ elevation difference was in place. Superposition relations suggest the boundary relief was established in the Mid-Late Noachian.

Nine MOLA passes cross the crustal dichotomy boundary zone in eastern Mars [1,2] where the transition from cratered highland terrain (CT) to lowland smooth plains (SP)

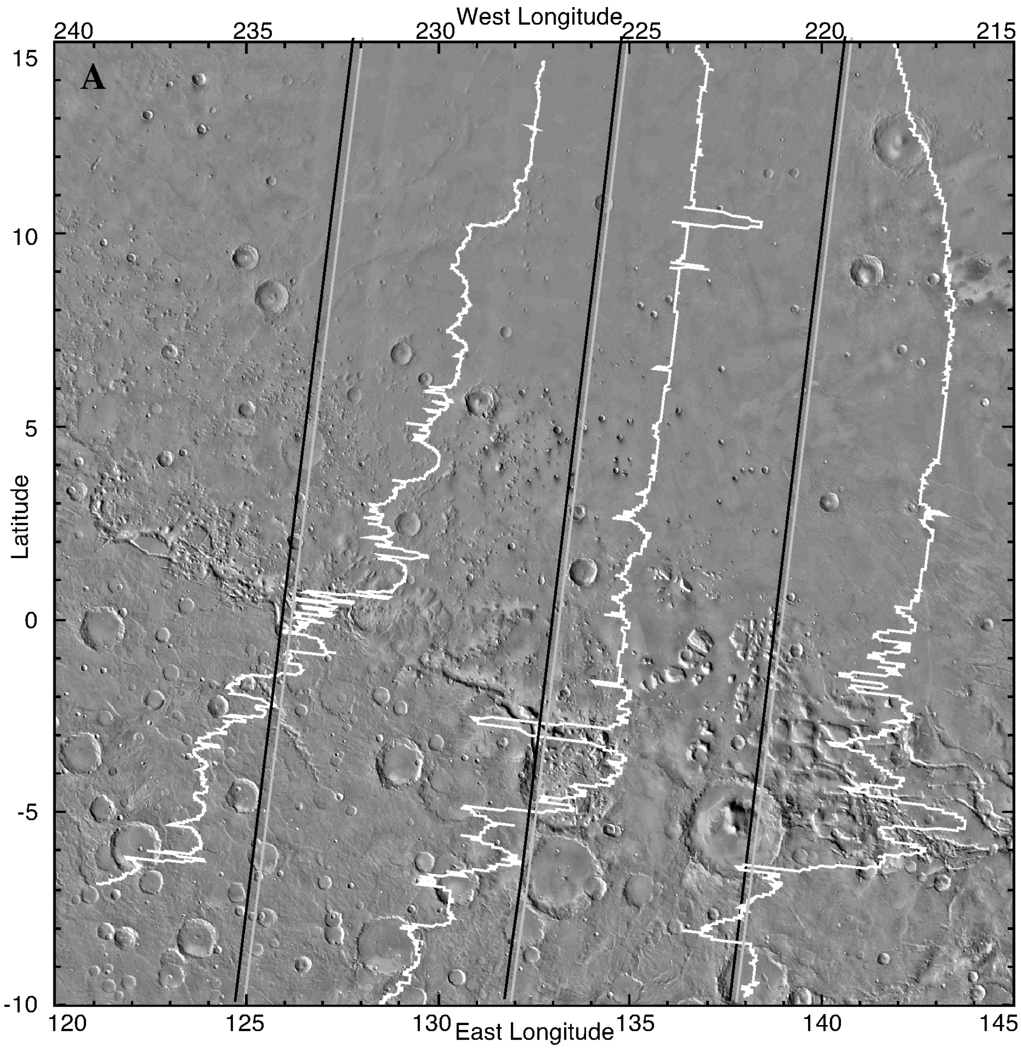

Figure 1. A) Viking digital image mosaic (64 pixels/degree). MOLA data tracks for passes 02, 20, and 36 (left to right) are shown as black lines, the track locations on adjusted to their apparent location on the image data are shown as gray lines, and the white data traces are the topography plotted perpendicular to the adjusted data tracks. B) (next page) High resolution plot of topography and topographic scales for passes 02, 20, and 36.

is particularly well marked by a variable width transition zone (TZ) of detached plateaus, mesas and knobby terrain [3]. In this paper we discuss three profiles (MOLA passes 02, 20, and 36) which cross the dichotomy boundary zone in the Aeolis region between 220° and 235°W at approximately 8°S to 3°S. The geomorphic character of the boundary zone varies significantly in this region [3], as does the topographic character. Figure 1 shows the MOLA passes superimposed on a Viking image mosaic for the area 15°N to 10°S, 215° to 240°W. The topography is plotted both perpendicular to the ground track on the image and separately in Figure 1B.

A linear contact runs NW to SE across the image, separating a region of abundant large craters, of which Gale is the most prominent, from transition terrain (mesas and knobs separated by smooth plains) to the north. This is also a contact between higher and lower elevations: the MOLA data show the terrain N of the CT/TZ contact to be lower than that to the S. In all three profiles the minimum change in median elevation (CT to TZ) is ~4 km, with some local slopes frequently in the 10° to 20° range and regional (5 to 100 km) slopes between 1° and 10° (see[2]). By contrast, local and regional slopes in the northern plains (SP) are <1° and commonly <0.1° [1]. Local slopes in the CT have considerable variability due to crater walls, but regional slopes are a few degrees or less, and frequently <1° [2].

Considerable variation in the topography across the TZ is obvious from the profiles. To the west (pass 36) the CT steps gradually down at an average 0.5° slope before dropping by about 1.5 km over ~15 km (>5° slope). North of this the TZ continues to slope gently downward (~0.1°). In contrast, the drop to relatively flat plains in the TZ in pass 20 is more abrupt, some 3.2 km over 7.7 km (23°).

The different degradation states of Knobel-N and Gale suggest different emplacement times relative to the formation of the relief across the boundary. From the ~1° slope between the north and south rims, and the location of the central peak deposits (nearly entirely within the lower north half of the crater cavity), Gale appears to have been emplaced on a pre-existing slope (see Figure 1). The CT/TZ boundary is visible E and W of Gale, but the crater lies on top of the transition, and is better preserved than the majority of the nearby large craters to the south. The gain in median elevation across the dichotomy boundary here is about 3.4 km, but over 2 km of that occurs between the S and N rims of Gale. The more degraded Knobel-N is an interesting contrast. The median elevation gains across the dichotomy boundary at Knobel-N are nearly the same as at Gale, but this all occurs N of the crater (the N and S rims are at the same elevation). The northern edge of the CT lies just outside the N rim, the boundary truncating both ejecta and part of the rim itself. From these differences, it seems clear that the better-preserved Gale was emplaced *after* (at least some) topographic relief was present at the dichotomy boundary, whereas Knobel-N was emplaced *before* (most of) the current relief existed.

Stratigraphically, Knobel-N lies in the unit *Hnu* and adjacent to Middle Noachian *Npld* to the S and Early Hesperian *Hpl*$_3$ to the E (Figure 1) [4]. Gale is shown as superimposed on upper Noachian plains (unit *Npl*$_2$), and on the adjacent *Hpl*$_3$ [4]. But close inspection of the region west of Gale suggests the opposite: the smooth unit appears to be overlapping the ejecta from Gale, partially burying it. If true, then Gale is younger than the late Noachian *Npl*$_2$ unit on which it is superimposed, but older than the Early Hesperian *Hpl*$_3$ unit which partially obscures its ejecta. And if, as suggested above, the elevation difference was already in place when Gale formed, then that must have occurred between the Middle Noachian and the end of the Noachian.

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References. [1] MOLA Science Team. [2] Frey et al., this volume. [3] Frey, H. et al., Proc. 18th Lunar Planet. Sci. Conf., 679-699, 1988. [4] Greeley, R. And J. E. Guest, 1:15M Geol. Ser. Map I-1802-B, 1987.