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CHARACTERISTIC STRUCTURES OF THE HIGHLAND BOUNDARY ON MARS: EVIDENCE AGAINST A SINGLE MEGA-IMPACT EVENT?

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Wilhelms and Squyres(1) have suggested that an early mega-impact event might explain the fundamental crustal dichotomy on Mars. Detailed morphological mapping of the structures which characterize the boundary between the cratered highlands and northern plains does not support this idea: the distribution of these features along and especially away from the boundary is more consistent with a larger number of smaller but overlapping impacts.

We have assembled a data base for the study of the highland boundary through quantitative mapping (including crater counts) based on the 1:2 M controlled photomosaics (2,3,4). Whole and partial craters larger than 10 km in diameter, knobby terrain, detached plateaus and intervening plains-forming units have been identified wherever they occur on Mars between +65 and -45° latitude. We find evidence for occurrences of possibly old cratered terrain (or its remanants) at high latitudes well north of the current or likely former location of the proposed Borealis Basin(1) rim which are difficult to reconcile with an impact structure of the proposed size and location. In a low resolution map showing the fractional area(2,3) occupied by impact craters, knobby terrain and/or detached plateaus, the overlap produced by combinations of these features is obvious along the highland boundary in eastern Mars. Significant occurrences are also found along the western margin of Mareotis-Tempe, in the outflow channels and chaotic terrain south of Chryse, and in the knobby terrain unit in Elysium-Amazonis. This last area is particularly difficult to understand in terms of a mega-impact event.

The Elysium-Amazonis knobby terrain block is high standing and in many places consists of incomplete large crater rims thinly covered by younger plains. The unit lies on the more gently sloping eastern flank of the high Elysium volcanic complex, at an elevation of 0 to 3 km above reference(5) or perhaps lower(6). While this elevation is in part due to the proximity to Elysium, it is unlikely that it would be lowered by removal of that major structure (off-loading of the Elysium volcanic pile might even cause the crust to rebound). The large partial craters outlined by much of the knobby terrain have a size frequency distribution similar to that of the cratered highlands further south. Schultz(7) has suggested a large impact basin near the Elysium volcanic constructs. This evidence favors the interpretation that this block, which represents as much as 10% of the area of the proposed Borealis Basin, is a relic of old cratered highlands thinly veiled by plains-forming units(8,9). The northermost portion of this unit lies near the proposed center of th mega-impact (50°N, 190°W); the southernmost portion lies only 500 km from the proposed basin rim in Aeolis.

Detailed mapping of landforms found along the highland boundary does not support the idea that the northern third of Mars is a single large impact basin. Widely scattered occurrences of knobby terrain and occassional detached plateaus are found throughout the high latitude portions of the northern lowlands. Irregular distribution of knobby terrain of

different scales parallel to the present highland boundary west of the Isidis Basin become much less obvious to the east, departing from the parallel orientation and instead striking northeast. While some of these may represent units younger than the highland boundary(10), there is implication of possible structural control not dominated by the Borealis Basin rim. The major "holes" in the distribution of high latitude knobs and detached plateaus occur in the two lowest parts of Vastitas Borealis, at 230°W north of Utopia Planitia and at 30°W north of Acidalia Planitia. The first of these lies adjacent to the proposed center of the mega-impact; the second straddles the proposed basin rim. Although the topography in these regions is suspect(6), these "holes" are the only two portions of the high latitude plains lower than 2 km below reference (i.e., as deep as the Chryse Basin). At higher elevations some evidence for possibly old terrain usually exists.

As described elsewhere(11), evidence for a continuous circular highland boundary is lacking, especially in western Mars. It is not obvious this lack is due to subsequent geologic events. The occurrence of possibly old terrain at relatively high elevations in the northern lowlands, especially close to the proposed basin center, the lack of convincing topographic expression of the basin(9), and the patchy distribution of both elevations and landforms north of the highland boundary all are more easily understood in terms of multiple overlapping impacts of more moderate size.

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