GEOGRAPHIC DISTRIBUTION OF QCDS AROUND THE NORTHERN PLAINS BASINS OF MARS AND THE RELATIONSHIP TO LOWLAND MATERIALS.

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Introduction: It has been suggested that quasi-circular depressions (QCDs) without a structural representation in Viking and MOC visible imagery represent buried impact craters [1,2,3,4]. Topographic depressions will form over impact craters buried by a differentially compacting cover material because total cover thickness, and thus total compaction, is greater over the center of completely buried impact craters than their rims [5]. If this is the process by which QCDs form, then only areas of differentially compacting materials should have QCDs.

Previous work has established that there is a relationship of surface relief to diameter for QCDs around the Utopia Basin [6]. The slope of the trend of this relationship varies depending on cover thickness, becoming steeper with decreasing thickness [7]. Comparing trendslopes of QCDs around different lowland basins might give us insight into the relative thickness of the cover material in these areas.

We explore the geographic distribution of QCDs around the Utopia, Isidis and Acidalia basins and compare their location to geologic units and materials. We also compare evidence for relative thickness of cover material at the three basins.

Utopia QCDs: [6] identified 115 QCDs around the Utopia Basin but found no QCDs in its south-east region (Fig. 1). The areas lacking QCDs correspond to the Elysium lava flows (unit Als_1 in [8]) in Utopia Planitia. There are also no QCDs in the Alc unit [8], which is interpreted as volcaniclastic flows formed by magma/ volatile interactions. In fact, all of the QCDs around the Utopia Basin occur in the hummocky member (unit AHvh in [8])of the Vastitas Borealis Formation (unit VBF in [8]).

Unit AHvh is interpreted as outflow-channel sediments whose pervasive alteration has been aided by subsurface volatiles [8]; this interpretation is consistent with the differently compacting material predicted by [9] for the polygonal terrain of Utopia Planitia. Both units Als_1 and Alc are younger than the hummocky member of the VBF, and may be covering QCDs that formed in the underlying AHvh. Indeed, polygonal terrain occurring in AHvh almost completely surrounds the Utopia Basin in a circle of radius 17º (Fig. 3 in [10]), except in the region covered by units Als1 and Alc, suggesting that the younger Elysium flows covered pre-existing polygons. But then, why did new QCDs not form in the younger flows over impact craters on top of the AHvh? The lava flows of unit Als_1 would not be expected to differentially compact, precluding the formation of QCDs. And while volcaniclastics could differentially compact, unit Alc is interpreted to have undergone modification by volatile escape subsequent to deposition [8], a process that would almost certainly have erased any QCDs that formed.

The trendslopes of Utopia QCDs have been used to suggest that cover material in Utopia thickens toward the center of the basin and that cover material is thicker to the north of the basin than to the south [6,7].

Isidis QCDs: While the majority of Isidis Planitia is covered by unit AHvh, an approximately 300 x 800 km area to the west of the basin is mapped as younger chaos material (unit Act in [8]). Chaos material is described as VBF materials disrupted by volatile discharge and collapse [8]. This region of Isidis borders Syrtis Major Planum and [8] suggests that late-stage magmatic heating beneath the volcanic plateau may have caused discharge of volatiles from Isidis materials or over-pressurization of subsurface volatiles. This could have resulted in fracturing and collapse, forming the definitive chaos structures and erasing any QCDs that may have existed.

Isidis Planitia is covered with many tens of partially-buried impact craters, implying that the cover material in the basin is thin. In fact, Isidis has only 17 QCDs, all to the north and east of the basin (Fig. 2), the largest of which is only 35.54 km in diameter. According to [11] a 35.54 km martian impact crater would have a rim height of roughly 400 m. The lack of any QCDs larger than 35.54 km suggests that the cover material in Isidis is relatively thin, although thicker than 400 m. The surface relief to diameter trend of the QCDs in Isidis has a slope that is steeper than the trendslope of the Utopia QCDs, also supporting a thin cover material in this basin [6,7].

Acidalia QCDs: As in Utopia and Isidis, all of the Acidalia QCDs are found in unit AHvh. Acidalia is bordered by unit Hb_2 [8], which is interpreted to be the deposition of materials eroded off other units and in which we found no QCDs. In general, the distribution of QCDs is affected by Acidalia Mensa and Acidalia Colles. Acidalia Mensa is an outcrop of highland material (unit HNu in [8]) inside the basin. It is embayed to the west by unit Hb_2 [8]. Acidalia Colles is a depression several hundred meters deep filled with a knobby material interpreted by [8] as unit Act. There are no QCDs on either of these features, but they are encircled by QCDs in the surrounding AHvh material. The southern regions of Acidalia Planitia are covered by channel material (unit Hch in [8]) from the Chryse basin, interpreted as fluvial sediments and debris flows; we found no QCDs in these materials in Acidalia.

Acidalia Planitia is a more complicated basin than either Utopia or Isidis. Predictions of Acidalia cover thickness are confused by the presence of the overlapping Chryse basin directly to the south-west [12]. Further confusing any estimates of cover thickness is the presence of the highstanding Acidalia Mensa. Trendslopes do not steepen consistently from the center of either the Acidalia or Chryse basins, as they do from the center of Utopia. It may be that the overlap of the two basins has interfered with the depth of the basement floor. However, the QCD trendslopes do indicate thicker cover materials immediately toward the center of the Acidalia basin. The trendslopes also show that cover material consistently thickens with distance from Acidalia Mensa, up to 750 km away.

Other QCDs: Three QCDs were discovered on the topographic saddle between the Isidis and Utopia basins (Fig. 2), mapped as unit Hb_2 [8]. These are the only QCDs we observe that are not in unit AHvh. The cover material is probably very thin. The largest of the QCDs has a diameter of 17 km; an impact crater this size has a crater rim only 216 m high [11]. The lack of more data points makes the trendslope of the three QCDs of dubious value. However, it is steeper than even the Isidis trendslope, suggestive of a cover material over the topographic saddle that is thinner than the cover in Isidis.

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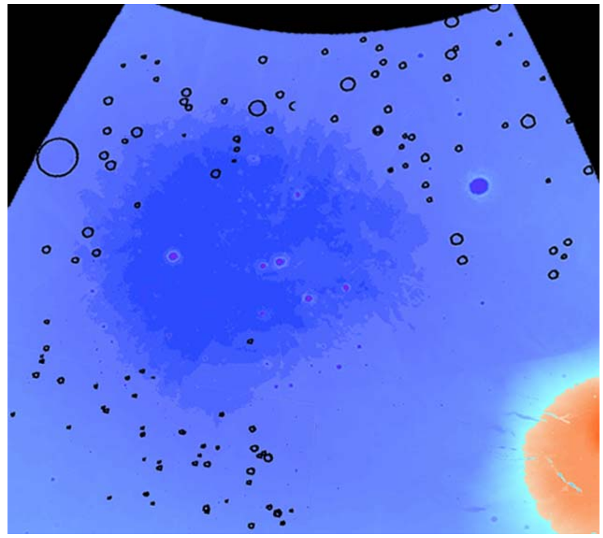

Figure 1. Distribution of QCDs (diameters ranging from 7-100 km) around the Utopia basin.

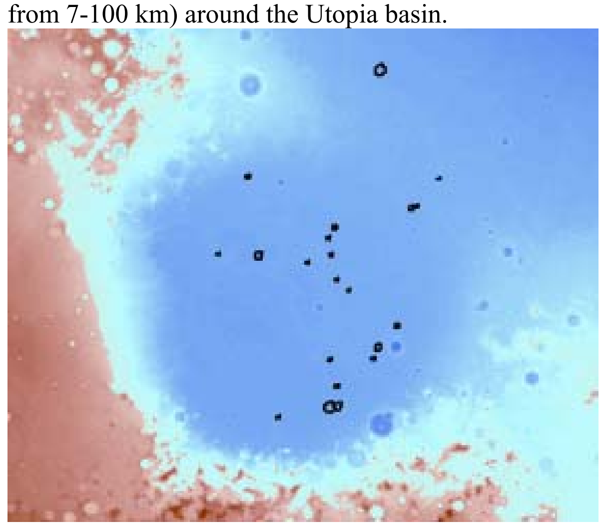

Figure 2. Distribution of QCDs (diameters ranging from 8.56 - 35.54 km) around the Isidis basin.

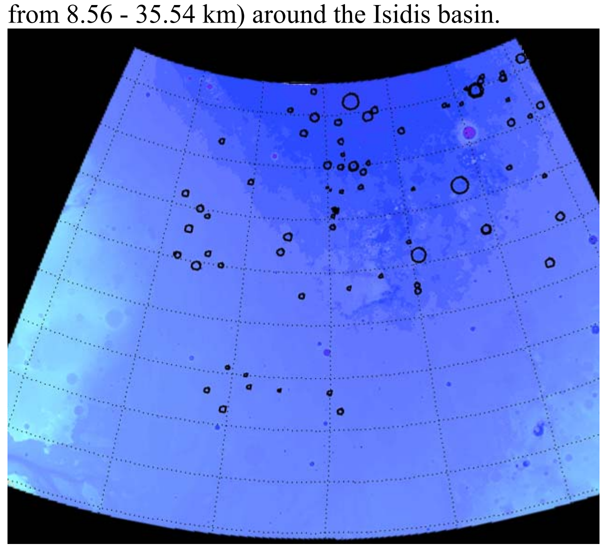

Figure 3. Distribution of QCDs (diameters ranging from 7-100 km) around the Acidalia basin.