A VERY LARGE POPULATION OF LIKELY BURIED IMPACT BASINS IN THE NORTHERN LOWLANDS OF MARS REVEALED BY MOLA DATA. H. V. Frey[1], K. M. Shockey[2] , E. L. Frey[3], J. H. Roark[4], and S. E. H. Sakimoto[5], [1]Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, frey@core2.gsfc.nasa.gov, [2]Astronomy Program, University of Maryland, College Park, MD 20741, kmshock@core2.gsfc.nasa.gov, [3]South River High School, Edgewater, MD 21037, dancer7068@aol.com, [4]Science Systems & Applications, Inc., Lanham, MD 20706, roark@core2.gsfc.naasa.gov, [5]UMBC at the Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD 20771, sakimoto@denali.gsfc.nasa.gov,.

Summary: High resolution MOLA data have revealed a large number of subdued quasi-circular depressions (QCDs) >50 km diameter in the northern lowlands of Mars which are generally not visible in Viking imagery and which may be buried ancient impact basins. Cumulative size-frequency distributions of the lowland QCDs are greater than that for visible impact basins in adjacent highland terrain but less than the total population of visible plus MOLA-found QCDs in the highlands. The smooth and sparsely cratered Hesperian and younger lowland plains on Mars are likely only a thin veneer overlying much older crust.

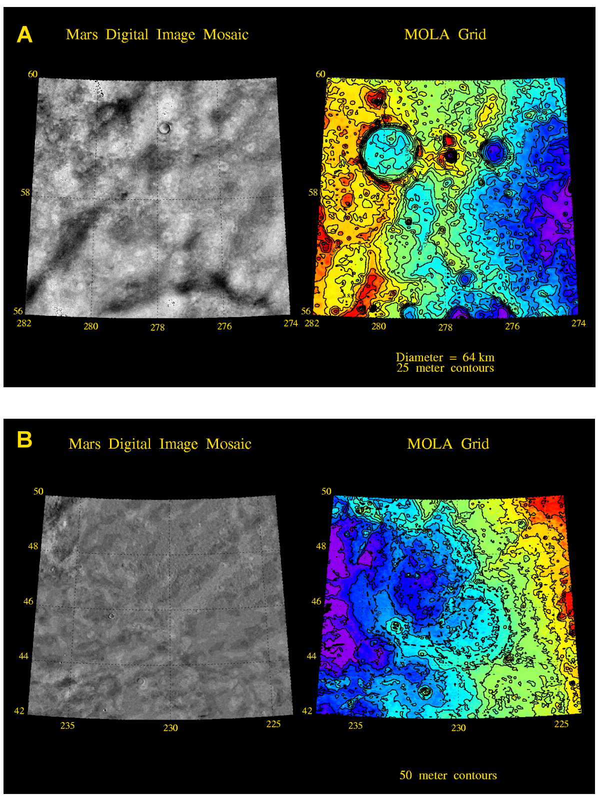

Figure 1: Colored and contoured MOLA topography compared with MDIMs for two areas of the northern lowland plains. The larger isolated circular depression in (a) is 64 km across. A smaller 34 km QCD is also obvious to the right of the larger depression. In (b) there appear to be two overlapping QCDs of diameter roughly 250 and 175 km. Other smaller circular depressions are also apparent in this area.

Introduction: We previously reported the existence of large quasi-circular depressions (QCDs) on Mars revealed by Mars Orbiter Laser Altimeter (MOLA) data. Although the first of these was found using early MOLA profile data [1], we now use an interactive IDL-based program to shift and stretch the color representation of the latest MOLA gridded data [2]. In an earlier detailed search of the 180 degrees of longitude centered on 0W between +/-75 degrees latitude we found 127 QCDs larger than 200 km diameter, compared with 42 visible impact basins of the same size [3]. At all diameters the cumulative number of “MOLA-found” basins is ~3 times that of the visible basins. We cannot prove the QCDs are buried impact basins, but their close association with other impact basins in the cratered highlands, the similarity of the size-frequency distribution for QCDs and known impact basins, and the fact that in this search we avoided obvious tectonic regions suggest that most (if not all) of the QCDs found *could be* ancient but now buried impact basins. *If the QCDs are buried impact basins*, there are important implications for early Mars: (1) the early bombardment of Mars in this size range (D>200km) was much greater than previously thought, and (2) early resurfacing on Mars (which subsequently buried ¾ of the impact basin population) must have been more significant than previously understood.

In the earlier study [3] we found very few basins in the northern lowlands and it was difficult to recognize QCDs smaller than ~200 km diameter. This was likely due to the relatively low resolution of the MOLA gridded data available at that time (initially 8 pixels per degree and later 16 pixels per degree). More recently a four-fold increase in the resolution of the MOLA gridded data has made possible the detection of both smaller and more subdued (shallower) features. We therefore undertook a systematic search for QCDs larger than 50 km in diameter in the lowland plains. Figure 1 shows two examples of QCDs in the lowlands which are fairly obvious in MOLA data but not visible in Viking MDIMs.

Results: Preliminary results are shown in Figure 2. We found 644 QCDs larger than 50 km diameter in the lowland plains, of which less than 90 (14%) are readily or even barely visible in MDIMs. 232 of these are larger than 100 km diameter (of which 16 or 7% are "visible") and 62 are larger than 200 km diameter (with only 1 in this size range readily visible). While these QCDs are reasonably well distributed across the lowland plains, there are some areas in which we found none at all (e.g., N of Alba Patera and SW of Olympus Mons). Young and thick lava flows in these regions may have completely obscured the relic topographic signature which elsewhere seems to show through the plains.

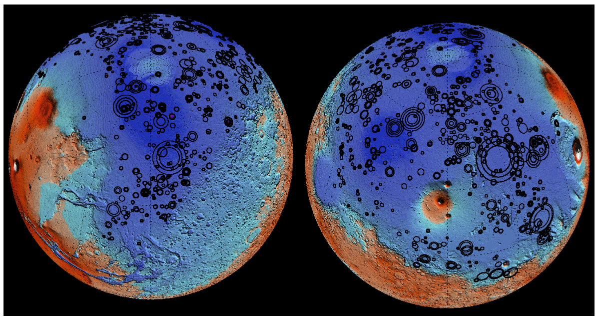

Figure 2. QCDs in the northern lowlands of Mars larger than 50 km diameter based on MOLA data. 644 features are shown, ranging up to over 1000 km across. Most of these (>85%) are hidden (MOLA-found). At least two areas near major volcanic features (N of Alba, SW of Olympus Mons) have no detectable QCDs.

We cannot prove these lowland QCDs are buried impact basins, but this remains the simplest and therefore most attractive alternative. *If they are buried impact features*, there is an important and inescapable implication for the nature of the lowlands: *the sparsely cratered visible lowland plains are only a thin veneer over a much older surface.*

Figure 3 shows the cumulative frequency (per million square km) for lowland QCDs [this study] and for visible and "MOLA-found" highland basins from the earlier study [3] (QCDs larger than 200 km diameter). Over common diameters with enough QCDs to be meaningful (roughly 200 to 500 km) the curves are remarkably parallel. More importantly, the total lowland population (which is 90% "MOLA-found") lies higher than the visible highland population but lower than the MOLA-found highland population. That is, the inferred buried basin density in the subsurface lowlands is greater than the exposed basin density on the highlands (the basis for its inferred Noachian age). A limited but direct comparison by one of us (ELF) of QCDs>100km diameter in the Chryse-Acidalia lowlands and adjacent Arabian highlands independently confirms this result.

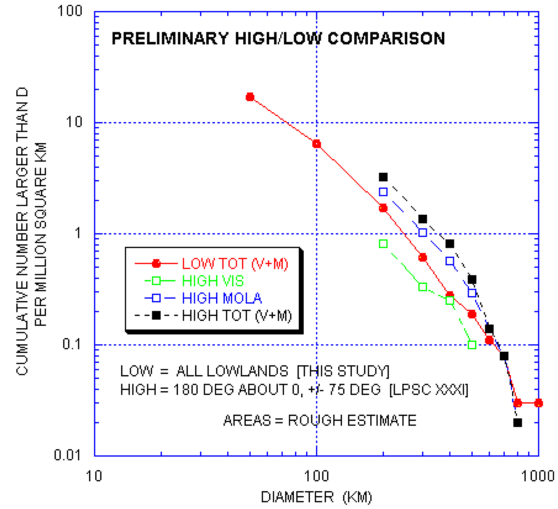

Figure 3. Cumulative frequency curves for two separate studies of QCDs. Shown are the visible and MOLA-found (hidden) basins and the combination of these for the central highlands and the combined visible and hidden basins in the lowlands from this study. Note that the lowland curve is higher than that for the exposed (visible) highland and close to the total highland curve.

The buried lowlands surface is thus at least as old as the exposed (Noachian) highland surface, as indicated by the visible basins. This has important implications for the origin of the lowlands. Models which generate the whole thickness of the lowland crust much after the highland surface was established can not be viable. Plate tectonic models [4] and crustal overturn convection models which delay until the Hesperian the generation of the lowland crust [5, 6], are not likely. Only the upper veneer of the lowlands can be as young as the Hesperian. This still allows models for the lowlands in which crust is lowered early and then heavily cratered [7, 8, 9], or in which old crust is lowered (but not destroyed) [10, 11], and then covered by younger volcanics.

References. [1] Frey, H. et al. GRL 26, 1657-1660, 1999. [2] Roark, J. et al. LPSC XXXI, CDROM Abstract #2026, 2000. [3] Frey, H. et al., LPSC XXXI, CDROM Abstract #1736, 2000. [4] Sleep, N. H., JGR (Planets) 99, 5639-5656, 1994. [5] Breuer, D. et al., Planet. Space Sci. 41, 269-283, 1993. [6] Zhong, S. and M. Zuber, Spring 2000 AGU, S292, EOS Suppl. May 9, 2000. [7] Frey, H. and R. A. Schultz, GRL 15, 229-232, 1988. [8] McGill, G. E., JGR 94, 2753-2759, 1989. [9] Wilhelms, D. E. and S. W. Squyres, Nature 309, 138-140, 1984. [10] McGill, G. E. and A. M. Dimitriou, JGR 95, 12,595-12,605, 1990. [11] Wise et al., JGR 84, 7934-7939, 1979.