VERY LARGE DIAMETER IMPACT BASINS ON MARS: CONTRIBUTIONS FROM CRUSTAL THICKNESS DATA H. V. Frey[1] and L. A. Edgar[2], [1]Planetary Geodynamics Lab, Goddard Space Flight Center, Greenbelt, MD 20771, Herbert.V.Frey@nasa.gov, [2]Earth Science Department, Dartmouth College, Hanover, NH 03755 , Lauren.A.Edgar@dartmouth.edu

Summary: The Circular Thin Areas (CTAs) derived from stretched crustal thickness data contain a half dozen features not previously seen as QCDs, bringing the total population of possible very large impact basins > 1000 km diameter to about 20. The largest of these new CTA basins is in Amazonis, a region that appears to be very old based on the number of smaller CTAs found there. The cumulative frequency curve for these very large features follows a -2 powerlaw trend for diameters between 2000 and 3000 km. These large QCDs and CTAs may be the oldest recognizeable structures on Mars, and the N(300) crater retention age derived by extrapolation of the -2 trend at large diameters may be the oldest surface age available.

Introduction: : Previous studies of large Quasi-Circular Depressions (QCDs) revealed by MOLA data [1] indicated about a dozen features with diameters >1000 km. Most of these were well-recognized giant impact basins such as Hellas, Argyre, Isidis, Chryse, Utopia and Acidalia. Very subdued and apparently very old highland basins were also found. As described in companion abstracts [2,3], stretching crustal thickness model [4] data reveal a very large number of Circular Thin Areas (CTAs) larger than about 300 km diameter and ranging up to several thousand km diameter. Some of these correspond to Quasi-Circular Depressions previously mapped from MOLA data [2], but many do not. Among these are several very large features not previously recognized on the basis of topography alone. We describe a preliminary assessment of these new features and suggest the implications of their being additional very large but previously unrecognized impact basins.

QCDs and CTAs > 1000 km diameter. Figure 1 shows stretched crustal thickness data [4] in the region east of Elysium. The now recognized Utopia impact is indicated by the thin ring of thickened crust (light blue to green) surrounding the circular area of thin crust (purple) just west of the obvious thicker region corresponding to the Elysium region (yellow and red). East of Elysium, in the Amazonis region, there is a fairly obvious ring of thickened crust with a diameter of about 1150 km. The ring is nearly complete except on the western side. A much larger but much fainter feature is also found in this region, with a diameter of about 2900 km. This feature, which we refer to as Amazonis, is the largest of the Circular Thin Areas identified in the crustal thickness data that is not associated with a known QCD. It encloses a region which is characterized by a very large number of smaller CTAs. If these are buried impact basins [2], the implication is that Amazonis is a much older region than is, for example, Utopia to the West, where fewer smaller CTAs are found within the main ring of the basin.

In a preliminary search aimed specifically at features > 1000 km diameter, 6 potential new very large impact basins were identified in stretched versions of the crustal thickness data [4]. These include two very tentative features in the greater Tharsis region. In a companion abstract we indicate that an earlier search found no large candidate basins in Tharsis, and that this might indicate that Tharsis crust is new and not built on pre-existing ancient highland crust. Further work is needed to verify or refute the existence of these features, which are among the most poorly preserved (if real) in the crustal thickness data.

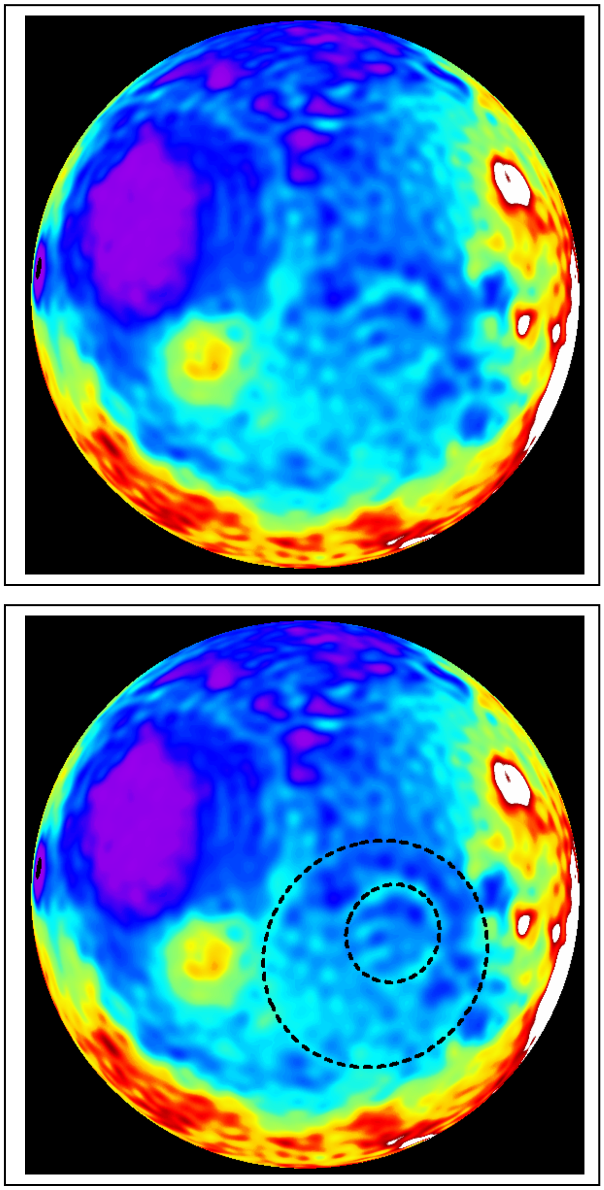

Figure 1. Stretched crustal thickness data of the Utopia-Amazonis region of Mars. Reds indicte thick crust, blues and purples the thinnest crust. Utopia is the large circular thin area in the upper left, Elysium the yellowish thick crust region below and to the right of Utopia. The Amazonis region has a complicated thickness pattern which includes many Crustal Thin Areas, and perhaps two much larger basins, shown by the dashed circles.

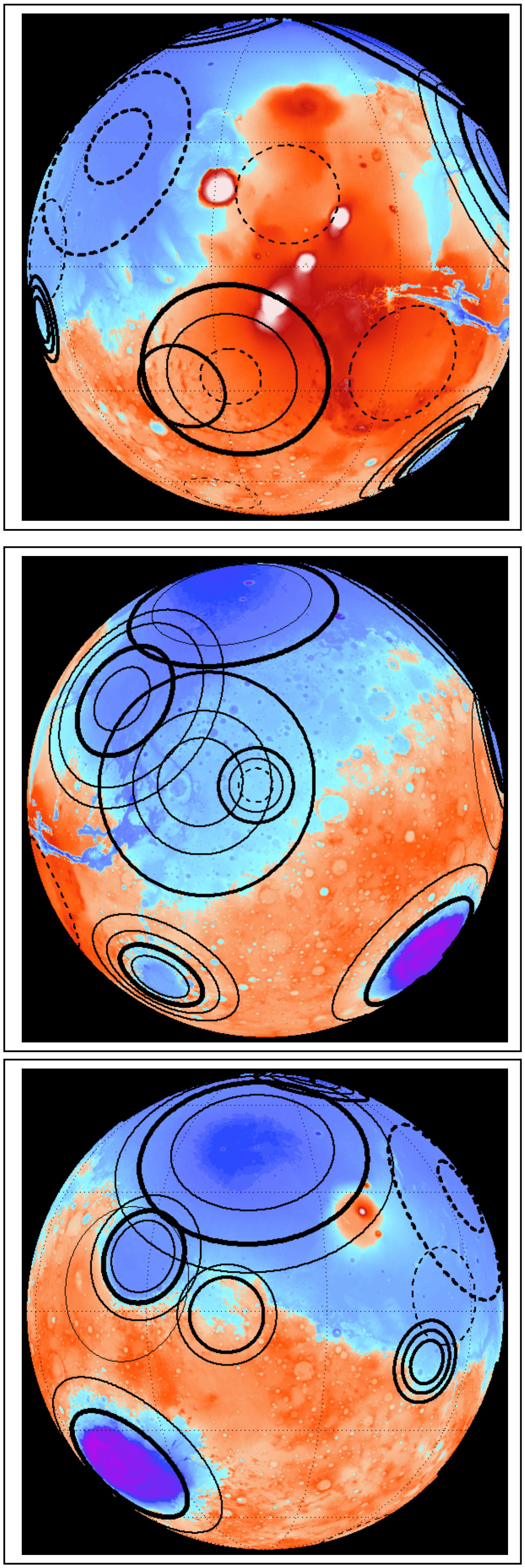

Figure 2 (left) shows the 20 possible very large basins identified in this preliminary work superimposed on MOLA topography. Those previously identified as QCDs are shown as solid circles; dashed circles show the new CTA candidates. The thickest circle in each case is that inferred to be the main ring, and it is that diameter used in the cumulative frequency plot shown in Figure 3.

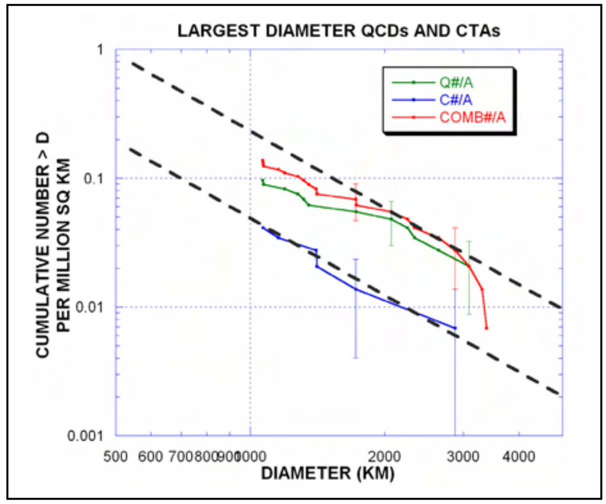

Figure 3. Cumulative frequency curves for large (> 1000 km) diameter QCDs (green), non-QCD CTAs (blue) and the combined population (red). Between 2000 and 3000 km diameter the curves follow a -2 powerlaw (dashed lines); the CTA curve follows it over the entire diameter range, even though this includes only 6 features.

The cumulative frequency curve shows separately the contribution from QCDs and CTAs. Note that these and the combined curve all follow a rough – 2 power law slope over the diameter range 200 to about 3000 km. Extrapolation of this to N(300) provides an estimate of the crater retention age for the very old surface which preserves these basins, and is close to the combined QCD + non-QCD CTAs for the highlands and lowlands as a whole, as discussed in two companion abstract [5,6].

N(300) ages for the individual basins can be derived from counting the superimposed QCDs + non-QCD CTAs described elsewhere [3]. This is underway, but preliminary results show that the prominent basins Hellas, Argyre and Isidis are the youngest, as was found using QCDs alone [2]. Daedalia, Ares, and the new Amazonis Basin appear to be among the oldest. Amazonis may be the oldest yet found, as it appears to contain a very large population of CTAs.

Among the important implications of this larger population of very large basins is that – if the features showns here are real – nearly all the present-day lowland plains lie within some large basin.

References. [1] Frey, H.V., JGR (Planets) 111, E08S91, doi:10.1029/2005JE002449 (2006). [2] Edgar, L.A. and H. V .Frey, H., LPSC 38 (this volume, 2007). [3] Frey, H.V and L.A. Edgar, LPSC 38 (this volume, 2007) [4] Neumann, G. A. et al., JGR (Planets), 109, E08002, doi : 10.1029/2004JE002262 (2004).