IT'S DONE*! A NEW MARTIAN GLOBAL CRATER DATABASE TO 1.0 KM.

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**This should not be construed to imply the crater database is completed.*

Introduction: The first global database of Martian craters was created from Viking images in the late 1980s by Nadine Barlow of craters $D \geq 5$ km. Since then, many other researchers have cataloged craters to smaller diameters but in isolated sections of the planet. In the first decade of the 21st century, Dr. Barlow started the process of revising her original catalog [1], while in the intervening years, others have compiled automated [2] or merged and computer-assisted catalogs [3] of Martian craters. None, however, are complete to diameters smaller than ~3-5 km, and the largest contains 130,301 craters [3]. Our catalog is 5× more extensive and complete to diameters of ~1.0 km across the entire face of the planet (Figs. 1, 2).

Construction of the Crater Database: All craters for our database were identified manually in THEMIS Day IR mosaics, Viking MDIM 2.1 where gaps exist in THEMIS coverage, CTX mosaics in isolated cases, and MOLA data. With a THEMIS resolution of ~100 m/pix, we used *ArcGIS* software to outline each crater rim and cohesive ejecta blanket (if present) at ~500 m cadence. *Igor Pro* software is used to calculate best-fit circle and ellipse parameters for each crater. Each $D \geq 3$ km crater was re-identified if possible in MOLA 1/128° gridded data to determine rim height, surface elevation, and floor depth. THEMIS data were used to classify crater interior and ejecta morphology, ejecta morphometry, and crater degradation state.

Our crater database includes MOLA- and THEMIS-based latitude, longitude, diameter, and ellipse parameters; MOLA-based rim, surrounding surface, and floor elevation; crater degradation state; three crater interior morphology descriptors and three ejecta morphologies; detailed morphometric data of cohesive ejecta; whether or not the crater is an obvious secondary; and subjective likelihood the feature is a true impact crater. Full details are available in [4] detailing how the database was constructed and basic trends in context with previous work (and will be submitted shortly for peer review).

Status: As of September 2011, the complete database contains ~632,000 craters at diameters down to ~0.5 km. Globally, the database is statistically complete to 0.96 km with completeness locally to diameters as small as 0.76 km (Fig. 1). We are publicly releasing the 378,540 craters only down to $D = 1.0$ km; additional, smaller craters may be obtained by request. The ≥1.0 km crater catalog will be submitted to PDS and PIGWAD through the Mars Crater Consortium by October 2011. We are also making it available in a highly customizable search format on the website `http://craters.sjrdesign.net`, a website that will be the first to receive incremental updates to the database because we have the most direct control over it. It also contains a feedback form where people can submit any potential problems / necessary fixes or changes.

Besides crater identifications to 1.0 km, the other crater descriptors are not completed as of this time. In this first release, all topographic information that could be obtained for craters $D \geq 3.0$ km from MOLA data are included. All crater interior morphology, ejecta morphology, ejecta morphometry, and degradation states for craters $D \geq 3.0$ km are also included. Data on whether the crater is a secondary is not included in this release for craters of any size, but it is our next-priority task.

Future work will seek to extend the ejecta data to the 1.0-km-diameter craters, classify all craters that can be identified as secondaries, and potentially include topographic measurements from available HRSC DTMs. Incremental future releases will be available on the afore-mentioned website, while larger batch updates will be submitted to the third-party ones (PDS and PIGWAD). Change logs will be included.

Basic Cratering Results: We have spent a significant amount of time verifying that the database reproduces previous trends and distributions to validate our catalog relative to others [1, 2, 3, in 4]. Once completed, we then used it to examine two fundamental crater properties – crater depth/Diameter (d/D) relationships and the simple-to-complex morphology transition [4]. Examining the d/D relationship involved separating craters into simple and complex morphologies, then dividing these into six different regions. We calculated the relationship for global craters, those equator-ward of ±40°, and poleward of ±40°. We also looked at craters in the northern plains, volcanic, southern highlands, and polar terrain types. We calculated best-fits for the deepest craters, fresh-only craters, and all craters within each location on the planet. We posit that the most robust results will be to use the deepest crater results for the different terrain types for both simple and complex craters [4].

Similarly, in examining the simple-to-complex crater transition, we divided the craters into seven different latitude or terrain types. The transition was then determined based upon four different criteria: At what diameter the crater (a) showed the distinctive flat-floor type versus bowl-shape, (b) had central peaks, (c) wall terraces, or (d) the d/D simple and complex best-fits intersected. The means of these were calculated and show there are significant differences between higher and equatorial latitudes (Fig. 3).

Secondary Cratering Results: As this is the first global database to contain small, kilometer-sized craters, it is also the first to allow a broad, uniform study of secondary craters. We have used this in two studies to-date. The first is the identification of vast streamers of what are likely secondary craters throughout Isidis basin (and elsewhere) that appear to be products of the large Lyot Crater (30°E, 50°N) [5]. We have also examined the large secondary crater fields of 24 primary craters across the planet and developed a simple model that could be used in automated population studies of primaries (*e.g.*, to age-date) to remove the vast majority of secondary craters without detailed removal of individual craters based on morphology [6].

Future Analyses: Even though the database is now released to the public, we are still hard at work mining it for current and planned research projects. Besides an omnibus paper on secondary craters, we will be looking at ellipticity trends across the planet, layered ejecta blanket properties, age-dating large ($D \geq 200$ km) craters, infilling and erosional trends, and transitional craters.

References: [1] Barlow N. G. (1988) *Icarus*, *75*, 285-305. [2] Stepinski T. *et al.* (2009) *Icarus*, *203*, 77-87. [3] Salamunićcar G. *et al.* (2011) *P&SS*, *59*, 111-131. [4] Robbins, S.J. (2011) Ph.D. Thesis. [5] Robbins, S.J. and B.M. Hynek (2011) *GRL*, doi:10.1029/2010GL046450. [6] Robbins, S.J. and B.M. Hynek (2011) *JGR-Planets*, doi:10.1029/2011JE003820.

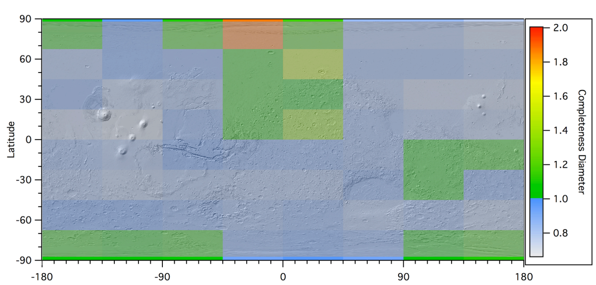

Figure 1: Color-coded area plot showing statistical completeness of crater diameters across the planet. Bins are 22.5° latitude by 45° longitude resolution. The low completeness in the bin centered at 78.75°N, -22.5°E is due to the young, large Lomonosov impact crater and the north polar cap, and the one centered at 56.25°N, 22.5°E is due to the similarly young, large Lyot impact crater.

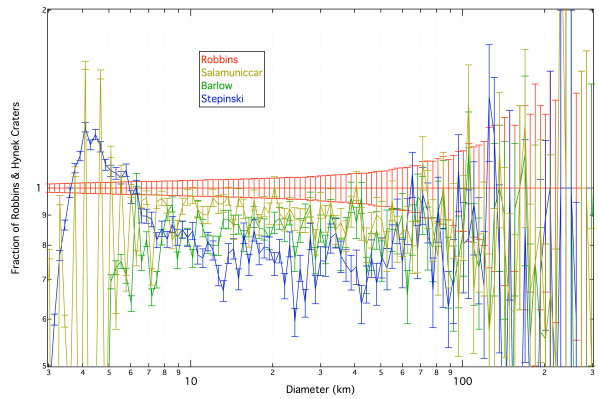

Figure 2: Ratio comparison between four global Martian crater databases with craters binned in $2^{1/16}D$ intervals. The original Barlow database [1] is not complete to $D = 5$ km, though the current in progress version is closer to ours. The Stepinski database [2] displays a marked increase in craters $3 < D < 7$ km. Salamunićcar *et al.*'s database [3] relative to this shows good agreement until diameters $D \lesssim 6$ are reached, at which point their diameters are posterized.

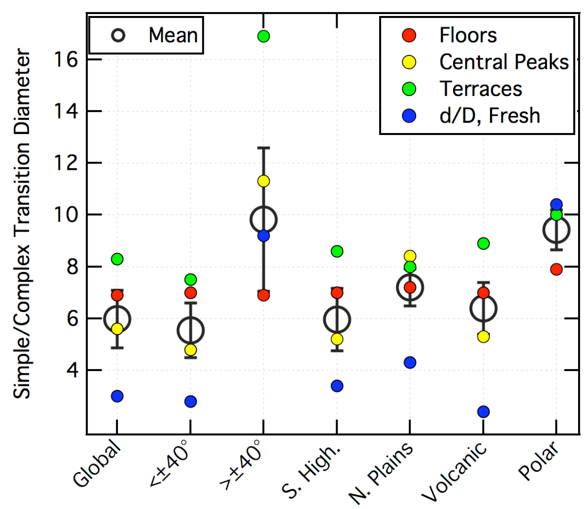

Figure 3: Combined results using different morphologic and morphometric indicators to determine the transition between simple and complex crater morphology on Mars. Solid circles are points showing different morphologic and morphometric indicators, the key to which shown by the legend to the upper right. Black open circles are the arithmetic means for the colored circles. Error bars are the standard deviation from the means of the three or four values divided by $N^{1/2}$.