RE-EXAMINATION OF THE POPULATION, STRATIGRAPHY, AND SEQUENCE OF MERCURIAN BASINS: IMPLICATIONS FOR MERCURY'S EARLY IMPACT HISTORY AND COMPARISON WITH THE MOON. C. Orgel[1], C. I. Fassett[2], G. G. Michael[1], C. H. van der Bogert[3], L. Manske[4], H. Hiesinger[3]. [1] Freie Universität Berlin, Institute of Geological Sciences, Berlin, Germany (orgel.csilla@fu-berlin.de), [2] NASA Marshall Space Flight Center, Alabama, USA, [3]Westfälische Wilhelms-Universität, Münster, Germany, [4]Museum für Naturkunde, Berlin, Germany.

Introduction: Mercury has one of the best preserved impact records in the inner Solar System due to the absence of an atmosphere, but it has much higher rates of surface modification than on the Moon [1-3]. The earliest geological mapping of the planet revealed a variety of important differences from the Moon, regarding the impact basin (≥ 300 km) and cratering record, as well as the extensive volcanic plains of Mercury [1-3]. It has been shown [3] that the bombardment history of the terrestrial planets is lunar-like and linked in terms of impactor population(s) and impact rates. Recent studies suggest that Mercury and the Moon had the same early impactor populations based on the similarity of their crater size-frequency distributions (CSFD), however the impact rates on Mercury are higher than on the Moon [4, 5]. Fassett et al. [6] catalogued and characterized the basin population on Mercury using early optical data obtained by the MESSENGER spacecraft and found 46 certain and probable impact basins, as well as a few more tentative basins. Many of these tentative basins were proposed on the basis of Mariner 10, but could not be verified with the available new data.

In this study, we re-investigate the number of the Mercurian impact basin (≥ 300 km) and their superposed crater populations. Moreover, we revisit the stratigraphic relationships of basins based on $N(20)$ crater frequencies and superposition observations. Finally, we infer the characteristics of the potential projectile populations on a relative crater frequency plot (R-plot) and compare the findings to a similar study we performed for the Moon [7].

Data and Methods: The primary data for this study are optical images mosaicked into a 166 m/pixel global data set and topography (665 m/pixel) from MESSENGER's Mercury Dual Imaging System (MDIS) and Mercury Laser Altimeter (MLA) (250 m/pixel), respectively. All data products are available from the Planetary Data System (PDS). The data were analyzed in ESRI ArcGIS 10.3. The CraterTools extension in ArcMap [8] was used to map the basins and their related crater populations. On the basis of completeness of their rims, we classified the basins as either "certain", "probable" or "tentative". We use two different mapping approaches: (1) measuring craters on basin rims excluding all areas resurfaced by the smooth plains, and (2) mapping all craters inside the basin cavity, which provides a lower limit of crater density for the basins. Most commonly, we applied the second approach, because the basins are fully or partially covered by plains with various thicknesses [6]. To derive the CSFDs of impact basins, we use CSFD_Tools [9], and apply the buffered crater counting technique [10].

Results: We identified 80 certain or probable basins on Mercury (Figure 1), 1.7x as many as in the previous study [6] that at the time had no access to topography data. This increase in number has substantial implications for the early history of Mercury´s crust. Most of the basins are buried by smooth plains, inter-crater plains, or both. In addition, candidate basins are often surrounded by scarps and other tectonic landforms, rather than obvious intact rims. Thus topographic data are extremely useful for identifying "hidden" basins not seen by earlier studies [1, 3, 6]. In most of the cases, the stratigraphic position of the basins is in good agreement with the lower limit of crater densities.

To investigate the nature of the impactor population(s), we plotted the summed CSFDs of the Pre-Tolstojan-aged basins and Tolstojan-aged basins (including Tolstoj) (Figure 2/a) on a R-plot as was done by [7] (Figure 2/b). Our results show that the shape of the CSFD does not change between these two time periods, suggesting either a single impactor population or multiple populations that have the same size-frequency distribution. Thus, this work is consistent with our previous study on the Moon [7]. However, this study does not preclude changes to the CSFD in more recent epochs [12].

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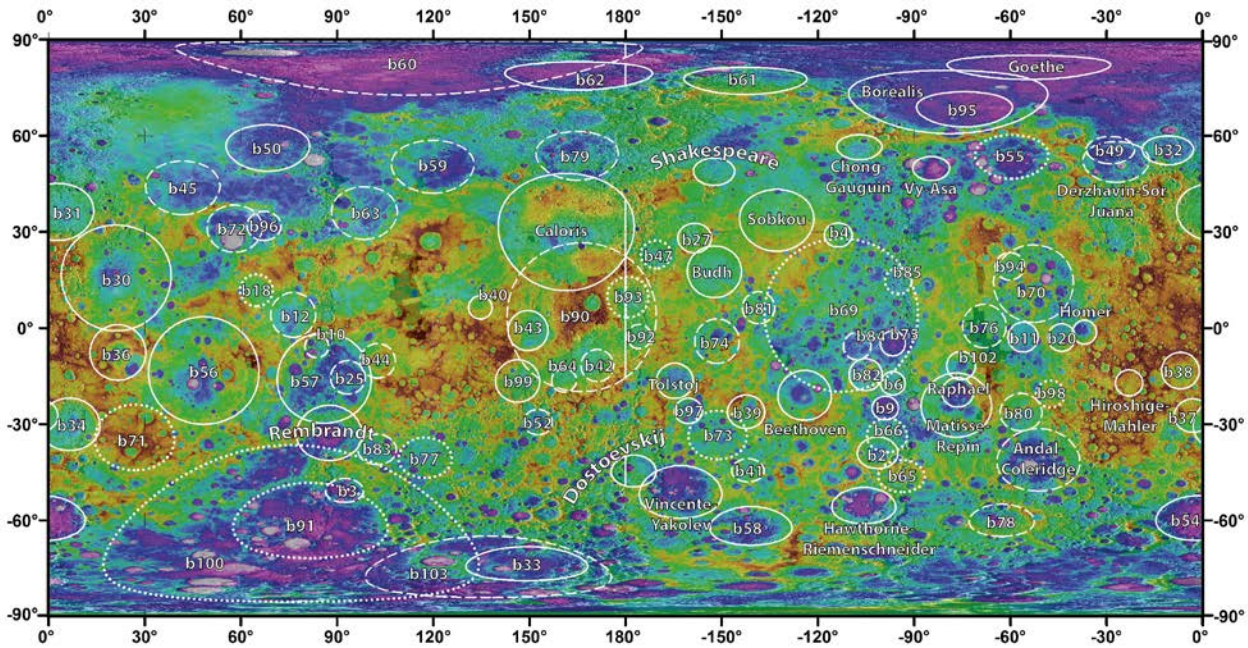

Figure 1: Global distribution of basins in equidistant cylindrical projection on Mercury determined from MESSENGER MDIS DEM 665 m/pix resolution data. Basins were classified as (1) "certain" (solid line), (2) "probable" (dashed line), and (3) "tentative" (dotted line).

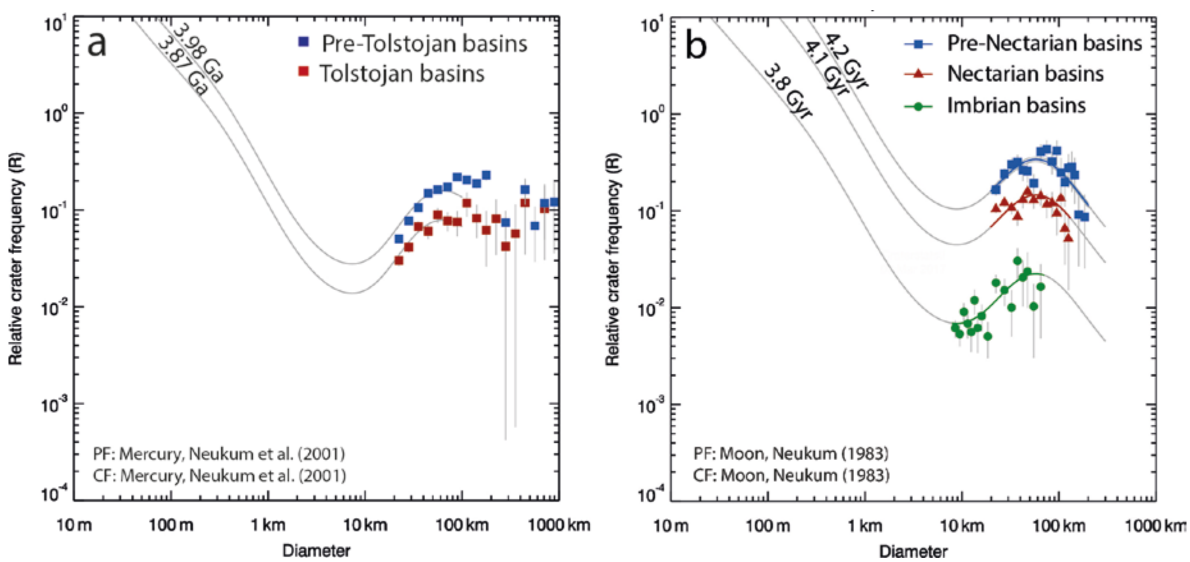

Figure 2: Summed CSFDs to study the impactor population(s) using an R-plot representation. A) Summed CSFDs of the Pre-Tolstojan-aged basins (blue filled square) and Tolstojan-aged basins (including Tolstoj, red filled square) using the buffered crater counting technique [10]. The shape of Pre-Tolstojan CSFD shows a steep slope in the diameter range from 20 km to 35 km, similarly to the study on the Moon [11]. B) Summed CSFDs of the Pre-Nectarian-aged basins (excluding SPA, blue filled square), Nectarian-aged basins (including Nectaris, red filled triangle) and Imbrian-aged basins (including Imbrium, green filled circle). The shape of the summed CSFDs shows similarities using the buffered non-sparseness correction (BNSC) technique, which takes crater obliteration into account [7]. The steep slope in the summed CSFD of the Pre-Nectarian basins [11] is no longer present in [7]. Moreover, the steep slope in the Pre-Tolstojan basins might be no longer present using the BNSC technique. Thus, we infer no change in the shapes of CSFDs and thus, no evidence for a change in impactor population.