CONSTRAINTS ON THE TIMING OF TECTONIC ACTIVITY ON MERCURY'S LARGE-SCALE LOBATE-SCARP THRUST FAULTS. N.G. Barlow[1] and M. E. Banks[2], [1]Dept. Physics & Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010 Nadine.Barlow@nau.edu, [2]NASA/Goddard Space Flight Center, Greenbelt, MD maria.e.banks@nasa.gov.

Introduction: Lobate scarps deform all major geologic units on Mercury, providing valuable insight into the history of horizontal shortening on Mercury [1-2]. These landforms consist of curving or lobate cliffs produced by surface-breaking thrust faults. They can extend more than 500 km in length with up to ~3 km of vertical relief [1-4]. Their formation has been attributed primarily to compressional stresses produced by planetary cooling and global contraction [1–3, 5]. Understanding the history of crustal deformation provides constraints on thermal history models and insight into the interplay between tectonics and volcanism and the cooling and solidification of the interior [5]. We use a combination of cross-cutting relationships, crater morphology, and crater size-frequency distribution (CSFD) analysis to determine relative and absolute ages of Mercury's largest lobate-scarp thrust-faults.

Data and Methods: Orbital images and mosaics from the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) Mercury Dual Imaging System (MDIS) are used to identify all craters transected by or superposing the scarf face edge of Mercury's 30 large-scale named scarps (Fig. 1). Relative ages of the faults were determined from cross-cutting relationships between the craters and scarps based on the crater degradation state; craters of different ages exhibit different amounts of degradation ranging from sharp morphologies and the presence/absence of rays (Kuiperian and Mansurian craters, respectively), to moderately degraded (Calorian craters), and heavily degraded (Tolstojan and pre-Tolstojan craters) morphologies, characterized by subdued rims, infilling of the crater floor, and superposing craters [6-8].

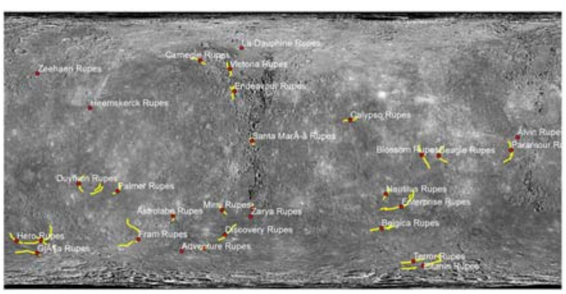

Figure 1: Distribution of the largest lobate-scarp thrust faults included in this study.

The narrowness of faults led to the Buffered Crater Counting technique (BCCT), which uses only craters and/or their ejecta that directly superpose the fault to determine the fault's age [9]. However, the low number of superposed craters leads to large uncertainties in the age of the fault. We developed a Modified Buffered Crater Counting technique (MBCCT) which uses superposed and transected craters in a larger area surrounding the fault to improve the statistical significance of the resulting absolute age. The MBCCT measures diameters of all craters directly superposing or transected by the fault edge and uses the mean diameter ($\overline{D}$) of these craters to calculate a buffer size around the fault, where the distance of the buffer edge from the fault is $1.5\overline{D}$. All craters ≥5-km-diameter within the buffer are included in the analysis and are classified as pre- or post-dating the fault based on their degradation state compared to the craters directly superposing or transecting the fault (Fig. 2). A test area indicates the MBCCT gives statistically equivalent results to the BCCT, but with smaller error bars.

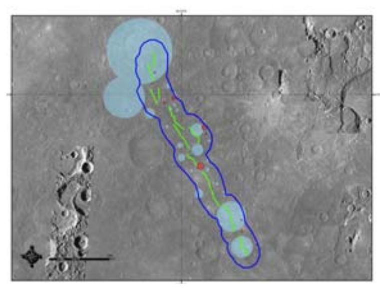

Figure 2: Example of the MBCCT for the Blossom scarp. Superposed craters are indicated in red while transected craters are shown in blue.

Absolute ages were computed using the Marchi crater model production function and inner solar system chronology [10]. Absolute and relative estimated ages of the earliest (transected craters) and most recent detectable activity (end of peak activity; superposing craters) were assessed for each lobate-scarp thrust fault; periods of most-recent activity are shown in Fig. 3 relative to Mercury's stratigraphic periods utilizing the recently revised age boundaries [10-11].

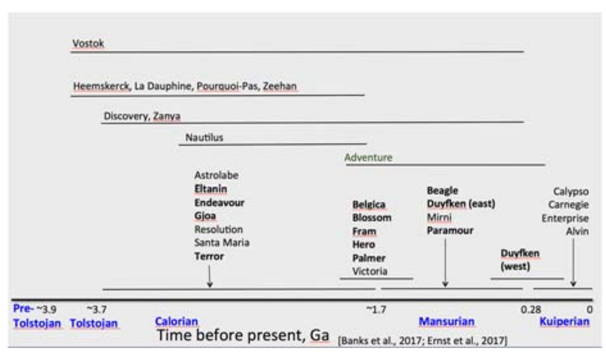

Figure 3: Period of most-recent activity along the large-scale lobate-scarp thrust faults. Length of horizontal lines is the uncertainty. Scarps polewards of 40° latitude shown in bolded text.

Results: All scarps in this study crosscut surfaces Tolstojan or older in age (>~3.7 Ga). The most recent detectable activity along lobate-scarp thrust faults ranges from Calorian to Kuiperian (~3.7 Ga to present). Our MBCCT results complement previous relative-age studies with absolute ages and indicate global contraction continued over the last ~3-4 Gyr. At least some thrust fault activity occurred on Mercury in relatively recent times (<280 Ma).

Scarps poleward of ~40° S latitude generally do not show conclusive evidence of activity on associated thrust faults more recently than the end of the Calorian (~3.7-1.7 Ga). Scarps at latitudes north of ~40° S show evidence of activity ranging from Calorian to the Kuiperian. This might have implications for Mercury's thermal and tectonic evolution near the end of volcanism associated with it's youngest widespread smooth plains, ~3.6 Ga [12].

References: [1] Strom, R. G., Trask, N. J., and Guest, J. E. (1975) *JGR*, *80*, 2478–2507. [2] Watters, T. R. et al. (2009) *Earth Planet. Sci. Lett.*, *285*, 283–296. [3] Watters, T. R., Robinson, M. S., and Cook, A. C. (1998) *Geology*, *26*, 991–994. [4] Watters, T. R. et al. (2004) *GRL*, *31*, L04071, doi:10.1029/2003GL019171. [5] Solomon, S. C. et al. (2008) *Science*, *321*, 59–62. [6] Spudis, P. D. and Guest, J. E. (1984) in *Mercury*, U. Ariz. Press, 118–164. [7] Banks M. E. et al. (2015), *JGR*, *120*, 1751–1762. [8] Banks M. E. et al. (2017), *JGR*, *122*, 1010–1020. [9] Fassett C. I. and Head J. W. (2008) Icarus, 195, 61-89. [10] Marchi, S. S. et al. (2013) *Nature*, *499*, 59–61. [11] Ernst, C.M. et al. (2017) *LPSC*, 48, #2934. [12] [10] Byrne, P.K. et al. (2016), *GRL*, 43, 7408-7416.