STRATIGRAPHIC RELATIONSHIPS BETWEEN LOBATE SCARPS AND YOUNG IMPACT CRATERS ON MERCURY: IMPLICATIONS FOR THE DURATION OF LOBATE SCARP FORMATION. Maria E. Banks[1], Thomas R. Watters[1], Robert G. Strom[2], Sean C. Solomon[3], Sarah E. Braden[4], Clark R. Chapman[5], Zhiyong Xiao[2, 6], and Nadine G. Barlow[7]. [1]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560, USA, banksme@si.edu; [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85719, USA. [3]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC 20015, USA. [4]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85281, USA. [5]Department of Space Sciences, Southwest Research Institute, Boulder, CO 80302, USA. [6]China University of Geosciences (Wuhan), Wuhan, Hubei, P. R. China, 430074. [7]Department of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011, USA.

Introduction: Lobate scarps, the expression of surface-breaking thrust faults, are widely distributed on the surface of Mercury. They are thought to result from compressional stresses due to interior cooling and global radial contraction that produced a net decrease in Mercury's surface area [1-7]. Stratigraphic relationships observed in Mariner 10 images and images from the first flyby of the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft indicate that the thrust faulting that formed the lobate scarps began some time before the end of Calorian smooth plains emplacement and continued after the emplacement of the youngest major smooth plains deposits [1-7]. However, how long lobate scarp formation and development continued after the emplacement of the youngest major smooth plains deposits is not clear.

We use data from the Mercury Dual Imaging System (MDIS) on MESSENGER to further analyze stratigraphic relationships between lobate scarps and young impact craters (Mansurian in age or younger). A better understanding of the timing and duration of lobate scarp formation on Mercury has important implications for the interior thermal evolution and the history of planetary contraction [5-6]. A better understanding of the age of lobate scarps will allow the thermal and mechanical structure of the lithosphere to be constrained through modeling of the associated thrust faults [8-10], and will provide insight into the interplay between tectonics and volcanism [11].

Data and Methods: MESSENGER MDIS targeted monochrome images with a pixel scale of up to 20-50 m/pixel and monochrome (250 m/pixel) and color (500 m/pixel) global mosaics were used to analyze stratigraphic relationships between lobate scarps and young impact craters. Young craters, also known as morphological Class 1 craters, are characterized by crisp morphologies with sharp rims, well-developed secondary craters, and continuous ejecta with radial lineaments [3, 12-13]. They formed after the Late Heavy Bombardment and are estimated to be Mansurian in age or younger [3]. The freshest Class 1 craters have bright ray systems. They have been conservatively estimated to have ages less than 1 Ga [3], but model ages obtained with new crater production and chronology functions suggest that they may be younger than 200 Ma [14-16]. We have analyzed over 500 rayed craters and more than 1000 Class 1 craters without detectable rays thus far.

Preliminary Results: Several examples of lobate scarps transecting Class 1 craters lacking rays have been identified in MDIS images and mosaics (Fig. 1). This finding suggests that at least some scarps continued to develop into the Mansurian System. No examples of lobate scarps transecting rayed craters or ray material has yet been confirmed with available MDIS images. However in ~10 locations found thus far, scarps appear to be superposed by secondaries from rayed craters (Fig. 2).

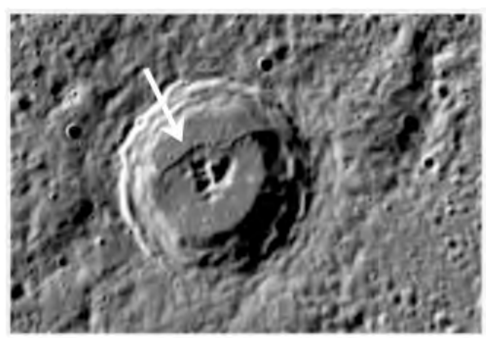

Figure 1. Example of a lobate scarp (white arrow) crosscutting a Class 1 crater (~50 km in diameter) without a ray system (MDIS image: EW0213416030G).

Lobate scarps are also observed possibly transecting very small-scale impact craters, only a few kilometers or less in diameter (Fig. 3). From the study of fresh craters on the Moon, lunar craters that are ≤ 3 km in diameter are estimated to be Copernican in age (<1 Ga) [17-18]. Small-scale lobate scarps, only a few tens of kilometers or less in length and with a relatively crisp morphology, have also been observed in MDIS images (Fig. 4). These scarps are comparable in scale to Copernican-age lobate scarps observed on the Moon [19-20]. Degradation rates on Mercury are estimated to be higher than those on the Moon due to the higher flux and impact velocities of bombarding micrometeoroids

[21]. Thus, small-scale and relatively-fresh lobate scarps and impact craters on Mercury are expected to be Kuiperian in age and may be even younger than comparable-scale features on the Moon.

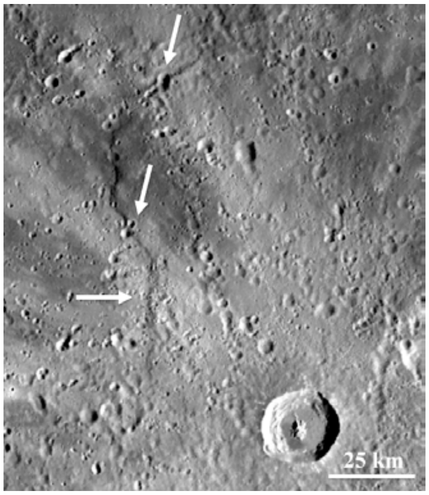

Figure 2. Lobate scarp superposed by secondaries (white arrows) that may have originated from the rayed crater (bottom right corner) (MDIS mosaic).

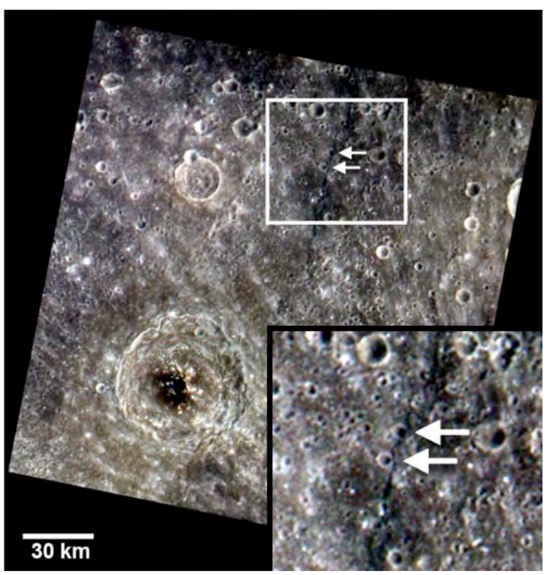

Figure 3. Newly detected ~75-km-long lobate scarp potentially transecting two craters ~3 km in diameter. The rims of these small craters have bright material that is obscured by the scarp (MDIS wide-angle camera image EW0215590606G).

Implications for the Duration of Lobate Scarp Formation: New results confirm that contraction and scarp formation continued well past the end of the Late Heavy Bombardment and more recently than the formation of at least some Class 1 craters (Mansurian in age or younger). No conclusive evidence that lobate scarps are younger than rayed craters (potentially <200 Ma) has yet been identified. Several possible examples of lobate scarps transecting small craters (only a few kilometers or less in diameter) and relatively-fresh small-scale lobate scarps (tens of kilometers or less in length) suggest that scarp formation and development continued into the Kuiperian System. If these findings are confirmed with future MDIS images, they indicate continued slip on faults on Mercury within the last ~1 billion years.

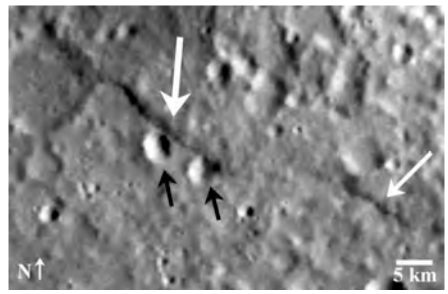

Figure 4. Potential small-scale scarp segment ~30 km in length (large white arrow) with an even smaller potential scarp segment, ~10 km in length, to the east (small white arrow). The rims of two ~4-km-diameter craters (black arrows) may be transected by the larger scarp segment, but this suggestion cannot be confirmed at this image resolution (200 m/pixel, MDIS image: EN0212367766M).

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