

**TECTONIC FEATURES REVEALED IN MESSENGER IMAGES DETAILED WITHIN MARINER 10 STEREO TOPOGRAPHY.** Sarah L. Andre<sup>1</sup> and Thomas R. Watters<sup>1</sup>, <sup>1</sup>Center for Earth and Planetary Studies, Smithsonian Institution, National Air and Space Museum, P. O. Box 37012, Washington, DC 20013-7012, USA, andres@si.edu.

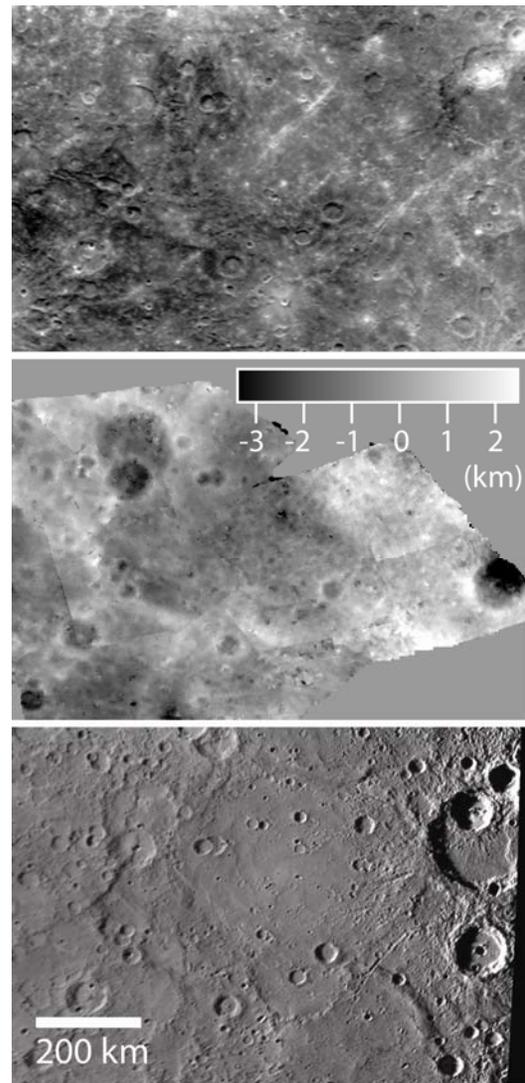
**Introduction:** The MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission [1] has completed two encounters with Mercury. The MESSENGER spacecraft imaged some of the same areas of the surface as Mariner 10 with better lighting conditions for the identification of morphologic features [1]. Previously unrecognized tectonic landforms were revealed in MESSENGER images within areas imaged by Mariner 10 [2,3]. Some of these tectonic landforms are recognizable in Mariner 10-derived stereo topography. We present topographic data for some newly identified tectonic features within an area of the Michelangelo quadrangle.

**Methods and Data:** Images from the Mariner 10 mission and MESSENGER's first flyby were used to identify and characterize tectonic features. Topography was obtained using Mariner 10 stereo images [4] and the stereo-matching software SMTK [5]. The resulting topographic data have 1-2 km spatial resolution [5]. For the Michelangelo study area (and much of the Mariner 10 stereo topography), features at scales of less than 10 km are not resolved spatially, features at scales between 10 and 15 km are poorly resolved, and those larger than 15 km are well resolved spatially [5]. Vertical height accuracy for Mariner 10 stereo pairs has been estimated at  $\pm 0.160$  km [5]. Average heights of tectonic features were determined by taking an average of  $>10$  profiles across the feature.

**Observations:** The study area ( $19^{\circ}$ - $37^{\circ}$ S,  $242^{\circ}$ - $273^{\circ}$ E) was previously imaged by Mariner 10 with less than optimal incidence angles. Many features, including craters, are difficult to recognize in the Mariner 10 image mosaic (Figure 1). Within the Mariner 10-derived topography, many additional landforms can be identified. The MESSENGER images clearly resolve previously unrecognized tectonic landforms, and the Mariner 10 topography can be used to measure the relief of these landforms.

The western edge of the study area is bounded by a prominent lobate scarp (Figure 2). Lobate scarps are linear or arcuate features that are interpreted to be the surface expression of thrust faults [6-13]. The lobate scarp is  $\sim 310$  km long and transects two impact craters (85 km and 100 km in diameter), suggesting that the scarp is relatively young. Mariner 10 stereo-derived topography indicates that the scarp has a maximum relief of greater than 1 km.

A 165-km-long high-relief ridge is located near the southeastern margin of the study area (Figure 3). High-relief ridges are tectonic features thought to be surface expressions of reverse faults and are generally more symmetric in cross-section than lobate scarps [10,11,13]. Topographic profiles across the high-relief ridge indicate an average relief of  $\sim 1$  km.



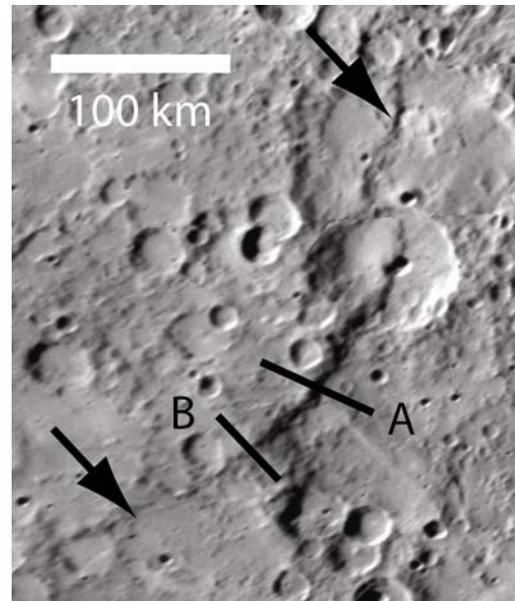
**Figure 1.** The top panel shows the study area ( $19^{\circ}$ - $37^{\circ}$ S,  $242^{\circ}$ - $273^{\circ}$ E) as imaged by Mariner 10. The middle panel shows the Mariner 10 derived digital elevation model (DEM), which is a hand-laid mosaic of individual DEMs [4]. Heights vary above and below a

reference sphere of 2439.7 km in radius. Gaps in data exist (solid gray background), and occasional seams are visible due to tilting errors caused by camera pointing errors [4,5]. The bottom panel shows the same area as imaged by MESSENGER. The MESSENGER Mercury Dual Imaging System (MDIS) Narrow Angle Camera (NAC) mosaic (flyby 1) is centered at 28.0°S and 257.3°E, and has a resolution of 1 km/pixel. The craters intersected by the scarp (and the scarp) are virtually unrecognizable in the Mariner 10 image, but they can be easily observed within the Mariner 10 stereo topography and the MESSENGER mosaic.

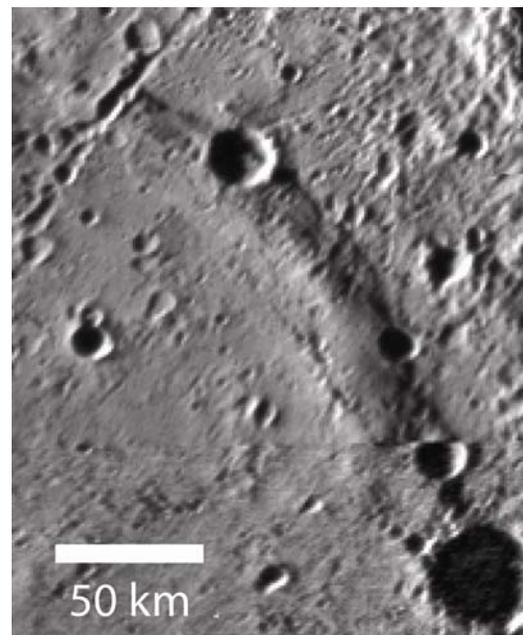
Several small-scale (~5 km wide and less than 80 km in length) wrinkle ridges are observed in smooth plains that occupy a topographic low. These wrinkle ridges are below the spatial resolution of the Mariner 10-derived digital elevation model and thus are not observed in the digital elevation model. Consequently, their relief cannot be measured. The wrinkle ridges and smooth plains deposits may suggest the possibility of an ancient, degraded basin associated with the observed topographic low.

Topographic data obtained by the Mercury Laser Altimeter (MLA) [14] and MDIS stereo images will provide critical new measurements of the relief of landforms on Mercury. These data in addition to topography derived from Mariner 10 stereo images and Earth-based radar altimetry will be a valuable resource, adding to the wealth of data return from the orbital phase of the MESSENGER mission.

**References:** [1] Solomon S. C. et al. (2008) *Science*, 321, 59-62. [2] Solomon S. C. et al. (2009) *LPSC, XL*, 1750. [3] Watters T. R. et al. (2008) *EPSL*, submitted. [4] André S. and Watters T. R. (2007), *LPSC XXXVIII*, 2155. [5] André S. L. et al. (2008) *JGR*, doi:10.1029/2008JE003080. [6] Strom R. et al. (1975) *JGR*, 80, 2478-2507. [7] Cordell B. and Strom R. (1977) *PEPI*, 15, 146-155. [8] Dzurizin D. (1978) *JGR*, 83, 4883-4906. [9] Melosh H. and McKinnon W. (1988) in *Mercury*, pp. 374-400. [10] Watters T. R. et al. (1998) *Geology*, 26, 991-994. [11] Watters T. R. et al. (2001) *PSS*, 49, 1523-1530. [12] Watters T. R. et al. (2004) *GRL*, 31, doi:10.1029/2003GL019171. [13] Watters T. R. and Nimmo F. (2009) in *Planetary Tectonics*, in press. [14] Zuber M. A. et al. (2009) *LPSC, XL*, 1813.



**Figure 2.** A prominent lobate scarp is ~310 km long and transects two craters, 85 km and 100 km in diameter. The relief of the scarp is greater than 1 km at the location of profile A and ~1 km at profile B. This MESSENGER MDIS NAC mosaic is centered at 26.8°S and 253.7°E and has a resolution of 1 km/pixel.



**Figure 3.** A high-relief ridge extends for ~165 km and is generally less than 1 km in height along its extent. The digital elevation model for this area is a single Mariner 10 stereo pair and is not included within the mosaic shown in Fig. 1. This MESSENGER MDIS NAC mosaic is centered at 31.3°S and 266.8°E and has a resolution of 1 km/pixel.