MESSENGER OBSERVATIONS OF THE CALORIS BASIN. S. L. Murchie[1], L. M. Prockter[1], M. S. Robinson[2], N. R. Laslo[1], H. K. Kang[1], S. E. Hawkins, III[1], A. P. Harch[3], R. M. Vaughan[1], D. T. Blewett[1], J. W. Head[4], T.R. Watters[5], S. C. Solomon[6], and the MESSENGER Team. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 20723 (scott.murchie@jhuapl.edu); [2]Arizona State University, Tempe, AZ; [3]Cornell University, Ithaca, NY; [4]Brown University, Providence, RI; [5]National Air and Space Museum, Washington, DC; [6]Carnegie Institution of Washington, Washington, DC.

Introduction: During the MESSENGER spacecraft's first of three flybys of Mercury, on 14 January 2008, the Mercury Dual Imaging System (MDIS [1]) will acquire over 1200 images, most of which are of the hemisphere not previously imaged by Mariner 10. One of the most significant features imaged by Mariner 10 is the Caloris basin, a 1340 km-diameter impact structure thought to be the youngest major basin on Mercury. Only the eastern half of Caloris was within the 45% of Mercury's surface imaged by Mariner 10, at about 1 km/pixel resolution. MDIS images complement those of Mariner 10 by covering the central and western regions at higher spatial resolution, at stereo geometries, and in more wavelengths for spectral analysis.

Background: The Caloris basin (Figure 1) represents a significant stratigraphic marker in the study of Mercury's surface [2,3,4] and has been used to divide the geologic record in the same way that the Imbrium basin is used on the Moon [e.g., 5]. The basin consists of formations collectively named the Caloris Group, which have been investigated using Mariner 10 [5,6,7,8] and ground-based radar images [9]: (a) a main basin rim of rugged concentric massifs (the Caloris Montes Formation), which appear to be the structural equivalent of the main rims of lunar basins such as Orientale and Imbrium; (b) an undulating-to-blocky unit of intermontane plains near the basin rim (the Nervo Formation), analogous to the knobby facies of the Montes Rook Formation in Orientale basin and interpreted to be fallback ejecta mixed with impact melt; (c) rolling deposits outside the basin rim (the Odin Formation), equivalent to the Hevelius Formation at the Orientale basin and interpreted to be basin ejecta; which grades into (d) plains having lineations radial to the basin, thought to be distal sculpted ejecta (part of the van Eyck Formation) and (e) large (10-20 km) overlapping and irregular secondary craters in clusters or chains (also part of the van Eyck Formation).

Two types of smooth plains are associated with the part of Caloris basin imaged by Mariner 10, both of which have been interpreted as younger and embaying the Caloris Group. Caloris floor plains material occupy most of the basin interior to Caloris Montes, and exhibit tectonic deformation including both wrinkle ridges and younger, crosscutting extensional troughs [10-12]. Exterior to the basin, the Odin Formation is embayed by smooth plains that exhibit pervasive wrinkle ridges [10-12]. Both types of plains have been proposed to have originated as volcanic flows [e.g. 5,13] or impact melt and ejecta [e.g., 14].

Key Science Questions: The combination of Mariner 10 and MDIS coverage allows three major questions regarding Mercury's interior structure and thermal history to be addressed at the Caloris basin. First, the deeply excavated material is a probe of compositional stratification of Mercury's upper tens of kilometers. Mercury's surface is pervasively space weathered, but exposures of fresher material on massif slopes and in small fresh craters provide samples of spectral properties of the excavated material. MDIS's 11 spectral filters were chosen to discriminate mafic minerals, opaque minerals, and glass that may be present. Second, new coverage allows improved assessment of the distribution, origin, and tectonic deformation of smooth plains material. MDIS imaging will allow mapping of plains extent south and west of Caloris. Much of it has a spatial resolution of 200-300 m/pixel, facilitating the detection of vents and domes indicative of a volcanic origin, features that were below the resolution of Mariner 10 images. Third, the spatial distribution of extensional troughs and wrinkle ridges in and around Caloris allows estimation of the crustal thickness and the thickness of the elastic lithosphere at the time of basin formation [e.g., 10-12]. Coverage has been designed to provide the highest resolution and stereo geometries at expected locations of smooth plains, to allow mapping of wrinkle ridges and troughs and characterization of their morphology, and to estimate extensional and contractional strain.

Flyby Image Sequence: The MDIS flyby sequence was optimized for coverage of the Caloris Group and surrounding smooth plains (Figure 2), beginning about 12 minutes after closest approach to Mercury on the night side of the planet. Initial narrow-angle camera mosaics cover the southern and western parts of the basin at 200-300 m/pixel. A 3x3 frame wide-angle camera mosaic captures nearly the entire basin in 11 colors at 2.4 km/pixel and a relatively low solar incidence angle favorable to spectral mapping. Four subsequent narrow-angle mosaics cover the entire visible part of the illuminated hemisphere at 500-800 m/pixel, at a geometry providing a stereo complement to the higher-resolution mosaic.

We here present initial results of color and geomorphologic investigations of the western half of the basin, and we compare them to the previously studied eastern part.

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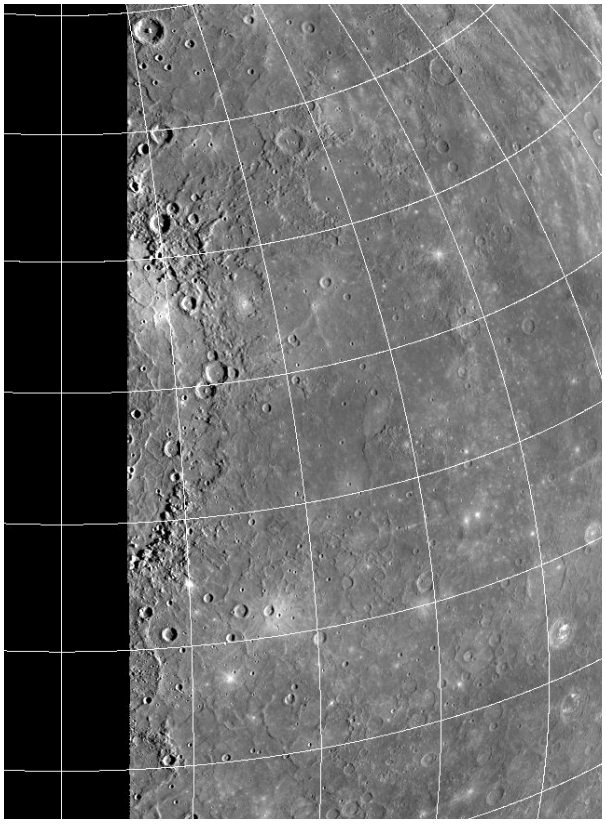
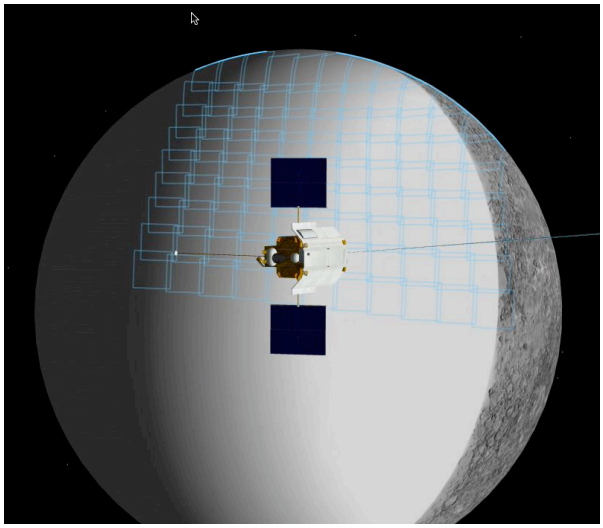


Fig. 1 (left). Orthographic projection of mosaicked Mariner 10 images corrected for photometric effects, centered on the center of Caloris basin. The Caloris Montes Formation forms most of the basin rim, and the Nervo Formation is best developed to the northeast. The basin interior is dominated by younger plains, and the exterior smooth plains occur in the dark annulus in the northeastern and eastern parts of the mosaic.



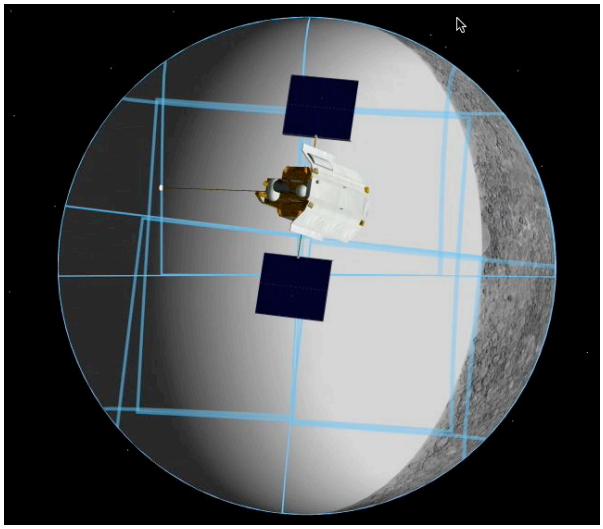


Fig. 2 (below). Two views of outbound image mosaics to be obtained during MESSENGER's first Mercury flyby. The orthographic views show Mercury as seen from MESSENGER, with Mariner 10 coverage overlain on a plain sphere with simulated illumination. Image footprints are shown in light blue. Left: The highest resolution coverage (200-300 m/pixel) is located to the south and west of Caloris to focus coverage on the Caloris Group and smooth plains. Right: Ten minutes after acquisition of the high-resolution mosaic, the whole Caloris Group is viewable. MDIS's wide-angle camera is used to take a 2.4 km/pixel mosaic in 11 spectral bands. Four subsequent narrow-angle camera mosaics cover much the same view at 500-800 m/pixel, providing a stereo complement to the high-resolution mosaic.