A TECTONIC SURVEY OF THE CALORIS BASIN, MERCURY. Paul K. Byrne[1], Thomas R. Watters[2], Scott L. Murchie[3], Christian Klimczak[1], Sean C. Solomon[1], Louise M. Prockter[3], and Andrew M. Freed[4]. [1]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington DC, 20015, USA (pbyrne@dtm.ciw.edu); [2]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington DC, 20013, USA; [3]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA; [4]Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, IN 47907, USA.

Introduction: Caloris is the largest impact basin recognized on Mercury [1–4]. Partially imaged by the Mariner 10 probe, the basin has been fully observed by the *MESSENGER* spacecraft from orbit. It is replete with tectonic landforms that, although described before [e.g., 3,5], show a far greater complexity than previously reported. Documenting the nature, distribution, and cross-cutting relations of these structures with orbital data will help elucidate further the deformational history of the Caloris basin.

Mapping: We are using the global Mercury Dual Imaging System (MDIS) [6] monochrome basemap at a resolution of 250 m/px, within a geographical information system (GIS), to map the tectonic structures on the basin floor, as well as other prominent physiographic features such as the floor outline and large superposed impact craters (**Fig. 1**). (We find that the floor of Caloris has east-west and north-south diameters of 1,640 km and 1,590 km, respectively.) With Mercury Laser Altimeter (MLA) [8] data we have correlated basin topography to our MDIS mapping results.

Tectonic Landforms: Both extensional and contractional tectonic landforms are widespread in the interior fill of Caloris and occur at almost every azimuth and from the basin center to its perimeter. Extensional faults are manifest as graben, whereas contractional structures are predominantly wrinkle ridges. We identify three generally spatially discrete families each of extensional and contractional features, and classify them according to their orientation with respect to the basin center — radial, circumferential, and oblique.

Radial graben. The most prominent graben family, termed Pantheon Fossae [3,5,9], originates from a point near the basin center and extends to ~0.55 of the radius of Caloris (r_C). Five large troughs up to 8 km in width are present, but the majority of the over 200 graben and graben segments are 1–2 km wide [9]. These structures display geometries typical of normal faulting and graben development, including relay ramps in step-over regions between them [10]. Although the bounding faults of some graben taper as the structures shoal out, others maintain their spacing along length, or even widen. Though radial graben occur almost axisymmetrically within Caloris, those that lie along ~east-west azimuths, and are thus subparallel to illumination directions, are difficult to identify. Moreover, the ejecta blanket from Atget crater obscures those at 110–170° azimuth. Also, at ~0.25–0.35 r_C along an azimuth of 230° lies a zone with no apparent radial graben.

Circumferential graben. At ~0.45–0.55 r_C, a set of graben concentric to the basin center generally bound the radial graben. These structures have similar lengths and widths to, but are more discontinuous than, their radial counterparts. To the northwest and southeast they form 2–3 distinct bands, but elsewhere they occupy a more diffuse zone of basin-concentric extension. In many instances concentric graben lie along the crests of circumferentially orientated wrinkle ridges.

Oblique graben. At ~0.55–0.9 r_C, extension is dominated by a set of graben with radial through intermediate to concentric orientations relative to the basin center, their intersections producing an annular pattern of polygons that extends to the basin floor margin. This complex map pattern contrasts strongly with the circumferential graben, though the radial element of this set of structures is clearly present in places. Nonetheless, due to the myriad of complex intersections and changes of azimuth along single structures in this graben family, we do not attempt to partition the radial and concentric elements therein. Graben forming polygonal patterns at ~0.55 r_C are 1–5 km in width, but narrow and shorten with increasing radial distance.

Radial, circumferential, and oblique contractional structures. Wrinkle ridges are prevalent from ~0.1 r_C to the basin's perimeter. In almost all cases wrinkle ridges are superposed by (and thus predate) extensional landforms in Caloris, a finding consistent with earlier studies [1–4]. Radially orientated ridges and scarps are less frequent than corresponding graben but are particularly prominent in the southwestern zone where radial graben are not observed. Circumferential wrinkle ridges appear to be the most abundant type of contractional landform, and vary in width from 2 to 8 km across the basin; they are often sinuous and display fault linkage with neighboring structures. At several sites, particularly within the northwestern and southwestern portions of the basin, wrinkle ridges appear dissected into discrete blocks, their leading edges seemingly offset laterally along the bounding faults of radial graben. Beyond ~0.7 r_C, ridges predominate in a polygonal pattern and decrease in width and length toward the basin margin.

Basin Topography: Stereo- and MLA-derived topographic data show that the floor of Caloris has long-wavelength topographic undulations [8,11,12]. The northern, southwestern, and southeastern portions of the floor are elevated, to above the basin rim in parts, while an ~east–west-orientated depression or trough crosses the basin's center. There is no obvious correlation between the topography and the extensional tectonics in Caloris. The polygonal pattern of graben lies along the northern elevated portion of the basin floor but is also prevalent within the central topographic low. Moreover, no contractional structures appear to bound the regions of elevated floor.

Outlook: This ongoing study facilitates renewed testing of current models for the tectonic evolution of the Caloris basin and the structures therein [e.g., 3,5,13–15], none of which fully satisfies our structural observations. Our map also provides constraints for new hypotheses that must account both for the variety of tectonic landforms within Caloris and for their relationship, if any, to present basin topography.

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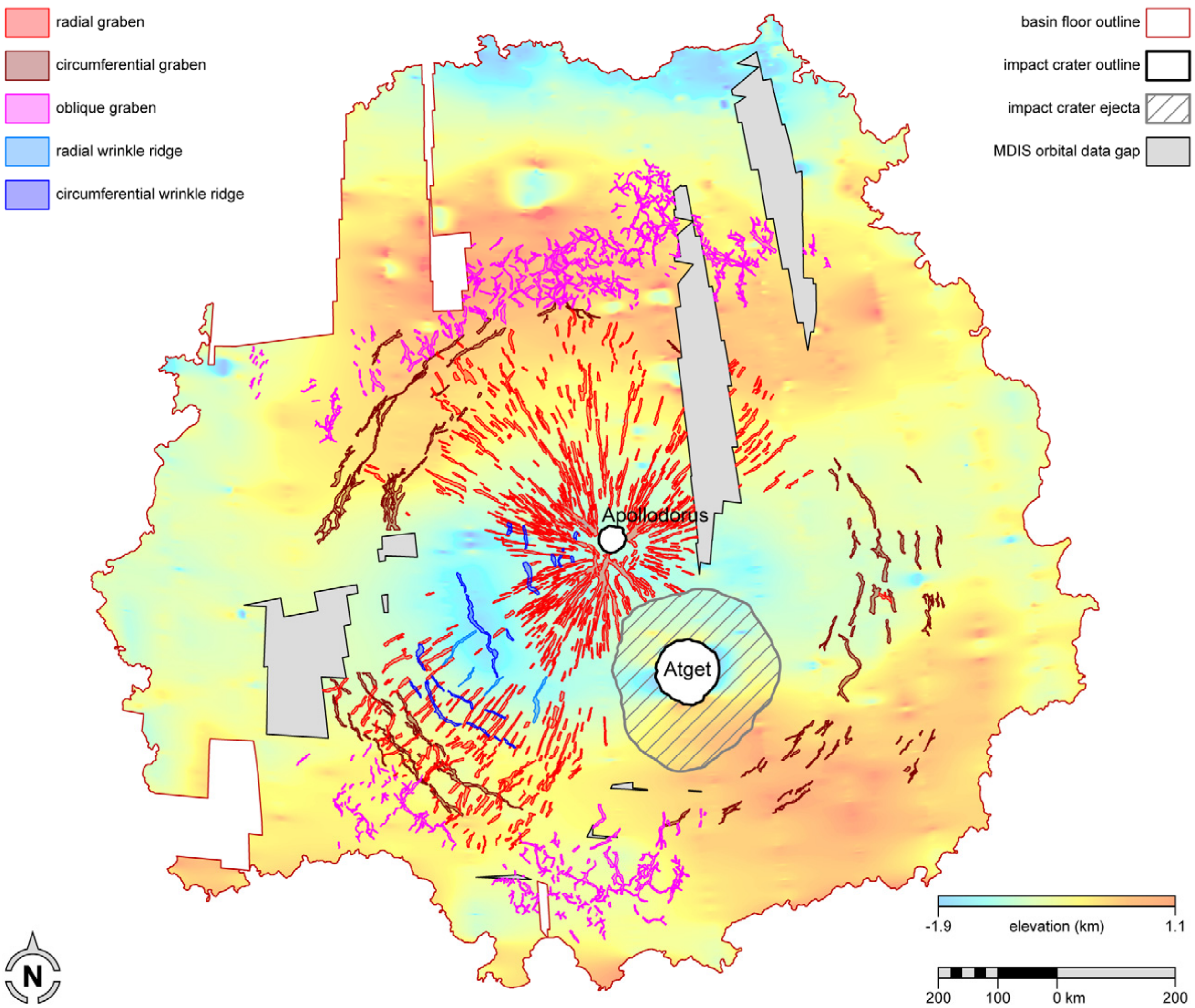

Fig. 1. The current state of the tectonic map of Caloris basin, shown in orthographic projection centered at 31°N, 163° E.