THE CURIOUS CASE OF RADITLADI BASIN. Louise M. Prockter[1], Thomas R. Watters[2], Clark R. Chapman[3], Brett W. Denevi[4], James W. Head III[5], Sean C. Solomon[6], Scott L. Murchie[1], Olivier S. Barnouin-Jha[1], Mark S. Robinson[4], David T. Blewett[1], Jeffrey Gillis-Davis[7], and Robert W. Gaskell[8]. [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, USA. Email: Louise.Prockter@jhuapl.edu. [2]Smithsonian Institution, Center for Earth and Planetary Studies, National Air and Space Museum, Washington, DC 20560, USA. [3]Southwest Research Center, 1050 Walnut St, Boulder, CO 80302, USA. [4]Arizona State University, School of Earth and Space Exploration, Tempe, AZ 85251, U.S.A. [5]Brown University, Dept. of Geological Sciences, Providence, RI 02906, USA. [6]Carnegie Institution of Washington, 5251 Broad Branch Rd., NW, Washington, DC 20015, USA. [7]University of Hawaii, Hawaii Institute of Geophysics and Planetology, Honolulu, HI 96822, USA. [8]Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ 85719, USA.

The Raditladi basin was imaged for the first time by the MESSENGER spacecraft during its first flyby of Mercury in January 2008 [1]. Raditladi is a ~250-km-diameter impact feature located at 27ºN, 119ºE, west of the Caloris basin (Fig. 1), and closely resembles lunar craters such as Schroedinger as well as similar-sized craters on Mercury such as Mozart. Contained within the basin is a distinctive and slightly offset peak-ring structure ~125 km in diameter. The basin walls have undergone modification and exhibit pronounced terraces to the north and west sides of the rim.

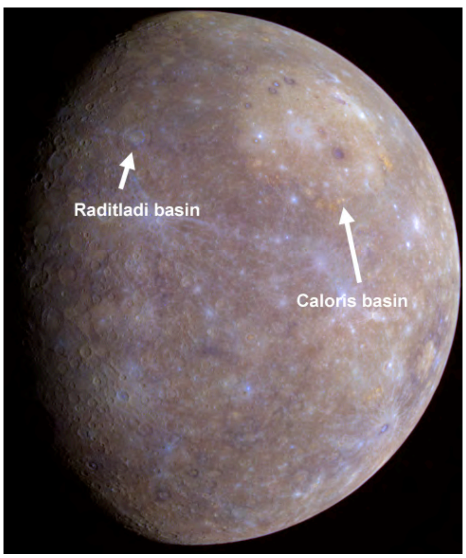

Figure 1: Location of Raditladi shown in global color image acquired during MESSENGER's first flyby. RGB image composite from 1000-, 700-, 430-nm RGB filters with hard stretch to highlight color differences.

Crater age-dating results [2, 3] suggest that Raditladi's interior smooth plains and ejecta blanket are of approximately the same age and, most interestingly, that crater densities at Raditladi are an order of magnitude less than those at Caloris. This implies that the Raditladi basin may be extremely young – perhaps less than 1 Ga.

The floor of the Raditladi basin is partially filled with smooth, bright reddish plains material that clearly embays the rim and central peak ring (Fig. 1). Smooth plains material with similar characteristics embays a number of craters and basins on Mercury and is interpreted to be primarily the result of volcanism [4, 5]. Portions of the basin floor to the north and south consist of dark, relatively blue hummocky plains material (Fig. 1), similar to terrain identified around the Caloris and Tolstoj basins [5]. We interpret this unit to be original basement material that has not been embayed by the red plains. The presence of the dark hummocky unit within the basin floor, coupled with embayment relationships, suggest that the smooth reddish plains were emplaced after the basin modification process. This favors a volcanic origin for the plains, rather than solidified impact melt. Nevertheless, evidence of impact melt exists in the form of pockets of smooth bright material found on top of the ejecta blanket. The amount of impact melt expected to occur in Mercury's craters is not well understood, but it is expected that the melt fraction will increase significantly with increasing crater size [e.g., 6]. Analyses are underway to bound the respective roles of volcanism and impact melting at Raditladi.

Extensional tectonics are extremely rare on Mercury and have thus far only been found in three locations. Radial trough complexes are found within Caloris [7] and a second newly viewed large basin [8], while the third occurrence of extension is found within Raditladi, where it is very different in form from the other two. Here, a number of partially concentric troughs are arranged in a circular pattern ~70 km in diameter, close to the center of the basin (Fig. 2). Some of the troughs have distinct flat floors and are interpreted to be graben. Most of the troughs are comprised of linear or curvilinear segments, arranged circumferentially around the basin center. With increasing distance from the basin center, the troughs become less circumferential, and on the northern side of the basin some troughs crosscut each other orthogonally. To the south and west of the basin, troughs are absent, possibly as a result of a superposed impact crater.

It has been suggested that the circular troughs in Raditladi are the surface manifestation of ring dikes or cone sheets [e.g., 9] formed above a magma reservoir [4]. This configuration would differ in geometry from the traditional sill formation thought to be responsible for lunar floor-fractured craters [e.g., 10]. If this interpretation is correct, then it extends the inferred duration of volcanism on Mercury. Alternative explanations for the extensional troughs involve the late-stage tectonic modification and uplift of the basin floor. One model that has been proposed to explain the polygonal troughs within the much larger and older Caloris basin invokes inward flow of the lowermost crust to produce uplift and near-surface extension in the basin interior [11]. This model may be less applicable to Raditladi, however, because it requires that Mercury's crust be sufficiently hot to undergo ductile flow at a recent time in Mercury's history, a conclusion at odds with thermal models that predict a thick, strong lithosphere.

A second scenario proposed to account for troughs in Caloris is that annular loading by smooth plains exterior to the basin led to flexural uplift of the basin interior [12]. There are relatively young smooth plains to the north and east of the Raditladi basin that have overprinted all large craters in their areas. Most of the circumferential troughs within Raditladi are distributed to the northeast of the basin center, which could be consistent with loading by these smooth plains, although part of the trough system to the west of the basin center appears to have been obscured by a later impact crater, so a directional bias is possible. However, the thickness of these exterior smooth plains is not well constrained. Crater counting can ascertain whether the smooth plains to the northeast of Raditladi are younger than the basin, a result that would support a model of annular loading.

A third possibility is that isostatic uplift of an uncompensated basin results in near-surface extensional stress sufficient to produce faulting. A condition for this explanation is that the floor material be emplaced prior to most isostatic uplift. In the case of Raditladi, floor material could be dominated by rapidly cooled impact melt, possibly up to several hundred meters thick. One question for this explanation is why we do not see similar tectonic structures in other comparably sized basins on Mercury and the Moon. A possibility is that most other basins, because they are substantially older, have been modified by later volcanism, deformation, or impact, whereas the relatively young age of Raditladi may mean that it has escaped significant such modification.

References: [1] Solomon S. C. et al. (2008) *Science, 321*, 59-62. [2] Strom R. G. et al. (2008) *Science 321,* 79-81. [3] Chapman C. R. et al. (2008) *Eos Trans. AGU, 89*(53), Fall Mtg. Suppl., abstract U11C-06. [4] Head J. W. et al. (2008) *Earth Planet Sci. Lett*., submitted. [5] Robinson M. S. et al. (2008) *Science 321,* 66–69. [6] Grieve R. A. F. and M. J. Cintala (1992) *Meteoritics* 27, 526–538. [7] Watters T. R. et al. (2008) *Earth Planet. Sci. Lett*., submitted. [8] Watters T. R. et al. (2009) *LPS XV*, 2009. [9] Grosfils E. B. (2007) *J. Volc. Geotherm. Res. 166,* 47-75. [10] Schultz P. H. (1976) *Moon 15,* 241-273, 1976. [11] Watters T. R. et al. (2005) *Geology, 33*, 669-672, 2005. [12] Melosh H. J. and W. B. McKinnon (1988) in *Mercury*, Univ. Arizona Press, 374.

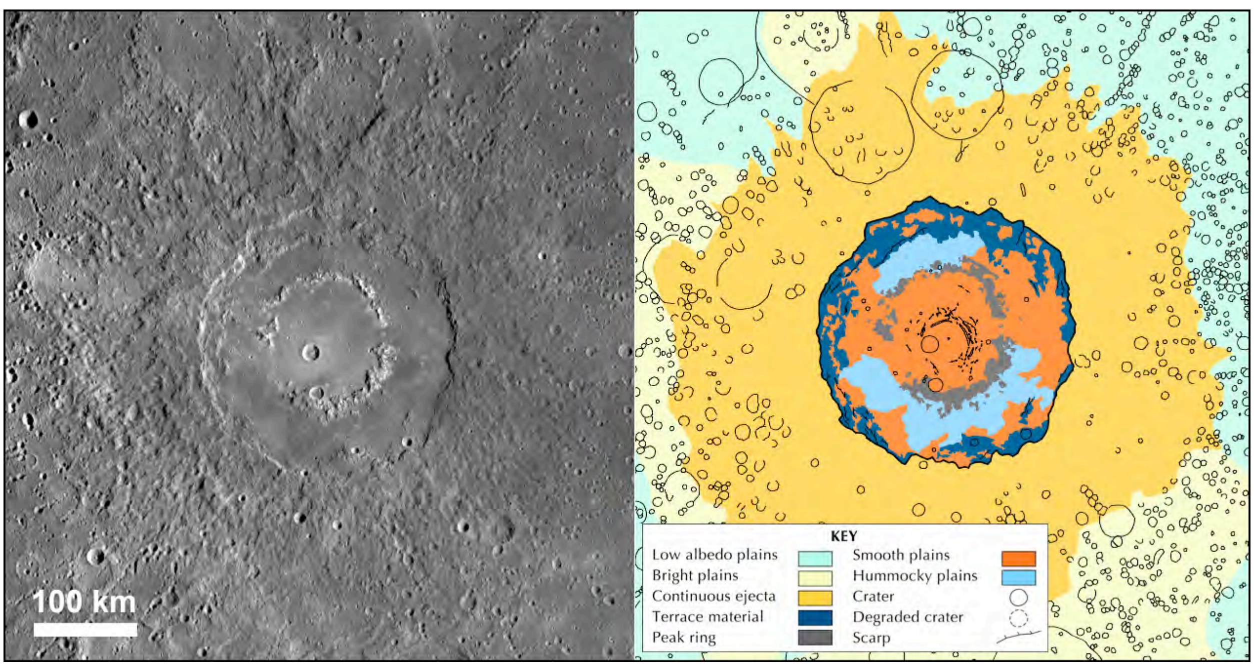

Figure 2: Left: MESSENGER image of Raditladi crater, orthographically projected, showing peak ring complex. Right: Preliminary geological map showing extent of continuous ejecta and circumferential troughs within center of basin.