

# Smooth plains deformation in a buried crater of Mercury

V. López (1), J. Ruiz (2) and A. Vázquez (1)

(1) Escuela Técnica Superior de Ingenieros en Topografía, Geodesia y Cartografía, Universidad Politécnica de Madrid, 28031 Madrid, Spain (valle.lopez.martin@alumnos.upm.es). (2) Departamento de Geodinámica, Universidad Complutense de Madrid, 28040 Madrid, Spain.

## 1. Introduction

The surface of Mercury shows different kinds of tectonics landforms, mostly indicating surface contraction [1,2]. Compressional features include lobate scarps, wrinkle ridges, and high relief ridges, which are different manifestations of thrust faults, depending on, for example, deep angle of faulting and type of surface geology [3-5]. Also, there are evidences of long-wavelength topography variations, affecting to the northern smooth plains and Caloris basin, which could also be the expression of contraction (and maybe large scale folding) related to the cooling of Mercury [6].

In this work we focus on the deformation in an area centered in the equator comprising a buried crater affected by two different sets of tectonic features.

## 2. Study area

The area studied in this work is in the equatorial region of Mercury, located between latitudes 10°N and 8°S, and longitudes 56°E and 86°E. We have used mosaics created by USGS using MDIS/NAC images from MESSENGER flybys. The illumination conditions of flyby images are more useful than higher resolution images from the orbital mission, because the angle of incidence enhances the shadows, which emphasize the relief of geologic structures.

Figure 1 shows a buried crater centered around 2°N, 74°E, with a diameter of approximately 450 km. It is superimposed to the Faulkner crater to the NE, and west to the crater Firdousi. The interior of the buried basin is covered by smooth plains, which also extend in the terrains between the craters Firdousi and Faulkner.

The topography derived from stereo DTM [7] clearly delimits the limits of the crater basin, whose surface exhibit the lowest elevation in the area. The plains in

the interior of the buried crater have an elevation roughly 1-2 km lower than the smooth plains out of that crater.

Figure 1 shows the main tectonic features deforming the smooth plains in the buried crater, and the crosscutting relations between them. The lobate scarp (black arrows) superimposed on the smooth plains crater in the southeast of the buried basin is the most prominent feature in the zone, with more than 1 km of relief, and is a complex, maybe indicating several pulses of activity in its formation or the superposition of several individual structures.

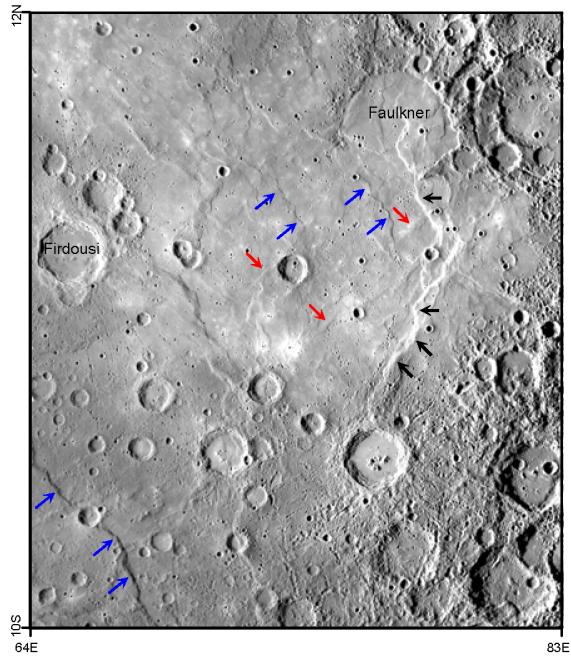


Figure 1: Black arrows indicate a lobate scarp superimposed on the buried crater, blue arrows indicate wrinkle ridges and red arrows indicate a set of NE-SW subtle features which could be buried wrinkle ridges or surface folds.

The smooth plains are affected by wrinkle ridges of orientation NNW-SSE (blue arrows), which are part of a more regional deformation, as they cross the entire buried impact basin, and have the same roughly orientation than the wrinkle ridges that deformed the surrounding terrain. There also is a set of regularly (~40 km) spaced NE-SW oriented “lineations” (red arrows), which is crossed by wrinkle ridges. Shadows reveal a relatively low relief, scarp-bounded or arched in cross-section, for these features, which are apparently limited to the buried basin, and they could be folds or buried wrinkle ridges.

### 3. Discussion

Our observations reveal at least two different stages of tectonic deformation of the smooth plains in the buried basin here studied. The NE-SW oriented “lineations” represent the older deformation stage recorded in this area. Later on, they were affected by wrinkle ridges of NNW-SSE orientation, indicating a change in the orientation of the implied stresses. The formation of the lobate scarp to the southeast would have postdated the formation of NNW-SSE oriented wrinkle ridges, although this lobate scarp is a composed, feature formed in several pulses, with some characteristics typical of wrinkle ridges in its northern portion.

In future work we will analyze the temporal relations between the plains-forming volcanism the NE-SW oriented “lineations”. Some of them appear to be scarp-bounded, suggesting to the partly buried wrinkle ridges. This would imply at least a stage of filling of the basing posterior to the NE-SW “lineations”, but previous to the NNW-SSE wrinkle ridges.

Thus, the deformation in the buried crater analyzed here provides information on the temporal relations between plains emplacement and tectonic deformation, as well as on changes (maybe related to convective patterns [8] or true polar wander [9]) in stresses orientation in Mercury.

### References

- [1] Strom, R.G., Trask, N. J., Guest, J. E.: Tectonism and volcanism, *J. Geophys. Res.* 80, 2478-2507, 1975.
- [2] Dzurisin, D.: The tectonic and volcanic history of Mercury as inferred from studies of scarps, ridges, throughs and other lineaments, *J. Geophys. Res.* 83, 4883-4906, 1978.
- [3] Watters, T.R., Solomon, S.C., Robinson, M.S., Head, J.W., André, S.L., Hauck, S.A., Murchie, S.L.: The tectonics of Mercury: The view after MESSENGER's first flyby, *Earth Planet. Sci. Lett.* 285, 283-296, 2009.
- [4] Watters, T.R., Nimmo, F.: The tectonics of Mercury. In: *Planetary Tectonics*, Watters, T.R., Schultz, R.A. (Eds.), Cambridge Univ. Press. Cambridge, pp 15-80, 2010.
- [5] Ruiz, J., López, V., Dohm, J.M., Fernández, C.: Structural control of scarps in the Rembrandt region of Mercury, *Icarus* 219, 511-514, 2012.
- [6] Zuber, M.T., et al.: 2012. Topography of the northern hemisphere of Mercury from MESSENGER laser altimetry. *Science* 336, 217-220, 2012.
- [7] Preusker, F., Oberst, J., Head, J.W., Watters, T.R., Robinson, M.S., Zuber, M.T., Solomon, S.C.: Stereo topographic models after three MESSENGER flybys. *Planet. Sp. Sci.* 59, 1910-1917, 2011.
- [8] King, S.D., Pettern of lobate scarp in Mercury's surface reproduced by a model of mantle convection. *Nat Geos.* 1, 229-232, 2008.
- [9] Matsuyama, I., Nimmo, F.: Gravity and tectonics patterns of Mercury: the effect of tidal deformation, spin-orbit resonance, non-zero eccentricity, despinning and reorientation, *J. Geophys. Res.* 114, E01010, 2009.