EPSC Abstracts
Vol. 11, EPSC2017-1006-1, 2017
European Planetary Science Congress 2017

Geology of the Shakespeare quadrangle (H03), Mercury

L. Guzzetta (1), V. Galluzzi (1), L. Ferranti (2) and P. Palumbo (3,1)
(1) INAF, Istituto di Astrofisica e Planetologia spaziali (IAPS), Rome, Italy (laura.guzzetta@iaps.inaf.it); (2)DiSTAR, Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università "Federico II", Naples, Italy; (3) Dipartimento di Scienze & Tecnologie, Università degli Studi di Napoli "Parthenope", Naples, Italy.

Abstract

A 1:3M geological map of the H03 Shakespeare quadrangle of Mercury has been compiled through photointerpretation of the remotely sensed images of the NASA MESSENGER mission. This quadrangle is characterized by the occurrence of three main types of plains materials and four basin materials, pertaining to the Caloris basin, the largest impact crater on Mercury's surface. The geologic boundaries have been redefined compared to the previous 1:5M map of the quadrangle and the craters have been classified privileging their stratigraphic order rather than morphological appearance. The abundant tectonic landforms have been interpreted and mapped as thrusts or wrinkle ridges.

1. Introduction

The observations of Mercury's surface made by the Mariner 10 (M10) and MESSENGER spacecraft have shown that Mercury displays a moderately cratered surface, several plains deposits and abundant lunar-type landforms which were interpreted as superficial expression of compressive tectonic structures [1]. With the first 1:5M geological maps of some quadrangles, based on M10 data, craters were mapped according to their degree of degradation and grouped into five classes from the oldest c1 to the youngest c5 [5]. The plains deposits were distinguished according to their morphologies and textures in smooth, intermediate and intercrater plains materials [3], [7]. In the H03 quadrangle were also distinguished peculiar morphologies associated with the Caloris basin [5]. Notwithstanding the MESSENGER images have a better global average resolution with respect to those of M10, only a global 1:15M geological map has been produced [6]. The most evident novelty of the geological map here presented is the adoption of a different crater classification, which solves some stratigraphic inconsistences derived from the five-class classification system when dealing with small craters. A better correlation between morphology and geological boundaries led to a significant redefinition of the spatial distribution of the intercrater and intermediate plain materials.

2. Data and methods

Mapping was performed on a reference monochromatic basemap of reflectance at 166 m/pixel resolution of the H03 quadrangle, located at middle-latitude of the northern hemisphere of Mercury. A suite of a lower resolution basemaps, useful for their different lighting conditions, and two available DTM's, useful in sectors with non-optimal lighting geometry, were also consulted. The datum adopted is that used in the data sets released by the MESSENGER team, in which Mercury's IAU radius (2439.7 km) is approximated to 2440.0 km. The most suitable projection at middle-latitudes is the Lambert conformal conic, as it reduces area distortions. The geological features were digitized within a geographic information system with a variable mapping scale between 1:300k and 1:600k. Craters were distinguished into those with $10 \leq D < 20$ km (small), for which only rim crests were mapped, and craters with $D \geq 20$ km (major), for which also crater materials were mapped and grouped into three morpho-stratigraphic classes (c1-c3) according to their overlapping relationships [2]. Based on the dominant contractional nature of Mercury's tectonics [1], [8], the structures have been interpreted as thrusts, if they show a relevant break in slope and a sinuous trace, or as wrinkle ridges, which generally show a less prominent ridge and occur within smooth plain materials and basins. The geologic contacts were mapped as 'certain' where they are clear and sharp, or 'approximate' where they are uncertain or gradational. The geologic units were distinguished according to their morphological aspects and following definitions of previous authors [3]. Other geomorphological elements such as 'hollows', crater chains and clusters, light coloured ejecta and bright deposits have also been mapped when their width is ≥ 3 km.

3. Map description

The intercrater plain (ICP) and smooth plain (SP) materials are the main plain materials of the quadrangle occurring in the eastern and west-central sector, respectively. The intermediate plain (IMP) materials occur only as small patches, mostly in the eastern area of the map. The basin materials, mapped in the western sector of the quadrangle, are associated with the Caloris basin and have been distinguished according to four formations (Caloris Group) termed with official names [5]. Tectonic structures mainly occur in this sector of the quadrangle. They have been gathered according to two preferential orientations: in the NE of Caloris, NE–SW trending thrusts appear to form a radial pattern with respect to the basin geometry, whereas the wrinkle ridges are mainly oriented between N10°E and N15°E. To the E of the basin, the NNE–SSW oriented thrusts and wrinkle ridges appear to have a non-radial geometry with respect to Caloris (Figure 1).

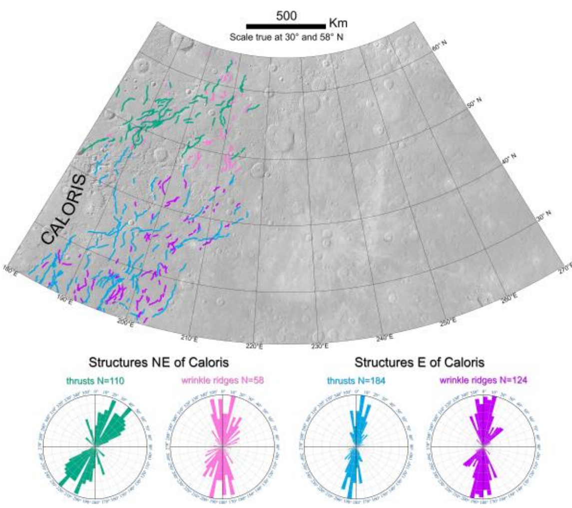

Figure 1: Distribution of the mapped structures nearby the Caloris basin and relative azimuth-frequency diagrams showing the main trend for thrusts and wrinkle ridges, respectively.

4. Summary and Conclusions

The MESSENGER images have allowed production of a more detailed 1:3M cartographic product of the Shakespeare quadrangle with respect to the previous 1:5M map. The craters were distinguished according to their diameter size in 'small' and 'major' craters. By integrating morphology, size and stratigraphy, the 'major' craters were grouped into three degradation classes, which allowed us to reduce the error in assigning relative ages. The western sector of the quadrangle is occupied by a portion of the Caloris basin and associated ejecta, which are embayed and partly covered by smooth plains deposits. The detected morpho-structures have contributed to an assessment of the deformation pattern of the quadrangle and will contribute to better evaluation of past stress states of the planet. This geologic map fills the gap between the two 1:3M maps of the Raditladi [4] and Victoria [2] quadrangles and can be considered an important support to future advanced local studies and target selection for the scheduled ESA-JAXA BepiColombo mission to Mercury.

Acknowledgements

The authors acknowledge the use of MESSENGER data processed by NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington. This research was supported by the Agenzia Spaziale Italiana (ASI) within the SIMBIOSYS project (ASI-INAF agreement n. I/022/10/0).

References

[1] Byrne, P. K., Klimczak, C., Şengör, A. C., Solomon, S. C., Watters, T. R., and Hauck, II, S. A.: Mercury's global contraction much greater than earlier estimates. Nature Geoscience, Vol 7(4), pp. 301–307, 2014.

[2] Galluzzi, V., Guzzetta, L., Ferranti, L., Di Achille, G., Rothery D. A., and Palumbo, P.: Geology of the Victoria Quadrangle (H02), Mercury. Journal of Maps, 2016.

[3] Guest, J. E. and Greeley, R.: Geologic map of the Shakespeare quadrangle of Mercury. Miscellaneous Investiagtions Series USGS, Map I-1408, 1983.

[4] Mancinelli, P., Minelli, F., Pauselli, C., and Costanzo, F.: Geology of the Raditladi quadrangle, Mercury (H04). Journal of Maps, 2016.

[5] McCauley, J. F., Guest, J. E., Schaber, G. G., Trask, N. J. and Greeley, R.: Stratigraphy of the Caloris basin, Mercury. Icarus, Vol 47(2), pp. 184–202, 1981.

[6] Prockter L. M., Kinczyk, M. J., Byrne, P. K., et al.,: The First Global Geological Map of Mercury. 47th LPSC, 21-25 March 2016, The Woodlands, Texas, 2016.

[7] Spudis, P. D., and Guest, J. E.: Stratigraphy and geologic history of Mercury. In F. Vilas, C. R. Chapman, & M. S. Matthews (Eds.), Mercury, pp. 118–164, University of Arizona Press, 1988.

[8] Watters, T. R. and Nimmo, F.: The tectonics of Mercury, in T. R. Watters and R. A. Schultz (Eds.), Planetary tectonics, pp. 15–80. Cambridge University Press, 2010.