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Mercury: a "dull" heavenly body with low relief, low albedo contrast, low iron content in crust, and justifying its place in the Solar system

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Abstract

Combined data of Mariner 10 and two flybys of MESSENGER [1 & others] clearly show that Mercury drastically differs from other terrestrial planets by its surface characteristics (not speaking about its large and massive core). Indeed, it has rather smooth surface, low albedo contrast of its wide planetary scale formations, low Fe content in rocks, seemingly strange combination of extension and contraction features, widespread development of lobate scarps and chains of 'pits' (secondary craters?). The surface smoothness is largely due to planetary scale development of volcanic floods [1].

All these peculiarities are normal from viewpoints of the wave planetology [2-4 & others] seeing them as regular consequences of Mercury's place in the Solar system. The closest to Sun planet, Mercury has the highest orbital frequency and thus the smallest and less amplitudinal tectonic granulation [2-5 & others] affecting surface relief range, from one side, and effective massive wiping out primary volatiles, from another. The massive loss of volatiles and with them angular momentum causes the planet's solid body rotate slower and shrink (angular momentum partitioning with escaping volatiles). The slower rotating solid body, in its turn, tends to restore the lost momentum by sending large masses of volcanics to surface (Fig. 2). To obtain this large volume of melts in the mantle requires intensive rock melting with involvement not only easily melting ferriferous fractions but also important volumes of harder melting magnesium fractions. That is why poor in iron rocks appear on the surface.

This simple but physically coherent scenario should explain main features of Mercury's surface structural and chemical characteristics revealed by the spacecrafts. Now we'll see how the smooth surface and massive degassing follow from comparative planetology of terrestrial planets.

Compare "sweeping" volatiles out of the planets. The wave tectonic granulation [2-5] strongly influencing this process and inversely proportional in size to the orbital frequencies is as follows: Mercury's granule size (a half of the warping wavelength) is πR/32, Venus πR/12, Earth πR/8, Mars πR/4. In a sphere of radius R there are 55.7 grains of radius πR/12 (Venus), 16.5 grains of radius πR/8 (Earth), 2.06 grains of radius πR/4 (Mars), 1057 grains of radius πR/32 (Mercury). Venus is 3.38 times finer-grained than Earth and 27.04 times than Mars, but 19 times coarser-grained than Mercury. Venusian wavelength 6000 km (πR/3) gives oscillation frequency 0.07 khz, terrestrial wavelength 10000 km (πR/2) 0.03 khz, martian 10660 km (πR/1) 0.025 khz, mercurian 960 km (πR/8) 0.3

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khz. Venusian oscillations 2.33 times more frequent than terrestrial ones and 2.8 times than martian ones, but 4.3 times less frequent than mercurian ones. If planets outgassing is proportional to the square (outgassing goes through surface) of the production of granulation and oscillation frequency, then Venus is 62 times more outgassed than Earth [$(3.38 \times 2.33)^2 = 62.1$] and 5732 times more outgassed than Mars [$(27.04 \times 2.8)^2 = 5732.3$]. The smaller martian mass (7.5 times less than Venus'mass) makes this outgassing difference 5732 x 7.5 = 42990 times. Actually venusian atmosphere is 90 times more massive than terrestrial one and ~18000 times than martian one. A rather high discrepancy between Venus and Mars (actually 18000, calculated 42990) is probably due to higher ellipticity of the martian orbit promoting volatile sweeping.

Following the established regularity one may say that Mercury is 477 times more degassed than Venus [$(19 \times 4.3)^2 = 6675$; 6675 : 14 (mass difference of the two planets) =477]. The most outgassed of the terrestrial planets Mercury is the only planet bearing distinct traces of an earlier planetary contraction: escarps or lobate ledges [6]. A direct evidence of earlier intensive degassing is in numerous so-called secondary craters. These small and deep holes are controlled by planetary lineaments, weakness zones. Two the most degassed planets –Venus and Mercury – rotate very slowly. This is due to angular momenta redistribution between solid and gaseous envelopes. Solid bodies slow down, atmospheres rotate faster. However, if Venus keeps its atmosphere, Mercury has lost it by solar wind sweeping (only traces of noble gases, Na, K remain). Mars, on the contrary, is very mildly outgassed and keeps a lot of CO_2 and H_2O. Two small terrestrial planets – Mars and Mercury – are in this sense "antipodean" bodies. Mercury is dull, heavy, Fe-rich, low-relief range, contracted, slowly rotating, without atmosphere ("candle-end"). Mars is bright, less dense, with high relief range, extended (at least partially), rapidly rotating, with an atmosphere. And this is due to different solar distances explaining not only different primary accretion compositions but also different orbiting frequencies so crucial for evolution of celestial bodies.

The lowest relief range of Mercury also is expected and modeled by the row of terrestrial planets with diminishing orbital frequencies [5]. Their surface relief also is inversely proportional to sizes (radii) of their tectonic granules.

Imaged in Fig. 1 roughly antipodean to Caloris basin Mercury's hemisphere shows traces of expansion (white planetary long lines – probably faults and rifts). It is expected for the bulged segment – hemisphere antipodean to primarily subsided Caloris basin segment (and now changed the subsidence to uplift evidenced by Pantheon Fossae). This is a manifestation of the tectonic dichotomy universally observed on other planetary bodies. Earth also has uplifted rifted continental hemisphere and subsided contracted Pacific basin.

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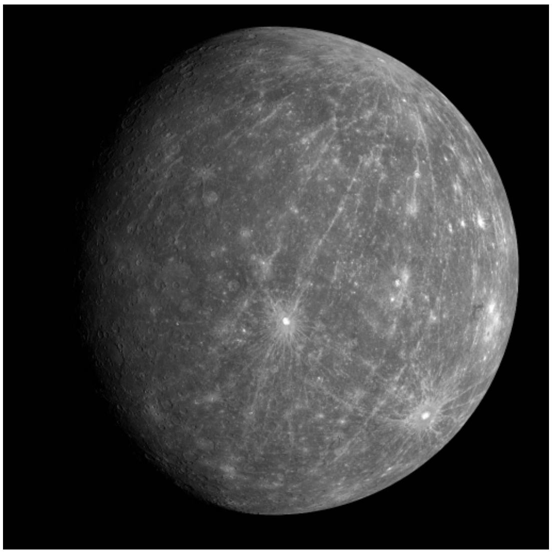

Fig. 1. Mercury as never seen before. Mercury Flyby 2; messenger_2008 1007_close.jpg. Planetary long white streaks probably caused by an extension fracturing.

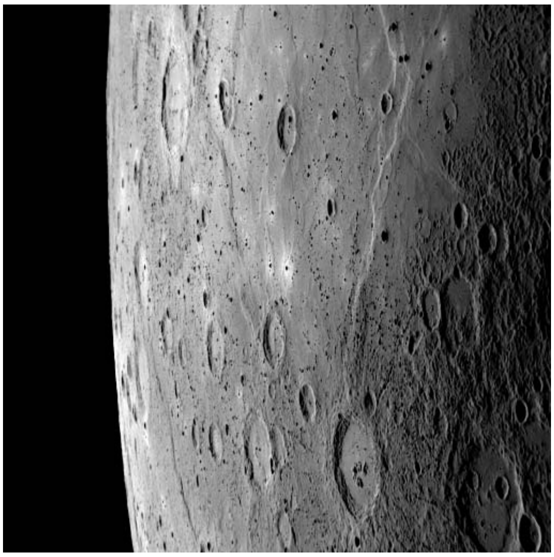

Fig. 2. At the edge of a world. Mercury Flyby 2; the right side of the image is about 430 km tall. An intensive volcanic flooding

Credit: NASA/Johns Hopkins University Applied Physics Laboratory/ Carnegie Institutions of Washington.