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Planetary relief range sequence as an indication of increasing distortion of planets with increasing solar distance

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Abstract

Cosmic experiments of the last several tens of years produced rather detailed maps of many Solar system bodies and one can use estimates of the relief ranges at some of them. In 1995, when the publication [1] was prepared, we knew that relief ranges increase from Venus to Mars from ~14 to ~30 km, Earth being in between with ~20 km. Without adequate topography on Mercury we theoretically assumed that this planet's relief range must be significantly lower (3-6 km) just to not violate the observed sequence (Fig. 3). Recently acquired Messenger's radar measurements (2008) show that the real range indeed does not exceed ~5 km and for widespread lobate scarps just a bit over 1 km [2]. And what is important, this small vertical relief differentiation is physically logically (the angular momentum action) accompanied by small petrologic (density) differentiation expressed by a low albedo range [3] (Fig. 3). This correlation is an illustration of the forth theorem of the planetary wave tectonics – "Angular momenta of different level blocks tend to be equal " [4-6]. With increasing relief ranges density ranges between rocks building lowlands and highlands also increase (Fig. 3).

So, the real relief amplitudes for four terrestrial planets are as follows: Mercury ~5 km, Venus ~14 km, Earth 20 km, Mars ~30 km (the martian relief span can be increased to 35 km if one takes into account collapsed summits of giant volcanoes with caldera radii 40 to 50 km and slope angle 5-6 degrees what makes heights of collapsed cones 4 to 5 km). Comparative to the Earth's span 20 km taken as a unit one has: Mercury 0.25, Venus 0.7, Earth 1.0, Mars 1.5 (1.8). Theoretical ranges taken as tectonic granules radii in planetary spheres reduced to unity for stressing a role of wave numbers are as follows (Fig. 1): Mercury 2πR/64.08, Venus 2πR/24.34, Earth 2πR/16.44, Mars 2πR/8.8. Relative to the Earth's range one has: Mercury 0.256, Venus 0.675, Earth 1.0, Mars 1.868. One can see a remarkable coincidence of the real measurements and the theoretical estimates [7]. Now, if one takes the real sizes of planets the overall picture slightly changes with smaller ranges for Mercury and Mars but the established important tendency remains [7].

This tendency can be projected into the asteroid belt where bodies are flattened and curved and thus have greater departure from a sphere and greater relief range between uplifted and subsided segments (hemispheres).

At the other end of the analyzed sequence is the solar photosphere (Fig. 1) where holes of the solar dark spots produce relief range of the order of ~300

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km. Relative to the solar radius (~700 000 km) it is not much and does not spoil a perfect solar sphericity. From our wave point of view a relief range mainly depends on orbiting frequencies and thus on size of supergranulation and should be ~183 km [8]. This figure is not far from the approximate observational data and thus is logical continuation of our wave sequence for solid planets into gaseous media. One more important confirmation of wave relief-forming potential of celestial bodies of various sizes and physical states very recently came from the icy saturnian satellites [9].

The saturnian system mimics the Solar system but orbital frequencies of its satellites starting from Iapetus are higher than the Mercury's one. So, this satellite sequence is a valid continuation of the frequency row from the higher frequency end. Recently published data on limb roughness of saturnian icy satellites [9] (Fig. 2) show that the roughness increases with the increasing distance from the planet, thus, with diminishing orbital frequencies proving the earlier established tendency. It is interesting that two near orbital frequencies, these of rocky Mercury and icy Iapetus (1/88 & 1/79 days) produce similar relief ranges (about 2 to 5 km). Thus, the warping waves act in various media and their relative lengths and amplitudes depend mainly on orbital frequencies. Iapetus ' roughness is 4.1 km, Enceladus' one is 0.44 km [9]. Orbital periods of studied satellites are as follows: Mimas 0.942 days, Enceladus 1.370, Tethys 1.888, Diona 2.737, Rhea 4.518, Iapetus 79.331 days. Iapetus in comparison with other icy bodies moves in much father from Saturn orbit, so, its relief range is much higher (Fig. 2) as should be expected.

It has to be mentioned that just appeared (March 24, 2009, NASA, Cassini project) new incomplete radar data on Titan's relief range (stereo views of ~2% of surface including a contact zone between dark lowlands and bright highlands) show that the total range of relief is 500, 700, 1000 m (PIA11829, 11830, 11831). The Titan's orbital period is 16 days, so the established rough correlation between relief and orbits is confirmed.

From all above solid observational data follows that with an increasing distance from a central body (Sun or Saturn) surface roughness (relief range) of planets or satellites increases. This means that disruptive action becomes more effective. But this conclusion is fully contradictive to effectiveness of classical tidal forces increasing with diminishing distance between two gravitating bodies. To explain this one must take into account a prevailing influence of alternating inertia-gravity forces (swing forces) excited in celestial bodies due to their movements in non-circular elliptical keplerian orbits with changing accelerations. This conclusion concerns all celestial orbiting and rotating bodies notwithstanding their classes, sizes, masses, densities, chemical compositions, physical states. This is an essential part of the supertectonics dealing with common structures of all heavenly bodies [10].

In this sense, a hypothesis of Yu.V. Barkin [11 & other publications) applying main reason of structurizing processes in celestial bodes to as if existing difference in gravitational traction for a core and a mantle should be reconsidered as

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contradictory to observations. Firstly, not all bodies are sharply differentiated into a core and mantle. Secondly, with increasing distance as if existing difference in gravitational traction must decline and its structurizing force nears zero.

References: **[1]** Kochemasov G.G. (1995) In: Golombek M.P., Edgett K.S., and Rice J.W.Jr., eds. Mars Pathfinder Landing Site Workshop II: Characteristics of the Ares Vallis Region and Field Trips to the Channeled Scabland, Washigton. LPI Tech.Rpt. 95-01, Pt. 1, Lunar and Planetary Inst., Houston, 63 pp. **[2]** Zuber, M.T., Farmer, G.T., Hauck II, S.A. et al. (2009) 40th LPSC, abstract 1813 pdf. (CD-ROM). **[3]** Head et al. (2009) 40th LPSC, abstract 2198 pdf. (CD-ROM). **[4]** Kochemasov G.G. (1995) Annales Geophysicae, Suppl.III to Vol. 13, Pt. III, Space and Planetary Sciences, 748. **[5]** Kochemasov G.G. (1999) 30th Vernadsky-Brown microsymposium on comparative planetology, Abstr., Moscow, Vernadsky Inst., 47-48. **[6]** Kochemasov G.G. (1999) Geophys. Res. Abstr., Vol. 1, # 3, 700. **[7]** Kochemasov G.G.(1993) 18th Russian-American microsymposium on planetology, Abstracts, Oct. 9-10, 1993, Moscow, Vernadsky Inst. (GEOKHI), 27-28. **[8]** Kochemsov G. G. (2009) European Space Agency International Conference on Comparative Planetology: Venus – Earth – Mars, ESTEC, Noordwijk, The Netherlands, 11- 15 May 2009. **[9]** Thomas P.C. et al. (2006). LPSC XXXVII, Houston, USA, Abstract 1639 pdf. (CD-ROM). **[10]** Kochemasov G.G. (2009) New concepts in global tectonics newsletter (NCGT) # 50, March 2009, 23-34. **[11]** Barkin Yu.V.(2002) 36th microsymposium on comparative planetology, Oct. 14-16 2002, Moscow, Russia, Vernadsky institute, Abstracts, CD-ROM.

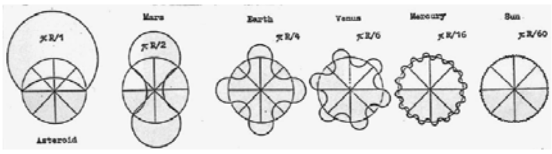

Fig.1: Geometric presentation of warping waves in the planetary system. All bodies are reduced to one size [7].].

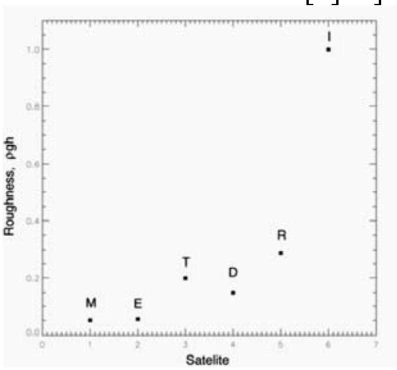

Fig.2: Limb roughness of saturnian satellites from Mimas-M and Enceladus-E (0.44 km) through Tethys-T, Dione-D, Rhea-R to Iapetus-I (4.1 km) [9].

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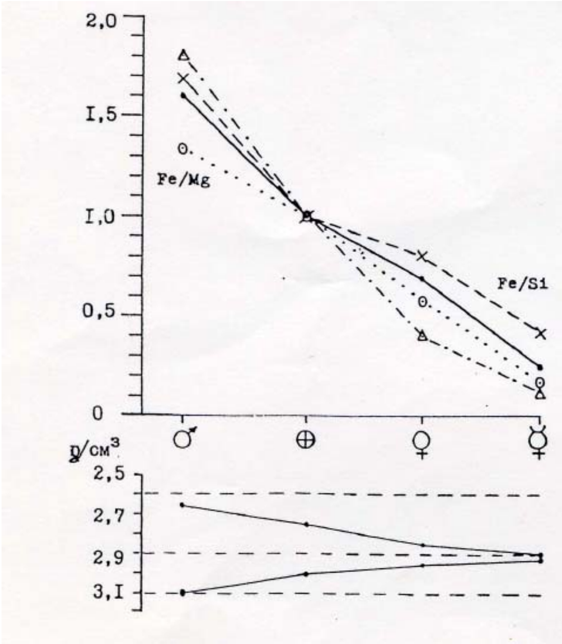

Fig.3 Ratios of some planetary crust parameters compared to the terrestrial ones taken as 1:solid line – relief, dashed cline – Fe/Si, dots – Fe/Mg in basalts of lowlands, dot-dashed line – highland/lowland density contrast. Below: increasing highland/lowland density contrast with increasing solar distance [1].