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Hartley and Itokawa: small comet and asteroid with similar morphologies and structures

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"Orbits make structures" [1-3]. This three-word sentence means that as all cosmic bodies moves in non-circular keplerian orbits they all are subjected to an action of inertia-gravity warping waves. These waves arise in bodies as a result of periodically changing accelerations causing inertia-gravity forces. These forces are absorbed by bodies masses and make them to warp. This warping is smoothed by gravity making globular shapes of the larger bodies. But smaller bodies with rather weak gravity keep their warped shapes. The wave nature warping happens in four interfering directions (ortho- and diagonal) and in various wavelengths. The fundamental wave 1 long $2\pi R$ makes ubiquitous tectonic dichotomy: an opposition of the uplifted segment-hemisphere and the subsided one. For small bodies a result of this is in their convexo-concave shape [3] (Fig. 1-7). The uplifted bulging segment expands and is breaking by cracks, faults, rifts. The opposed subsided concave segment contracts. As a result in the middle of an oblong body is formed a narrow thoroughly squeezed and degassed portion – a neck or waist (wringed out wet linen). Subsequently here at a weakened place could happen a break - formation of binaries, polycomponental bodies, satellites. Figures 1 to 4 show development stages of small bodies leading to a full separation of two parts.

Traces of warping waves of four directions are often seen on surfaces of many celestial bodies as cross-cutting lineations. A recent example of the small core of the Hartley 2 comet (2 km long) is very impressive. At received points of view are clearly seen at least three ortho- and diagonal lineations often marked by small outgassing craters (Fig. 1). Crossing lineations produce square forms (craters) earlier seen on the Eros' surface. Wave compression lineations make the Hartley 2 to appear as a wafer cake. A "waist" (neck) is formed as a result of nearing a concave depression, from one side, and deep cracks at the convex bulge, from the antipodean side (Fig. 5). The smaller rocky asteroid Itokawa (0.5 km long, Fig. 2) is surprisingly similar in shape and structure to the icy core of Hartley. It is also bent and rich in cross-cutting lineations o 4 directions marked by small holes-craters. But here they are extinct and lack of gas-dust jets. One sees a transition from a volatile rich comet core to an extinct mostly rocky mass – asteroid. In both cases (comet core and asteroid) in the middle develops a smooth "waist".

The bulged convex and antipodal concave segments-hemispheres in rotating bodies require somewhat different densities of composing them masses to equilibrate angular momentum of two halves (compare with the Earth's hemispheres: the eastern continental "granitic" and western Pacific "basaltic"). The near-IR images of two asteroids (Fig.6-7) confirm this. The concave and convex sides are compositionally different. In the Eros' case the concave side is richer in pyroxene, thus denser.

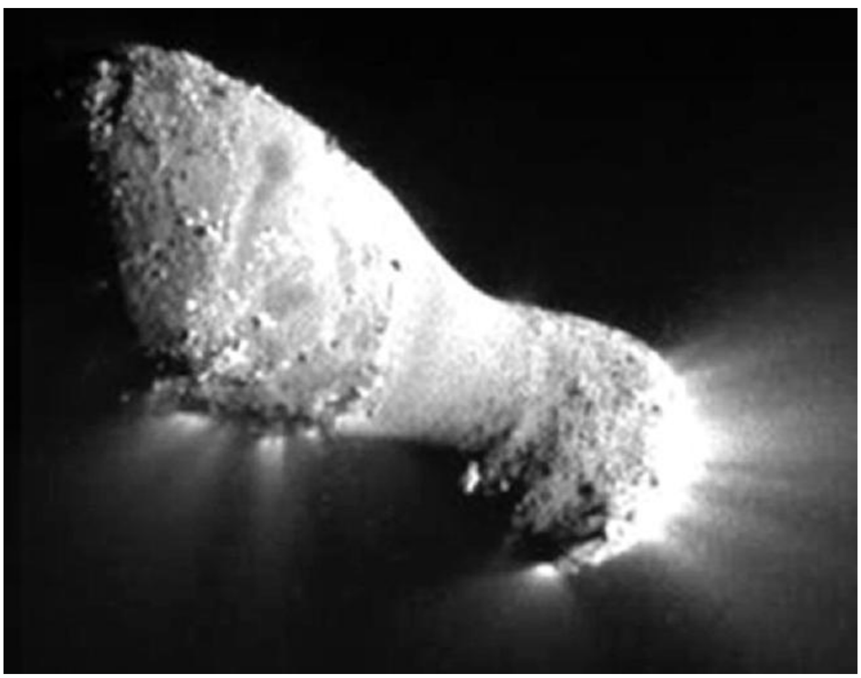

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Fig. 1. 103P/ Hartley 2, 2 km long, Credit: NASA/JPL-Caltech/UMD.

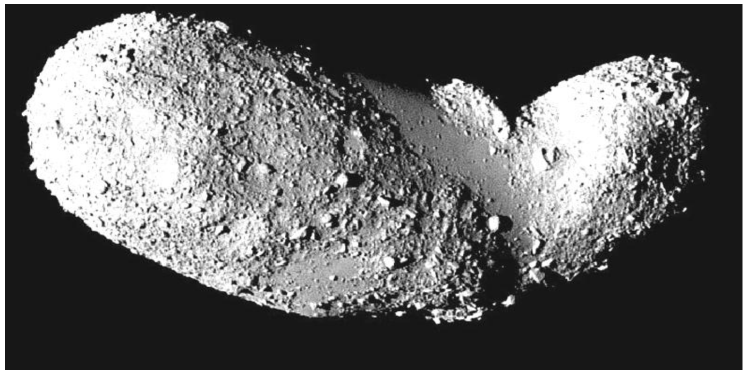


Fig. 2. Apollo asteroid 25143 Itokawa. 535 x 294 x 209 m. Itokawa07 Hayabusa. Jpg.

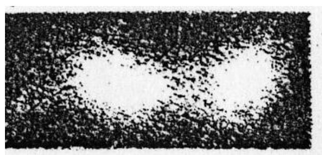
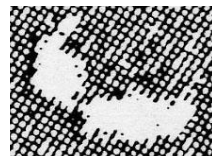
3  4 

Fig. 3. Asteroid 9969 Braille ("Deep space 1" mission), 2.2 km long, Pia01345.gif.
Fig. 4. Asteroid 4769 Castalia (Radar observations, S.J. Ostro, J.F. Chandler, 1990), 1.8 km long.

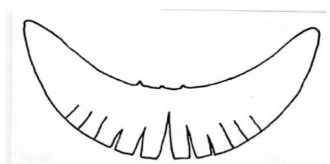


Fig. 5. Geometrical model of convexo-concave oblong shape of a small celestial body caused by the wave1 warping. Deep cracks of the convex hemisphere and the concave hemisphere cause development of a "waist" or 'neck" and finally lead to a body breakage

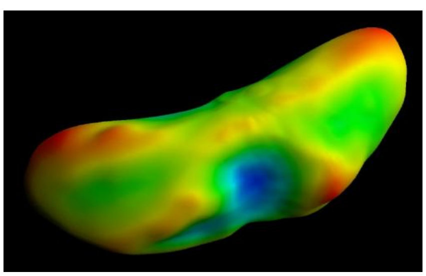
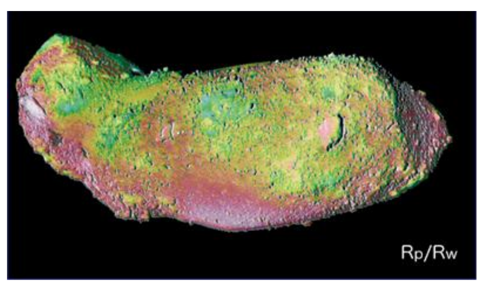
 6 7 

Fig. 6. Eros (33 km long, PIA03111). **Fig. 7.** Itokawa (0.5 km long). Reflectance ratios of P band (around 960 nm) and W band (around 700 nm). Red-high P, green-high W band. Fig01.GIF.

References: **[1]** Kochemasov G.G. (1998) Sectoral tectonics of the Earth's eastern hemisphere and its crucial role in localization of giant ore deposits, prominent rift systems and large flood basalt provinces // Global Tectonics and Metallogeny, V. 6, # 3 & 4, 1998, 195-197. **[2]** Kochemasov G.G.(1999) Theorems of wave planetary tectonics // Geophys. Res. Abstr., 1999. V.1, №3, p.700. **[3]** Kochemasov G.G.(1999) On convexo-concave shape of small celestial bodies // Asteroids, Comets, Meteors. Cornell Univ., July 26-30, 1999, Abstr. # 24.22.