ISOSTASY AND THE SHAPE OF IAPETUS. L. Czechowski, J. Leliwa-Kopystyński Institute of Geophysics, Department of Physics, University of Warsaw, Warszawa, Poland (lczecho@op.pl).

Introduction: Two spectacular features are observed on Iapetus: equatorial ridge (ER) and the equatorial bulge (EB) – Fig. 1. The existence of EB means that the satellite has abnormally large flattening. Iapetus' flattening is equal to 0.046 and it corresponds to rotational period 16 hours although the present period is 79.33 days. The origin of both features still remains an enigma; nevertheless a few different hypotheses were presented, e.g. [1]. We present here our hypothesis stating that EB and ER are in isostatic equilibrium and that they are formed as results of partial differentiation of the satellite's interior and later global overturn.

Let us note that the Cassini data concern the geometric shape only. The comparison of this shape with the shape of equipotential surface, i.e. the geoid, is necessary to prove that the flattening is non-hydrostatic. Most of terrestrial mountains are in isostatic equilibrium, i.e. they are underlain by 'roots' formed from low density matter.

The rheology of icy satellites is similar to terrestrial rocks although for different range of temperature and pressure. It means that mountains on the surface could exist for billions of year. The medium below the lithosphere is also solid but for very slow geologic processes it behaves like a viscous fluid**.**

Partial differentiation: The heating of satellite interior could lead to melting and consequently to gravitational differentiation of the matter. [2] developed the model of this process based on the finite difference method combined with parameterized model of convection. The full description of the model is given in [2]. Fig. 2 presents a sample result of this model. It indicates that for given parameters the radius of molten region is about 0.65 of radius of the satellite.

Gravitational overturn: After differentiation, the silicates form the central core, while the liquid forms a molten layer around the core. It is an unstable situation. It results in a global overturn. The buoyancy resulting from the difference of density $\Delta\rho$ is the main driving force. The result of the overturn is presented in Fig. 3. The low density matter forms roots below the equatorial region.

We hope that Cassini mission will provide data about gravity of Iapetus necessary to discriminate between hypotheses of hydrostatic and non-hydrostatic flattening.

References::

[1] Czechowski, L., Leliwa-Kopystyński, J., 2008. The Iapetus's ridge: Possible explanations of origin. Adv. Space Res., 42, 61-69.
[2] Czechowski, L., 2012. Thermal history and differentiation of Rhea. Acta Geophysica, 60, 4 1092-1212. [3] Thomas, P.C., 2010. Sizes, shapes, and derived properties of the Saturnian satellites after the Cassini nominal mission. Icarus 208, 395–401.

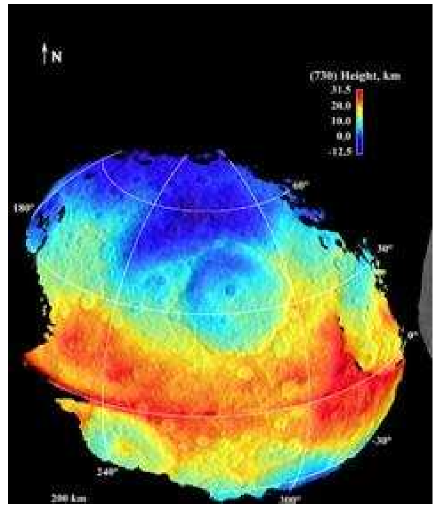

Figure 1. Topography of Iapetus. After [3]. Note narrow ER (dark red) over wide EB (red and yellow).

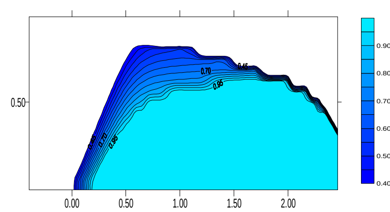

Figure 2. An example of melting history of Iapetus according to our model for t_{ini} = 0.4 My, t_{acr} = 1 My, $\eta_0 = 10^{12}$ Pa s. The vertical axis gives r/R_{sat}, the horizontal axis gives $\log_{10} t$, where t [My] is the time from the beginning of accretion. Figure presents fraction of latent heat supplied to the matter (1 means that matter is molten).

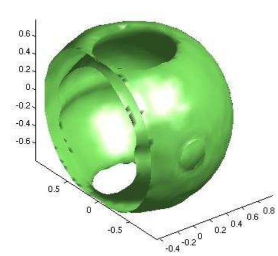

Figure 3. The distribution of low density matter as a result of gravitational overturn according to our hypothesis. The low density matter forms a layer between two given surfaces. Note deep roots below equatorial region.