

MECHANICAL CONSEQUENCES OF IMPACT FORMED CRATER STICKNEY ON PHOBOS.

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Stickney crater on Phobos is one of the largest crater in Solar system in respect with the dimension of the target body. In this paper some estimations of the mechanical parameters of the Stickney impact are presented to evaluate the possible geologic processes, which accompanied the crater formation.

1. **THE ENERGY OF CRATER FORMATION.** In the first approximation Phobos may be treated as the sphere 21.7 km across with the density 1.9 g/cm^3 , the gravity acceleration on the surface $.62 \text{ cm s}^{-2}$ and the escape velocity 11.4 m s^{-1} . The mechanical properties of the Phobos material are poor understood now. Taking into account the mean density of Phobos one can use at the first approximation such materials as tuff, dense sand or alluvium as the mechanical analogs of the Phobos material. Without any data on the strength properties of the Phobos material it is hard to say either strength or gravity determined the dimension of the Stickney crater. The different estimations have been made using the data (i) on craters, formed with Apollo stages impacts on the Moon [1], (ii) on explosion craters in alluvium [2], and (iii) on centrifuge modeling of high velocity impacts in the dense dry sand [3]. All estimations give the value of kinetic energy of the crater formation in the range from 100 to 1000 Mton TNT. The most probable value is about 400 Mton TNT ($1.7 \cdot 10^{25} \text{ erg.}$)

2. **STRESS WAVES.** One can evaluate the parameters of the stress wave, generated by the Stickney impact, using (i) the data on the shallow burst in alluvium [4] and the data on underground explosions in tuff [5]. Both approaches lead to the coincident results: the maximum particle velocity in the stress wave near the antipodal to Stickney point would be equal .3 to .4 m/s. The free surface velocity would be twice larger than this value. At other latitudes (in respect to Stickney) the free surface velocities would be increased with the decreasing of the distances to the impact point and in the equatorial plane the velocity would be about of 1 m/s.

3. **SPALLATION.** It is seems to be difficult now to calculate the complex history of the stress wave reverberating in the Phobos body, especially including the possible changes of the mechanical properties of the target material during this process. Although one can estimate the consequences of the first reflecting of the stress wave on the free surface. The normal component of the particle velocity would be about of 1 m/s. In the weak

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gravity field of Phobos the material with such initial velocity would lift up to 100 m above the initial level. This material may include the spall layer or only regolith layer with the low tensile strength. The uplifting of the surface layer would be accompanied with the tensile deformation of about 1 %, which is obviously above the elastic limit. So one can suppose, that the tensile fractures would be generated during the free flight of the surface layer. In the equatorial plain (in respect to Stickney) the total length of the equator would increase at approximately 600 m. This means the origin, for example, of 100 fractures with the width of 6 m each, or 10 fractures with the width of 60 m each. In the same time it is possible to open some preimpact fractures. This process seems to be connected with the origin of the well-known grooves on the Phobos, but much more work is needed to clarify this connection.

4. **DISTURBANCE OF ORBITAL MOTION.** To estimate the possible disturbance of the orbital motion of Phobos due to Stickney formation one needs to evaluate the value of the rebound impulse, generated with the crater formation. This value has been estimated using the data (i) on explosion experiments [6], (ii) on the kinetic energy of the ejecta , and (iii) Z-model of cratering [7]. All these approaches give the range of the change of the Phobos orbital velocity from .3 to 3 m/s with the most probable value of 1 m/s. This increment of the velocity may change the orbital period of the satellite up to 40 s, which is approximately .15 % of the observed period 7 h 39 m.

CONCLUSIONS. Although the formation of Stickney on Phobos had some inevitable influence on the surface (and may be internal) structure of the satellite, the rapid attenuation of stress waves in the relatively low density interiors seems to prevent the total disruption of Phobos. The Stickney impact does not appear to change drastically the orbital parameters of the satellite.

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