IMPACT CRATERING ON VENUS: PHYSICAL AND MECHANICAL MODELS;
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High-resolution radar survey of Venus by Magellan expands significantly our knowledge of this planet. One of the fruitful way to clarify some geologic processes on Venus is to study impact craters observed on the images. The analysis needs some models, which can connect different physical and mechanical processes involved in impact cratering at venusian environment. Pre-Venera 15/16 investigations as well as the results arisen from Venera 15/16 data analysis made a solid basis for the development of such models [1-6]. The aim of this presentation is to review some models which may be used for interpretation of Magellan images.

Breakup of meteoroids in the atmosphere of Venus. The Venusian atmosphere is massive enough to crush meteoroids of about several km in diameter [1]. As a first step in the study we used the simple parametric model to estimate the critical dimension (Lc) of crater-forming projectiles [6]. The main supposition of the model is as follows: at a given angle of incidence α for projectile's diameters $L > Lc(\alpha)$ the projectile decelerates as a rigid body and creates a crater on the surface; if $L < Lc(\alpha)$ the body is completely destroyed and has no cratering effect. The dependence of a Lc on α was supposed to be as $Lc(\alpha) = Lc(90)/\sin\alpha$ [1,4]. A fit of the calculated crater size-frequency distribution to the observed one yields the Lc value as .8 km for the vertical incidence of rocky meteoroids (α=90 degrees). This value of Lc corresponds to the minimum diameter of a crater, excavated by the impact of a single body in the range from 10 to 20 km for the 45 degrees incidence angle and velocities of impact from 10 to 40 km/s. For lower diameters of a crater one would see a transition to craters, formed by fragments of a single body. The information on Magellan results [11] confirms this prediction.

In the case of comet nuclei one should note that a stagnation pressure on the leading face of the large body in the lower atmosphere is in the range from 0.3 to 3 Mbar for velocities from 20 to 70 km/s. These pressures exceed the bulk modulus of ice or water which is about 20 kbar. So for icy meteoroids one has to take into account compressibility of the body material.

We have carried out finite difference calculations of the icy meteoroid passage through the venusian atmosphere using the Free-Lagrangian method. An icy spherical projectile bearing no strength was assumed to enter the atmosphere vertically at a speed of 20 km/s. The numerical simulation show that the body is compressed by the shock wave travelling from its leading side to the wake, and then the rarefaction wave returns. Instead of the total lateral expansion and the consequent enlargement of the cross-section area some gradual loss of the meteoroid particles is obtained at the edges. The shape of the projectile leading face at early stage of deceleration becomes close to conical with the blunt nose while the maximum cross sectional area doesn't appreciably changes and the trailing face has an approximately spherical form. We assume to continue a series of calculations varying the meteoroid parameters.

Crater formation and ejecta emplacement. In process of Venera 15/16 data analysis it was realized that passage of high velocity meteoroid through the venusian atmosphere transfers a lot of energy into atmosphere gases [4]. This energy spread out in the form of ballistic shock waves. The "fireball" of hot low-density gas above the point of impact seems to provide the almost airless style of ejecta emplacement around venusian craters.

The atmospheric shock waves, generated by a projectile, can hit the surface and change the microrelief of the surface around the crater [4]. This process was simulated in terrestrial atmospheric condition using the line charge detonation above the solid basement covered with a layer of fine sand of various thickness [7]. The experiments revealed formation of relatively large hummocky area around the point of "impact". The scaled diameter of this area is comparable with radar-bright halo around venusian craters on Venera 15/16 images.

The experiments have revealed a new effect of long-runout motion of sand: fine sand after the explosion is moved as far as several meters aside. There are some evidences that this "far" transport is non-ballistical and sand-air flow occures in a thin near-ground layer. Now these experiments are in progress.

This phenomenon may be considered as possible mechanism of formation of the "outflows" emerging from the crater ejecta blanket into the dark halo zone [11]. Another kind of far cratering action is impact-induced seismic shaking of the surface material. Now the estimates of effectiveness of this phenomenon are in progress too.

Cooling of impact melt. One of the main point in which Venus is drastically different from Earth is high temperature of the near surface rocks. This difference would change the characteristics of impact melt on Venus in respect to the terrestrial one. The model calculation shown that total volume of impact melt for an impact crater of a given diameter on Venus may be twice larger than on Earth [8].

The cooling history of massive impact melts consists of two stages: fast equilibration of temperatures between the melt and cooler clasts and less rapid cooling of the whole melt sheet [9]. The numerical model calculation of the equilibration stage shown that due to higher initial clast temperature the duration of this stage on Venus is 8-10 times longer than on the Earth. Therefore venusian impact melts seem to be able to flow with preserving low viscosity much longer than on Earth and the Moon and one can expect more smooth surface of impact melt ponds in venusian impact craters. The released Magellan images show rather smooth surface on the bottom of craters, for example in the area of the "crater farm".

It is well known that melt viscosity dramatically depends on the water content [10]. The continuing modeling of the cooling of venusian impact melts may be useful to constrain some characteristics of rock provided that appropriate geologic data would be available from Magellan images.

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