ON THE FRAGMENT-SIZE DISTRIBUTION OF EJECTA OF IMPACT CRATERS. B.A.Ivanov[1] and A.T.Basilevsky[2]: I - O.Yu.Schmidt Institute of Physics of the Earth, USSR Acad.of Sci. 2 - V.I.Vernadsky Institute of Geochem. and Analyt.Chem.,USSR Acad.of Sci.,Moscow.

Our work purposes to describe approximately within the common analytical dependence the fragment-size distribution of ejecta of impact craters (within the wide range of fragment sizes) and to estimate the coeffitions of the distribution from the observation data. As was shown in [I] in the process of fragmentation of rocks by high-explosive detonation a fragment-size distribution can be described by Weibull distribution:

$$v_{>x} = v_e . \exp[-(x/x_o)^n] , \qquad (I)$$

where v_e is volume of ejecta, $v_{>x}$ - cumulative volume of fragments larger than x, n and x_o - coefficients of the distribution. For $x \ll x_o$ a differential form of (I) is a power function:

$$(dv/d\ln x) \sim x^n \qquad (2)$$

A power function of the fragment-size distribution of relatively fine fraction was observed many times in laboratory impact and explosive experiments (see e.g. [2,3,4]) and in allogene breccia of impact craters also (see e.g. [5]). We have processed data of [2,3,4,5,] along with the Plougher nuclear explosion data [6] and have found that in (2) $o<n<1$, mostly $n \approx 0.5$. Similar conclusion was yet made earlier (see e.g.[3,7]). An extreme case of the power distribution approach had been suggested in[7]:

$$v_{>x} = v_e \sqrt{x/x_m} , \quad \text{for } x \leqslant x_m , \qquad (2a)$$

where x_m is size of the largest fragment for the given event.

Now using (I) or (2) we have a possibility to estimate the total fragment-size distribution based on the observed x_m values. Estimations of x_m (D) for several terrestrial impact craters was earliar made in[8] known in USSR from [2,7]. In our work we measured x_m for 56 lunar craters using the Lunar Orbiter and Apollo photographs. These data shown on Fig.I can be approximated as

$$x_m(\text{meters}) = (25 \pm 12).D^{0.69 \pm 0.03} \qquad (3)$$

where D is the rimcrest diameter of crater (km). Within the statical errors data on 47 mare craters and on 11 highland craters are in accordance. Because of scarcity of data for craters with D>I5 km we can not make any conclusions on possible difference of $x_m(D)$ for the simple and complex craters. From Fig.I where data on terrestrial craters Meteor, Arizona (A) and Ries (R)[2,7] as well as Popigay (P)[9] are shown it is evident that $x_m(D)$ for terrestrial and lunar craters seems to be not very different.

Supposing the geometric similarity of fragments Eq.(I) may be transferred into some expression which determines a quantity of fragments larger than x. Although any statistical distribution of type (I) is not applicable to little number of fragments near x_m we can interprete it as a statistically average dependence for many similar events. Then if we suppose that the observed fragment of maximum size (Fig.I) corresponds to upper portion of the distribution and the quantity of these fragments is little (e.g.I or I0) it is possible to estimate the value of x_o in (I) for any given v_e, n. To illustrate the described approach of estimation the dependence of differential share of fragments for given size x in a form $(I/v_e).(dv/d\ln x)$ are shown on Fig.2 for the lunar crater with D = 0.54 km. According to (3) $x_m \approx 16$ m.

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Solid and dashed lines correspond to (I) with n = 0.5, k_v = 0.7 (the fragment volume $v = k_v . x^3$) and x_0 estimation supposing that $N_{>x_m}$ = I and IO. Dash-and-dotted line corresponds to (2a). Circles designate the observed data for fragments belonged to lunar crater with D = 0.54 km [IO], crosses - data for crater with D = 0.52 km [II] . Taking into account natural uncertainties in such estimations the correspondence of empirical and theoretically estimated data seems to be rather well. Note that pure power approach (2a) does not give descending branch of the distribution.

Combining the above described method of estimation of the fragment-size distribution with the data on density of lunar craters of Imbrium, Eratosthenian, and Copernican age [I2] a possible cumalative volume of fractions < I mm and < I cm was evaluated. Applying this evaluation to the Venus surface and supposing the homogeneous distribution of this fine material over the surface the estimations of possible thickness t of the layer of this material were obtained: for fraction < I cm t = I cm to 3 m (n = I and 0.5 correspondingly), for fraction < I mm t = I mm to I m (n = I and 0.5).

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Fig. 1

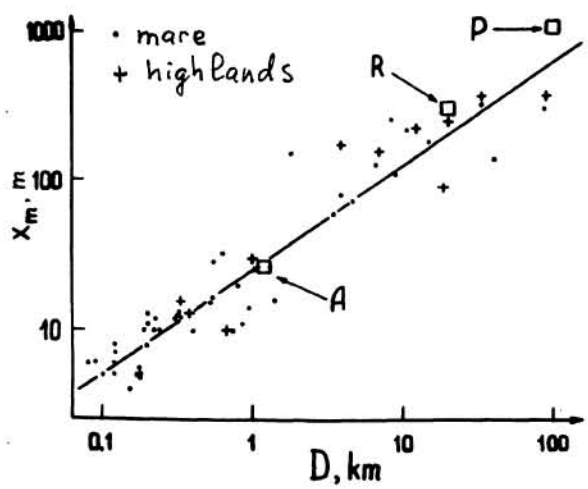

Fig. 2