PROBLEMS OF INTERPRETATION CRATER DATA IN THE SOLAR SYSTEM

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It is currently believed that most of the craters and mares (with and without mascons) on the Moon, Mars and Mercury were created by interplanetary bodies, which may to fell from 4.1 to 3.8 billion years ago during the so-called "late heavy bombardment by meteorites". However, this hypothesis faces serious difficulties due to an explanation of the size distribution of craters. This applies to both craters on continents (Fig. 1) and craters in mares (Fig. 2), which origin cannot be explained by the fall of cosmic bodies with a size distribution, as in the modern asteroid belt [Neumann et al, 2015].

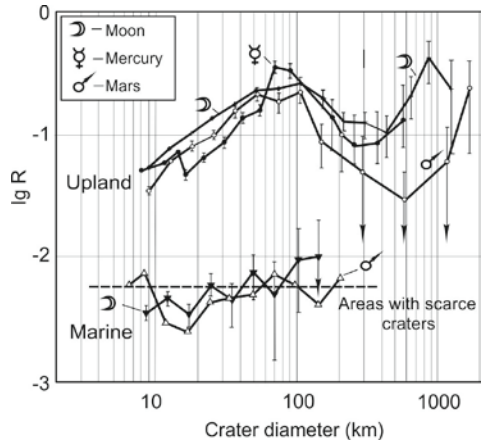

Fig. 1. Craters density in upland pieces of Moon, Mars and Mercury (upper graph) and in mares (lower graph) [Woronow, 1977]

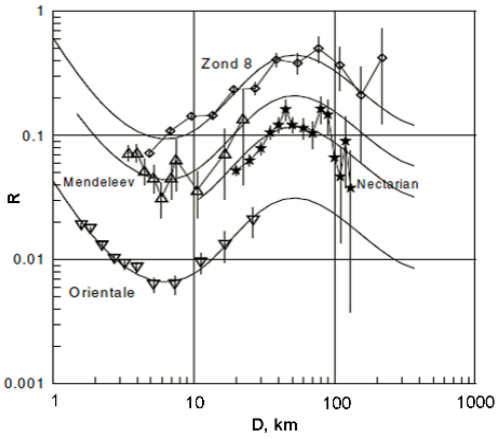

Fig. 2. Craters density with a diameter from 0.01 to 200 km in mares on the Moon. Curves – theoretical craters description [Neukum et al, 2001]

At now craters distribution (Fig. 2) is approximated by a polynomial of 12 members, which is then used in estimating the age of a planetary surface. This relationship is expressed by the formula: $N(1) = 5.44 \times 10^{-14} \left(\exp(6.93T) - 1\right) + 8.38 \times 10^{-4} T$, where: N(1) is number of craters with D > 1 km on an area of 1 km^2; T – accumulation time of craters in billion years [Neukum et al, 2001].

However, this theoretical model is very far from reality [Barenbaum, Shpekin, 2019].

New approach to interpretation of craters data

It is known [Barenbaum, 2010] that planets of Solar System are cyclically subjected to powerful bombardments by high-speed galactic comets. We found [Barenbaum, Shpekin, 2019] that large craters and mares on Moon, Mars and Mercury were created mainly by these comets 5–0.7 million years ago during last cometary bombardment. Since masses and energies of galactic comets are distributed exponentially, craters (Fig. 3) and mares (Fig. 4) formed by comets are also have exponential size distribution.

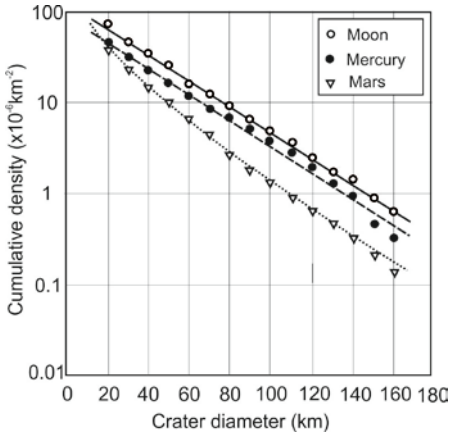

Fig. 3. Cumulative size distributions of continental craters on the Moon, Mercury and Mars in a semi-logarithmic coordinate system [Barenbaum, 2010]

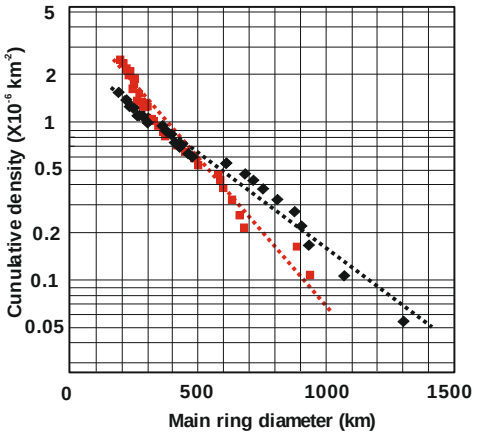

Fig. 4. Cumulative size-distribution of mares on near (red icons) and back (black icons) sides of Moon [Neumann et al, 2015] in a semi-logarithmic coordinate system

Our other findings are as follows:

- The continents of Moon, Mars, and Mercury (Fig. 3) are completely saturated with comet craters with diameter of D ≈ 10–180 km; there are no comet craters outside this range. Craters with D <7-10 km were destroyed as a result of later cometary falls, and structures with D> 180 km are considered mares.
- The mares arise as a result of the imposition of crater funnels from fall of many (k> 1) comets. With an increase in k, diameter of mares and the volume of magmatic melts accompanying their formation grow. Starting from D > 218 km, heating and melting of rocks reaches the mantle depths, which causes formation of mantle diapirs, creating Bouguer anomalies [Melosh et al, 2013].
- Marine craters with D < 7 km (Fig. 2) are created by the falls of interplanetary bodies. The size distribution of these craters follows the inverse quadratic dependence inherent in the bodies of the asteroid belt. These craters are no more than 700 thousand years old; they formed after the last bombardment of comets and continue to arise today.