MARTIAN BOLIDES AND EFFECTS ON CRATERING. O. P. Popova[1], W. K. Hartmann[2], and I.V.Nemtchinov[1] [1]Institute for Dynamics of Geospheres, Leninsky prospect 38, Bld.1, 119334, Moscow, Russia, olga@idg.chph.ras.ru, ivvan@idg.chph.ras.ru, [2]Planetary Science Institute, 620 N.6th Avenue, Tucson, AZ 85705 USA, 520-622-6300, hartmann@psi.edu

Introduction: We used models of atmospheric fragmentation of meteoroids to study meteoroid passage through present and past atmospheres of Mars. We calculated the sizes of the smallest objects to survive atmosphere passage, and hence the sizes of the smallest expected craters. We have analyzed also the causes of "small clusters" (20-m-scale pits scattered over few-hundred meter areas) and also "large clusters" (500-m scale craters scattered over 5 km areas)

Fragmentation effects: The smallest craters expected under current atmospheric conditions on Mars have diameter of the order 0.3 m, due to iron meteorites that survive atmospheric passage[1]. They might best be detected on Martian rocks, as discussed by [2]. The smallest Martian craters due to stony meteoroids range from 0.5 to 6 m in diameter, depending on the strength of the meteoroids, and the smallest craters due to hypothetical weak icy or icy/carbonaceous cometary meteoroids would be about 8 m across.
Fragmentation influences the crater formation process on Mars, but primarily in hypothetical denser past atmospheres. In the present atmosphere only the weakest bodies, with strength ~ 1 bar, would fragment. In dense atmospheres above 300 mbar fragmentation processes should cause dramatically decreased crater numbers in diameter distribution below crater size about 200-300 m, similar to the paucity of <300 m explosions craters on Earth. It may be hard to distinguish small crater clusters formed by our predict breakup of ordinary stones and irons under 30-300 mbar atmosphere, from the small clusters formed by weak stones in the present atmosphere. Craters much smaller than 0.3 m (such as “zap pits” in rocks) would be diagnostic of earlier periods with lower atmospheric pressure, perhaps caused by obliquity variations.

Martian clusters: We have identified two types of craters clusters on Mars. Small clusters involve craters with diameter D up to a few tens of m spread over typically 100-300 m [3,4], and large clusters involve craters with D~100-900 m spread over 5 to 30 km [4-6].

Existing models and observations are consistent with weak meteoroids breaking up in the Martian atmosphere and causing the observed “small clusters.”

The present fragmentation models fail to produce conditions that would explain our “large clusters” of 500 m craters spread over 5-30 km. Furthermore, we see no smooth continuum between the small and large clusters; they seem to represent two distinct phenomena.
We considered and rejected a number of possible explanations. The best explanation seems to be ejection of large, secondary fragmented blocks of material launched at sub-escape velocity out of impact craters. During their flight through the atmosphere they could separate to the spacings required to create such large crater clusters after reentry.

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