Experimental study on the impact properties of permafrost on Mars

Masahiko Arakawa[1]

[1] Inst. Low Temp. Sci., Hokkaido Univ.

http://risu.lowtem.hokudai.ac.jp/~arak/

Impact craters found on Mars are characterized by a rampart crater and a pit-type crater, whose origins are possibly related to permafrost buried in the ground of Mars. The impact properties of permafrost has been studied on the cratering efficiency and the impact strength because icy satellites are widely accepted to be composed of ice and silicate mixture and their surfaces are covered with impact craters. The basic physical properties of permafrost, e.g. impact strength, ejection velocity of the fragments and shock pressure attenuation, are a key to understand mechanisms of the formation process of a rampart crater and a pit-type crater, so that we have studied these properties by a series of impact experiments.

Samples were prepared by mixing water ice with serpentine powder at the mass ratio of 50 to 50. This ice-rock mixture has a shape of cylinder with the diameter of 50 mm or rectangular with the size of 20 mm. The thickness was changed from 2.4 to 46 mm for a cylinder and from 10 to 30 mm for a rectangular. The impact experiments was conducted in a cold room at the temperature of -10 deg. The two-stage light gas gun was used to accelerate a nylon projectile with the mass of 7 mg at the velocity of ~3km/s. A high-speed video camera and an image converter camera recorded successive images of the impact disruption at the speed of 3000fps to 5x10^5fps. The antipodal fragments were observed to measure the sizes and the ejection velocities.

The antipodal velocity has a good correlation to the sample thickness, i.e. it decreases with increasing thickness. The relationship for a rectangular sample shows the antipodal velocity higher than that for a cylindrical one at the same thickness. The distance between the impact point and the side of the rectangular sample is shorter than that of the cylindrical one, so that the strong reflection wave comes from the side to disrupt the sample. This mechanism must make the sample weaker and crush the antipodal fragments smaller. The relationship between the antipodal velocity (va) and the sample thickness (L) for the rectangular sample is found to be va ~L^-3.0. The power law index of the attenuation, 3.0, is apparently larger than that of water ice, 2.2, that is, the shock pressure propagating in the mixture could decay more rapidly than that in water ice. The good correlation was also observed in the relationship between va and the mass of antipodal fragments (ma), va=7.1 ma^-0.35.