CRATERING EXPERIMENTS ON BASALT TARGETS. Y. Takagi[1], S. Hasegawa[2], and K. Kurosawa[2], [1]Aichi Toho University, 3-11 Heiwagaoka, Meito-ku, Nagoya 465-8515, JAPAN (takagi@aichi-toho.ac.jp), [2]Institute of Space and Astronautical Science (ISAS)/Japan Aerospace Exploration Agency (JAXA), 3-1-1 Yoshinodai, Chuo-ku, Sagamihara 252-5210, JAPAN

Introduction: Since impact cratering phenomena on planetary bodies were the key process which modified surface topography and formed regolith layers, many experiments on non-cohesive materials (sand, glass beads) were performed. On the other hand, experiments on natural rocks were limited. Especially, experiments on basalt targets are rare, although basalt is the most common rocky material on planetary surfaces. The reason may be the difficulties of obtaining basalt samples suitable for cratering experiments.

Recently we obtained homogenous and crack-less large basalt blocks from a retailer (FURNITURE STONE Co., Ltd., http://www.f-stone.com/). We performed systematic cratering experiments using the basalts target,

Experimental Procedure: Impact experiments were performed using a double stage light-gas (hydrogen) gun at JAXA Sagamihara campus. Spherical projectiles of nylon, aluminum, and stainless steel were launched at velocities between 2400 and 5300 m/sec. The projectiles were 3.2 to 7.1 mm in diameter and 0.05 to 0.22 g in mass. The incident angle was fixed at 90 degrees.

Targets were rectangular blocks of Ukrainian basalt. The impact plane was a square with sides 20 cm long. The thickness was 9 cm. Samples were cut out from a columnar block so that the impact plane might become perpendicular to the axis of columnar joint. The mass was about 10.5 kg. The density was 2915±10 kg/m^3. Sixteen shots were performed.

Since the shapes of formed craters are remarkably nonsymmetrical (Fig. 1), the radius was assumed to be the average of distances from the impact point to the rim in eight directions (Fig. 2). The reason of irregular shapes may be pre-existent radial micro cracks formed when the columnar joint solidified.

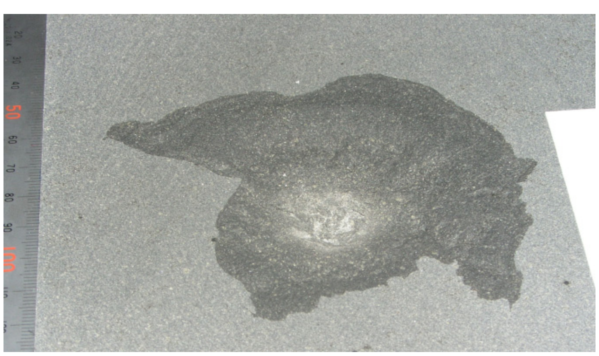

Fig 1. An example of irregular shape of formed crater.

Three-dimensional shapes and volumes of craters were measured by an image dimension measurement machine. Figure 3 shows an example of crater profile along a line crossing the impact point calculated from the 3-dimensional shape data. The depth of crater was measured from the profile.

Results: The shapes of formed craters (Fig. 1) and recovered fragments showed the large part of crater volume is excavated by the spallation. Fine particles also suggest the target near the impact point was destroyed the compression. Craters on basalt are also formed by the combination of two different mechanisms as shown by previous studies [1][2].

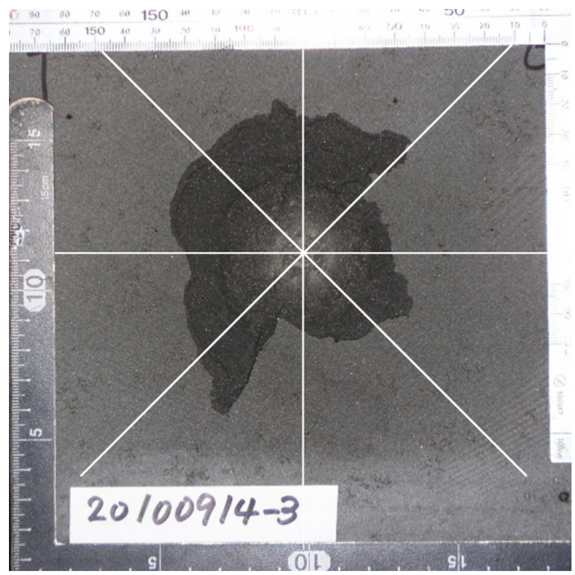

Fig 2. Method to measure the diameter.

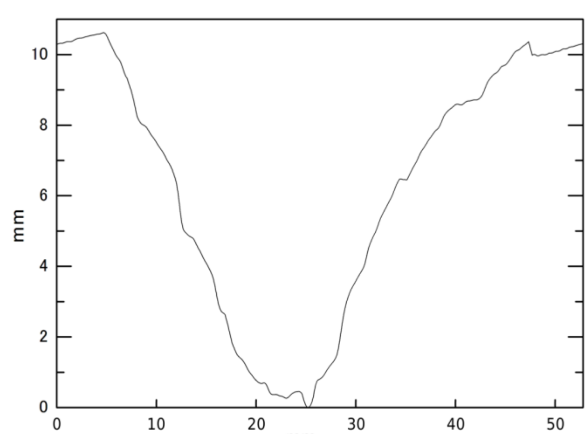

Fig 3. An example of crater profile.

However, it is impossible to define the boundary between the central pit and surrounding shallow spallation zone by the profile. Only the total volume, maximum depth from the original surface, and spallation diameter are analyzed in this paper, although to define the mechanism is important for scaling law.

As for diameters, depths, and volumes of craters formed by aluminum projectiles, the relations between the kinetic energy are expressed as follows :

$$D \propto E^{(0.45\pm0.07)} \tag{1}$$

$$d \propto E^{(0.34\pm0.10)} \tag{2}$$

$$V \propto E^{(1.12\pm0.28)} \tag{3}$$

where D is the diameter, d is the depth, V is the volume and E is the kinetic energy. Although the estimation error is large, the index of Eq. (3) is consistent with the classical scaling law in the strength regime that the crater volume is proportional to kinetic energy.

Measurements of 3-dimensional shapes and volumes of craters formed by stainless steel and nylon projectiles have not been completed.

Figure 4 shows the relationship between crater diameter and kinetic energy for all shots. There is an apparent dependence of diameter on projectile material. Preliminary analyses show the relations as

$$D \propto E^{(0.5\pm0.1)} \left(\frac{\rho_p}{\rho_t} \right)^{0.3} \tag{4}$$

where ρ_p and ρ_t are the density of projectile and target respectively.

The dependences of crater diameters on the kinetic energy and projectile/target density ratio expressed by Eq. (4) are consistent with the scaling law of previous studies [eg. 3]. However, further data in wide ranges of parameters are necessary for the establishment of scaling laws.

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References: [1] Lange, M. A. et al. (1984) *Icarus 58*, 383-395. [2] Polanskey C. A. and Ahrens T. J. (1990) *Icarus 87*, 140-155. [3] Holsapple K. A. and Schmitt R. M. (1982) *J. Geophys. Res. 87*, 1849-1870

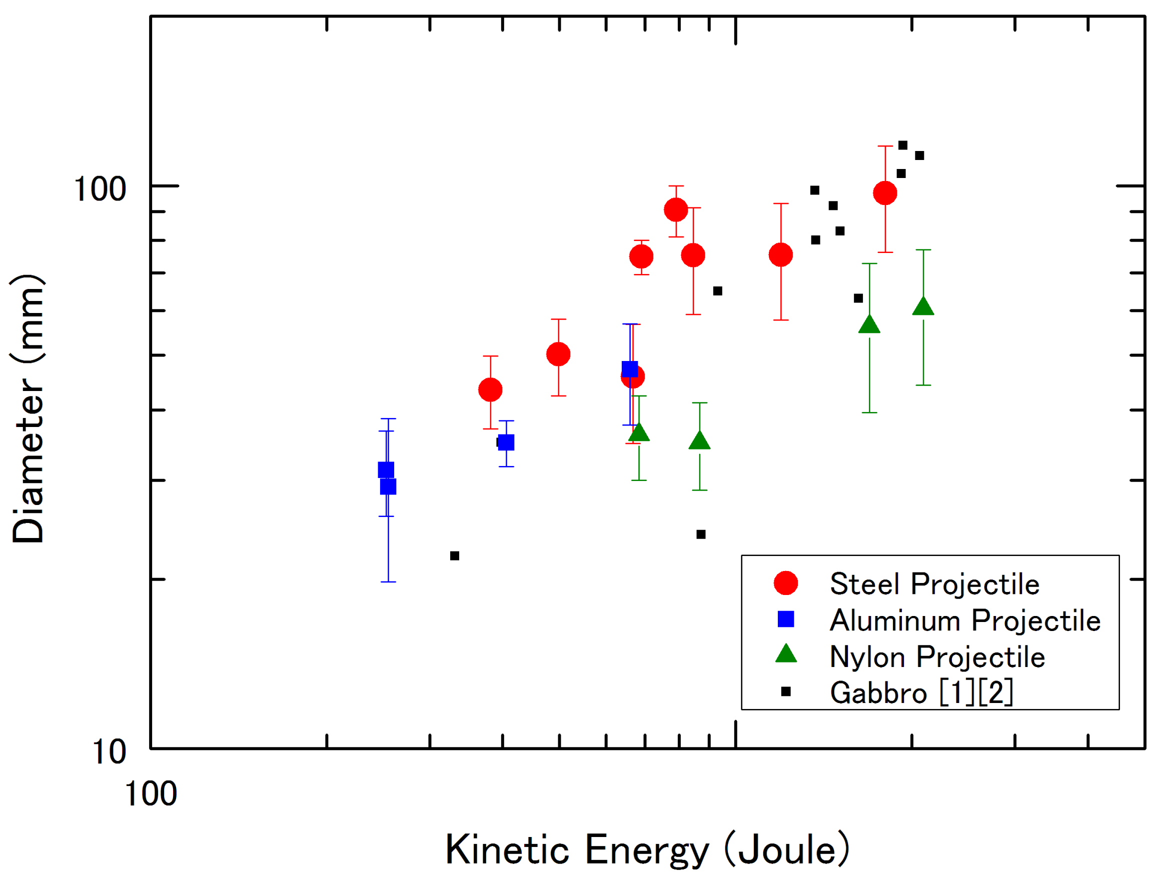

Fig 4. Relation of crater diameter to kinetic energy of impacts.