APPLICATION TO LARGE BLOCKS ON ASTEROID 25143 ITOKAWA: EJECTA MASS DISTRIBUTION WITH LOW VELOCITY FOR IMPACT CRATERING EXPERIMENT ON POROUS TARGET. T. MICHIKAMI[1] , K. MORIGUCHI[2] and R. NAKAMURA[2] . 1. Fukushima National College of Technology, Iwaki, Fukushima 970-8034, Japan ., (mitikami@fukushima-nct.ac.jp) , 2. ISAS, JAXA, 3-1-1 Yoshinodai, Sagamihara, Kanagawa, 229-8510, Japan.

The Hayabusa spacecraft will arrive at the asteroid 25143Itokawa in summer 2005. One of the biggest challenges at the arrival of Itokawa will be collecting the samples from the asteroid surface. However we do not know how many blocks there are on the surface. If there are many blocks larger than 1m, a minor collision might occur when the spacecraft touch down the asteroid surface. The blocks are produced during impact cratering, and only low velocity blocks can settle on the surface, because escape velocity from Itokawa is sub-meter per second. In order to examine the hazard that Hayabusa spacecraft collides with large blocks (>1m), it is necessary to estimate the number of large blocks, which have been ejected with low velocity during impact cratering.

There are very few experiments measuring the ejecta mass distributions with low velocity, because almost all ejecta are faster than 1m/s (e.g., [1], [2]). However, according to [3], there are many ejecta with lower velocities as long as the material strength of the target is small. As an example, in the case of one specific target (compressive strength 0.5MPa and porosity 43%), amount of ejecta with velocity lower than 1m/s is about 40% to the total ejecta mass. Recent observations demonstrated that asteroids have low densities and porous bodies. Therefore, if the result of the laboratory impact experiments is applied to the impact cratering on asteroid surface, many large blocks are likely to exist on the surface of Itokawa. In order to investigate the large blocks on Itokawa, impact cratering experiment was carried out and the ejecta mass distribution with low velocity was estimated.

We have produced well-characterized porous and weak target blocks by sintering soda lime glass beads of diameter 50μm and nominal density 2500kg/m^3. Cylindrical holes of 8.0cm in diameter by 4.0cm depth were drilled in a large blocks of graphite up to serve as a mold. The molds were filled up to the top level with the glass beads. The filled molds were heated gradually in an oven for 240min, after which the molds were cooled in an oven for 240min. Varing the oven temperature between 650C° and 750C°, we can obtain coherent, sintered target blocks with different porosities and strengths[3]. In this experiment, we have employed only one target with density 1421kg/m^3, porosity 43% and compressive strength 0.53MPa.

Impact experiment was carried out at a two-stage light-gas gun at ISAS, JAXA. An alumina projectile with density 3700kg/ m^3 was shot perpendicularly into the target surface at velocity 3.97km/s. The target embedded in an enclosed target holder of polystyrene foam, with one face exposed for the impact was mounted in a vacuum impact chamber. The pressure in the chamber was 67Pa. In this experiment, it was observed from the images of high-speed camera (2250 frames per second) that, most ejecta were ejected vertically from the target surface. A sheet was set on the floor in the extension chamber connected to target chamber, and is divided into several bins (see Fig. 1). The ejecta settle on this sheet due to gravity. The amount of ejecta in each bin was collected and measured up to the total length.

Figure 2 shows that almost all ejecta are distributed near the target surface and the amount of ejecta decreases with increasing the distance the between the fall point and the target surface. The velocities of some large ejecta could be measured, but most ejecta are too small to be observed from the images of high-speed camera. We estimated the ejecta velocity from the fall point distance. Because most ejecta are ejected vertically from the target, an ejecta velocity can be estimated in a simplified way by $v = L \sqrt{(g/2H)}$, where v is ejecta velocity, L and H are the distance between target surface and fall point, and height of the impact point respectively, and g is the gravity. The ejecta velocity shown in Fig.2 is proportional to the fall point distance. Figure 2 shows that there are a number of ejecta with very low velocities (<1m/s). Although this estimated value contains the errors arisen from the crater size, the width of bin and the variation of the ejection angle, the errors due to these is less than 20% from the analysis of images of high-speed camera.

The mass of the large ejecta (>0.002g) with low velocity (<1m/s) could be measured by directly collecting these. The resulting cumulative ejecta mass distributions are shown in Fig.3. The horizontal axis shows ejecta mass, and the vertical axis shows the cumulative number of ejecta mass. These ejecta are divided into three velocity ranges. Block points represent the sum of the three points. One can see that the ejecta mass distributions are similar and independent of velocities. In this experiment, it seems that the ejecta mass distribution is given by a power distribution $N(>m)=C\,m^{-2/3}$, where m is the ejecta mass and N is the cumulative number of ejecta having a mass larger than m. C is the coefficient and depends on the amount of total ejecta. The power distribution is compatible with the observed blocks size distribution on 433Eros[4]. The total number of ejecta and the number of large ejecta decreases with increasing the velocity. This result is consistent with past experiments ([5],[6]).

Here, we attempt to estimate the number of blocks larger than 1m on Itokawa, assuming that the blocks mass distribution is $N(>m)=C\ m^{-2/3}$. Most of large blocks on asteroid are produced during large impact cratering. In this paper, only one largest crater on Itokawa is considered for simplification. It is assumed that the largest crater radius (110m) is the ~60% of the mean radius (180m) of Itokawa. This is because the same percentages are observed on Eros and Mathilde. Total volume of this crater and total ejecta volume are assumed to be $(110)^3$ m^3. According to [7], the fraction of depositing ejecta mass to total ejecta mass depends on the material strength rather than its porosity. [7] have carried out the impact cratering experiments for targets with various compressive strengths (0.5-250MPa) in order to investigate the ejecta velocity distribution, and have estimated the fraction of depositing ejecta on asteroids. The material strength of a S-type asteroid Eros is estimated to be ~10MPa[8]. If the material strength of the same S-type asteroid Itokawa is similar to that of Eros, the fraction of depositing ejecta mass is estimated to be 0.5%[7]. That is, depositing ejecta volume and mass are $(110)^3\times0.005$ and $(110)^3\times0.005\times2500$ (density of Itokawa 2500kg/m^3 is assumed to be homogeneous), respectively. As the value integrating $N(>m)=Cm^{-2/3}$ over the whole mass is $(110)^3\times0.005\times2500$, $C=4.1\times10^4$ and the largest block mass = 8.3×10^6kg be able to determined. Assuming that the blocks are spheres, we predict the number of blocks larger than 1m is ~340. In conclusion, if there is the crater with radius 110m on Itokawa and the blocks produced by other crater is neglected, the number of blocks larger than 1m can be estimated to be ~340 on Itokawa.

References: [1] Gault, D.E. et al.,(1963) *NASA.Tech. Note,* D1767 [2] Housen, K.R.,(1992) *LPS XIII,* 555-556 [3] Michikami, T. et al., (2001) *Proc of the 34th ISAS Lunar and Planetary Sympo*, 107-110 [4] Thomas, P.C. et al.,(2001) *Nature 413*, 394-396. [5] Onose, N. and Fujiwara, A., (2004) *MAPS. 39*, 321-331 [6] Nakamura, A. and Fujiwara, A. (1991) *Icarus 92*, 132-146 [7] Michikami, T. (2001) *Ph.D.thesis, Univ.of Tokyo.*[8] Dombard, A.J. and Freed, A.M.(2001) *American Geophysical Union, Spring Meeting 2001*, abstract #P22B-02

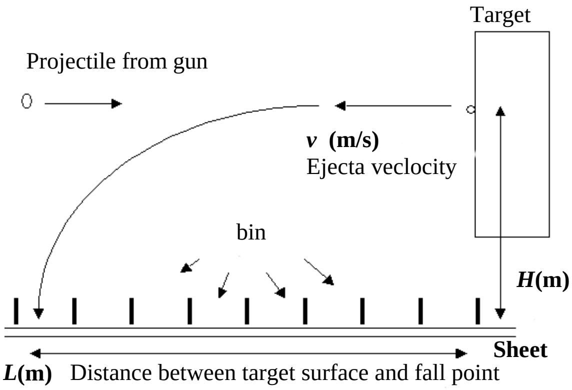

Figure 1. Configuration of experimental setup.

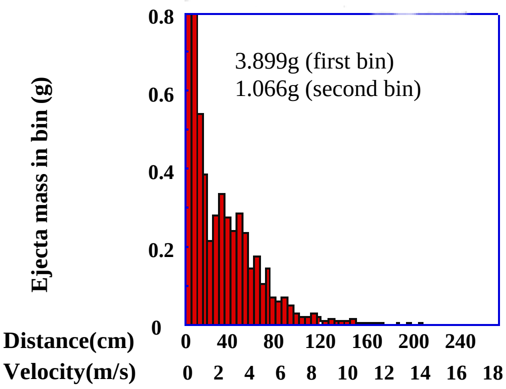

Figure 2. Collected ejecta mass. Vertical axis shows the collected ejecta mass in each bin. On horizontal axis, two different scales are shown. The top and bottom show the distance from target surface and the estimated ejecta velocity. Total ejecta mass is 8.769g.

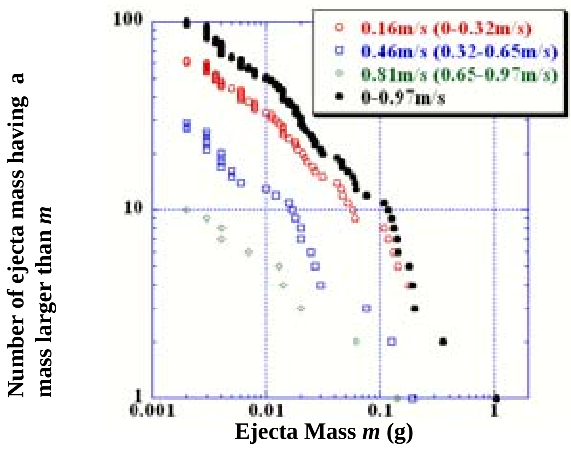

Figure 3. Ejecta mass distribution with low velocity (<1m/s).