Laboratory experiments of crater formation on basalt and dunite impacted at the velocity higher than 11 km/s

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High velocity impact experiments of crater formation on basalt and dunite have been conducted to study the origin of crater morphologies on the moon and other solid bodies. The impact velocity on the earth and the moon is usually higher than 11km/s, which corresponds to the earth's escape velocity. It has been theoretically studied that the impact velocity higher than 10km/s would cause the impact melting and vaporization for silicate material such as basalt and dunite, however laboratory impact experiments have been limited at the velocity less than 8km/s because there are no suitable acceleration methods for projectiles to be launched beyond 10 km/s.

Recently, Kadono et al. (2010) developed a novel method of the projectile acceleration beyond 10 km/s by using a strong laser beams in Osaka Univ. The laser system named Gekiko XII is used to launch a spherical projectile made of Al, Au, and Diamond. We used the same method to carry out impact cratering experiments on basalt and dunite. The cubic basalt and dunite with the size of 15 mm were set in a recovery box and the Al projectiles with the size of 100 and 250 μm were mainly impacted at the center of the target surface in the impact direction normal to the target surface. The impact velocity was from 9 to 61 km/s and the kinetic energy was from 0.1 to 4 J.

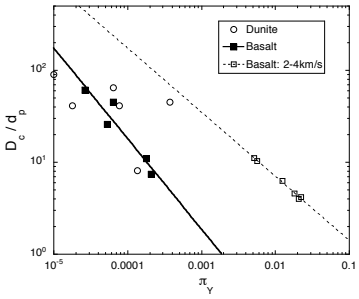

Fig. 1 D_c/d_p vs. π_Y

As a result, the relationship between the crater diameter and the impact condition is studied and compared with the previous studies. We adopted a scaling parameter in the strength regime to examine our results proposed by Holsapple and Housen (1990) in Fig.1. Our basalt and dunite results are well fitted by a power law equation of $D_c/d_p=0.002\pi_Y^{-1}$, where D_c and d_p are a crater diameter and a projectile diameter, respectively. This relationship is quite different from the previous result for basalt at the impact velocity below 4km/s. The crater efficiency in this high velocity impact above 10 km/s is rather lower than that in the low velocity impact; this drastic change might be caused by the impact melting and/or vaporization.