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Impact cratering experiments at transition between strength and gravity regimes

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Once diameter and depth of an impact crater are measured and a scaling law is applied, we can estimate the impact velocity, the size of the impactor, or the property of the target surface. Developing reliable scaling law is thus very important.
Strength and surface gravity are the two main factors of the surface that determine diameter and depth of craters. The regime where the influence of strength is larger than that of gravity is called "strength regime". On the other hand, the regime where the influence of gravity is larger than that of strength is called "gravity regime". When gravity is constant, strength of the surface determines the gravity-strength transition. However, any scaling law at the transition regime is not established.
In this experiment, we perform impact experiments in which we use sintered glass beads with various strength and granular glass beads as targets. We measured diameter and depth of final craters. The strength of the sintered targets is controlled by the sintering temperatures while the sintering duration is kept constant at 4 hours. Two types of glass-beads with particle size of 50 and 500 micron are used as granular targets. The shear strength of the smaller beads is larger. Soda-glass sphere of 1/8 inches is used as projectile. The impact velocity is about 240 m/s.
We determiend the depth / diameter ratio, and compared them to previous studies. As a result, we find they are separated into two groups. One group is consists of sintered targets whose depth / diameter ratio is about 0.5. The other group is mainly consists of granular targets whose ratio is about 0.14. The difference between these two groups is explained as follows. The group of the sintered targets (group of the larger shear strength targets) needs larger pressure for excavation and this larger pressure drives ejecta to outside of the crater. On the other hand, the group of the granular targets (group of the smaller shear strength targets) does not need large pressure, and thus the ejecta are not moved to outside of the crater and deposited inside of the crater, so the crater becomes shallower.
The dependence of the strength on the crater depth is not clear. The crater diameter of the sintered targets depends on strength while the crater diameter of granular targets does not clearly dependent upon the shear strength. Further experiments will be required in order to determine the transition between the two regimes.

Keywords: impact cratering, scaling low