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Size Dependence of Impact Disruption Threshold of Iron Meteorites

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Iron meteorites and some M-class asteroids are generally understood to be fragments that were originally part of cores of differentiated planetesimals or part of local melt pools of primitive bodies. On these primitive bodies and planetesimals, a wide range of collisional events at different mass scales, temperatures, and impact velocities would have occurred between the time when the iron was segregated and the impact that eventually exposed the iron meteorites to interplanetary space.

In this study, we performed impact disruption experiments of iron meteorite specimens as projectiles or targets at room temperature to increase our understanding of the disruption process of iron bodies. Our iron specimens (as projectiles or targets) were almost all smaller in size than their counterparts (as targets or projectiles, respectively), with one exceptional shot. Experiments of impacts of steel specimens were also conducted for comparison.

The fragment size distribution of iron material is different from that of rocks because in iron fragmentation, a higher percentage of the mass is concentrated in larger fragments, probably due to its ductility. The largest fragment mass fraction is dependent not only on the energy density but also on the size of the specimen. We show the largest fragment mass fraction has a power-law dependence to initial peak pressure normalized by a dynamic strength, which is defined to be dependent on the size of the iron material.

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Keywords: Small Bodies, Iron Meteorite, Impact Process