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The Impact Strength of Iron Meteorites

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INTRODUCTION

Iron meteorites and those asteroids which are believed to be metallic based on their high radar albedo are considered as fragments which were originally cores of differentiated planetesimals. According to radioisotopic age determination, iron-meteorite parent bodies were differentiated about 4.56 billion years ago, several My after CAI formation. Based also on the cosmic-ray exposure age, iron meteorites became to the present size by collisional disruption within 1.5 billion years. However, we have not known where iron-meteorite parent bodies formed, and when and where the collisional disruption occurred. Impact fragmentation experiments of cooled iron meteorites were carried out previously. However, recently, Bottke et al(2006) proposed a scenario that iron-meteorites parent bodies would have formed in the terrestrial planet region, and were scattered into the main belt. If iron -meteorite parent bodies stayed in terrestrial planet region when they were disrupted, they must had exhibited ductile behavior. Therefore, we conducted impact fragmentation experiments using iron materials, including iron meteorites, at room temperature in order to study collisional disruption of iron-meteorite parent bodies in the terrestrial planet region.

EXPERIMENTS

We performed impact experiments at two velocity regimes. In high?velocity impact experiments (~ 3.5km/s), we impacted several mm discs of steel, Mundrabilla iron meteorites, and Campo del Cielo iron meteorites onto serpentinite and dunite cubes. In low-velocity impact experiments (~1km /s) we impacted copper cylinders onto steel and Campo del cielo cylinders of 15mm in diameter and 15mm, 10mm, and 5mm in height.

RESULTS

All iron projectiles after the impacts were crashed and deformed. In case of rock, they were broken down into one remarkable largest fragment and many smaller fragments. While in this study, some of irons were disrupted radially and the fragments tended to have similar size. We examined the relation between the kinetic energy per unit iron mass, energy density, and mass fraction of the largest fragment to examine the impact strength Q^*. Q^*we estimated in this study is about twice of cooled iron meteorite, $7*10^8$(erg/g) derived in previous study. We also found that the ratio of largest fragment mass changed significantly with energy density. The disruption threshold in the initial peak pressure was different between the two experiments. The difference is due to impact materials as well as polycarbonate sabots attached to projectiles in high-velocity experiments. Further high velocity disruption experiments without the sabots are required.

Keywords: iron meteorite, impact, disruption, experiment