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Early impact events on differentiated protoplanets: Evidence from basaltic achondrites

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Impact events are a ubiquitous geological process on planetesimals and protoplanets, evidenced by the presence of shock and brecciated textures in asteroidal meteorites. However, evidence for early impact events were obliterated by overprints of later thermal events such as volcanism and thermal metamorphism. We investigated early impact events in these meteorites on the basis of mineralogical and geochemical data.

At present, there are ˜5 eucrites which were derived from distinct protoplanets. An anomalous eucrite, Ibitira, is a strongly recrystallized rock. Low-Ca pyroxene shows homogeneous compositions, indicating that these rocks experienced prolonged thermal metamorphism (˜900-1000 C), as did most basaltic eucrites. The presence of unequilibrated pyroxenes related to oxide grains can be explained by short reheating event (and partial melting) and rapid cooling. Normal eucrites, EET 90020 and Y 86763, and a cumulate eucrite Moore County seem to have experienced a similar history. Most likely explanation for this thermal history is that they were excavated by impact from hot interior.

Anomalous cumulate eucrites Dho 700 and EET 92023 are medium-grained granular rocks similar to cumulate eucrites. Anomalous basaltic eucrite, NWA 011 shows a recrystallized texture. These rocks are crystalline (unbrecciated) but contain significant amounts of impactor materials. Dho 700 and EET 92023 contain taenite which is not common in pristine eucrites. The high abundances of siderophile elements are explained by addition of ˜1% iron meteorites. Thus, these rocks experienced impact event before or during crystallization and thermal metamorphism.

All anomalous eucrites studied here show crystalline textures, but have evidence for impact melting or brecciation before thermal events. These meteorites record early collisional history possibly during the stage of runaway growth.