Petrologic evidence for early impact events inferred from differentiated achondrites

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Eucrites, grouped in the HED meteorites are the largest group of differentiated achondrites. There are several achondrites petrologically similar to eucrites but were derived from distinct sources. Detailed petrologic and geochemical studies of such asteroidal achondrites provide better understanding of early igneous, thermal and impact histories of differentiated planetesimals. We report petrology and geochemistry of achondrites, EET 92023 and Dho 007. Oxygen isotopic compositions of these meteorites are significantly shifted away from the eucrite fractionation line. EET 92023 is an unbrecciated achondrite whereas Dho 007 is a polymict breccia mainly composed of medium to coarse-grained granular clasts. These achondrites are mainly composed of low-Ca pyroxene and plagioclase, petrologically similar to normal cumulate eucrites. However, these rocks contain significant amounts of kamacite and taenite not common in unbrecciated, crystalline eucrites. EET 92023 and Dho 007 contain significant amounts of platinum group elements (PGEs) (~10% of CI), several orders of magnitude higher than those of monomict eucrites. We suggest that the metallic phases carrying PGEs were incorporated by projectiles during or before igneous crystallization and thermal metamorphism. The projectiles were likely to be iron meteorites rather than chondritic materials, as indicated by the lack of olivine and the presence of free silica. Therefore, the oxygen isotopic signatures are indigenous, rather than due to contamination of the projectile materials with different oxygen isotopic compositions. A significant thermal event involving metamorphism after the impact event indicates that EET 92023 and Dho 007 record early impact events which took place shortly after the crust formation on a differentiated protoplanet when the crust was still hot.

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