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小惑星ベスタにおける大規模衝突：ダイオジェナイトからの岩石学的証拠
Basin forming event on Vesta: Petrologic evidence from a diogenite, NWA 5480

山口 亮 [1*] ; Barrat Jean-Alix[2] ; 白井 直樹 [3] ; 海老原 充 [3]
YAMAGUCHI, Akira[1*] ; BARRAT, Jean-alix[2] ; SHIRAI, Naoki[3] ; EBIHARA, Mitsuru[3]

[1] 国立極地研究所, [2]Universite Europeenne de Bretagne, U.B.O.-I.U.E.M., [3] 首都大学東京
[1]National Institute of Polar Research, [2]Universite Europeenne de Bretagne, U.B.O.-I.U.E.M., [3]Tokyo Metropolitan University

The HED (Howardite, Eucrite, Diogenite) meteorites are the largest group of achondrites, and are derived from the regolith and crustal lithologies of asteroid 4-Vesta, which is the only surviving differentiated protoplanet in the Solar System. Diogenites are considered to have been derived from intrusions from within the curst or from a deep global layer. Some of them display high levels of platinum group element (PGE) concentrations that have been attributed to impact events on the parent body.

NWA 5480 is an unusual olivine diogenite. It has a heterogeneous crystalline texture. Irregular and subrounded clasts of dunite and fragments of olivine and chromite are set in an igneous matrix mainly composed of Low-Ca pyroxene. In some cases, large dunite clasts are intersected by pyroxene matrix. Flow textures are observed near some clasts. Olivine, chromite, and pyroxene show minor chemical zoning, implying relatively rapid cooling compared to typical diogenites. NWA 5480 contains a significant amount of PGE (CI x ˜0.001 for Ir) with chondritic relative proportions. All these line of evidence support that NWA 5480 is an impact melt breccia from a target composed of olivine and pyroxene-rich lithologies.

Upon heating of olivine diogenites, low-Ca pyroxene is the earliest phase to melt, and olivine and chromite are the last at >˜1600 C. The irregular and rounded shape resulted from resorption, and pyroxene veins and flow textures formed by violent mixing during impact melting. The pyroxene matrix crystallized from impact melts. Cooling rates estimated from the shape of Ca zoning of profiles near the rims in olivine fragments could be several tens of C/year, corresponding to burial depths less than a few km in impact melt sheet. An impact crater with diameter >a few hundreds km would be needed to produce impact melt sheet >a few km in thickness. Thus, we suggest that NWA 5480 was derived from impact melts from a very large crater of Vesta. The bulk chemical compositions indicate that the target was an area where olivine and orthopyroxene-rich rocks are largely exposed. However, there are no such areas on Vesta except minor olivine spots. Thus, it is likely that NWA 5480 sampled a part of large impact melt sheet (>a few km thick) formed by melting of deep crustal materials rich in olivine and orthopyroxene. One of the best candidates is the Rheasilvia basin (˜500 km diameter), where orthopyroxene-rich materials were observed in the crater floor.

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