Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PPS22-26 会場:A02 時間:5 月 28 日 17:45-18:00

始原的エコンドライト隕石 NWA 6704 の鉱物化学的研究
A mineralogical and chemical study of primitive achondrite NWA 6704

日比谷 由紀[1*] ; 小澤 一仁[2] ; 飯塚 毅[3] ; 山口 亮[4]
HIBIYA, Yuki[1*] ; OZAWA, Kazuhito[2] ; IIZUKA, Tsuyoshi[3] ; YAMAGUCHI, Akira[4]

[1] 東京大学, [2] 東京大学, [3] 東京大学, [4] 国立極地研究所
[1]The University of Tokyo, [2]The University of Tokyo, [3]The University of Tokyo, [4]National Institute of Polar Research

Introduction: Primitive achondrites provide unique insights into the early stage of growth and differentiation of planetesimals. Northwest Africa (NWA) 6704 is an ungrouped primitive achondrite found in Algeria in 2010. This meteorite is composed mainly of low-Ca pyroxene, olivine, feldspar, chromite, awaruite, heazlewoodite, pentlandite, and whitlockite. The U-Pb dating of this meteorite shows the crystallization age of 4563.75 $\pm$ 0.41 Ma (1). To better understand the formation process of this primitive meteorite, we carried out a mineralogical and chemical study of NWA 6704 using SEM-EDS, EPMA and LA-ICP-MS.

Results & Discussion: Seven polished thin sections (TS-1~7; 10$\times$18mm; 10$\times$20mm; 9$\times$10mm; 10$\times$12mm; 10$\times$11mm; 15$\times$28mm; 19$\times$28mm) have been investigated. The texture is best characterized by the existence of many orthopyroxene (Opx) megacrysts up to 1.56 cm in length ($Fs_{40-42}En_{53-57}Wo_{3-4}$). Olivine ($Fa_{50-53}$) typically occur as interstices associated with feldspar and have subhedral shapes, but locally occur as the vermicular olivine within the Opx. The vermicular olivine share the same optical extinction position under crossed-nicols and occurs only in one place near the center of each Opx crystal if present. Feldspar ($Ab_{91-93}An_{5-6}Or_{2-30}$) occurs in the Opx and the interstices as anhedral cuspate grains with extremely low dihedral angles and sharing the same optical extinxtion position over up to 1cm, which implies that it's pseudomorph of a melt-filled interstitial pore. Other phases include chromite (Cr# = 0.90-0.96) and awaruite (78-81 wt% Ni) also occur associated with feldspar. We estimated fO_2 of FMQ -2.6 using the Olv-Opx-Spl oxygen geobarometer (4).

The texture is properly represented by aggregate of large Opx hollow (skeletal) megacrysts with finer interstices. Other phases such as olivine are present in the hollow cores, and some of them are isolated from the interstices. The contiguity of feldspar in the Opx megacrysts with or without olivine in three dimensions is clearly demonstrated by the fact that the same optical extinction position are shared by feldspar isolated in the megacrysts and those present in the interstices. The distribution of the Opx hollow crystal and the vermicular olivine are highly heterogeneous. In TS-1 and TS-6, Opx $<$6.2 mm across are dominant and more than five of them include vermicular olivine; in TS-2~5 and TS-7, Opx megacrysts up to 1.56cm across are common and only a few of them contain vermicular olivine. The vermicular olivine may be a decomposition product of the precursor pyroxene through the abrupt heating ($>$1400 ℃). There is a negative correlation between size of Opx and the number of vermicular-olivine bearing Opx. Given this fact, a new scenario can be derived: this vermicular olivine and its host acted as nuclei for crystallization of hollow Opx crystals, and the number of nuclei limits the size of Opx. Thus, more nuclei in a given area result in smaller grain size as seen in TS-1,6. The abnormally large size of Opx and its hollow morphology indicates that the initial crystallization occurred under rapid cooling. The SEM images, however, show that some pigeonite contain sub-micrometer-size augite ($Fs_{17}En_{45}Wo_{39}$) exsolution lamellae. We estimated equilibrium temperatures of 1050 ℃ using two-pyroxene geothermometry (3) and of 773 ℃ using Olv-Spl $FeMg_{-1}$ exchange thermometry (4). The cooling rate between 1100-950 ℃ was estimated to be ~0.02 ℃/hr from the thickness and wavelength of multiple exsolution lamellae (5), indicating significant decrease in cooling rate at a later crystallization stage. The inferred thermal history suggests high internal temperature of the parent planetesimal due to ^{26}Al decay, which was abruptly heated by impact followed by rapid cooling up to the ambient temperature to sustain slower cooling.

References: (1) Iizuka et al. (2013), (2) Warren et al. (2012), (3) Lindsley & Andersen (1983), (4) Ballhaus et al. (1991), (5) Jackson (1961)

キーワード: 始原的エコンドライト, NWA6704
Keywords: Primitive achondrite, NWA6704