Petrology and mineralogy of Northwest Africa 7397 lherzolitic shergottite

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Martian meteorites are important samples in order to understand geologic process on Mars. Shergottite, which is the largest group among Martian meteorites, is divided into three groups based on their petrologic and mineralogical features; i.e., basaltic shergottite, olivine-phyric shergottite, and lherzolitic shergottite. The petrologic and mineralogical features of lherzolitic shergottites are similar each other. In addition, their crystallization and exposure ages are also identical each other. Accordingly, it is widely accepted that lherzolitic shergottites share the same original source on Mars, and were probably ejected by the same impact event, and finally fell on the Earth as separate falls [1]. The major object of this study is to describing the detail petrographic and mineralogical characteristics of a newly found lherzolitic shergottite, Northwest Africa 7397 (NWA 7397).

A polished thin section of NWA 7397 was prepared for this study. A field-emission scanning electron microscope (FE-SEM) was employed for detailed textual observations. The chemical compositions of individual minerals were determined with an electron probe micro-analyzer (EPMA). Phase identification of the minerals was conducted using a laser micro-Raman spectrometer.

Our FE-SEM observations and EPMA analyses reveal that the petrologic and mineralogical features of NWA 7397 are similar with other lherzolitic shergottites. NWA 7397 shows two areas with poikilitic and non-poikilitic. In the poikilitic area, coarse-grained pyroxene oikocrysts enclose olivine (< ~500 μm) and chromite (< ~150 μm) grains. In the non-poikilitic area, the major constituents are olivine, pyroxene, and plagioclase (now maskelynite), with minor chromite, ilmenite, alkali feldspar, Ca-phosphate, and Fe-sulfide. Pyroxenes in the poikilitic area are chemically zoned from core ($En_{71}Fs_{25}Wo_4$) to rim ($En_{65}Fs_{25}Wo_{10}$). Most pyroxenes in the non-poikilitic basaltic area are pigeonite with small amount of augite. Olivine in the non-poikilitic area (Fa_{38-40}) is more Fe-rich than that in the poikilitic area (Fa_{29-37}). NWA 7397 may have originally been located at a shallower level within the lherzolitic shergottite igneous block because Fe contents in the olivine are higher than those in other lherzolitic shergottites. Several melt-pockets were observed in the non-poikilitic area. The existences of maskelynite and melt-pockets are obvious evidences for an impact event occurred on Mars. Some plagioclase entrained in the melt-pockets dissociate into CAS + stishovite. This is the first report of CAS and stishovite from lherzolitic shergottites. Based on the phase diagram of basaltic composition [2], the pressure and temperature conditions recorded in the melt-pocket are estimated to be ~25 GPa and 2300-2500 °C. Olivine around the melt-pockets probably dissociated into bridgmanite + magnesiowüstite. The bridgmanite would have back-transformed to glass due to residual heat during adiabatic decompression.

References

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