PETROGENESIS ON MILLER RANGE 090032: COMPARISON WITH OTHER MARTIAN METEORITES

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Introduction: Evidences of aqueous alteration such as iddingsite veins on olivine grains are reported on nakhlite group Martian meteorites [1-3]. Such secondary altered veins are also found in Miller Range (MIL) 090032 nakhlite [4]. Hallis et al. [4] conducted detailed transmission electron microscopic works and suggested that the veins were formed either under Mars (iddingsite, Fe-smectite phyllosilicate) and terrestrial (jarosite, gypsum, amorphous silicates, Fe-oxides and hydroxides) conditions. Terrestrial alteration products occurred at the edge of meteorite block and exposed to terrestrial condition. Therefore, alteration products on nakhlite and surrounding materials are important to understand the petrogenesis of nakhlites. Here we report comparison of MIL 090032 and other martian meteorite (shergottites) and discuss petrogenesis of martian meteorites.

Sample and method: A thin section of MIL 090032 allocated from the Meteorite Working Group was observed under an optical microscope. Scanning electron microscope observation has conducted at the Chiba Institute of Tech-nology using a JEOL JSM-6510LA. Electron microprobe analyses were performed on a JEOL JXA-8900 at the Uni-versity of Tokyo.

Results: MIL 090032 consists of orthopyroxene, olivine, fine-grained mesostasis include dendritic minerals and glassy materials. Shock feature is minor and found small shock vein. Pyroxene grains show euhedral shape with size of 300 µm to over 1mm and remain igneous chemical zoning, core of the grains is homogeneous and rich in Mg ($En_{38}Fs_{21}Wo_{41}$) relative to Fe-rich rim ($En_{10}Fs_{58}Wo_{32}$). Olivine grains show subhedral to anhedral shape with size of over 1mm. Olivine grains also remain chemical zoning, core of the grains is homogeneous with Mg-rich composition ($Fo_{44}Fa_{56}$) relative to Fe-rich rim ($Fo_{16}Fa_{84}$). Mesostasis of the rock composed of dendritic spinel, SiO_2-rich material, and glassy materials. Round-shape, SiO_2-rich material could be relict of primary mineral.

Alteration veins are ubiquitous in olivine grains. Some veins show two-layer structure; an outer layer is enriched in Cl than the inner layer (Fig.1). These veins are cross cutting olivine grain, but do not continue to be surrounding other minerals such as pyroxene.

Discussion and summary: Zoning trends in pyroxene and olivine grains are consistent with normal igneous process and could be a two-stage magmatism, residence in a deep magma chamber and following rapid cooling. We did not observe a reverse zoning trend in MIL 090032. Zagami and Larkman Nunatak 12011 shergottites [5-7] show a reverse zoning, possibly indicating a magma mixing or crustal assimilation. Rim of pyroxene grains in MIL 090032 have Fe- and Ca-rich compositions which close to hedembergite. This trend also indicates that MIL 090032 solidified rapidly. The texture is similar to that of Olivine-rich lithology of Zagami which intruded into Normal Zagami. The difference is that Zagami contains more evolved materials such as fayalite (Fa_{97}) [5]. MIL 090032 does not show any intrusive structure or chemical zoning trend, suggesting magma mixing or crustal assimilation is less plausible. MIL 090032 experienced minor aqueous alteration interact with volatile-rich (Cl) fluid after crystallization.

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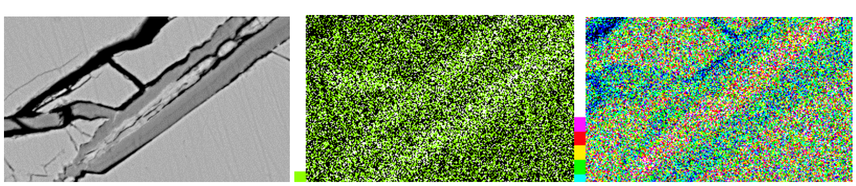

Figure 1. Alteration veins in olivine grain. Outer layer contains Cl and is poor in Fe. (left backscatter electron image, middle, Cl distribution, right: Iron distribution.