Petrography and formation process of Martian breccia meteorite NWA 7034

Kei Nozu[1], *Shin Ozawa[2], Eiji Ohtani[2]

1.Department of Earth and Planetary Materials Science, School of Science, Tohoku University, 2.Department of Earth and Planetary Materials Science, Graduate School of Science, Tohoku University

NWA 7034 and its pairings were identified as Martian regolith breccia meteorites. Some minerals in these meteorites have chemical compositions similar to those in SNC meteorites and Martian soil. In this study we analyzed the textures and chemical compositions of this meteorite, and considered its formation process.
NWA 7034 meteorite is a polimict breccia composed of various clasts and fine-grained matrix. We divided the clasts into six groups, such as igneous clast, monomineralic clast, proto-breccia clast, Group X clast, Group Y clast and melt clast.
I) Igneous clast is composed of multiple minerals (plagioclase, pyroxene, magnetite, ilmenite and others), and have ophitic and glanular textures similar to those in Martian igneous rocks. The clast size is 40 μm~1 mm, and most mineral grains are 10–50 μm. Chemical composition of pyroxene resembles that in SNC meteorites. Based on the texture and chemical composition of minerals, we concluded the igneous clasts originated from Martian igneous activity.
II) Monominaralic clast is a fragment of feldspar, pyroxene, apatite, magnetite and ilmenite. The size of the fragments are mostly <100 μm. Plagioclase and pyroxene clasts have various chemical compositions, and some clasts have exsolution textures. This clast may be fragments of other clast groups such as an igneous clast based on the similarity of their chemical compositions.
III) Proto-breccia clast is composed of fine and elongated crystals (<1 μm), and subhedral crystals (<100 μm). Both crystals are mainly plagioclase, pyroxene and magnetite. The clast size is 340 μm~1.8 mm. We consider these are the breccia formed before NWA 7034 breccia formation, and it was partially melted and quenched by impact or other processes.
IV) Group X clast is composed of two or three crystals, but they don't interlock like igneous clasts. The clast size is 40 μm~1 mm. Constituent minerals are plagioclase, pyroxene, apatite, magnetite and ilmenite. On the basis of the texture and constituent mineral assemblages, we considered these clasts are fragments of igneous clasts.
V) Group Y clast is fine-grained pyroxene (<10 μm) aggregate with plagioclase rim. These clasts are 70–580 μm in size, and have various forms (amoeboid, spherical and so on). Some clasts contain magnetite inside. This clast is also included in proto-breccia clasts.
VI) Melt clast has a spherical shape and its diameter is 3 mm. The clast contains olivine dendrites. The length of the olivine dendrites are 1 mm at the center, and 150–200 μm in the margin. As unique nature, it has three-layered rims. The innermost rim contains needle-like pyroxene crystals (50–150 μm long). Mg# of these pyroxene is higher than that of olivine in the main body. The middle rim contains Na-rich plagioclase crystals that have similar size and shape with pyroxene in the innermost rim. Some olivine, pyroxene and plagioclase crystals are partly joined and form a single acicular crystal aggregate. The outermost rim is composed of fine-grained (<1 μm) plagioclase, pyroxene and Fe-oxide. In terms of the spherical shape and the existence of olivine dendrite, this melt clast is formed by a similar process with that of chondrules (i.e., rapid quenching from a melt droplet). The two rims that contain needle-like pyroxene and plagioclase crystals might have formed at the time of secondary heating. The mineralogy of the rim is different from any of chondrules in meteorites.
VII) Matrix fills the space between the clasts, and is composed of mineral fragments (several to 10

μm in diameter) and fine-grained minerals (<1 μm). Constituent minerals are plagioclase, pyroxene, apatite and magnetite.
As summarized above, NWA 7034 breccia meteorite contains various clasts that formed by fracturing, brecciation and melting of Martian igneous rocks. The formation age and formation environment of each clast would be different, and some clasts experienced brecciation at least twice.

Keywords: Martian meteorite, regolith breccia, melt spherule

