Petrography of a new polymict ureilite from Antarctica, Yamato 983890.

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Introduction:

Ureilites are the second largest group of achondrites. They are classified into two major types: monomict and polymict. More than 90 % of ureilites are classified as monomict ureilites [1]. They are unbrecciated ultramafic rocks with coarse-grained igneous textures [2]. On the other hand, polymict ureilites are relatively rare with only 23 individual meteorites [1]. They are breccias consisting of lithic clasts and mineral fragments from various kinds of meteorites [3–6]. They are thought to represent regolith formed on the surface of ureilite parent bodies. Polymict ureilites provide important information on the origin and impact history of the ureilite parent bodies, which cannot be extracted from monomict ureilites.

Yamato (Y-) 983890 is a recently classified polymict ureilite. It was corrected as a 10.79 g stone from Yamato Mountains, Antarctica in 1998. We conducted petrographic observations on Y-983890. Here, we will present our preliminary results on the petrography of the new polymict ureilite.

Observational and analytical methods:

We investigated a polished thin section of Y-983890, 50-1 that was made for its initial classification. Petrological and mineralogical textures of the sample were observed with an optical microscope (OM) Nikon ECLIPSE LV100POL and a scanning electron microscope (SEM) JEOL JSM-5900LV. Chemical compositions of the constituent minerals were determined by using an electron probe micro analyzer (EPMA) JEOL JXA-8200 and an energy-dispersive X-ray spectrometer (EDS) equipped with the SEM.

Results:

Y-983890 consists of lithic clasts and mineral fragments that represent a variety of lithologies. Most of them are monomict ureilite-like clasts/fragments but others are non-monomict ureilite-like ones.

Monomict ureilite-like clasts/mineral fragments

Most of the lithic clasts and mineral fragments in Y-983890 are compositionally and texturally similar to monomict ureilites. The monomict ureilite-like clasts/mineral fragments consist of coarse-grained (up to 1 mm) olivine and/or pyroxene with interstitial dark carbonaceous materials and/or graphite. Olivine has a chemical composition of $Fo_{74–96}$ with high CaO (0.26–0.46 wt%) and Cr_2O_3 (0.47–0.91 wt%) contents, which is characteristic feature of olivine in monomict ureilites. Pyroxene is mainly pigeonite ($En_{72–87}Fs_{8–17}Wo_{5–11}$) and orthopyroxene ($En_{79–85}Fs_{10–17}Wo_{2–5}$), but minor augite ($En_{55–64}Fs_{1–6}Wo_{33–39}$) is also present. Olivine and pyroxene have reduction zone along grain margins or fractures. In these zones, olivine and pyroxene are reduced to nearly FeO-free compositions and low-Ni Fe metal is precipitated.

Feldspathic clasts

Since monomict ureilites do not contain feldspar, lithic clasts containing feldspar are considered to be of non monomict-ureilite origin. We identified four distinct clasts containing feldspar. Each of them shows different igneous textures and chemical compositions of constituent minerals (feldspar and pyroxene) are also different in each clast. Most feldspar has albitic composition ($Ab_{80-87}An_{6-20}Or_{3-8}$), but more An-rich one ($Ab_{55}An_{45}Or_{6}$) is also present in a clast. Pyroxene is mostly augite ($En_{40-62}Fs_{0-39}Wo_{21-38}$) and some clasts contain enstatite (En_{100}, $En_{67}Fs_{29}Wo_{4}$) and pigeonite ($En_{38}Fs_{48}Or_{15}$). The size of these clasts is a few hundred micrometers in diameter.

Sulfide-rich clasts

Some large (up to a few hundred micrometers in diameter) sulfide-rich clasts are scattered about the thin section. Most of them are composed of only pyrrhotite ($Fe_{0.9}S$) but some contains idiomorphic or rounded olivine (Fo_{54}) and/or magnetite.

Dark clasts (carbonaceous chondrite-like)

Y-983890 contains many (more than five) dark clasts. They are rounded or interstitial in shape and their size ranges from a few hundred micrometers to more than 1 mm in diameter. They mainly consist of fine-grained phyllosilicate-rich matrices with variable amounts of opaque minerals such as magnetite and sulfides. Magnetite occurs as spherical or framboidal grains, or as irregular aggregates. Sulfides such as pyrrhotite and pentlandite occur as euhedral idiomorphic crystals or polycrystalline aggregates. Some pyrrhotite aggregates contains phosphate grains (probably apatite). Some dark clasts contain exotic mineral fragments such as olivine ($Fo_{78–84}$) and pigeonite ($En_{79}Fs_{10}Wo_{10}$). These dark clasts resemble the matrices of CI carbonaceous chondrites.

Chondrule or chondrite fragment

A chondrule or chondrite fragment was identified in Y-983890. It shows the barred olivine chondrule texture, consisting of barred olivine crystals ($Fo_{79–82}$) with interstitial devitrified mesostasis with albitic composition ($Ab_{83}An_{9}Or_{9}$). The size of the fragment is ~170 µm in diameter.

Mineral fragments of non-monomict ureilite origin

Some mineral fragments seem to be non-monomict ureilite origin. That includes ferroan olivine (Fo_{61-68}), highly-magnesian olivine (Fo_{97}) and enstatite (En_{100}), and albitic plagioclase ($Ab_{90}An_{10}$)

Lithic clasts and mineral fragments in Y-983890 described above are mostly similar to those of other polymict ureilites such as DaG 319 [3-6]. Y-983890 would originate from similar environment with other polymict ureilite such as regolith on the surface of the ureilite parent bodies. However, since this is the first discovery of polymict ureilite from Yamato Mountains, Antarctica, it is likely that Y-983890 is not paired with other previously found polymict ureilites

References:

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