A unique amoeboid olivine aggregate in Y-86009 CV3 chondrite.

Mutsumi Komatsu[1]; Takashi Mikouchi[2]; Tomoko Arai[3]; Masamichi Miyamoto[4]

[1] Univ. Museum, Univ. of Tokyo; [2] Dept. of Earth & Planet. Sci., Univ. of Tokyo; [3] Univ. of Tokyo; [4] Space and Planetary Sci., Univ. of Tokyo

Introduction

Amoeboid olivine aggregates (AOAs) are important refractory components of carbonaceous chondrites (except CH and CB chondrites) and have been interpreted to represent solar nebular condensates that largely escaped melting, but experienced high-temperature annealing [1].

Y-86009 is a Bali-type oxidized CV3 chondrite which experienced hydrous alteration. In previous study, we have found that an AOA in Y-86009 has an unusual texture [2]. Here we describe the detailed mineralogical characteristics, and propose a formation history of the unique AOA in this meteorite.

Mineralogy and petrography

A unique AOA in Y-86009 is a porous aggregate composed of fine-grained olivine (Fo_{92-99}), Al-diopside associated with spinel (FeO 2-6 wt.%), and anorthite. Most anorthite grains are replaced by fine-grained Al-bearing phyllosilicates. The olivine shows an enrichment in FeO toward the grain boundaries, in contact with phyllosilicates. Some olivine grains are overgrown by euhedral pyroxenes ($Wo_{41}En_{56}Fs_3$, about 10 microns in size) along the AOA rim. This pyroxene has higher contents of MnO and Cr2O3 (-1.9 wt.%) than those in Al-diopside in the AOA interior, indicating that they have different origin. Based on the mineralogy of AOA and other components in Y-86009, it is likely that AOAs in Y-86009 were originally similar to those in reduced CVs, and subsequently experienced a low-temperature aqueous alteration.

The most characteristic feature of this AOA is that an unusual feldsparhic phase is present associated with the AOA. The feldspathic phase, ~100 micron in size, has a homogeneous composition similar to anorthite, but with high FeO (FeO; 8.1 wt.%). EBSD (Electron-back scattering diffraction pattern) study shows that the phase is probably a glass. Porous enstatite (Wo_7En_{91}), Al-diopside, and a silica-rich phase, which contains minor Mg and Al, are enclosed in the feldspathic phase.

Discussion

The amorphousness of feldspathic phase suggests that it experienced melting and rapid cooling. Because thermal effects in the parent body are limited to alteration at relatively low temperatures of less than 500 ^{o}C [e. g., 3], and a clear boundary is present between the feldspathic phase and the matrix, the heating event to generate the feldspathic phase can be separated from the alteration process on a parent body.

Two possible scenarios for the origin of the feldspathic phase are considered.

(i)Thermal processing of a single AOA.

Thermal processing after the AOA formation is largely accepted from the study of primitive AOAs [e.g., 3]. However, the occurrence of the feldspathic phase (it exists interstitially within the AOA clumps, also around the AOA) and a modal abundance of general AOAs indicate that the feldspathic phase was unlikely formed by heating of a single AOA.

(ii)The collision of AOA and exotic Ca,Al-rich phase. Another possibility is that the fragments of Ca, Al-rich phase were somehow incorporated to the AOA, and the mixtuire material experienced rapid cooling. The precursor of the feldspathic phase can be a Ca, Al-rich phase, such as the fragments of anorthite or melilite in CAIs or mesostasis in chondrules. The collision and heating event may have affected the original AOA, resulting in the formation of low-Ca pyroxene by reaction between forsterite and gaseous SiO [3]. The presence of Al-diopside found in the feldspathic phase may indicate that Al-diopside in AOA survived this thermal processing.

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