Mineralogical studies of amoeboid olivine aggregates in the oxidized CV chondrite Y-86009.

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Introduction: The CV (Vigarano-type) chondrites are mineralogically diverse group of meteorites, which are divided into reduced and two oxidized subgroups, is Allende-like and Bali-like[1,2] , which largely reflect their complex alteration history [e.g., 3]. 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 experienced high-temperature annealing, but largely escaped melting [4]. Because AOAs are composed of fine-grained minerals (forsterite, anorthite, spinel) that are easily modified during postcrystallization alteration, their mineralogy can be used as a sensitive indicator of metamorphic or alteration processes. In order to understand the alteration history of the CV chondrites, we performed mineralogical studies of AOAs in the Yamato-86009 oxidized CV carbonaceous chondrite.

Results: Y-86009 consists of chondrules (53 vol%), AOAs (2 vol%), Ca-Al-rich inclusions (1 vol%) and fine-grained matrix (43 vol%) with isolated mineral fragments (1 vol%). In chondrules, anorthite-normative mesostasis is partly replaced by Al-bearing phyllosilicates. AOAs are commonly surrounded by accretionary rims (˜20-micron thick) dominated by fine-grained fayalitic olivine (Fa10-40).

AOAs in Y-86009 are irregularly-shaped objects composed of anhedral, fine-grained olivines (Fo96-99), Al-diopside, and spinel (FeO 2-6 wt%). Anorthite is rare; it is largely replaced by fine-grained Mg, Al-silicates, which although are too small to be analyzed by EPMA, appear to be similar in BSE images to phyllosilicates described in the Mokoia CAIs [3]. Anhedral grains of Ca-Fe-rich pyroxene occur along grain boundaries. In some AOAs, olivine shows enrichment in FeO along the grain boundaries in contact with phyllosilicates. Also, some primary forsterite grains are overgrown by euhedral fayalitic olivine (Fa63-71). They are rather coarse (up to 10micron across) and show reverse Mg/(Mg+Fe) zoning, possibly indicating reactions with a fluid phase.

Discussion: AOAs in Y-86009 are mainly composed of forsteritic olivine, Al-diopside and spinel. Although they are texturally similar to those in the reduced and the Allende-like oxidized CV chondrites [3], they show important mineralogical differences. The Y-86009 AOAs experienced hydrous alteration that resulted in replacement of anorthite by phyllosilicates. Most forsterite grains have undergone minimal alteration, though some show enrichment in FeO. In addition to phyllosilicates, other secondary minerals are fayalitic olivine and Ca-Fe-rich pyroxene. These alteration features are similar to those in CAIs, chondrules, and matrices of the Bali-like oxidized CVs [3]. The characteristic alteration minerals of the Allende AOAs, which include zoned ferrous olivine, nepheline and sodalite are absent in the Y-86009 AOAs. We infer that AOAs in Y-86009 were originally similar to those in reduced CVs [4], and subsequently experienced low-temperature aqueous alteration; alteration conditions differed from the conditions that produced nepheline, sodalite and Fe-enriched olivine in the Allende AOAs.