AMOEBOID OLIVINE AGGREGATES IN ANTARCTIC CR CHONDRITES: PETROLOGIC VARIATIONS AMONG CR CHONDRITES.

M. Komatsu[1,2], T. J. Fagan[2], A. Yamaguchi[1,3], T. Mikouchi[4], M. Yasutake[1,3], and M. E. Zolensky[5], [1]SOKENDAI, The Graduate University for Advanced Studies, Kanagawa, Japan (komatsu_mutsumi@soken.ac.jp), [2]Dept. Earth Sciences, Waseda University, Japan, [3]National Institute of Polar Research (NIPR), Japan, [4]Dept. Earth and Planetary Science, The University of Tokyo, Japan, [5]ARES, NASA Johnson Space Center, Houston, USA.

Introduction: Amoeboid olivine aggregates (AOAs) are important components of carbonaceous chondrites that are interpreted as solar nebula condensates [e.g. 1], and can be used as sensitive indicators of metamorphic or alteration processes [2;3]. We have been investigating a set of Antarctic CR chondrites from the Japanese-NIPR collection in order to study variations within the CRs in general and their AOAs in particular. Main goals are to identify variations in conditions of nebular condensation, parent body effects and terrestrial weathering.

Methods: Polished thin sections of Antarctic CR chondrites Y-791498, Y-792518, Y 982405, A-881828, and A-881595 were examined in this study. Back-scattered electron imaging, mineral identification and EDS analyses were performed using a JEOL JSM-7100F FE-SEM at NIPR. Chemical analyses and X-ray maps were obtained using a JEOL JX-8200 EMPA at NIPR.

Results: Chondrule/matrix textures are well defined in all of the samples studied. The AOAs have Fe-poor olivine ($Fo_{>90}$); subtle variations are described below.

Y-791498 and A-881828 : These two samples have chondrules with glassy mesostasis and texturally unaltered phnocrysts. One AOA was identified in each sample. Both AOAs are composed of forsteritic olivine (Fo_{95-100}), anorthite, high-Ca pyroxene, low-Ca pyroxene, and Fe-Ni metal grains. Similar to AOAs in primitive carbonaceous chondrites [1], the two AOAs show no FeO-enrichment along olivine grains, or replacement of feldspar by phyllosilicates or feldspathoids. Some chondrules in Y-791498 have a rim with a "honeycomb" texture [4], consisting of fine-grained patches of nearly pure SiO_2 and low-Ca pyroxene. Some lithic clasts occur in A-881828.

Y-793261: Fe-rich veins appear to be due to terrestrial weathering, but AOA silicates show little evidence of weathering. The abundance of AOAs and CAIs is higher than other CRs; eight AOAs are present whereas the other CR thin sections have only 0 to 3 AOAs. All AOAs appear primitive. One of the AOAs (AOA #4) contains ultra-refractory Sc-rich pyroxene and a Zr-rich oxide [details in 5]. The AOA also contains ~5 μm sized, nearly pure SiO_2 with low-Ca pyroxene grains. The presence of ultra-refractory phases indicate condensation of AOA #4 at unusually high temperature and silica + low-Ca pyroxene indicate continued interaction with gas at low temperatures.

Y 982405: In this meteorite, Fe-oxides (probably caused by a combination of parent body aqueous alteration and terrestrial weathering) are commonly observed replacing Fe, Ni-metal and FeS. Chondrules are preferentially aligned and the matrix has lower porosity than the other CRs, indicating impact-induced deformation [3,6]. Y 982405 olivines are lower in MnO (~0.2 wt.%) than those of other CRs. Three AOAs are found in Y-982405. AOA #14 shows Fe-enrichment along the grain boundaries, and some anorthites are replaced by phyllosilicates.

A-881595: This meteorite was originally classified as a CR2 [7], but reclassification as an ungrouped C3 has been suggested [8;9]. Opaque grains show multi-layers of Fe-oxides. Replacement of chondrule mesostasis by phyllosilicates is common, showing a higher degree of aqueous alteration than the other CRs. Two AOAs were found. Olivine is highly forsteritic (Fo_{99-100}), but some of the anorthite in A-881595 AOAs is replaced by phyllosilicates.

Occurrence of LIME (low-iron, Mn-enriched) olivines: LIME olivines (MnO/FeO >1.0) have been found in AOAs in CRs in other studies and are interpreted as indicators of relatively low-T condensation [10;11]. LIME olivines were identified in Y-791498, A-881828, and A-881595. Although AOAs in A-881595 show a higher degree of aqueous alteration, the presence of LIME olivine indicates parent body heating was not strong enough to eliminate the LIME signal of nebular condensation conditions.

Discussion and Conclusion: Based on the petrology of AOAs, chondrules and matrix textures, Y-791498, Y-793261, and A-881828 are less altered than the other CRs in this study. A-881595 has undergone some aqueous alteration, evident in chondrules and AOAs, and Y-982405 has undergone shock deformation. The presence of LIME olivine in several AOAs and ultra-refractory minerals combined with SiO_2 and low-Ca pyroxene in one AOA indicate a wide range of temperatures during formation of AOAs in CR chondrites.

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