PSEUDOMORPHS OF CHONDRULES AND CAIs IN DARK CLASTS IN THE ALLENDE CV3 CHONDRITE.

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Introduction: Dark clasts (DCs), also known as dark inclusions, are common in CV3 chondrites. DCs commonly contain rounded aggregates consisting mainly of fine-grained Fe-rich olivine. Previous researchers [1–3] suggested that DCs have undergone aqueous alteration and thermal metamorphism on the meteorite parent body, and the aggregates in DCs are pseudomorphs of chondrules and CAIs. However, mineralogy and variations of pseudomorphs in DCs remain poorly characterized. Here, we present the results of SEM (back-scattered electron) and TEM observations of pseudomorphs in two DCs (DC1 and 2) in Allende.

Results and Discussion: In SEM images, DC1 (88 mm^2 in area) consists mainly of fine-grained Fe-rich olivine and appears featureless. However, our observations in transmitted light reveal that DC1 contains numerous pseudomorphs, which have been almost completely replaced by fine-grained minerals. The pseudomorphs range in diameter from 20–850 μm, but most are <250μm; their sizes are much smaller than the chondrules in the host meteorite. We found ten large pseudomorphs (>400 μm). All of them are surrounded by opaque rims (20–250 μm in thickness), whereas most of the smaller pseudomorphs have no rims.

SEM observations reveal that the ten large pseudomorphs also consist largely of fine-grained Fe-rich olivine but nine of them have distinctly higher abundances of particular minerals compared to the surrounding materials, and they can be divided into three different types: 1) diopside-hedenbergite-rich, 2) nepheline-sodalite-rich, and 3) pentlandite-awaruite-rich. Most of these particular minerals are typical products of hydrothermal alteration. The differences in mineralogy between the pseudomorphs probably reflect the differences between precursor chondrules.

Fine olivine grains in DC1 generally contain submicrometer-sized opaque inclusions and voids. TEM observations reveal that the inclusions are pentlandite and awaruite. We found that the olivine grains in the rims around the large pseudomorphs are smaller in size and contain more abundant micro-inclusions than those in other areas.

DC2 (19 mm^2) also consists mainly of fine-grained Fe-rich olivine, but some chondrules preserve coarse-grained phenocrysts, which indicates that DC2 has been less altered than DC1. We found some pseudomorphs are composed of fine-grained diopside-hedenbergite, andradite, kirschsteinite, wollastonite, and calcite. We infer that the precursors of these pseudomorphs are CAIs. The presence of calcite strongly suggests that DC2 experienced hydrothermal alteration.

These results are consistent with that the pseudomorphs were formed by replacement of chondrules and CAIs under a hydrothermal condition. The precursor of DC1 is clearly different from host Allende. The absence of rims around the majority of smaller pseudomorphs suggests that the smaller pseudomorphs were fragments of larger chondrules before alteration of the precursor lithology.

References: [1] Kojima T. and Tomeoka K. 1996. *Geochimica et Cosmochimica Acta* 60:2651–2666. [2] Buchanan P. C. et al. 1997 *Geochimica et Cosmochimica Acta* 61:1733–1743. [3] Krot A. N. et al. 1995. *Meteoritics* 30: 748–775.