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Oxygen isotopic composition in a CR chondrule

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CR (Renazzo-type) chondrite is most pristine among carbonaceous chondrites, because degrees of thermal and aqueous metamorphisms in the parent body is the smallest. Therefore, the components of CR chondrite, i.e. chondrules, Ca, Al-rich inclusions and Amoeboid Olivine Aggregates, might preserve chemical reactions of nebula. In this study, we analyzed the oxygen isotopic composition for each grain of chondrule in CR chondrite and discuss the condition of chondrule-forming region in the solar nebula.

Most chondrules in CR chondrites have core and rim structure. The rim shows igneous texture. The igneous rim of chondrule suggests that multiple heating events would be occurred in the solar nebula. The petrologic and the bulk O isotopic study of CR chondrule were performed (Weisberg et al., 1993; Kong and Palme 1999; Clayton and Mayeda 1989), but O isotopic studies of each grain in CR chondrules have not been made.

In this study, we performed in-situ microanalysis of O isotopes in a chondrule (NWA530-1) thin section of NWA530 CR2 chondrite. NWA530-1 is a MgO-rich (type I), porphyritic chondrule. The size is about 2.6 mm in semimajor axis length and 2.2 mm in semiminor axis length. NWA530-1 consists of core and rim. Phenocrysts in the core mainly consist of forsterite and enstatite. Mesostasis in the core consists of Ca-rich pyroxene and plagioclase. The phenocrysts are 50-250 micron in size, except for one phenocryst which is exceptionally large, about 1200 micron in length and 400 micron in width. The igneous rim is 100 micron in thickness. Bulk compositions of the rim is Ca, Al-richer than those of core. The rim crystals are mostly enstatite. Forsterite, plagioclase, Ca-rich pyroxene and Fe-rich pyroxene also exist although they are small abundance. The crystals are 10 micron in size. Mesostasis with feldspathic composition enclosed the crystals. Fe-Ni metal blebs containing 5 wt% Ni scattered in the mesostasis.

O isotopic compositions of each mineral in the core/rim minerals show close to terrestorial value. However, olivine which exists in the rim is 16O-rich (d 17,18O SMOW = ~ -35 permil).

Existence of 16O-rich olivine in the rim shows that solar nebula dusts in the CAI formation stage survive until chondrule formation stage. Variations of 16O-enrichment reported in chondrules might reflect different abundances of 16O-rich dust in the chondrule precursors. Further researches of O isotopic analysis focused in chondrule-rim of various kinds of chondrites reveal temporal and/or spatial dust evolution in solar nebula.