OXYGEN ISOTOPE RATIOS OF MAGNETITE IN CI-LIKE CLASTS FROM A POLYMICT UREILITE.

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Introduction: Polymict ureilites contain a variety of ≤mm to cm sized non-ureilitic clasts, many of which can be identifed as chondritic and achondritic meteorite types [e.g., 1-3]. Among them, dark clasts have been observed in polymict ureilites that are similar to CI chondrites in mineralogy, containing phyllosilicates, magnetite, sulfide and carbonates [2,4]. Bulk oxygen isotope analyses of a dark clast in Nilpena plot along the CCAM line and above the terrestrial fractionation line, on the ^{16}O-poor extension of the main group ureilite trend and clearly different from bulk CI chondrites [5]. One possible origins of such dark clast is that they represent aqueously altered precursors of ureilite parent body (UPB) that were preserved on the cold surface of the UPB [e.g., 6]. Oxygen isotope analyses of dark clasts are key to better understanding their origins [e.g. 2]. Oxygen isotope ratios of magnetite are of special interest because they reflect the compositions of the fluids in asteroidal bodies [7-11]. In primitive chondrites, Δ^{17}O (= δ^{17}O-0.52× δ^{18}O) values of magnetites are always higher than those of the bulk meteorites and represent minimum Δ^{17}O values of the initial ^{16}O-poor aqueous fluids in the parent body. Previous SIMS analyses on magnetite and fayalite in dark clasts from the DaG 319 polymict ureilite were analytically difficult due to small grain sizes, though data indicated positive Δ^{17}O values of 3-4‰ [12], higher than that of the dark clast in Nilpena (1.49‰, [5]).

Samples and Methods: We selected 3 dark clasts, 300-400 µm in size, in a thin section of the DaG 165 polymict ureilite. SEM and petrographic descriptions, as well as EPMA analyses showed that they consist of phyllosilicates with abundant magnetite, sulfides, and rare anhydrous silicates. Magnetite grains are typically sub-µm to several µm in size. We chose 13 magnetite grains larger than 4 µm in size. For accurate SIMS aiming, we made 1 µm square "FIB marks" at the center of magnetite grains according to the procedure for cometary particle analyses [13]. In order to minimize crystal orientation effect on magnetite analyses, impact energy of primary ions was reduced to 13 keV [14]. The primary beam was set to 5 pA with 2×1 µm size and the secondary ^{16}O intensity was ~5×10^{6} cps. A single analysis took 12 min. The external reproducibility of δ^{18}O, δ^{17}O, and Δ^{17}O of magnetite standard (magnetite 5830 [14]) were better than 2 ‰. Other analytical conditions are similar to [13].

Results: The results of oxygen isotope analyses are shown in Fig. 1. They plot above the terrestrial fractionation line and left of the CCAM line. Data from the three clasts are similar to each other and plot along a single line with slope of ~0.7 and the Y intercept of +4.8‰. The Δ^{17}O values range mainly from +4‰ to +6‰, which are higher than bulk analyses of the Nilpena dark clast [5]. They are also significantly higher than those of magnetite analyses from CV, CO, CR, CM chondrites (~0‰ [8-11]), but similar to those of magnetite in Semarkona LL3.0 (+5‰ [7]).

Discussions: If these dark clasts are xenolithic in polymict ureilites, they represent CI-like materials that are not sampled as meteorites. If they represent altered precursors of ureilites, the UPB might have had ^{16}O-poor ice at the time of accretion with minimum Δ^{17}O of +5‰. Then, a variability in Δ^{17}O among main group ureilites (–2.5‰ to –0.2‰ [5]) could have been produced by a reaction of ^{16}O-rich anhydrous silicates and ^{16}O-poor fluid to the igneous differentiation. Such two component mixing is analogous to the model for interpreting oxygen isotope systematics of chondrules in carbonaceous chondrites that assume +5‰ ice and –6‰ anhydrous dust in the protoplanetary disk [16].

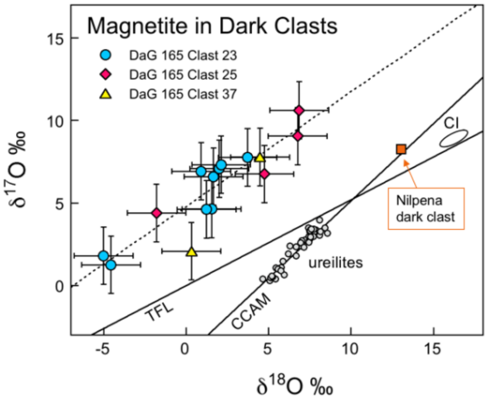

Fig. 1. Oxygen isotope ratios of magnetites from dark clasts in DaG 165. The regression line of all data is shown as a dotted line. Other bulk literature data are from [5, 15].

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