O-Isotope Signatures of Olivine and Pyroxene Grains in C1 and CM-like Clasts

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Introduction

C1 and CM-like clasts have been identified based on petrographic criteria in various chondrite and achondrite brec-cias (e.g., HEDs, Ureilites, CR and ordinary chondrites) [1-4]. While CM-like clasts most likely are composed of similar material as CM chondrites, C1 clasts differ from CI chondrites in various isotopic compositions (H, O, and S)[5,6]. In this study, the goal is to compare the O isotopic compositions of olivine and pyroxene grains in various types of clasts with those of different groups of aqueously-altered chondrites.

Analytical Methods

Oxygen isotope compositions of olivine and pyroxene grains from 12 C1 clasts in three polymict ureilites (Dar al Gani (DaG) 164, DaG 999, DaG 1000, and Elephant Moraine (EET) 83309), from two C1 clasts in two CR chon-drites (Renazzo and Al Rais), and from 20 CM-like clasts in HEDs (Northwest Africa (NWA) 776, NWA 5697, NWA 7542, MacAlpine Hills (MAC) 02666, EET 87513, Mount Pratt (PRA) 04401, Jodzie, and Saricicek) were obtained by using a Cameca IMS 1280 at the University of Heidelberg and at the Swedish Museum of Natural History, Stockholm. Uncertainties (2σ) of oxygen isotopic data of olivine and pyroxene are typically 0.2 ‰ in $\delta^{18}O$ and 0.3 ‰ in $\delta^{17}O$.

Results

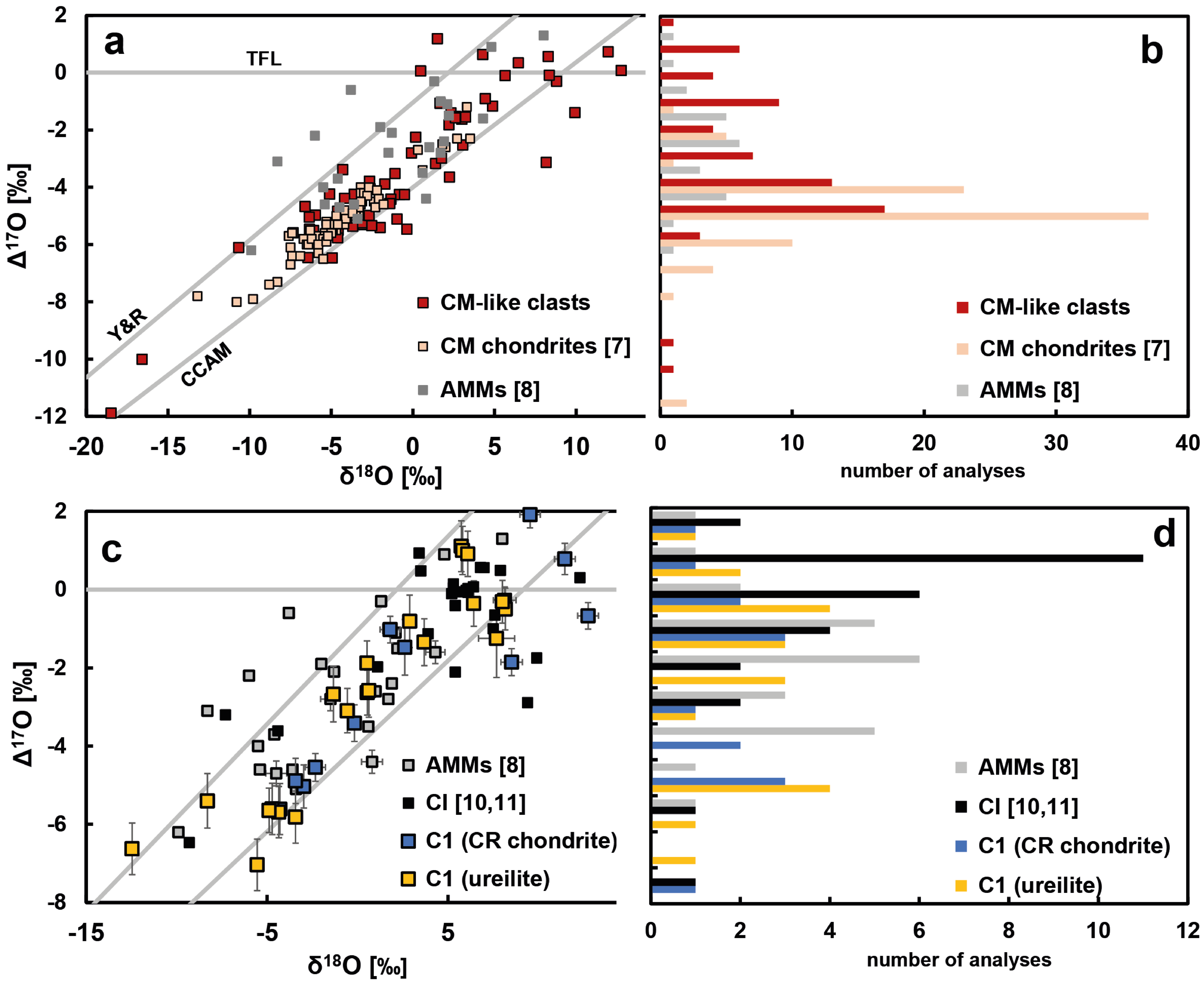

Fig. 1: (a) $\delta^{18}O$ vs. $\Delta^{17}O$ plot illustrating the oxygen isotopic composition of olivine and pyroxene grains for CM-like clasts, CM chondrites [7], and Antarctic micrometeorites (AMMs [8]). (b) Histogram of $\Delta^{17}O$ signatures shown in (a). (c) $\delta^{18}O$ vs. $\Delta^{17}O$ plot illustrating the oxygen isotopic composition of olivine and pyroxene grains for C1 clasts in ureilites, CR chondrites as well as those in CI chondrites [10,11] and AMMs [8]. (d) Histogram of $\Delta^{17}O$ signatures of olivine and pyroxene grains from C1 clasts in ureilites and CR chondrites compared to those in CI chondrites[10,11] and AMMs [8]. TFL = Terrestrial Fractionation Line, CCAM = Carbonaceous Chondrite Anhydrous Mineral line; Y&R= Young and Russell line. Histograms include data < -12 ‰ and > 2 ‰ for CM-like clasts and data < -8 ‰ and > 2 ‰ for C1 clasts.

Observations

CM-like clasts:

Overall, the oxygen isotope composition of olivine and pyroxene grains overlap well with those reported for CM chondrites (e.g. [7]; Fig. 1a). The $\Delta^{17}O$ of olivine and pyroxene grains in CM-like clasts peak at around 5 ‰ and -1 ‰ (Fig. 1b). The peak at -5 ‰ overlaps well with that for CM chondrites [7] and the peak at 1 ‰ overlaps with that of Antarctic micrometeorites (AMMs, [8]) and one of CM chondrites indicating that part of the population of CM-like clasts in HEDs might derive from the same reservoir as AMMs (or vice versa). Most of the analyzed AMMs are in the size fraction of 50-100 µm, which is well in the range of the olivine and pyroxene grains analyzed in CM-like clasts. Previous work suggests that most of the AMMs and micrometeorites from Greenland derive from carbonaceous chondrites [9].

C1 clasts:

There are no clear peaks for the $\Delta^{17}O$ signature of olivine and pyroxene in C1 clasts due to lower number of analyses (Fig. 1d). The $\Delta^{17}O$ for the grains in C1 clasts seems to extend towards more negative values when compared to those in CI1 chondrites [10,11] indicating they incorporated olivine and pyroxene with a wide range in composition. Most olivine and pyroxene grains plot between the CCAM and the Y&R line, along the PCM (Primitive Chondrite Mineral) line (Fig. 1a).

References and Acknowledgement

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