OXYGEN ISOTOPE DISTRIBUTION IN NWA739, A CH CHONDRITE WITH AFFINITIES TO ACFER 182.
R. H. Jones[1] (rjones@unm.edu), Y. Guan[2], L. A. Leshin[2,3], T. Larsen[1], and Z. D. Sharp[1]. [1]Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131; [2]Department of Geological Sciences, [3]Center for Meteorite Studies, Arizona State University, Tempe, AZ 85287-1404.

Introduction: CH carbonaceous chondrites have many unusual properties that distinguish them from other chondrite groups. They have been interpreted as having either a nebular [1-4] or impact [5] origin. CH chondrites are metal-rich, and contain chondrules that are significantly smaller than those in other chondrite groups. They were included as members of the CR chondrite clan by [6]. Acfer 182, although very similar in many respects to ALH85085, differs from it in several significant respects: it has larger chondrules (mean chondrule diameter is ~ 90 μm vs. ~20 μm), and a lower metal content (9 vs 20 vol. %) [7]. Bischoff et al. [7] suggested that Acfer 182 should be included in the CH group, whereas Weisberg et al. [6] argued that it is sufficiently different from the other CH chondrites that it should be considered a unique chondrite.

The CH chondrite, NWA739 [8], has close affinities to Acfer 182. Here we report the results of preliminary studies of the oxygen isotope distribution in this chondrite. We are investigating the relationship between NWA739, Acfer182 and the ALH85085-like chondrites, as well as the possibility, suggested by [6], that chondrule silicates in CR clan chondrites lie on the equilibrated chondrite slope-1 line (ECL) on an oxygen 3-isotope plot.

Description of NWA739: NWA739 conists of two stones that fit together, with a total mass of 60g. It is a metal-rich chondrite with small chondrules, and an average chondrule size of 87 μm (Fig. 1). Most of the larger chondrules are porphyritic and fragmented; round, cryptocrystalline chondrules are typically smaller. Rare CAIs are small (< 60 μm) and consist of a variety of types, including grossite-rich. Metal constitutes 11 vol% of the chondrite and is mostly kamacite, mean Ni = 6.5 wt%. Rare tetrataenite and silicon-rich metal grains are present. Sulfides are rare (<1 vol%). We discuss the metal phase in NWA739 in more detail in a separate abstract [9].

Mineral compositions: Olivine and pyroxene compositions are heterogeneous throughout the chondrite. Most olivines and pyroxenes are FeO-poor, with peaks at Fa = 2-3 and Fs = 2 in histograms of random analyses. The most FeO-rich olivine and pyroxene analysed so far are Fa_{32} and Fs_{34}. Pyroxene compositions also vary considerably in Wo content (0.1 to 11.7) and Al_2O_3 content (0 to 12.5). For FeO-poor olivines only (Fa <6), the mean composition contains 2.6 wt% FeO, 0.57 wt% Cr_2O_3, 0.12 wt% MnO, and 0.27 wt% CaO. This is very similar to olivine compositions in the other CH chondrites.

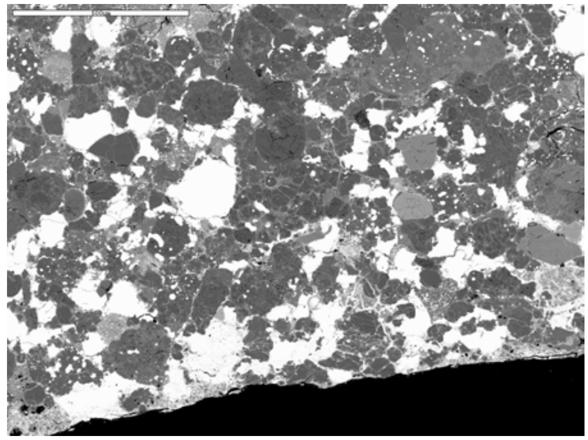

Fig. 1. Back-scattered electron image of NWA739. Scale bar is 0.5mm.

Bulk rock oxygen isotope ratio: The oxygen isotope ratio of the bulk chondrite was determined by a laser ablation technique using a Finnigan Mat Delta Plus XL mass spectrometer at UNM. Two separate fragments of the chondrite that each weighed approximately 2 mg were placed in nickel sample holders and oxygen was extracted by laser ablation in a BrF_5 atmosphere. Errors on individual measurements are ± 0.2 ‰ for $\delta^{17}O$ and ± 0.1 ‰ for $\delta^{18}O$. The two measurements are very similar: $\delta^{18}O$ = +4.33 ‰, $\delta^{17}O$ = +1.63 ‰; and $\delta^{18}O$ = +4.31 ‰, $\delta^{17}O$ = +1.86 ‰. The oxygen isotope ratio of an H chondrite analysed in the same run is $\delta^{18}O$ = +3.71 ‰, $\delta^{17}O$ = +2.79 ‰, consistent with data of Clayton for H chondrites [10].

The mean bulk oxygen isotope composition for NWA739 does not lie on the line defined by the CR clan [11] (Fig. 2). It lies closer to Acfer 182 than to ALH85085 and the main group of CH chondrites, but closer to the TF line. NWA739 does not appear to be displaced towards the TF line by terrestrial alteration. The two NWA739 separates were taken from the interior of the meteorite. Also, the degree of weathering in NWA739 appears to be significantly less than in Acfer 182 in which Fe-rich veining is common throughout olivine and pyroxene grains [7]. Such veining is present but not ubiquitous in NWA739. The bulk oxygen isotope ratio of NWA739 lies closer to that of bulk enstatite chondrites [12] than to ALH85085.

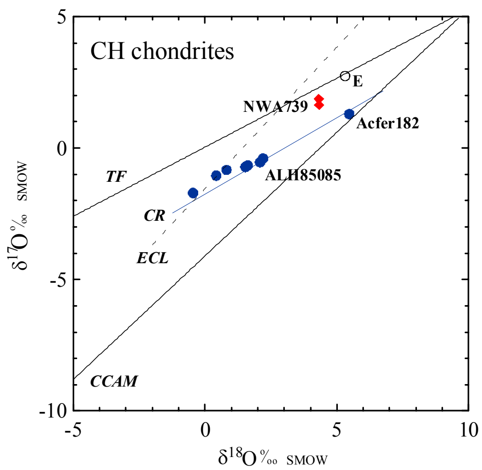

Fig. 2. Bulk oxygen isotope composition of NWA739 compared with other CH chondrites and E chondrites.

Oxygen isotope ratios of silicate minerals: We determined oxygen isotope ratios on individual grains in situ using the Cameca 6f SIMS at ASU. We analysed olivine and pyroxene, one isolated spinel grain, and several cryptocrystalline (pyroxene-normative) droplet chondrules. Olivines and pyroxenes have a wide range of Fe/(Fe+Mg) and Wo contents. Two droplet chondrules have extremely low CaO contents, and three have Wo between 0.5 and 1.3 mole%.

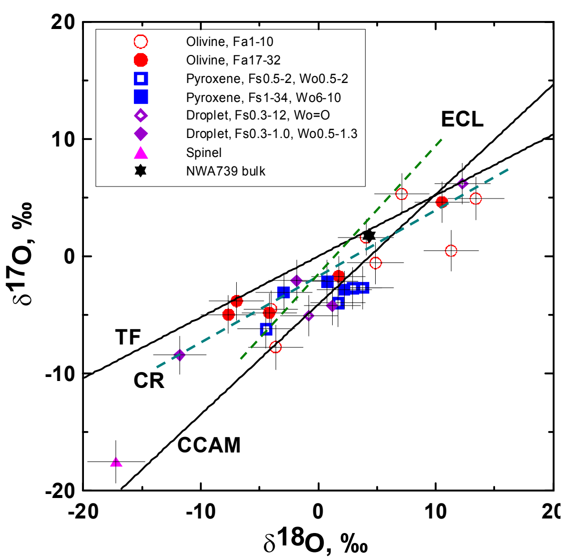

Fig. 3. Oxygen isotope data for bulk NWA739 and individual silicate phases.

The isolated spinel grain lies on the CCAM line (Fig. 3). It is the most ^{16}O-rich grain analyzed, and its $\delta^{18}O$ value (-17‰) is comparable to spinels in the ^{16}O-poor group of CAIs in other CH chondrites [13].

Olivine and pyroxene show a wide spread in $\delta^{18}O$ from -10 to +15 ‰ (Fig. 3), similar to that reported by [14] for chondrules in Acfer 214 (which is paired with Acfer 182). There are no apparent oxygen isotopic differences between chondrule and isolated grains. Most pyroxenes and some olivines lie close to the CCAM line. However, a significant population of olivine grains appears to lie along the bulk CR line. These include the FeO-rich grains, Fa17-32. FeO-rich olivine in general is more ^{16}O-rich than FeO-poor grains: this is the reverse of observations in other carbonaceous chondrite groups [e.g. 15].

Droplet chondrules have a similar range of oxygen isotopic compositions to chondrule and isolated grains. Droplet chondrules with extremely low refractory element compositions (CaO, Al_2O_3, TiO_2 <0.03 wt%) are not isotopically distinguishable.

Discussion: NWA739 is very similar in many respects to Acfer 182: Acfer 182 is no longer unique. However, there is a small but significant difference in bulk oxygen isotope composition between these two chondrites. Our in-situ data do not readily explain why the bulk composition of NWA739 lies above the CR mixing line: we have not observed a population of high-$\delta^{17}O$ grains that lies above TF. There does not appear to be a strong argument for a distribution of silicate materials in NWA739 on the ECL line.

Oxygen isotope ratios of the silicate phases in NWA739 suggest the possibility that there are two types of material present: silicates that are distributed along the CCAM line, similar to most other carbonaceous chondrite groups, and silicates that are related to the CR clan of chondrites. These latter include FeO-rich olivines. NWA739 may be a mixture of these two types of chondritic materials. However, since CR chondrule phases lie along the CCAM line [16], we need to explore this suggestion further.

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