COMPOSITIONAL STUDIES OF FOUR LOW-FeO ORDINARY CHONDRITES: IS A NEW CHONDRITIC METEORITE PARENT BODY NECESSARY? J. M. Friedrich[1,2], J. Troiano[1], D. Rumble III[3], M. L. Rivers[4], [1]Department of Chemistry, Fordham University, Bronx, NY 10458, [2]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY 10024 (email: friedrich@fordham.edu), [3]Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road NW, Washington DC 20015 (e-mail: rumble@gl.ciw.edu), [4]Consortium for Advanced Radiation Sources, University of Chicago, Argonne, IL 60439.

Introduction: The H, L and LL groups of ordinary chondrites account for the vast majority of known meteorites [1] and are distinguished from each other through differences in bulk chemical and isotopic composition, chondrule size and oxidation state [2]. Each of these attributes was primarily established prior to accretion within the solar nebula and/or by incorporation of nebular components in slightly varying amounts. However, some ordinary chondrites (OC) cannot be easily placed within any one of the H, L or LL categories. These may have petrochemical characteristics that fall between the H and L or the L and LL groups, especially in terms of redox indicators such as kamacite Co content and olivine composition and have been called L/LL or H/L [3,4]. Similar to these intermediate chondrites are the chondrule-bearing inclusions within the anomalous IIE iron meteorite Netschaëvo, which displayed compositional trends that extend well beyond the H chondrite group [5], to what may be called an "HH" chondrite. A third example includes a small set of ordinary chondrites (OC), such as Burnwell, whose mafic silicates contain amounts of FeO below those commonly found in the H chondrites (~17-20 mol% Fa). These latter atypical OC are sometimes collectively referred to as reduced OC or low-FeO OC [6,7]. Often, these materials also have isotopic compositions distinctive to them, with oxygen isotopic ratios falling between those indicative of membership within the OC and enstatite chondrite clans or even appearing to be startlingly unique [8,7].

The previously mentioned Burnwell, LaPaz Icefield (LAP) 04757, Elephant Moraine (EET) 96031, and Miller Range (MIL) 07273 are four potential examples of these reduced OC. Burnwell shares chondrule sizes with the H chondrites [7], but mean olivine compositions in Burnwell are low (15.8 mol% Fa) and the oxygen isotope signature of Burnwell seemed unusual when compared to those established for the OC groups [7,9]. Burnwell has a total Fe abundance indistinguishable from the H chondrites so the lower amount of FeO in its silicates is balanced by an increase in reduced Fe abundance. EET 96031, LAP 04757 and MIL 07273 share the lower mean FeO mol% in olivine [10, 11, 12]. However, other compositional affinities to Burnwell, the H chondrites, or even other OC have not been investigated for these three Antarctic chondrites.

Here, we detail our efforts to investigate the above four low-FeO chondrites by comparing their compositions with those established for the OC. For our comparisons, we have quantified the trace element abundances and reanalyzed or analyzed oxygen isotopic abundances of Burnwell, LAP 04757, EET 96031 and MIL 07273. To build upon our existing OC trace element compositional comparison database, we additionally report on the trace element abundances in the two typical H chondrite falls Miller (Arkansas) and Forest City. In comparing these unusual chondrites with more typical OC, we hope to examine if a separate parent body source is necessary to account for their compositional similarities or differences.

Samples and Methods: We reanalyzed (in the case of Burnwell) or analyzed the bulk O isotopic composition of each of the four low-FeO chondrites in this study. Oxygen isotopic analyses were performed as in [16] and are compared with prior results [17] below.

We quantified 45 trace elements in all four low-FeO chondrites by ICPMS using a ThermoElemental X-Series II ICPMS with a technique well established for chondritic meteorites [13]. To build upon our comparison database, we also analyzed the trace element abundances in the two typical H chondrite falls Forest City and Miller (Arkansas).

We also collected synchrotron x-ray microtomography (μCT) data on each sample at the GSECARS 13-BM beamline located at the Advanced Photon Source of the Argonne National Laboratory. To extract compositional and spatial data from our 3D representations, we used BLOB3D [14,15]. Extracted μCT data gives information on Fe_{metal} and FeS abundances and opaque grain morphology.

Results and Discussion: Our oxygen isotope, trace element, and μCT results can be summarized as follows:

Oxygen isotopes. Oxygen isotope results for the four low-FeO chondrites fall are shown in Figure 1 below. Our new result for Burnwell is contrasted with that found by [7], which the authors took as evidence for a separate parent body serving as the source for Burnwell. $\Delta^{17}O$ of the low-FeO chondrites in this study also lie at values known for the H chondrites. From an O isotope perspective Burnwell, LAP 04757, EET 96031, and MIL 07273 can be regarded as H chondrites.

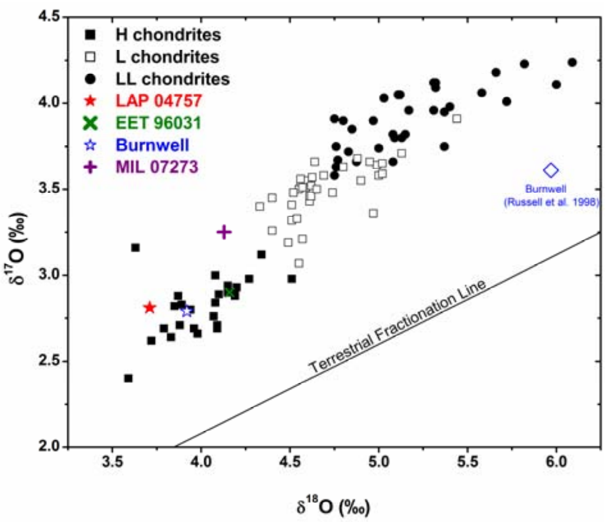

Figure 1. Three isotope plot of oxygen isotopic compositions of Burnwell, LAP 04757, EET 96031, MIL 07273 compared with other ordinary chondrites [17]. Each of the four low-FeO ordinary chondrites possesses isotopic affinities akin to the H chondrites. The previously measured [7] isotopic composition of Burnwell is shown.

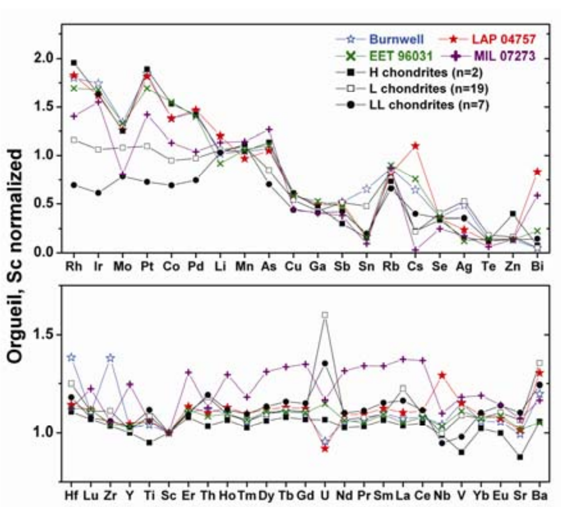

Figure 2. Mean CI and Sc normalized abundances of lithophiles, siderophiles and moderately volatile elements in Burnwell, LAP 04757, EET 96031, and MIL 07273 compared with means for H, L and LL chondrites. Elements are organized by increasing putative volatility and similar geochemical character. The four low-FeO chondrites investigated in this study compositionally resemble the H chondrites.

Trace elements. Figure 2 shows abundances of lithophiles, siderophiles and moderately volatile elements in the four low-FeO chondrites and mildly-shocked (S1-S3) ordinary chondrites analyzed by our methods. Data are CI (Orgueil) and Sc normalized abundances to eliminate the effects of volatiles on the comparison. All other characteristics aside, Burnwell, LAP 04757, EET 96031, and MIL 07273 compositionally appear to be H chondrites [also see 18].

Three dimensional petrography. μCT data was collected on chips of each low-FeO chondrite. Opaque mineral abundances inferred from our data indicate similarities to the H chondrites, but the small samples analyzed may prohibit a meaningful comparison. At first glance, the morphology of metal grains appears to be distinct from the H chondrites, with a highly angular appearance. A detailed three-dimensional analysis and comparison of these grains with the H chondrites is underway.

Conclusions: Oxygen isotopes the four low-FeO considered here are within the range of values established for H chondrites as are trace element and opaque mineral abundance data. The primary difference between these four low-FeO chondrites and the H chondrites is the slightly lower Fa mol% present. Given this, we prefer a common origin asteroidal origin for the low-FeO and H chondrites. Scenarios for this will be discussed.

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