SUPRA-TFL OXYGEN ISOTOPIC COMPOSITIONS IN METAL-POOR "ORDINARY" CHONDRITES: SAMPLES FROM UNRECOGNIZED CHONDRITIC PARENT BODIES.
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Ordinary and Not So Ordinary Chondrites: The well known groups of ordinary chondrites (H, L and LL) all have oxygen isotopic compositions that plot above the terrestrial fractionation line in fairly well defined subparallel arrays at mean $\Delta^{17}O$ values of (nominally) +0.686, +1.008 and +1.156, respectively (see Figure 1). Other groups of chondrites with supra-TFL oxygen isotopic compositions are the oxidized R chondrites [2] and a small group of reduced metal-bearing chondrites with more magnesian silicate compositions [3]. As part of a survey of specimens from Northwest Africa, we have identified a variety of relatively metal-poor chondrites that do not have oxygen isotopic compositions consistent with their metal contents or silicate mineral compositions, and even some that plot closer to the TFL than H chondrites.

Analytical Procedures: Oxygen was extracted from all specimens (mostly in replicate) by laser fluorination after removal of metal with a clean hand magnet and repeated ultrasonic washing in dilute HCl to remove terrestrial iron hydroxides. Isotopic compositions were determined on a MAT 252 mass spectrometer. These procedures are similar to those used at GL previously [4], and the reported offsets in $\Delta^{17}O$ from the TFL were calculated for a slope of 0.526 [4].

Samples and Results: Table 1 shows results for 14 specimens, which are plotted in Figure 2. Beni Semguine and Wray(a) are relatively metal-rich specimens with anomalously Mg-rich mafic silicates, and thus are further examples of the reduced types of ordinary chondrites identified by Wasson et al. [3]. Many of the other specimens plot on or near the trend for H chondrites, yet they contain far too little metal (measured accurately from BSE modes) to be either H or L chondrites. Finally, NWA 2041, NWA 3127, NWA 4294 and NWA 4486 (as well as Willaroy [1]) have oxygen isotopic compositions that plot considerably closer to the TFL than H chondrites.

An important concern with Northwest African and other hot desert meteorite falls is the degree of terrestrial weathering that they have experienced. Obviously this could affect both the amount of remnant metal and the oxygen isotopic composition of bulk samples (unless careful acid washing procedures are employed).

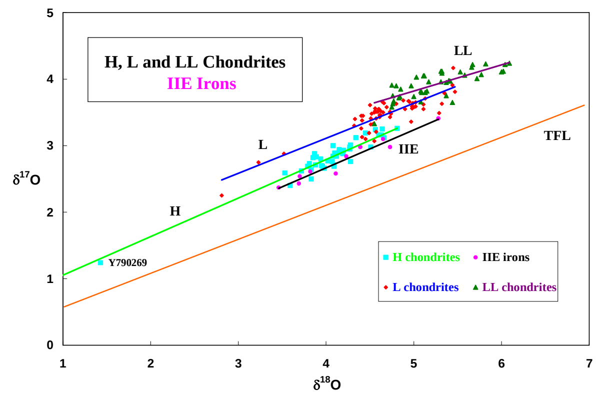

Figure 1: Oxygen isotopic compositions of nominally H, L and LL chondrites and IIE irons (data from [1]).

Table 1. Analytical results [olivine range (median)]

Specimen	Type	%Fe^0	Fa$_{ol}$	$\delta^{18}O$	$\delta^{17}O$	$\Delta^{17}O$
NWA 960	3	1	2-29(3)	6.04	3.78	0.639
				6.03	3.74	0.604
				6.18	3.83	0.579
NWA 2040	3	8	0-50(3)	4.61	3.20	0.775
				4.70	3.21	0.737
NWA 2041	3	2	5-25(6)	4.85	3.00	0.449
				4.88	3.03	0.466
NWA 3114	3.8	2	19-26	5.32	3.25	0.456
NWA 3127	3.1	2	0-50(3)	5.96	3.43	0.295
				5.96	3.37	0.235
NWA 3157	3	1	0-39(4)	5.30	3.48	0.692
				4.85	3.29	0.739
NWA 4294	3	3	2-25(6)	5.38	3.34	0.508
				5.31	3.23	0.443
NWA 4298	3	2	0-46(4)	5.96	3.78	0.639
				5.57	3.51	0.573
NWA 4486	3	2	5-29(6)	5.11	3.15	0.465
				5.51	3.29	0.400
NWA 4531	3	2	4-27(6)	5.25	3.47	0.709
Beni Sem-	H5 anom		14.2±0.4	4.37	3.18	0.886
-guine				4.06	2.99	0.849
Wray(a)	H5 anom		15.6±0.1	4.47	3.23	0.872
				4.62	3.27	0.836
NWA 3161	LL3	1	0-40(3)	5.49	4.01	1.122
				5.34	3.93	1.121
NWA 3154	H3.9	15	16.4±0.3	4.59	3.30	0.889
				4.54	3.18	0.791

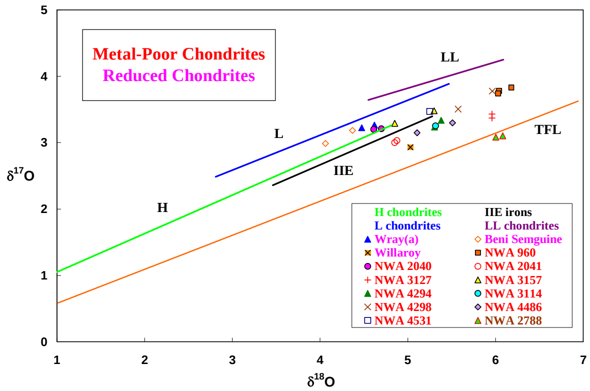

Figure 2: Oxygen isotopic compositions of analyzed specimens compared with mean values from Figure 1. Data from Table 1, [1] and [5].

Petrography: All specimens have closely packed chondrules (see Figure 3). None is strongly weathered (in fact less so than most other NWA meteorites we have analyzed). All contain fresh metal and troilite, and there is no evidence that metal has been extensively dissolved (except to form minor grain boundary veining by iron hydroxides). We conclude that the low metal abundances in these various specimens are primary features. Nor do we feel that the measured oxygen isotopic compositions are compromised by addition of terrestrial oxygen, since we treated these samples with the same acid washing procedure that has proven to be effective and reproducible for other NWA meteorites with similar or greater levels of terrestrial weathering, and thus the results should be accurate for the constituent silicates.

Discussion: One interpretation is that some of the metal-poor specimens could signify large variations in metal abundances on the H chondrite parent body, but this does not apply to others. More likely we believe is that they derive from several (at least 3) previously unrecognized chondritic parent bodies. Their supra-TFL oxygen isotopic compositions probably exclude a relationship to carbonaceous chondrites, which all plot below the TFL (including unique carbonaceous metachondrite NWA 2788 with $\Delta^{17}O$ = -0.087 per mil [5]). In one sense then these metal-poor chondrites are more like the traditional groups of ordinary chondrites, but they are far from typical. Without oxygen isotopic analyses, other such specimens may have been overlooked as being traditional ordinary chondrites.

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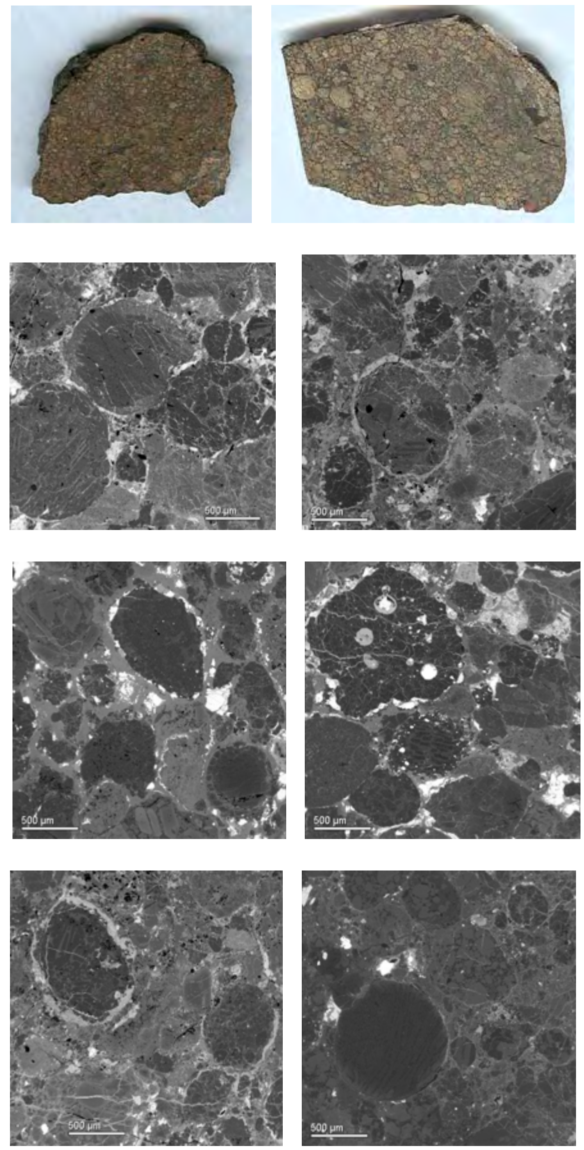

Figure 3: Macro and BSE images of analyzed specimens (a) NWA 3127 (*3.6 cm*) (b) NWA 2041 (*4.5 cm*) (c) NWA 960 (d) NWA 3127 (e) NWA 3157 (f) NWA 4486 (g) NWA 4298 (h) NWA 4531. Mg-rich silicates (darker gray), Fe-rich silicate rims (medium gray), troilite and metal (bright white) – scale bar is 500 µm.

References:

[1] Clayton R. N. et al. (1991) *Geochim. Cosmochim. Acta* **55**, 2317-2337; Clayton R. N. and Mayeda T. K. (1996) *Geochim. Cosmochim. Acta* **60**, 1999-2017. [2] Kallemeyn G. W. et al. (1996) *Geochim. Cosmochim. Acta* **60**, 2243-2256 [3] Wasson J. T. et al. (1993) *Geochim. Cosmochim. Acta* **57**, 1867-1878 [4] Rumble D. et al. (2007) *Geochim. Cosmochim. Acta* **71** [5] Bunch T. E. et al. (2006) *EOS, Trans. AGU* **87**, *Fall Meet. Suppl.*, #P51E-1246.