THE OXYGEN ISOTOPE PROPERTIES OF OLIVINES AND PYROXENES IN CHONDRULES IN ORDINARY CHONDRITES. Derek W. G. Sears*, Ian Lyon†, John Saxton†, and Grenville Turner†. *Cosmochemistry Group, Dept of Chemistry and Biochemistry, University of Arkansas, Fayetteville, Arkansas 72701, USA. †Dept of Earth Sciences, University of Manchester, Manchester M13 9PL, UK.

The Manchester ion-microprobe has been used to determine oxygen isotope compositions of 11 olivine grains in seven chondrules from the Semarkona LL3.0 chondrite. The data resemble those of whole-chondrule samples from ordinary chondrites previously measured by other techniques with no significant differences between the various chondrule groups, although the present data arguably plot at the ^{16}O-rich end of the ordinary chondrite field. The present olivines have oxygen isotopes unlike those of the isolated olivine grains from the Julesburg (L3.7) whose oxygen is isotopically light. Although olivines in group A chondrules have several properties in common with them, the ^{16}O-rich Julesburg olivines previously reported are not simply olivines from group A chondrules.

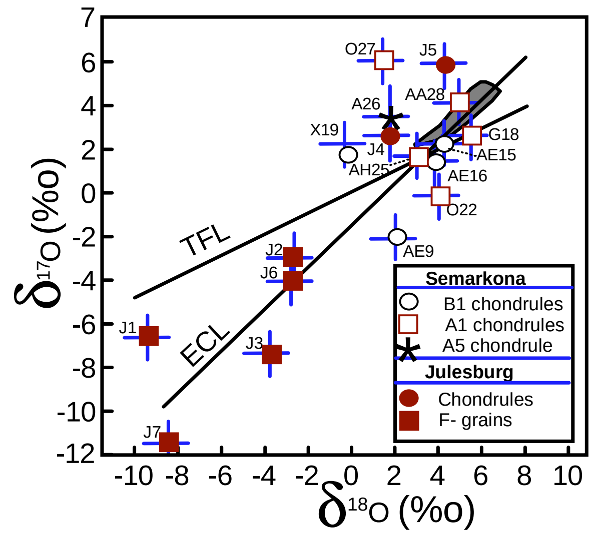
The relative abundance of oxygen isotopes in ordinary chondrites, which are thought to be of particular genetic significance and are commonly used for classification, are a reflection of the properties of the individual components. Thus understanding the properties of the various components, and the minerals in them, is crucial in understanding the origin of the meteorites. Especially significant are samples that lie on the opposite side of the terrestrial fractionation line from the host meteorites (1). Such samples might be simply be xenolithic, but they might also offer new insights into the relationships between the chondrite groups. Recently, Saxton *et al.* (2,3) reported five olivines having very forsteritic cores (all but one showing blue cathodoluminescence, CL) in the Julesburg L3.7 ordinary chondrite which plotted below the terrestrial line, some with δ^{18}O values as low as -15 per mil. These samples - described as F-grains - had been chosen on the basis of their low Fa content and blue CL. They are thus similar to group A chondrules in containing low Fa and bright CL, but unlike them in that the group A olivines display red CL.

We measured oxygen isotope compositions of olivines in chondrules from the Semarkona ordinary chondrite using the Isolab 54 ion microprobe (4-7). A polished section of Semarkona was prepared and reflected light and cathodoluminescence maps prepared. These enabled chondrules to be classified and chondrules and grains to be located in the ion microprobe. We analyzed 11 olivines from seven chondrules; two group A1, two group A2, one group A5 and two group B1. Before and after analysis, mineral identifications and analysis locations were checked with an SEM equipped with EDX facilities. Accuracy (1σ) of the meteorite measurements is +/- 2 per mill, for δ^{17}O, δ^{18}O and D^{17}O. This accuracy is derived from the repoducibility of measurements on a San Carlos olivine standard.

Our results are shown plotted in Fig. 1. Six of the 11 olivines plot within one sigma of the equilibrated chondrite line, while ten are within two sigma. An outlier (spot O27) lies about 5 ‰ to the high ^{17}O or low ^{18}O side of the equilibrated chondrite line. Another olivine from the same chondrule (point O22) plots much closer to the terrestrial line. Figure 1 also compares the present data with the Julesburg data (2,3). The present olivines, whether group A or group B, have oxygen isotope compositions unlike the isolated olivine grains from the Julesburg. Two other occurrences of olivine in Julesburg, J4 and J5, which were clearly within chondrules and had higher Fa-contents than the F-grains, have oxygen isotope data more similar to the present data.

Clearly the isolated olivine grains Julesburg are not grains from group A chondrules. As previously suggested by their unusual cathodoluminescence, they are unrelated to any of the major chondrule classes in ordinary chondrites.

Fig. 1 Oxygen isotope compositions for chondrule olivines from Semarkona (LL3.0) and for chondrules and matrix grains from Julesburg L3.7 chondrite. The chondrule groups, the field for chondrules from equilibrated ordinary chondrites, and two lines are indicated; TFL, terrestrial fractionation line; ECL, equilibrated chondrite line. The stippled field refers to chondrules from a number of ordinary chondrites. All data have two per mil error bars.



The Semarkona data plot in the same general region of the three isotope plot as whole-chondrule samples from ordinary chondrites previously measured by other techniques. Just as most are within two sigma of the terrestrial line, most are within two sigma of the bulk chondrules measured by Clayton *et al.* (8). The data are also similar to several group B chondrules from Semarkona reported by Huang *et al*. (9) and chondrules of both groups reported by Sears *et al.* (10). There is some indication that the present data are plotting to the lower end of the equilibrated chondrite chondrule field, perhaps suggesting that the mesostasis contains isotopically heavy oxygen. Bridges *et al*. (11,12) recently reported correlations between isotope data for separated Chainpur (LL3.4) and Parnallee (LL3.6) chondrules and chondrule class, and suggest that the mesostasis of group B chondrules was ^{16}O-poor while this was not true of group A chondrules. The four olivines from group B1 chondrules have δ^{17}O values below 2.5 per mil, while olivines from the group A1, A2 and A3 chondrules have values generally above this. Such a ready distinction is not made in δ^{18}O, although the two olivines with the highest δ^{18}O are group A and the lowest is an olivine from a group B1 chondrule. There is thus only the slightest indication of olivine in group B1 chondrules containing lighter oxygen than the other groups, but is it not significant within the uncertainties of our data. The fact that the Julesburg F-grains are not simply and directly related to one of the major chondrule groups in primitive meteorites means that, in addition to them being xenolithic, there is no evidence in the present data that chondrule formation is a means of moving material from one side of the terrestrial line to the other. In other words, the ordinary and carbonaceous chondrite classes are not simply related through chondrule formation. Of course these data do not preclude a more primitive connection that predated the formation of the present chondrules or that more extensive thermal treatments than involved in chondrule formation (e.g. that involved in forming the CAI) would not affect oxygen isotopes. The present data might also indicate that group A and group B chondrules shared a common precursor, and that the reduction and evaporation that accompanied chondrule formation resulted in the loss of oxygen without significant isotopic fractionation.

(1) Mayeda T. K. *et al.* (1980) *Meteoritics* **15**, 330-331. (2) Saxton J. M. *et al*. (1996) *Meteorit. Planet. Sci.* **31**, A123. (3) Saxton J. M. *et al*. (1998) *Meteorit. Planet. Sci.*(submitted). 4. Saxton J. M. *et al.* (1995) *Analyst* **120**, 1321-1326. 5. Saxton J. M. *et al.* (1996a) *Internat. J. Mass Spec. Ion Proc.* **154**, 99-131. 6. Lyon I. C. *et al.* (1994) *Rapid Comm. Mass Spec.* **8**, 837-843. 7. Lyon I. C. *et al.* (1995*) J. Mass Spec. Ion Proc.* **154**, 1-16. 8. Clayton R. N. *et al.* (1991). *Geochim. Cosmochim. Acta* **55**, 2317-2337. 9. Huang S. *et al.* (1996). *Icarus* **122**, 316-346. 10. Sears D.W.G. *et al.* (1997) *Meteorit. Planet. Sci.* **32**, A118-A119. 11. Bridges J. C. *et al.* (1997) *Lunar Planet. Sci.* **28**, 155-156. 12. Bridges J. C. *et al*. (1997). *Earth Planet. Sci. Lett.* (in press).