OXYGEN ISOTOPES IN CHONDRULES OF ORDINARY AND CARBONACEOUS CHONDRITES.

N. Onuma,[1,2] R. N. Clayton,[2] Y. Ikeda,[1] I. D. Hutcheon,[2] T. K. Mayeda,[2] and C. Molini-Velsko.[2] [1]Department of Earth Sciences, Ibaraki University, Mito , Japan; [2]Enrico Fermi Institute, University of Chicago, Chicago, IL 60637.

Previous oxygen isotope studies of individual chondrules from unequilibrated ordinary chondrites [1, 2] have shown that: (1) chondrules have variable isotopic compositions, scattering about a slope-1 line on the three-isotope plot, (2) the isotopic compositions bear no relationship to the iron-group of the parent meteorite, (3) the isotopic compositions bear no evident relationship to textures or chemical compositions of the chondrules, except for a weak correlation with total iron content. These data have been interpreted as resulting from isotopic exchange between hot silicates and a surrounding nebular gas during chondrule formation [3]. Solid precursors of the chondrules may have had an ^{16}O-rich composition similar to the precursors of carbonaceous chondrite silicates and oxides, but the two classes of meteorites must have exchanged with gases of two different compositions in order to produce two distinct mixing lines. Principal conclusions from these studies were that: (1) chondrules pre-date their parent bodies, (2) chondrules were formed in space in the presence of an abundant oxygen-containing gas, such as CO, and (3) chondrules of the various iron group meteorites were derived from a common pool.

We present new isotopic and chemical data on 21 chondrules from the Allende meteorite, which support the silicate-gas exchange hypothesis, and which provide possible additional links between the unequilibrated ordinary chondrites and the carbonaceous chondrites. The samples analyzed consisted of eight barred olivine, one excentroradial pyroxene, and 12 porphyritic chondrules, characterized by SEM and/or optical microscope examination of polished surfaces, and by EDAX broad-beam major element analysis. Both oxygen and silicon isotope analyses were performed. Silicon isotopic variations covered about 1‰ in $\delta^{30}Si$, and no departures from mass-fractionation were seen in a $\delta^{29}Si$ vs. $\delta^{30}Si$ plot. Correlations between silicon isotopes and other chemical or isotopic properties have not been found for these samples.

The oxygen isotope data define a trend not previously observed in meteorites. The chondrules define a band, possibly nonlinear, from the vicinity of $\delta^{18}O = -2.6‰$, $\delta^{17}O = -6.5‰$ to $\delta^{18}O = +3.8‰$, $\delta^{17}O = +1.5‰$. This trend has a slope distinctly greater than one; at its lower end, it intersects the mixing line for Allende Ca-Al-inclusions; at its upper end it approaches the ordinary chondrite chondrule trend. There is a distinct separation between barred and porphyritic chondrules, with the former being tightly clustered at the upper end of the trend. The barred olivine chondrules tend to have higher iron contents. Several detailed features of the trend imply that it was generated by exchange of ^{16}O-rich precursors with an external reservoir. However, the deviation of the chondrule trend from the Allende inclusion line requires separate external reservoirs for the two classes of object from the Allende meteorite.

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