RELICT OLIVINE, CHONDRULE RECYCLING, AND EVOLUTION OF OXYGEN RESERVOIRS.

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Introduction: Using SIMS techniques we have analyzed oxygen isotopes and trace elements in relict olivine grains [1], together with co-existing overgrowths and normal olivine, within chondrules of the Chainpur (LL3.4) and Sahara 97210 ("Sahara", LL3.2) chondrites. As relict olivine grains predate the formation of host chondrules, they provide an opportunity to study how chondrule components evolved.

Results: Fig. (a-c) shows standard 3-isotope oxygen plots for selected data we have obtained. Typical ordinary chondrite materials (OCM) cluster around the average compositions of equilibrated H-, L- and LL-chondrites and are distinct from the carbonaceous chondrite anhydrous materials (CCAM) line [2,3].

Magnesian olivine relicts enriched in ^{16}O. Fig. (a) shows that some magnesian relict olivine grains, including refractory forsterites (RFs) and other anomalous Mg-rich grains, are distinctly enriched in a ^{16}O component compared to more ferrous olivine in the chondrules. These data are consistent with the idea that nebular reservoirs evolved over time to heavier oxygen compositions [2-5].

Magnesian olivine relicts not enriched in ^{16}O. The O-isotopic compositions of some Mg-olivine grains are similar to co-existing ferrous grains and lie close to the terrestrial fractionation (TF) line (Fig. b). The relict RFs in Sah-9 and Ch-3 have similar major- and trace-element compositions, yet very different O-isotopic compositions (Fig. a, b). This suggests that chemical and isotopic compositions of chondritic olivine may be strongly decoupled, in contrast to the models of others [4,5].

Dusty olivine relict grains. Fig. (c) indicates that dusty and normal olivine grains have overlapping O-isotopic compositions with no evidence of a difference between them in $\Delta^{17}O$. There is a hint of mass fractionation between dusty and normal olivine in Ch-7 but not in Ch-9. The similar $\Delta^{17}O$ values between dusty relicts and normal olivine are consistent with a reduction reaction to form dusty olivine from more ferrous olivine during chondrule recycling [6].

Chondrule recycling. Taken as whole, our data can be understood if chondrule precursors were recycled during chondrule formation under different conditions. Some Mg-olivine, dusty olivine, and Fe-olivine formed when oxygen reservoirs were isotopically heavy and approaching the composition in which OCM formed; other, possibly earlier, Mg-olivine formed when the reservoir composition was isotopically light and similar to that in which carbonaceous chondrites formed.

References: [1] Jones R.H. (1996) *Chondrules in the Protoplanetary Disk*, 163-172. [2] Clayton R.N. et al. (1991) *GCA 55*, 2317-2337. [3] Clayton R.N. (1993) *Annu. Rev. 21*, 115-149. [4] Kunihiro T. et al. *GCA 68*, 3599-3606. [5] Pack A. et al. (2004) *GCA 8*,1135-1157. [6] Jones R. and L.R. Danielson (1997) *MAPS 32*, 753-760.