OXYGEN ISOTOPIC HETEROGENEITY IN EQUILIBRAED ORDINARY CHONDIRTES.

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Even though it has long been known that oxygen isotopic heterogeneity are preserved in solid solar system materials [1,2], there may be an unspoken consensus that (chemically) equilibrated chondrites are also in O-isotopic equiibrum. Thus, there have been only limited numbers of attempts to measure O isotopes in individual minerals in equilibrated ordinary chondrites (EOCs) [e.g. 3]. Here we report *in situ* meaurements of O isotopes in olivines of several EOCs using the NanoSIMS 50 at KBSI showing that the EOCs are not in complete O-isotopic equilibrium.

Olivine grains in chondrules of Jinju (H5, fall [4]), Ghubara (L5, find [5]) and Duwun (L6, fall [6]) were chosen for the study. A focused ~300 pA Cs^+ ions were rastered to make ~ 5×5 μm crater on carbon-coated sample surface. One raster takes 4 s and one measurement consists of 100 raters (thus 400 s for each analysis). Secondary ions were collected using the multi-collector system; $^{16}O^-$ with a faraday cup and $^{17}O^-$, $^{18}O^-$, $^{27}Al^-$ and $^{30}Si^-$ with four electron multipliers (EMs). Electron flooding of ~5 μA was used for charging compensation. Enterence slit #4 (15×140 μm) and aperture slit #2 (200×200 μm) were inserted in the secondary beam path. The smallest exit slit (5×1600 μm) was used for EM1 that measured $^{17}O^-$ in order to separate $^{16}OH^-$, while the largest ones (50×1600μm) used for the other dectectors. Based on mass scans, the contribution of tail of $^{16}OH^-$ in $^{17}O^-$ peak is estimated less than 0.1 ‰. Terrestrial olivine and spinel were used as standards. Relative gains of detetors and instrumental mass fractionation (IMF) were obtained with San Carlos (SC) olivine. Drifts of gains and IMF, if any, during each analytical session were also monitored and corrected with SC olivine measured every 1 or 2 hours. Typical internal precisions (2σ) measured with SC olivine were ±0.3 ‰ and ±0.6 ‰ for $\delta^{18}O$ and $\delta^{17}O$, respectively. Reproducibility of SC olivine $\delta^{18}O$ in each analytical session varies and is somewhat larger than expected from internal precision, depending probably on alignments of secondary ion optics and sample charging (stability of electron gun?). However, since the variation mosly occurs along the mass fractionation line, reproducibilities of $\Delta^{17}O$ are similar to internal precision.

Data from Duwun show only hint of oxygen isotopic heterogeneity with our current precisions, however, there are measurable heterogeneities in Jinju and Ghubara. The O isotopic compositions of olivine in Jinju and Ghubara show variations of >5‰ in $\delta^{18}O$ and fall along the equilibrated chonidrite line (ECL) [7]. Most significant heterogeneity is found in a Al-rich chondrule of Jinju. The chondrule is one of the largest (~250mm in diameter) we found in Jinju and has a large olivine phenocryst in the center surrounded by recrystallized mesostasis and smaller olivine phenocrysts. The large olivine in the center has relatively ^{16}O-rich composition that all slightly below the TF line, while measurements of the smaller olivine phenocrysts fall along the ECL.

Oxygen isotopic heterogeneities in these EOCs show the thermal processes responsible for chemical equilibrium was not sufficient enough for oxygen isotopic equilibrium. Thus it is unlikely that thermal processes was due to internal heat source, such as decay of ^{26}Al, but more likely due to a rapid and episodic event, such as impact.

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