OXYGEN ISOTOPE EXCHANGE OF CHONDRULES WITH ABSORBED OXYGEN DURING BRIEF MELTING

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Introduction: Oxygen-isotope compositions of refractory inclusions and chondrules in primitive chondrites form a near slope-1 line on a three-isotope diagram, with chondrules have heavier oxygen relative to refractory inclusions [1,2]. The line has been interpreted as results of incomplete mixing of two or more reservoirs with distinct isotopic compositions [1,2]. Experimental studies [3,4] show that isotopic exchange between the nebular gas and liquid phases during chondrule-forming event was negligible unless duration of melting time were much longer and/or oxygen fugacity were higher than the canonical solar nebular condition. Here we suggest that oxygen-bearing gaseous molecules could be absorbed in pore space of chondrule precursors followed by sufficient isotopic mixing during chondrule-forming melting event.

Experiments: Chunk of Murchison (CM2) has been stored in a desiccator at room temperature and pressure with a sealed bottle of 70% ^{17}O-enriched water for about a year. We measured oxygen-isotope composition and found that the meteorite was contaminated with ^{17}O-rich oxygen. It implies that the sealing of the bottle was broken and that evaporated H_2O was absorbed in the meteorite. Several fragments of the contaminated Murchison were briefly (<1 min) melted with a CO_2 laser to make artificial chondrules. Some of them were mounted in epoxy to make a thick section for petrological observation and *in situ* analyses. Bulk oxygen isotopes were measured by laser-fluorination technique at UCLA and Korea Polar Research Institute. SIMS analyses were made using the Cameca 1270 at Hokkaido University.

Results: The bulk compositions of contaminated Murchison fall along a line connecting the original Murchison and ^{17}O-enriched spike water: the Δ^{17}O values of the contaminated range from +27 to +17‰. The ^{17}O-enrichment was significantly reduced when we washed the sample with distilled water (Δ^{17}O down to ~+1‰), implying ^{17}O-rich components are absorbed phases. Bulk of the artificial chondrules have Δ^{17}O of ~+3‰. The artificial chondrules show igneous texture having olivine phenocrysts and mesostasis. Some relict olivine grains are also found. Oxygen-isotope compositions of phenocrysts and mesostasis are similar to the bulk: Δ^{17}O ranges from +2 to +7‰, while those of relict grains fall along CCAM line with negative Δ^{17}O.

Conclusions: We suggest chondrule precursors with highly porous structure acted like efficient molecular sieves to absorb gas phases in the nebula and that oxygen-isotope mixing happened during chondrule forming melting event. According to this model major isotopic exchange would have happened at the first melting event and multiple heating events had less impact on oxygen isotopes since chondrules were no more highly porous.

References: [1] Clayton R. N. 1993. *Annual Review Earth & Planetary Science* 21:115–149. [2] Yurimoto H. *et al*. 2008. *Reviews in Mineralogy & Geochemistry* 68:141-168. [3] Yu, Y. *et al*. 1995. *Geochimica et Cosmochimica Acta* 59:2095-2104. [4] Boesenberg J. S. *et al*. 2005. *Meteoritics & Planetary Science* 40:A22.