STUDY OF CHONDRULES IN CH CHONDRITES - III: OXYGEN ISOTOPE RATIOS OF SILICA-BEARING, METAL-BEARING, AND ^{16}O-RICH CHONDRULES.

D. Nakashima[1], M. Kimura[2], K. Yamada[2], T. Noguchi[2], T. Ushikubo[1], and N. T. Kita[1]. [1]University of Wisconsin-Madison, USA. (naka@geology.wisc.edu) [2]Ibaraki University, Japan.

Introduction: From a systematic survey of chondrule oxygen isotope ratios in Asuka-881020 (CH), we reported that magnesian and ferroan cryptocrystalline (CC) chondrules were derived from two distinct isotope reservoirs with Δ^{17}O values of –2‰ and +1.5‰, respectively [1]. CH chondrites also contain ferroan non-porphyritic chondrules such as silica-bearing (SB) and FeNi metal-bearing (MB) chondrules [2], which may be related to ferroan CC chondrules according to their similar sizes (<100μm) and FeO-rich chemistry. Exceptionally ^{16}O-rich oxygen isotope ratios were reported from a glassy chondrule with olivine rim by [3] in Acfer 214 (CH). Here we report additional oxygen three-isotope analyses of several minor types of chondrules in Asuka-881020.

Results: IMS-1280 at UW-Madison was used to obtain oxygen isotope ratios using 2×4μm spots, which yield analytical precisions of 1-2 ‰ (2SD). All data plot along a slope 1 line on a three-isotope oxygen diagram (δ^{17}O vs. δ^{18}O). Isotope ratios of ferrous pyroxene and silica in SB chondrules are consistent within the analytical uncertainties. Nine SB chondrules with spherical shapes have nearly identical Δ^{17}O values with the average +1.2±1.4‰ (2SD), while five SB chondrules with irregular shapes and fine-grained textures have variable Δ^{17}O values from –6 to +5‰. Three ferroan MB chondrules have Δ^{17}O values from 0 to +2‰. Two olivine-rimmed Al-rich chondrules show Δ^{17}O values of –12‰ and –6‰, respectively. We analyzed one magnesian MB chondrule that shows the Δ^{17}O value (–21‰) as low as CAIs, though it has no olivine rim.

Discussion: Nearly identical oxygen isotope ratios of ferrous pyroxene and silica in SB chondrules suggest formation from common isotope reservoirs. Spherical SB and ferroan MB chondrules have similar Δ^{17}O values to ferroan CC chondrules, and are depleted in refractory and volatile elements like ferroan CC chondrules. Thus, these three types of ferroan chondrules might have formed via fractional condensation from an isotopically uniform gaseous reservoir. Δ^{17}O range of irregular-shaped SB chondrules overlaps with that of type I porphyritic chondrules in Asuka-881020 [1], implying that the irregular-shaped SB chondrules formed in the solar nebula like the porphyritic chondrules [4].

Al-rich chondrules with olivine rim show intermediate Δ^{17}O values between ^{16}O-rich CAIs [5] and ferromagnesian chondrules [1] in CH chondrites, indicating mixing of CAI-like materials and ferromagnesian chondrules as their precursors. The lowest Δ^{17}O value from this work was obtained from the magnesian MB chondrule, which is not enriched in refractory elements unlike CAIs. The origin of the magnesian MB chondrule would be related to that of olivine-rimmed glassy chondrule in [3]. They may have formed from a ^{16}O-rich gaseous reservoir or preserved the ^{16}O-rich composition after melting [3].

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