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Oxygen isotopic composition of calcite in a CAI of Murchinson meteorite by nano-SIMS

K. Kudo (1), H. Fujimaki (1), Y. Sano (2), and N. Takahata (2)

(1) Tohoku University, Earth and Planetary Science, Sendai, Japan (kudokntr@ganko.tohoku.ac.jp, (2) Ocean Research Institute, The University of Tokyo, Nakano, Tokyo, Japan (ntaka@ori.u-tokyo.ac.jp)

Refractory inclusions (CAIs) in chondritic meteorites are commonly regarded to represent the most primitive materials formed in the solar nebula. We discovered a unique spherical CAI consisting of calcite, spinel, diopside that is partly surrounded by PCP in Murchison meteorite for the first time. Calcite coexists with spinel and diopside in the CAI, and a number of micron-sized vacancies were recognized in calcite grains using electron microscope. Such vacancies cannot be observed under the optical microscope. One apparent calcite grain seems to be an aggregate of tiny calcite fragments. The calcite grain is mostly surrounded by thin film-like diopside and then by spinel. Their occurrence suggests evidence against in-situ formation of calcite as the secondary phase on the parent body. The textual characteristics of the CAI also imply that the replacement is unlikely to produce calcite on the parent body. The oxygen isotopic data were obtained by a nano-SIMS. The primitive phases of spinel and diopside have typical low δ^{17}O and δ^{18}O values (-30 to -50 ‰) common to the primitive phases and they distribute on or near the CCAM line on the three isotopic diagram. In contrast the calcite has rather high δ^{17}O values of -7 to 11 ‰ and δ^{18}O values of 5 to 11 ‰. Oxygen isotopic compositions of spinel and diopside are similar to those of non-altered CAIs of CV chondrites. Although the calcite has rather high values of oxygen isotopic ratios, they plot neither on the TF line nor near the TF line. Their data scatter between CCAM line and TF line. Our result indicates that calcite formed initially in low δ^{17}O and δ^{18}O environments. Neither alteration nor replacement on the parental body can be recognized in the CAI (except PCP) and this may demonstrate that the neither of them should be the reason to produce isotopic shift of the calcite toward TF line. The calcite in the refractory CAI of Murchinson meteorite should keep primitive isotopic compositions of oxygen formed in the early solar nebula.