Abundances of new-PCP in Acfer 094 and other carbonaceous chondrites

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New-PCPs are the most O-17 and O-18 rich or O-16 poor material plotted on the extended slope-1 line in the three oxygen isotope diagram. It is believed that the characteristics of extremely heavy oxygen isotope anomaly are due to a remnant of primordial water ice or primordial water vapor in the solar nebula (Sakamoto et al., 2007). The new-PCP was observed in a very primitive and unique carbonaceous chondrite, Acfer 094. However, the new-PCP has not been discovered in other chondrites. Systematical studies of new-PCP in other chondrites are important to constrain the origin and the forming environment. In this study, we surveyed new-PCPs in 11 carbonaceous chondrites using a chemical mapping technique.

Polished thin sections of 11 carbonaceous chondrites were used in this study: Acfer 094 (ung.), Adelaide (ung.), Mac87300 (ung.), Ningqiang (ung.), Tagish Lake (ung), ALHA77307 (CO3.0), Colony (CO3.0), Y-81025 (CO3.0), Vigarano (CV3), Murchison (CM2) and NWA530 (CR2). The new-PCP survey was performed by electron probe microanalysis using an energy dispersive X-ray spectrometer (EDS, Oxford INCA Energy) attached on a field-emission type scanning electron microscope (FE-SEM, JEOL JSM-7000F). In order to quantify the abundances of new-PCPs in different chondrites, X-ray elemental maps were prepared for one to three regions of 1 mm x 1 mm area for each thin section using the FE-SEM-EDS. The X-ray maps consist of pixels of 0.2 micrometers/pixel, but the spatial resolution of the X-ray maps is about 1 micrometer due to the electron beam broadening in the thin sections.

Three X-ray maps of three of 1 mm x 1 mm area of Acfer 094 have been analyzed. The matrix areas were calculated to be 1.96 square millimeters in the areas. New-PCP of 39 grains were observed in the matrix area, corresponding to grain abundances of 21 grains/square millimeter. The average size and matrix normalized volume abundance of new-PCP from the observation are calculated to be 28 square micrometers and 571 ppm, respectively. There are many iron hydroxide veins across the matrix because of terrestrial weathering. New-PCP grains are found in the vein. This suggests that new-PCP grains can survive under the terrestrial weathering experienced on Acfer 094. Small dark inclusions were rarely embedded in the matrix. The dark inclusions are less than 100 micrometers across and aqueously altered clasts contained many framboidal and spherical magnetite grains. No new-PCP grains have been observed in dark inclusions. This result indicates that aqueous processes on the parent asteroid decomposed new-PCP grains.

The X-ray mapping technique has been applied to other chondrites. However, we have not found any new-PCP grains in these carbonaceous chondrites. These results suggest that new-PCP is easily decomposed under aqueous/thermal processes on carbonaceous parent bodies because it is believed that Acfer 094 is the least altered object for asteroidal processes among chondrites ever studied. If extremely heavy oxygen isotope anomalies such as in new-PCP are survived in these chondrites, magnetite would be a plausible carrier for these carbonaceous chondrites.