ABUNDANCES OF NEW-PCP IN ACFER 094 AND OTHER CARBONACEOUS CHONDRITES. K. Abe[1], N. Sakamoto[2], A. N. Krot[3] and H. Yurimoto[1, 2], [1]Department of Natural History Sciences, Hokkaido University, Sapporo 060-0810, JAPAN (abeken@ep.sci.hokudai.ac.jp), [2]Isotope Imaging Laboratory, Creative Research Initiative "Sousei", Hokkaido University, Sapporo, 001-0021, JAPAN, [3]Hawai'i Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa, Honolulu, HI 96822, USA.

Introduction: New-PCPs are the most ^{17}O- and ^{18}O-rich or ^{16}O-poor material on the slope-1 line in the solar system [1]. 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 because the new-PCP is composed of aggregates of nano-crystalline magnetite and Fe-sulfide [2, 3].

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.

The new-PCPs have similar bulk compositions of Fe: O: S ≈ 4: 4: 1 for atomic ratio. Parts of Fe are often exchanged by Ni. Such compositions are unique for the new-PCPs and have not been observed in other components of chondrites. In this report, we surveyed new-PCPs in several carbonaceous chondrites using a chemical mapping technique.

Experimental: 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 thin section of Acfer 094 was different one from the previous study [1].

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 1x1 mm^2 area for each thin section using the FE-SEM-EDS. The X-ray maps were acquired by 15 kV electron probe of 0.1 μm in diameter with 10nA beam current. The X-ray maps consist of pixels of 0.2 μm/pixel, but the spatial resolution of the X-ray maps is about 1 μm due to the electron beam broadening in the thin sections. Measurement time over 1x1 mm^2 area was about 20 hours.

We used Fe, S and O maps to identify new-PCP grains. From these elemental maps, we construct a RGB color map assigned by that red is Fe, green is S, and blue is O. New-PCPs appear as a characteristic orange color in the RGB map.

After the identification of each new-PCP grains, the exposed-surface area for each grain were determined using back scattered electron images of 10-50nm resolution.

We calculated volume and grain abundances of new-PCP normalized by matrix area. The matrix areas are excluded mineral fragments larger than ~50 μm.

A Hokudai isotope microscope system (Cameca ims-1270 + SCAPS) has been used to measure oxygen isotope distribution (isotopography) [4] of new-PCPs and the related objects. The analytical techniques of isotopography were followed those described elsewhere [1].

Results and Discussion:

Acfer 094 Three X-ray maps of 1x1 mm^2 area have been analyzed (Fig. 1) New-PCP grains were embedded throughout matrix of Acfer 094 (Fig. 2). There are many iron hydroxide veins across the matrix because of terrestrial weathering. New-PCP grains are founded in the vein (Fig. 3). This suggests that new-PCP grains can survive under the terrestrial weathering experienced on Acfer 094.

The matrix areas were calculated to be 1.96 mm^2 in the X-ray mapping areas of 3 mm^2, corresponding to 65% fraction, which is consistent to the previous matrix fraction estimate (63%) [5]. Small dark inclusions were rarely embedded in the matrix. The dark inclusions are less than 100 μm across and aqueously altered clasts contained many framboidal and spherical magnetite grains.

New-PCP of 39 grains were observed in the matrix area, corresponding to grain abundances of 20±3 grains/mm^2. The maximum and minimum sizes observed are 250 μm^2 and 0.9 μm^2, respectively. Because smaller new-PCP grains are more abundant and the size distribution appears to follow power law (Fig. 4), the observed minimum size would be limited by resolution limit of the X-ray map technique applied. The average size and matrix normalized volume abundance of new-PCP from the observation are calculated to be 28 μm^2 and 550 ppm, respectively.

No new-PCP grains have been observed in dark inclusions. This result indicates that aqueous processes on the parent asteroid decomposed new-PCP grains.

Other carbonaceous chondrites The X-ray mapping technique has been applied to Adelaide, Mac87300, Ningqiang, Tagish Lake, ALHA77307, Colony, Y-81025, Vigarano, Murchison and NWA530 over the areas of 1 mm^2, 2, 1, 1, 1, 1, 1, 1. 1, and 2, respectively. However, we have not find any new-PCP grains in these carbonaceous chondrites. These results suggest that grain abundances of new-PCP larger than 1 μm are smaller than 1 grains/mm^2 in these chondrites. This value is more than ten times smaller than the case of Acfer 094. The estimated volume abundances of new-PCP in these chondrites are calculated to be less than 1 ppm corresponding to more than five hundreds times smaller abundance comparing with the case of Acfer 094. 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.

References: [1] Sakamoto N. et al. (2007) *Science* **317,** 231-233. [2] Seto Y. et al. (2007) *MaPS* **42,** 5168. [3] Seto Y. et al. (2008) *GCA (submitted).* [4] Yurimoto H. et al. (2003) *Appl. Surf. Sci.* **203-204,** 793-797. [5] Newton J et al. (1995) *Meteoritics* **30,** 47-56,

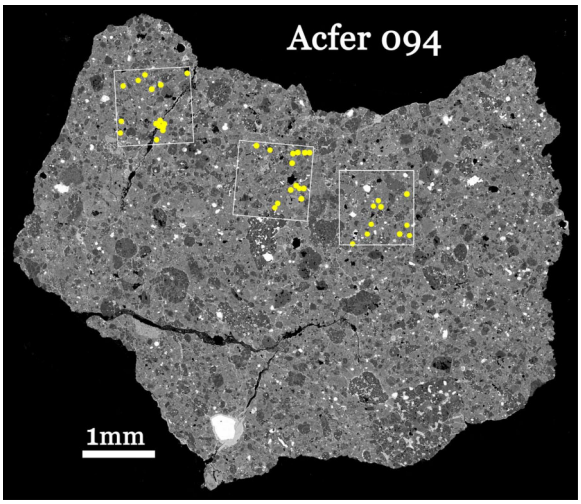

Fig. 1. Back scattered electron image of Acfer 094 thin section used in this study. Three-square regions correspond to X-ray mapping area. Yellow points in squares indicate positions of new-PCP grains embedded.

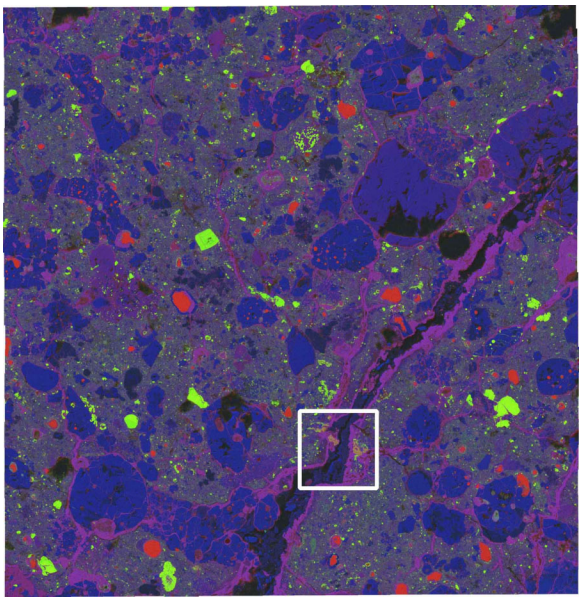

Fig. 2. RGB map combined by X-ray elemental map of Fe (red), S (green) and O (blue) of left squared region in Fig. 1. Orange color corresponds to new-PCPs, Green is Fe-sulfides and red is Fe-metals. Field of view is 1x1mm^2.

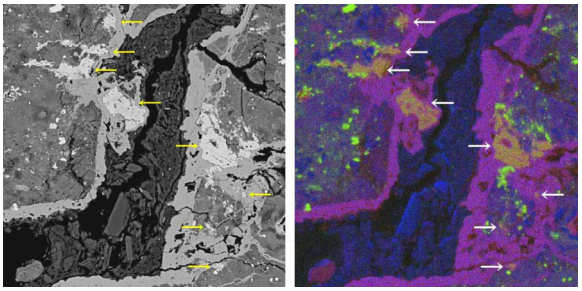

Fig. 3. BSE image and RGB map of squared region in Fig. 2. Arrows indicate new-PCP grains in weathering veins.

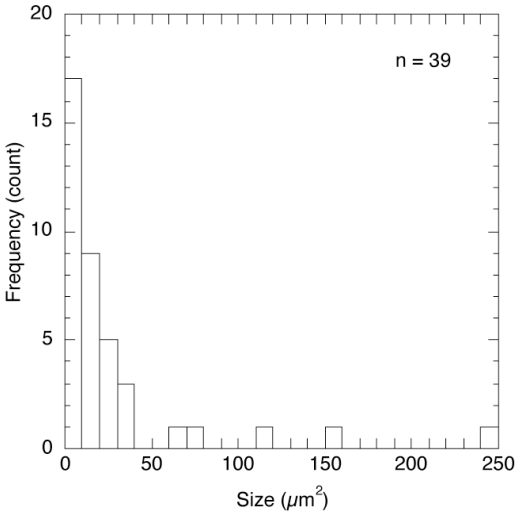

Fig. 4. Size distribution of new-PCP grains in Acfer 094.