PRESOLAR GRAINS FROM PRIMITIVE ORDINARY CHONDRITES. A.Tonotani[1], S. Kobayashi[1], K. Nagashima[2], N. Sakamoto[1], S. S. Russell[3], S. Itoh[1] and H. Yurimoto[1]. [1]Division of Earth and Planetary Sciences, Hokkaido University, Sapporo, Hokkaido 060-0810, Japan (azusa@ep.sci.hokudai.ac.jp); [2]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; [3]Department of Mineralogy, The Natural History Museum, London, SW7 5BD, U. K.

Introduction: Primitive chondrites contain trace amounts of presolar grains in the matrices. Among the presolar grains, presolar silicates have recently been discovered in primitive carbonaceous chondrites (e.g. Acfer 094, NWA 530, Y-81025, ALHA77307, Adelaide, Murchison.) [1-4]. Ordinary chondrites are the most abundant meteorite group fallen on the earth. Presolar oxide grains have been well characterized for ordinary chondrites [5-8]. On the other hand, studies of presolar silicate grains in ordinary chondrites have been only reported about one grain and two grains from Semarkona (LL3.0) and Bishunpur (LL3.1), respectively [9,10]. In this study, we report presolar carbonaceous and silicate grains in five primitive (the least aqueously/ thermally altered) ordinary chondrites; Semarkona (LL3.0), Bishunpur (LL3.1), Krymka (LL3.1), Jiddat al Harasis (JaH) 026 (L3.1) and Dhofar 008 (H/L 3.2/3.3). From the results, we discuss the abundances of presolar grains in primitive ordinary chondrites.

Sample: Polished thin sections of ordinary chondrites of Semarkona, Bishunpur, Krymka, JaH 026 and Dhofar 008 were prepared in this study.

Experimental: A Hokudai isotope microscope system (Cameca ims-1270 + SCAPS; originally installed in TiTech and now in Hokkaido Univ. (Hokudai)) has been used for in-situ survey of presolar grains [11]. We obtained secondary ion images of $^{12}C^-$, $^{13}C^-$, $^{12}C^-$, $^{27}Al^-$, $^{28}Si^-$, $^{16}O^-$, $^{18}O^-$, $^{16}O^-$, $^{17}O^-$, $^{16}O^-$ for one analytical sequence. We used a 50 μm contrast aperture (CA) except for C isotopes. A 150 μm CA was used for C isotopes. Beam irradiation time for the sequence was ~1 hour. The primary beam intensity was adjusted to ~0.3 nA. The sputtering depth was less than 100 nm for the sequence. An image processing method of moving average with 3 x 3 pixels was applied to reduce the statistical error of an isotope image (isotopograph). The other analytical methods for the isotopography were same as those in [3]. The selection criterion for distinguishing presolar grain is that one of their isotopic ratio is >2σ away from the 3σ ellipse of the distribution of isotopically normal matrix.

Results: Numbers of 3, 0, 1, 6 and 6 presolar carbonaceous grains were identified in C isotopographs of 76,900 μm^2 for Semarkona, 68,300 μm^2 for Bishunpur, 64,000 μm^2 for Krymka, 153,000 μm^2 for JaH 026 and 95,400 μm^2 for Dhofar 008, respectively (Fig. 1). Numbers of 6, 2, 3, 1 and 9 presolar silicate grains were identified in O isotopographs of 68,000 μm^2 for Semarkona, 48300 μm^2 for Bishunpur, 57,700 μm^2 for Krymka, 112,000 μm^2 for JaH 026 and 91,700 μm^2 for Dhofar 008, respectively (Fig. 2).

Matrix-normalized abundances and grain densities (in parentheses) of presolar carbonaceous grains are calculated to be 3.5 ppm (39/mm^2), <1.3 ppm (<15/mm^2), 1.4ppm (16/mm^2), 3.5 ppm (39/mm^2), 5.7 ppm (63/mm^2) for Semarkona, Bishunpur, Krymka, JaH 026 and Dhofar 008, respectively. Those of the presolar silicate grains are calculated to be 7.9 ppm (88/mm^2), 3.7 ppm (41/mm^2), 4.7 ppm (52/mm^2), 0.8 ppm (9/mm^2) and 8.8 ppm (98/mm^2) for Semarkona, Bishunpur, Krymka, JaH 026, Dhofar 008, respectively. For the abundance calculations grain size was assumed to be 0.3 μm in diameter because we cannot specify all of the grains. The 0.3 μm is expected to be the average grain size of presolar silicate grains.

Most presolar silicate grains from the ordinary chondrites are enriched in ^{17}O relative to the solar composition, categorizing into group 1 of presolar oxide grain defined by [12, 13] (Fig. 3). Two grains are enriched in ^{18}O and is categorized into group 4. One grain is depleted in ^{17}O and ^{18}O categorizing into group 3.

Discussion: The characteristics for the most presolar silicate grains enriched in ^{17}O would be an origin of O-rich red giant or AGB stars. On the other hand, two and one grains are highly enriched in ^{18}O and depleted in ^{17}O and ^{18}O, suggesting an origin high-metallicity stars or super novae and of low-metallicity red giant or AGB stars, respectively [12,13].

The abundances of presolar carbonaceous grains for LL chondrites (Semarkona, Bishunpur and Krymka) are slightly lower than those determined by exotic noble–gas components from isolated presolar grains by a chemical processing [14]. On the other hand, the abundance of presolar silicates for Semarkona is fairly consistent with the results of Nano SIMS study (4.5 ppm [9]), whereas the results for Bishunpur may be inconsistent with a Nano SIMS study (21.7 ppm [9,10]). These discrepancies suggest that presolar grains may be locally concentrated in micro-scale regions of matrices and wide area survey over hundreds-micron square areas should be required to estimate the accurate abundance of presolar grains in chondrites.

Systematic changes of presolar grain-abundances have not been observed with the petrographic sub-types. The presolar carbonaceous- and silicate- grains are distributed nearly constant in the primitive ordinary chondrites. The best estimated abundances in primitive ordinary chondrites are to be ~5 ppm for carbonaceous presolar grains and ~8 ppm for silicate grains.

The comparable abundances between carbonaceous and silicate presolar grains in ordinary chondrites may not reflect the original distributions of the presolar grains at the chondrite forming region in the solar nebula because presolar grain-abundances in primitive carbonaceous chondrites are clearly higher for presolar silicate grains than for the carbonaceous grains [3,4]. Presolar silicate grains are easily decomposed by aqueous alteration on the parent body but not for carbonaceous grains [4]. The partial decomposition of presolar silicate grains is supported by evidence of mild aqueous alteration for ordinary chondrite parent body [15].

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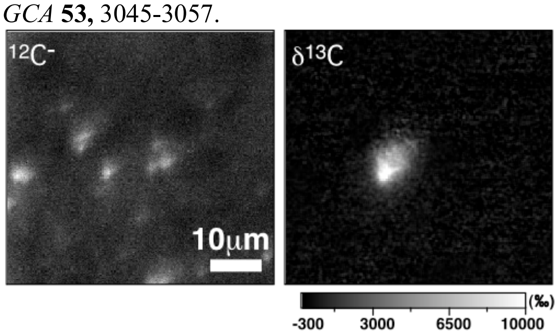

Figure 1. Corresponding images of secondary ion of $^{12}C^{-}$ (left) and of isotope ratio of $\delta^{13}C$ (right) indicating a carbonaceous presolar grain from JaH 026.

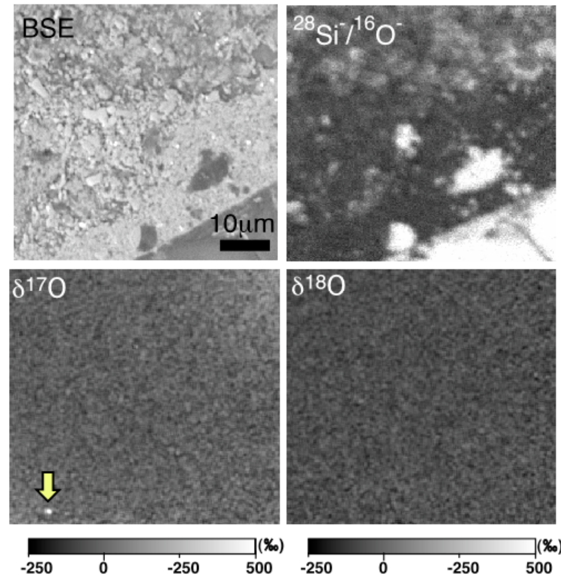

Figure 2. Corresponding images of BSE, secondary ion ratio of $^{28}Si^{-}/^{16}O^{-}$ and O-isotope ratios ($\delta^{17}O$ and $\delta^{18}O$). A yellow arrow indicates location of presolar silicate grain from Krymka.

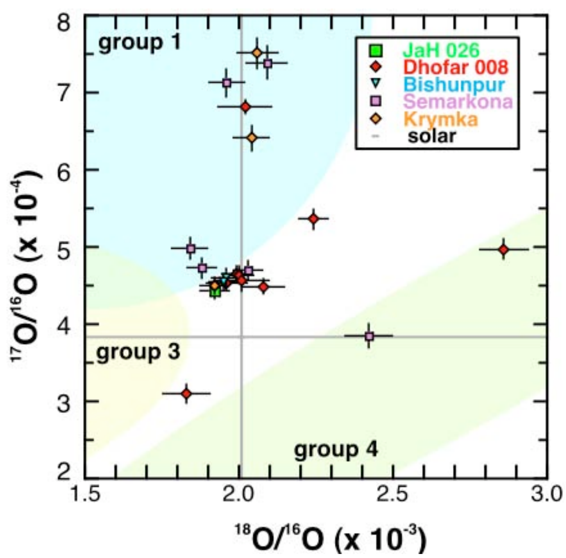

Figure 3. O-isotopic ratios of presolar silicate grains from Semarkona, Bishunpur, Krymka, JaH 026 and Dhofar 008. Error bars are 2σ. Also shown are ranges of O-isotopic compositions for three groups of presolar oxide grains defined by [12].