DISTRIBUTION OF OPAQUE MINERALS IN PRIMITIVE ACHONDRITES; K. Yugami[1], H. Takeda[1], H. Kojima[2] and M. Miyamoto[1], [1]Mineralogical Institute, Graduate School of Science, University of Tokyo, Hongo, Tokyo 113, Japan, [2]National Institute of Polar Research, Kaga, Itabashi-ku, Tokyo 173, Japan.

We studied distribution of opaque phases (FeNi metal and troilite) in three "winonaites", Yamato (Y) 74025, Y75305 and Y8005 and compared them with a lodranite-like acapulcoite Elephant Moraine (EET) 84302. The thin sections of Y74025, Y75305 and Y8005 include very large opaque grains. The difference between the distribution patterns of opaque minerals in these four meteorites may reflect the different degrees of aggregation of opaque minerals. The heterogeneous distribution of materials in each thin section and between thin sections of each meteorite indicates that the heterogeneity exists in rather small scale in the parent bodies of primitive achondrites. It supports the idea that the local heterogeneity of materials in the parent body can explain the depletion of low-temperature melting materials from lodranites.

Introduction. Primitive achondrites include acapulcoites, lodranites, winonaites and silicate inclusions in IAB and IIICD irons [1]. Their oxygen isotope compositions indicate that the parent body of winonaites and IAB irons and of acapulcoites and lodranites are different [2]. Winonaites contain Mg-rich silicate minerals [3]. The Cr contents of troilite in winonaites (0.2-0.85 wt%) are higher than those in acapulcoites (0-0.3%) [3, 4]. The distinction between winonaites and IAB irons is somewhat arbitrary [5]. Previous works on acapulcoites and lodranites suggest that iron meteorites like IAB irons can be formed in the parent body of acapulcoites and lodranites, although such iron meteorites have not been found yet [6, 7]. EET84302 is a lodranite-like acapulcoite which has large heterogeneity of distribution of minerals and large opaque grains which have complicated shapes [6, 7]. Y8005 is classified as a winonaite [8] by its texture and mineralogy (Fa 1.2% and Fs 2.2% [8]). The oxygen isotope composition of Y8005 has not been determined. In this study, we studied two winonaites Y74025, Y75305 [3, 9] and Y8005 and compared them with EET84302 to examine the trend of material distribution of meteorites between stony meteorites and iron meteorites. From the trends of opaque minerals in these winonaites, we propose a model how the opaque grains migrate to aggregate together.

Samples and techniques. We measured the areas of the polished thin sections (PTSs) and the areas (S) and perimeters (L) of opaque grains (FeNi metal, troilite, etc., except for chromite) of Y74025,52-4, Y75305,52-2 [3] Y8005,51-3 and EET84302,28 by processing the photomicrograph images on Macintosh Quadra 700 computer using the public domain NIH Image program. The value of $L/\sqrt{(4\pi S)}$ (= A) is used as an index of complexity of the grain shape [7]. The compositions of opaque minerals have been measured by using an electron probe microanalyzer (EPMA). We also observed Y74025,52-2, Y75305,52-1, Y8005,51-1 and 51-2 by an optical microscope.

Results. The entire area of PTS Y74025,52-4 is 38.7 mm^2 (Fig. 1a). The largest opaque grain is mainly troilite (Cr 0.35 wt%) with minor FeNi metal and daubreelite in one opaque grain and its area is 1.3 mm^2 (3 vol%, A = 5.4). Ni in kamacite is 6.49 wt%. Y74025,52-2 includes no large opaque grain. The total area of opaque minerals is 3.5 mm^2 (9 vol%).

The entire area of PTS Y75305,52-2 is 20.4 mm^2 (Fig. 1b). The area of the largest opaque grain is 2.2 mm^2 (11 vol%, A = 3.9). The original grain seems to have been larger because it is cut by the edge of the PTS. The large metallic grains in PTS ,52-2 nearly enclose a cluster of silicate grains. PTS ,52-1 roughly looks like ,52-2. Ni in kamacite is 7.25 wt% and Cr in troilite is 0.37 wt%.

The entire area of PTS Y8005,51-3 is 69.7 mm^2 (Fig. 1c). The area of the largest opaque grain is 5.7 mm^2 (8 vol%, A = 2.4). This grain is mainly kamacite (Ni 6.36 wt%) and it includes shreibersite (Ni 41.4 wt%) grains and taenite grains. Cr in troilite is 0.37 wt%. The total area of opaque minerals is 9.5 mm^2 (14 vol%). The opaque grains located at upper right side in Fig. 1c (A = 1.9-3.2, for the largest three) have complicated shapes that resemble the opaque grains in EET84302 (Fig. 1d). Y8005 rarely include middle-sized opaque grains which are abundant in Y74025. The silicate minerals of Y8005 are very fine-grained (0.02-0.2 mm). PTS ,51-2 resembles ,51-3. PTS ,51-1 includes no large opaque grain. Large opaque grains in Y75305 and Y8005 are mainly FeNi metal and most troilite grains exist as smaller grains between silicate grains, but the largest opaque grain of Y74025 is mainly troilite.

The entire area of PTS EET84302 is 80.7 mm^2. The area of the largest opaque grain is 1.6 mm^2 (2 vol%, A =

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3.2). The total area of opaque minerals is 18.3 mm^2 (23 vol%). Ni in kamacite is 6.16 wt% [5].

Discussion. Some opaque grains in EET84302 and Acapulco seem to align along a line, or in circles that are the parts of big networks [7]. The fact suggests that if these meteorites included more opaque minerals, they would form shapes of lines or circles. Y75305 includes large grains which apparently look like parts of a ring. These textures can not be explained by gravitational separation. The driving force to migrate Fe-Ni-S-P eutectic melt might be caused by large interface energies between solid silicates and the eutectic melt. Local temperature gradient might promote further migration. Aggregation of the eutectic melt droplets will favor the lowering of the entire surface energy of the system. The value of $L/\sqrt{(4\pi S)}$ of each grain seems to increase when the grain is not very large because narrow interstice between silicate grains are connected and the value seems to decreases when the grain grow as large as the largest grain in Y8005 to minimize the surface energy.

The largest opaque grain in Y8005 looks like an iron meteorite. The opaque grains located at upper right side in Fig. 1c have complicated shapes that resemble the opaque grains in EET84302. These grains exist only one side of an arc, and it is similar to Y75305. Y8005 has interesting heterogeneity. Cr content of Y8005 troilite is close to those of Y74025 and Y75305, in the range of winonaites. The determination of oxygen isotope composition of Y8005 is required.

Since the very large opaque grains occupy the large portion of the total amounts of opaque minerals of each PTSs, Y75305, Y74025 and Y8005 have heterogeneity of distribution of opaque minerals in the scale of one PTS. The very large opaque grains do not exist in every PTS of these samples. There are heterogeneity between different PTSs of the same meteorite. This study of winonaites supports an idea of the formation of the acapulcoite-lodranite group in that the presence of lodranite should be supplemented by the formation of metallic aggregate somewhere else, although such metallic aggregate is not represented in our meteorite collections.

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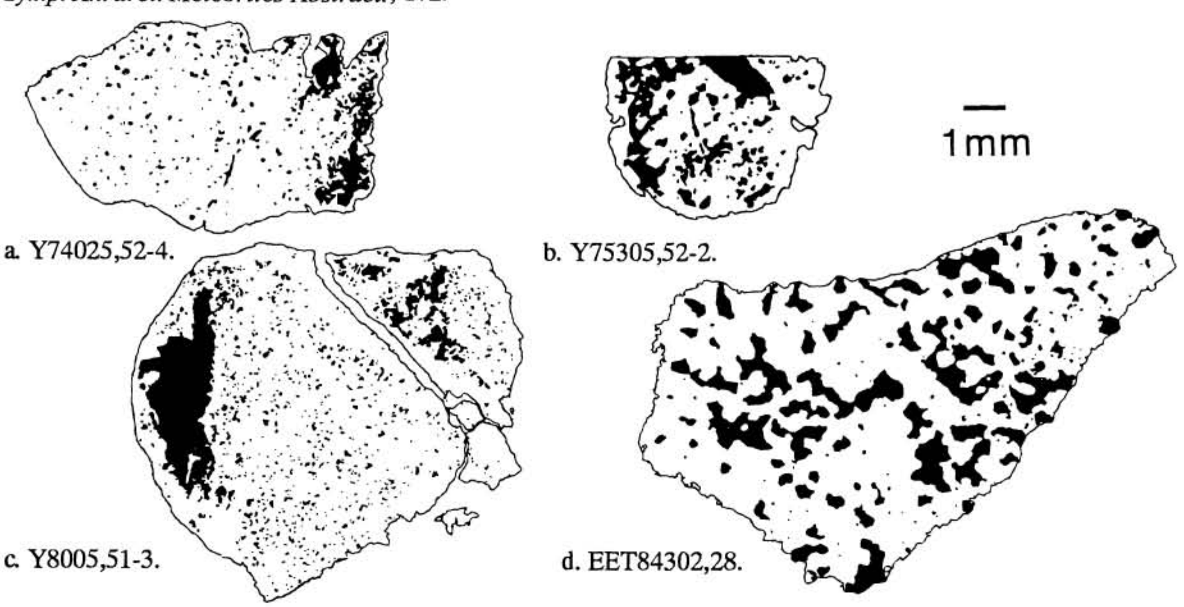

Fig. 1. Distribution of the opaque minerals in PTSs of Y74025,52-4, Y75305,52-2, Y8005,51-3 and EET84302,28 in the same scale. The black parts are the opaque minerals (FeNi metal, FeS, schreibersite etc.).