Petrofabric Analysis of Acapulcoites and Lodranites. M. Yasutake[1] and A. Yamaguchi[2], [1]Dept. of Polar Science, School of Multidisciplinary Science, SOKENDAI, [2]Antarctic Meteorite Research Center, National institute of Polar Research. 10-3 Midoricho, Tachikawa, Tokyo, Japan

Introduction: Acapulcoites and lodranites are group of primitive achondrites that are genetically related. Acapulcoites have finer-grained textures and chondritic mineral composition. On the other hand, lodranites have coarser-grained textures with depletions of troilite and plagioclase. Lodranites experienced <20 % partial melting of chondritic precursors on the basis of bulk chemical studies [1, 2]. The continuous bulk chemical and O-isotopic compositions between acapulcoites and lodranites indicate that they formed in the same parent body that experienced various degree of heating. Therefore, acapulcoites and lodranites are the most suitable meteorites to better understand early metamorphism and magmatism of planetesimals.

Petrofabric study gives us important information about deformation and melt migration [e.g., 3]. Although there are petrofabric studies of some acapulcoites and lodranites [4, 5], there has been no systematic study to reveal comprehensive petrofabric among acapulcoites and lodranites. Here, we tried to reveal relationship between petrofabric and melt migration process in their parent body.

Samples and Methods: We studied 3 acapulcoites (Acapulco, Yamato (Y-) 74063 and Y981725) and 4 lodranites (Y-74357, Y-791491, Y-791493 and Y981725). Although Y981725 has bulk composition similar with those of acapulcoite [6], we reclassified it as a lodranite on the basis of the texture. We prepared polished thin and thich section of each meteorite. We polished samples in 0.25μm diamond paste to make flat surface. After that we polished them in colloidal silica to remove surface damage. We conducted Electron Backscatter Diffraction (EBSD) analysis by using of AZtecHKL (Oxford Instruments) attached to Field Emission Scanning Electron Microscopy (FE-SEM) JEOL JSM 7100 at National Institute of Polar Research, Tokyo. The condition of EBSD analysis was working distance of ~25 mm, acceleration voltage of 15 kV and probe current of 10 nA. Samples were inclined at 70° to incident beam during analysis. Lattice Preferred Orientation (LPO) was analyzed to measure petrofabric by HKL channel 5 software (Oxford Instruments). We set olivine in Pnma space group. <100> of olivine in this study is corresponding to <010> of traditional space group, Pbnm. To avoid oversampling of large grain, we obtained one LPO data for one grain. We obtained roughly modal abundance of FeNi metal and troilite by image analysis by using of ImageJ software (National Institute of Health).

Textures: In acapulcoites, we identify 2 types of textures. Acapulco and Y981505 have equigranular textures with about 100 μm-sized grains. Y-74063 shows a heterogeneous and has more finer-grained texture with 30-100μm-sized grains. There is some rounded region which seems to be relict chondrules. All lodranites have typical coarse-grained textures. Y-74357 dominantly consists of olivine. There are many fractures filled with tiny troilite blebs in olivine grains. Y-791491 shows a poikilitic texture where many olivine grains are enclosed in orthopyroxene (Opx) and metal grains. Y-791493 has a similar texture to that of Y-791491, but has few enclosed olivine grains. Y981725 also has a poikilitic texture. Some olivine grains and Opx grains are enclosed in large amoeboid metal grains. We summarize brief features of samples we studied in Table 1.

	Texture	Metal	Troilite	DPM
Acapulco	Equi.	3.7%	4.5%	<1%
Y-74063	Hetero.	2.3%	4.5%	<1%
Y981505	Equi.	18.0%	0.7%	-
Y-74357	Equi.	6.2%	0.5%	>10%
Y-791491	Poikili.	10.3%	1.1%	>10%
Y-791493	Equi.	5.3%	0.4%	>10%
Y981725	Poikili.	20.0%	0.8%	-

Table 1. Textures, modes of FeNi metals and troilites, and degree of partial melting (DPM) of acapulcoites and lodranites.
Equigranular (Equi.), heterogeneous (Hetero.), poikilitic (Poikili.), and modal abundance (vol. %) of metal and troïlite. Degree of partial melting (DPM) are from [1].

Petrofabric: There is no strong fabric of olivine in the acapulcoites we studied. Their Multiples of Uniform Density maximum (MUD) is <4. Acapulco and Y-74063 do not show strong concentrations of LPOs of metal. However Y981505 show a strong concentration of {111} direction (Fig. 1). Inverse Pole Figure (IPF) colored mapping image of whole sample also shows widely distributed clusters of metal grains with same direction (Fig. 2). Some metal grains consist of few micrometer sized polycrystalline domains with varied directions. We did not count them in measuring of fabric. LPOs of troilite has concentration along to one direction as the LPO of Acapulco reported by [5].

In lodranites, LPOs of olivine also does not show strong fabric. However LPOs of Y-74357 and Y-74063 shows a week concentration of <100> and vacancy of <001> along to the same direction (Fig. 3). LPOs of metal shows no strong concentration. We also observed polycrystalline metal grains with

varied direction. We treated them as polycrystalline grains in acapulcoites. LPOs of troilite have concentration along to some direction. However their MUD is not as strong as concentration along to one direction of Lodran which has maximum MUD of 157 [5]. In this study we did not asses the LPO of Y-791493, because we cannot judge its LPO is native feature or result of sampling bias by small samples.

Discussion: LPOs of olivine in all acapulcoites represent random orientations. We suggest that fabric of Y-74063 is the most pristine, because it have a heterogeneous texture. This is supported by the fact that Y-74063 has chondritic bulk composition [6]. Y981505 and Y981725 had undergone further melting. Y981505 is proposed to be transitional acapulcoites to lodranites [7]. Therefore, olivine crystals in acapulcoites and lodranites had completely random fabric at first. Their fabrics were not modified during melting, at least, until the formation of transitional acapulcoite.

On the other hands Y-74357 and Y-791491 show weak fabric. Nagahara and Ozawa [4] found the concentration of c axis (<010> direction) in Y-791493 and concluded that it is made by strong magmatic flow. However, our study indicates that both LPOs show concentration of <100> rather than <010>. Further studies are needed to identify these differences. Although fabrics of Y74357 and Y-791491 are unclear, they are different from random fabric (e.g., Y981505). Therefore, we conclude that these fabrics represent pristine features during further melting.

Fabrics of metal are found only in Y981505. Y981505 shows a strong fabric which implies that the metals were interconnected. It is consistent with the result of [6] which indicates that Y-74063 experienced high degree FeNi-FeS eutectic melting. On the other hand, there are no strong fabric among lodranites with nearly the same metal-troilite modal abundance. Hidaka et al. [6] suggested that metal of lodranites are residual portion in contrast to Y981505 [6]. However, the IPF mapping images show that some neighboring metal grains have same direction. Therefore, residual metal might have a strong fabric but destroyed by further partial melting.

References:

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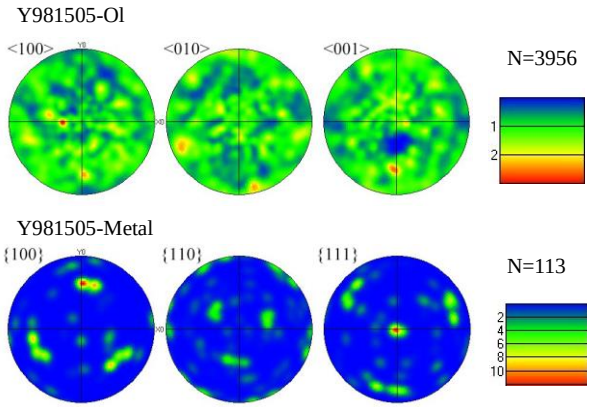

Fig. 1. LPO of olivine (upper) and metal (lower) in Y981505. Upper hemisphere and equal area projection. Density is in Multiple of Uniform Distribution (MUD). Maximum MUD is 3.00 and 12.43 respectively. N is the number of analyzed grains.

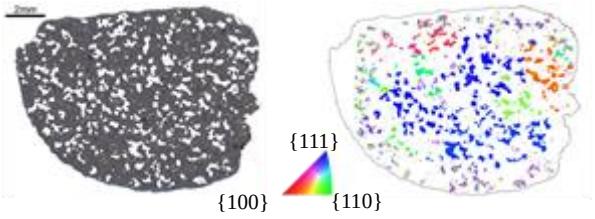

Fig. 2. Whole photo of Y981505 under reflected light (left). In this photo metal is showed by white. IPF colored mapping image of metal (right). Blue color shows metal grains of which {111} direct along to ND.

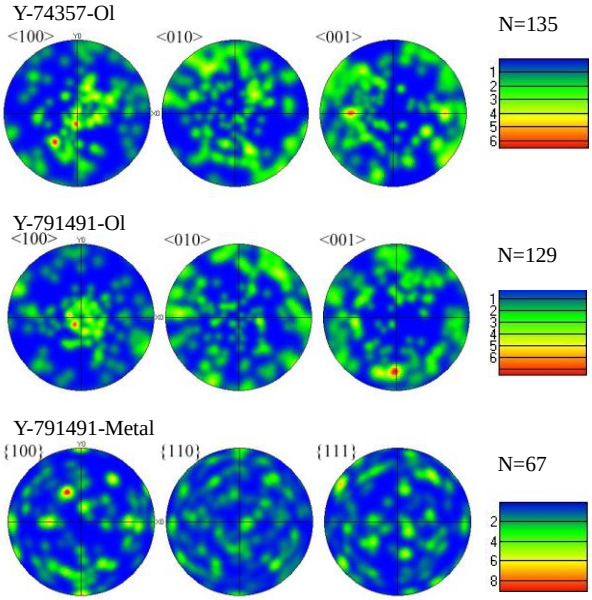

Fig. 3. LPO of olivine in Y-74357 (upper), Y- 791491 (middle) and LPO of metal in Y-791491. Upper hemisphere and equal area projection. Maximum MUD is 6.59, 7.58 and 9.13 respectively. N is number of analyzed grains.