COMPOSITIONS OF RELICT OLIVINES AND PYROXENES IN MICROMETEORITES: IN COMPARISON WITH UNEQUILIBRATED CHONDRITES. N. Imae[1] and N. Iwata[2], [1]National Institute of Polar Research, Kaga 1-chome, Itabashi-ku, Tokyo 173-8515, Japan, imae@nipr.ac.jp, [2]Department of Earth and Environmental Sciences, Yamagata University, 1-4-12, Kojirakawa, Yamagata 990-8560, Japan.

Introduction: Coarse-grained relict olivines and pyroxenes which survived the atmospheric entry heating are common in micrometeorites (MMs) except the most abundant barred olivine cosmic spherules. Most of their chemical compositions are similar to those of unequilibrated chondrites, especially to carbonaceous chonrites, but not to equilibrated chondrites (ordinary, enstatite, and Rumuruti) [1-4]. However, chemical groups in carbonaceous chondrites to which olivines and pyroxenes in MMs are similar have not been clearly distinguished so far. Compositional comparisons of these minerals in MMs with those in known chondrite groups are important in order to recognize whether MMs are originated from identical or different parent bodies of chondrites. In the present study, we carried out the comparison of olivines and pyroxenes of MMs with several unequilibrated chondrites in detail.

Experiments: We identified 23 MMs including relict olivines and 10 MMs including relict pyroxenes (9 Ca-poor pyroxenes and 1 Ca-rich pyroxene) collected from the Antarctic ice, on the coast region of the Tottuki area near Syowa Station [5]. Olivines in MMs independently occurred from pyroxenes in the study. Among 23 and 10 MMs, 14 and 8 MMs are from the filter of 40-100 μm, and 9 and 2 MMs are from one of 100-238 μm, respectively. Small Fe-Ni metal droplets occur embedded in relict olivines from 4 MMs. In order to compare compositions of these minerals, we used seven unequilibrated chondrites, Yamato (Y) 980051 (Y98) CM2, Y-81020 (Y-81) CO3.0, Tagish Lake (TL) ungrouped carbonaceous, Y-793495 (Y-79) CR2, A-881595 (A-88) unique CR2, Kainsaz CO3.2, and Semarkona LL3.0. Analyses were carried out by an electron probe micro-analyzers, CAMECA SX-100 and JEOL JXA-8200.

Results: *Olivines in unequilibrated chondrites.* Compositions of olivines in Y98 (Fig. 1a), Y-81, TL A-88 concentrate on FeO ≦ 1 wt%, making a similar chemical trend in the compositional range of FeO = 0-1 wt%. Instead, differences among these unequilibrated carbonaceous chondrites are seen for olivines of FeO ≧1 wt%, especially for compositional range of type II chondrules. While, olivines of FeO ≦ 1 wt% are scarce for Y-79 (Fig. 1b), but the majority of olivines is in the range of 1 ≦ FeO ≦ 2 (wt%), which is shifted toward 1wt% higher FeO content than those of Y98, Y-81, and TL (Fig. 1b), and the FeO content in olivines in Y-79 is more widely distributed (up to FeO = 4 wt%) than these unequilibrated chondrites.

Relict olivines in MMs. MMs including relict olivines of FeO ≦ 1 wt% is only from two (TT001b108 and TT001c5-5, Fig. 1). Most of the other olivines are distributed in the range of FeO = 1-20 wt% (Fig. 1).

Pyroxenes in unequilibrated chondrites. The occurrence of pyroxene grains in each studied unequilibrated chondrite is much smaller than that of olivines. The occurrences of pyroxenes are also different among chemical groups of unequilibrated chondrites; pyroxenes (mainly enstatites) in Y-81, Y-79, and A-88 are much more abundant than those in Y98 and TL, which are severely hydrous altered chondrites.

Relict pyroxenes in MMs. Most pyroxenes do not show any significant Fe-Mg chemical zoning (Fig. 2). One exception is TT001c4-21.

Discussion: The limited number of forsterites of FeO ≦ 1 wt% in MMs have been recognized also from other studies: two from among 26 [1], 12 among 140 [2], and 2 among 136 [3]. The scarcity of forsterite of FeO ≦ 1 wt% in MMs is consistent with consistent with the Y-79 CR2 chondrite, but not with the most other carbonaceous chondrites. The scarcity of FeO ≦ 1 wt% olivines in MMs does not exclude any similarities of MMs to the other unequilibrated chondrites because there are MMs similar to these chondrites in the range of FeO ≧ 1 wt%, e.g., olivines in TT001c5-5 are similar to those in Y98 (Fig. 1a), Y-81, TL, Y-79 (Fig. 1b), and A-88.

Enstatites in TT001b005 (Fig. 1b), TT001b083, and TT001c3-15 are consistent with those in Y-81, Y-79 (Fig. 2a), and A-88, but not Y98 (Fig. 2b) and TL. The Fe-Mg zoned Ca-poor pyroxene in TT001c4-21 is consistent with those in Semarkona (Fig. 2c). However, TT001c5-48 is unique having higher Mn content than all other studied chondrites (Fig. 2).

Conclusion: Relict olivines and pyroxenes in MMs tend to be similar to CR2 and CO3.0 rather than CM2 and TL.

Acknoledgements: We are grateful to Engrand, Duprat, and Dobrica for fruitful discussions and suggestions on studies of MMs, and also to Smithsonian Institution for the loan of the Semarkona and Kainsaz meteorites and Dr. Funaki for the Tagish Lake meteorite.

References: [1] Steele I. M. (1992) GCA56, 2923-2929. [2] Beckering W. and Bischoff A. (1995) Planet. Space Sci. 43, 435-449. [3] Williford K. et al. (2008) LPSCXXXIX #2269. [4] Imae N. and Iwata N. (2008) Meteoritics & Planet. Sci., 43, A62. [5] Iwata N. and Imae N. (2002) AMR, 15, 25-37.

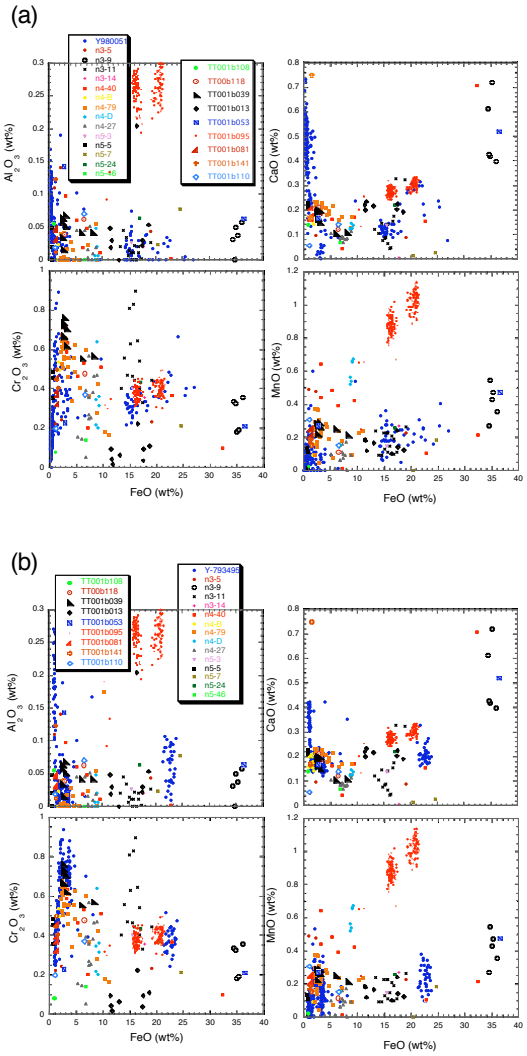

Fig. 1. 23 relict olivines in comparison with (a) Y980051 CM2 (*n*=261) and (b) Y-793495 CR2 (*n*=216).

Fig. 2. 10 relict pyroxenes in comparison with (a) Y-793495 CR2 (*n*=193), (b) Y980051 CM2 (*n*=17), and (c) Semarkona LL3.0 (*n*=74). TT001c5-21 is only Ca-rich pyroxene.