CHEMICAL CHARACTERISTICS FOR CK CARBONACEOUS CHONDRITE. M. Isa[1], N. Shirai[1], M. Ebihara[1], S. Kubuki[1] and A. Yamaguchi[2], [1]Department of Chemistry, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan. (shirai-naoki@tmu.ac.jp), [2]National Institute of Polar Research, Tachikawa, Tokyo 190-8518, Japan.

Introduction: CK chondrites became acknowledged as a new group of carbonaceous chondrites after the collection of Karonda meteorite. Approximately 200 CK chondirte samples have been recovered so far. There are two falls, Karoonda and Kobe. Most of other CK chondrites were found in the Sahara and Antarctica. CK chondrites consist of ~75% matrix and ~15% chondrules, with 0.5% CAIs [1]. The most pronounced feature of CK chondrites is their high oxidation state. Matrix has Ni-rich olivine. Fe-Ni metals are rare. Therefore, Fe exists as oxide and/or sulfide. CK chondrites are the only major group of carbonaceous chondrites that show evidence of thermal metamorphism. Their petrographic grades range from 3 to 6.

It is pointed out that CK chondrites are closely related to CV and CO chondrites based on petrology, bulk chemical composition and oxygen isotopic composition [2]. New high-precision oxygen isotope measurements reveal that CK and CV chondrites have close affinity while no possibility of a linkage between CK and CO chondrites exists [3]. Then, Greenwood et al. [3] concluded that CK and CV chondrites derived from a single common parent body. In order to investigate any relationship among CK, CV and CO chondrites, we performed bulk chemical analysis and Mössbauer spectrometry. Based on volatile elements abundances (Zn, Pb, Bi, In, Tl and Cd), we discuss about thermal metamorphism on CK chondrites.

Analytical Procedures: Table 1 lists the meteorites analyzed in this study, the published classification and some suggested classification from this work. Four CV chondrites (A-880835, A-881317, Y 86009 and Y 980146,) and two CO chondrites (A-881632 and Y 81025) were also analyzed for comparison. Bulk major, minor and trace elements abundances were determined by using prompt gamma-ray analysis and instrumental neutron activation analysis. Volatile elements (Zn, In, Cd, Tl, Pb and Bi) abundances for these chondrites were determined by isotope dilution method (for Zn, In, Cd and Tl) and external calibration method (for Pb and Bi) using inductively coupled plasma mass spectrometry (ICP-MS). Mössbauer spectrometry was used for confirmation of the valence state of iron.

Results and Discussions: *New Classification.* All Antarctic meteorites have been so far classified by petrology and mineralogy. MET 01194 was once grouped into CK chondrite and later reclassified as R chondrite based on petrology, mineralogy and bulk chemical compositions [4]. Therefore, we first examined 19 "CK" chondrites based on their chemical composition. Figure 1 compared Al/Mn and Zn/Mn ratios for chondrites. As sown in Fig 1, LAP 03834 falls in the range of R chondrites along with MET 01149. CI normalized refractory and volatile element abundances pattern for LAP 03834 is consistent with those for R chondrite but not for CK chondrites (not shown). Therefore, we suggest that LAP 03834 is R chondrite, not CK. It is also noticed in Fig. 1 that LAP 03923 and MAC 02453 exist in the LL chondrite region, suggesting that these two meteorites be classified into LL chondrite. CK are characterized by the presence of magnetite. According to Mössbauer spectrometry, these four meteorites were confirmed not have detectable magnetites. Therefore, we concluded that the three chondrites once classified into CK should be reclassified as R (for LAP 03834) and LL (for LAP 03923 and MAC 02453). It may be emphasized that bulk chemical compositions can be essential for classification of meteorites. In the following discussion, we exclude these four meteorites (MET 01194, LAP 03834, LAP 03923 and MAC 02453) from CK chondirtes.

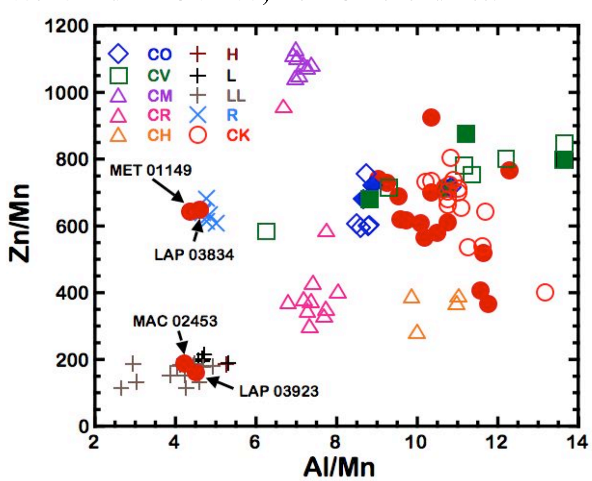

Figure 1. Al/Mn vs. Zn/Mn ratios for chondrites. Solid and open symbols represent our data and literature values, respectively.

Chemical characteristics of CK chondrites. Our Mg-, CI-normalized refractory and volatile element abundance data are compared with literature values for CK, CV and CO chondrites [2, 5] in Fig. 2. Our mean values for refractory and volatile elements are consistent with literature values for CK chondrites [2]. The CK chondrite means are similar to those of CV chondrites and higher than those of CO chondrites. Considering standard deviations of our analytical data for CK chondrites, however, bulk chemical compositions for CK chondrites seem to overlap with those for CO chondrites.

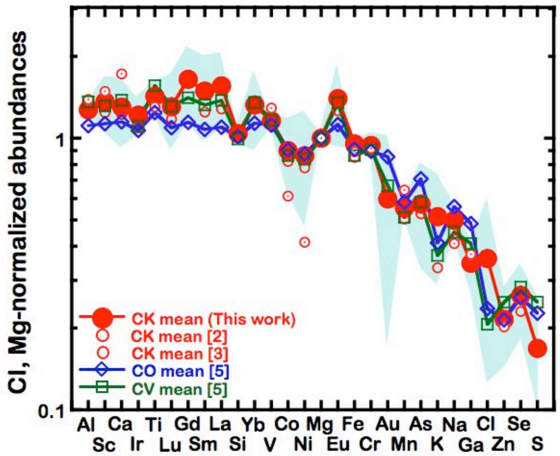

Figure 2. Mg, CI-normalized abundances for refractory and volatile elements of CK, CV and CO chondrites. Solid and open symbols represent our data and literature values, respectively. Shaded regions represent standard deviations (1σ) of 16 CK chondrites data. Elements are ordered with decreasing nebular 50% condensation temperature.

Figure 3 compared our volatile elements abundance data for CK and CV with literature values [6]. Our ICP-MS data are in good agreement with RNAA data. As reported by [6], CK chondrites have relatively high variations of Tl abundances, which is clearly seen in Fig. 3. Volatile elements abundances do not vary with petrologic type (4, 5 and 6) in CK chondrites. Although Pb, In and Cd abundances for CK chondrites are similar to those for CV chondrites, CK chondrites have somewhat lower Bi and Tl abundances than CV chondrites.

Linkage among CK and CV. Previous studies [2,3] concluded that CK chondrites are related to CV chondrite. As CK chondrites have higher metamorphosed grade than CV chondrites, it could be asssumed that CK chondrites were metamorphosed from CV chondrites. In this case, there must be differences in volatile elements abundances between CK and CV chondrites, assuming that CK chondrites were metamorphosed in a open system. Ceartainly, CK chondrites have somewhat lower Bi and Tl abundances than CV chondrites, as shown in Fig. 3,. However, this scenario is not consistent with volatile elements abundances for CK. Volatile elements abundances among CK are not varied with petrolographic grades, as seen in Fig. 3. Therefore, we concluded that CK chndrites have different source from CV chondrites in terms of elemental composition.

References: [1] Krot A. N. et al. (2004) *Meteorites, Comets and Planets*, 83-128. [2] Kallemeyn G. W. et al. (1991) *GCA*, *55*, 881-892. [3] Greenwood R. C. et al. (2010) *GCA*, *74*, 1684-1705. [4] Righter K. (2010) Antarctic Meteorite Newsletter, 33(1). [5] Wasson J. T. and Kallemeyn G. W. (1988) *Phil. Trans. Roy. Soc. Lon. Ser. A*, 325, 535-544. [6] Xiao X. and Lipschutz M. E. (1992) *JGR*, *97*, 10199-10211.

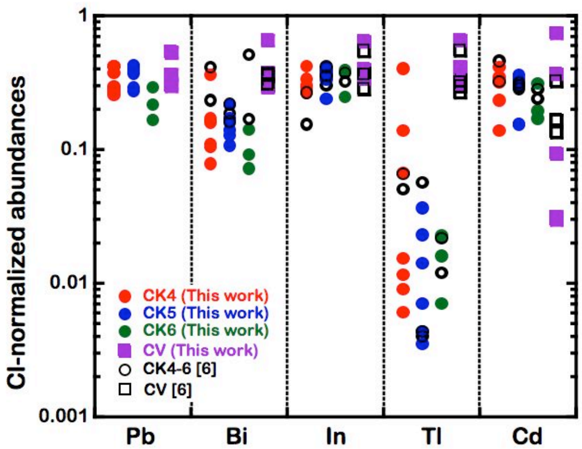

Figure 3. CI-normalized abundances for volatile elements of CK and CV chondrites. Solid and open symbols represent our data and literature values [7], respectively.

Table 1. Details of the sample analyzed in this study.

	published class	suggested class
LAP 03834	CK3	R
MET 01149	R	
ALH 85002	CK4	
DAV 92300	CK4	
EET 99430	CK4	
LAR 04318	CK4	
LEW 86258	CK4	
PCA 91470	CK4	
PCA 82500	CK4/5	
EET 83311	CK5	
EET 87507	CK5	
EET 90015	CK5	
LAP 03784	CK5	
LAP 03923	CK5	LL
LAR 06874	CK5	
MAC 02453	CK5	LL
RBT 03522	CK5	
EET 87860	CK5/6	
LAR 06872	CK6	
LEW 87009	CK6	