CHEMICAL VARIATIONS OF MILLER RANGE 07710 (L4) AND MILLER RANGE 091010 (CV3) COLLECTED IN THE ICE AT MILLER RANGE, ANTARCTICA. N. Shirai[1] and C. D. Vu[1], S. Sekimoto[2], M. Ebihara[1], K. Nishiizumi[3], [1]Department of Chemistry, Tokyo Metropolitan University, Hachioji, Tokyo 192-0397, Japan (shirai-naoki@tmu.ac.jp), [2]Kyoto University Research Reactor Institute, Senna-gun, Osaka 590-0494, Japan, [3]Space Sciences Laboratoy, University of California, Berkeley, CA 94720, USA

Introduction: Most of meteorites are currently collected from cold and hot deserts. As these meteorites may have resided on the Earth's surface, they have experienced variable degree of terrestrial weathering. Terrestrial weathering obscure petrographic and chemical features, leading to misclassification and misunderstanding of geochemistry and cosmochemistry of these meteorites. In addition, misinterpretations probably result from sampling effect [e.g., 1]. A large data set for chondrites were obtained by using 250-300 mg of sample [2,3]. This amount of sample is not enough to obtain representative chemical compositions [1]. Therefore, we examine how terrestrial weathering and sampling problem affect chemical classification by using MIL 07710 (L4) and MIL 091010 (CV3) which were collected in the ice at Miller Range, Antarctica.

Analytical methods: Eight and six different aliquots were taken from the two meteorites (MIL 07710 and 091010), respectively, and were analyzed by using INAA, RNAA, IPAA, ICP-AES and ICP-MS.

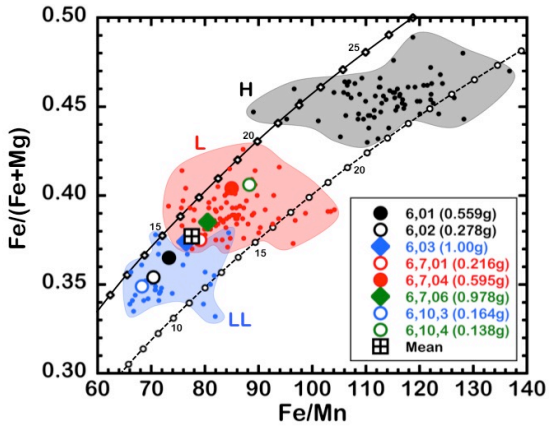

Figure 1. Fe/Mn vs. Fe/(Fe+Mg) diagram for ordinary chondrites. Solid and dash lines represent mixing between metal [10] and low Ca-pyroxene [11], and metal [10] and olivine [11]. The proportional contributions of metal are shown as percentages among the mixing lines. Parentheses in sample position represent homogenized mass.

Results and Discussion: *MIL 07710.* This meteorite was grouped into L4 based on petrological and mineralogical studies [4]. The homogeneity of chemical compositions was found to be less than 10% (1σ; n=8) for most lithophile elements analyzed. In constrast, the heterogeneity exceeding 10% was found in

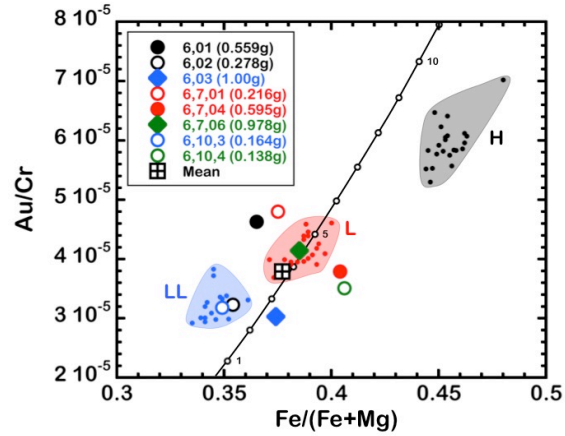

Figure 2. Fe/(Fe+Mg) vs. Au/Cr diagram for ordinary chondrites. Solid lines represent mixing between silicate and metal [10].

siderophile (Co, Ni, Os, Ir and Au) and chalcophile elements (Cu and Se). This observed heterogeneity is considered to be due to sampling problem and/or terrestrial weathering. We investigated how this heterogeneity affects chemcal classification of this meteorites. Fe/Mn and Fe/(Fe+Mg) ratios of eight different aliquots of this meteorite are plotted in Fig. 1. As seen in Fig. 1, two samples weighing about 1 g fall within the field of L, while Fe/Mn and Fe/(Fe+Mg) ratios for other samples with having less than 0.6g fall in the ranges of L and LL. Eight samples display a positive correlation between Fe/Mn and Fe/(Fe+Mg) ratios. Such a trend can be explained by different modal abundances of metal and/or terrestrial weathering of metal. Jarosewich [5] compared major element abundances of fall meteorites with those of find meteorites from Antarctica and found that total Fe contents of Antarctic H chondrites are lower than those of fall H chondrites, but that total Fe contents of Antarctic L and LL chondrites can not be distinguished from those of fall L and LL chondrites. Therefore, terrestrial weathering could not explain such a positive correlation seen in Fig. 1. Fe/Mn and Fe/(Fe+Mg) ratios for mixtures of metal and olivine, and metal and low-Ca pyroxene were calculated, and the calculated results are shown in Fig. 1. Different modal abundances of metal can explain observed positive correlation among eight samples. It is concluded that metal is heterogeneous distributed in sample weighing less than 0.6 g. Figure 2 compares Fe/(Fe+Mg) and Au/Cr ratios of three ordinary chon-

drites groups. As shown in Fig. 2., these elemental ratios are also useful for classifitcation of ordinary chondrites. In contrast to Fig. 1, most samples do not fall within the any range of ordianry chondrites. Fe/(Fe+Mg) and Au/Cr ratios of the mixture of silicates and metals are estimated, and calculated values are plotted (Fig. 2). Few samples fall on the mixing line. It is well known that sulfides and metals are more susceptible to terrestrial weathering than silicates [6] and that some Antarctic chondrites show fractionated abundance patterns for chalcophile and siderophile elements [7]. Therefore, observed scatterings of Au/Cr ratios are attributed to terrestrial weathering. Similar scattering can be seen in Ni and Ir (not shown).

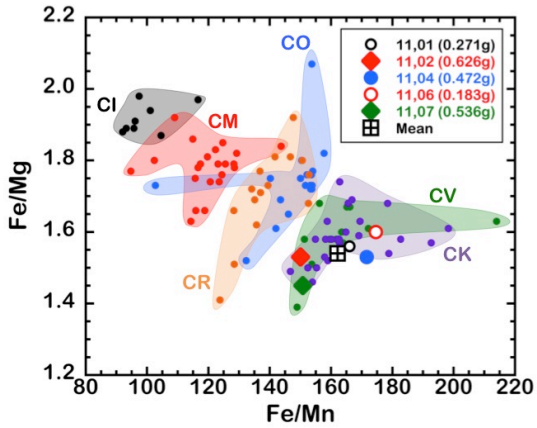

Figure 3. Fe/Mn vs. Fe/Mg diagram for carbonaceous chondrites.

MIL 091010. Compared with MIL 07710, heterogeneity of chemical compositions are significantly higher (less than 10% for Mg, P, Cr, Mn, Fe and Cu; more than 20% for other elements). It has been shown by Goodrich and Delaney [8] that carbonaceous chondrites can be easily distinguished from each other in Fe/Mn and Fe/Mg ratios. Figure 3 compares Fe/Mn and Fe/Mg ratios of carbonaceous chondrites. As seen in Fig. 3, our five samples have Fe/Mn and Fe/Mg ratios similar to those for CV and CK. It was reported that there are no clearly resolvable difference between CV and CK chondrites [9]. Our observations are consistent with mineralogical and petrological results of this meteorite [4]. Carbonaceous chondrites can be also distinguished from each other based on volatile elements abundances relative to refractory elements abundances. Figure 4 shows Al/Mn and Zn/Mn ratios of our five samples. Most samples do not fall in the ranges of CV and CK. It was observed that variations of Al/Mn ratios among the five samples are significantly higher than those of Zn/Mn. The sample mass of about 0.6g is not large enough to obtain the representative chemical compositions (Fig. 4). Aluminum is cosmochemically grouped into refractory elements, while Mn is grouped into moderately volatile elements. In CV chondrites, a major host phase for Al is considered to be CAI. Therefore, observed large variations of Al/Zn ratio are attributed to the heterogeneously distribution of CAIs. The two samples (11,04 and 11,07) have higher refractory element abundances than those for the other three samples. Such a trend can also be seen in rare earth elements (REE). Two samples (11,04 and 11,07) have higher REE abundances than those for the other three samples. One sample (11,07) has CI-normalized REE abundance pattern similar to those of CAI type II (higher light REE/heavy REE and positive Tm anomaly).

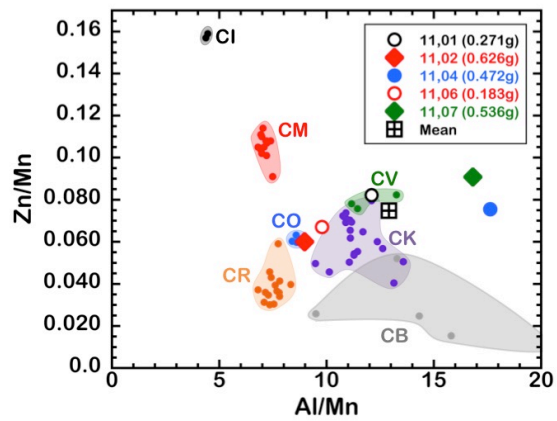

Figure 4. Al/Mn vs. Zn/Mn diagram for carbonaceous chondrites.

Halogens (Cl, Br, I). These two meteorites were encased in ice. Probably, MIL 07710 and MIL 091010 were enclosed in the ice immediately after their fall on Earth. These meteorites have Br abundances similar to those of the corresponding fall chondrites, while their Cl and I abundances are significantly higher than those of the corresponding fall chondrites. These enrichment suggest that these meteorites were not embedded in ice throughout its terrestrial history.

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