PETROGRAPHIC EXAMINATION OF UNEQUILIBRATED ORDINARY CHONDRITES WITH LOW PETROLOGIC SUBTYPES.

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Introduction: Chondrules acquired chemical and isotope signatures that reflect their formation environments and processes, which help us to understand the evolution of solids in the protoplanetary disk. However, most chondrites experienced parent body thermal metamorphism and/or aqueous alteration processes at various degrees [1,2]. Therefore, it is important to identify pristine chondrites that experience minimal parent body processes in order to investigate early Solar Systen evolution through the studying of chondrules. In particular, Al-Mg chronology requires chondrule samples from pristine chondrites with the lowest petrologic subtypes <3.1, because Mg self-disffusion in Al-rich minerals and glass is relatively fast [3, 4]. For the purpose of finding chondrules that are suitable for Al-Mg chronology, we selected six unequilibrated ordinary chondrites that have been classified as 3.00-3.05 based mainly from Cr_2O_3 contents in olivine [1]. Here we report results of our petrologic examination of metal phases in these meteorites that are sensitive to mild thermal metamorphism [2]. In addition, we compare petrography and mineral analyses of individual chondrules in these meteorites along with those of Semarkona (LL3.01).

Samples and Methods: Three North West Africa (NWA) meteorites were allocated from Institute of Meteorites, University of New Mexico; NWA 7731 (L3.00 [5]), NWA 8276 (L3.00; possibly paired with NWA 7731 [6]), and NWA 8649 (LL3.05 [6]). Three Antarctic meteorites were allocated from NASA-JSC; QUE 97008 (L3.05 [1]), MET 00526 (L/LL3.05 [1]) and MET 00452 (L/LL3.05; paired with MET 00526). We used scanning electron microscope (SEM) at NIPR for the observations of metal phases in chondrules in these six UOCs according to the method described in [2]. Chondrules from these meteorites and Semarkona (USNM 1805-9) were examined for their petrography and mineral compositions using Hitachi S-3400N SEM equipped with EDS spectrometer at UW-Madison.

Results and Discussion: The results of metal phase observations are shown in Fig. 1. All data fall in the range of 3.05-3.10 UOCs, which are consistent with their Cr abndance in olivine. However, NWA 7731 and NWA 8276 are more metamorphosed than Semarkona (L3.01), suggesting they are not as pristine as 3.00 subtype.

We examined olivine and pyroxene compositions for 80-165 chondrules from NWA 7731, NWA 8649, QUE 97008, and Semarkona (other meteorites are in progress). Although pyroxene compositions often show igneous zoning, the ranges of olivine and pyroxene Mg# (=[MgO]/[FeO+MgO] molar %) are consistent within each chondrule excluding obvious relict olivine grains. Secondary zoning in olivine is visible mainly toward the rim of large crystals (2-5 µm) and small crystals in mesostasis usually show lower Mg#. While a part of these zoning could be caused by the diffusional Fe-Mg exchange in olivine during parent body metamorphism, most of these olivine zoning would be igneous origins during chondrule formation. Chondrule mesostasis are generally unaltered, very similar to those in Semarkona. However, preliminary examination of chondrules in NWA 8276 show more extensive zonation in olivine and slightly altered mesostasis, suggesting that the meteorite would have experienced higher degree of thermal metamorphism and/or alteration.

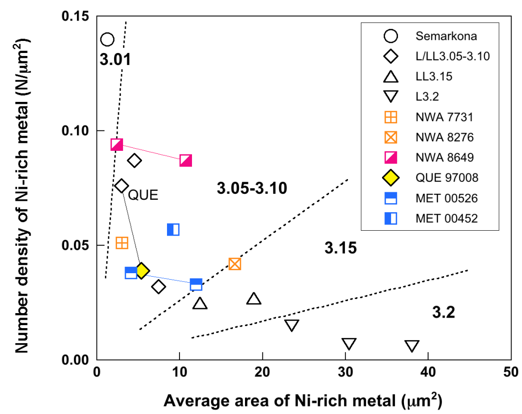

Fig. 1. Average areas versus number density of Ni-rich metal grains in metal spherules in chondrules from six UOCs. Some samples were analyzed from two sections and data are shown individually. Open symbols are those of L/LL3.01-3.2 from [2], which include data from a separate section of QUE 97008.

The total range of olivine Fo contents among chondrules seem to be systematically different between L (NWA 7731 and QUE 97008) and LL (NWA 8649 and Semarkona). Olivine compositions in LL chondrites show a narrower peak at ~90, while L chondrite contains more type II (Mg#<90) chondrules with a broader range of Fo compositions between 75 and 90. The difference may be related to bulk Fe contents (21.6% and 18.5% in L and LL, respectively [7]) and may suggest that Fe-Ni metal would have been depleted in formation regions of LL chondrites prior to the time of chondrule formation.

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