MIL03346 NAKHLITE AND NWA2737 ("DIDEROT") CHASSIGNITE: TWO NEW MARTIAN CUMULATE ROCKS FROM HOT AND COLD DESERTS. T. Mikouchi, A. Monkawa, E. Koizumi, J. Chokai, M. Miyamoto, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, E-mail: mikouchi@eps.s.u-tokyo.ac.jp.

Nakhlites and chassignite are olivine-pyroxene cumulates sharing identical crystallization and ejection ages [1]. Although Chassigny is the only sample of the chassignite group, several nakhlite samples have been found, and they show similar mineralogy and petrology, clearly suggesting a common origin from the same igneous body [2]. However, each nakhlite sample is slightly different from one another, and considered that the formation at different areas (or burial depths) in the same cumulate piles caused systematic mineralogical changes [3]. The discovery of new samples of these groups is important to better understand their formation processes and petrogenetic relationship. In this abstract we report mineralogy and petrology of the newly discovered nakhlite (MIL03346) from Antarctica and chassignite (NWA2737) from the Sahara. Because we have just started analyzing these rocks, the results here are mostly preliminary.

MIL03346: MIL03346 (MIL) is mainly composed of augite with minor olivine set in the glassy mesostasis (Fig. 1). Although the initial description reports the absence of olivine [4], the section studied (MIL03346,103) contains several olivine grains (modal abundance: 74% augite, 4% olivine, 22% mesostasis). Augite crystals are usually euhedral or lathy reaching ~2 mm long. Polysynthetic twinning is common for augite. Augite has a large homogeneous core ($En_{38}Wo_{41}$) with the ~20-30 μm zoned hedenbergite rim (~En_5Wo_{47}) adjacent to the mesostasis (Fig. 2). Both Al and Ti are positively correlated (TiO_2: 0.25-1.5 wt%, Al_2O_3: 0.8-4 wt%) with *fe#* of pyroxenes (0.35-0.9). No exsolution lamellae were observed at the pyroxene rim by FEG-SEM. Olivine is euhedral to subhedral and the largest grain reaches 3 mm across, poikilitically enclosing augite grains. Chemical zoning of olivine is extensive ($Fa_{56\text{-}93}$). Olivine cores contain 0.5-0.6 wt% CaO, which decreases down to 0.1 wt% at the rim. Olivine is altered into brown color along fractures and grain boundaries. The mesostasis is mainly composed of Si-rich feldspathic glass with skeletal Ti-magnetite (with fine ilmenite exsolution lamellae) and small crystals of Fe-rich olivine ($Fa_{\sim 90}$), hedenbergite, Ca phosphate, and silica (Fig. 1). The low total sums of Fe-rich olivine (85-95 wt%) and Ti-magnetite (90-95 wt%) in the mesostasis suggest the presence of significant amounts of Fe^{3+}.

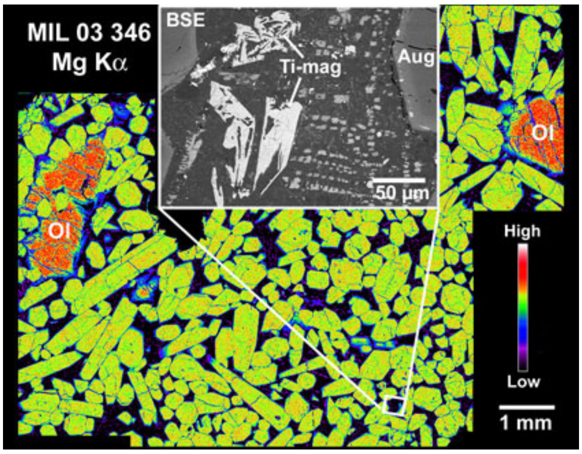

Fig. 1. Mg X-ray map of MIL. The BSE image of the mesostasis area is inserted.

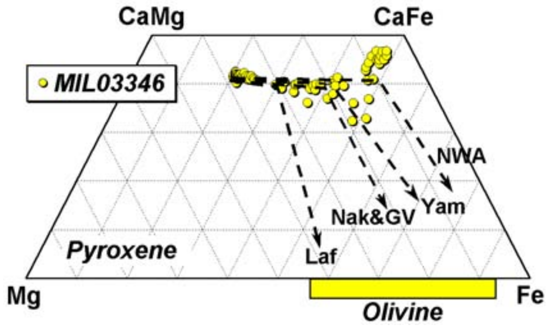

Fig. 2. Pyroxene and olivine compositions of nakhlites (NWA: NWA817, Yam: Y000593, GV: Governador Valadares, Nak: Nakhla, Laf: Lafayette).

This study shows close mineralogical affinities of MIL to other nakhlites, but NWA817 (NWA) is most similar to MIL in many respects. The abundant mesostasis (~20 %) with skeletal Ti-magnetite grains is observed only in NWA [3,5]. The Fe-rich olivine compositions ($Fa_{\sim 90}$) at their rims are similar to those of NWA (Fa_{85}) and clearly more Fe-rich than those of other nakhlites ($Fa_{68\text{-}82}$) [3]. The chemical composition of the olivine alteration product is also identical between MIL and NWA. Because it is very unlikely that the same alteration product formed in Antarctica and the Sahara, this observation supports their Martian origin [6]. We have not yet had a chance to estimate the cooling rate of MIL olivine, but we expect that it must have cooled as rapidly as NWA as judged from similar zoning patterns of Ca and Fa between the two. The only clear differences between MIL and NWA are the absence of Fe-rich pigeonite and the smaller olivine abundance in MIL. This may be because MIL cooled slightly faster than NWA. If this is the case, MIL was located at the top of the nakhlite cumulate pile [3]. Nevertheless, the presence of the identical alteration product in MIL and NWA suggests that they were closely located.

NWA2737: NWA2737 or called "Diderot" as a working name (DID) is a new chassignite found in Morocco [7]. The rock chip of this meteorite shows black color unlike Chassigny (CHA). The thin section is composed of ~89 % brown color olivine (usually 0.5~2 mm), ~3 % scattered chromite grains (~400 μm), and interstitial areas (~4 % low-Ca pyroxene, ~3 % diopside, and ~1 % alkali feldspathic glass) (Fig. 3). Olivine usually displays two sets of planar deformation structures and some grains show 120^{o} triple junctions when in contact with the neighboring grains. The Fe-Mg composition of olivine is homogeneous ($Fo_{79\text{-}80}$) (Figs. 3 and 4), but Ca shows decrease from the core to the rim (0.25-0.05 wt% CaO). The calculated cooling rate by assuming that the original Ca profile was homogeneous is 30 ^{o}C/year (1150-650 ^{o}C) (though more precise analysis is required). We analyzed the electron backscatter diffraction (EBSD) patterns of olivine and confirmed that all the obtained patterns could be indexed by the forsterite structure. Single crystal X-ray diffraction photos (precession camera) of olivine show reflections with diffuse streaks, possibly caused by strong shock (Fig. 5). It is probably responsible for the dark color of olivine. Olivine sometimes contains magmatic inclusions composed of pyroxenes, feldspathic glass, kaersutite, and some minor phases. Rare kaersutite grain associated with pyroxenes and feldspathic glass is also found in the interstitial area, which has the identical composition to that in the olivine magmatic inclusion. Because the formation of kaersutites in Martian meteorites may be related to shock metamorphism [8], this is an interesting sample to explore this hypothesis. Pyroxenes are present in the interstitial areas as both low- and high-Ca pyroxenes with the compositions scattered along a single tie line ($En_{80}Wo_2$-$En_{45}Wo_{46}$) (Fig. 4) due to the presence of fine exsolution lamellae. Feldspathic glass does not give the feldspar stoichiometry (67-70 wt% SiO_2, 17-22 wt% Al_2O_3, 1-2 wt% CaO, 3 wt% K_2O, 3-6 wt% Na_2O). Chromite shows minor chemical zoning (6-13 wt% Al_2O_3, 1-4 wt% TiO_2, 27-35 wt% FeO, 5-7 wt% MgO, 42-57 wt% Cr_2O_3).

The mineralogy and petrology of DID clearly show that it is the 2nd chassignite as O isotope analysis confirmed it [7]. Because the DID petrology is nearly identical to that of CHA [8], they are likely to have followed similar formation history. However, all the chemical compositions of mafic minerals (olivine, pyroxenes, chromite, and kaersutite) in DID are slightly more Mg-rich than those of CHA [9]. Probably, all these minerals were equilibrated with more mafic surrounding melt or they originally crystallized from more mafic parent melt than CHA. Since the olivine cooling rate of DID (30 ^{o}C/year) is close to that of CHA (28 ^{o}C/year) [10], their burial depths should have been similar.

References: [1] McSween H. Y. Jr. (2002) *Meteoritics & Planet. Sci.*, *37*, 7-25. [2] Harvey R. P. and McSween H. Y. Jr. (1992) *GCA*, *56*, 1655-1663. [3] Mikouchi T. et al. (2003) *AMR*, *16*, 34-57. [4] *Antarct. Meteorite Newsl.* (2004) *27 (2)*. [5] Sautter V. et al. (2002) *EPSL, 195*, 223-238. [6] Gillet Ph. et al. (2002) *EPSL, 203*, 431-444. [7] Beck P. et al. (2005) *LPS XXXVI* (this volume). [8] Monkawa A. et al. (2003) *LPS XXXIV*, Abst. #1534. [9] Floran R. J. et al. (1978) *GCA, 42*, 1213-1229. [10] Monkawa A. et al. (2004) *LPS XXXV*, Abst. #1535.

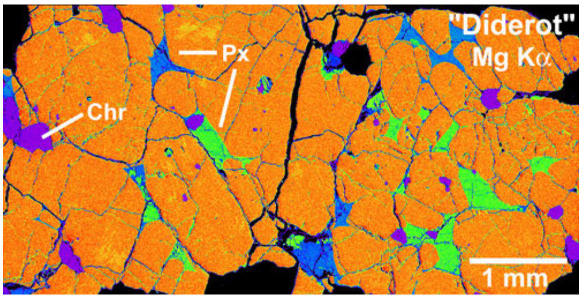

Fig. 3. Mg X-ray map of DID.

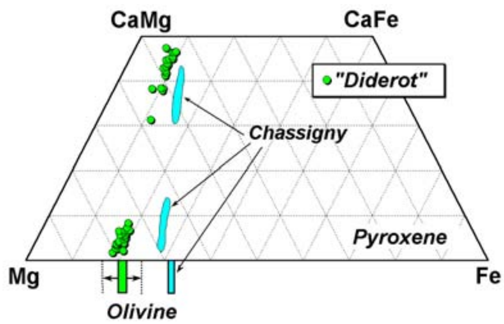

Fig. 4. Pyroxene and olivine in DID and CHA.

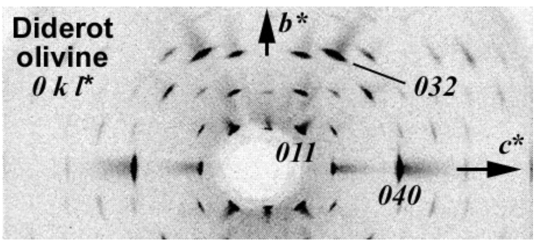

Fig. 5. A precession X-ray diffraction photograph of an olivine single crystal from DID showing diffuse streaks of reflections.