OLIVINE COOLING RATE OF THE NORTHWEST AFRICA 1068 SHERGOTTITE. T. Mikouchi and 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. (mikouchi@eps.s.u-tokyo.ac.jp)

Introduction: NWA 1068 (tentatively named, "Louise Michel") is a new shergottite recently found in the western Sahara. It is mainly composed of pyroxenes, olivine, and plagioclase glass ("maskelynite"). According to the presence of abundant olivine grains, it may be rather appropriate to call this rock "picrite". We recently obtained a small rock chip of this meteorite and here present a very preliminary result of its mineralogy and petrology. We especially paid attention to chemical zoning of olivine, and calculated its cooling rate by using Fa and Ca contents.

Petrography: The thin section studied (*ca.* 4 x 4 mm), shows a picritic texture with evidence for strong shock metamorphism (*e.g.*, maskelynitization of plagioclase, undulatory extinction of pyroxene and olivine). The modal abundances of minerals are 51.6% pyroxenes (42.3% low-Ca pyroxene and 9.3% augite), 27.2% olivine, 15.5% plagioclase glass, 1.8% Ca phosphates, 1.4% ulvöspinel, 1.3% K-feldspar, 0.6% Fe sulfide, and 0.5% chromite. Pyroxenes show polysynthetic twinning, and are euhedral to subhedral. The pyroxene size is usually several tens of µm though some lath grains reach up to 500 µm. Olivines exhibit variable textural forms. They are euhedral to subhedral and usually present as single crystal, yet clusters of multiple grains also occur. Abundant spinels are sometimes associated with olivine grains. The largest olivine single grain reaches 1 mm. Some interesting feature of olivine is the presence of the outer edges of the remnant euhedral crystal overgrown by the olivine rims (Fig. 1). This feature is further explored in later to estimate a cooling rate of olivine. Olivines often contain magmatic inclusions (Al-, Ti-rich pyroxenes plus feldspathic glass). Plagioclase glass ("maskelynite") is subhedral to anhedral (interstitial to pyroxenes and olivine) and reaches up to 100 µm. Minor phases include euhedral chromite sometimes rimmed by ulvöspinel (~a few hundreds of µm), Ca phosphates (~several tens of µm), and Fe sulfide. Terrestrial weathering is not significant.

Mineral Chemistry: We have had only two days yet to analyze the thin section by electron microprobe. Therefore, the analytical result presented here should be revised by the time of the conference.

Both low- and high-Ca (augite) pyroxenes are present, but augite abundance is small. Pyroxenes are extensively zoned, and their compositions range $En_{68}Wo_5$ to $En_{48}Wo_{11}$ and $En_{51}Wo_{27}$ to $En_{33}Wo_{31}$ (Fig. 2). Al_2O_3 and TiO_2 contents in low-Ca pyroxene are 0.5-3.0 wt% and 1.1-3.5 wt%, respectively. In augite, they are 0.08-0.8 wt% and 0.2-1.0 wt%, respectively. Olivine is also remarkably zoned. Large olivine grains have the Fa_{25-30} core and zoned towards the Fa_{50-55} rims (Fig. 2). Minor elements in olivines are 0.4-1.0 wt% MnO, 0.4-0.1 wt% CaO, 0.05-0.2 wt% Al_2O_3, and ~0.1 wt% NiO. Plagioclase composition ranges from $An_{57}Or_2$ to $An_{42}Or_5$ (Fig. 2). Plagioclase contains 0.5-1.0 wt% FeO.

Olivine Cooling Rate: The presence of the "ghost" euhedral crystal in one of the olivine grains suggests that there was an interval or change of environment between the crystallization of the inner olivine and overgrowth (Fig. 1). Also, this olivine is rimmed by pyroxene having the same extinction under optical microscope (Fig. 1). This may be because the pyroxene is a reaction product between olivine and surrounding magma. The microprobe traverse from the olivine core to the overgrowth could offer information about its cooling history. Fa zoning shows a systematic increase towards the rim (Fig. 3). However, Ca zoning marked the boundary between the inner original olivine and overgrowth (Fig. 3). We calculated the cooling rate of olivine by analyzing these zoning profiles. The detailed calculation procedures are in [1]. We assumed that the original composition was homogeneous (Fa_{29}, CaO: 0.33 wt%). Cooling calculations were performed for the temperature ranges of 1300-900 ^{o}C and 1200-800 ^{o}C, respectively. The obtained best fit cooling rates for 1300-900 ^{o}C are 10 ^{o}C/hr (Fa) and 0.5-1.0 ^{o}C/hr (Ca), respectively (Fig. 3). The 1200-800 ^{o}C cooling gave slower cooling rates. They are 3 ^{o}C/hr (Fa) and 0.2 ^{o}C/hr (Ca), respectively (Fig. 3). Although the Ca zoning provides one order of magnitude slower rates than Fa, the slowest cooling (0.005 ^{o}C/hr for 1200-800 ^{o}C of Ca) corresponds to the burial depth of only 2 meters. Therefore, these results suggest that olivine cooled near the surface in spite of the wide range (0.05-10 ^{o}C/hr) of the obtained cooling rates.

Implications: In our previous study, we suggested that EETA79001 and Dar al Gani 476 crystallized near the martian surface (burial depth: <3 m) [1]. The obtained cooling rate for NWA 1068 olivine is also comparable to this. However, the presence of homogeneous large "ghost" olivine implies that the olivine crystallization may have occurred at depth and subsequent eruption to the surface (or some environmental change) may have caused rapid groundmass crystallization. Thus, most shergottite samples in our hands indicate rapid cooling. We briefly compared the compositions of the major phases in several shergottites (Fig. 2). Nevertheless, it is not clear yet whether NWA1068 and other shergottites are petrogenetically related. Further analysis is required to discuss this.

Acknowledgment: We thank University Museum at University of Tokyo for the sample.

References: [1]Mikouchi T. *et al*. (2001) *Meteoritics & Planet. Sci.*, *36*, 531-546.

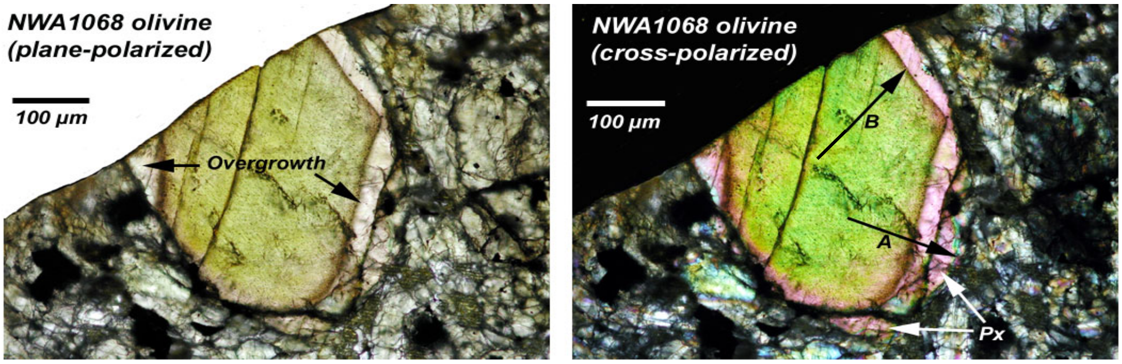

Fig. 1. Photomicrographs of a unique olivine grain in NWA 1068. Left: Plane-polarized light. Right: Cross-polarized light. Note the presence of euhedral "ghost" olivine rimmed by the overgrown olivine ("Overgrowth"). In the right image, pyroxene ("Px") is again rimming the overgrown olivine. It is interesting that they share the same extinction angle under cross-polarized light. The arrows "A" and "B" in the right image are microprobe traverses. "B" is used to calculate the olivine cooling rate (Fig. 3).

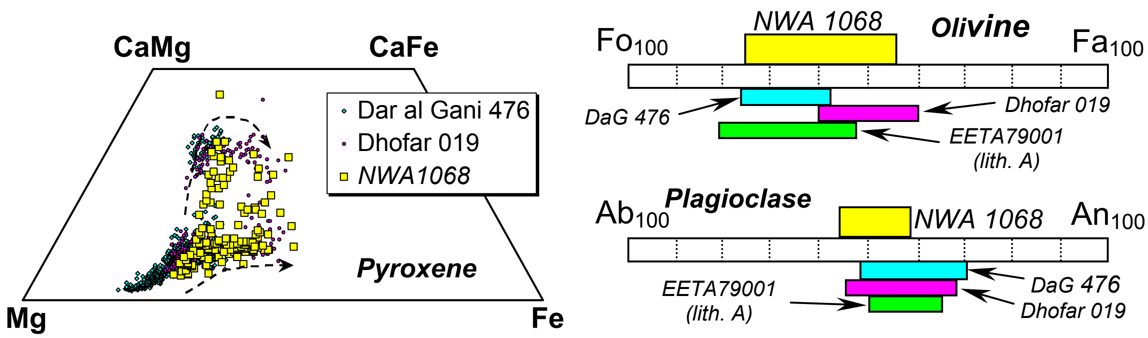

Fig. 2. Pyroxene, olivine and plagioclase compositions of NWA1068. Data from Dar al Gani 476, Dhofar 019, and EETA79001 (lithology A) are also shown for comparison.

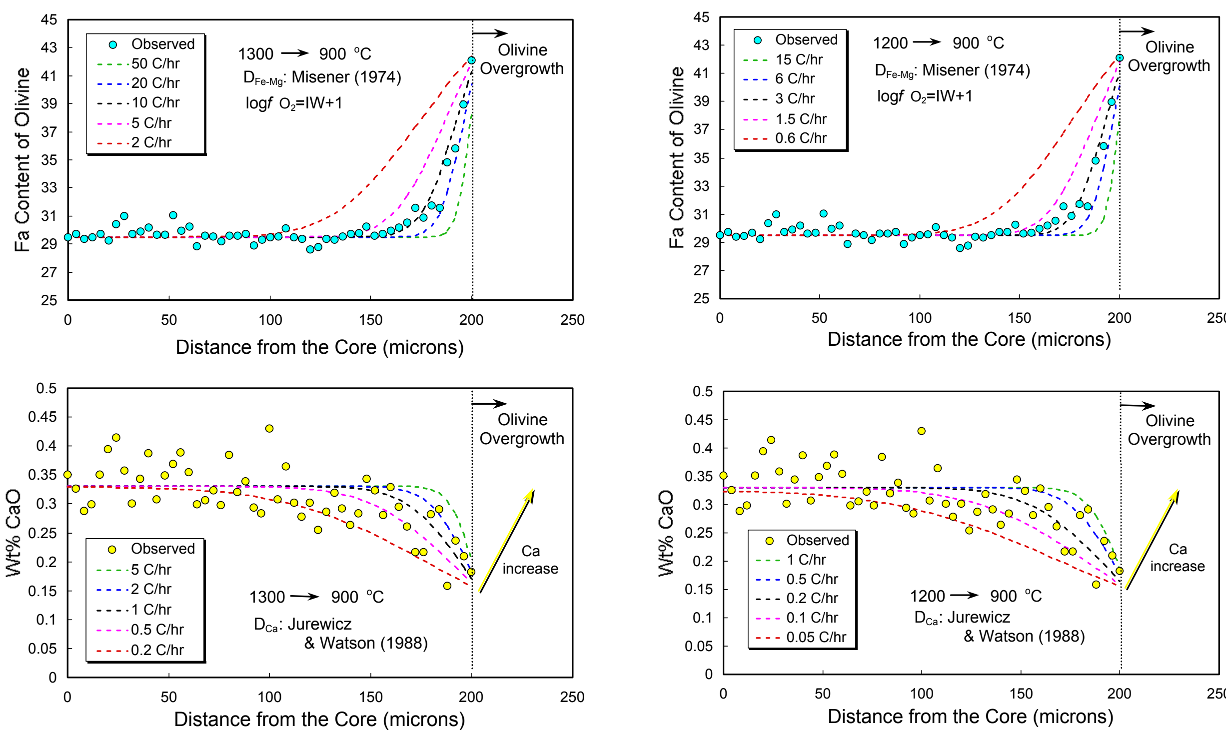

Fig. 3. Observed (colored circles) and calculated zoning profiles (dashed lines) of Fa and Ca contents in olivine from NWA 1068. The microprobe traverse is shown in Fig. 1 (Line "B"). Left: Cooling from 1300 to 900 ^{o}C. Right: Cooling from 1200 to 800 ^{o}C.