MINERALOGY AND PETROLOGY OF THE OLIVINE PHYRIC SHERGOTTITE NORTHWEST AFRICA 4880. Q. He[1, 2], L. Xiao[1]. [1] Planetary Science Institution, China University of Geosciences, Wuhan, 430074, China. [2]. Department of Earth, Atomospheric & Planetary Sciences, Massachusetts Institute of Technology. MA 02139.

Introduction: NWA 4880 was found in 2007 in the same area as NWA 2975/2986/4766 and 4783 and all such meteorites might be paired. However, our petrologic work shows that NWA 4880 has an olivine-phyric texture, which is different from other basaltic shergottites. Here, we report the mineralogy and petrology of this meteorite that, up to date has not got much attention.

Petrology: NWA 4880 has a porphritic texture consisting of olivine phenocrysts (grain size ~ 0.3- 0.5 mm) in a fine-grained groundmass (grain size ~50-100 microns) (Fig. 1). The olivine phenocrysts occur in clusters, of which, some contain chromite and melt inclusions, and some appear corroded/resorbed texture (The olivine grains have been broken apart and intruded by groundmass material, Fig. 2).

The olivine phenocrysts are zoned from Mg-rich cores to more Fe-rich mantles (Fo_{70-57} -Fo_{65-53} from core to rim). However, they are relatively lower Mg compared to most primitive olivine-phyric shergottites such as Y 98 and LAR 06319[1, 2]. Most of the olivine grains are usually euhedral, and corroded olivines are also present. Fig. 3 shows two megacryst olivines. Ol1 has a prominently homogeneous core with a zoned Fe-rich rims, while Ol2's core is inhomogeneous, suggesting a complex petrogenetic history.

The fine-grained groundmass consists mainly of euhedral to subhedral pyroxene crystals and interstitial maskelynite and small unzoned olivine grains (< 0.13mm). Minor phases are chromite, Ti-chromite, ilmenite, sulfides, merrillite, Cl-apatite, fayalite and a K-rich mesostasis glass. Shock-induced melt veins and pockets are observed (Fig. 2).

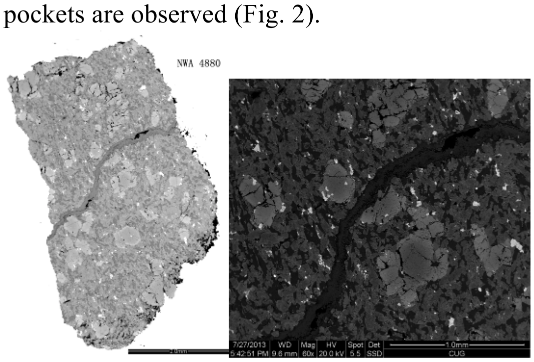

Fig. 1. The back-sattered electron (BSE) image of NWA 4880 thick section used in this study. The enlarged area is shown in the right.

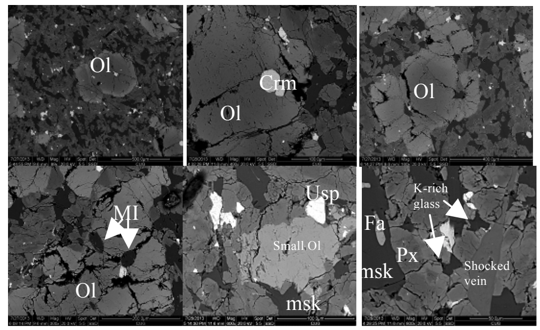

Fig. 2. Petrographic features in NWA 2975. Ol-olivine; Px-pyroxene; msk-maskelynite; Crm-chromite; Usp-ulvöspinel; Fa- fayalite; MI-melt inclusion.

Both pigeonite and augite are present as subhedral to euhedral crystals and they are also zoned (from core to rim $En_{65}Fs_{28}Wo_7$ to $En_{46}Fs_{43}Wo_{10}$, and $En_{55}Fs_{25}Wo_{20}$ to $En_{36}Fs_{42}Wo_{22}$). The zoning of pyroxenes in NWA 4880 resembles that observed in NWA 1068[3] as in Shergotty and Zagami (Fig. 4), but is different from that of LAR 06319 (with pigenite core, augite rim and outmost Fe-rich rim [4]).

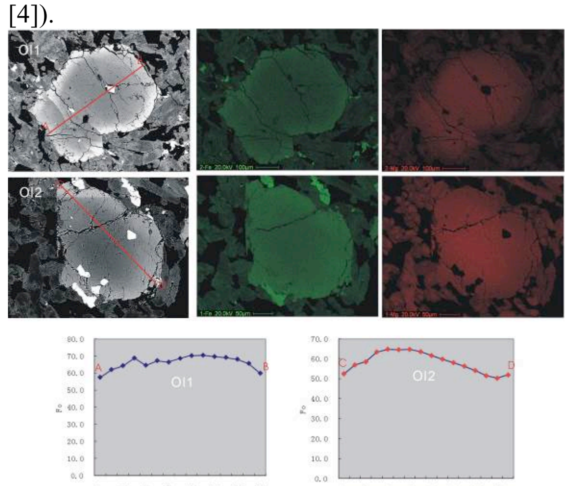

Fig. 3 Back-scattered electron (BSE) images (left) and Fe (middle) and Mg (right) X-ray mappings of two olivine phencrysts. Fe X-ray in green and Mg X-ray in red. The shading shows that olivine megacrysts are zoned from Mg-rich cores (dark) to more Fe-rich mantles (brighter).

Plagioclases have entirely been converted to maskelynite and cluster tightly near a composition of $An_{48-53}Or_{2-5}$. Smaller unzoned olivines in matrix are more Fe-rich ($Fo_{48\pm4}$), and homogeneous in terms of major elements. Small fayalites always occurred in maskelyntes (Fo= 39-41, Fig. 2). Both merrillite and Cl-apatite are present in NWA 4880. The majority is merrillite in composition with 1.4 to 2.8 wt% MgO.

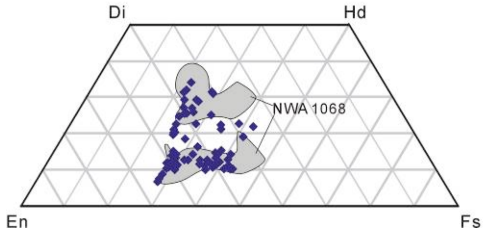

Fig. 4. Pyroxene compositions in NWA 4880 and olivine-bearing enriched shergottite NWA 1068.

Four types of Cr-Fe-Ti oxides are found in NWA 4880(Fig. 5). Chromites, most of which are mainly euhedral or subhedral grains with a composition of $Chm_{76-80}Sp_{12-13}Usp_{1-3}Mt_{5-8}$, are enclosed in the olivine megacrysts. Ti-rich chromites are in contact with maskelynite with a composition ($Chm_{32-46}Sp_{8-12}Usp_{17-26}Mt_{25-35}$) and the edges have less Cr and more Fe. Ulvöspinels are enriched in TiO_2 (19-24wt %), with low Al_2O_3 (2.1-2.5wt %) and Cr_2O_3 (7-9wt %) contents with the composition of $Chm_{11-14}Sp_{5-6}Usp_{55-71}Mt_{11-28}$. Ilmenite always attached to ulvöspinel as the exsolution products (Fig. 5).

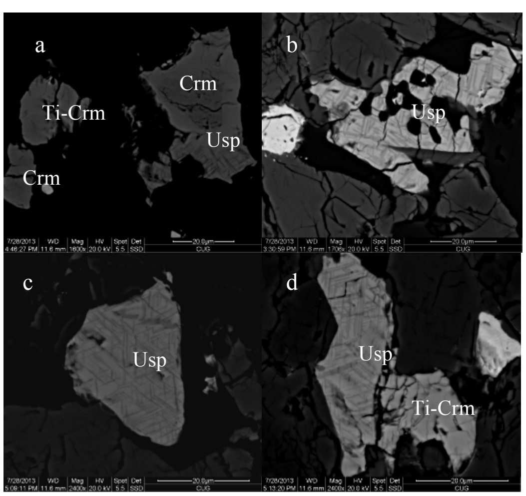

Fig. 5. Backscattered-electron image Cr-Fe-Ti oxides. a, ulvöspinel (clear gray) with a chromite core (gray). b, a skeletal ulvöspinel (clear gray). The crystal contains K-rich mesostasis (black) and is in contact with maskelynite. c and d, ulvöspinel grains have fine exsolution lamellae of ilmenite.

Igneous Petrogenesis and discussion:

The origin of the olivine megacrysts in most olivine-phyric shergottites (e.g. NWA 1068, DaG 476, SaU 005, EETA, LAR 06319) is a matter of debate as they are xenocrysts or cumulate crystals [3-6]. In fact, the occurrence of large corroded crystals and the observation that polycrystalline assemblages are sometimes broken apart and intruded by groundmass material, suggest that the olivine megacrysts are xenocrysts. We suggest that some of the NWA 4880 megacrysts might originate from disrupted cumulates, probably with strong affinities with peridotitic shergottites. The answer could be possibly given by detail analyses of the inclusions, as shown in the DaG, SaU and LAR 06319 shergottites to discuss more precisely the origin of the megacrysts.

Previous studies have shown that martian magmas have a wide range of oxygen fugacities (fO_2) [7]. The Cr-Fe-Ti oxides assemblages are conducive to the application of oxybarometers, and Peslier et al. [4] argued that fO_2 can increase during shergottite magma differentiation process, producing more oxidized magmas. NWA 4880 might also show a variation of the fO_2 with crystallization resemble that of LAR 06319. The crystallization of olivine megacrysts cores to rims, and then small olivine in matrix are concurrently with crystallization from chromites to Ti-rich chromites, and then to ulvöspinel.

NWA 4880 shows close affinity in mineral to olivine-phyric shergottite NWA 1068. Both of NWA 4880 and NWA 1068 are distinctly porphyritic, but the matrixe in NWA 4880 is much finer grained (0.5-1.0 mm). This may imply that all stages of grain growth apparently occurred more rapid cooling in comparison to other porphyritic shergottites. The whole rock composition of NWA 4880 is required in further study in order to check if it has a similar flat REE pattern as NWA 1068.

References: [1] Usui et al. (2008) Geochim. Cosmochim. Acta 72:1711-1730 [2] Basu Sarbadhikari et al. (2009) Geochim. Cosmochim. Acta 73: 2190–2214 [3] Barrat et al. (2002) Geochim. Cosmochim. Acta 66 , 3505–3518 [4] Peslier et al. (2010) Geochim. Cosmochim. Acta 74, 4543-4576 [5] Geochim. Cosmochim. Acta, 47,1501–1513 [6] Goodrich (2003) Geochim. Cosmochim. Acta 67, 3735–3771 [7] Herd C. (2003) MAPS, 38, 1793-1805; Wadhwa M. (2001) Science, 291, 1527-1530.