PETROGRAPHY AND GEOCHEMISTRY OF THE SHERGOTTITE NORTHWEST AFRICA 2975. Q. He1, W. Hsu1, L. Xiao1, Y. Guan2. 1 Faculty of Earth Science, China University of Geosciences, Wuhan, 430074, China. 2 Division of Geological and Planetary Sciences, Caltech, CA 91125.

Introduction: NWA 2975 is a basaltic shergottite found in Morocco [1]. An initial study of the petrology and mineralogy indicates that it is one of the more evolved basaltic shergottites identified similar to Shergotty and Los Angeles [2]. Here, we report the major and trace element concentrations of individual minerals in NWA 2975, combining with oxybarometry to provide new insights into Martian differentiation history.

Petrology: NWA 2975 is a medium-grained, subophitic to granular texture basalt composed primarily of clinopyroxene and maskelynite [2]. Accessory phases include ulvöspinel, ilmenite, merrillite, pyrrhotite, Si-Al-K-Na-rich glass and baddeleyite. Fresh fusion crusts (partial), shock-induced melt veins and pockets are observed.

Pyroxenes in NWA2975 have late-stage overgrown Fe-rich rims (Fig. 1) that mostly have exsolution features. Some later crystallized pyroxenes are extremely Fe-rich (Fig. 2). Plagioclases have entirely been converted to maskelynite (An25-54Or1). Some trapped melt inclusions or melts intrude in large ulvöspinel grains. These melts exhibit marginal rims of Fe-rich pigeonite + merrillite surround cores of Si-Al-K-Na-rich glass (Fig. 3a). Ilmenite always attached to ulvöspinel as the exsolution products (Fig. 3b). Ulvöspinel are enriched in TiO2 (22-25wt %), with low Al2O3 (1.6-2wt %) and Cr2O3 (0-1wt %) contents.

REE Geochemistry: In situ REE analyses were carried out for pyroxene, maskelynite, merrillite, mesostasis glass, and the fusion crust of NWA 2975. Representative REE patterns are reported in Fig. 4. Both pigeonite and augite from cores and rims were analyzed. Augite has higher REEs than pigeonite. Both show HREE enriched patterns (Fig. 4a).
comparison with abundances for “enriched” basaltic shergottites (data from [3]).

There are two groups of pyroxenes according to their Eu anomaly. Pigeonite and augite from the cores do not have pronounced Eu anomalies, whereas the pyroxenes in rims have small negative Eu anomalies. In addition, some of augites in rims appear to be affected by terrestrial weathering, showing elevated their LREE contents from La to Sm (Fig. 4b). Maskelynite is generally depleted in REEs (except for Eu) with a LREE-enriched pattern and positive Eu anomalies. Merrillite has the highest concentrations of REEs (~400 × CI), with a negligible negative Eu anomaly.

The CI-chondrite-normalized REE patterns for the whole rock (fusion crust) are parallel to that of “enriched” basaltic shergottites, but with higher the absolute abundances.

**Fig. 5.** CI-chondrite-normalized REE patterns for calculated melts equilibrated with the cores of pyroxene, plagioclase and merrillite of NWA 2975.

We estimated the REE compositions of parent magmas that equilibrated with the cores of augite, pigeonite, plagioclase and merrillite in NWA 2975, respectively, using the REE partition coefficients (Ds) in [4]. As shown in Fig. 5, the melt calculated from the Augite (cores) have equivalent REE abundances and patterns to fusion crust. The calculated melt from pigeonite and plagioclase have higher REE abundances suggest that they may have encountered thermal reequilibration.

**Oxygen fugacity from mineral equilibria:** Recent studies have shown that Martian magmas had a wide range of oxygen fugacity (fO2) and that this variation is correlated with the variation of La/Yb ratio and isotopic characteristics of the Martian basalts, shergottite meteorites [4]. Oxygen fugacity for NWA 2975 magma was estimated based on coexisting Fe-Ti oxides (ulvöspinel-ilmenite, Fig. 6). For basaltic rocks, they are among the last crystallized phases. Thus, the oxides may record temperatures (725°C) and oxygen fugacities (~3.4 NNO) that lower than those of the original magma. Our result also implies that oxygen fugacity can vary during cooling throughout the crystallization sequence of a basaltic melt.

**Fig.6.** Oxygen fugacity (lg fO2) vs. temperature for coexisting ilmenite and ulvöspinel pairs. NNO: nickel-nickel oxide buffers.

**Igneous Petrogenesis:** Petrographic and geochemical analyses suggest that pyroxene and plagioclase are the first phases crystallized from the parental melt, and then Fe-rich pyroxenes. Finally the residual melt crystallized ulvöspinel associate with extremely Fe-rich pyroxene, silica mineral, alkali feldspar and phosphates. Fe-rich pyroxenes contain exsolution suggest the original lithology was cooled slowly, which is also consistent with the ulvöspinel exsolution phenomena.

The REE patterns and abundances in NWA 2975 indicate that its parent melt had a trace element budget similar to those of the other enriched basaltic shergottites. The oxygen fugacities of the NWA 2975 parent magma decreased during slow cooling. REE contents of Augite cores were equilibrium with the original parent melts, while the pigeonites and plagioclases were re-equilibrated. The pigeonite rims crystallized under lower fO2 condition have slightly Eu negative anomalies and had terrestrial weathering signatures.