PRELIMINARY PETROGRAPHIC AND MELT-INCLUSION STUDIES ON THE NORTHWEST AFRICA 7397: ANOTHER ENRICHED "LHERZOLITIC" SHERGOTTITE. Q. He[1] (qi_he@cug@edu.cn), L. Xiao[1]. [1] Planetary Science Institute, Faculty of Earth Science, China University of Geosciences, Wuhan, 430074, China.

Introduction: Lherzolitic shergottites are a small subgroup of shergottites that share similar petrology and geochemistry, and were probably ejected from same igneous unit on Mars [e.g. 1, 2]. Recently, RBT 04262/1 and GRV 020090 are reported as enriched "lherzolitic" shergottites, distinct from other lherzolitic shergottites with geochemically kin to enriched basaltic shergottites [3-5]. NWA 7397 is a new lherzolitic shergottite found in Morocco in 2012. Our detailed petrologic and comparison studies suggested that NWA 7397 is probably another enriched "lherzolitic" shergottites that similar to RBT 04262/1 and GRV 020090. Here, we report petrologic study on NWA 7397, combining with oxybarometry and melt inclusion study to provide new insights into the petrogenetic relationships among shergottites.

Petrology: NWA 7397 is lherzolitic shergottites. Like other lherzolitic shergottites, NWA 7397 exhibits two distinct lithologies: poikilitic and nonpoikilitic (Fig.1). The poikilitic area (30%) is smaller than the nonpoikilitic area (70%). In poikilitic areas, large low-Ca pyroxene oikocrysts (up to 1.5cm across) enclose multiple olivine and chromite chadacrysts. In the nonpoikilitic area, olivine, low-Ca and high-Ca pyroxene and interstitial maskelynite are major phases, and minor phases include chromite, merrillite, sulfide, ilmenite (Fig.1).

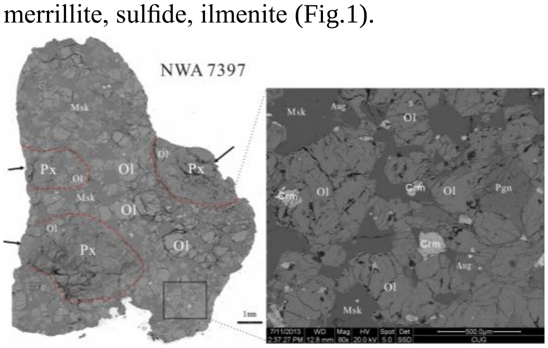

Fig.1. The back-sattered electron (BSE) image of NWA 7397 thick section used in this study. Black arrows and the red dashed line indicate the poikilitic areas composed of large pigeonite oikocrysts enclosing olivine and chromite. The enlarged portion of nonpoikilitic area is shown in the right. Ol-olivine; Pgn-pigeonite; Aug-augite; msk-maskelynite; Crm-chromite.

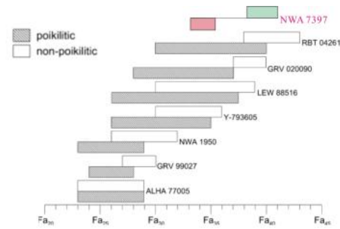

Fig. 2. Fa contents of olivine from NWA 7397 and comparison with those in other lherzolithic shergottites. Olivine data for the other lherzolitic shergottites are from [3, 5-7].

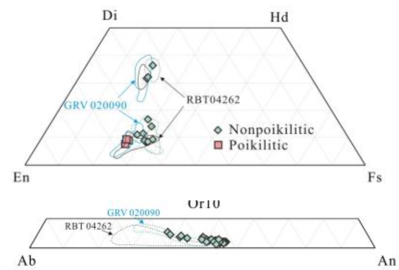

Fig.3. Quadrilateral diagram of pyroxenes and maskelynite compositions from NWA 7397. Literature data for the RBT 04262 and GRV 020090 are from [3-5]. The fields for pyroxenes in the poikilitic (solid lines) and nonpoikilitic (dashed lines) show the oikocrysts are FeO-poor compared with the grains in nonpoikilitic area.

Both olivine and pyroxene do not show compositional zone in both areas and their composition ranges are intergrain variations. Olivine shows bimodal compositions (Fig. 2). The chadacrysts (Fa 33.2-35.4 mol %) contain lower FeO contents than those in the nonpoikilitic area (Fa 38.3-41 mol %). Olivine in nonpoikilitic area for NWA 7397 is slightly more ferroan than those in typical lherzolitic shergottites (e.g., LEW 88516), and comparable to that of RBT 04261 (e.g., Fa30-43, [3]) and GRV 020090(e.g., Fa37-40, [5], Fig.2).

Low-Ca pyroxene in the poikilitic area mainly consists of pigeonite ($En_{65-66}Fs_{25-26}Wo_{7-9}$). It is also more magnesian than that in the nonpoikilitic area ($En_{56-61}Fs_{27-33}Wo_{8-17}$) (Fig. 3). Augite mainly occurs in nonpikilitic area and has compositions of $Fs_{44-48}En_{19-20}Wo_{31-36}$. Both pigeonite and augite in NWA 7397 are comparable to those of RBT 04262 and GRV 020090, but more ferroan than those in typical "lherzolitic" shergottites (e.g., LEW 88516, Fig.3, [3-5]). Plagioclases have entirely been converted to maskelynite ($An_{37-56}Or_{1-5}$, Fig. 3). No K-feldspar was observed in NWA 7397 that is different from that of GRV 020090[4]. Chromite occurs both in poikilitic and in nonpoikilitic areas, but shows different chemical compositions. Chromite grains in poikilitic areas have compositions of $Chm_{72-79}Sp_{13-18}Mt_{5-7}Usp_{2-3}$(Fig. 4). Chromite grains in nonpoikilitic areas show a good correlation between Cr and Ti, with compositions ranging from $Chm_{71}Sp_{16}Mt_{10}Usp_{4}$ to $Chm_{21}Sp_{6}Mt_{17}Usp_{56}$ (Fig. 4). Chromite in NWA 7397 has a similar $Mg^{\#}$ and Usp components to that of GRV 020090(Fig. 4) [3, 5].

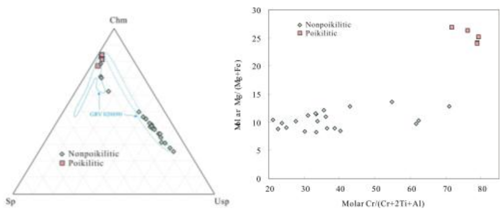

Fig.4. a. Chromites from the different lithologies in NWA7397. b. $Mg^{\#}$ [molar Mg/ (Mg + Fe)] versus $Cr^{\#}$ [molar Cr/ (Cr + 2Ti + Al)] of chromites.

The main phase of phosphate in NWA 7397 is merrillite. Besides CaO (45.9- 47.4 wt %) and P_2O_5 (44.1- 45.5 wt %), merrillite contains Na_2O (1.9), MgO (3.1- 3.2), and FeO (1- 1.36).

Oxygen fugacity from mineral equilibria: Studies have shown that Martian magmas had a wide range of oxygen fugacity (fO_2) and that this variation is correlated with the variation of La/Yb ratio and isotopic characteristics of the Martian basalts, shergottite meteorites [8, 9].

Oxygen fugacities and temperatures of NWA 7397 magma were estimated based on coexisting chromite-olivine-pigeonite assemblages for both poikilitic and nonpoikilitic lithologies. The assemblages in nonpoikilitic area record temperatures (850 ℃) and oxygen fugacities ($\log fO_2$= -3.01QFM) that lower than that of the poikilitic (1260 ℃, $\log fO_2$= -0.88 QFM). Our result also implies that oxygen fugacity of NWA 7397 overlaps with that of GRV 020090[3].

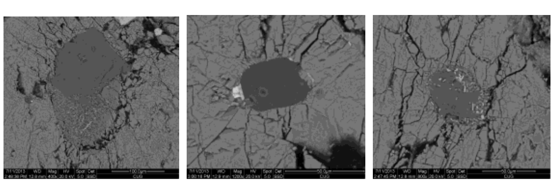

Fig. 5. Back-scattered electron images of melt inclusions in olivine, consisting of low-Ca pyroxene, sulfide, and glass.

Melt inclusions: Melt inclusions are common in olivines in nonpoikilitic lithology, with round or subround shapes (Fig. 5). Most inclusions are partial crystallized with low-Ca pyroxenes rims and tiny sulfide. We reconstructed primary trapped compositions as used in [10]; by addition of a portion of secondary olivine and corrections for inclusion-host interactions. The 20 wt% FeO_T was used as the parental magma for reconstruction. Two kinds of primitive compositions are obtained (Table 1): i.e., K-poor and K-rich.

Table 1. The reconstructed compositions of the melt inclusions for NWA 7397.

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	P_2O_5
1	49.6	0.01	16.2	2.22	18.0	5.28	5.43	2.89	0.35	0.02
1-2	50.8	0.06	15.8	2.22	18.0	5.28	4.75	2.67	0.48	0.02
3	56.9	0.17	11.2	2.23	18.1	5.29	0.52	1.13	4.34	0.11
3-2	56.9	0.20	11.1	2.22	18.0	5.28	0.47	1.11	4.54	0.11

Igneous Petrogenesis: Our petrographic and geochemical analyses suggest NWA 7397 has ferroan compositions of olivine and pyroxenes, Ti-enrichment of the nonpoikilitic chromite, and high oxygen fugacity (-0.88 QFM), like RBT 04262/1 and GRV 020090; therefore, it can be referred to as an enriched lherzolitic shergottite. The olivine-hosted melt inclusions study shows that two kinds of primitive compositions probably involved in the formation of this meteorites. The high-K trapped melt was reported for nakhlites [11]. However, whether high-K melt was a possible property for lherzolitic shergottites is unknown. Farther geochemical and comparison studies are needed to constrain the formation of this meteorite and other enriched lherzolitic shergottite.

References: [1] Nyquist et al. (2001). Space Sci. Rev. 96: 105-164; [2] Bridges and Warren. (2006). journal of the geological society 163: 229-251; [3] Usui et al. (2010). GCA.74:7283-7306; [4] Lin et al. (2013); Meteorit. Planet. Sci. [5] Jiang and Hsu. (2012); Meteorit. Planet. Sci. 47:1419-1435; [6] Mikouchi. (2005) Meteorit. Planet. Sci. 40: 1621-1634; [7] Mikouchi et al. (2008); XXXIX LPSC abstract #2403; [8] Herd C. (2003) Meteorit. Planet. Sci. 38, 1793-1805; [9] Wadhwa M. (2001) Science, 291, 1527-1530. [10] He et al. (2013) Meteorit. Planet. Sci 28, 474-493; [11] Goodrich et al. (2013) Meteorit. Planet. Sci 48, 2371-2405.