GEOCHEMISTRY AND PETROLOGY OF MASKELYNITE IN NWA1195 SHERGOTTITES AND ITS COMPARISON WITH MASKELYNITE FROM LONAR CRATER, INDIA.

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Introduction: The martian meteorite shergottite occurs in four sub-classes, e.g., olivine-phyric, olivine-orthopyroxene phyric, lherzolitic and basaltic shergottites [1]. The Northwest Africa 1195 (NWA1195) meteorite [2] is an olivine-orthopyroxene phyric shergottite that contains large (upto 4 mm), prismatic low-Ca pyroxene set in a finer grained groundmass of pigeonite, olivine, maskelynite, Ti-chromite, ilmenite, pyrrhotite and Mg-bearing merrillite [3, 4]. Petrographically this specimen resembles other olivine-pyroxene-bearing shergottites such as DaG476, NMA2046 and NWA2626 [3]. The Sm-Nd whole rock-mineral isochron defines a crystallization age of 347±13 Ma for NWA1195 [4].

Although, information are available on the olivine and pyroxene compositions of the MWA1195, these data are insufficient for the maskelynite; it is only known that maskelynite has a limited range of compositions between An63 and An59 [4]. In this work, a detail observation on petrology and geochemistry on these maskelynites are made, and they are compared with Lonar maskelynite [5].

Analytical techniques: A JEOL8200 eletron microprobe with five wavelength-dispersive (WD) spectrometers at the University of New Mexico, Albuquerque, USA, was used for quantitative analyses of major oxides and few trace elements (Zn, Ba, Pb) using a 15 μm broad beam, 15 KeV accelerating voltage and 20 nA sample current, with ZAF correction routines [5, 6].

Petrography: Chen and El Goresy [7] summarized petrography of diaplectic feldspar glass and meteoritic maskelynite. The BSE images of NWA1195 maskelynite show that the pyroxene and olivine constituents of this meteorite are extensively fractured and highly altered along these fracture planes (Fig. 1). However, maskelynites are mostly homogeneous; lack cleavage, cracks and fractures in general; and occupy interstitial spaces between subhedral groundmass minerals. Fragments of altered groundmass silicates (may be pyroxene or olivine) are present within the maskelynites. In rare cases, fractures with alteration veins penetrate the maskelynites. However, NWA1195 maskelynites do not show surrounding radiating and open expansion cracks as observed by [7]. The Lonar maskelynite, on the other hand, show extensive fracturing [5] (Fig. 2), which is the characteristics of diaplectic plagioclase glass [7], and in cases exhibits flowage structure [5].

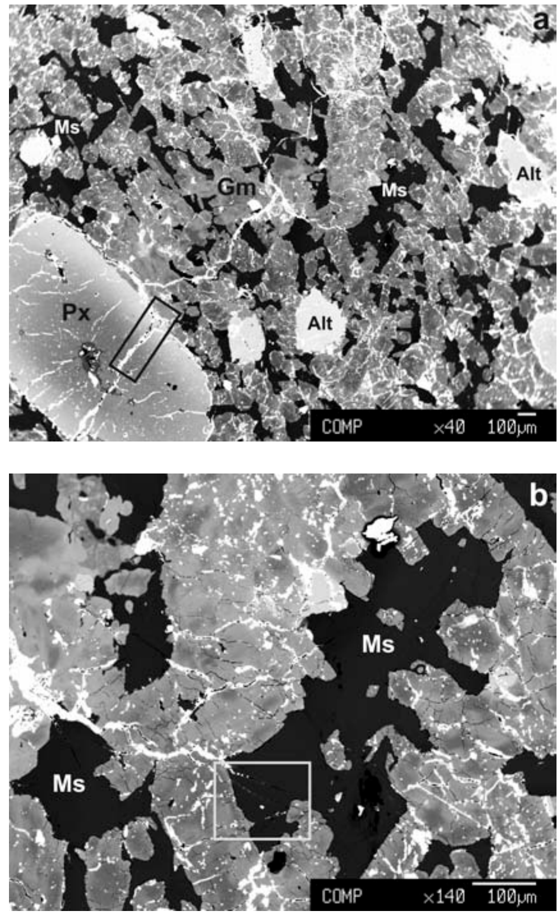

Fig. 1. BSE image of NWA1195 shergottite showing (a) porphyritic nature of the sample, note highly fractured nature of groundmass cross-cutting the phenocrysts (shown by box) and alteration along these fractures. Anhedral maskelynite occurs in interstitial spaces of subhedral groundmass minerals. (b) Box showing fractures crosscutting maskelynite indicating late origin of fractures. Abbreviations: Px- phenocrysts, Gm-groundmass, Ms- maskelynite, Alt- alteration.

Geochemistry: The average geochemistry of maskelynite from NWA1195 shergottite and from Lonar crater, India, is compared in table 1. The NWA1195 maskelynite is marginally enriched in Na_2O and P_2O_5, and depleted in Fe_2O_3, MgO, CaO, K_2O, BaO and PbO in comparison to those of the Lonar crater maskelynite. In the SiO_2 versus Al_2O_3 and CaO bivariant plots maskelynite from NWA1195 shows sharply defined decreasing linear trends (Fig. 3a, b), while the trend is linearly increasing in SiO_2 versus

Na_2O plot (Fig. 3c). Other oxides that show good correlations with SiO_2 are TiO_2, K_2O, BaO and PbO.

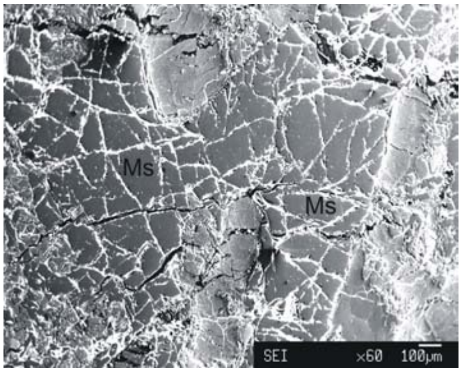

Fig. 2. BSE image of highly fractured maskelynite (Ms) in shocked basalt from Lonar crater, India.

Table 1. A comparison of average geochemistry of maskelynite from NWA1195 and Lonar crater, India, SD- standard deviation.

Source	NWA1195		Lonar crater	
Grain no.	14		3	
No of analyses	50		36	
	Avg	Sd	Avg	Sd
SiO_2	52.4	1.01	51.3	1.99
TiO_2	0.056	0.03	0.066	0.02
Al_2O_3	29.6	0.86	30.3	1.27
$Fe_2O_3^T$	0.599	0.38	0.738	0.29
MnO	0.010	0.01	0.008	0.01
MgO	0.182	0.24	0.229	0.10
CaO	12.1	0.89	13.2	1.53
Na_2O	4.55	0.44	3.86	0.75
K_2O	0.118	0.04	0.216	0.12
P_2O_5	0.014	0.001	0.007	0.01
ZnO	0.020	0.02	0.028	0.02
BaO	0.006	0.01	0.018	0.01
PbO	0.004	0.01	0.014	0.01
Sum	99.6		100.0	

Discussion: The Lonar crater and NWA1195 maskelynites differ from each other in petrography indicating their different mode of origin. The absence of fractures and the smooth texture of NWA1195 maskelynite suggest its evolution by rapid chilling of a completely liquid feldspar melt. This phase perhaps post-dated the extensive fracturing and alterations observed in the rest of the meteorite body.

Minor geochemical differences exist between NWA1195 and Lonar maskelynites, which may be due to the difference in original plagioclase compositions in the hosts or due to shock impact processes. We observed that both in the heavily fractured Lonar diaplectic glass [5] and in NWA1195 maskelynite, stoichiometric proportions are maintained [also 7] (Fig. 3). This definitely indicates that a pressure of ~50 GPa and temperature more than 1000°C that are required to form maskelynite [8] were not sufficient to alter the plagioclase melt composition although crystallographic structure of the original feldspar was completely destroyed by the shock process.

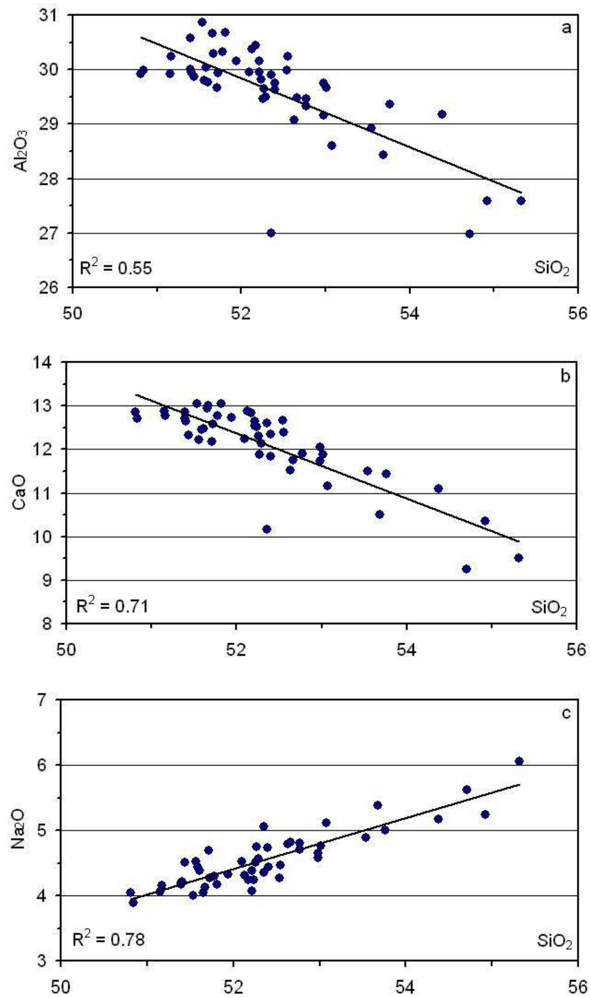

Fig. 3. Major oxide bivariant plots of maskelynite from NWA1195 shergottites.

References: [1] McSween Jr. H. Y. (1994) *MAPS*, 29, 757-779. [2] Irving A. J. et al. (2002) *MAPS*, 37, A69 (abs.). [3] Irving A. J. et al. (2004) 35th LPSC, abs. #1444. [4] Symes S. J. K. et al. (2008) GCA, 72, 1696-1710. [5] Misra S. et al. (2007) 38th LPSC, abs. #1672. [6] Misra S. et al. (2009) MAPS, *44*, 1001-1018. [7] Chen M. and El Goresy A. (2000) Earth Planet. Sci. Lett., 179, 489-502. [8] French B. M. (1998) LPI contribution no. 954, 1-120. Funding provided by NASA Planetary Geology and Geophysics grants NNG05GJ42G, and NNH07DA001N (HEN).