PETROLOGY OF THE L-MELT ROCK NWA 7251 AND IN SITU U-PB DATING OF PHOSPHATES.

Y. Li[1] and W. Hsu[1,2]. [1]Purple Mountain Observatory, Nanjing, China. E-mail: liye@pmo.ac.cn, [2]Space Science Institute, Macau University of Science and Technology, Macau.

Introduction: Impact is one of the fundamental processes during the formation and evolution of the solar system [1]. NWA 7251, a 13kg stone, was classified as an L-melt rock [2]. Here we report the petrology and phosphate U-Pb dating results of NWA 7251, with the attempt to seek evidence of extensive impacts on the L-chondrite parent body.

Petrography: NWA 7251 mainly consists of three parts: chondrite host, impact-melt portion and impact melt vein. The host contains locally blurred chondrules and has relatively homogenous mineral compositions (olivine $Fa_{24.9\pm0.6}$; orthopyroxene $Fs_{21.1\pm0.3}Wo_{1.6\pm0.4}$; augite $Fs_{9.3\pm2.3}Wo_{41.5\pm4.5}$). Some olivine or pyroxene grains in chondrules were replaced by microcrystals with interstitial albitic glass or metal. Over all, the host is an L5 chondrite with a shock of S4 (Fig.1a). The impact melt portion has a fine-grained igneous texture, composed of euhedral olivine (10-40 μm; $Fa_{24.4-27.2}$), pyroxene (15-200 μm), interstitial albitic glass (up to 40 μm; Na_2O = 6.59-8.05 wt%), phosphate, Fe-Ni metal and troilite, with minor olivine/pyroxene-rich fragment (~2 vol%) (Fig.1b). The impact melt contains a lower abundance of opaque minerals than the host and average L-chondrites as well (Table 1). In the impact melt, relatively large prismatic pyroxene grains usually poikilitically enclose olivine inclusions, and are zoned from low-Ca cores ($Fs_{18.4-20.5}Wo_{1.9-8.2}$) to high-Ca rims ($Fs_{13.2-15.8}Wo_{26.9-37.2}$). The olivine/pyroxene-rich fragments are composed of fine-grained crystals (<20 μm) with interstitial albitic glass or metal. Impact melt veins crosscut the host. Compared to the impact melt, the impact melt vein has much finer grain sizes, slightly lower olivine Fa contents (23.1-25.9), comparable high-Ca pyroxene ($Fs_{13.3-14.6}Wo_{28.2-34.5}$), and more variable low-Ca pyroxene ($Fs_{18.3-25.3}Wo_{0.3-11.6}$) and glass components ($Na_2O$ 4.66-9.70 wt%)(Fig.1c). The enrichment of metal in the melt vein is due to locally penetration of the metal veins (Fig.1c). Zonation texture can be found in a few olivine grains, with Mg-rich in cores ($Fa_{15.5-21.6}$) and Mg-poor in rims ($Fa_{21.3-24.2}$).

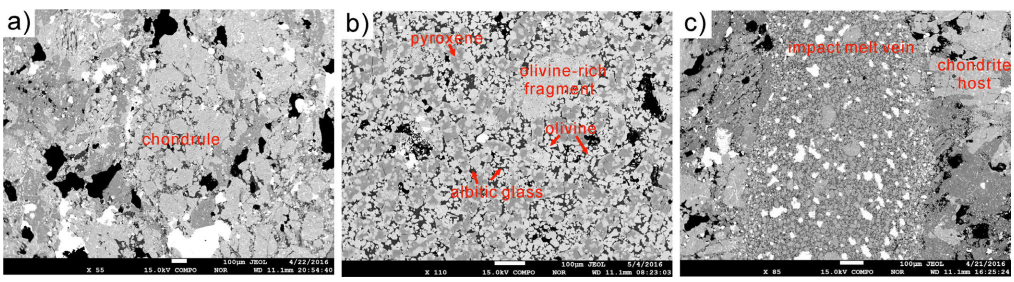

Fig. 1. BSE images of (a) chondrite host , (b) impact melt, and (c) impact melt vein in NWA 7251

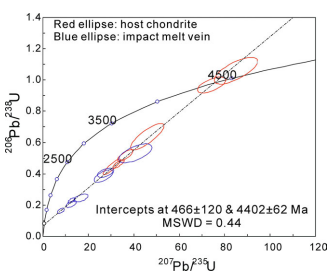

Fig.2. U-Pb dating of phosphate

Phosphate U-Pb dating: Anhedral-subhedral phosphate grains occur in the impact-melt portion and the host, usually 5-50 μm in size and inter-grown with metallic phases. Phosphates in the impact melt are too small for the analysis. Seven analyses (3 of merrillte and 4 of apatite) in the host yield an upper intercept of 4415 ± 71 Ma and a lower intercept of 542 ± 170 Ma on the concordia diagram. Six analyses (merrillite) in the melt vein yield similar results, with an upper intercept of 4436 ± 180 Ma and a lower intercept of 444 ± 190 Ma. Over all, 13 analyses plot on a discordia line, with an upper intercept of 4402 ± 62 Ma and a lower intercept of 466 ± 120 Ma (Fig.2). The old age is coincident with the timing of Moon-forming giant impact [6], and the young one records the catastrophic disruption of the L-chondrite parent body [7].

TABLE 1. Modal composition of NWA 7251 and L-chondrites.

	L-chondrites		NWA 7251					
			Chondrite host		impact melt vein		impact melt	
	wt% [3]	wt% [4]	vol%	wt%*	vol%	wt%*	vol%	wt%*
Plagioclase/ Albitic glass	10.1	9.7	9.9	6.4	7.9	4.9	13.4	9.0
Olivine	47.0	44.8	49.0	49.2	49.8	48.0	45.7	47.6
Low-Ca pyroxene	22.7	24.2	26.7	25.2	28.2	25.5	24.9	24.3
High-Ca pyroxene	4.6	5.0	3.4	2.8	1.0	0.8	10.0	8.5
Fe-Ni metal	7.5	8.4	4.7	9.2	8.1	15.4	3.9	8.0
Troilite	6.1	5.8	5.7	6.6	4.8	5.3	2.1	2.5
Chromite	0.6	0.8	0.5	0.5	0.1	0.1	0.1	0.1
Phosphate	0.6	0.5	0.1	0.1	0.1	0.1	0.1	0.1
Orthoclase	0.6	0.6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Total	99.8	99.8	100.0	100.0	100.0	100.0	100.1	100.0

* vol% converting to wt% followed the method of [5] Note: n.d. = none detected

References: [1] Scott E. R. 2002. in *Asteroids III*. pp. 697-709. [2] Ruzicka A. et al. 2015. *MAPS* 50: 1-136. [3] Mason B. 1965 *Am. Mus.* 223: 1-38. [4] McSween H. Y. Jr. et al. 1991. *Icarus* 90, 107-116. [5] Weirich J.R. et al. 2011. *MAPS* 45: 1868-1888. [6] Yin Q. Z. et al. 2014. *MAPS* 49: 1426-1439. [7] Haack H. et al. 1996. *Icarus* 119:182-191.

Acknowledgement: This work was supported by NSFC (41273079, 41573059), the Minor Planet Foundation of Purple Mountain Observatory, and Macau FDCT (039/2013/A2).