Mineralogy and Petrography of Lunar Feldspathic Breccia Northwest Africa 11460

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ISS 山东大学空间科学研究院 Institute Of Space Sciences Shandong University

Introduction

- Northwest Africa (NWA) 11460 is a new lunar meteorite found in 2017, classified as feldspathic breccia and contains ~1 cm sized basaltic and gabbroic lithic clasts [1].
- we present preliminary results on the mineralogy and petrography of NWA 11460, focusing on the shock metamorphism and potential source of individual lithic clasts.

Experimental methods

- The BSE imaging and EDS compositional mapping (Na, Mg, Al, Si, S, Ca, Ti, Fe) of NWA 11460 via Zeiss Supra 55 SEM and FEI Nova NanoSEM 450 at the National Astronomical Observatories of the Chinese Academy of Sciences (NAO, CAS) and Shandong University, Weihai.
- Spot electron probe microanalyses (EPMA) was done via JEOL JXA-8230 electron microprobe at NAO, CAS.
- Laser point-counting Raman spectroscopic measurements of NWA 11460 were conducted using the state-of-art inVia® Raman system (Renishaw Company) .

Modal mineralogy

- Raman point-counting measurements [2] (n=400) were done at ~1000 μm intervals within an area of ~3.2 cm × 1.6 cm.
- Plagioclase is the most abundant mineral phase with minor irregular fracture (Table 1).
- Olivine is the second abundant mineral phase, exhibiting euhedral texture.
- Pyroxene is less abundant and composed of orthopyroxene (6 vol.%), clinopyroxene (3.8 vol.%), and disordered pyroxene (0.3 vol.%).
- Accessory minerals including ilmenite, spinel (chromite, ulvöspinel, Gahnite), troilite, merrillite, apatite, and Fe-Ni metal are also found in this meteorite.

Table 1. Modal mineralogy of NWA 11460 by Raman point-counting method.

Minerals	Proportions (vol.%)
Plagioclase	61.6
Olivine	28.3
Orthopyroxene	6.0
Clinopyroxene	3.8
Disordered pyroxene	0.3

Shock metamorphism

- No maskelynite was observed in NWA 11460 (20–30 GPa) [6-8].
- Pyroxene grains generally exhibit nominal Raman peaks with less fractures.
- Olivine grains also present fractures but no distorted olivine are found.
- NWA 11460 could experience moderate shock pres-sure (<30 GPa).

Petrography

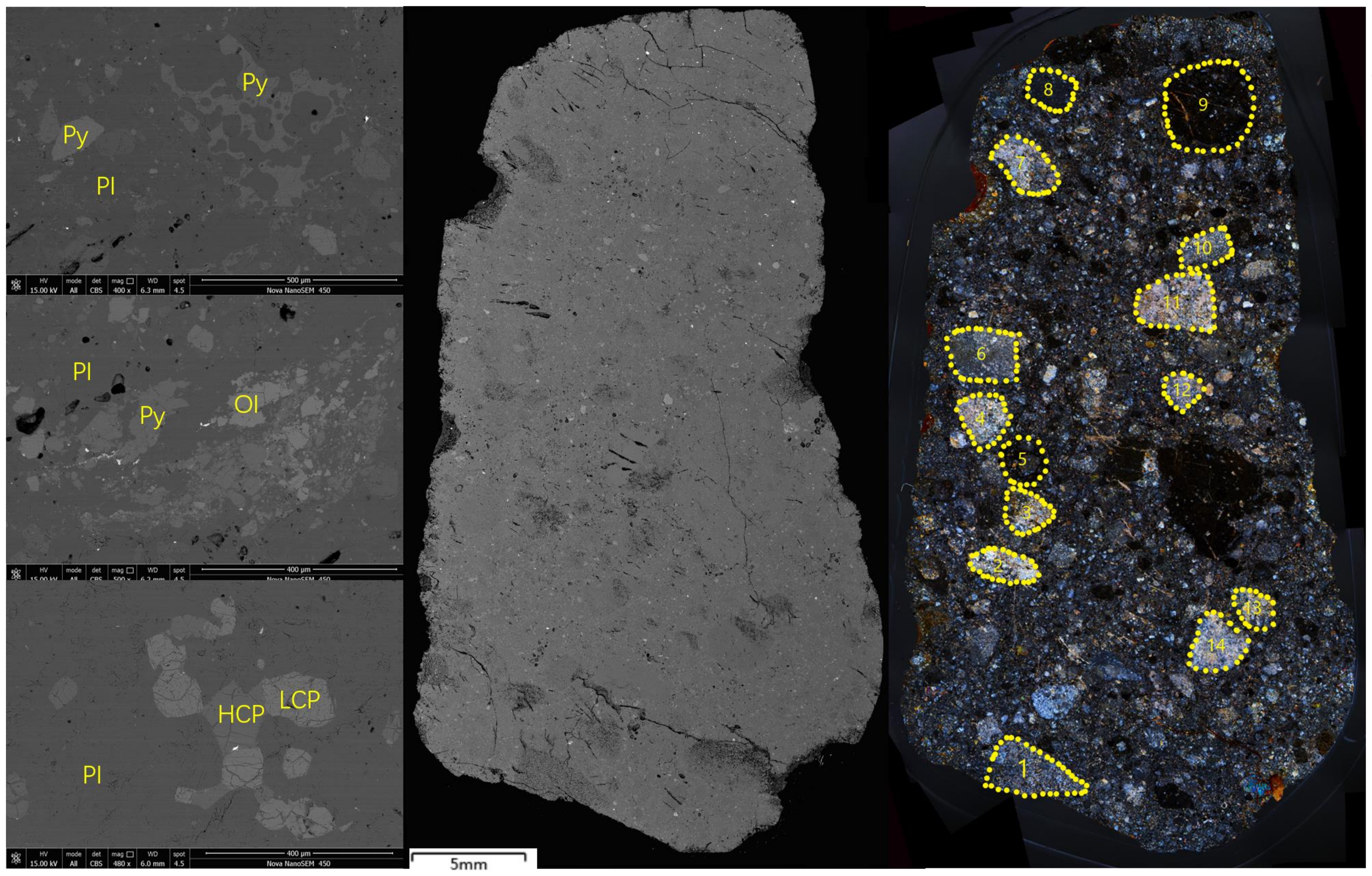

Figure 1. Back scattered electron (BSE) images and XPL montaging image of NWA 11460.

- It shows various sized lithic and mineral clasts in fine-grained matrix.
- Pyroxene grains generally exhibit exsolution lamellae which are ~1 μm thick with minor irregular intragranular fractures.
- Many clusters of olivine and pyroxene occur within matrix in the range from 10s to 100s μm.
- No maskelynite grains are not observed and plagioclase account for ~60% of the mode as matrix.
- Breccia is distributed in the edge with fine grains, mainly composed of plagioclase and minor pyroxene (Figure 1).
- Clasts 2, 3, 4, 7, 8, 11, 12, and 13: noritic/troctolitic anorthosite (olivine: $Fo_{57.8-86.5}$; low-Ca pyroxene: $Fs_{23.1-25.2}Wo_{1-4}En_{71.2-73.7}$; plagioclase: $An_{82.3-88.4}$, possibly originating from Mg-suite lithologies (Figure 2 and 3).

Mineral compositions and source lithologies of clasts

- Clasts 1, 6, 14: troctolitic anorthosite (olivine: $Fo_{75.5-82.6}$, plagioclase: $An_{86.8-89.2}$), possibly coming from Mg-suite lithologies (Figure 2 and 3) [3-6].

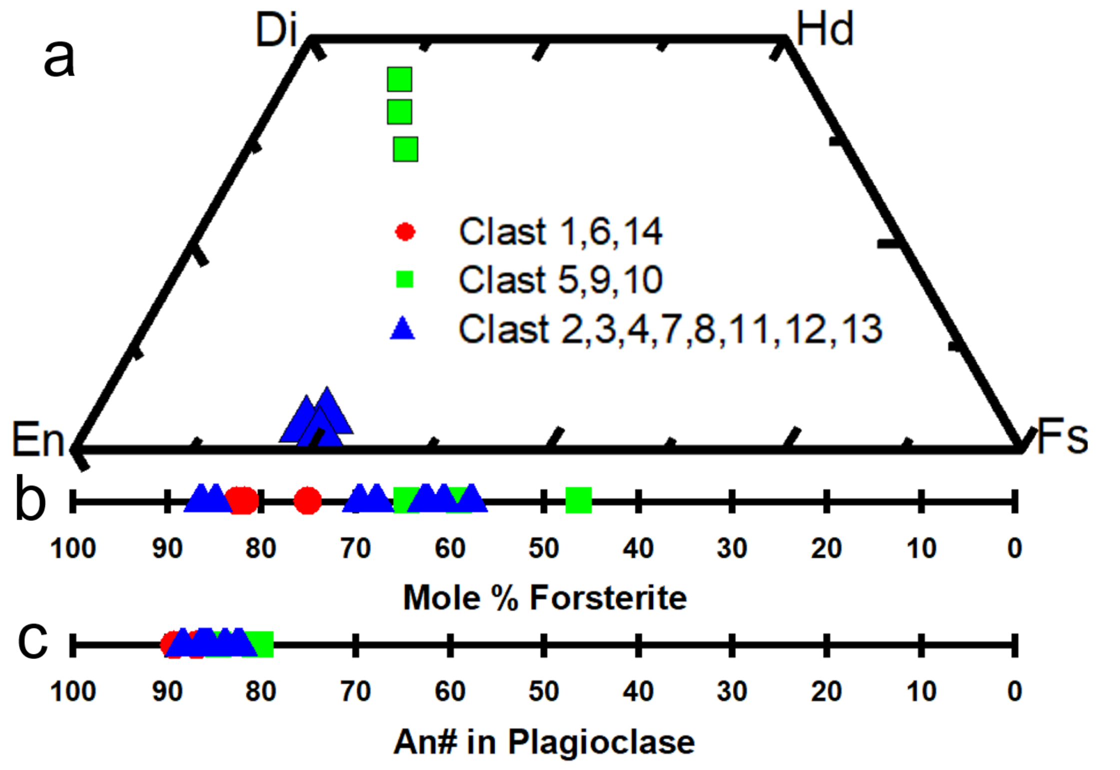

Figure 2. Mineral compositions from Raman data. a) pyroxene. b) olivine. c) plagioclase (An contents).

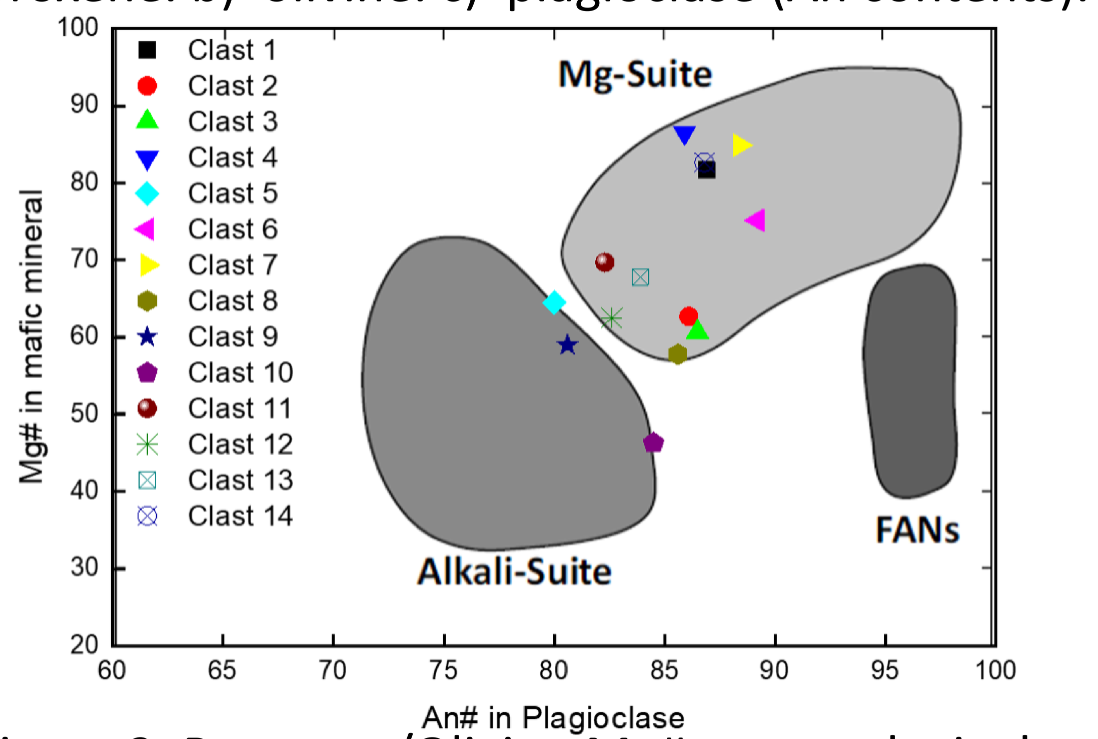

Figure 3. Pyroxene/Olivine Mg# versus plagioclase An content.

- Clasts 5, 9, 10: troctolite (olivine: $Fo_{46.3-64.5}$; high-Ca pyroxene: $Fs_{11.8-16.8}Wo_{36.4-45}En_{43.1-45.2}$; Plagioclase: $An_{80-84.5}$, possibly originating from alkali-suite lithologies (Figure 2 and 3).

Conclusion

The mineral compositions of anorthositic clasts in NWA 11460 are consistent with those of Mg-suite, exhibiting large compositional variation. Troctolite clasts of NWA 11460 are similar to alkali-suite. It suggests that this meteorite may originate from Mg-rich lunar highland regions.

Future work

Lithic compositional analysis will be conducted by using electron microprobe (EMP) for quantitative study. The determination of bulk composition to constrain its origin and potential relationship to Apollo Mg-suite or alkali-suite lithologies need to be confirmed.

Acknowledgements: We thank Q. Zhou, Y Xiao and Q. H. Huo for their assistance with EMPA and SEM-EDS operations. This research was supported by the Key Research Program of the Chinese Academy of Sciences (Grant NO. XDPB11), the National Natural Science Foundation of China (41473065), Natural Science Foundation of Shandong Province (JQ201511), Qilu (Tang) Young Scholars Program of Shandong University, Weihai (2015WHWLJH14).

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