PETROGRAPHY AND MINERALOGY OF LUNAR FRAGMENTAL BRECCIA DHOFAR 910. X. Gu[1], J. Chen[1,2], H. Cao[1,2], Z. Ling[1,2,*], X. Fu[1,2]. [1]School of Space Science and Physics, Shandong University, Weihai, 264209, China (guxiyunow@foxmail.com), [2]Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, Institute of Space Sciences, Shandong University, Weihai, 264209, China (zcling@sdu.edu.cn).

Introduction: Dhofar 910 is a lunar breccia and was discovered in Oman (19°19'54"N, 54°46'44"E) in 2003 [1]. In this work, we report preliminary characterization of petrography and mineral compositions of Dhofar 910.

Experimental methods: Dhofar 910 thin section was characterized via optical polarization microscopy and (Figure 1) backscattered electron (BSE) imaging (Figure 2) to understand the petrography. BSE and energy dispersive spectrometry (EDS) compositional (including Na, Mg, Al, Si, S, K, Ca, Ti, Mn, Fe) mapping (Figure 3) were conducted by Zeiss Supra 55 Scanning Electron Microscope (SEM) at the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC).

Mineral modal abundances in Dhofar 910 thin section were determined by point-counting Raman analyses, with an equally spaced (~500 μm apart) grid within an area of ~18.5 mm × 14.5 mm (703 positions), assuming that the fraction of spectra containing diagnostic peaks of specific mineral is equal to its volume percentages within section [2]. Raman spectroscopic measurements were performed with Renishaw inVia® Raman Microscopes at Shandong University, Weihai (SDUW). The green laser at 532 nm was employed for excitation. The spatial resolution of spot Raman analyses is better than 1 μm with a tightly focused beam under the 100× objective. The Raman scattered signals were dispersed by a 2400-groove/mm grating after an entrance slit with width of 65 μm. The system was calibrated before data acquisition by measuring the main Raman mode (520.5–520.7 cm^{-1}) of a silicon wafer standard. Spectra were collected in the Raman shift range of 100–1400 cm^{-1} with a spectral resolution better than 1 cm^{-1} and spectral repeatability of ±0.2 cm^{-1}.

Results:

Petrography. Optical polarization and BSE images of the polished thin sections of Dhofar 910 shown in Figure 1 and Figure 2 demonstrate this meteorite to be a fragmental breccia consisting of numerous mineral fragments and feldspathic lithic clasts embedded in a vesicular glass-rich matrix of fine-grained plagioclase and olivine (Figure 1 and Figure 2).

Modal mineralogy. The modal mineralogy of Dhofar 910 thin section obtained from point-counting Raman analyses are given in Table 1. Dhofar 910 consists of plagioclase (92.7 vol.%), olivine (6.2 vol.%), and pyroxene (1.1 vol.%).

Mineral composition. Although presenting abundant shock melts, transformation into maskelynite from plagioclase is not observed in this meteorite. Raman peak positions of plagioclase grains are of the anorthite [2]. Peak position difference between two strong peaks around ~500 cm^{-1} (Δ_{ab}) and FWHM of the main peak at ~504 cm^{-1} (Γ_a) have been calibrated to estimate plagioclase composition [3]. Both calibration formulae based on Δ_{ab} and Γ_a determined self-consistent compositions with each other. The compositional ranges of plagioclase in Dhofar 910 ($An_{84.3–97.9}$, Figure 4) agree with previous measurements by EPMA [1] within the analytical uncertainties (5–10 An%).

Olivine compositions [5] in this meteorite occurs as two clusters (Figure 4): $Fo_{10.7–47.5}$ and $Fo_{47.5–73.7}$. Pyroxene compositions [6] in this meteorite ($Fs_{21–52}Wo_{5–39}En_{24–58}$, Figure 4), range from pigeonite/augite to ferroaugite.

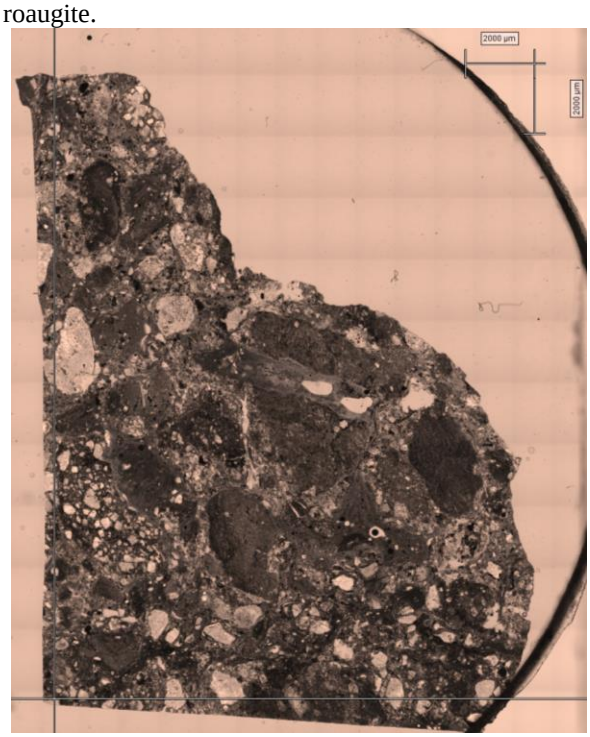

Figure 1. Optical polarization image of Dhofar 910 showing typical texture.

Figure 2. BSE mosaic image of Dhofar 910 showing typical texture and X-ray mapping area.

Table 1. Modal mineralogy (volume%) of Dhofar 910 thin section.

Minerals	Proportions (vol.%)
Plagioclase	92.7
Olivine	6.2
Pyroxene	1.1

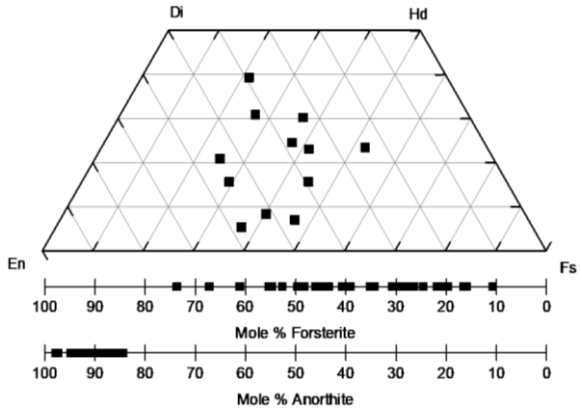

Figure 4. Pyroxene, olivine, and plagioclase compositions of Dhofar 910.

Acknowledgement: This study is supported by the National Natural Science Foundation of China (No. 41473065), Natural Science Foundation of Shandong Province (JQ201511), the Key Research Program of the Chinese Academy of Sciences (Grant NO. XDPB11), and the State Scholarship Fund (No. 201706220310). We thank David Mann and Antoinette Mann for their help in sample preparation at High Mesa Petrographic, and Qin Zhou and Yuan Xiao for their help in SEM experiments at NAOC.

References: [1] Russell S. S. et al. (2004) *Meteoritics & Planet. Sci., 39, Nr 8, Supplement*, A215–A272. [2] Haskin L. A. et al. (1997) *JGR, 102, E8*, 19293–19306. [3] Freeman J. J. et al. (2008) *The Canadian Mineralogist, 46*, 1477–1500. [4] Bersani D. et al. (2018) *Journal of Raman Spectroscopy, 49(4)*, 684-698. [5] Kuebler K. E. et al. (2006) *Geochimica et Cosmochimica Acta, 70*, 6201–6222. [6] Wang A. et al. (2001) *American Mineralogist, 86*, 790–806.

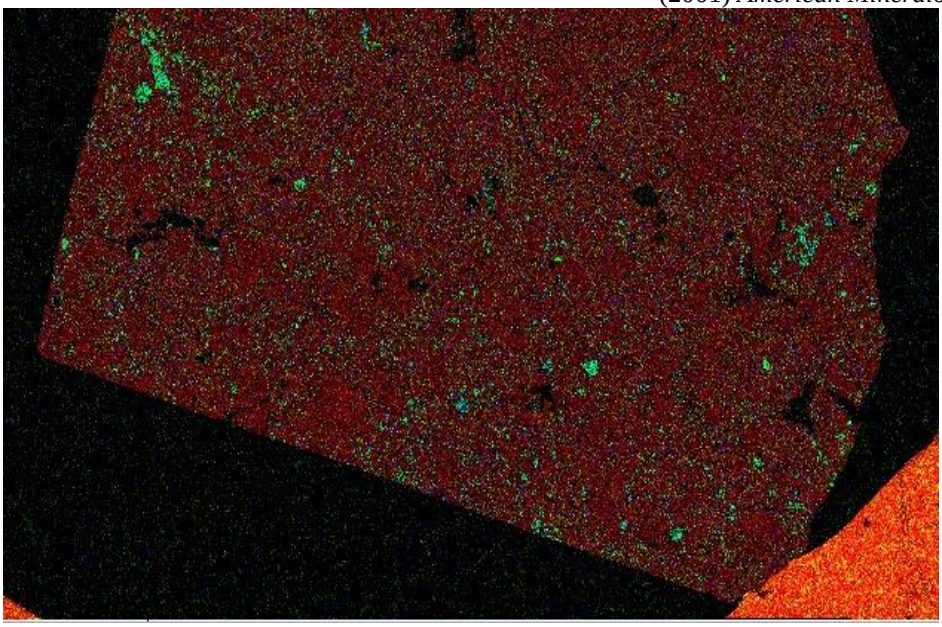

Figure 3. X-ray composite image, red-Al, green-Mg and blue-Fe. Plagioclase is red and olivine is light green.