Mineralogy, Petrography, and Geochemistry of Lunar Meteorite Dhofar 081: New Developments. J.T. Cahill[1], L.A. Taylor[1], M. Anand[1], A. Patchen[1] and M.A. Nazarov[1,2]; [1]Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996, USA (jcahill@utk.edu), [2]Vernandsky Institute of Geochemistry, RAS, Moscow 117975, Russia.

Introduction: Lunar meteorite Dhofar 081 was found in November 1999 in the Dhofar desert region of Oman and classified as a shocked, feldspathic-fragmental-highland breccia [1]. Approximately 200 m from this locale, lunar meteorite Dhofar 280 was also discovered [2]. These meteorites contain similar clast populations and are being investigated for possible pairing [3]. Dh-081 bimineralic clasts show similar compositions to Dh-025 and Dh-280, plotting within the "gap" between the FAN and HMS fields, on a graph of Mg# versus AN [3, 4]. These clast chemistries are indicative of a FAN-rich locale for the origin of this lunar rock.

Petrographic Description: Dh-081 is a fragmental breccia with a glass- and melt-rich matrix and abundant vesicles [1]. The meteorite is segregated into four distinct breccia clasts held within the melt-matrix. The original Dh-081 sample was 174 g with a small portion of the fusion crust missing [1]. Alteration products are minor, being present in the form of small (< 3 µm) carbonate and sulfate minerals.

A total of 39 clasts were studied by petrographic microscope and electron microprobe (EMP). These clasts include anorthosite fragments, impact-melt breccias, bimineralic impact-melts, interstitial-mineral fragments, and granulite lithologies with granoblastic textures. Mare, regolith (agglutinates and glass spherules), and pristine-highland lithologies are not present.

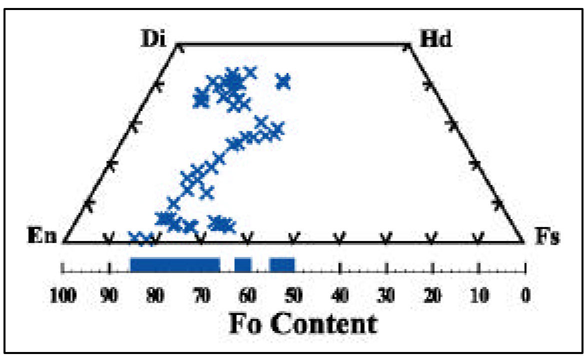

Figure 1: Dh-081 pyroxene and olivine mineral chemistry.

Monolithic-plagioclase clasts are abundant (14) in Dh-081 clasts. Maskelynite is not present. Mafic minerals are rare within clasts, but relic-mafic-mineral fragments are abundant on and around vesicle rims and in the melt-matrix. Olivine is the most-prevalent mafic mineral in Dh-081 bimineralic clasts, mineral fragments, and melt-matrix. Pyroxene is observed in bimineralic clasts, but generally occurs on rims of relic-olivine fragments, altered by embayment of impact-melt.

Mineral Chemistry: Fourteen clasts within Dh-081 are anorthosite fragments. Porphrytic-plagioclase in most clasts is extremely anorthite-rich (An_{94-98}), with a lower limit of An_{92}, typical of lunar highlands mineralogy. Plagioclase compositions in clasts and melt-matrix are identical. Plagioclase is commonly seen embaying relic-olivine and pyroxene fragments. Olivine grains encompass a wide range of compositions (Fo 51-80; Fig 1). Clasts may contain multiple relic-grains with contrasting Fo content (e.g., Fo~71 versus Fo~80). Often olivine grains have rims with higher Fo contents than within cores (ΔFo ~10). In particular, one olivine fragment (~350 µm in size) had a compositional variance of 20 Fo units from core to rim (i.e., Fo ~53 to Fo~73). This is possibly due to reequilibration with the impact-melt; however, it is indicative of a relatively rapid cooling rate of ~0.5°C/hr [5] likely for an impact-breccia blanket. Pyroxene rimming this fragment had an Mg# ~41.

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Bimineralic-clasts tend to be pyroxene-poor with a chemistry range, Mg# 58-78. Pyroxene generally occurs rimming olivine fragments in the melt-matrix (Mg# 41-72). However, monomineralic pyroxene ranges in composition from Mg# 66-80 and has augite to pigeonite mineralogy (Fig. 1). Accessory minerals include Cr-spinel (Cr_2O_3 ~ 24.5 wt%; Al_2O_3 ~ 43 wt%), Ti-chromite (TiO_2 ~ 5.1 wt%; Al_2O_3 ~ 12.5 wt%), and troilite.

Depiction of highland-rock compositions is found on an Mg# versus AN graph (Fig. 2). The majority of bimineralic clasts plot within the FAN-field, but with several clasts also in the FAN-HMS "gap". Prior studies have mostly shown granulites plotting within this gap [6]. However, recent lunar meteorites have begun to exhibit more diverse compositional lithologies within this field. These meteorites include the recent Dhofar lunar rocks 025, 280, 301, 302, and 303 [3, 4, 7].

Discussion: The proximity of discovery locales for Dh-081 and Dh-280 leads to the general question of similarity or pairing. In the thin sections studied, Dh-081 does not contain any lunar regolith clasts, found in Dh-280. This includes the absence of glass spherules and FeNi metal grains. Indeed, Dh-280 contains numerous FeNi grains in addition to three new Fe-Si mineral phases [4]. Despite this, the two meteorites have a similar overall mineralogy and chemistry, which may indicate origins from a similar terrain on the moon. However, these meteorites do not appear to be paired.

Dh-081 was compared to other highland rocks collected from the frontside of the moon, especially Apollo 16 rocks, similar to the attempt of [1]. Despite the close similarity of Dh-081 and some Apollo 16 samples, they [1] abandoned this comparison specifically because of the absence of granulites and KREEP-signatured lithologies in this lunar meteorite. However, the granulite lithologies documented from the additional sections examined during the present study reinforce the original suggestion of comparison between the Dh-081 and Apollo 16 breccia samples. However, chemical signatures in minerals of Dh-081 clasts are indicative of a derivation from a primarily FAN-rich terrain, with few HMS constituents (Fig. 2). This is not common to Luna and Apollo-sampled regions. Therefore, Dh-081 more likely originated from a highland terrain on the farside of the moon. In this locale, lunar rocks are distinctly more FAN-rich, and far removed from KREEP-signatured regions.

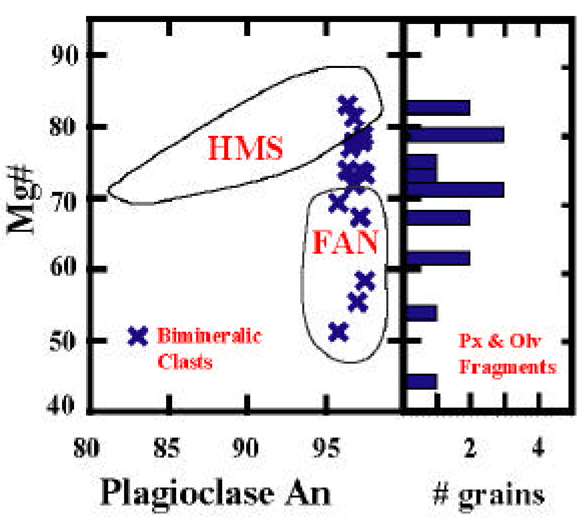

Figure 2: Mg# versus An plot for Dh-081 bimineralic clasts. Mineral fragments chemistries are plotted in adjacent figure.

References: [1] Greshake et al. (2001) *MAPS,* 36, 459-470. [2] Nazarov personal com. (2001). [3] Anand et al. (2002) *LPSC*, 33rd, this volume. [4] Cahill et al. (2001) *LPSC*, 32nd, #4185. [5] Taylor et al. (1977) *PLSC*, 8th. [6] Cushing et al. (1999) *MAPS*, 34, 185-195. [7] Nazarov et al. (2001) *LPSC*, 33rd, this volume.