BULK CHEMISTRY AND OXYGEN ISOTOPIC COMPOSITIONS OF LUNAR METEORITES DHOFAR 025 AND DHOFAR 026.

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Introduction: Dhofar 025 (Dh25) and Dhofar 026 (Dh26) are new lunar meteorites found ~20 km apart in the desert of Dhofar, Oman. These meteorites are very different in texture, mineral chemistry, and noble gas composition [1-3]. Dh25 is a gas-rich regolith breccia containing abundant lithic clasts and mineral fragments in a glassy matrix [1]. Dh26 is a gas-poor, crystalline melt breccia consisting of rare mineral fragments and lithic clasts in fine-grained, crystalline matrix [2]. Here we report the first data on major- and trace-element chemistries and oxygen isotopic compositions of these meteorites. Both lunar samples are similar in composition to other lunar highland meteorites. However, each meteorite is distinctly different within the compositional range of lunar highland meteorites.

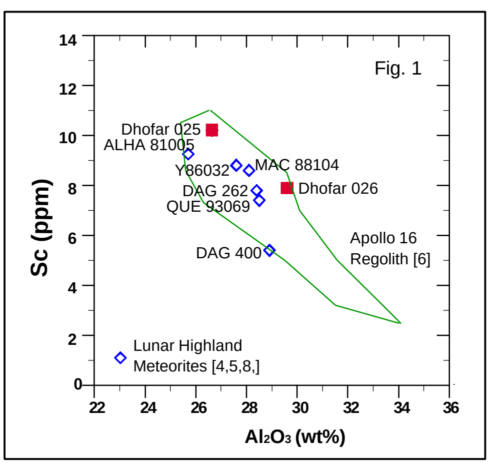
Methods: 1-g samples were powdered in an agate mill to obtain homogeneous material for whole-rock analyses. Si, Ti, Al, Cr, Fe, Mn, Mg and Ca were determined by XRF and ICP. Na and K were measured by atomic absorption. Trace elements were analyzed by INAA. The major- and trace-elements are given in Table 1. Separate splits weighing ~10 mg were used to measure oxygen isotopic compositions [4].

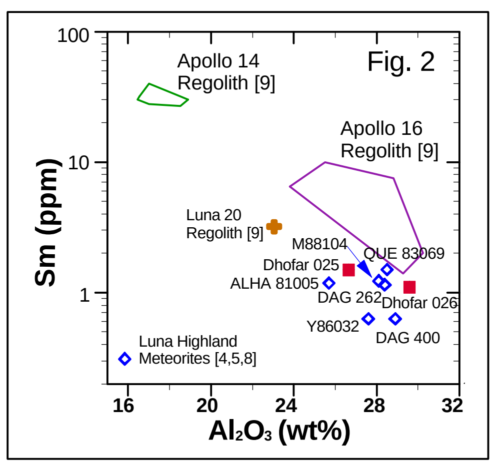
Results: Dh25 and Dh26 have anorthositic compositions, which are typical for lunar highland meteorites [e.g., 5,6]. The very high Sr content in Dh25 is apparently caused by terrestrial weathering and suggests that Dh25 is more altered than Dh26, which does not show the Sr anomaly. This indicates that the primary-element relationships may also be altered to various degrees by terrestrial weathering in both meteorites, particularly for Ca, K, Cs and possibly Si.

Compared to Dh25, Dh26 is richer in Al, Ca, and Eu and poorer in Fe, Mg, and all other trace elements. This is due to the higher feldspar content in Dh26. The lower Na/Ca ratio of Dh26 further indicates that the feldspar is higher in An content relative to Dh25. Also, the mafic constituent of Dh26 must be richer in Fe/Mg than that in Dh25. Within the compositional range of lunar highland meteorites, the differences between Dh25 and Dh26 are significant (Fig.1-3). Dh26 is one of the highest in Al and poorest in Mg# and Fe. In contrast, Dh25 is one of the highest in Mg# and Sc and poorest in Al.

Dh25 and Dh26, as well as other lunar highland meteorites, are compositionally similar to lunar highland rocks. The similarity is reflected in the range of concentrations of elements like Al and Sc which are carried mainly by plagioclase and pyroxene, respectively (Fig. 1). Though similar to other lunar highland meteorites, Dh25 and Dh26 are poor in Na, Ti, and incompatible elements compared to the typical Apollo 16 highland regolith (Fig. 2). Compared to pristine FAN and HMS rocks, these meteorites have intermediate Ti/Sm ratios (Fig. 3). They are similar in composition to noritic anorthosites 60135 and 67513 [7].

Siderophile element contents of Dh25 and Dh26 fall within the range reported for lunar meteorites [5,6] and indicate the presence of a meteoritic component. Ni/Ir ratios are practically chondritic and show low indigenous contents of Ni. The indigenous content of Co is calculated to be ~8 ppm, using the chondritic Co/Ir ratio to correct for meteoritic contribution. This value is typical for lunar highland meteorites. The Au/Ir ratio of Dh25 is lower than that in chondrites whereas Dh26 shows a relative enrichment in Au/Ir.

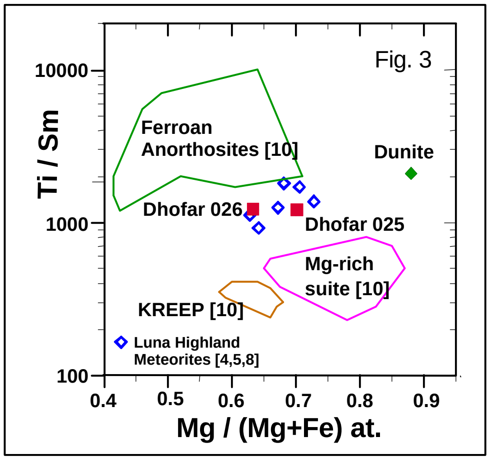


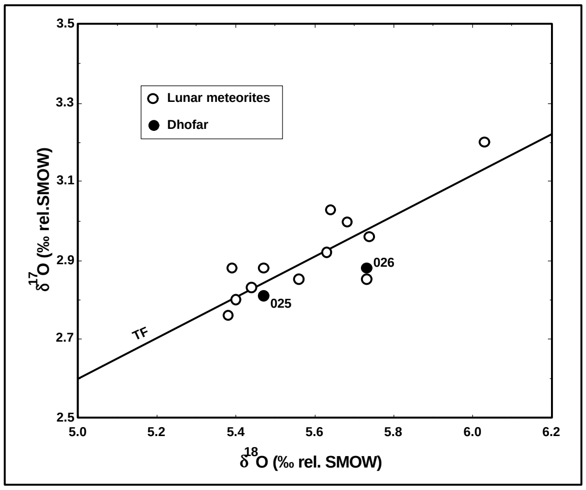


Dh25 has $\delta^{18}O$ = +5.47 and $\delta^{17}O$ = +2.81; Dh26 has $\delta^{18}O$ = +5.77 and $\delta^{18}O$ = +2.87. The oxygen isotopic compositions lie on the terrestrial fractionation line and are consistent with those reported for all other lunar meteorites [6,8] (Fig. 4).

Discussion: Dh25 and Dh26 are breccias, and therefore, bulk compositions of the meteorites result mainly from mixing of primary lunar lithologies. The chemistry of the lithologies may have been modified due to impact-induced fractionation before and during the mixing. It appears that both these meteorites are dominated by a component with a ferroan anorthosite (FAN) composition. A minor Mg-rich component is also present in Dh25. The anorthosite and perhaps the Mg-rich components are depleted in incompatible elements and are similar to the Luna 20 regolith (Fig. 2). It is possible, therefore, that , that the source area of these lunar highland meteorites might be located on the far-eastern limb of the lunar nearside or on the farside, where FAN materials are thought to dominate. In addition, these meteorites do not show any geochemical evidence of KREEP material that is typical for the highlands at least on the central- and western-regions of the lunar nearside. The very-low Ti content in Dh25 and Dh26 also suggests that any mare basalt component is insignificant in these rocks, or might be a VLT type if present at all.

Additional data on the major- and trace-element chemistry of the lunar meteorites Dh25 and Dh26 and of another lunar meteorite, Dhofar 081, are discussed in [12].





References: [1]Cahill et al. (2001) *this volume*; [2]Cohen et al. (2001) *this volume*; [3]Shukolyukov (2001) *this volume*; [4]Clayton and Mayeda (1983) *EPSL 62*, 1-6; [5]Palme et al. (1991) *GCA 55*, 3105-3122; [6]Bishoff et al. (1998) *MAPS 33*, 1243-1257; [7]Korotev (1997) *MAPS 32*, 447-478; [8]Clayton and Mayeda (1996) *GCA 60*, 1999-2017; [9]Zipfel et al. (1998) *MAPS 33*, A171; [10]Warren and Wasson (1980) *PLSC 11th*, 431-470; [11]Taylor (1982) *Planetary Science-A Lunar Perspective*; LPI. [12]Warren (2001) *this volume*.

Table 1: Whole-rock chemistry of Dh25 and Dh26.

		Dhofar 025	**Dhofar 026**
SiO_2	wt.%	43.86	44.31
TiO_2	wt.%	0.302	0.222
Al_2O_3	wt.%	26.65	29.59
Cr_2O_3	wt.%	0.102	0.08
FeO	wt.%	4.98	4.06
MnO	wt.%	0.076	0.064
MgO	wt.%	6.53	3.92
CaO	wt.%	16.11	16.99
Na_2O	wt.%	0.282	0.243
K_2O	wt.%	0.065	0.082
P_2O_5	wt.%	0.08	0.05
H_2O	wt.%	0.27	0.57
Total	wt.%	99.31	100.18
Sc	ppm	10.2	7.9
Cr	ppm	674	465
Co	ppm	16.5	13.6
Ni	ppm	200	170
Sr	ppm	2010	200
Zr	ppm	62	32
Cs	ppm	0.55	0.44
La	ppm	3.6	2.9
Ce	ppm	8.6	6.6
Nd	ppm	5.2	3.8
Sm	ppm	1.5	1.1
Eu	ppm	1.3	1.1
Tb	ppm	0.35	0.25
Yb	ppm	1.2	0.85
Lu	ppm	0.21	0.15
Hf	ppm	1.3	0.86
Ta	ppm		0.24
Ir	ppb	7.2	6.3
Au	ppb	3	9
Th	ppm	0.8	0.36
U	ppm	0.27	