DHOFAR 311, 730 AND 731: NEW LUNAR METEORITES FROM OMAN.

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Introduction: Three new lunar meteorites, Dhofar 311, 730 and 731 were found recently in the Dhofar region of Oman. Here we report the first data on the petrography and mineralogy of these rocks. All of them are anorthositic impact-melt breccias and were recovered nearby Dhofar 081, 280, 302, 303, 305, 306, 307, 309 and 310 [1,2]. However, the new lunar finds are definitely not paired with Dhofar 081 and 280, but may be related to other lunar stones of the group.

Dhofar 311 is light-gray, moderately weathered stone weighing 4 g. This is an anorthositic impact-melt breccia, in which mineral fragments and rounded lithic clasts occur within a fine-grained to cryptocrystalline impact-melt matrix. The lithic-clast population consists of impact-melt breccias, as well as cataclastic granulitic and igneous rocks of anorthositic and troctolitic compositions. Clasts of impact-melt breccias are most abundant and typically show breccia-in-breccia textures. Mineral chemistries are feldspar, An_{95-98}; orthopyroxene, $Wo_{2-5}En_{45-85}$; clinopyroxene; $Wo_{6-45}En_{40-74}$; olivine, Fo_{57-88} (Fe/Mn ≈ 91 at). Accessory minerals include: Cr-pleonaste, Al-chromite, troilite, and FeNi metal (3-27 wt% Ni; 0.2-1.9 wt% Co). The impact-melt matrix has an approximate composition: SiO_2 44.1 wt%, TiO_2 0.13, Al_2O_3 29.9, Cr_2O_3 0.08, FeO 3.17, MnO 0.05, MgO 5.08, CaO 16.8, Na_2O 0.34, K_2O 0.01, and P_2O_5 0.05. Terrestrial phases are calcite, gypsum, celestite, barite, and Fe hydroxides. On an AN versus Mg# plot (Fig. 1), most of the minerals in the lithic clasts plot within the gap between FAN and HMS, but some reside in the HMS field.

Dhofar 730 is a light-gray, moderately weathered stone weighing 108 g. This is an anorthositic impact-melt breccia, in which lithic clasts and mineral fragments are set within a fine-grained impact-melt matrix. The lithic-clast population is dominated by impact-melt breccias, cataclastic granulites, and igneous rocks of anorthositic and troctolitic compositions. Rare dunite fragments are present. Mineral phases have rather large compositional ranges: feldspar, An_{86-98}; orthopyroxene, $Wo_{2-4}En_{56-85}$; clinopyroxene, $Wo_{6-46}En_{14-71}$; olivine, Fo_{55-92} (Fe/Mn ≈ 86 at). Accessory minerals are chromite, Cr-pleonaste, armalcolite, ilmenite, silica, troilite, and FeNi metal (6-48 wt% Ni; 1-2.4 wt% Co). The impact-melt matrix has an approximate composition: SiO_2 43.7 wt%, TiO_2 0.17, Al_2O_3 27.7, Cr_2O_3 0.09, FeO 4.13, MnO 0.06, MgO 6.90, CaO 15.9, Na_2O 0.35, K_2O 0.02, and P_2O_5 0.05. Calcite, gypsum, celestite, barite, and Fe hydroxide terrestrial additions are also present. Mafic minerals of Dhofar 730 show a wide compositional range (Fig. 2). However, lithic clasts are rich in Mg# and plot mainly within the HMS field and in the 'gap' with the FAN field (Fig. 2).

Dhofar 731 is a light-gray, moderately weathered stone weighing 36 g. This is also an impact-melt breccia. Lithic clasts and mineral fragments are cemented by a fine-grained, impact-melt matrix. The lithic-clast population consists mainly of impact-melt breccias of anorthositic and troctolitic compositions. Mafic-mineral fragments show large compositional ranges: orthopyroxene, $Wo_{2-5}En_{53-85}$; clinopyroxene, $Wo_{6-45}En_{30-81}$; olivine, Fo_{52-87} (Fe/Mn ≈ 84 at), but feldspar composition, An_{95-97}, is restricted. Accessory minerals include: Cr-pleonaste, chromite, ilmenite, troilite, and FeNi metal (0.5-66 wt% Ni; 0.2-2 wt% Co); Cr-pleonast is most common. The composition of the impact-melt matrix: SiO_2 43.4 wt%, TiO_2 0.14, Al_2O_3 28.1, Cr_2O_3 0.08, FeO 3.52, MnO 0.06, MgO 6.55, CaO 16.1, Na_2O 0.36, K_2O 0.02, and P_2O_5 0.06. Calcite, gypsum, celestite, barite, smectite, and Fe hydroxides are the terrestrial additions. Most of Dhofar 731 mineral fragments plot within the gap between FAN and HMS groups (Fig. 3).

Trace elements: Dhofar 311, 730, and 731 are characterized by low-Sm and -Sc and high-Mg# contents (Fig. 4). This woud seem to suggest that these highland breccias should be enriched in troctolitic lithologies, similar to Dho 302, 303, 305, 306, 307, 309 and 310 found nearby. However, Dhofar 081 and 280, recovered close by, are significantly lower in Mg#. These meteorites are dominated by FAN material and contain lower Ba and Sr (Fig. 5), which probably indicate a lower degree of weathering [2]. In contrast, the troctolitic meteorites are high in these elements and should have an older terrestrial age. Dhofar 731 is distinctly higher in Ba and Sr, as compared to Dhofar 311 and 730, but all of the new meteorites reside within the field of troctolitic meteorites (Fig. 5).

Discussion: The new lunar meteorites are very similar to each other. All contain abundant troctolitic lithologies and have similar mineral- and trace-element chemistries (Fig. 1-5). However, Dhofar 731 seems to be more weathered. It contains smectite and is enhanced in Ba and Sr (Fig. 5). Dhofar 730 appears to

have the most polymict composition. Mafic minerals of this meteorite demonstrate the widest compositional range (Fig. 2). It is entirely possible that these differences are not significant and may be simply related to the heterogeneities in the meteorites. It is probable that the meteorites may be paired with each other and with other troctolitic meteorites (Dhofar 302, 303, 305, 306, 307, 309, 310) recovered nearby, except maybe for Dhofar 302 and 305, which have some special mineralogical characteristics [1]. But, the lunar meteorite population is definitely not related to Dhofar 081 and 280, which have FAN compositions and represent the youngest lunar meteorite fall in the Dhofar district [2]. Interestingly, Dhofar 311 was found only 25 m away from Dho 280. All these meterotie finds suggest that the flux of lunar meteorites the Earth is not as extremely low as some postulate.

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References: [1] Demidova S. I. et al. (2003) *LPS XXXIV,* 1285.pdf. [2] Nazarov M. A. et al. (2003) *LPS XXXIV,* 1636.pdf.