THE PETROGENESIS OF VERY LOW-TI MARE BASALTIC CLASTS IN LUNAR METEORITE DHOFAR 1442.

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Introduction: Lunar meteorite Dhofar (Dho) 1442 is a clast-rich regolith breccia with a glassy and vesicular matrix [1-2]. The lithic clast content includes basalts, mafic breccias, gabbros, norites, anorthosites, impact spherules and evolved lithologies-granophyres [1-4]. Dho 1442's bulk composition is the 2nd most incompatibly trace element rich sample to date [1, 5], after the impact melt clast component of Sayh al Uhaymir (SaU) 169 [6]. The provenance of Dho 1442 is almost certainly within the Procellarum KREEP Terrane (PKT) [2]. In the present work, in order to clarify the petrogenesis of basaltic clasts in Dho 1442, we conducted a detailed study on the petrography, mineralogy and geochemistry of basaltic clasts using *in-situ* electron microprobe and LA-ICP-MS techniques.

Results: Six mare basaltic clasts were identified in the meteorite section we studied. They exhibit a range of textures from subophitic to porphyritic. There are no apatite or merrillite or zircon found within the Dho 1442 basaltic clasts. Using the Apollo mare basalt classification scheme of Neal and Taylor [7], three of these basaltic clasts (named Ba1, Ba3, Ba5) can be classified as very low-Ti (VLT), high-Al (15-18 wt%) basalts, and two clasts (Ba2, Ba4) are VLT (0.5-1 wt%), low-Al (6-8 wt%) basalts, and one (Ba6) can be classified as a low-Ti (2.5 wt%), high-Al (18.5 wt%) basalt. These basaltic clasts all have low incompatible element (ITE) concentrations. Both Ba1 and Ba4 show positive Eu-anomalies (Ba1 = 1.6 Eu/Eu*; Ba4 = 3.0 Eu/Eu*, where $Eu/Eu^* = Eu_{cn}/\sqrt{[Sm_{cn}*Gd_{cn}]}$), which is not typical of the majority of Apollo mare basalts.

Discussion: Although these clasts are small (150-500 μm), they can potentially provide new insights to lunar volcanism and the processes that caused magma production at different times in the Moon's past.

What were the source regions of basaltic clasts in Dho 1442? The high Al_2O_3 and CaO content (15.3 and 11.1 wt%, respectively) of Ba1 suggest that its source region was predominately composed of plagioclase and pyroxene. Thus, the parent magma of Ba1 may have been derived from decompression-driven partial melting of a leuconoritic crustal lithology. Alternatively, the generation of Ba1 might be from melting of a hybridized source consisting of a mixture of early- and late-stage lunar magma ocean cumulates (orthopyroxene+olivine and clinopyroxene+plagioclase, respectively). Ba4 in Dho 1442 is an unusual VLT mare basalt. With the exception of Ba4, other VLT mare basalts in lunar meteorites and returned samples exhibiting positive Eu-anomalies contain >11 wt% Al_2O_3 [e.g., 8-9] and are classified as high-Al basalts. In contrast, the bulk Al_2O_3 content of Ba4 is only 7.8 wt%. As Al_2O_3 is an incompatible oxide, the Al_2O_3 content in the basaltic partial melt should be enriched relative to the content in the source region. In other words, the Al_2O_3 content of Ba4 source region might be lower than ~4 wt% (assuming ~50% degree of melting), ruling out the possibility of partial melting of a plagioclase-rich lithology. If the source region of Ba4 was dominated by orthopyroxene, its Al_2O_3 and CaO content were ~3 wt% and ~2 wt% respectively based on the Al and Ca partition coefficients of orthopyroxene-basalt [10-11]. Both the calculated Al_2O_3 and CaO content of Ba4 source region are consistent with the composition of lunar orthopyroxene [e.g., 12-13], indicating origin from partial melting of a mantle region dominated by early orthopyroxene cumulates of the magma ocean.

What was the role of KREEP? Although the bulk rock composition of the Dho 1442 meteorite suggests it originated within the nearside PKT region, compared with high-Ti and low-Ti mare basalts, low concentrations of ITEs in Dho 1442 basaltic clasts indicate that the parent magmas of these basalts was not from urKREEP-rich portions of the mantle, and that during ascent the magmas did not mixed with any KREEPy crustal rocks or KREEPy impact melt components. Thus, the basalts may represent mantle melting that was not driven by KREEP induced heating.

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