GEOCHEMISTRY OF 5 ANTARCTIC HOWARDITES AND THEIR CLASTS

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We have performed INAA and petrographic investigations of matrix and clast samples from 5 Antarctic howardites as part of investigations being conducted by consortia set up by us and J.C. Laul. The meteorites under study are EET82600, EET87503, EET87509, EET87513 and EET87531. The 4 EET87 howardites are thought to be paired (1). Petrographic descriptions for samples from Laul's consortium have been presented (2-3). We present here INAA data and preliminary petrographic details for samples from our consortium, and preliminary INAA data for samples from the Laul consortium.

MATRIX SAMPLES. A total of 18 matrix samples have been analyzed: 2 each from EET82600 and EET87503, 4 each from EET87509 and EET87531 and 6 from EET87513. Using major and trace elements that should be the least susceptible to weathering (Cr, Ca, Sc; Fig. 1), we suggest that EET82600 may be paired with EET87509 and EET87531. EET87513 is richer in Cr and poorer in Ca and Sc than the 600-509-531 group, indicating a greater diogenitic component in this howardite. EET87513 may not be paired with the 600-509-531 group, but additional data are needed to evaluate this possibility. EET87503 is intermediate in composition between EET87513 and the 600-509-531 group. A semi-quantitative estimate suggests ~15% diogenitic component in the 600-509-531 group, ~20% in EET87503 and ~35% in EET87513.

"BLACK" CLASTS. Five of the clasts analyzed are dark or "black" clasts. These samples were selected in hopes that they were carbonaceous chondrite fragments, but all five are HED parent body materials. One clast, EET87503,35, is howarditic in composition with low Ca and Sc and high Cr. The Co and Ni contents of this clast are similar to those of the matrix of this meteorite. The composition of ,35 indicates that roughly 45% diogenitic component may be present. Two clasts, EET87531,103c (a small clast we separated from the matrix sample) and EET87509,49 (clast d of (2)) are fine-grained basalts. EET87509,49 (clast d) has been classified (3) as belonging to the type B or Na-rich basalt trend of (4). Two black glassy clasts, EET82600,38 and ,39, are generally similar in composition to the matrix of this meteorite and may be impact melts. Both are highly depleted in Na, but neither exhibits siderophile element enrichment that might be expected for impact melts. We await final data for these clasts in order to further evaluate their origin.

ORTHOPYROXENITE CLASTS. We have analyzed 6 orthopyroxenite clasts. They range in FeO content from ~15 wt% (typical of most diogenites) to ~21 wt% (similar to Y75032 type diogenite pyroxenes (5)). Two of the clasts have low Sc contents of 8-9 ppm similar to the trace element poor diogenite Shalka and to Manegaon (6). One of the Sc poor orthopyroxenites is the most ferroan in the suite (~21 wt% FeO) and has atypically low Cr (~1100 ppm). One clast has a Sc content (~23 ppm) similar to that of the ferroan Y75032 type diogenites (~21 ppm), but is, however, lower in FeO (~18 wt%) than the Y75032 type pyroxenes we have measured (~21 wt%, (6)).

BASALTIC CLASTS. We have analyzed 14 basaltic clasts. At least 7 of them have had their trace element contents altered by terrestrial weathering. Two of the clasts are probably impact melts. Both have Cr, Ca and Sc contents similar to matrix samples of the meteorites and one, EET87509,75 (clast q of (2)), contains elevated Ni (~230 ppm) and Co (~55 ppm) contents similar to those of matrix samples. This clast is a pigeonite vitrophyre (2) and is more Mg-rich than typical eucrites (3). Of the remaining basaltic clasts, one is especially noteworthy. EET87509,73 (clast e of (2)) is an evolved melt similar to Nuevo Laredo. This clast contains ~40 ppm Sc *vs.* ~38 ppm for Nuevo Laredo, and ~2.3 ppm Sm *vs.* ~2.3 ppm for Nuevo Laredo. The high Sm and Sc contents of EET87509,73 indicates that it is a residual melt from a Juvinas-like precursor. However, ,73 is poorer in FeO (~14 wt% *vs.* ~20 wt%) and considerably richer in Na_2O (~0.80 wt% *vs.* ~0.52 wt%) than Nuevo Laredo. Two clasts are slightly evolved compared to Juvinas type eucrites: EET87503,23 and ,25. These clasts have Sc contents of 34-35 ppm, Sm contents of 2.2-2.5 ppm and are FeO-rich (20-22 wt%), which compares well with mean Lakagaon (Sc - 34.9 ppm, Sm - 2.2 ppm, FeO 21.6 wt%). The remainder of the basaltic clasts are generally similar to Juvinas group eucrites.

CUMULATE GABBRO CLASTS. Three clasts are cumulates with low Fe and Sc, generally high Cr, low +3 REE and high Eu. Two of the clasts are generally similar to Serra de Mage in REE content, and the other is more trace element rich like Moore County. The effects of possible weathering are more difficult to estimate for cumulates, however, and further evaluation of the data are needed before the petrogenesis of these clasts can be discussed.

WEATHERING EFFECTS. We have analyzed interior/exterior sample pairs from two basaltic clasts from EET87503 and matrix from EET82600, EET87503 and EET87513 in order to further our investigation of weathering effects (7-8). The interior sample of medium-grained basalt EET87503,53 exhibits no effects of weathering in its REE pattern, while the exterior sample shows slightly depleted LREE and a slight negative Ce anomaly. Fine-grained basalt EET87503,23 exhibits no obvious weathering effects in the exterior sample, while the interior sample shows a slight negative Ce anomaly. The matrix samples show more extreme weathering effects, although the trends are not consistent. For example, the exterior samples of EET82600 shows low +3 REE with positive Eu and positive Ce anomalies consistent with leaching of REE from phosphates (7). The interior sample is enriched in LREE, and has negative Ce and Eu anomalies, possibly indicating deposition of the dissolved +3 REE in the interior of this stone. In contrast, the exterior of EET87503 is enriched in +3 REE relative to the interior sample and has a negative Ce anomaly. Clearly, weathering effects have left complex signatures in Antarctic HEDs that may not be correlated with depth in the stone. This is supported by the conclusions of (8), who also show that visible weathering effects are not necessarily correlated with the abnormal trace element signatures that are caused by weathering.

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Fig. 1. Cr - Ca and Cr - Sc relationships of EET howardite matrix samples.