STRANGE CLASTS IN ANTARCTIC HOWARDITES: EVIDENCE FOR ADVANCED DIFFERENTIATION AND COMPLEX PROCESSES. John L. Berkley, Department of Geosciences, SUNY, College at Fredonia, NY 14063.

Howardites are surface impact breccias that contain basalt and pyroxenite fragments, among others. Lithic clasts in howardites are considered to be part of the HED assemblage, although their precise relationship to monomict eucrites and diogenites has not been thoroughly established. To further that end, lithic clasts in five Antarctic howardites (LEW85313, EET87503, LEW85015,LEW87005, & LEW85441) have been analyzed by electron microprobe (Dept. of Geology, Rensselaer Polytech., Troy, NY), including bulk analyses. Bulks were obtained by calculating weighted averages of oxide components using microprobe analyses of major minerals, and modes obtained by digital processing of backscattered electron (BSE) images. Calculated bulks do not consider opaque minerals, thus show lower total iron, Cr, and Ti compared to eucrites analyzed by conventional techniques. Low iron, sampling problems, and probable errors associated with the digital modes, lead to offsets from liquidus boundaries of projected compositions on phase diagrams (Figs. 1 & 2; reader beware!).

Composition groups. Clasts fall into four major groups as follows:

1. "normal" eucrite-like basalts: These plot near the px-ol-pl minimum in Fig. 1, have granoblastic or subophitic textures, but also include one fine-grained, possible cumulate, 85313-E6 [1]. **2. intermediate silica clasts:** Compositionally like terrestrial andesites (SiO_2 52-56%), all but one contain modal silica, and plot near (more or less) to the px-pl-si minimum in Fig. 1. They have subophitic and variolitic textures. **3. ultra-high silica clasts:** These contain high modal silica and bulk SiO_2 equals 65-70%. 85441-E7 (65% SiO_2) is a variolitic, pl-px-si vein crosscutting an opx grain (Fs50). 87005-E4 (70% SiO_2) is a fine-grained, granoblastic, and distinctly foliated opx-cpx-si assemblage. It resembles some terrestrial tectonites.

4. primary fayalite-bearing clasts: Of the three clasts in this group, two contain a silica mineral, 85313-S8 (Fa[85]-ferrohyp-si-witlockite) and 87503-E5 (Fa[87]-ferroaug-si). 85313-S9 is a large (1.5 mm) opx (Fs62;Wo1.6) grain with irregular augite and Fa(84) inclusions. Bulk 87503-E5 is plotted in Fig. 2.

Discussion. The origin of eucrites similar to group 1 (above) have been discussed by several authors, for example [2], [3], and [4]; this discussion will center on the less common groups, 2, 3, and 4.

Group 2: These clasts originated either as partial melts from source materials more differentiated than those that gave rise to ordinary eucrites, or as derivative compositions produced by fractional crystallization of mostly px and pl from eucrite-like parents (Fig. 1). [5] recently suggested that fractional crystallization is the most likely origin for highly differentiated rocks in LEW85300, 85302, 85303 polymict eucrites, and this origin seems likely for 87503-E6 and E4 here. Both have higher Fe, Ti, and K/Na than most other clasts, although total alkalis are low consistent with volatilization during crystallization. 85313-S1, however, is more Mg-rich than most other clasts and monomict eucrites, so is not likely derived from "normal" eucrites by fractional crystallization. Nevertheless, textures in all three group 2 rocks are consistent with eutectic crystallization with silica as a major player. They represent products of more advanced, or more complex crystallization histories compared to common eucrites.

Group 3: The exceptionally high silica in 85441-E7 vein likely results from sampling error; it may actually belong to group 2. It has affinities to 85313-S1 (above), being very magnesian (mg#=0.62) but high in K/Na and total alkalis. 87005-E4 is essentially an Fe-rich, silica-px rock nearly devoid of feldspar. A more representative bulk composition could be expected to plot near the pig-aug-sil minimum in an iron-rich version of Di-Ol-Q, assuming it represents a liquid composition. If so, it may have been derived from a source previously depleted in feldspathic components.

Group 4: These are primary Fa-bearing rocks similar to those recently described by [5], except none of the clasts described here contain feldspar. The bulk obtained for 87503-E5 plots close to the point of fa-opx-sil saturation in SiO_2-MgO-FeO (Fig. 2). It is extremely Fe-rich (mg#=0.20), low in alkalis and Cr, but has high Ti and superchondritic molar CaO/Al_2O_3 (34.0). Thus, it is a reasonable candidate for derivation by melting of feldspar-depleted, iron-enriched cumulates.

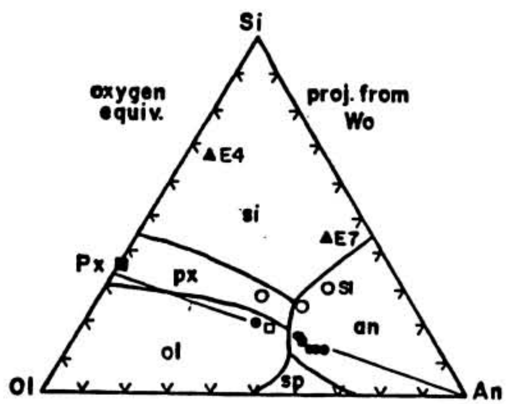

Fig. 1. Si-Ol-An projected from Wo, after [4]. Symbols: open square = avg. eucrites plus 85313-E6 "cumulate"; closed circles = grp.1 how. clasts; open circles = grp.2 how. clasts; triangles = grp.3 how. clasts; closed square = grp.4 (87503-E5,cpx-fa-q; also see Fig. 2).

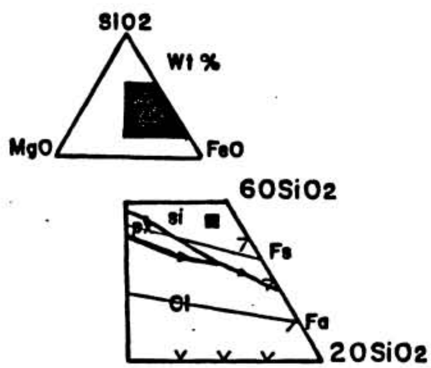

Fig. 2. Portion of SiO2-MgO-FeO, Bowen and Schairer, 1935. Howardite clast 87503-E5 (cpx-fa-q) is plotted as closed square.

References: [1] Berkley, J.L., 1989, LPSC XX, p.63. [2] Stolper, E., 1977, GCA **41**, p.587. [3] Hewins, R.H. and Newsom, H.E., 1988, in *Meteorites in the Early Solar System,* p.73. [4] Longhi, J. and Pan, V., 1988, Proc. LPSC XVIII, p.459. [5] Kozul, J.M. and Hewins, R.H., 1989, Meteoritics **24**, in press.