

**EUCRITE AND DIOGENITE CLASTS IN THREE ANTARCTIC ACHONDRITES** Paul C. Buchanan and Arch M. Reid, Department of Geosciences, University of Houston, Houston TX 77204-5503

Mineralogic and petrographic studies have been made of 17 clasts from 3 achondrites (EET87509, EET87513, EET87531) in the 1987 U.S. Antarctic collection. Eucrite clasts are more abundant than diogenites, and carbonaceous fragments are rare (1). The clasts show evidence of a range of thermal histories from pristine quench textures through various degrees of subsolidus annealing to complete recrystallisation.

**CLAST TYPES.** The 17 clasts studied show a wide range of compositions, as determined from mineral analyses. The most magnesian clasts are fine-grained equigranular orthopyroxenites (En<sub>79</sub> to En<sub>68</sub>), which we interpret as recrystallised diogenites. The very Fe-rich clasts are eucrites with mineral compositions comparable to those in the common eucrites, e.g. Juvinas, and ranging to higher Fe/Mg values, comparable to Nuevo Laredo. Very Fe-rich clasts have fine to medium-grained igneous textures and generally unzoned, exsolved pyroxenes. A significant number of the separated clasts are eucrites with pyroxene compositions intermediate between those in the common eucrites and those in diogenites. Pyroxene and feldspar are in subequal abundance and most have igneous textures though in some clasts the original texture has been obliterated. Most of these intermediate clasts have highly Mg-Fe zoned pyroxenes: the spatial distribution of the Fe-rich areas and the correlation of Fe with minor elements such as Ti, Al, Cr, Mn are consistent with primary, i.e. growth zoning. In terms of metamorphism these intermediate clasts are of lower grade (less annealed) than either the diogenite clasts or the clasts that compositionally resemble the common eucrites. Extending the metamorphic classification of Takeda et al. (2), we have subdivided the clasts into 8 metamorphic grades. On this scale, the diogenites are type 8 (most annealed) and the common eucrites are types 4 to 6, whereas the intermediate clasts are commonly type 3. Several clasts, particularly in EET87509, have quench textures ranging from vitrophyric, through very fine-grained holocrystalline, to glassy with microphenocrysts. These clasts are of eucrite composition but with a range of Mg/Mg+Fe ratios (.59 to .38). The compositions, textures, and occurrence (association with other fine-grained eucrite fragments) are consistent with a magmatic origin, but do not exclude an impact origin.

**COMPARISONS AMONG EUCRITIC CLASTS.** Figure 1 shows the compositional ranges of coexisting pyroxenes and feldspars in the clasts from all three meteorites. In figure 2 mineral data for a range of clasts are plotted as average Mg/Mg+Fe for pyroxene versus average anorthite content of coexisting plagioclase. Two distinct trends are recognised on this plot, equivalent to the A and B trends of Ikeda and Takeda (3), and to the peritectic and evolved basalts of Delaney et al. (4). The upper series of Fe-rich eucrite clasts (trend A or peritectic trend), with compositions similar to the common eucrites, define a rather narrow trend of increasing Na/Ca with increasing Fe/Mg. The non-Antarctic common eucrites mostly plot within trend A (e.g. Juvinas). The lower series of eucritic clasts (trend B or evolved group) shows a wide range of pyroxene Mg/Mg+Fe values, from highly magnesian eucrites, with pyroxene compositions approaching diogenite values, to eucrites with pyroxenes comparable to those in the common eucrites. Type B clasts have more sodic plagioclase for equivalent pyroxene compositions. The non-Antarctic eucrite Pasamonte would plot with the type B eucrites. Other distinctions can also be noted between the two trends. Type A eucrites have igneous textures but lack any mesostasis: their pyroxenes are generally equilibrated, i.e. unzoned but commonly exsolved. Type B eucrites have igneous textures with mesostasis present, and highly zoned pyroxenes. The two series appear to represent two distinct evolutionary paths for eucritic melts, with significantly higher Na (and other volatiles?) in the type B eucrites. There are also differences in the extent to which the eucritic clasts have undergone subsolidus annealing. Type B eucrites are less metamorphosed than the diogenites and the type A eucrites.

**DISCUSSION.** The eucrites range from compositions more Fe-rich than the common eucrites through to high Mg compositions that approximate feldspathic diogenites. Intermediate eucrites are fine-grained and show extensive Mg-Fe zoning, most of which is interpreted as primary zoning. No definite cumulate textures were recognised in these intermediate clasts. The type B clasts thus provide evidence for the presence of melts with compositions intermediate between diogenite and common eucrite. There has been much debate as to whether the common eucrites are the products of partial melting (e.g. 5,6) or of fractional crystallisation from a more magnesian parent melt (e.g. 3, 7-10). Both hypotheses may be correct. The type A eucrites with their limited compositional range, close to the peritectic composition, fit the picture of partial melts, as do the common non-Antarctic eucrites. The compositional range exhibited by type A eucrites (Figure 2) may reflect crystal-liquid fractionation of peritectic liquids (towards Nuevo Laredo type compositions). The type B eucrites represent the crystallisation of a series of fractionated liquids, starting from a composition like that of EET87513, clast Y, and evolving towards the composition of evolved eucrites, such as the Fe-rich type B clasts, or Stannern in the non-Antarctic eucrites. The origin of these compositionally different eucrite suites (escape of volatile components from the surface of a magma ocean according to Ikeda and Takeda (3)) is unclear, as is the mechanism by which the volatile-poor eucrites (type A) have undergone more extensive subsolidus annealing.

**REFERENCES.** (1) Buchanan P.C. and Reid A.M. (1990) LPSC XXI, 141-142. (2) Takeda H., Mori H., Delaney J.S., Prinz M., Harlow G.E., and Ishii T. (1983) Proc. 8th Antarct. Meteor. Symp. NIPR, 30, 181-205. (3) Ikeda Y. and Takeda H. (1985) Proc. 15th Lunar Planet. Sci. Conf., J. Geophys. Res. 90, C649-C663. (4) Delaney J.S., Prinz M., Nehru C.E., and Harlow G.E. (1981) LPSC XII, 211-213. (5) Stolper E. (1977) Geochim. Cosmochim. Acta 41, 587-611. (6) Consolmagno G.J. and Drake M.J. (1977) Geochim. Cosmochim. Acta 41, 1271-1282. (7) Mason B. (1962) Meteorites. John Wiley and Sons, N.Y. 274 pp. (8) McCarthy T.S., Erlank A.E., and Willis J.P. (1973) Earth Planet. Sci. Lett. 18, 442-443. (9) Takeda H. (1979) Icarus 40, 455-470. (10) Nehru C.E., Delaney J.S., Prinz M., Weisberg M., and Takeda H. (1983) LPSC XIV, 550-551.

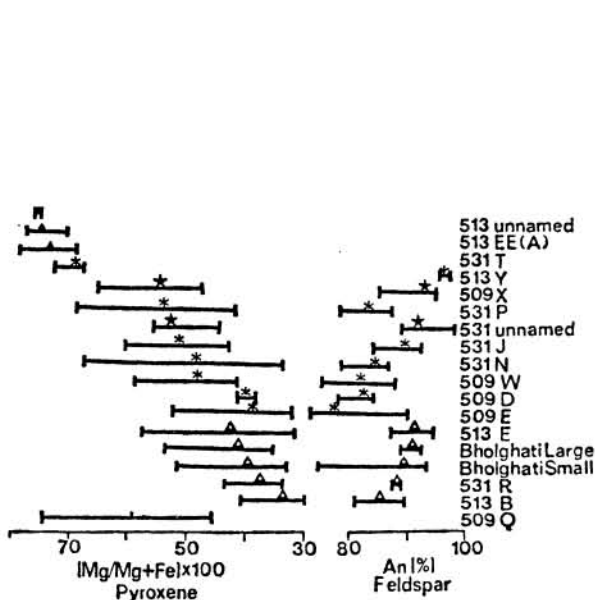


Figure 1. Ranges and averages of Mg/Mg+Fe in pyroxene and An content of plagioclase for coexisting minerals in eucrite and diogenite clasts in achondrites EET87509, EET87513 and EET87531

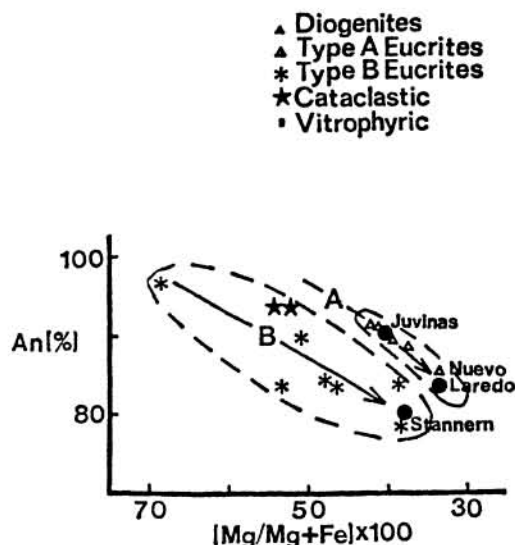


Figure 2. Anorthite content of plagioclase versus Mg/Mg+Fe of coexisting pyroxene for eucrite clasts in achondrites EET87509, EET87513 and EET87531. Two clasts from Bholghati are included in the type A eucrites.