THE POLYMICT EUCRITES

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The polymict eucrites are a newly defined subgroup within the basaltic achondrites suite of meteorites (1). They are polymict breccias dominated by clasts derived from many types of mafic rocks. They form a compositional-textural continuum with the howardites (which also contain an important orthopyroxenite component in addition to the mafic clasts). A formal division between the two groups at 10% orthopyroxenite component has been proposed (1). Three Antarctic localities; Yamato Mtns, Allan Hills (ALH) and Elephant Moraine (EET); have yielded polymict eucrites and three non-Antarctic achondrites become polymict eucrites using the definition above. At least 32 specimens are known but the number of meteorites is probably smaller: Bialystok, Nobleborough, Macibini, 2 from Allan Hills, 2 from Elephant Moraine and at least 2 from Yamato Mtns.

Polymict eucrites have bulk compositions generally similar to the monomict eucrites but with important differences. Yamato meteorites have less Al_2O_3 and more MgO than ALHA or monomict eucrites (3-13). EETA meteorites have low Ca, high Mg/(Mg+Fe) and enigmatic high K_2O contents (3). In general, the ALHA polymict eucrites are compositionally most like the monomict eucrites, whereas the Yamato and EETA meteorites are closer to the howardites. Isotopically (7) bulk ALH meteorites are similar to monomict eucrites, but separated clasts have lower I_{Sr} ratios. At least one separated clast has unusual oxygen isotopes (14) that are not linked to the basaltic achondrites by mass fractionation. Impact mixing of oxygen reservoirs may, however, account for these data (15).

The most characteristic feature of all the polymict eucrites is the diversity of clast types sampled. The monomict eucrites generally have very uniform textures and compositions from clast to clast suggesting that they are truly monomict breccias, but the influence of pervasive metamorphism in all eucrites except Pasamonte has not yet been totally assessed (16). In the polymict eucrites, and in the howardites, many different mafic clast types are known.

Mafic Clasts. The earliest descriptions of Yamato polymict eucrites (9,20) emphasized the presence of both cumulate eucrite and basaltic eucrite pyroxene. Most Yamato meteorites contain pyroxene in lithic and mineral clasts that have exsolution textures and chemistry comparable with Binda, Juvinas, Pasamonte and Nagaria. All of these pyroxene types have also been located in lithic fragments indicating that the Yamato meteorites sampled a wide range of mafic rocks. The ALHA and EETA meteorites appear to be lacking the Binda-like fraction, but sample all the others as lithic clasts. Coarse gabbroic clasts that are not simply comparable with any eucrite textures are also found but their compositions are generally eucritic. In all the Antarctic polymict eucrites, glassy and very fine-grained spherulitic basalt clasts are present sampling either surface volcanics or impact melts. Some glasses have xenocrysts and compositions similar to the bulk meteorites suggesting that they are impact melts but others have compositions suggesting some crystal-liquid fractionation and are, therefore, probably volcanic. Mafic rocks from polymict eucrites are their main components. Although they sample rocks like monomict eucrites (En_{30-40} Wo_{5-15}+An_{88-92}), rare feldspar cumulate fragments (An_{93-95}+En_{45-55}) and pyroxene cumulate fragments (En_{64}) the most important clasts are those not seen as meteorites. Clasts having Mg/(Mg+Fe) ratios comparable to all eucrites but coexisting with more sodic feldspar (An_{75-85}) confirm the existence of several suites of basaltic rocks on the basaltic achondrite parent body (21). Some unequilibrated clasts are probably impact generated basalts and once recognized, can provide further information of regolith diversity. The

range of clast compositions observed (22) does not seem compatible with the simple partial melting model (23) and requires additional fractionation or variable source regions.

Metamorphic Overprint. In all Antarctic polymict eucrites, clasts may be subdivided into equilibrated (or annealed) clasts and unequilibrated clasts (cf 17). Evidence for metamorphism of portions of the ALH and EET breccias (18,19) indicate that the unequilibrated clasts are probably late introductions to the breccia. The EETA79004 and 79011 breccia are dominated by a metamorphic overprint that may have equilibrated many of the mafic clasts with one another (19). In ALHA76005 metamorphism was not so well developed and appears to have affected limited area (18). In ALH, non-Antarctic and most Yamato specimens, annealing or metamorphism of most lithic clasts occurred before incorporation into the breccia. At least one Yamato meteorite (Y790260), however, has textures suggesting that it sampled a heavily metamorphosed or even partially melted breccia. This meteorite is distinct from EETA79004 as the mafic clasts it contains do not show such complete homogenization of Fe/Mg.

Pyroxenites. Careful searches for 'diogenitic' pyroxene in the Antarctic specimens have been generally unsuccessful. Occasional En_{70+} compositions have been found in Yamato and Allan Hills specimens but appear to be phenocryst cores rather than orthopyroxenite fragments. The non-Antarctic meteorites and ALHA78006 all have diogenitic pyroxene. These meteorites all plot in the monomict eucrite field of the ol-an-SiO_2 pseudoternary (22) and are chemically more like eucrites than some polymict eucrites. They have, however, modal pyroxene/plagioclase ratios within the Antarctic polymict eucrite range (2). The whole group is modally transitional between the howardites and the monomict eucrites and clearly is part of a continuum of polymict breccias.

CONCLUSIONS (1) The polymict eucrites are part of a continuum of polymict breccias that extend the howardite range to overlap the monomict eucrites. **(2)** Polymict eucrites may be treated in mixing calculations in the same way as howardites but available data suggest that only some clasts are identical to the monomict eucrites. Many represent previously unsampled rocks. **(3)** The mafic clast population of the polymict eucrites together with that of howardites constitutes a very diverse suite of volcanic and plutonic igneous rocks that provide much more rigorous constraints on their parent body than do the eucrites alone. **(4)** The petrogenesis of these meteorites involved several stages (i) Formation of an early igneous crust that was brecciated to form regolith. (ii) Metamorphism of some areas. (iii) Variable degrees of rebrecciation. (iv) Further igneous activity of either volcanic or impact origin. (v) Incorporation of late igneous rocks into the present breccias.

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Notes. PL(P)SC=Proc. Lunar (Planet.) Sci. Conf. : MNIPRSI=Mem. Natl Inst. Polar Res. (Japan), Spec. Issue : LPS=Lunar Planet. Sci. (extended abstract) : G.C.A.=-Geochim. Cosmochim. Acta. Funding NSG 7258 (M. Prinz, P.I.).