PETROGENETIC MODELS FOR EUCRITE GENESIS. Arch M. Reid, A.R. Duncan, and A. Le Roex, Departments of Geology and Geochemistry, University of Cape Town, Rondebosch, South Africa.

Eucrites are monomict breccias (1) and bulk compositional data can thus be used to test whether consistent models can be erected to explain the compositional differences among the eucrites by crystal-liquid partitioning. Unfortunately the number of bulk analyses of eucrites is small and many are unreliable. In addition the differences between many eucrites are small enough that only data sets from a single laboratory can be used to test petrologic models.

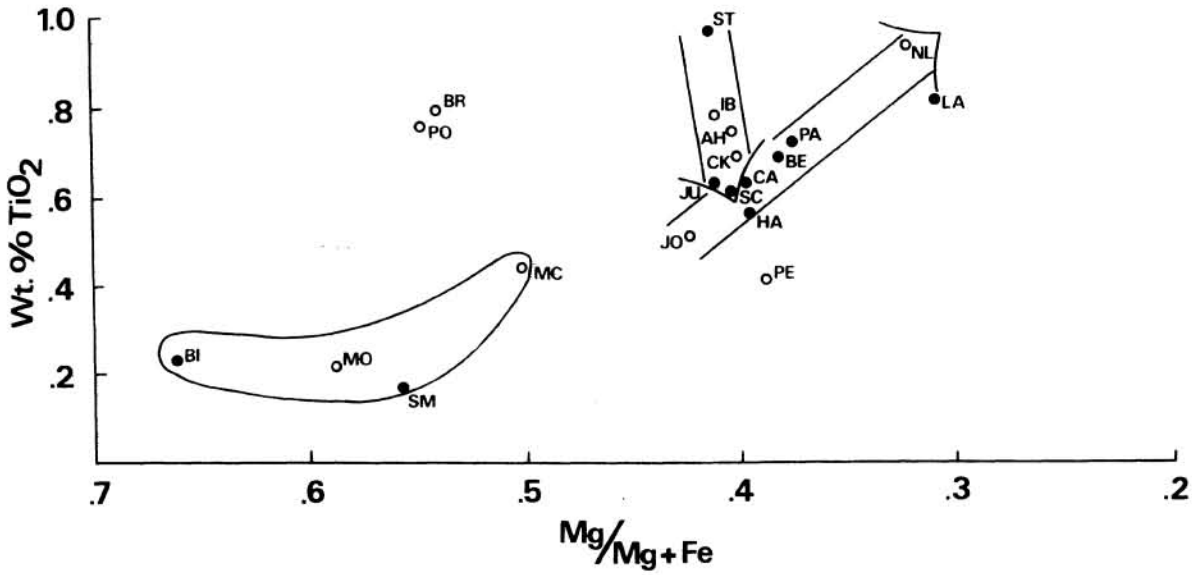

Figure 1 : Plot of TiO_2 (wt.%) versus Mg/Mg+Fe (atomic) for analysed eucrites. Eucrites plotted are AH - Allan Hills 76-05, BE - Béréba, BI - Binda, BR - Brient, CA - Cachari, CK - Chervony Kut, HA - Haraiya, IB- Ibitira, JU - Juvinas LA - Lakangaon, MO - Moama, MC - Moore County, NL - Nuevo Laredo, PA - Pasamonte, PO - Pomozdino, SM - Serra de Magé, SC - Sioux County and ST - Stannern. Solid circles represent analyses from University of Cape Town.

EUCRITE GROUPS. Figure 1 is a plot of TiO_2 versus Mg/Mg+Fe (atomic) for the eucrites. This plot satisfactorily separates the eucrites into four main groups which are described below (the reader is warned that the classification is to some extent model-dependent). 1. Main Group Eucrites. On all plots of eucrite bulk data there is a clustering of compositions which in Figure 1 occurs around an Mg/Mg+Fe value of 0.4 and a TiO_2 content of 0.6, and includes

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Sioux County, Juvinas, Cachari and Haraiya. Jonzac, Chervony Kut and Béréba also have similar compositions. These are the Main Group Eucrites which are the most common meteorite basalt. 2. The Stannern Group. This group of eucrites defines a trend, from the Main Group to Stannern on Figure 1 (Chervony Kut, Allan Hills 76-05, Ibitira, Stannern) along which there is an increase in TiO_2, alkalis, and large ion lithophile trace elements accompanied by only minor changes in major element composition and Mg/Mg+Fe ratio. 3. The Nuevo Laredo Group. This group extends from the Main Group Eucrites to Nuevo Laredo and includes Béréba, Pasamonte, Lakangaon and Nuevo Laredo. Compositional changes along this trend encompass increases in TiO_2, alkalis and large ion lithophile trace elements accompanied by systematic changes in major element composition and decreases in Mg/Mg+Fe ratio. 4. The High-Mg Eucrites. This group includes those eucrites with higher Mg/Mg+Fe ratios than the Main Group Eucrites (Moore County, Serra de Magé, Moama and also Binda). They are coarser grained and some have cumulate textures. Other eucrites for which analyses are available do not fit readily into any of these groups (e.g., Brient, Pomozdino, Peramiho).

EARLIER WORK. Stolper (2) showed that the Main Group Eucrites were multiply-saturated basaltic liquids with compositions consistent with partial melting of an olivine, pigeonite, plagioclase, Cr-rich spinel, and metal source. Stannern could be derived from the same source by a lesser degree of partial melting, whereas the Nuevo Laredo Group could be explained as derivative liquids by near-surface fractionation of a Main Group liquid. The High-Mg Eucrites were explained by Stolper as cumulates from a more iron-rich liquid, not equivalent to any known eucrite. Other authors had independently reached similar conclusions for some of these eucrites. This scheme was quantified by Consolmagno and Drake (3) who modelled the inter-eucrite relationships using the REE for control. Consolmagno and Drake's results complemented Stolper's conclusions and showed that the Main Group Eucrites could be derived from a source with chondritic REE abundances, both relative and absolute, by 10-15 % equilibrium partial melting. Stannern could be derived from the same source by about 4% partial melting. Our results are a direct extension of these two studies and essentially confirm their conclusions.

PARTIAL MELTING MODELS. We used the same approach as Consolmagno and Drake (3) to model the Main Group Eucrites but used the elements Zr, Sc, Ba, Sr, and Y rather than the REE. The Main Group Eucrite compositions are consistent with equilibrium non-modal partial melting of a source with condritic abundances of Zr, Sc, Ba, Sr, and Y in a source region assumed to have 85% olivine and 5% each of clinopyroxene, orthopyroxene, and plagioclase. Assuming melting proportions of 40% plagioclase, 60% pyroxene, Juvinas requires 12-13% melting and Sioux County 14%. This is just at or beyond the point of exhaustion of plagioclase in the source, accounting for the flat REE patterns in the Main Group Eucrites. The Stannern trend can also be modelled for these elements with Stannern being equivalent to $\sim$ 6% melting. These results are in extremely good agreement with those of Consolmagno and Drake (3), but derived from a quite different set of elements. In order to explore this model further we would require reliable trace element data for the other

eucrites in the Stannern Group.

FRACTIONAL CRYSTALLISATION MODELS. We have calculated fractional crystallisation models for the Nuevo Laredo Trend utilising major element compositions and treating Main Group Eucrite compositions as the parental magma. The most magnesian pyroxene and the most calcic plagioclase in an 'unequilibrated' (1) eucrite such as Pasamonte indicate the composition of the first formed phases. In practice the liquid line of descent for the Main Group Eucrites was modelled by removal of pyroxene and plagioclase compositions equivalent to those in the High-Mg Eucrites. Béréba, Pasamonte and Nuevo Laredo can be modelled quite accurately by removal of 11, 14 and 29% of pyroxene and plagioclase (in a 58:42 ratio) from a Main Group liquid of Sioux County composition. Cachari and Lakangaon also fall on or close to the Nuevo Laredo trend but cannot be modelled successfully, and would therefore appear to be derived from a parent liquid different in composition from the Main Group Eucrites.

A similar procedure has been used to model the High-Mg Eucrites as mixtures of cumulus pyroxene and plagioclase with trapped liquid. Moore County and Serra de Magé can be modelled with approximately 60:40 proportions of pyroxene and plagioclase, together with approximately 40 and 12% trapped liquid respectively. The agreement between pyroxene-plagioclase proportions in our cumulate models for these High-Mg Eucrites with the proportions fractionated in our model for the Nuevo Laredo Group supports the contention of many previous authors that some of the High-Mg Eucrites are complementary cumulates to the High-Fe Eucrites of the Nuevo Laredo Group. It should be noted however that our mixing models are relatively insensitive to the Fe/Mg ratio of the trapped liquid.

It has not been possible to model Binda as a mixture of pyroxene and plagioclase (using analyses from Binda) with a trapped liquid represented by any eucrite in the Main Group or the Nuevo Laredo Group.

CONCLUSIONS. Our petrogenetic modelling supports the unified hypothesis for the interrelationships among eucrites (2,3). It is evident however that some eucrites, e.g. Cachari, Lakangaon, Binda, have compositions that are not compatible with this model. The eucrites must therefore derive from more than one magmatic system on one or more parent bodies.

References

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