CONSTRAINTS ON THE PARTIAL MELT MODEL OF EUCRITE GENESIS THROUGH INVESTIGATION OF SC PARTITION COEFFICIENTS FOR OLIVINE AND PYROXENE. Cassi R. Paslick, University of Michigan, Ann Arbor, MI 48109, John H. Jones, Gordon McKay, NASA, Lyndon B. Johnson Space Center, Houston, TX 77058

INTRODUCTION: Eucrite meteorites fall under the general classification of basaltic achondrites, and are composed mainly of calcic plagioclase and calcium-poor pyroxene. Eucrites are believed to have formed either: a) by extensive fractional crystallization of more magnesian liquids [1]; b) as primary melts [2]. Ultimately the phase relations controlling these two crystallization paths depend on pressure and Fe/Mg ratio, making it difficult to distinguish between the two genetic models on the basis of major element chemistry alone.

Although Rare Earth Element plots of the eucrites are relatively flat, suggesting an originally chondritic source, other trace elements, such as Sc, are markedly depleted. Earlier work using Sc partition coefficients (${}^{Sc}D$) for olivine [3], indicated that olivine alone as a residual phase could account for the Sc depletion seen in eucrites. ${}^{Sc}D$ was not measured specifically for eucrites, however, and the results were claimed accurate only to within 20% [3]. We have experimentally determined Sc partition coefficients for olivine and pyroxene in eucritic melts, and used these new data in the modeling equations of [3] to place further constraints on the melting history of the eucrites.

ANALYTICAL METHODS: A synthetic material of eucrite composition was prepared (based on Sioux County) containing 1 wt% Sc; to this was added 10 wt% olivine, moving the sample into the olivine field and ensuring olivine crystallization. Samples of 125 mg were placed on a platinum wire loop and heated in a Deltech furnace to above their liquidus (1200° to 1250°C) at iron-wustite fO_2. A 3 wt% iron loss to the platinum wire was detected in an initial run and corrected for in subsequent runs. Compositions from which pyroxene would crystallize were made by adding 5 wt% SiO_2.

Four experiments were run, involving eight separate charges. Charges were held above their liquidus for between two and 24 hours, then dropped to liquidus temperatures (1200° to 1190°C), where they were held and allowed to grow crystals for 24 to 68 hours. The samples were air-quenched and good crystal growth was achieved in all charges. All samples were analyzed on the Electron Microprobe for Sc, Fe, Mg, Al, Si, and Ca.

RESULTS: ${}^{Sc}D$ values for olivine are lower than those used by Jones [3] and range in value from 0.20 to 0.22 (see Table 1). Values for pyroxene are also lower than predicted by Jones [3], and range from 0.72 to 0.83. (The estimated error is 10% based on microprobe counting statistics.) In some of the olivine crystals there is reverse zoning of Fe and Mg; however, our Fe/Mg K_D's for both olivine and pyroxene are in good agreement with those of Stolper [2], and we believe that the samples came as close to equilibrium as possible on a laboratory time scale.

The pyroxene crystals obtained were dendritic and gave variable results. Another pyroxene experiment was run in which a four stage cooling procedure was used to allow slower, more uniform crystal growth. These samples have not yet been analyzed.

CONCLUSIONS: Assuming equilibrium partial melting of an eucrite parent body with originally chondritic element ratios (Sc/La and Mg/Al), it is possible to solve for the partial melt percentage, as well as the percent olivine and the percent pyroxene remaining in the eucrite source region using the procedure outlined in [3]. Using ${}^{Mg}D_{ol}$, ${}^{Mg}D_{px}$, ${}^{Sc}D_{ol}$, and ${}^{Sc}D_{px}$ from analyses of our experimental charges, Sc/La and Mg/Al ratio's for Sioux County from Palme et al. [4], and Sc/La and Mg/Al ratios for chondrites from Dodd [5], we calculated a unique solution of 20% partial melt, with 96% olivine and 4% pyroxene remaining in the source region. If the ${}^{Mg}D_{ol}$ from [2] is used in the model the amount of pyroxene necessary to produce the Sc depletion measured in eucrites is about 10%. The composition of Sioux County was chosen for these experiments because it is at the high Mg end of the range of eucrite compositions, and thus is more likely to be representative of the most primitive eucrite magma.

If the constraint of an originally chondritic element ratio is relaxed, for either Mg/Al or Sc/La, the equations produce a set of non-unique solutions, which are shown graphically in Fig. 1. The Sc/La ratios of eucrites vary from about 9.5 to 15. With a Sc/La ratio of 9.5 it is possible to get as much as 29% pyroxene (see Table 2). Sioux County, however, with a Sc/La ratio of 13.1 is representative of an average eucritic Sc/La ratio, and represents the convergence of the partial melting trend [2] and the fractional crystallization trend on a plot of Sc vs. La for eucrites (data from unpublished compilation by Mittlefeldt).

A Sc/La ratio of 13, and originally chondritic Sc/La and Mg/Al ratios for the source region, are reasonable assumptions for a primary eucritic liquid. Using these assumptions, the amount of pyroxene left in the source region is constrained to 4%. Constraints on bulk composition and relationships between eucrites and diogenites permitted by these data are discussed by Jones et al. [6] in this volume.

REFERENCES:

[1] Mason B., 1962, Meteorites (New York: Wiley), pp. 116-119. [2] Stolper E., 1977, *Geochim. et Cosmochim. Acta,* Vol. 41, pp 587-611. [3] Jones J.H., 1984, *Geochim. et Cosmochim. Acta,* Vol. 48, pp 641-648. [4] Palme et al. 1978, *Proc. Lunar Planet. Sci. Conf. 9th,* pp. 25-57. [5] Dodd R.T., 1981, Meteorites, (Cambridge University Press), Cambridge, pp. 368. [6] Jones, J.H., Paslick, C.R., McKay, G., 1990, this volume.

Table 1: Partition Coefficients

OLIVINE:			PYROXENE:		
Sample #	ScD	Fe-Mg KD	Sample #	ScD	Fe-Mg KD
CP-1	0.22	0.38	CP-3	0.79	0.31
CP-2	0.20	0.37	CP-4	0.72	0.30
CP-5	0.22	0.36	CP-8	0.83	0.30
CP-6	0.21	0.36	Stolper's*		0.30
Stolper's*		0.35			

KD = [Fe/Mg(crystal)]/[Fe/Mg(liquid)]
ScD = [Sc(crystal)/Sc(liquid)]
** Stolper, (1977) determined in experiments on Juvinas and Sioux County.*

Table 2: Variation of % Pyroxene with Sc/La ratios.

Sc/La	% Pyroxene	% Melt	Eucrite
9.5	29	19	Chervony Kut
11.5	11	19	Cachari
11.9	8	19	Bereba
13.1	2	19	Sioux County

Fraction of pyroxene vs. Fraction of melt

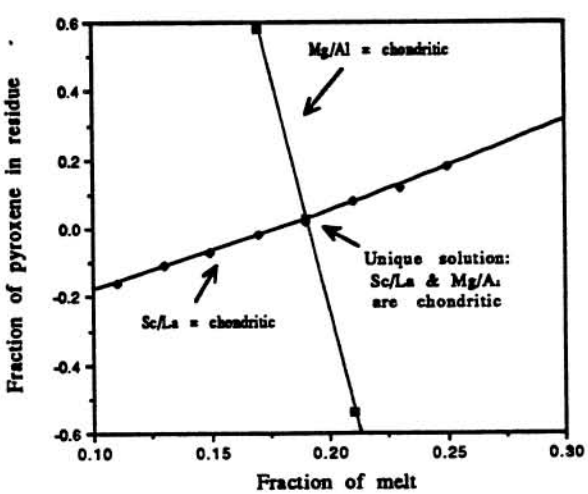

Fig. 1