SOLID-SOLID TRACE-ELEMENT PARTITIONING BETWEEN EXSOLVED PYROXENES IN CUMULATE EUCRITES; Aurora Pun and James J. Papike, Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131-1126, USA.

We have increased the database in our continuing study of understanding trace-element partitioning during pyroxene exsolution processes. In addition to Binda [1], we have examined Moore county, Moama and Serra de Mage'. SIMS analyses of both the high-Ca augite lamellae and their corresponding orthopyroxene or pigeonite hosts show that augite is an important repository for REE during the exsolution process. Distribution and abundances of the REE in the augite lamellae and orthopyroxene or pigeonite host are consistent among these eucrites and reflect the different crystal structures of the pyroxenes. We also determined the solid-solid major, minor, Sr, Y, and Zr partition coefficients between the lamellae and host pairs.

All four of these meteorites are monomict cumulate eucrites that show textural evidence of extensive subsolidus reequilibration of pyroxenes. Binda is the only one of the four meteorites that is brecciated. Orthopyroxenes from Binda, Moama, and Serra de Mage' typically show coarse "remnant (001)" exsolution lamellae of augite formed before inversion of primary monoclinic pigeonite to orthopyroxene. Later and thinner (100) augite exsolution lamellae are formed in the host orthopyroxene as temperatures decrease. These solid state reactions lead to the characteristic exsolution texture, called "inverted pigeonite" texture. Unlike the other cumulates, Moore County contains (001) augite lamellae in host pigeonite; most primary pigeonite did not undergo inversion to orthopyroxene in the sample we studied.

A few pyroxene grains from each meteorite were selected for trace-element analyses using SIMS. These analyses were performed on a Cameca 4f ion probe at the UNM/SNL Ion Microprobe Facility, a joint operation of the Institute of Meteoritics, UNM and the Sandia National Laboratories. Complimentary major element analyses were measured using a JEOL 733 electron probe with an Oxford-Link imaging system.

The spidergrams in Figure 1 show the results of the trace-element analyses normalized to CI chondrite (average CI, [2]). Points for Gd have been estimated. All four cumulates show similar patterns and indicate similar distribution behaviors of the trace-elements during the exsolution process. All of these patterns are consistent with those expected for high-Ca/low-Ca pyroxene partitioning. There is a HREE enrichment over LREE in the low-Ca pyroxenes and abundances of REE in augite are greater than those found in the hosts. This reflects the pyroxene crystal chemistry whereby the Ca in the M2 site of augite "prop" open their structures to incorporate more REE, the "Ca effect" [3,4]. The ionic radii of the LREE are too large to be incorporated easily into the M2 sites of the orthopyroxenes and this is reflected in their depleted LREE patterns. Sr abundances behave systematically by following the Ca ions reflecting the geochemical similarity of the two elements.

The higher abundances of the REE found for Moore County pyroxenes may reflect higher initial enrichments of the trace-elements in the Moore County melt. This is consistent with the higher Fe# found in the pyroxenes of Moore County (Figure 2). Also, the higher abundances and flatter slope of LREE in Moore County pigeonite host reflect the fact that the pigeonite structure is more receptive to these large REE than orthopyroxene.

Solid-solid partition coefficients were determined for the high and low-Ca pyroxenes of the cumulates. They were calculated based on the elemental weight percents of the components involved. The Ca content of the low-Ca pyroxenes are determined to be in the sequence Moore County > Moama > Binda >Serra de Mage'. The partition coefficients for the HREE are found to be the same among the cumulates. Slight variations of the partition coefficients may reflect the differences in subsolidus reequilibration temperatures. Temperatures were calculated for the lamellae-host pairs using a geothermometry program, QUILF, provided by Don Lindsley [5]. Average temperatures calculated for all four meteorites range from approximately 850°C to 950°C. The orthopyroxenes of Serra de Mage' are the most depleted in Ca and contain the most complicated exsolution textures, suggesting the melt equilibrated further down the pyroxene solvus, in agreement with the lowest calculated temperatures.

The pyroxenes from these cumulate eucrites are a natural example of pyroxenes from an almost pure Wo-En-Fs system. The pyroxene chemistries contain very little "other" components [6] and all fall closely within the pyroxene quadrilateral. As a result, these pyroxenes required very little corrections in calculating subsolidus temperatures. Independent of the fact that these trace-element measurements were for cumulate eucrites, these are a good estimate of the solid-solid trace-element partition coefficients between high-Ca and low-Ca pyroxenes.

PARTITIONING BETWEEN EXSOLVED PYROXENES: A. Pun and J.J. Papike

Acknowledgements: We thank M.N. Spilde for technical assistance on the electron probe and Graham D. Layne and Grant Fowler for technical assistance on the SIMS. We also thank the Smithsonian Institution for the thin sections of Binda, Moore County and Moama. This work is supported by NASA grant NAGW-3347 (J.J.P.) and NGT-70223 (NASA GSRP training grant for A.P.).

References: [1] Pun A. *et al.* (1993) *Meteoritics*, **28**, 402. [2] Anders E. and Grevesse N. (1989) *GCA*, **53**, 197-214. [3] Papike J.J. *et al.* (1988) *LPSC*, **19th**, 901-902. [4] Shearer C.K. *et al.* (1989) *GCA*, **53**, 1041-1054. [5] Andersen D.J. *et al.* (1993) *Computers & Geosciences*, **19**, 1333-1350. [6] Papike J.J. and Cameron M. (1976) *Rev. Geophy. Space Phys.*, **14**, 37-80.

Figure 1:

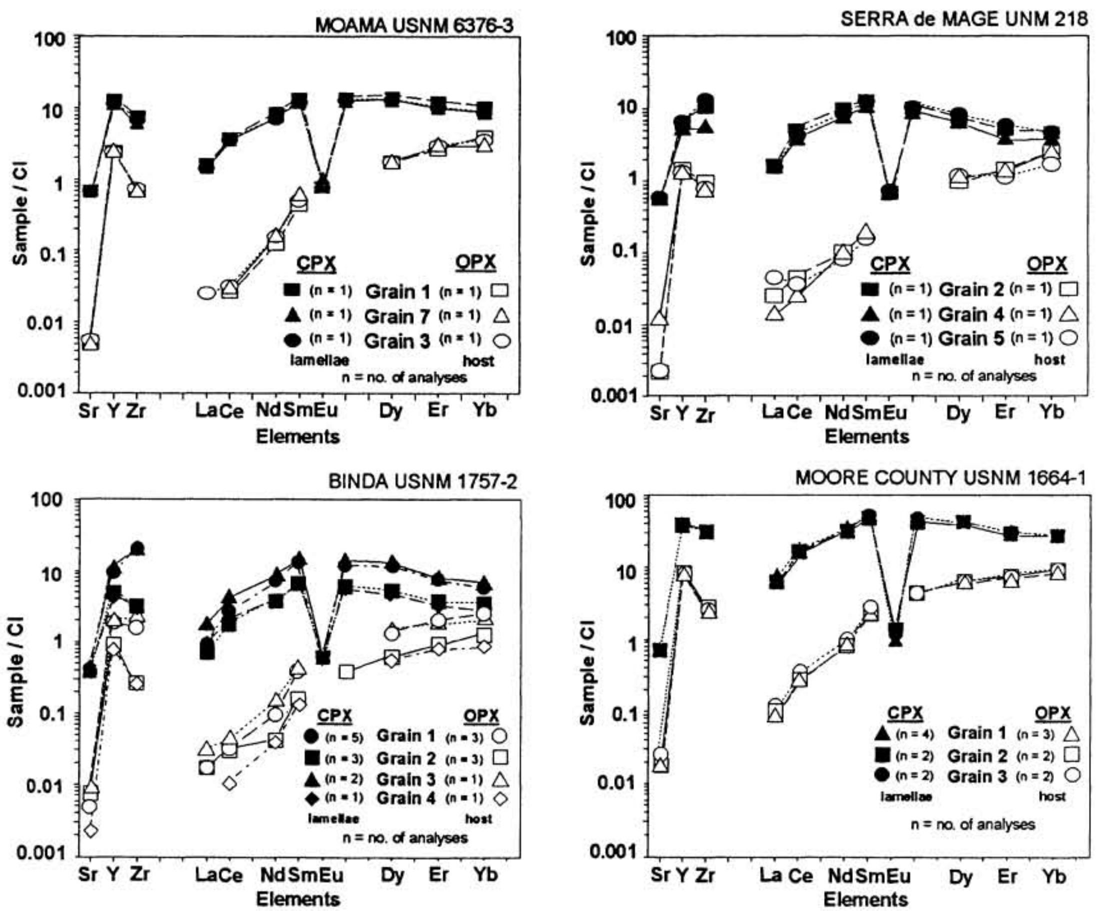

Figure 2: