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TRACE ELEMENTS IN PENA BLANCA SPRING OLDHAMITE

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Murrell and Burnett (M-B) (1982) reported that oldhamite (CaS) is the primary host phase of U and Th in the E6 chondrites. E-chondrite Th/U values were all cosmic, indicating a lack of Th-U fractionation in both oldhamite and in the bulk meteorites. In Khairpur (E6), they attributed excess fossil fission tracks to the presence of ^{244}Pu in oldhamite. Rare earth (REE) enrichments were inferred for an Abee (E4) water soluble phase(s) (Frazier and Boyton, 1981), presumably oldhamite, and perhaps niningerite. These led M-B to suggest that the enstatite chondrites may be well-suited for Pu-U chronology and possibly for providing the initial Pu/U Value in the solar system. If minimal Th-U-lanthanide fractionation were obtained for CaS, then minimal Pu-U fractionation could be expected. The most striking CaS U enrichments were found in the enstatite achondrite, Peña Blanca Spring (PBS): 1920 ± 100 ppm U in two large CaS grains. M-B attempted REE electron-microprobe analyses for these but only established upper limits of < 700 ppm Ce, < 500 ppm Nd, ≤ 150 ppm Y.

Because of their large size compared to those in the E chondrites, we have analyzed the same two PBS CaS, using the proton microprobe (Maggiore, 1980) at the Los Alamos Van de Graaff. Our proton beam energy was 2.0 MeV. We typically ran at 1-2 nA currents and obtained 6-12 μ Coul integrated doses. The beam spot was 10 by 40 μ. The proton-induced X-rays were detected with a 160 eV (Mn K α) resolution Si (Li) detector with a 1.5 mil Al absorber. Deadtimes were typically $\leq 5\%$. We used a glass comprised of 25% Durango apatite in order to estimate absolute contents. Published analyses of the apatite contents vary significantly (Young *et al.*, 1969); consequently, it is not a satisfactory standard and our present data must be considered tentative. Further, we have not yet done a detailed deconvolution of the spectra. From this preliminary analysis, we obtain ~ 30 ppm Ce and ~ 20 ppm Nd, after correction for the $\sim 30\%$ difference in the X-ray absorption in the CaS relative to that in the reference glass. The REE data from the two CaS grains are consistent. We also find Y (195 ± 35 ppm, 390 ± 75 ppm), Sr (55 ± 15 ppm, 80 ± 20 ppm), and Se (30 ± 10 ppm and 75 ± 25 ppm). No Se data are available from the reference sample; the absolute concentrations were inferred from the Sr data, using published relative thick target yields. The estimated uncertainties for all but the REE are dominated by the spread in the data for the reference sample (Young *et al.*, 1969). The counting statistics for all the trace element peak counts range from 5-12%, but we consider the REE results to be good to only a factor of two, due the large uncertainties in our background corrections, as well as those in the reference data (Young *et al.*, 1969). Our Ce-Nd estimates are consistent with a chondritic Ce/Nd ratio. While significant enrichments of the REE occur in CaS, the enrichment factors, relative to chondritic REE abundances, are ~ 45, or at most ~ 100. U enrichments in PBS CaS, on the other hand, are more like ~ 200 (Murrell and Burnett, 1982). Thus, it appears that U-REE fractionation did occur for PBS CaS. Whether this fractionation occurred in E6 meteorites is still in question, and we will attempt analyses of the smaller E6 CaS grains. We are presently analyzing data from ferroan alabandite (Mn, FeS), where Cr, Cu and Ni are clearly evident; daubreelite (Fe, CrS), containing Zn and Cu; troilite, bearing Ni; and enstatite showing Ti, V, Cr, Mn and Zn.

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