The similarity in the Ca and Ti isotopic compositions of hibonite and pyroxene indicates that the hibonite and pyroxene are co-genetic. The coexistence of hibonite and pyroxene are not consistent with gas-solid condensation. The morphology of the grain and the complementary nature of the REE fractionations indicate that this inclusion crystallised from a melt. References: 1. Ireland (1988) GCA 52, in press. 2. Ireland et al. (1988) GCA 52, in press.


Of the possible processes involved in Type B CAI history, igneous processes are the most tractable for study. Temperature and time scales inferred [1, 2] are commensurate with feasible laboratory simulations. We have previously reported melilitic (mel) crystal liquid partition coefficients, Di [3], for Sm, Yb, Sr (Eu++ analog), and Y (Ho analog). Our data for akermanite (Ak) 30 mel compositions is in good agreement with literature data where direct/extrapolated comparisons are possible [4, 5, 6, 7]. Even allowing for significant variations in Di with progressive crystallization, comparisons of predictions for the initial (0–30%) fractional crystallization of mel with our Sr, Y contents obtained for mel cores in Allende Type B CAI, with comparable Ak contents, indicate that the natural data substantially exceed factors of 1.5–2.5 × those predicted. Similar results are obtained for Y, Zr in fassait (fass) based on estimates of the Di from literature data. In this case, excesses of these trace elements are up to factors of about 5. Thus, while the trace elements observed in natural CAI (Sr in mel and Y, Zr in fass) are in qualitative agreement with igneous partitioning, the trace element abundances are higher than quantitative predictions. Actinide data are also available for individual mel grains from Type B CAI [8, 9, 10]. For mel, U-Di values near 1 are needed to explain the U abundances of early-crystallizing mel. This seems unreasonable for such a highly incompatible element like U, and we have demonstrated this for Th. Mel-Th-Di values for the synthetic samples described were obtained using Th-alpha-track radiography. Di(Th) = 8.4 × 101. Comparisons of predictions for Th with Th in natural samples [8] indicate enhancement factors (natural/predicted) of about 100.

Excesses of lithophile trace elements thus suggest that relict unmelted phases were incorporated in CAI. There is general agreement that some spinel is relict. But spinel can’t account for the refractory lithophile enrichments observed. [8] suggested perovskite (pv) as a likely candidate. We have searched for surviving relict grains in 3, mm-sized Allende mel. All inclusions were characterized, but most were metals. There were two submicron pv grains. Pv are rare, but they must be relict, since pv is soluble in Type B CAI melts. We have searched for evidence of resorbed pv by looking for Ti hot spots in Allende mel. As shown in the figure, there is a general decrease in Ti with Ak, which is contrary to predictions based on our Ti-Di value (0.020). There are also three distinct Ti hot spots evident. Subsequent high resolution SEM observations of the spots analyzed revealed a submicron pv inclusion for one of the hot spots, but there was no visible inclusion at the other two, in the SEM or with high magnification transmitted light optical observation. Detailed profiles show hot spot sizes of 10–20 microns. These might be sites of resorbed pv. However, actinide data indicate that relict pv is unlikely to account for the observed trace element data. TS23 mel data show [8] a CI normalized U/Ti ratio of about 10, but the corresponding pv ratio is approximately 1. This requires another trace element carrier(s), or an igneous pre-history for relict pv. High resolution SEM and optical observations also were made of anorthite that had yielded U stars in the [8] study. These too showed no evidence for visible inclusions to which the actinide-rich sources could be attributed. References: [1] Stolper E. (1982) GCA 46, 2159. [2] Stolper E. and Paque J. M. (1986) GCA 50, 1785. [3] Woolum D. S. et al. (1988) LPS 19, 1295. [4] Beckett J. et al. (1988) LPS 19, 49, [S] Ringwood (1975) The Moon 12, 12. [6] Nagasawa et al. (1980) EPSL 46, 431. [7] Kuehner S. M. et al. (1988) LPS 19, 653. [8] Murrell M. & Burnett D. (1987) GCA 51, 985. [9] Schirck. J. (1975) Thesis. Washington University, St. Louis. [10] Wark D. (1984) Thesis. University of Melbourne.© Meteoritical Society • Provided by the NASA Astrophysics Data System