TRACE ELEMENT CONTENT OF CHONDRITIC COSMIC DUST: VOLATILE ENRICHMENTS, THERMAL ALTERATIONS, AND THE POSSIBILITY OF CONTAMINATION; G.J. Flynn,[1] S.R. Sutton,[2] and S. Bajt,[2] 1) Dept. of Physics, SUNY Plattsburgh, Plattsburgh NY 12901, 2) Dept. of Geophysical Sciences, University of Chicago, Chicago IL 60637.

We have measured trace element abundances in 51 chondritic Interplanetary Dust Particles (IDPs) by Synchrotron X-Ray Fluorescence (SXRF). The data allow us to determine an average composition of chondritic IDPs and to examine the questions of volatile loss during the heating pulse experienced on atmospheric entry and possible element addition due to contamination during atmospheric entry, stratospheric residence and curation.

The average composition of the 51 chondritic IDPs shows a volatile enrichment for all elements with atomic numbers from Cr to Br having nebula condensation temperatures lower than 1277K (Cr) (see Figure 1). The volatiles Cu, Ga, Ge, Se, and Zn are enriched by factors of 2 to 3 over the CI meteorite abundances of these elements. Bromine is more dramatically enriched, to 30xCI. This volatile element enrichment pattern is roughly complimentary to the depletion pattern of the CM2 meteorites relative to CI, suggesting the chondritic IDPs are a new chemical type of chondritic material, more volatile rich than any known meteorite.

However, the trace element contents measured for individual IDPs may not reflect pre-atmospheric compositions because of volatile loss during atmospheric entry heating or contamination during atmospheric entry, stratospheric residence or curation. The trace element data, coupled with mineralogy, provide clues to the degree of thermal alteration and contamination.

We have shown that Zn, of all the elements measured by SXRF, is most severely depleted by heating on atmospheric entry (1), These Zn depletions correlate with the production of magnetite rims (2,3), attributed to entry heating (4), indicating that the 15 particles with low Zn ($Zn/Fe \leq 0.2XCI$) are the most severely heated of the 51 chondritic particles studied. These low-Zn particles may also have lost other volatile elements due to heating. Removing these 15 thermally altered particles from the data set is likely to result in an average composition which more accurately reflects the pre-atmospheric composition of the IDPs. The set 36 particles lacking a Zn depletion has slightly higher abundances of the volatile elements than the set of 51 particles, but the enrichment pattern is not changed significantly (see Figure 2). The differences between the average compositions of the 15 low-Zn and the 36 normal Zn particles are more dramatic.

If the low-Zn particles are assumed to have had the same average pre-atmospheric composition as the less heated IDPs, then differences in composition between the two sets would indicate the relative volatilities of the elements in the IDPs. Comparing the two data sets, we find Zn is most extremely depleted element ($Zn_{low-Zn}/Zn_{norm} = 0.025$), followed by Br ($Br_{low-Zn}/Br_{norm} = 0.31$) and Ge ($Ge_{low-Zn}/Ge_{norm} = 0.39$), while all other measured elements from Cr to Br agree to $\pm 20\%$ in the low-Zn and normal-Zn averages.

We have previously identified a subset of the chondritic IDPs which shows no enrichment in volatile content above CI (5). These 9 IDPs, identified by their roughly chondritic Se and Cu contents (as described in Ref. 5), have an average composition falling between CI and CM2 meteorites for all elements from Cr to Se, but show a large Br enrichment (see "+" pattern in Figure 1). This high Br content in particles not enriched in the other volatiles suggests the mechanism for Br enrichment is different

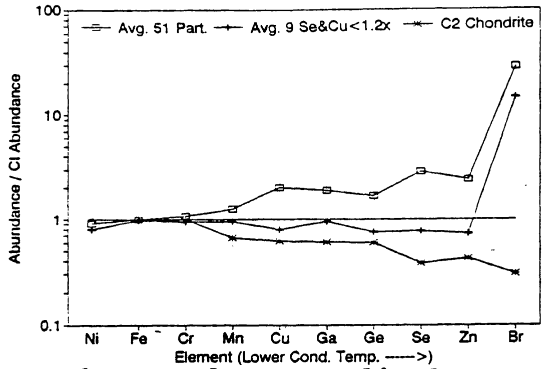

Figure 1: Fe and CI normalized average trace element contents of 51 chondritic IDPs, 9 chondritic IDPs with Se/Fe and Cu/Fe <1.2xCI, and C2 chondrites.

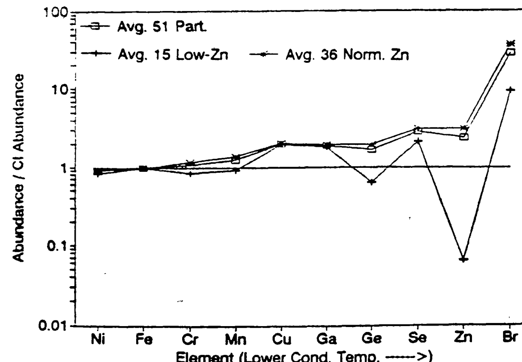

Figure 2: Fe and CI normalized average trace element contents of 51 chondritic IDPs, 15 low-Zn chondritic IDPs, and the 36 chondritic IDPs with normal Zn.

from the mechanism which resulted in the enrichment of the other volatile elements. This decoupling of the Br enrichment from the other volatile enrichments is consistent with, but does not prove, the conclusion of Rietmeijer (6) that some of the Br in the IDPs is a contaminant acquired during stratospheric residence. We note, however, that the average Br content of these 9 particles (15xCI) is only half that of the 51 particle set. If this represents the average level of Br contamination, then the chondritic IDPs would still be Br rich relative to CI.

Jessberger et al. (7) have suggested that all the volatiles above the CI level are contaminants acquired during atmospheric entry. If their hypothesis is correct, then the level of contamination they propose is 1 to 2 times CI for Cu, Zn, Ga, Ge, and Se, and a large fraction of the IDPs must receive significant contamination since 18 of the 36 chondritic IDPs not altered by entry heating have Zn contents above CI. The existence of volatile depleted particles, such as the igneous (8) and low-Zn (2) particles, indicates that contamination does not overprint the distinctive trace element abundance patterns of these unusual particles, strongly constraining the degree of contamination.

However, normal chondritic IDPs provide the best evidence against substantial trace element contamination. The measured Zn content of the 36 normal chondritic IDPs is 3.2xCI, suggesting an average contamination of 2.2xCI if the Jessberger et al. (7) hypothesis that the pre-atmospheric volatile content is CI is correct. This contamination should also affect those IDPs which were significantly heated, and thus Zn depleted, on atmospheric entry. Their proposed level of contamination is sufficient to return these Zn depleted particles to chondritic Zn abundances. Thus TEM analyses of IDPs with chondritic Zn should yield a significant number of cases exhibiting mineralogical indications (such as magnetite rims) of entry heating. No such particles have been identified among the 14 IDPs examined by SXRF and TEM in attempts to test the Zn entry heating thermometer (2,3). The good correlation between chondritic Zn content and the absence of mineralogical indicators of entry heating suggests that any Zn contamination of IDPs during atmospheric entry, stratospheric residence, or curation is substantially below the level suggested by Jessberger et al. (7) or that particles which are depleted in Zn on atmospheric entry are subsequently immune to contamination.

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