CHEMICAL COMPOSITION OF LARGE STRATOSPHERIC DUST PARTICLES: COMPARISON WITH STRATOSPHERIC IDPS, CLUSTER FRAGMENTS, AND POLAR MICROMETEORITES; G. J. Flynn[1], S. Bajt[2], S. R. Sutton[2], and W. Klock[3]. 1) Dept. of Physics, SUNY-Plattsburgh, Plattsburgh, NY 12901, 3) Dept. of Geophysical Sciences, The University of Chicago, Chicago, IL 60637, 4) Institut fur Planetologie, Westfalische Wilhelms-Universitat, 48149 Munster, Germany.

Interplanetary dust particles (IDPs) larger than 25 microns collected from the stratosphere overlap in size with the smallest micrometeorites collected from polar ices. Comparison of these particles should permit an understanding of polar alteration effects. Element abundances in 6 stratospheric IDPs, all larger than 35 microns, were measured using the synchrotron x-ray microprobe. These IDPs are not dramatically depleted in Ni or Ge, suggesting the depletions of these elements in polar micrometeorites result from weathering on Earth. Lead was undetectable in each IDP, thus the large Pb enrichments in polar micrometeorites are most likely terrestrial contamination. These large IDPs are not enriched in volatiles relative to CI, indicating they are chemically different from the smaller IDPs. Some of the small, volatile-enriched IDPs are fragments of large clusters, suggesting the structurally weaker IDPs may be chemically distinct from those which survive collection intact. The absence of Zn and S depletions and the survival of hydrated phases in these large IDPs are inconsistent with the severe atmospheric entry heating predicted theoretically for large IDPs.

The introduction of Large Area Collectors resulted in the collection of many large interplanetary dust particles (IDPs) from the Earth's stratosphere. Some large IDPs fragment on collection, resulting in a localized cluster of debris, while others are collected intact. This may indicate a difference in structural strength, perhaps related to porosity. The largest of these stratospheric IDPs overlap the size range of the smallest micrometeorites collected from the polar regions (25 to 50 microns), allowing examination of particles of the same size with and without polar alteration effects.

Element abundances in 5 large IDPs, each greater than 35 microns in its largest dimension, from the L2011 collector [L2011N3, L2011N13, L2011O4, L2011P12, and L2011R13] were measured by Synchrotron X-Ray Fluorescence. All 5 IDPs were classified as C-type in the Johnson Space Center (JSC) Cosmic Dust Catalog. One other IDP larger than 35 microns, L2005J24, with a JSC Catalog classification of C?-type, but which has an unambiguously chondritic Ni/Fe ratio and trace element abundance pattern, was measured previously. None of the 6 is listed as a cluster fragment.

Each of the six IDPs is depleted in Ca relative to CI, with an average Ca abundance of 0.3xCI. L2011N3, L2011N13, and L2011O4 have been examined in the Transmission Electron Microscope (TEM). Each is a hydrated particle dominated by smectite. L2011P12 contains abundant cronstedite and Mg-rich serpentine. L2011R13 and L2005J24 have not yet been examined for mineralogy, but both have low Ca and are platey particles. Thus it is likely that all 6 of these large IDPs are hydrated.

Comparison with Smaller IDPs

The average abundances of the volatile trace elements show a relatively flat pattern depleted from about 0.7 to 0.95xCI, except Br which is enriched to 25xCI (see Figure 1). The 6 large chondritic IDPs are distinctly different in volatile content from the 51 smaller chondritic IDPs previously measured (1) and from the heated and unheated hydrated subsets of that group (2). The 51 smaller IDPs show average enrichments in the volatiles from Cu to Zn by factors of 2 to 3, and a larger enrichment in Br. The unheated hydrated subset is similarly enriched (2), and even the heated hydrated subset is enriched in Cu, Ga, and Se (2).

This difference in volatile content might result in several ways. The most direct explanation would be dilution of a volatile-rich matrix (compositional similar to the smaller IDPs) by large volumes of refractory (low-volatile) minerals, such as olivines and pyroxenes. However, large abundances of olivines and pyroxenes were not seen in the TEM examination of the 4 IDPs studied thus far. Alternatively, these large IDPs might sample a different reservoir of solar system material, compositionally similar to bulk CM meteorites and distinct from that sampled by smaller IDPs.

Many of the smaller IDPs are pieces of larger particles which fragmented during collection (either cluster particles or particles listed as associated with other fragments in the JSC catalog descriptions). The pre-fragmentation sizes of these IDPs are difficult to establish. Even if all fragments are recovered from the collector and measured, an uncertainty in how to reassemble them persists. However, in one case we have determined the element abundances in 4 fragments of a large cluster, estimated to have been about 60 microns in size, described in detail in Thomas et Al. (3). Prior to fragmentation, the original IDP was larger

than any of the 6 large IDPs included in this study. It was an anhydrous IDP and some fragments have partial magnetite rims while others have high He release temperatures, both indicative of significant entry heating (3). The average volatile content of the 4 fragments of this cluster agrees well with a previously determined average for 8 heated anhydrous IDPs. The volatiles Cu, Ga, Se and Br show enrichments relative to CI, while Ge and Zn are depleted relative to CI. This Ge and Zn depletion appears to reflect preferential loss of these volatile elements due to atmospheric entry heating. Thus we suspect the cluster fragments would have shown enrichments in Ge and Zn, as found in unheated anhydrous IDPs, if the particle had not experienced significant entry heating. This large cluster particle is enriched in Cu, Ga, and Se to levels about 4 times those found in the 6 large IDPs included in the present study, and we would expect similar enrichments for Ge, Zn, and Br if the effects of atmospheric entry heating could be removed from the cluster particle data set. These results suggest the possibility there might be two types of large IDPs: a weak type (which fragments on collection, perhaps because of high porosity) with volatiles enriched above CI by factors of 2 to 3, and a stronger type (which does not fragment on collection) having a volatile content slightly depleted from CI (except Br).

Comparison with Polar Micrometeorites

Large, compact micrometeorites (25 microns and up in size) have been recovered from the polar ices. The average abundances of Ni, Ge, and Se are depleted in 16 polar micrometeorites (50 to 150 microns in size) relative to 51 IDPs (typically 10 to 25 microns) and CI meteorites, but polar micrometeorites are dramatically enriched in Pb (4). These 6 large IDPs are not significantly depleted in Ni (Avg.=0.9xCI) or Ge (Avg.=0.9xCI), suggesting the depletions of these elements (Ni=0.21xCI, Ge=0.4xCI) in the polar micrometeorites result from weathering, probably FeNi-sulfides weathered to sulfates and dissolved in water. Lead was undetectable in each of the six IDPs (detection limits ranging from 0.4 to 6xCI) thus the large Pb enrichments (Avg.=150xCI) in polar micrometeorites most likely result from terrestrial contamination.

Atmospheric Heating Effects

Model calculations demonstrate that most large IDPs should be severely heated on atmospheric entry, even if they entered at Earth escape velocity. Like the polar micrometeorites, these 6 large stratospheric IDPs show no major depletion of Zn. Since the Zn depletions (to 0.3xCI or less) in smaller stratospheric IDPs correlate well with severe atmospheric entry heating inferred from the presence of magnetite rims and high He release temperatures in those particles (5, 6, 7), the absence of a Zn depletion in these large stratospheric IDPs suggests they were not severely heated. Sulfur, which is lost from IDPs heated above 800° C (8), also shows no significant depletion. The survival of hydrated phases in the 4 particles examined in the TEM is also inconsistent with severe atmospheric entry heating. How these large IDPs escape the expected effects of entry heating is not yet clear, although interior regions could be shielded from high surface temperatures by endothermic phase transitions (9).

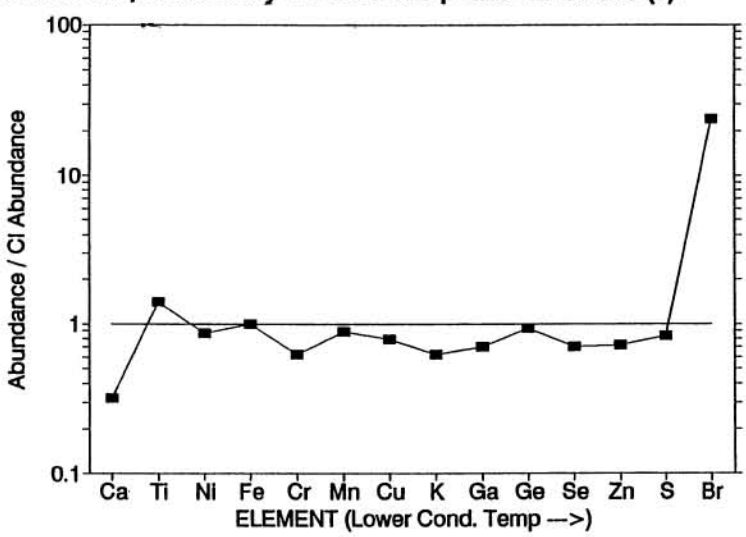

Figure 1: Average CI normalized element abundance pattern in the set of 6 IDPs larger than 35 microns. Fe content assumed equal to 18.5%.

REFERENCES: 1. G.J. Flynn et Al. **Lunar Planet. Sci XXIV**, 495-496, 1993. 2. G. J. Flynn et Al. **Lunar Planet. Sci. XXV**, 381-382, 1994. 3. K.L. Thomas et Al. **Lunar Planet. Sci. XXV**, 1391-1394, 1994. 4. G.J. Flynn et Al. **Proc. NIPR Symp. Antarct. Meteorites 6**, 304-324, 1992. 5. G. J. Flynn et Al. **Lunar Planet Sci. XXIII**, 375-376, 1992. 6 K. L. Thomas et Al. **Lunar Planet. Sci. XXIII**, 1427-1428, 1992. 7. W. Klock et Al. **Meteoritics 27**, 243-244, 1992. 8. P. Fraundorf et Al. in **Comets**, U. of Az. Press, 383-409, 1982. 9. G.J. Flynn "Thermal Gradients in IDPs: The Effect of an Endothermic Phase Transition," this volume.