ELECTRON MICROPROBE ANALYSES OF ANTARCTIC MICROMETEORITES AND INTERPLANETARY DUST PARTICLES COLLECTED IN THE STRATOSPHERE; C. Engrand[1,2], M. Maurette[1], M. Zolensky[3], G. Kurat[4] and J. Walter[4]. [1]CSNSM, Bat.104, 91405-Orsay, France; [2]LEM, ONERA, BP 72, 92322 Chatillon, France; [3]SN2, NASA Johnson Space Center, Houston, TX, 77058 USA; [4]Mineralogische Abteilung, Naturhistorisches Museum, Postfach 417, Wien, Austria.

ABSTRACT: Both stratospheric IDPs (herein simply IDPs) and Antarctic micrometeorites (AMMs) consist of highly unequilibrated mineral assemblages, usually including a major carbonaceous component, and show similarities with the most primitive carbonaceous chondrites. Very few attempts have been made to compare IDPs and AMMs on the same scale of analyzed volume, with similar instruments. We report here on precise electron microprobe analyses of "polished" flat surfaces of IDPs and AMMs embedded in the same epoxy resin in order to compare their abundances of major elements on a similar scale. On the scale of ~10μm we observe a strong variability of Si-normalized Al, Mg and Fe abundances, from CI bulk values to the average composition of the much smaller grains from comet Halley. A particular depletion of Ca, S and Ni is observed in both types of grains, with depletion in IDPs being less marked. These results further complicate the identification of the most primitive objects of the solar system and characterization of the dominant interactions between the terrestrial environment and IDPs and AMMs.

We previously reported on electron microprobe analyses of the fine-grained matrix of AMMs and 28 unequilibrated chondrites, as performed on polished sections at a scale of ~10-100μm [1], and we compared these analyses to semi-quantitative EDS analyses of IDPs available at this time, mostly collected from irregular exterior surfaces. But analyses of these external surfaces were found to be unreliable, because they can be coated with a ~1μm thick layer of magnetite and/or deposits of tiny sulfate grains probably resulting from the scavenging of stratospheric aerosols [2]. We have now accumulated additional electron microprobe analyses of AMM polished sections, and electron microprobe analyses from flat internal surfaces of IDPs prepared with an ultramicrotome. We present here a comparison of these more accurate electron microprobe analyses on internal/flat surfaces as summarized by correlation plots of the Al, Mg, Fe, Ca, S and Ni contents (relative to silicon) reported in the figures. Both types of grains were embedded in the same epoxy resin. Stratospheric IDPs are subject to minor Si contamination from Si-oil used in their collection, but this has been shown to be insignificant for these analyses.

The variability of the Al, Mg, and Fe contents is rather similar for IDPs and AMMs, when internal flat surfaces are analyzed on a similar scale of 10μm (see the figures). In particular, the values spread between CI bulk values and the Halley dust composition defined by the average values of the "best" data from the in-situ analyses of much smaller (~100nm) grains released by comet Halley [3]. Indeed, we concluded previously that only AMMs were depleted in Al, Mg, and Fe, with fine-grained chondrite matrix and IDPs showing only a depletion of Ca and S, and Ca, respectively. This conclusion has to be revised as the new correlation plots (see the figures) show a general depletion of Ca, S and Ni for both AMMs and IDPs. There is great variability in the Al, Mg, Fe, and Ca contents of chondrite matrix at the scale of 10μm [1&4], similar to that found for AMMs and IDPs. Chondrite matrix shows a clear depletion for Ca/Si, yielding an average value of 0.65CI, intermediate between the values observed for AMMs (0.24CI) and IDPs (0.79CI). The average values for Al/Si, Mg/Si, and Fe/Si in chondrite matrix are 1.25CI, 0.87CI and 0.86CI, respectively. The observed values are similar in AMMs and IDPs (AMMs: Al/Si=1.15CI; Mg/Si=0.79CI; Fe/Si=0.83CI) (IDPs: Al/Si=0.87CI; Mg/Si=0.69CI; Fe/Si=1.24CI).

We previously attributed the S, Ca and Ni depletions of AMMs to the dissolution of their most soluble salts during their recovery from melt ice water at a few °C in Antarctica [5]. But a similar Ca depletion and a significant, though weaker, depletion of S and Ni is now observed for IDPs recovered in the stratosphere. AMMs were selected at random, from unmelted to partially melted grains. The IDPs were selected to exclude melted grains. Therefore our selections were not biased toward grains strongly heated during atmospheric entry, and the observed depletions are unlikely to be related merely to frictional heating. Elemental depletions in IDPs might be partially related to their long gravitational settling time and exposure to stratospheric aerosols that could displace soluble salts to the external surfaces. However, it is possible that many (most?) AMMs and IDPs experienced aqueous alteration on their parent bodies, which could have selectively leached Ca, Ni and S (among other species) from the fine grained matrix, depositing them in veins as sulfates and carbonates, as in CI chondrites. These vein materials are unlikely to have survived atmospheric entry as independent grains.

The few attempts to compare IDPs and AMMs reported previously involve (a) the search for polycyclic aromatic hydrocarbons, showing that the two particle types are very different [6], (b) the abundance of volatile elements such as Zn and Br, which are rather similar for IDPs and AMMs[7], (c) the isotopic composition of D and N, which are dissimilar [8], and (d) mineralogical trends [9]. The fine-scale trends in elemental abundances discussed in this paper extend to smaller scales (~100nm - corresponding to the size of large Halley grains) [10], and further suggest similarities in the formation and/or reprocessing of the fine grained matrix of IDPs and AMMs. In summary we find that AMMs and IDPs are not identical materials, but rather are complementary.

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