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LASER MICROPROBE STUDY OF COSMIC DUST (IDPs) AND POTENTIAL SOURCE MATERIALS; E. K. Gibson, Jr., SN4/NASA JSC, Houston, TX 77058 and M. S. Sommer, II, LEMSCO, NASA JSC.

The study of cosmic dust or interplanetary dust particles (IDP) can provide vital information about primitive materials derived primarily from comets and asteroids along with a small unknown fraction from the nearby interstellar medium. The study of these particles can enhance our understanding of comets along with the decoding of the history of the early solar system. The study of the cosmic dust or IDP particles can assist in the elucidation of the cosmic history of the organogenic elements (i.e., H, C, N, O, S, etc.) which are vital to life processes. Studies to date on these particles have shown that they are complex, heterogeneous assemblages of both amorphous and crystalline components. In order to understand the nature of these particles, any analytical measurements must be able to distinguish between the possible sources of these particles. We have undertaken a study using the laser microprobe interfaced to a quadrupole mass spectrometer for the analysis of the volatile components present in cosmic dust particles, terrestrial contaminants present in the upper atmosphere along with the primitive carbonaceous chondrites (CI, CM and CV). From the study of the volatiles released from the carbonaceous materials by the laser microprobe, it is hoped that one could distinguish between components and sources in the IDP particles analyzed.

An Nd-glass, Q-switched laser microprobe has been interfaced to a quadrupole mass spectrometer. Samples of cosmic dust or analogs are placed in a chamber with a quartz window. The chamber is evacuated to at least 10^{-8} torr during bake-out at 110 ^{o}C. Samples are "zapped" by the laser and the released volatiles are measured with the mass spectrometer. The sample chamber can be moved to allow distinct different areas to be analyzed within the sample to be studied. For a meteorite fragment of 1-2 mm size, regions of different lithologies can be studied in situ for their volatile contents. The laser beam which interacts with the samples can be varied in size from 10 to 50 microns. For most cosmic dust grains the beam diameter is similar in size to the particles and the volatiles released are a composite of those present within the total particle.

Our studies have concentrated on CI, CM, and CV meteorite compositions along with cosmic dust particles. Single "chunks" of the Orgueil CI meteorite maximum size 1 mm) along with freshly broken surfaces of the Murchison CM and Allende CV carbonaceous chondrites were studied. Studies of a chondritic type cosmic dust particle (W7027B8) and an aluminum oxide particle (W7027C7) have shown that significant differences in volatile inventories can be measured. This type of analysis provides a new technique for the study and characterization of these important IDP materials.

Volatiles released from CI and CV carbonaceous materials are shown for the dark matrix of the Orgueil (CI) (Fig. 1) and the gray matrix of the Allende (CV) (Fig. 2) meteorites. As expected, the CI sample released a factor of six more volatiles than the CV material. The volatiles released from the Orgueil included H_2O, CH_4, CO + N_2, hydrocarbons, O_2, H_2S, Ar, CO_2, SO_2, COS, and CS_2. The greatest abundances were seen for the H_2O, CO_2, followed by CO + N_2 (mass 28), and O_2. Volatiles released from Allende included CH_4, H_2O, CO + N_2, and CO_2 along with minor amounts of hydrocarbons and argon. As expected the CI matrix contained considerable more volatiles than the CV matrix (ion current abundances 32,767 vs. 5000).

Cosmic dust particle W7027B8 (identified as a Type C particle) was analyzed with the laser microprobe-mass spectrometer (Fig. 3). The major gas phase released was CO_2 with minor amounts of H_2O, CO + N_2, and CH_4, and trace amounts of O_2 and CS_2. The volatiles released were similar to those previously seen from the analysis of carbonaceous chondrite matrix materials. Semi-quantitative measurements of the water and carbon abundances in the particle have shown the minimum water and carbon abundances are around 1% H_2O and 1% CO_2. These abundances are similar to those observed for CM or CV carbonaceous chondrites. Analysis of particle W7027C7 (identified as a TCA or Al particle) showed that the particle was indeed depleted in volatiles. The only species present from the analysis was CO + N_2 (mass 28) and CH_4 along with trace amounts of H_2O and Ar (Fig. 4). It appears that most of the mass 28 may be related to residual silicon oil from the collecting surface. Studies are currently underway to determine if the observed volatiles might be from the silicon oil of the collecting plate. The total ion current from the TCA particle was 30% less than the chondritic particle. From the studies carried out to date using the laser microprobe-mass spectrometer analysis technique, it appears that the method can be used to provide useful information about the nature of cosmic dust particles and further analysis are planned.

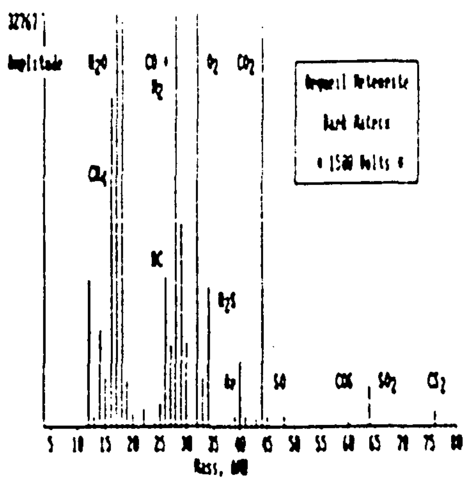

Fig.1 Volatiles released from Orgueil

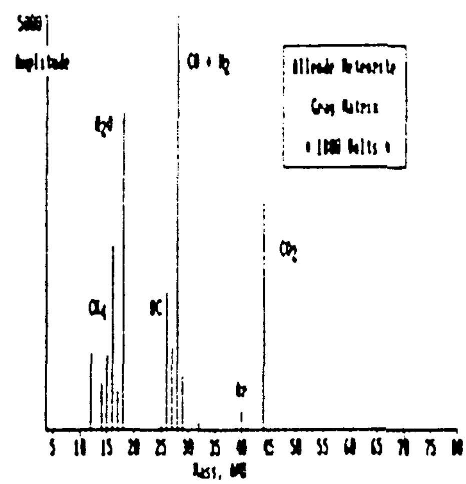

Fig.2 Volatiles released from Allende

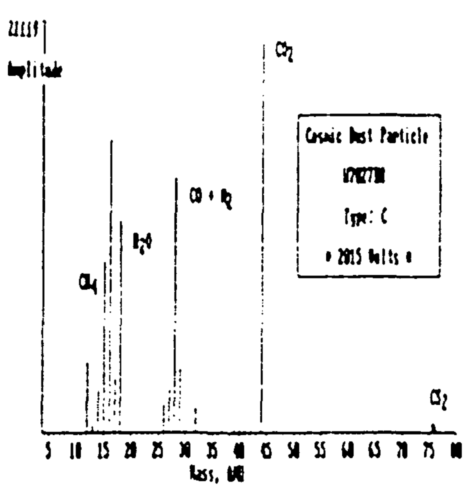

Fig.3 Volatiles released from W7027B8

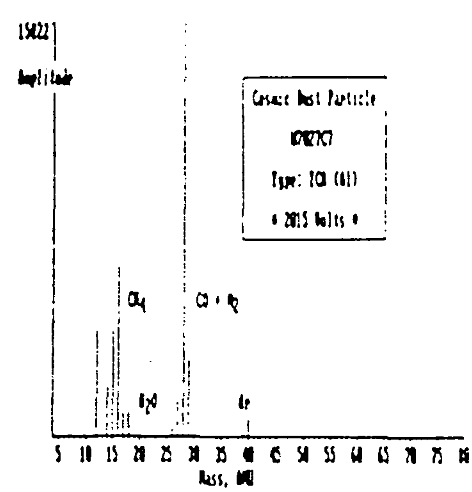

Fig.4 Volatiles released from W7027C7