STRATOSPHERIC DUST COLLECTION: AN ISOTOPIC SURVEY OF TERRESTRIAL AND COSMIC PARTICLES; F.J. Stadermann, R.M. Walker, and E. Zinner, McDonnell Center for the Space Sciences and Physics Department, Washington University, St. Louis, Missouri 63130, USA.

We report isotopic measurements of H, C, N, and Si in stratospheric dust grains and present evidence for the extraterrestrial origin of chondritic *and non-chondritic* particles.

For several years NASA has been collecting particles from the Earth's stratosphere. In most cases the captured particles are first characterized in a standardized procedure [1,2]: the grains are hand-picked from the collector flag, cleansed of the silicon oil that was used as capture medium, and the size, morphology, and major element composition are determined by scanning electron microscopy and energy dispersive X-ray spectroscopy (EDX). The distribution of different types and the total number of particles are highly variable among individual flags, and depend on the total collection time and the relative contributions from various classes of artificial and natural terrestrial contaminants. For most collected particles this initial characterization is the last step in their study, because they are classified as "probable terrestrial contaminants". In many cases, however, this vague classification is not based on a direct assignment of individual particles to any specific source of terrestrial contamination.

This procedure has the obvious advantage of minimizing the time wasted with further analyses of contaminants and of focusing work on the better known classes of cosmic dust grains. It may, however, lead to misconceptions regarding the composition of the cosmic dust that enters the Earth's atmosphere; *i.e.* the selection procedure is biased. Only few efforts have been made to identify previously unknown classes of cosmic dust particles [3]. The main difficulty is that there are no simple means to decide whether or not a single 10 μm size particle is of extraterrestrial origin. Typical indicators for a cosmic origin are, e.g., isotopic anomalies [2,4], noble gas contents [5], and solar flare tracks [6], although the absence of any of these is no proof for a terrestrial origin.

The best documented group of interplanetary dust particles is the so-called "chondritic" subset. This term originally described particles that have the same bulk major element composition as C1 chondritic meteorites. However, this definition is not used stringently and opinions differ on what constitutes a chondritic dust particle. It should also be noted that even a C1 chondrite does not necessarily exhibit a chondritic composition in all its fragments on a 10 μm size scale. Chondritic fragments have been demonstrated to be extraterrestrial; evidence has also been found for the extraterrestrial origin of other, non-chondritic stratospheric dust grains (e.g. "FSN" = Fe-S-Ni containing particles [7,9] and refractory particles [10]), but investigations in this field have been scarce.

In this study we tried to overcome some of the selection effects in the study of stratospheric dust particles by making isotopic measurements on the *entire* set of dust grains that were captured on a given collector flag. Sample preparation and measurements were made according to the previously described routines established in this lab [2,7,8]. The isotopic compositions of H, C, N, and Si were measured in more than 100 fragments of 68 particles with a modified CAMECA IMS-3f secondary ion microprobe. Of these 68 particles, roughly 13 can be identified as chondritic, 4 are AlO or FeO spheres, 4 others are mainly composed of light elements, such as C and O, while the other particles exhibit a large variety of compositions from "nearly chondritic" to Cd and Zn rich.

Significant isotopic anomalies were found for H and N, while C and Si show essentially normal isotopic compositions in all of the measured particles. As expected, most anomalies were detected within the chondritic subset of the analyzed particles. Deuterium depletions and enrichments were observed, with δD values ranging from -373 to +933 ‰ relative to SMOW. For N only ^{15}N *enrichments* were found. One fragment from the most ^{15}N-enriched particle, "Florianus", has a $\delta^{15}N$ value of (411 ± 20)‰ relative to air. This is close to the largest previously reported $\delta^{15}N$ value in interplanetary dust particles [9]. Interestingly, the ^{15}N-enriched chondritic particle "Florianus" appears to be rather homogeneous with respect to its N isotopic composition.

Isotopic anomalies, however, are not restricted to the chondritic particles, and several other dust grains show significant non-terrestrial isotopic signatures. All particles whose EDX spectra are shown in Fig. 1 have ^{15}N enrichments and are thus identified as interplanetary. In particle "Pupienus", for example, $\delta^{15}N$ values range up to (306 ± 21)‰. There are also indications for isotopic anomalies in other Si-rich particles. It is interesting to note that extraterrestrial particles of non-chondritic compositions also have been identified by Ne isotopic measurements in grains recovered from polar sediments [11].

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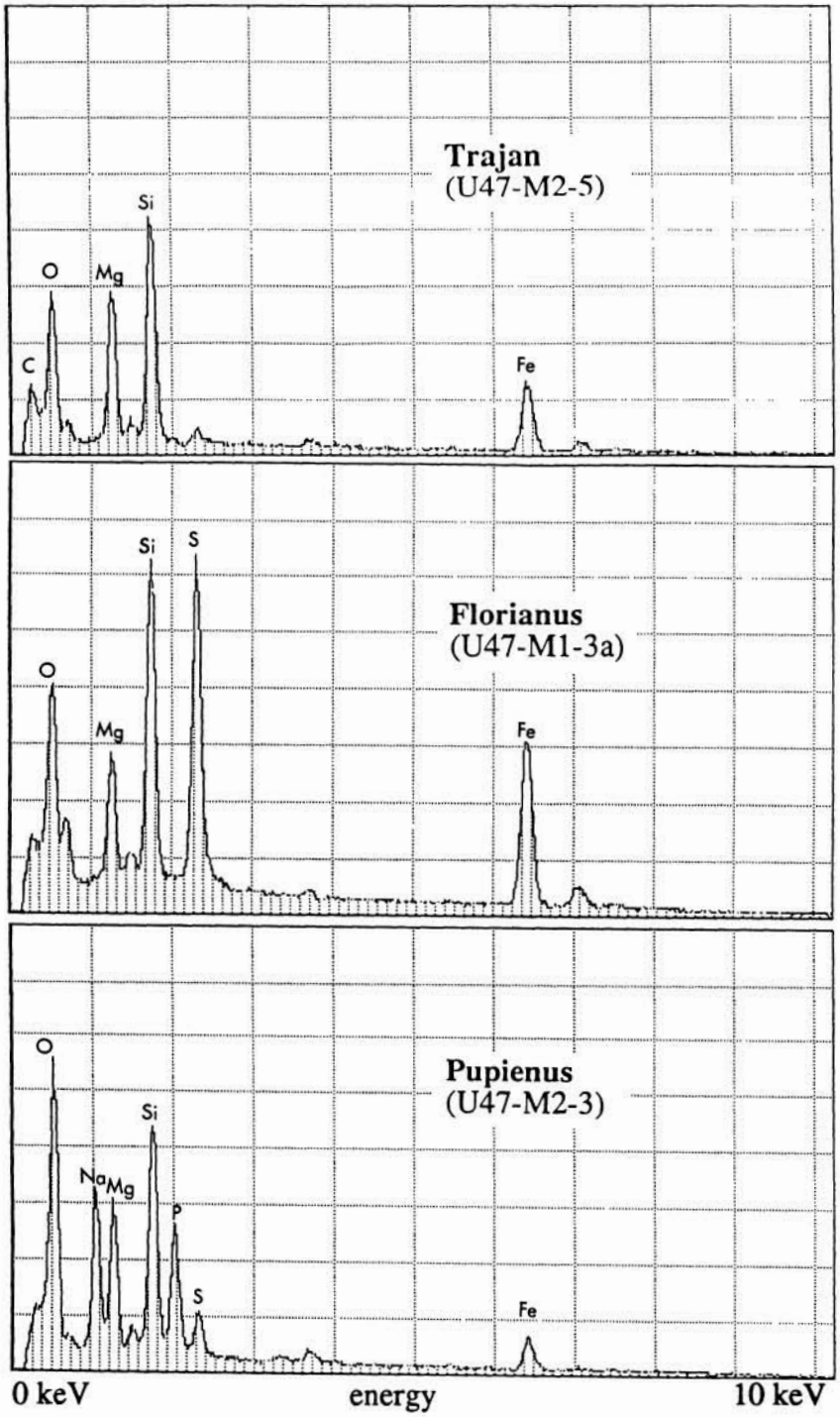

Figure 1: EDX spectra of three of the analyzed particles which show significant ^{15}N enrichments ($\delta^{15}N > 100$ ‰). Note that only "Trajan" has a typical chondritic spectrum. "Florianus" is considerably enriched in S, while "Pupienus" appears to have a completely different elemental composition. (The spectra have been taken at 15kV; the counting time was 50s.)