ION PROBE MEASUREMENTS OF HYDROGEN AND CARBON ISOTOPES IN INTERPLANETARY DUST. E. Zinner and K. D. McKeegan, McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130.

Ion probe measurements in different fragments of two stratospheric dust particles (SDP's) showed large D-excesses [1] establishing these particles to be primitive material of extraterrestrial origin. In continuation of this work we have measured D/H ratios in 8 fragments of another SDP (r21-M3-5A) and remeasured D/H in fragments of r21-M4-7 on a finer spatial scale than was done previously. Carbon isotopic ratios were also measured.

D/H-ratios: Measurement techniques for D/H are given in [1]. In addition, negative ion signals were measured at a series of selected mass peaks [2] in order to obtain, be it only semiquantitatively, information on the chemical composition of the carrier of the D-excess. Ion probe analysis was preceded by SEM characterization and EDAX analysis of each fragment. Particle r21-M3-5A is the second half of r21-M3-5B for which D/H values were reported previously [1]. Its FTIR spectrum is characteristic of the "hydrated silicate class" [3]. δD-values in this SDP vary from $\sim$60°/oo to 700°/oo between individual fragments. Variations of D/H values indicate heterogeneity of the H isotopic composition and not a lack of precision in the measurement. Such variations are observed even within individual fragments, which are typically $\sim$5 microns in size. Comparison of D/H with ion signals at different mass peaks shows a correlation between the D-excess and the relative concentrations of C, N, and S. This indicates that the carrier of the isotopically anomalous H is associated with carbonaceous material, and in this respect the interplanetary dust particles are similar to certain primitive meteorites [4]. Fig. 1 is a plot of δD values vs. the C^-/O^- ratio measured in individual fragments of r21-M3-5A. Similar plots are obtained for δD vs S^-/O^-, CN^-/O^- and S^-/Si^-. The same kind of general correlation is seen in different grains of the meteorite Semarkona [5]. Particle r21-M4-7 is more heterogeneous than r21-M3-5A. Whereas silicates are the main components in each fragment of r21-M3-5A, EDAX and ion probe data show that the individual fragments of r21-M4-7 are either mostly silicate (fragment α), Fe-oxide (fragment β), or carbonaceous material (fragments γ-η). The range of δD values (120°/oo to 2500°/oo) is much larger and the C^-/O^- ratio much higher than in r21-M3-5A. Also in this SDP the D-excess correlates with the C^-/O^- ratio (fig. 2).

$^{13}C/^{12}C$ - ratios: Preliminary results of C isotopic measurements were reported in [6]. Since then we have measured $^{13}C/^{12}C$ in a larger number of fragments with NBS-21 (graphite) used as an isotopic standard ($\delta^{13}C$ = -28.1°/oo vs the PDB standard). In fig. 3 the $\delta^{13}C$ values calculated relative to PDB are plotted for r21-M3-5A and r21-M4-7. The average $\delta^{13}C$ values of the particles differ by 37.2°/oo, much more than variations in the measurements of different fragments of either SDP. In order to investigate whether a matrix dependence of the mass fractionation seen in the ion probe can account for such a difference, we compared $^{13}C/^{12}C$ ratios measured in NBS-21 (graphite) with those measured in NBS-18 (carbonatite) and NBS-19 (limestone), respectively (table 1). The results indicate that apparent differences in $\delta^{13}C$ values of up to 20°/oo between graphite and calcite could be caused by matrix dependent mass fractionation, although the relative difference between limestone and carbonatite (both are calcite) is puzzling. For both standards we measured fragments from a $\sim$100μm grain. Since the homogeneity of isotopic standards on a small spatial scale is a formidable problem, additional studies on well homogenized samples have to

confirm this difference between limestone and carbonatite. The $\delta^{13}C$ values in different fragments of either SDP are remarkably constant in view of their varying chemical compositions (see C^-/O^- ratios in figs. 1 and 2). Since in both particles most of the C is present in the form of carbonaceous material (C^- does not correlate with O^-) and since the difference in $\delta^{13}C$ between them exceeds that between graphite and carbonatite by more than a factor of two, we conclude that the $^{13}C/^{12}C$ ratios in the two interplanetary dust particles are distinctly different.

References: [1] E. Zinner et al., Nature 305, 119 (1983), [2] K. McKeegan et al., 46th Met. Soc. Meeting, Abstracts, p.123 (1983), [3] S. Sandford et al., 45th Met. Soc. Meeting, Abstracts (1982), [4] F. Robert and S. Epstein, G.C.A. 47, 2199 (1983) [5] K. McKeegan and E. Zinner, This volume (1984) [6] E. Zinner et al., 46th Met. Soc. Meeting, Abstracts, p.221 (1983), [7] H. Craig, G.C.A. 12, 133 (1957).

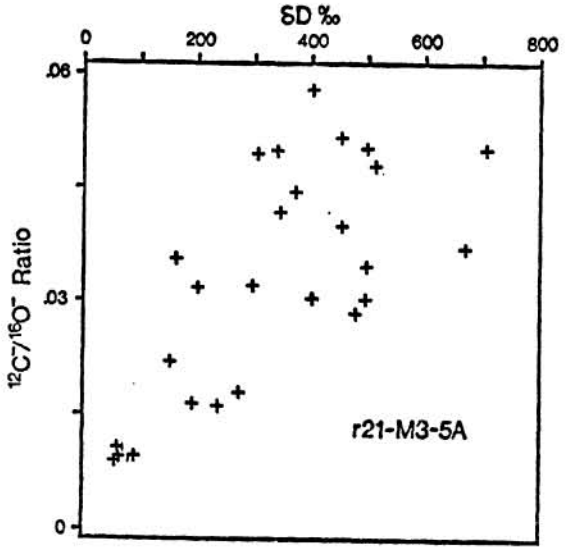

Figure 1

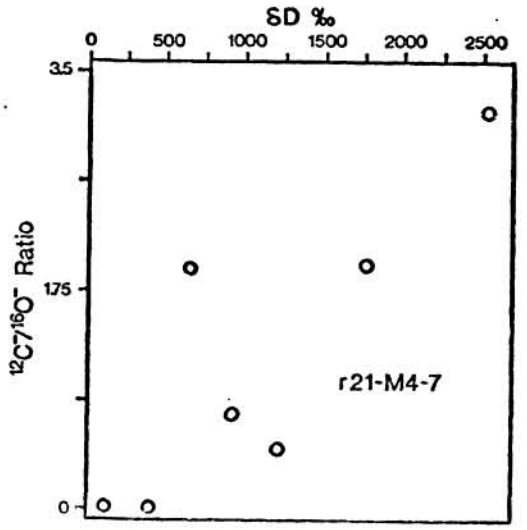

Figure 2

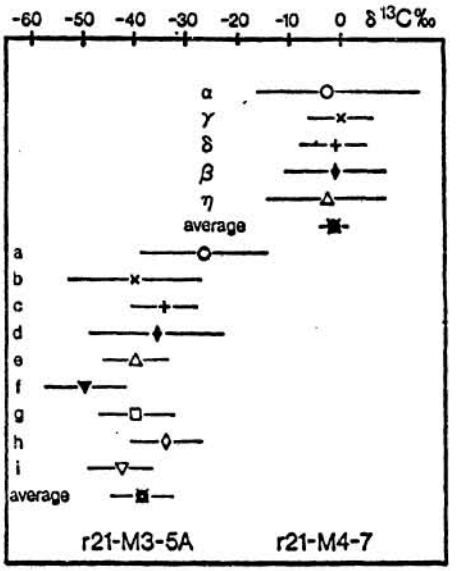

Figure 3

Table 1

	NBS-21 Graphite	NBS-19 Limestone	NBS-21 Graphite	NBS-18 Carbonatite
Number of measurements	38	32	18	18
Average $\delta^{13}C$ measured*	-48.0	-26.8	-59.3	-54.7
Standard deviation of all measurements	2.4	8.4	6.0	5.3
Standard deviation of repeated measurements on same grain	1.7	5.5	2.1	4.4
Average error of individual measurements	1.8	5.3	2.9	5.0
$\delta^{13}C$ of standard vs PDB+	-28.10	1.92	-28.10	-5.00
Mass fractionation in ion probe#	-19.9	-24.9	-31.2	-49.7
Difference of instrumental mass fractionation	6.8		18.5	

* Relative to $^{13}C/^{12}C$ in PDB=.011237 [7]

\+ National Bureau of Standards, August 1983

\# The two measurement series were performed on different dates under different instrumental conditions.