NITROGEN COMPONENTS AND ISOTOPIC SIGNATURES IN THE ACAPULCO METEORITE; Gloria Sturgeon and Kurt Marti, Chemistry Dept., B-017, University of Calif., San Diego, La Jolla, California 92093-0317.

The unique meteorite Acapulco has a major element composition similar to that of H chondrites (1). The meteorite is metal-rich and shows a high degree of recrystallization indicating formation conditions with temperatures of \(-1100^\circ\text{C}\), a reducing environment and a fast cooling rate of >10°C/My. These conditions would be consistent with its oxidation state being between those of H and E chondrites (1). However, some volatile elements show an abundance similar to that of Cl chondrites and planetary noble gases are present at significantly higher concentrations than in equilibrated ordinary chondrites.

A small chip was used in a pilot study to assess nitrogen concentration, temperature cuts and the release pattern. A larger chip (0.24g) was used for a higher resolution isotopic study. Both bulk samples of Acapulco were wrapped in aluminum foil and the N analyzed by static mass spectrometry. Extraction of the gas was accomplished by stepwise pyrolysis, and nitrogen was measured as N\(_2\). The excess observed at mass 30 is due mainly to CO and was used to correct for CO at masses 28 and 29.

The nitrogen fractions were cleaned by exposure to CuO at 650°C for 20 min., converting these gases to CO\(_2\) and H\(_2\)O. The water and CO\(_2\) were collected in a liquid nitrogen trap and later discarded. Extraction blanks were determined using Al foils only and the sample protocol at all temperatures, for the second sample corrections, were <4.5%, except for the very small 450°C and 1400°C fractions. Since the CO interference in the mass spectrometer was time dependent, the data were extrapolated to the time of sample admission.

In Figure 1, the \(\delta^{15}\text{N}\) is plotted versus % nitrogen released for the large chip. The isotope ratio remains constant during 45% of the nitrogen release then drops stepwise and, with the exception of a hump in the 1300°C fraction, appears to asymptotically approach \(\delta^{15}\text{N} \leq -110.5\%\). The data reveal at least two distinct components. At temperatures below 1000°C, "heavy" nitrogen with an isotopic signature, \(\delta^{15}\text{N} = +8.9 (\pm 1.2)\%\), is released. At temperatures \(\geq 1000^\circ\text{C}\), the ratios reflect mixing ratios with "light" nitrogen with an isotopic signature of \(\delta^{15}\text{N} = -110.5 (\pm 4.0)\%\). Assuming a two component mixture, the total amount of this "light" nitrogen is 1.02ppm. Although corrections for cosmic-ray-produced \(^{15}\text{N}_c\) are expected to be small for a \(-7 \text{ Ma}\) exposure age, they are not negligible. The small rise in \(^{15}\text{N}/^{14}\text{N}\) at 1300°C may suggest the appearance of a spallation component. However, the shift is about twice as large as the expected total \(^{15}\text{N}_c\) contribution, and we do not expect a release in a single temperature step. If we assume a constant percentage of \(^{15}\text{N}_c\) in the nitrogen released above 1000°C, along with the \(^{21}\text{Ne}_c\) measured by (1), and a \(^{15}\text{N}\) to \(^{21}\text{Ne}\) production rate ratio of 3 \(\pm 1\) (2), we calculate that the \(\delta^{15}\text{N}\) values in all steps >1000°C will have to be decreased by 4\%.

The 1300°C data, corrected for spallogenic \(^{15}\text{N}_c\), give \(\delta^{15}\text{N} = -114.5\%\) for the "light" nitrogen, which we consider to be an upper limit, since the relative spallation contribution in the final release might be larger.

The 1300°C fraction presents an interesting fine structure. If there were only two nitrogen components released with simple mixing down to 1400°C, we would expect the \(\delta^{15}\text{N}\) for the 1300°C fraction to be lower than in the 1230°C step. As discussed earlier, the increase in the \(\delta^{15}\text{N}\) exceeds the shift
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expected due to the presence of spallogenic $^{15}$N$_c$. The higher $\delta^{15}$N value could be explained by the release of "heavy" nitrogen from a refractory phase. Alternatively, another "heavy" component with a distinct isotopic signature may exist. An analysis of mineral separates should be helpful here.

The "heavy" nitrogen component we observed in Acapulco is within the range of ordinary chondrites (3). The "light" nitrogen component, on the other hand, is outside the range of components reported for bulk meteorites. However, "light" nitrogen components $\delta^{15}$N $\leq$-100‰ were reported for the stepped combustion of an oxidized, acid resistant residue of Allende, $\delta^{15}$N $\leq$-115‰(4), and an even lower value of $\sim$-326‰ was reported from the 500°C-600°C fraction of an oxidized, acid resistant residue (5).

The presence of two nitrogen components with very distinct isotopic signatures implies that the carriers of these nitrogen components were not equilibrated. The nitrogen appears to have originated from at least two sources. These results suggest that N was isotopically inhomogeneous in the protosolar system. This is the interpretation preferred by Prombo and Clayton (6) who reported extremely positive $\delta^{15}$N values in Bencubbin and Weatherford. In agreement with the oxygen isotopic signature (7), the nitrogen data point to an Acapulco parent body different from that of either the H or E chondrites.

![Figure 1](image)

Fig. 1 shows the isotopic data from a stepwise release of N in Acapulco. The observed $\delta^{15}$N values (relative to air) are shown versus the fractional release of N; uncertainties reflect 95% C.L. and temperatures are given in °C.