PURSUIT OF SOLAR NITROGEN: NITROGEN COMPONENTS IN THE PESYANOE METEORITE; S.V.S. Murty and K. Marti, Chemistry Dept., B-017, University of California, San Diego, La Jolla, California 92093.

Studies during the past 10 years of nitrogen extracted from lunar regolith samples revealed distinct "solar-type" isotopic signatures and were consistent with the hypothesis (1) that solar wind nitrogen, as observed in lunar soils, has undergone a long-term secular increase in the ratio $^{15}N/^{14}N$. Possible mechanisms for generating the required increase were discussed (2,3), and it was concluded that solar processes are not capable of quantitatively accounting for a >30% secular increase. Other models considered a secular increase due to contributions from a nearby planetary nebula (4) and an admixture to solar or planetary nitrogen of a hypothetical light nitrogen component (3). We still do not know the isotopic composition of solar nitrogen, and no direct measurements of present solar wind nitrogen are available. Furthermore, there is at least a three-fold excess of solar-type nitrogen in lunar soils, with respect to the present-day flux (5), as well as non-solar nitrogen/noble gas elemental abundance ratios, as observed in ilmenites (6) which require explanations. A variability with time of the solar wind composition indicates that at least two mechanisms have to be considered when relating the solar wind composition to the composition of the source region (7), but neither one is capable of substantially enriching N relative to Ar.

We are studying nitrogen components in the well-documented gas-rich meteorite Pesyanoe, in order to obtain additional information on isotopic signatures of N in solar system reservoirs. Although we have no direct evidence on the time of the solar wind loading of the Pesyanoe breccia (8), a precompaction exposure on the parent body, presumably early in solar system history, is indicated. On the basis of the hypothesis of a secular increase in $^{15}N/^{14}N$ in the wind, we would expect to observe the signature of light nitrogen in the solar component. We report nitrogen isotopic abundances in two grain-size fractions of Pesyanoe (P18: $\geq 960\mu m$; P21 $\leq 340\mu m$). Both samples were analysed by stepwise heating, and the noble gases were used as monitors of the solar wind and spallation components. The low-temperature data of P18 (curve a) indicated the presence of a nitrogen component with positive $\delta^{15}N$ which was suspected to be due to contamination. We have reanalysed the low-temperature steps of P18 by initially heating it with a light source to ~350°C in vacuum, then at O_2 pressures of 10 mtorr and 100 mtorr respectively. These data are also shown in the figure (curve b). Measured and spallation-corrected $\delta^{15}N$ values initially are negative, reveal mixima in the 700-800° region, then drop again and show a final rise at 1400-1600°C. The final increase is due to the spallation component, but the spallation gas is not restricted to the high-temperature fractions and, therefore, a monitor is clearly required. Since we have measured all noble gases in addition to N, we have several monitor options, but our experience has shown that spallation $^{21}Ne_s$ is a good approximation. In the figure, a "spallation corrected" curve is obtained by subtracting a spallation component $^{15}N_s = (4 \pm 1)^{21}Ne_s$ in the individual temperature fractions. Although the assumption that N and Ne spallation ratios should be constant in the various temperature steps is based only on the fact that both components are predominantly released from enstatite, the results indicate that this spallation monitor is quite reasonable. The corrected ratios above 1000° are the same within error limits in all temperature fractions and in both samples. The two samples may disagree somewhat in the 800-1000° range, but it is not clear whether this is due to our approximation or due to the component which is prominent in the 700-800° region, the range where solar-type noble gases are also released. This "heavy nitrogen" component, which is observed mainly in the 700° and 800° fractions, corresponds to a $\delta^{15}N$ signature of $\gtrsim 0$ and is distinct from the "light trapped" Pesyanoe nitrogen which is predominantly released at higher temperatures and reveals a characteristic signature of $\delta^{15}N = -33‰$. The nitrogen concentrations corresponding to the different components are: $N_{(heavy)}$ about 3 and 9 ppm, respectively for the P_{18} and P_{21} samples, and $N_{(-33‰)}$ about 9 and 17 ppm, respectively. These concentrations are larger by more than two orders-of-magnitude than those expected from solar wind implantation based on measured solar-type Ne and Ar concentrations and solar N/Ne or N/Ar abundance ratios. The isotopic signature of component $N_{(-33‰)}$ corresponds to the lowest $^{15}N/^{14}N$ ratios observed in the stepwise release of nitrogen in Abee (9). Therefore, this nitrogen signature appears to be common to enstatite chondrites and achondrites, an important result relating to the question of solar system nitrogen components.

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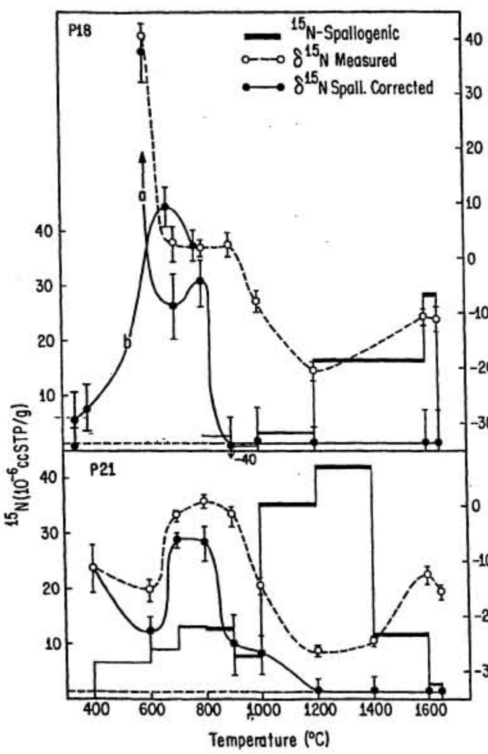

Fig. 1: Nitrogen isotopic systematics in Pesyanoe data from a coarse sample P18 ($\geq 960\mu m$) are shown in top portion and data of P21($\leq 340\mu m$) in bottom portion. Isotopic composition, in $\delta^{15}N$ relative to atmospheric N, is given on right hand scale, concentrations on left.