Most meteorites have whole-rock N $\delta^{15}N$ from -90‰ to +100‰. A small group contain N with much larger $\delta^{15}N$ values; some even reaching +1000‰ or higher: Bencubbin, Acfer 182, CR chondrites and polymict ureilites. This study is aimed at determining the origin of this heavy N. The approach is to attempt to concentrate any carriers of the N component and establish if any other distinct isotopic signatures are associated with the N. This would help determine the possible mechanism for generating the $^{15}N$ enrichment. Samples (whole-rock and acid residues) were stepped heated and the $^4He$, $^{12,13}C$, $^{20,21,22}Ne$ and $^{36,38,40}Ar$ together with N analysed on the automated mass spectrometer system, FINESSE.

Initial investigations concerned Bencubbin, a stony iron breccia with unique clasts shock welded into a glassy matrix and a whole-rock N isotopic composition of $\delta^{15}N \approx 1000‰$ [1]. Despite a previous extensive study [2] the origin of the heavy N has remained elusive. This study showed that virtually all the heavy N is located in an acid resistant phase (combustion temperature $\approx 400°C$) shielded by a refractory but acid soluble phase. A conjoint noble gas, C and N analysis of acid residues suggested a possible association between the heavy N carrier and a small amount of planetary argon, however it was understood that this could be an effect of acid damage to the main argon carrier [3,4].

To eliminate the possible acid damage to the argon carrier (and N carrier), a much milder treatment with CuCl$_2$ was devised [5,6]. This resulted in the removal of Fe-Ni metal from the clasts and matrix leaving the sulphide and silicate clasts and silicate glass. Analysis of the residues from this treatment established that there was no association between the acid resistant phase containing the heavy N and any detectable noble gas or C release, indicating that the heavy N carrier in Bencubbin is isolated from noble gases and C.

More recently investigations have been extended to polymict ureilites. This has also entailed a survey of main group ureilites (MGUs) to enable resolution of features unique to polymict ureilites. Two MGUs (ALHA 77257, HH126) and three polymict ureilites (Nilpena, EET 87720, North Haig) have been investigated [7]. All the ureilite release profiles were dominated by the release of isotopically light N, C and planetary noble gases at $\approx$600°C, a cosmogenic neon release at $\approx$750°C and a low temperature release of N at $\approx$300°C with an isotopic composition of $\delta^{15}N=20‰$. In the polymict ureilites, the N composition became much heavier between 300°C and 600°C, up to $\delta^{15}N=120‰$, but without any detectable peak in the release profile. This indicates that a relatively small amount of isotopically heavy N is being released on the shoulder of the isotopically more “normal” N. More importantly, as with Bencubbin, the heavy N release does not appear to be associated with any noble gas or C release.

The isolation of the heavy N carrier from noble gases in the polymict ureilites and Bencubbin seems to indicate that the N is chemically bound to a carrier and rules out a cosmogenic origin for the heavy N. There being no other unusual signatures makes a presolar grain origin also unlikely. This leaves some form of extreme isotopic fractionation as the most viable remaining possibility. A common link with all these meteorites is the brecciation event. This could suggest that the N carrier is a late stage nebular residue component which may have been carried into the regolith gravitationally or with the impactor.