Herein we present the first results of C and N isotopic measurements along with N, Ar and He content study of shock originated diamonds extracted from the impactites of Popigai crater and Ebeliakh placer deposits. $\delta^{13}$C values suggest that two different populations may be involved.

The time when diamonds can be thought of only as inclusions in kimberlites has long since passed. They are found in many meteorites (1) and can be linked with metamorphic rocks and to impact produced deposits (2,3). Since diamond is one of the most resistant minerals in terms of surviving weathering, it can preserve a geochemical signature of the formation processes and source materials involved in its origin. The subject of this research is diamonds produced by meteorite shock. Such diamonds were recognised to be associated with several meteorite craters in Russia, K/T boundary and the Norlinger Ries impact structure. Diamond/loansdaleite can now be suggested to be a very reliable indicator of impact produced circular structures. However, in some cases, if diamond is not intergrown with lonsdaleite and has been found in placer deposits, relations to the impact process can not always be recognised unambiguously using mineralogical properties only. New features have to be investigated, therefore we have studied C, N and Ar isotopic composition and N, Ar and He contents of samples from the Popigai crater and lonsdaleite bearing aggregates recovered from the Ebeliakh river placers, to decide if any diagnostic values can be recognised.

Twenty diamond aggregate specimens (1-2 mm size) from Popigai crater shock transformed rocks and five diamond samples (5-7 mm size), where lonsdaleite was detected by X-rays, from Ebeliakh river placers were studied. One sample from Ebeliakh was considered to be yakutite (shock produced diamonds after Kaminsky (4)) by its appearance, however, further X-ray investigation does not confirm the suggestion since no lonsdaleite was detected and the sample was not polycrystalline. Nitrogen isotopic composition and content were measured by static mass spectrometer (5) along with Ar isotopic composition and He content. Carbon isotopic composition was analysed by a conventional gas flow dynamic mass spectrometer. One stepped combustion experiment was carried out to determine the location of the radiogenic Ar.

The carbon isotopic composition of diamonds from Popigai vary within the previously reported limits ($\delta^{13}$C -10 to -22‰) (4-7) whereas diamonds from the placer produced heavier values of $\delta^{13}$C (-7 to -10‰). All the specimens studied contain very low amounts of nitrogen, mostly <20 ppm, but a few up to 60 ppm were detected. One exceptional sample as mentioned above without lonsdaleite, from Ebeliakh contains 800 ppm of N. For samples, where the quantity of nitrogen allowed reliable analysis (at least three times above blank), $\delta^{15}$N values were found to range from 0 to +11.9‰. Several specimens both from the crater and the placer were characterised by radiogenic Ar (0.0003cc/g, $^{40}$Ar/$^{36}$Ar 10000), whereas the majority of the specimens from both locations have lower concentrations (2 x 10$^{-6}$ to 5 x 10$^{-6}$ cc/g) and $^{40}$Ar/$^{36}$Ar ratios close to atmospheric in composition. Only samples from Ebeliakh have been analysed for He content; it was found to be within the range 6 x 10$^{-6}$ to 5 x 10$^{-6}$ cc/g which is within the limits of variation of diamonds derived by kimberlites.
C, N, He AND Ar OF SHOCK PRODUCED DIAMONDS. SHELKOV, D. et al.

Given the slight difference in $\delta^{13}$C between the two groups, maybe the placer deposits represent material from an impact event other than Popigai, not inconceivable given the great distance between the two locations. The high $\delta^{13}$C of diamond/loansdaleite from Ebeliakh, i.e. approximating to ordinary mantle diamonds (-5 ± 3‰) could suggest that deep seated carbon played a role in their origin. The low nitrogen content observed for the majority of analysed samples may be a diagnostic feature of impact produced diamonds. Where slightly higher N, ca 60 ppm, are encountered differences in source material could be implicated. Organic derived carbon should have much higher N content than sources involving pre-existing graphite. However, irrespective of its origin, the majority of any nitrogen could escape under the extreme P and T conditions associated with impact.

Very few experiments provided reliable N isotopic compositions due to the low nitrogen content and sample size. Most of the $\delta^{15}$N values acquired are in the range reported for organic and other crustal materials i.e. 0 to 11.9‰. However, one sample from Ebeliakh released significantly lighter nitrogen ($\delta^{15}$N value -3.8 ± 1.4‰, N content 9 ppm, $\delta^{13}$C value -7.3‰), which is in agreement with the suggestion that some impact diamonds contain mantle derived material based on the carbon isotopic composition, since mantle diamonds have isotopically light N (8).

The argon content and isotopic composition from one of the samples from Ebeliakh and one from Popigai analysed are unlike diamonds of any other origin. A combined stepped heating and combustion experiment has demonstrated that the radiogenic Ar is concentrated in the actual structure of the diamond since only very low amounts of argon with atmospheric isotopic compositions are released by heating up to 1100°C; the radiogenic gas is not liberated. If the silicates carried the radiogenic Ar, they would have melted and trapped Ar would have diffused out. During stepped combustion from 600°C to 900°C, the argon comes off together with CO₂ generated from the carbon i.e. it is in the carbonaceous part of the sample. The most probable explanation of the presence of radiogenic argon must be a source material having a high radiogenic abundance (high $^{40}$Ar concentrations has been previously reported in Precambrian graphite (9)). On the other hand it could be related to a process connected with an impact event, since extreme radiogenic Ar concentrations have been observed in some quartz grains from the Vredefort impact crater (10). Those samples with argon having an atmospheric isotopic composition, however, are more readily interpreted as being of impact origin.

ACKNOWLEDGEMENTS This work is supported by PPARC and by a studentship to D.S. from the de Beers Corporation.