Alpha-radiation damage in diamond

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We studied both the extent and distribution of structural damage in diamond crystals that was generated through either natural or artificial irradiation with alpha particles (i.e. He^{2+} ions with energies in the MeV range), and the related formation of colour-centres. A range of non-destructive micro-techniques was applied. At high irradiation doses $\geq 10^{16}$ ions per cm^2, diamond may be transformed locally into an amorphous state (maximum damage generated at the far ends of helium trajectories). The resulting volume expansion causes compressive strain in the neighbouring (crystalline) diamond, detected by an upshift of the diamond *LO=TO* Raman band [1, 2]. This volume expansion is why radiation-damaged spots at the surface of natural diamond crystals often have an up-domed shape.

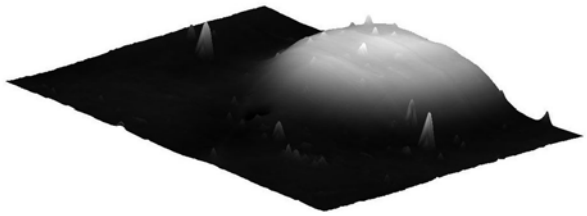

Figure 1: Topography (AFM scan) of the surface of a diamond from Namaqualand, R.S.A. The radiation-damaged spot is seen as a broad hump (diameter ~36 μm, height ~400 nm); small peaks are artefacts (dust particles at the surface).

Visible radiation-induced green colouration of diamond (mainly caused by a broad absorption band at ~16000 cm^{-1} assigned to the GR1 centre) is generated at moderate doses of 10^{14}–10^{15} He ions per cm^2 [3]. This irradiation resulted in a lowly damaged state (maximum damage ≤0.005 dpa).

[1] Hanfland *et al.* (1985) *Phys. Rev*. B31, 6896-6899. [2] Nasdala *et al.* (2005) *Am. Mineral*. **90**, 745-748. [3] Vance *et al.* (1973) *Miner. Mag*. **39**, 349-360.

Helium-Ne-Ar systematic in Lena Trough lavas, Arctic Ocean

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Lena Trough is considered as a non-volcanic continental rift in the Arctic Ocean. Nevertheless, rare volcanic rocks dredged at 3500 m deep in the southern Lena Trough are alkali-rich lavas with SiO_2> 51%, Al_2O_3>18% and K_2O ~2 wt%. Based Sr-Nd-Hf-Pb isotopes, these lavas are interpreted as reflecting a binary mixing between a depleted MORB mantle component and a garnet non-peridotitic fertile component derived [1]. Furthermore, these lavas display a DUPAL-like anomaly. In order to test the binary mixing scenario and the origin of the Arctic DUPAL anomaly, we have measured concentrations and isotopic ratios of He, Ne, and Ar by step crushing. Lena Trough lavas display $^4He/^3He$ between 89,650 and 96,860 similar to the mean MORB ratio. Neon isotope ratios display values from 10.08 to 11.04 for $^{20}Ne/^{22}Ne$ and from 0.029 to 0.0434 for $^{21}Ne/^{22}Ne$. The samples fall on the MORB line. $^{40}Ar/^{36}Ar$ vary from 349 to 6964, lower than the MORB mantle value of ~27,000 suggesting the presence of an atmospheric component (air contamination or mantle-derived). Samples have typical MORB helium compositions and the fertile component is not detected with He. This distinguishes the Arctic from the south hemisphere DUPAL anomalies where radiogenic helium ratios were measured. The fertile component is therefore considered either as strongly degassed in helium before mixing or as young or/and U-Th depleted. Origin of this fertile component will be discussed in the light of He-Ne-Ar systematic.

[1] Nauret, F., J.E. Snow, and D. Weis, *J. Petrol*., submitted.