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Noble Gas Investigations of Early Proterozoic Lamproites from the Eastern Baltic Shield

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We present results of noble gas abundances and isotopic data of early Proterozoic lamproites (whole rock and mineral separates) from the eastern Baltic Shield (Kostamuksha/Karelia craton).

Ar isotope data from K-rich mineral separates (mica and kfs), released by stepwise heating, define a linear correlation when plotted in a $^{40}Ar/^{36}Ar$ versus $^{40}K/^{36}Ar$ diagram (Fig. 1). The slope of the regression line corresponds to an age of 1223 ±13 Ma which agrees well with Sm-Nd and Rb-Sr dating (1235 Ma, Belyatskii et al, 1997). The Ar isotopic data of K-free minerals (cpx, quartz, carbonate) reveals the presence of excess argon which was also found in a fluid inclusion component, released by crushing of whole rocks. Diffusion of in-situ produced Ar from the matrix into the fluid inclusions is not likely, because the $^{40}Ar/^{36}Ar$ ratios in the fluid inclusions are not related to those in the crystal matrix. Therefore, we regard interaction of the rock material with a external fluid phase as a more likely explanation. The Ne isotopic ratios of crushed samples, when plotted in the Ne three-isotope diagram, display mixing between air and a crustal component (Kennedy et al., 1990). Therefore, any possible mantle component seems to be swamped by a fluid component with crustal origin.

In order to determine the $^{40}Ar/^{36}Ar$ ratio of the trapped component, we used a plot (not shown) of $^{21}Ne/^{22}Ne$ versus $^{40}Ar/^{36}Ar$ of crushed whole rock samples and melted K- and F-free mineral separates. Because of the different rare gas abundance ratios in the end members, the mixing line shows a more hyperbolic than linear array, indicating an upper limit for the $^{21}Ne/^{22}Ne$ ratio of 0.046. This corresponds to a $^{40}Ar/^{36}Ar$ ratio of ~ 5500 for the trapped component. Although a similar ratio is postulated for the Kola plume source (Marty et al., 1998), we do not suggest a mantle origin of the fluid for our samples, because their $^{20}Ne/^{22}Ne$ ratios are lower than atmospheric.

The neon stepwise heating data of whole rocks and micas show the presence of nucleogenic ^{21}Ne and ^{22}Ne, produced by Wetherill reactions $^{18}O(\alpha,n)^{21}Ne$ and $^{19}F(\alpha,n)$ ^{22}Na (β^+) ^{22}Ne, in proportions distinct from the crustal composition observed in fluid inclusions. To assess this quantitatively, fluorine determinations are in progress.

The U/Th-He method yields ages of 100 - 450 Ma, indicating > 90% diffusion loss of He for most of the samples. No evidence of excess ^3He, either by crushing or by stepwise heating, was found. Measured $^3He/^4He$ ratios of melted samples are in good agreement with calculated $^3He/^4He$ production ratios via (n,α)-reaction of ^6Li (Mamyrin and Tolstikhin, 1984). $^3He/^4He$ ratios of crushed samples display the crustal ratio.

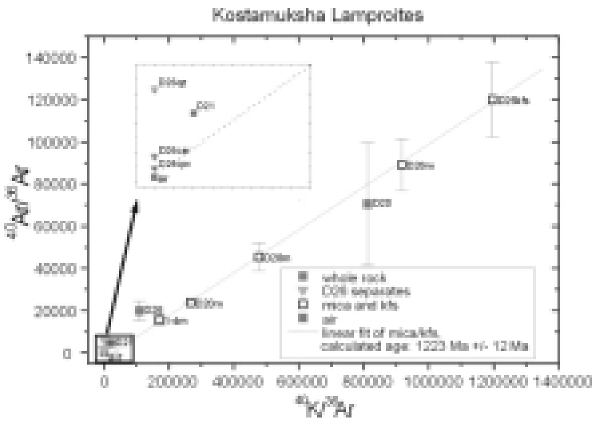

Figure 1: $^{40}Ar/^{36}Ar$ vs. $^{40}K/^{36}Ar$ plot of Kostamuksha lamproites, showing the presence of excess argon for K-free minerals. The slope of the regression line derived from K-rich minerals corresponds to an age of 1223±13 Ma.

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