Noble gases in Indian carbonatites

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We present preliminary data for step-heating and crushing measurements of elemental and isotope compositions of light noble gases (He, Ne, Ar) for Neoproterozoic carbonatite complexes from Sevattur and Samalpatti, Tamil Nadu, S India, in order to constrain the nature of the fluids which apparently played a role in their formation. These data are paralleled by microthermometry studies on fluid inclusions.

The $^{3}He/^{4}He$ ratios of Sevattur carbonatites range from 4.5 to 7.4 R_A, and show a broadly negative correlation with the $\delta^{13}C$ values of the host carbonate [1]. Apatite appears to hold higher $^{3}He/^{4}He$ than coexisting calcite (4.3 versus 2.9 R_A). The amounts of Ne released by crushing were approximately one order of magnitude higher than those released during step-heating, while the opposite is usually obtained. The Ne isotope systematics are consistent with the presence of a nucleogenic component, apparent in $^{22}Ne/^{20}Ne$ ratios below air. This component could represent Ne isotope signature of the original fluid composition implying that the parental fluid already carried this feature. Alternatively, nucleogenic Ne could have been produced in the crystal lattice and had diffused into fluid inclusions later. Neon isotope systematics in calcite show steeper slopes compared to apatite although the opposite would be expected due to lower O/F ratios in apatite. This may require that the fluid which was trapped in calcite and fluorite already contained a significant amount of nucleogenic Ne. With the exception of one sample, all $^{40}Ar/^{36}Ar$ show a significant non-atmospheric component ($^{40}Ar/^{36}Ar$ from ~1,000 to ~8,600). This is confirmed with preliminary results of crushing experiments.

The microthermometry results indicate the presence of mixed H_2O and CO_2 inclusions in calcite, and pure CO_2 inclusions in apatite. These cumulative observations suggest that the fluid from which carbonatitic rocks formed was heterogeneous and might result from mixing of deep seated mantle and lithospheric fluids.

Analyses of carbonatites from Amba Dongar and other localities as well as Li, Th and U concentration analyses to calculate nucleogenic production of ^{3}He are pending.

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[1] Ackerman et al. (2017) Lithos, in press.