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Time-integrated heat production of the cratonic lithospheric mantle below Jagersfontein, South Africa

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The lithospheric mantle that underlies cratons is characterized by large degrees of melt extraction that mainly occurred during the Archean and Paleo-proterozoic. This resulted in a higher buoyancy and viscosity and lower geothermal gradients compared to both younger continental lithosphere and the convecting mantle. This, along with them being the main source of diamonds and other resources, has made cratonic roots the focus of research for decades. However, there are still properties that remain poorly constrained, such as the abundance of heat-producing elements and the thermal evolution of cratonic roots. Here, we present in-situ chemical data, reconstructed bulk rock compositions and heat production estimates for 11 peridotite xenoliths sampled by the Jagersfontein kimberlite, in the Kaapvaal craton.

The samples are grouped as (i) low-PT (3.0-4.4 GPa, 790-1050 °C) coarse-textured, (ii) medium-PT (3.9-4.8 GPa, 990-1080 °C) coarse-textured, and (iii) high-PT (5.3-5.9 GPa, 1280-1360 °C) deform-textured. Of all primary mineral phases present, garnet and orthopyroxene are the largest contributors to the bulk rock U content (up to 90 and 100% of the bulk budget respectively), which in turn has a major control on the heat production in the samples studied. Garnet is widespread in deeper cratonic roots and possesses low Th/U ratios (median ~0.4), it therefore plays an important role in controlling the variation of bulk rock Th/U ratios in depleted mantle rocks (median Th/U in garnet peridotite ~2.7, depleted MORB mantle ~2.9 [1]).

A present-day heat production of 0.005 – 0.009 $\mu W/m^3$ is estimated for group A samples at shallower depths (<100 km), and a lower heat production for group B samples, at the base of the lithosphere (0.002 – 0.0005 $\mu W/m^3$). These values are lower than lithospheric mantle estimates from measured bulk rock [2].Ongoing Pb isotope analyses on garnet separates will allow us to reconstruct the time-integrated evolution of heat production, and the changes of Th/U ratios of cratonic roots and their departure from the “canonical” Bulk Silicate Earth values.

[1] Salters, V. J., & Stracke, A. (2004). *Geochemistry, Geophysics, Geosystems*, 5(5).

[2] Rudnick, R. L., McDonough, W. F., & O'Connell, R. J. (1998), *Chemical Geology* 145(3-4), 395-411.