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Apatite U–Pb/trace elements geochemistry points toward late-Paleoarchean stabilization of the lithosphere under the Kaapvaal craton

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Archean cratons form nucleus onto which present-day plate tectonics developed. Despite being central in the development of modern style—emerged—continents, the means and timing of stabilization of the Archean lithosphere remains unclear. Over the last decades, major efforts have been conducted to extract this information from the geochemical signatures preserved in zircon hosted in TTGs, the volumetrically dominant igneous suite in Archean cratons. Although valuable, this focus on zircon may have biased our views toward what geochemical signature zircon can actually record. Looking at these rocks from another perspective is necessary.

We present major/traces elements and U–Pb/Sr isotopes in situ analyses of apatite, $Ca_5(PO_4)_3(OH,Cl,F)$ extracted from two well-characterized TTG bodies exposed in the eastern Kaapvaal craton (South Africa): Kaap Valley & Salisbury Kop. A combination of evidence suggests that these apatite crystals are igneous and are late-Paleo to early Mesoarchean in age, similar to zircon U–Pb dates. Interestingly, apatite major and trace element geochemistry shows strong analogies with that of apatite from rocks belonging to sanukitoid suites. This is interpreted as indicating the contribution of a mantle component to the source of the mid-Archean TTGs investigated here, a signal unclear at the whole rock scale.

Our results indicate that direct mantle contribution—pivotal in the production of large, long-lived and stable cratonic terrains—in mid-Archean TTGs of the eastern Kaapvaal craton is a major process. This process, so far largely unidentified, can go unseen if not using a multi-geochemical proxy approach. Cratonization of the Kaapvaal craton was therefore an active process as soon as ca. 3.2 Ga, i.e. more than 0.5 Ga before the emplacement of sanukitoid suites, the typical marker of cratonization. The contribution of a mantle component to the source of these rocks is hard to reconcile with vertical-style tectonics.