A 3.2 Ga hotspot in the Kaapvaal Craton? Evidence from high-temperature magmatism and extremely ^{18}O-depleted metamorphism

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A prevailing opinion that modern-style plate tectonics started on the Earth at ca. 3.2 Ga has supports from studies on metamorphic and magmatic rocks in the Barberton greenstone belt (BGB), Kaapvaal craton. However, our systematically petrographic and geochemical observations of a suite of middle-lower crustal rocks of the Kaapvaal Craton, i.e., charnockite, trondhjemite, metapelite, and metagabbro from the Ancient Gneiss Complex (AGC), Swaziland, argue against such an interpretation. Zircon SIMS U-Pb dating yields coeval metamorphic and magmatic ages of 3.2 Ga for these rocks. The metapelite and metagabbro record a high-T and low-P metamorphic event. Zircon grains in these rocks have extremely low $\delta^{18}O$ values (to 0.55 ‰), indicating that they crystallized within protoliths that record high-temperature hydrothermal exchange between shallow crustal material and ^{18}O-depleted meteoric fluids. The trondhjemites have low MgO, high Y and HREE contents, and negative Eu anomalies, with high zirconium saturation temperatures of 906-921 °C, indicating that they were derived from partial melting of mafic materials at high-T and low-P conditions. It is consistent with the high formation temperature (about 950°C) at low pressure (0.5 GPa) of charnockite. All these observations suggest that they were formed in a high geothermal setting analogous to that of the Yellowstone-like hotspot, not in a plate tectonic setting.