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High-grade metamorphism and crustal melting at ca. 3.2 Ga in the eastern Kaapvaal craton, southern Africa

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The Ancient Gneiss Complex (AGC) of Swaziland is a multiply deformed medium- to high-grade terrane in the eastern Kaapvaal craton and consists of 3.66-3.2 Ga granitoid gneisses and infolded greenstone remnants, metasedimentary assemblages and mafic dykes. High-strain deformation has led to structural parallelism at almost all contacts, making it virtually impossible to map different gneiss generations in the field. We report on a 3.2 Ga granulite-facies assemblage in central Swaziland (cooling path from ~800 to 600 °C at pressures between 7 and 9 kbar) and relate the occurrence of numerous ca. 3.2 Ga granitoid gneisses in the AGC to a major tectono-thermal event that not only affected the AGC but also the neighbouring Barberton granitoid-greenstone terrane. Our SHRIMP zircon ages, in combination with Hf-in-zircon and whole-rock Hf-Nd isotopic data, suggest that extensive melting of Palaeoarchaean granitoid crust, in combination with variable but relatively small additions of mantle-derived material, was responsible for the generation of the 3.2 Ga granitoid suite.

Previous models have related the 3.2 Ga event in the eastern Kaapvaal craton to subduction and collision processes [1,2] but we see no evidence for long, narrow belts and metamorphic facies changes reflecting lithospheric suture zones, and there is no unidirectional asymmetry in the thermal structure across the entire region from Swaziland to the southern Barberton granite-greenstone terrane as is typical of Phanerozoic and Proterozoic belts [3]. Instead, we envision a major underplating event at ca. 3.2 Ga, giving rise to widespread and extensive melting in the lower crust and mixing with mantle-derived under- and intraplated mafic magma to generate the voluminous granitoid assemblages now observed in the AGC and the southern Barberton terrane. This is compatible with large-scale crustal reworking during a major thermo-magmatic event, and the apparent lack of a mafic lower crust in the Kaapvaal and a sharp and flat Moho [4].

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