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The metamorphic history of Paleoarchean, Mesoarchean and Neoarchean sedimentary rocks and associated basement along the eastern and northern edge of the Kaapvaal craton: Insights into the enigmatic geodynamic processes that formed and shaped the Archean Earth.

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When plate tectonics started on Earth, as well as the form that early plate tectonic processes took, is currently the subject of considerable debate and investigation. Evidence from the Archean granite–greenstone rocks is interpreted to reflect partial convective overturn (PCO) of the crust due to gravity driven vertical tectonics [1,2], whilst others interpret similar rocks to record crustal thickening and orogenic collapse due to lateral plate movement [3]. The Archean crust exposed along the eastern and northern edge of the Kaapvaal craton includes granulite and amphibolite facies metasedimentary rocks formed across a wide range of ages: ca 3.45 Ga Theespruit formation (Barberton greenstone belt (BGB)); ca 3.24 Ga Figtree group (BGB); ca 3.00 Ga La France formation (Murchison greenstone belt); and, ca 2.73 Ga (Bandelierkop formation; South Marginal Zone, Limpopo belt) that allow their maximum age of sedimentation, their age of metamorphism and their peak pressure and temperature conditions of metamorphism to be constrained. In combination, the age constraints and the conditions of metamorphism allow the minimum rate of burial of the sediments to be determined. Each of the sedimentary successions examined has an inherited zircon age distribution that is characteristic of sediments produced during accretionary and collisional tectonics. However, minimum burial rate recorded by the Kaapvaal Archean metasediments varies between approximately 2.2 km/Ma and 0.6 km/Ma. In contrast, for Proterozoic and Phanerozoic metasediments this value varies between 1.4 and 0.5 km/Ma, and 1.0 and 0.4 km/Ma respectively. Thus, burial of Archean sediments preceding metamorphism was fast and appears to have decreased as Earth aged. The maximum burial rate in the Archean record of 10 km/Ma comes from the Pilbara greenstone belt [4]. This is proposed to be consequence of vertical tectonics [4]. However, this is at odds with the hypothesis that PCO is dependent on incubation of the mid-crust by thick volcanic successions, leading to mid-crustal partial melting and gravity driven ascent of granite domes [1].

The eastern Kaapvaal craton granite–greenstone basement caries a very strong NE–SW structural grain that continues into the SMZ. At map scale, this regional fabric is defined by the strongly elongated greenstone belt units and the rocks generally young from south to north. In the north, the approximately 860 °C and 11 kbar granulite facies metasediments of the Bandelierkop formation were deposited after 2733 ± 13 Ma and underwent peak metamorphism at 2713 ± 8 Ma [5]. By 2686 ± 7 Ma these metasediments had been thrust at least 80 km south as a nappe over the northern edge of the trondhjemite–tonalite–granodiorite basement of the Kaapvaal craton, which had not experienced metamorphic conditions above those of the amphibolite facies. The regional picture of a strong linear structural grain, sequential episodes of sedimentation, rapid sediment burial, metamorphism to

moderate to high grades and rapid exhumation of the sediments is a clear indication of growth of the Kaapvaal craton by accretionary tectonic processes on its northern margin.

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