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Thrust exhumation of the Southern Marginal Zone of the Limpopo Complex in the Neoarchaean: link of distinct high-grade shear zones with DC and IC P-T-t paths

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The Limpopo Complex is a ∼750km long E-W trending zone of predominantly granulite facies rocks situated between the Archaean Kaapvaal and Zimbabwe cratons of southern Africa. Large ductile shear zones are an integral part of the Limpopo architecture, defining the boundaries between the belt and the adjacent cratons and are interpreted to have been responsible for uplift (exhumation) of over thickened crust during the Neoarchaean [10 and references therein; 1]. The Hout River Shear Zone forms the terrane boundary between the granite-greenstone terrane of the Kaapvaal craton in the south and the high-grade Southern Marginal Zone (SMZ) of the Limpopo Complex in the north. Integrated structural, metamorphic, magmatic and age data collected over a period of more than 30 years provide convincing evidence for a Neoarchean high-grade tectono-metamorphic event that affected the SMZ in the interval ∼2.72 - 2.60 Ga [4; 5, 6; 7; 2; 8; 9; 11]. The thrust-controlled exhumation of the SMZ is demonstrated by the convergence of a retrograde P-T path in the hanging wall (SMZ) and a prograde P-T loop in the footwall (Kaapvaal Craton) of the steeply SW-verging Hout River Shear Zone [4; 5]. The coeval ages (∼2.69 Ga) of the two contrasting metamorphic histories are indicated by geochronological data [2; 3]. In addition, the establishment of a retrograde isograd and zone of rehydrated granulites in the hanging wall by hydrous CO2-rich fluids derived by dehydration of the low-grade rocks in the footwall provides another convincing link between the two contrasting metamorphic environments [10]. Distinct retrograde P-T paths [4; 6; 8] linked to distinct shear deformational events document evidence for a two-stage post-peak exhumation history of the SMZ: (i) granulites sampled far from the contact with the cool rocks of the Kaapvaal Craton are characterized by P-T paths with two distinct decompression-cooling (DC) stages (DC=>DC paths), (ii) granulites sampled close to this contact are characterized by P-T paths with an inflection that reflects near-isobaric cooling (IC) (DC=>IC paths). The early (2.69-2.664Ga) DC stage (P ∼8 kbar, T ∼825oC to P ∼6.5 kbar, T ∼750oC) of exhumation is linked to the transportation of the high-grade rocks up the steep ramp section of the Hout River Shear Zone that controlled their emplacement to upper crustal levels. The later (∼2.62-2.6Ga) near-IC stage (P ∼6.5kbar, T ∼700oC to P ∼ 5kbar, T ∼500oC) of exhumation is linked to the flat section of SW-verging thrusts that reflect the emplacement of the high-grade rocks over the cool rocks of the adjacent craton. These low-angle thrusts also account for the presence of high-grade klippen [10] located on the craton far south of the Hout River Shear Zone. Peak UHT metamorphic conditions (T > 900oC at P > 10kbar) recently reported for the SMZ [9] might have been reached at ∼2.72 Ga, as is suggested by shallow northerly verging ∼2.72Ga thrusts on the Kaapvaal Craton [3]. These thrusts, which are truncated by the steeply SW-verging ∼2.69Ga Hout River Shear Zone are probably linked to a crustal thickening event that controlled the initial burial of SMZ granulites to depths >30 km. Integrated D-P-T-t paths constructed for hanging wall granulites and footwall greenstones provide evidence in support of a tectonic model for the evolution of the SMZ (and of the Limpopo Complex as a whole) that is either linked to a crustal thickening event involving the collision in the Neoarchean of the Kaapvaal and Zimbabwe cratons [10] or to a gravitational redistribution model [1].

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