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The Donkerhuk batholith (Namibia): Evolution of and processes in a giant magma reservoir

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The Donkerhuk batholith represents a gigantic accumulation of felsic magma and thus provides insight into the processes and outcomes in at least some huge felsic magma bodies. The largely S-type batholith, which intrudes amphibolite-facies metaturbidites of the Kuiseb Formation, was emplaced at about 530 Ma, in the Southern Zone of the Damara Belt, following the collision of the Kalahari Craton with the Congo Craton (to the north) in the earliest Phanerozoic. It is a vast, elongate body, > 200 km long and 15 to 40 km wide, trending NE-SW, parallel to the Okahandja Lineament and the general structural grain of the Belt. Our current tectonic model for the Donkerhuk magmatism involves intense and prolonged crustal heating due to the opening of a slab window. Over large areas, the granitic rocks carry variably developed magmatic foliations and, in places, solid-state fabrics, underlining its syn- to late-tectonic emplacement, during northwest shortening and pure-shear-dominated transpression. The magmas were not derived through melting of the Kuiseb schists, but rather from older metasedimentary crust just a few km below emplacement level. They were added to the 'magma chamber' as thousands of separate pulses, preserved as sheets that retain their individuality, at least near the margins and roof zones. In the core of the batholith there was evidently some greater degree of thermal insulation and individual sheets are less easily identified. Thus, the 'magma reservoir' was never a large molten mass, but grew over perhaps 14 Myr, in small increments. This set of processes meant that only very local differentiation look place, that there was little or no mixing between magma batches, even in the core of the batholith where the individuality of the pulses became blurred due to a prolonged crystallisation history. As a result, the Donkerhuk rocks preserve a remarkably high degree of source-inherited elemental and isotopic heterogeneity. We suggest that great caution be applied in attempting to model petrogenetic processes (e.g. magma mixing, homogenisation, restite unmixing, crystal fractionation, wall-rock assimilation and AFC) that are perceived to operate in large felsic magma bodies derived through partial melting of pre-existing crust.