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The Marshall Rocks-Pofadder Shear Zone and other late-Namaqua dextral shear zones between Ai-Ais and Pofadder in the western Namaqualand Metamorphic Province: Fabrics, timing and late stage melt controls

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The Marshall Rocks-Pofadder Shear Zone (MRPSZ) forms one of the largest shear zones in Africa. Stretching over 500km from the Namibian west coast to Pofadder in South Africa, the MRPSZ is one of several Mesoproterozoic-Neoproterozoic NW-SE trending zones that formed during the final stages of the polyphase evolution of the western Namaqua Metamorphic Province (NMP). Deformation of the western NMP has traditionally been subdivided into four main phases [1] with the Paleoproterozoic D_1 Orange River Orogeny (ca. 1880Ma) only partly preserved in southwestern Namibia. Elsewhere, D_1 has been transposed by the intense, high grade Mesoproterozoic Namaqua Orogeny (D_2 and D_3; ~1220-1005 Ma) related to ductile deformation and thrusting tectonics. The Namaqua Orogeny concluded with the development of the MRPSZ and other large, dextral D_4 transpressional shears possibly related to late-stage lateral escape of the NMP. Recent, detailed and regional geological mapping in the area between Ai-Ais in Namibia and Pofadder in South Africa [2],[3] has been able to trace and largely characterise the fabrics of the MRPSZ and identify its spatial and temporal relationship to synchronous S-type leucogranites and pegmatites. D_4 is defined as a progressive dextral shearing event that can be subdivided into three main phases based on cross-cutting relationships, differences in fabric elements and strain regimes during the shear-zone evolution and progressive exhumation, namely D_{4a}, D_{4b} and D_{4c} [2],[3]. D_{4a} defines the initial stages of shear zone development and is characterised by ductile drag, rotation and transposition of the wall rock gneisses into parallelism with the MRPSZ. D_{4b} forms the dominant fabric within the shear core and is characterised by the progressively overwhelming development of upper-greenschist/ lower amphibolite facies, pervasively banded, brittle-ductile mylonites, cataclasites and extensive phyllonites that largely overprint evidence of the initial stages. D_{4c} is developed as narrow (<30m) discrete, ultramylonitc shear zones that cross-cut and displace earlier MRPSZ structures at shallow angles. In the Kum Kum region, the MRPSZ forms a 7 km-wide D_{4b} mylonitic core-zone with the drag of the adjacent wall rocks up to 30 km north of the shear zone. Here the shear displays an asymmetrical strain gradient across the shear, progressing from the D_{4a}-deformed northern wall rocks to a sharp D_{4b} southern margin where phyllonites are juxtaposed against only weakly deformed (D_2) wall rocks. Around Pofadder and Ai-Ais, the shear zone has a higher concentration of laterally extensive 20-50 m thick, D_{4c} truncating ultramylonites. Here strain gradients appear symmetrical across the core-zone with the effects of shearing (D_{4a}-D_{4b}) only evident in wallrocks up to 2 km away. In Ai-Ais, a single 20 km-long, 80 m-thick shear defines the MRPSZ-core and is largely reworked to a fluid-altered fault breccia. The variation in the manifestation of the D_4 fabrics along strike likely reflects an inward plunging/deepening of the shear towards its central exposure. U-Pb monazite ages from structurally controlled pegmatites within the MRPSZ suggest D_4 continued from 1005 Ma to at least 958 Ma [3]. Several other parallel shears and splays off of the MRPSZ are identified in the mapped

region which have similar in characteristics, strain regimes, orientations, geometries, kinematics and affiliation with late-stage felsic granites and pegmatites and are considered to be coeval structures formed under similar tectonic regimes.

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