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Structural analysis of the Steenkampskraal Monazite Deposit, Western Cape, South Africa

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The Steenkampskraal Mine was first established in 1952, to extract monazite for the production of thorium concentrate. Refurbishment of the historic mine area and new exploration programs for rare earth elements and thorium in recent years have resulted in re-mapping and re-evaluation of the expanded Mineralized Monazite Zone (MMZ). This contribution presents a structural review of the MMZ and its emplacement based on recent data and in the context of its setting at the southern extent of the Bushmanland Subprovince of the Namaqua-Natal Metamorphic Province. New surface and underground mapping and an updated 3D model indicates that the MMZ is a moderately-dipping vein, which intruded into gneissic host rocks that occur on the southern limb of a broad F_3 antiform. Thickness variations, both down-dip and along-strike, are the result of both D_2 and D_3 deformation.

The significant lateral variation in the thickness of the MMZ, in both E-W and N-S directions, comprises a "chocolate tablet" geometry, caused by extension and pinch-and-swell. This is accompanied by the preferential remobilization of Cu and possibly magnetite into intervening, relatively lower-strain pinch zones or boudin necks. These zones also contain a high volume of granitic host-rock, in the form of clasts and slivers, compared to the remainder of the MMZ. Such boudin necks also show pronounced Fe-staining and the development of malachite.

A systematic pattern is evident at the terminations of thicker MMZ zones. Along several footwall drives, the MMZ shows extreme thinning or attenuation, concomitant with steepening and $S_{2/3}$ development. The "variable-thickness geometry" is consistently repeated along the dip of the MMZ, which suggests that it is instrumental in the segmentation of the MMZ between levels. The volume enclosing the MMZ and the MMZ itself show structures identical to monoclinal steep structures (as described by Kisters *et al.*, 1996a, b) wherein the MMZ is steepened, sheared, and offset in a ductile manner with downthrow to the south. The pre-existing S_2 gneissic fabric and the MMZ are steepened and transposed within these zones, which show the local development of an $S_{2/3}$ fabric. The contact of the intensified, steeper gneissic or shear fabric is gradational with S_2, suggesting that it is a transposition fabric, formed by the partial rotation of S_2 into $S_{2/3}$, possibly accompanied by the local development of a new fabric (S_3). It is reasonably assumed that where one encounters a fabric and MMZ dip of 70° or greater, transposition has occurred.

Steep-structures are typical of the Okiep copper district, located approximately 150km north of Steenkampskraal. Recent geochronological data suggest that the MMZ was intruded or emplaced at 1046±7.5 Ma, at the start of the D_3 "Klondikean" episode. Consequently, the MMZ was not intruded *into* a steep structure, similar to those of the Hester Malan steep structure, the Koperberg steep structure, the Narrap Valley megabreccia, and the Klondike Central and Klondike East steep structures.

Rather, its emplacement, while still within the Klondikean, predated these steep structures, as it is cross-cut *by* steep structures.