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Syntectonic veins in the Lower Ugab Valley, southern Kaoko zone, Namibia

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The junction between two related Neoproterozoic – Cambrian Mobile belts, the Kaoko and Damara Belts lies in the lower Ugab Valley in NW Namibia. The area consists of siliciclastic and carbonates metaturbidites of Neoproterozoic age which are characterized by spectacular quartz and calcite veins, which show a complex but systematic deformation pattern regular over an area of more than 3000 km^2. These syntectonic veins are important markers of deformation since they carry information on polyphase structural evolution, shear sense and the fluid composition during deformation. A detailed structural study on the veins in the Lower Ugab domain adds important new data to our understanding of the regional evolution at the junction of the mobile belts.

The lower Ugab Domain is affected by three phases of deformations related to two main tectonic events (Passchier et al. 2002). D1 and D2 mark a continuous event of sinistral transpressional E-W shortening. D1 forms kilmometer scale N trending upright to west vergent folds accompanied by the main regional S1 slaty cleavage in axial planar position. The less conspicuous D2 phase of deformation developed coaxial open folds, mostly in the flat limb of D1 folds, and with an S2 crenulation cleavage that everywhere overprints S1 at high angle. Both D1 and D2 occurred at regional metamorphic peak conditions in greenschist facies in the biotite zone (Goscombe et al. 2004). D3 produced E-W to NE-SW trending minor folds and foliations and is associated to a late N-S shortening event. The metaturbidites are intruded by a series of plutons composed of syenite and granite. Hornblende syenite, intruded during D1/D2 in the early Cambrian and biotite granite intruded during D3 in the middle to late Cambrian.

Three main types of sytectonic veins are distinguished in the meturbidites. Type I

veins are striped bedding veins of quartz showing pre D1 top to the west bedding-parallel slip. Type II and III veins are two contemporary set of composite quartz and calcite veins occurring during the D1 deformation. Type II veins lie at small angle to the S1 slaty cleavage, slightly oblique to the D1 fold axes. They show a present constant orientation in both limbs of D1 folds dipping towards the E-SE. In the steep limbs and wherever the tip of the veins penetrated a few centimetres from metapelite into the adjacent sandstone, hook shaped folds developed, interpreted as an effect of reorientation by flexural slip during tightening of D1 folds. Type III are lensoid veins that lie approximately orthogonal to D1 folds axes and which formed by N-S extension during the D1 deformation. They are strongly deformed due to D1 - D3 shearing which produced a characteristic asymmetric shape of the boudins and flanking fold alongside the veins, defining a sinistral sense of shear in outcrop. Type II and III veins are generally restricted to the more pelitic layers in the siliciclastic formations, which is unusual for boudinage and crack formation which elsewhere usually occurs in more competent sandstone layers. The preference for metapelite may be explained by fluid overpressure, favoured by devolatilization reactions induced by the seynite intrusions. Quartz and calcite isotopic compositions indicate a mainly local origin of vein filling. The contemporaneous formation of two sets of veins, Type II and III, approximately orthogonal is explained by local inversion of stress axes $\sigma 2$ and $\sigma 3$ which were probably very similar in magnitude during vein formation.

References:

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