Abstract

The Central Zone of the Limpopo Complex displays two major structural features: the roughly east-west oriented Tshipise Straightening Zone Paleoproterozoic in age and a "Cross Folded Zone" to the north of the Straightening Zone comprising large-scale sheath and cross folds suggested to have developed during a Late- Archaean high grade tectono-metamorphic event. This study presents and discusses structural-metamorphic data showing that two closely associated folds (Ga-Tshanzi and Campbell) in the eastern part of the Cross Folded Zone near Musina, record different structural and metamorphic histories that may be applied to the evolution of the entire Central Zone of the Limpopo Complex.

The Ga-Tshanzi structure has an ovate-shaped closed outcrop pattern approximately 4km long, and 3km wide with the long axis of the fold pattern oriented in a westerly direction. The fold geometry, characterized by a central fold axis that plunges steeply to the SSW, is very similar to other closed folds in the Central Zone previously interpreted as sheath folds. The Ga-Tshanzi fold deforms rocks of the Beit Bridge Complex (calc-silicate, metaquartzite, metapelite and magnetite quartzite and quartzofeldspathic Singelele Gneiss), and members of the Messina Layered Suite. The ovate structure is characterised by a gneissic fabric comprising peak metamorphic mineral assemblages. This regional gneissic fabric that occurs throughout the Central Zone also defines the shape of the neighbouring Campbell fold. Mineral lineations and fold hinges in the Ga-Tshanzi fold mainly present within metaquartzites and calc-silicates, plunge steeply to the southwest, parallel to its central fold axis indicating a NNE-SSW transport direction during fold formation. A decompression-cooling P-T path calculated for metapelitic gneisses from the Ga-Tshanzi fold shows that the closed fold developed under high-grade, deep crustal conditions. Peak P-T conditions of 7.5kbar/799ºC were followed by decompression and cooling down to 5.23kbar/605ºC. Water activity during this event was low, ranging from 0.122 at peak conditions, and decreasing to 0.037 at the minimum calculated conditions. The Ga-Tshanzi closed fold and the closely associated Campbell cross fold were thus formed at deep crustal levels and partially exhumed along a similar decompression-cooling P-T path to mid-crustal levels during the early orogenic event.

The Campbell fold, described as a cross fold in the literature, is approximately 15km long and has a V shaped outcrop pattern that tapers from 12km in the southeast to 2 km in the northwest. This fold is developed in lithologies similar to those of the Ga-Tshanzi fold as well as in Sand River Gneisses. It has a near isoclinal fold geometry with both limbs dipping towards the southwest and a fold axis that plunges moderately to the west-southwest. This fold, that is interpreted to have developed during the same deformational event as the Ga-Tshansi structure has, however, subsequently been affected at mid- to upper crustal levels by shear movement along the Tshipise Straightening Zone displaying widespread development of younger planar and linear structural features. Planar features include north-south-trending high temperature shear zones that crosscut the regional fabric and flexural slip planes particularly evident in quartzites. Linear features from the Campbell fold that are mainly developed in younger shear and flexural slip planes, indicate, in contrast to the Ga-Tshanzi fold, an ENE-WSW directed crustal movement that is in accordance with the sense of movement suggested for the Tshipise Straightening Zone. The calculated decompression-cooling P-T path for sheared metapelitic gneisses from discrete high temperature shear zones deforming rocks of the Campbell cross fold shows that this superimposed shear deformational event occurred under peak P-T conditions of 4.98kbar/681ºC, followed by decompression and cooling down to 3.61kbar/585ºC. Water activity during this shear event was high, ranging from 0.217 at peak conditions and decreases to 0.117 at minimum calculated conditions.

Structural and metamorphic data for the two folded areas thus indicate two distinct tectono-metamorphic events: (i) a late Archaean peak metamorphic and deformational event responsible for the formation of the Ga-Tshanzi fold, and similar folds throughout the Central Zone including the Campbell cross fold that was accompanied by steep NNE-SSW transport of crustal material, and (ii) a shear deformational event linked to the Paleoproterozoic Tshipise Straightening Zone that partially obliterated the early structural and metamorphic history of the Campbell fold during mid to upper crustal conditions during relatively shallow ENE-WSW directed movement of crustal material. The fact that this superimposed event had no apparent metamorphic effect on the studied metapelitic rocks of the closely associated Ga-Tshanzi closed fold, suggests that shearing was constrained to discrete north-south orientated zones.