

# **An integrated titanite U-Pb and trace element study of sub-solidus veining, Limpopo Belt, South Africa**

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The Central Zone (CZ) of the Limpopo Belt underwent granulite-facies metamorphism at ~ 2.7-2.5 Ga ~2.03-2.01 Ga. The latter was associated with the development of major ENE-WSW-trending, sub-vertical high-strain zones. During this event, the CZ stayed above the wet solidus until as late as ~2.006 Ga, based on U-Pb zircon ages from late melt patches and pegmatites. High-grade metabasites from the eastern CZ occur on the margin of one such high-strain zone, and are partially reoriented into it. They are locally cut by discordant, patch-like pegmatites and associated with quartz vein stockworks. The latter are surrounded by alteration halos rich in either diopside+titanite or tremolite+ titanite. Alteration of the metabasites is related to exsolution of fluid from crystallisation of the pegmatites, at or below the wet solidus, and thus represents a critical time marker. MC-ICP-MS dating of titanite from the alteration zones yields a weighted mean <sup>207</sup>Pb/<sup>206</sup>Pb age of 2029±2 Ma i.e. the same age as is recorded by monazite and zircon in granulite-facies assemblages elsewhere in the CZ and ~20 Ma older than the youngest pegmatites/melt patches. This suggests either that the titanite in the alteration zones is inherited from the metabasite, or that the rocks at this locality were at sub-solidus temperatures at the same time that CZ rocks elsewhere were at granulite grade. Several lines of evidence suggests that titanite formed as part of the alteration assemblage: 1) it contains inclusions of diopside identical in composition to that in the alteration zones, but distinct from that in the metabasite; 2) it is apparently absent in the host metabasite; 3) empirical trace element partitioning suggests that titanite in the alteration zones is in REE equilibrium with diopside in the alteration zone. This suggests that the titanite age dates sub-solidus veining, that the CZ cooled differentially across the wet solidus, and that reworking in the ENE-WSE high strain zones began before ~2.03 Ga