Granulite-facies metamorphic events in the northwestern Ubendian Belt of Tanzania: Implications for the Neoarchean to Paleoproterozoic crustal evolution

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Abstract

We present a geological evolution model for the Paleoproterozoic Ubendian Belt. This model is deduced from the metamorphic histories of metasediments and metamafites combined with previously obtained crust formation and metamorphic ages obtained from different rock types of the Katuma Block in the NW Ubendian Belt.

Geothermobarometry and pseudosection modelling of metabasites indicate that the granulite-facies coronas containing garnet–clinopyroxene–quartz–hornblende formed at about 8.9–6.6 kbar and 790–700 °C. The formation of the corona textures is attributed to the post magmatic cooling history in the deep crust following their intrusion at about 2.65 Ga. This period correlates with the age of deposition of sediments in the Katuma Block, as deduced from the age of detrital zircon grains. The metamorphic P–T path of these sediments contrasts with that of the Archean mafic rocks. The common occurrence of sillimanite pseudomorphs after cm-sized kyanite crystals in migmatitic metapelites provides evidence that an early stage of metamorphism took place in the kyanite stability field whereas the subsequent peak metamorphism was characterised by the stability of the mineral assemblage sillimanite-garnet/cordierite-K-feldspar. Modelling of the X_{Mg}ratios of compositionally homogenous cores of garnet porphyroblasts together with GASP barometry suggest peak P-T conditions of about 7 kbar and 770 °C. The formation of plagioclase coronas around garnet in metapelites, the decrease in X_{Mg} and an increase of the spessartine fraction in rims of garnet porphyroblasts point to a near isothermal uplift after peak metamorphism.

Texturally controlled in situ U–Th–total Pb microprobe dating of monazite in metapelites resulted in two ages for metamorphic events. The monazite of the two dated samples is mostly complex and patchy zoned. The cores record ages of 1957 ± 10 Ma and 1967 ± 16 Ma, whereas the rims give ages of 1837 ± 6 Ma and 1848 ± 16 Ma. As the two ages of monazite growth zones (core and rims) are found in monazite of the rock matrix and in monazite inclusions of garnet porphyroblasts, we conclude that garnet growth occurred during or after the second metamorphic event at 1840 Ma. This interpretation is in agreement with the depletion of HREE and Y in the monazite rims. We correlate the second, high-grade event with the collisional stage between the Tanzania Craton and the Bangweulu Block. The first event that preceded the collision for about 120 Ma is attributed to the kyanite grade metamorphism during accretionary

processes and associated calc-alkaline magmatism along the continental margin of the Tanzania Craton.

Combining our new data with those of previous studies on the geochemistry and zircon geochronology we develop a new evolutionary model for the Paleoproterozoic orogenic cycle. The geologic history in the Ubendian Belt began in the Neoarchean (2.7–2.6 Ga) with a magmatic crust formation phase in an active continental margin setting. In the following Neoarchean–Paleoproterozoic (2.65–2.05 Ga) stage of a tectonically inactive, passive continental margin the protoliths of metabasites cooled under near-isobaric conditions and sediments were deposited on the Neoarchean crust. Subsequently, there was a protracted period of subduction (2.05–1.84 Ga) at an active continental margin, which was associated with magmatic additions and metamorphic events during tectonic accretions, that led to kyanite-grade metamorphism in wedge sediments. The final collision at 1.84 Ga leading to garnet–sillimanite–cordierite grade metamorphism in metapelites most likely was responsible for the exhumation of the 1880–1860 Ma MORB-type eclogites in the Ubendian Belt.

Keywords

Monazite dating;
Granulite facies metamorphism;
Paleoproterozoic evolution model;
Ubendian Belt