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Metamorphic evolution of metapelites of the Gyani greenstone belt, South Africa

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The Limpopo granulite complex (South Africa) is a seminal example of the Neoarchean fold belt, which was formed at ~2.72 Ga between two Paleoarchean cratons, i.e. Northern Kaapvaal and Zimbabwe. The Southern Marginal Zone of the Limpopo complex is overthrusted onto the Kaapvaal craton along the Hout River Shear Zone (HRSZ). Along this shear zone, granulites of the SMZ were exhumed over the greenstone belts of the craton, which were concomitantly buried under the granulite nappe and progressively metamorphosed up to amphibolite-facies conditions (Perchuk et al., 1996; van Reenen et al., 2011). In order to demonstrate variability of P-T conditions, which were attained in the craton rocks during this "hot iron" metamorphism, we systematically studied metamorphic evolution of various metapelites from the Gyani greenstone belt, which is located at the immediate contact with the SMZ of the Limpopo complex.

The studied rocks represent a series of garnet and/or staurolite-bearing two-mica schists of different Mg-number and variously saturated with alumina (kyanite-bearing or kyanite-free). Usually, these schists contain abundant ilmenite and apatite. Based on structural features and mineral composition, garnet-bearing two-mica schists show three paragenesis of muscovite, biotite and garnet, which correspond to consequent kinematic stages of metamorphism. Garnet porphyroblasts in some samples show a "saddle-shaped" zoning reflecting both prograde and retrograde stages. These stages are also reflected in regular variations of X_{Mg} and the TiO_2 content in biotite, as well as celadonite and paragonite contents of white mica. Syn-kinematic to peak-metamorphic stages in these samples are reflected in compositions of cores of garnet porphyroblasts with oriented inclusions and micas forming schistosity of the rocks, while post-kinematic retrograde stage is recorded in compositions of sub-euhedral garnet peripheral zones and micas truncating schistosity. However, some samples did not recorded evidence for the prograde evolution showing. Their garnets show "bell-shaped" zoning corresponding to the metamorphic peak and the retrograde evolution only.

Using both conventional thermobarometry and pseudosection approach (PERPLE_X) we have estimated peak metamorphic conditions for the studied samples of metapelites. Samples of garnet-bearing two-mica schists with the "saddle-shaped" zoned garnets allowed reconstruction of clock-wise prograde-retrograde P-T loops, which reflects a burial of the rocks and their subsequent exhumation along the HRSZ, i.e. the contact with the granulites complex (Perchuk et al., 1996; van Reenen et al., 2011). All samples show close peak temperatures 520-550°C. However, estimated pressures are clustered around two ranges, 5.0-5.5 kbar and 6.0-6.5 kbar.

That means that the studied metapelites belonged to rock blocks, which were buried on different depths (i.e 15-16 km and 18-19 km, respectively) under granulites. We assume that these blocks were, probably, initially situated on different crustal depths within the greenstone belt. In spite of different depths of the metamorphic peak, the rocks were influenced by a single heat source, which was hot granulites, and were heated to nearly equal temperatures.

References

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