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Determination of thermal conditions during deformation of a partially molten crust using TitaniQ geothermometer: an example from the anatectic domain from Araçuaí belt (East Brazil)

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The Araçuaí neoproterozoic belt of southeast Brazil comprises a huge anatectic unit (300 x100km) that represent a pervasively molten middle crust. Most studies performed in this orogenic segment, and especially in its eastern anatectic domain, focused on the characterization of magmatic episodes and strain distribution. Constrains on the thermal conditions prevailing during the deformation and partial melting remain few. The Araçuaí belt was formed during the amalgamation of West Gondwana by the collision of the São Francisco and Congo cratons during the Neoproterozoic. Metamorphism and widespread partial melting occured associated to the regional deformation. The anatectic unit comprises a variety of migmatites and aluminous granites resulting from partial melting of kinzigitic and granulitic metasediments. Anatexites are composed by K-feldspar, quartz, plagioclase, biotite, garnet, cordierite, sillimanite, ilmenite and rutile. Granulites in addition contain orthopyroxene, ±hornblende and magnetite. Migmatitic structures such as stromatic, nebulitic and schileren leucossomes, rich in garnet and feldspars, are often observed. Migmatitic kinzigite also display a marked gneissic banding, which is characterized by alternating felsic and mafic layers. Structural mapping combined with microstructural observations revealed a complex strain distribution, which was interpreted as resulting from strain partitionning due to variable contributions of gravitional force and tectonic stress.

Considering the lack of metamorphic assemblages in migmatites suitable for P-T estimates, we applied the TitaniQ thermometer to interstitial quartz grains. This method is rather simple to use since it requires analysis of only one phase (quartz). Our main aim is to constrain the thermal conditions prevailing during the deformation. In addition, for comparison, we carried out a conventional thermobarometric study on kinzigite. The average Ti concentration in quartz from the anatexites is ∼129 ppm and ∼136 ppm in migmatitic kinzigite. The calculated crystallization temperatures are in the range 700-850 oC. Anatexites display two significant temperature peaks between >750 and 850 oC. Considering the homogeneity of composition of analyzed quartz grains, these temperatures are regarded as close to the temperature prevailing in the anatexites when quartz crystallized. Migmatitic kinzigite show a main peak ranging >750 - 800 oC. From P-T estimates obtained using the garnet-biotite geothermometer, we suggest that migmatitic kinzigite underwent a metamorphic peak at T = 700 - 840oC and P = 650 - 700 MPa, then, probably, a retrogressive stage to T = 550 - 650 oC and P = 350 – 450 MPa. The peak temperatures determine with the Gt-Bt geothermometer are very close to those obtained with TitaniQ (T ∼ 700 - 850 oC). This supports that TitaniQ temperature estimates in migmatitic rocks are reliable. A better estimate of the synkinematic temperatures in the anatexites allowed us to better constrain the proportion of melt and the viscosity of this partially molten middle crust during the deformation.