Geophysical Research Abstracts
Vol. 16, EGU2014-6228, 2014
EGU General Assembly 2014

Metamorphic record and Thermo-mechanical modelling of lower crust exhumation during the Palaeoproterozoic Eburnean orogeny, West African Craton

Muriel Gerbault (1), Jerome Ganne (2), and Sylvain Block (2)

(1) GEOAZUR IRD, Geoazur, UNS-IRD-CNRS, France, Sophia-Antipolis, France, (2) Laboratoire Geosciences Environnement, Toulouse, France

A thermo-mechanical interpretation of the metamorphic evolution of moderate- to high-pressure volcano-sedimentary rocks (6-8 to >10 Kb) in the Birimian Province (2.2-2.0 Ga) of the West African Craton is explored in terms of burial and exhumation processes. Metamorphic data collected in Burkina Faso, southwest Ghana and eastern Senegal suggest that during the Eburnean orogeny (∼2.1 Ga),this Palaeoproterozoic Birimian crust was dominated by moderate apparent geothermal gradients of 20-30°C/km (M2a), that produced greenschist- to amphibolite-facies metamorphic assemblages associated with regional shortening and granitoid intrusions. The M2a gradient is superimposed on a colder thermal regime (M1 : <10-15 °C/km) that produced high-P greenschist- to blueschist-facies metamorphic assemblages, and which most likely recorded the earlier formation of the protolith. The geodynamical origin of M1 is not directly addressed here. Thermo-mechanical two-dimensional numerical models were built in order to test whether late-stage compressional tectonics could generate the exhumation of meta-sediments, collected in Ca0-poor granitoids and which record elevated metamorphic pressures (P> 6-8 Kb). The poor data quality provide limited constraints on the appropriate initial setup conditions, and a number of tests have led us to conceptualize the spatial distribution of a hypothezised succession of volcanic island arcs emplaced on top of CaO rich TTG (Tonalite- Trondjhemite-Granodiorite suites) basement, tectonically paired with sedimentary basins. We postulated therefore the preexistence of wide (about 250 km) and thick flexural sedimentary basins (depth 15 km) in an orogenic mafic crust (about 20 km thick), underplated by a more felsic and lighter layer representing a TTG melange. The numerical results show that a mechanism of burial, heating and exhumation of meta-sediments can occur by simultaneous folding and gravitational instabilities within the broad extent of the basin, provided the conversion rate is slow enough, and the basin is weak and thick enough. At around 25 km depth and after about 30 Myrs of compression at a rate of 5mm/yr, the TTG layer has deepened enough to reach appropriate PT conditions for melting. The buoyant and low-viscosity partially molten material (comprising a fraction of CaO-poor melt and residual material) then ascends through the overlying sediments, and entrains upwards lower crustal material as well as the surrounding sediments up, to about 10 km depth, and over the ∼200 km width of the basin. This scenario explains the important breaks in metamorphic conditions observed in the Birimian province between the thin slivers (< 2 km thick) of high-pressure rocks (P> 8 Kb) preserved in the thermal aureoles of granites, and the adjacent greenstones synforms, which consist of low-grade metasediments (P< 6 Kb; T< 450°C). This scenario is consistent with a significant recycling of the TTGs in the genesis of CaO-poor granitoid melts. Although we cannot model the subsequent evolution, we propose that further exhumation to the surface occurred by transcurrent motion. In the discussion about the implications of our results on the tectono-metamorphic and mechanical evolution of Palaeoproterozoic orogenies, the question rises as to whether an external change in far-field boundary motion or increasing internal driving forces triggered this transcurrent motion, that ended the Eburnean orogeny.