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A thermo-mechanical numerical scenario aiming at reproducing the metamorphic record of high-P rocks in the Palaeoproterozoic Eburnean orogeny.

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We test a scenario of the evolution of the Palaeoproterozoic Eburnean event characterising the Birimian Province (2.2-2.0 Ga, Western African Craton). A compilation of field data and petrological modeling indicates that an early thermal regime (M1, <10-15°/km) would have produced high-P greenschist to blueschist metamorphism assemblages, that most likely originated in thick sedimentary basins (depth>=20 km), and which would have formed above an original Birimian oceanic crust (possibly preaccreted forearc-backarcs systems). These assemblages record elevated pressures (P> 6-8 Kb) and are found in the thermal aureoles of CaO-poor granitoids. A second warmer, dominant geothermal gradient M2a (20-30°C/km) is found superimposed on M1, associated to greenschist-amphibolite metamorphic assemblages of moderate- to high-pressure rocks. We suggest that these rocks underwent exhumation processes in close association with continued regional shortening and granitoid intrusions.

A thermo-mechanical model is proposed here for the Birimian crust, in which we choose an initial setting of oceanic arc resistant layer underlain by a layer of buoyant granitoids (CaO-rich TTGs). At the center of the model, this layer is itself overlain by a tectonically paired, mechanically weak basin several hundreds of kilometers wide (forearc-backarc system ?). Under applied compression, the model reproduces a mechanism of burial and distributed large-scale folding of this juvenile crust. As the oceanic arc and TTGs layers fold below the overlying hydrated sediments, their hinges deepen and they reach appropriate PT conditions to start melting and transform into a dominantly buoyant (CaO-poor) melt product, of lower viscosity and density (by ∼5%). This newly formed material ascends and migrate laterally towards the upper parts of the buckle folds, and then pursues its ascension through the weak overlying sediments, within about 50 Myrs. This spatially periodical and "diapiric" mode of exhumation is capable to entrain preserved lower crustal material as well as re-heated sediments, upwards to about 10-15 km depth. A significant recycling of TTGs in the genesis of CaO-poor granitoid melts is thus expected. We suggest that final exhumation through the upper crust would have been completed by independent or subsequent transcurrent strike-slip zones along the mechanically weakened thermal aureoles of these granitoids.

This scenario of exhumation significantly depends on initial layers thicknesses, viscosity and density contrasts, as well as on the timing of compression. These effects were numerically tested.