EGU22-4048
https://doi.org/10.5194/egusphere-egu22-4048
EGU General Assembly 2022

Convection and segregation in partially molten orogenic crust: application to the formation of Naxos migmatite domes (Greece)

Olivier Vanderhaeghe, Aurélie Louis-Napoléon, **Muriel Gerbault**, Thomas Bonometti, Roland Martin, and Nathan Maury
GET, Université Paul Sabatier, Toulouse 3, France (olivier.vanderhaeghe@get.omp.eu)

The deep roots of the Archaean to Phanerozoic continental crust reveal domed structures of kilometer to deca-kilometer sizes. These domes are typically cored by migmatites, which attest of the dynamics of the partially molten crust and associated heterogeneous mass redistribution. We model here numerically the development of gravity instabilities in a continental crust heated from below with no lateral motion, simulating the conditions prevailing at the transition between orogenic climax and collapse. The chemical and physical heterogeneity of the crust is represented by deformable inclusions of distinct viscosity and density with power-law temperature and strain-rate dependent viscosities. We use the VOF Method (Volume Of Fluid, OpenFoam code) that reproduces well the coalescence and separation of inclusions, of sizes of a few hundred meters.

In previous work (Louis-Napoleon et al., GJI, 2021) we identified three distinct flow regimes depending on two Rayleigh numbers Ra_{UM} and Ra_{PM}, which characterize the solid and molten domains, respectively. A"suspension" regime (high Ra_{UM} and $Ra_{PM)}$ describes the entrainment of the inclusons in the convective cells. A “stratification” regime (low Ra_{UM} and high Ra_{PM}) characterizes how the light inclusions amalgamate as floating clusters under the rigid upper crust, which can then form kilometer scale dome structures. A “diapirism” regime corresponds to the segregation of the heavy and light inclusions to to form layers at the bottom and top of the molten layer, respectively.

The present study incorporates 3D models that evidence the key role of the size and concentration of the inclusions for the “stratification” regime, and pinpoint the fundamental characteristics of Earth’s rocks heterogeneity at the crustal scale.

Application of our results to the kilometer-scale subdomes within the crustal-scale migmatite dome exposed on Naxos Island (Greece) probe basal heating for 5-10 Ma, below a 45 km thick crust. There, several cycles of zircon precipitation dated from 24 to 16 Ma have been interpreted in terms of convective motion (Vanderhaeghe et al., 2018). Three distinct configurations validate this scenario in which the viscosity and density distributions, and the basal heating time were varied. All configurations also lead to the final formation and preservation of domes cored by the low-viscosity-density material of a diameter of 2 to 5 km, at a depth of ca. 15 km. These results show that the efficiency of material redistribution within a partially molten crust depends on the flow regime associated to the development of gravitational instabilites and is very sensitive to the

physical heterogeneity of the crust.