Geophysical Research Abstracts
Vol. 12, EGU2010-5261, 2010
EGU General Assembly 2010

Numerical modelling of lithospheric extension: doming vs. thermal condition

Filippo Luca Schenker (1), Taras Gerya (2), Boris Kaus (2), and Jean-Pierre Burg (1)

(1) ETH Zurich, Geological Institute, Earth Science, Zurich, Switzerland (filippo.schenker@erdw.ethz.ch), (2) ETH Zurich, Institute of Geophysics, Earth Science, Zurich, Switzerland

Structural aspects of extensional doming have been modelled numerically using simplified 2D visco-plastic models (e.g. Huismans et al. 2005, Buiter et al. 2008) concentrating mainly on symmetric/asymmetric doming, fault tectonics and deformation of domes and surrounding rocks. Recent works focus their attention to the influence of geotherms on the rheology (Tirel et al. 2008), even taking into account melting (Rey et al., 2009). However, thermal aspects remain difficult to compute because of the coupled interaction between mechanical forces and temperature. This coupling is fundamental, because it provides a link between modelling and thermochronometry. Indeed, cooling ages of extensional dome flanks can constrain time, size, and patterns of metamorphic overprints simulated in thermo-mechanical models. We treat mechanical and thermal aspects together (including modelling of metamorphic P-T-time paths of crustal rocks), using a visco-elasto-plastic rheology in a four layer setup (upper crust, lower crust, lithospheric mantle and asthenospheric mantle). The asthenospheric mantle is considered in order to predict the bending effect of the lithosphere. We employed I2ELVIS, a numerical 2D computer code designed for conservative finite differences method. The model domain is 300 km wide and 160 km deep.

We observed two modes of dome development and geometry, depending on first order parameters such as temperature at the Moho and thickness of the crust: (i) Lower crustal doming: with a hot Moho (TMOHO > 700 °C) and/or a thick crust, strain is localized in the upper crust and distributed in the mantle. At these conditions partial melting in the lower crust forms the core of the dome and maintains a flat Moho. (ii) Asthenospheric-triggered doming: with a cold Moho (TMOHO < 700 °C), strain is distributed in the crust and localized in the lithospheric mantle, which allows upwelling of the asthenosphere. The migmatite "core complexes" develop after the upwelling of the asthenosphere. Low geotherms have the tendency to produce asymmetric domes.

Changes in second order parameters such as extension rate and elastic rebound influence the size and the timing of doming. Furthermore, using strain softening, we are able to produce an asymmetric doming without prescribing any kind of weak zone. In fact, the elastic rebound of the lithosphere is crucial in enhancing the dome asymmetry. Our new thermomechanical model can in particular explain existence of crustal extension regions characterised by flat Moho topography.

REFERENCES

Buiter S. J. H., Huismans R. S. & Beaumont C. 2008: Dissipation analysis as a guide to mode selection during crustal extension and implications for the styles of sedimentary basins, Journal of Geophysical Research, 113, B06406.

Huismans R. S., Buiter S. J. H. & Beaumont C. 2005: Effect of plastic-viscous layering and strain softening on mode selection during lithospheric extension. Journal of Geophysical Research, 110, B02406.

Rey P. F., Teyssier C. & Whitney D. L. 2009: Extension rates, crustal melting, and core complex dynamics. Geology, 37, 391-394.

Tirel C., Brun J.-P. & Burov E. 2009: Dynamics and structural development of metamorphic core complexes. Journal of Geophysical Research, 113, B04403.