Interference of Different Subduction/Collisional Systems in Mediterranean orogens

Liviu Matenco, Katharina Vogt and Ernst Willingshofer
Faculty of Geosciences, University of Utrecht, The Netherlands

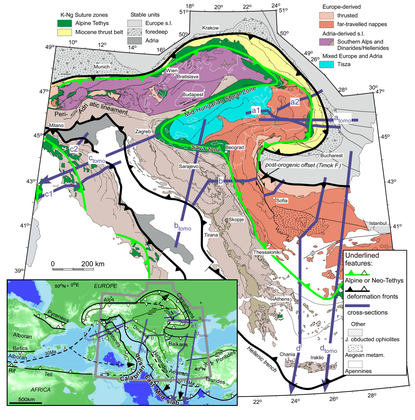
Universiteit Utrecht

Faculty of Geosciences

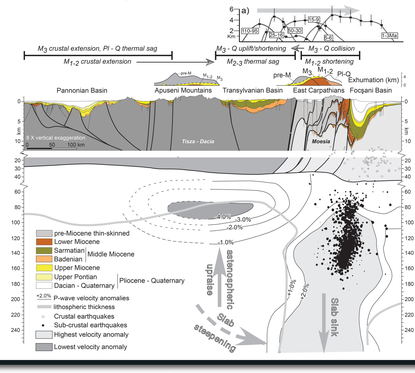
RATIONALE

INTRODUCTION

Collisional orogenic mechanics in slab retreating systems assumes the coeval evolution of continental accretion in forelands and extensional back-arcs in hinterlands. During convergence of major tectonic plates, a number of rather local roll-back systems may develop on a spatially restricted area, inferring the possibility of foreland accretion and back-arc extension driven by different slabs interacting in the same area. We aim to investigate this interaction in the case of the many instances of rapid roll-back subductions that dominated the recent evolution of the Mediterranean orogenic systems.



A typical evolution, such as the one of the Carpathians below, indicate that the shortening has gradually duplicated crustal blocks from the lower continental plate and shifted the subduction zone far towards the foreland without any significant formation of retro-wedges. This results in a gradual migration of contractional exhumation in a foreland-ward direction, which is opposite to the commonly assumed double-vergent collisional wedges.

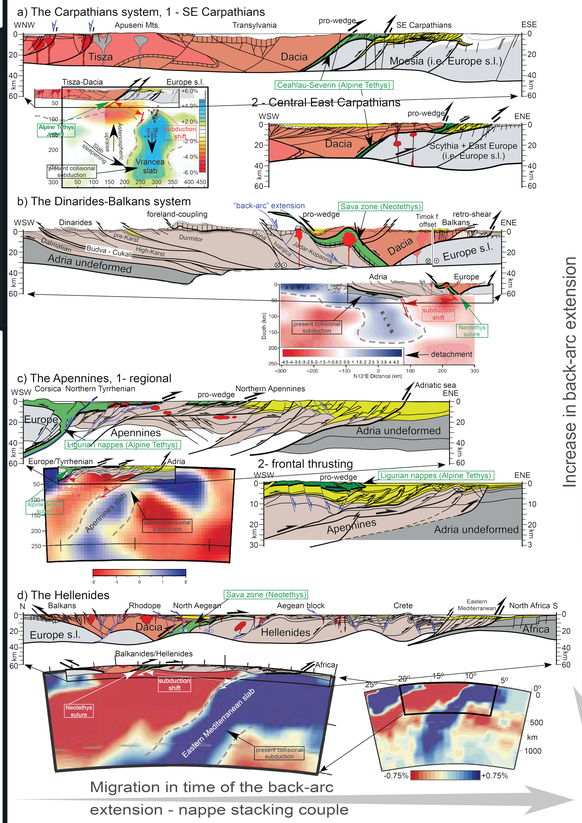


NATURAL SCENARIOS

OBSERVATIONS

The extension may take place far at the interior of the upper plate, as is the case in various segments of the Carpathians, but in most cases of the Dinarides, Apennines or Hellenides it take place superposed or far into the foreland when compared with the position of oceanic suture zones. In all the systems, extension in the back-arc and frontal accretion migrate gradually towards the foreland, coeval with the slab retreat. The amount of extension is proportional with the amount of retreat and the amount of crust accreted from the lower plate.

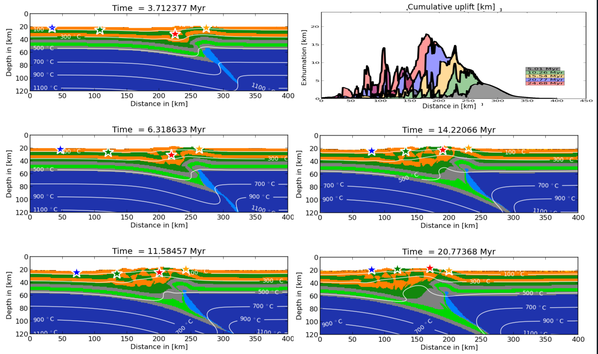
These observations infer a different mechanical behavior of orogens affected by slab retreat during collision: crustal accretion by the migration of deformation and exhumation



MODELLING

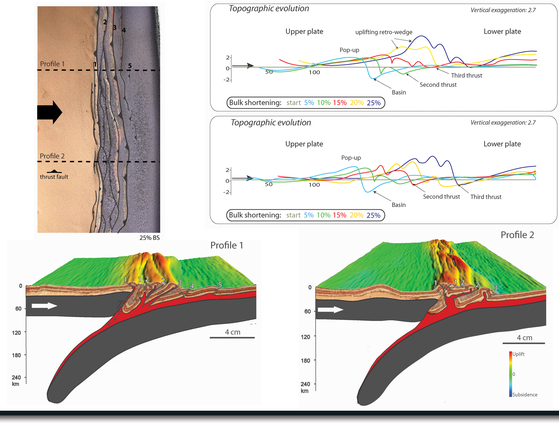
NUMERICAL

Numerical model of collision demonstrating the concept of foreland propagation of crustal scale accretion and associated exhumation. The model contains a 2 layer crust (upper 20km wet quartzite, and 15 km plagioclase). The model assumes a thermal gradient of 25C/km for the first 10km and subsequently 10C/km until the base of lithosphere at 118 km. The shortening in the model is 1cm/year, an erosion rate of 9mm/year and as sedimentation rate of 0.9 mm/yr.



ANALOGUE

Analogue model of collision demonstrating the concept of foreland propagation of crustal scale accretion and associated exhumation. The lithospheric model contains a 2 layer crust that is rheologically coupled in the upper plate and decoupled in the lower plate. The model records up to 25% bulk shortening (~300km).

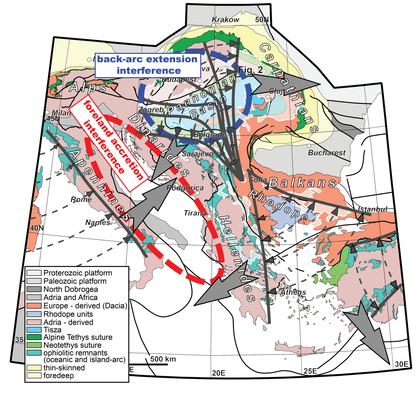


CONCLUSIONS

INFERENCES

Observations in a number of Central Mediterranean orogenic areas combined with coupled analogue and numerical modelling provide a number of important inferences:

- The internal geometries and the behavior of the mantle lithosphere of Mediterranean-type orogens depend on the strength and the degree of rheological coupling between various lithospheric layers;
- During collision, these orogens evolve by gradual accretion of crustal material from the lower plate and gradual migration of shortening, exhumation and back-arc extension. No orogenic retro-wedges are required in such orogenic evolution;
- The gradual shift is driven by the main retreat of the subduction zone. The accreted lower crustal block will connect with the main subduction zone and may actively delaminate the lithospheric mantle;
- Due to rapid coeval evolution in a restricted area during Africa-Europe convergence, the retreat of different slabs induced similar effects in the same area. The back-arc extension of the Pannonian Basin resulted from slab retreat in both the Carpathians and Dinarides, while foreland crustal accretion and associated exhumation interacted in the Adriatic foreland during the final stages of convergence of both the Dinarides and the Apennines.



References

Matenco, L., Krézsek, C., Merten, S., Schmid, S., Cloetingh, S., Andriessen, P., 2010. Characteristics of collisional orogens with low topographic build-up: an example from the Carpathians. Terra Nova 22, 155-165.

Matenco, L., Radivojević, D., 2012. On the formation and evolution of the Pannonian Basin: Constraints derived from the structure of the junction area between the Carpathians and Dinarides. Tectonics 31, TC6007.

Vogt, K., Matenco, L.C., Gerya, T., Cloetingh, S., 2014. Mechanisms of doubly-vergent vs. single-sided orogens: insights from numerical modelling, AGU Fall meeting, T13A-4623.

Willingshofer, E., Vogt, K., Sokoutis, D., Matenco, L.C, 2014, Formation of Retro-Wedges during Collision: Insights from Analog and Numerical Modeling, AGU Fall Meeting, T13A-4612.