Apatite fission-track central ages and modelling combined with zircon central ages, together with local structural observations, constrain the subsequent exhumation history of the magmatic rocks. They indicate rapid cooling from above 300 to ca. 80 °C between 16 and 10 Ma for both age groups, caused by extensional exhumation of the plutons that are located in the footwall of core-complexes (D4). Miocene magmatism and core-complex formation thus affected not only the Pannonian basin but also a part of the mountainous areas of the internal Dinarides.

For the geodynamical setting of the Balkan Peninsula we propose, based on new Hf isotope analyses and the discussion of an extensive set of age data from the literature, that Late Eocene to Oligocene magmatism, which affects the Adria-derived lower plate units of the internal Dinarides, was caused by delamination of the Adriatic mantle from the overlying crust, associated with post-collisional convergence that propagated outward into the external Dinarides. Miocene magmatism, on the other hand, is associated with core-complex formation along the southern margin of the Pannonian basin, probably associated with the W-directed subduction of the European lithosphere beneath the Carpathians and interfering with ongoing Dinaridic–Hellenic back-arc extension.

P-T-time paths associated with extensional doming: constraints from thermomechanical numerical models

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Extensional doming in continental environment has been studied numerically using 2D visco-plastic codes yielding good results on prediction of large-scale structures such as symmetric or asymmetric domes, fault tectonics and deformation of domes and surrounding rocks. However, the thermal evolution of extensional domes remains difficult to compute because of the coupled interaction between mechanical forces and temperature. This coupling is fundamental, because it provides a link between modelling on one side and thermobarometry and thermochronology on the other side. In effect, P-T-time evolution of exhumed rocks of an extensional dome 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). 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.

Two modes of dome development and geometry were obtained depending on first order parameters such as initial temperature at the Moho and initial thickness of the continental crust: (i) Lower crustal doming: with a hot Moho (T_{MOHO} > 700 °C) 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. The migmatites are exhumed in the footwall of a high-angle detachment that progressively rotates with ongoing extension to form a low-angle detachment bounding a migmatitic “core complex”. The P-T-time path of these migmatites is characterized by a one-stage decompressional cooling. (ii) Asthenospheric-triggered doming: with a cold Moho (T_{MOHO} < 700 °C), strain is distributed in the crust and localized in the lithospheric mantle, which allows upwelling of the asthenosphere. The low angle detachment migmatite “core complex” develops after the asthenosphere upwelling. The migmatites show a two-stage P-T-time path with isobaric heating followed by decompressional cooling. Thus, different thermal regimes produce similar structural patterns that have quite different geodynamic evolutions. Topography of the Moho and P-T-time paths of the footwall rocks are therefore key tools to discriminate at which initial thermal condition the migmatite “core complexes” developed.