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Geospeedometry in the inverted metamorphic gradient of the Nestos Thrust Zone in central Rhodope (Northern Greece)

Stefania Cioldi (1), Evangelos Moulas (2), and Jean-Pierre Burg (1)

(1) Geological Institute, ETH Zurich, Sonneggstrasse 5, 8092 Zurich, Switzerland (stefania.cioldi@erdw.ethz.ch), (2) Institute of Geochemistry and Petrology, ETH Zurich, Clausiusstrasse 25, 8092 Zurich, Switzerland

Thrust tectonics and inverted metamorphic gradients are major consequences of large and likely fast movements of crustal segments in compressional environments. The purpose of this study is to investigate the tectonic setting and the timescale of inverted metamorphic zonations related to crustal-scale thrusting. The aim is to contribute understanding the link between mechanical and thermal evolution of major thrust zones and to clarify the nature and the origin of orogenic heat. The Rhodope metamorphic complex (Northern Greece) is interpreted as a part of the Alpine-Himalaya orogenic belt and represents a collisional system with an association of both large-scale thrusting and pervasive exhumation tectonics. The Nestos Shear Zone overprints the suture boundary with a NNE-dipping pile of schists displaying inverted isograds. The inverted metamorphic zones start from chlorite-muscovite grade at the bottom and reach kyanite-sillimanite grades with migmatites in the upper structural levels.

In order to reconstruct the thermo-tectonic evolution of inverted metamorphic zonation, reliable geochronological data are essential. ^{40}Ar/^{39}Ar geochronology with step-heating technique on white mica from micaschists provided a temporal resolution with the potential to characterize shearing. ^{40}Ar/^{39}Ar dating across the Nestos Shear Zone yields Late Eocene-Early Oligocene (40-30 Ma) cooling ($\sim$400-350°C) ages, which correspond to local thermo-deformation episodes linked to late and post-orogenic intrusions. U-Pb Sensitive High Resolution Ion Microprobe (SHRIMP) zircon geochronology on leucosomes from migmatitic orthogneisses were considered to estimate the age of peak metamorphic conditions, contemporaneous with anatexis. U-Pb ages of zircon rims specify regional partial melting during the Early Cretaceous (160-120 Ma). This is in disagreement with previous assertions, which argued that the formation of leucosomes in this region is Late Eocene (42-35 Ma) and implied multiple subductions and multiple metamorphic cycles during orogeny.

Garnet geospeedometry considers the kinetic response of minerals and allowed estimating the absolute time-dependent thermal evolution by diffusive element profiles in garnet. Inverse-fitting numerical model considering Fractionation and Diffusion in GarnEt (FRIDGE) calculates garnet composition profiles by introducing P-T-t paths and bulk-rock composition of a specific sample. Preliminary results of Fe-Mg – Ca – Mn garnet fractionation-diffusion modelling indicate very short timescale (between 2 and 5 Ma) for peak metamorphic conditions in the Rhodope collisional system.