

# **Metamorphism, exhumation, normal faulting and large-scale extension of the Hellenic subduction system**

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## **Summary**

The main aim of this long-running project is to integrate metamorphic petrological, geochronological and structural data to decipher the exhumation history and mechanisms of subduction-related high- and medium-pressure rocks associated with the Cenozoic Hellenic subduction system in the eastern Mediterranean. The main results obtained so far are summarized below.

The Cenozoic history of the retreating Hellenic subduction involves subduction, accretion, arc magmatism, exhumation, normal faulting and large-scale continent extension from about 60 Ma until the present day. Ages for high-pressure metamorphism in the central Aegean Sea region range from about 53 Ma in the north to 25-20 Ma in Crete in the south, equivalent to a decrease in age down-section. Younging of high-pressure metamorphism in a southerly direction reflects the southward retreat of the Hellenic subduction zone. The shape of pressure-temperature-time paths of high-pressure rocks is remarkably similar across all tectonic units, suggesting a steady-state thermal profile of the subduction system and persistence of deformation and exhumation stiles. The high-pressure metamorphic events were caused by the underthrusting of fragments of continental crust that were superimposed on slab retreat. Most of the exhumation of high-pressure units occurred in extrusion wedges during ongoing subduction and overall lithospheric convergence. At 23-19-Ma b.p. large-scale lithospheric extension commenced, causing metamorphic core complexes and the opening of the Aegean Sea basin. This extensional stage caused limited exhumation at the margins of the Aegean Sea but accomplished the major part of the exhumation of 21-16 Ma old high-grade rocks in the central Aegean. The age pattern of extensional faults, as well as contoured maps of apatite and zircon fission-track cooling ages, do not show a simple southward progression but reflect fluctuations in regional partitioning of extensional deformation and related exhumation from 23-19 Ma to the Recent. The data support a temporal link between drapping of the subducted slab over the 660 km discontinuity and large-scale extension causing the opening of the Aegean Sea basin.

## **Publications**

Will, T.M., Okrusch, M., Schmädicke, E., Chen, G. (1998): Phase relations in the greenschist-blueschist-amphibolite-eclogite facies in the system Na<sub>2</sub>O-CaO-FeO-MgO-Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub>-H<sub>2</sub>O (NCFMASH), with applications to the PT-evolution of metamorphic rocks from Samos, Greece. - Contributions to Mineralogy and Petrology, 132, 85-102.

Schmädicke, E., Will, T.M. (2003): Pressure-temperature evolution of blueschist-facies rocks from the island of Sifnos, Greece, and constraints on exhumation processes. - *Journal of Metamorphic Geology*, 21, 799-811.

Ring, U., Glodny, J., Will, T.M., Thompson, S.N. (2007): Crustal shortening versus crustal extension on Evia Island, Aegean Sea, Greece. - *Journal of the Geological Society of London*, 164, 637-652.

Thompson, S.N., Ring, U., Brichau, S., Glodny, J., Will, T.M. (2009): Timing and nature of formation of the Ios metamorphic core complex, southern Cyclades, Greece. - In: Ring, U., Wernicke, B. (eds.), *Extending a continent: architecture, rheology and heat budget*. Geological Society of London Special Publication, 321, 139-167.

Ring, U., Glodny, J., Will, T.M., Thompson, S.N. (2010): The retreating Hellenic subduction system: high-pressure metamorphism, exhumation, normal faulting and large-scale extension. - *Annual Review of Earth and Planetary Sciences*, 38, 45-76.