

Tectono-metamorphic evolution of the Ossa and Pelion HP-LT blueschists: U-Pb zircon and apatite constraints on subduction underplating and regional paleogeographic correlations in eastern Thessaly, Greece

Emily R. Hinshaw – Department of Geological Sciences, Jackson School of Geosciences, University of Texas at Austin

Daniel F. Stockli - Department of Geological Sciences, Jackson School of Geosciences, University of Texas at Austin

Konstantinos Soukis – Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece

In the Aegean region, the Cycladic Blueschist Unit (CBU) represents early Cenozoic subduction-related HP-LT metamorphic complexes exhumed in the back-arc of the Hellenic subduction zone. One of the largest coherent packages of blueschist-facies metamorphic rocks is exposed in the Pelion peninsula of eastern Thessaly, and a second is exposed further northwest at Mt. Ossa. While these tectonic slices have been linked to each other and to the CBU further south, little is known about the tectonic affinity, structural position, or timing of metamorphism for these rocks in eastern Thessaly. Their tectonic relationship is critical for understanding the early evolution of subduction dynamics, underplating, and shallow metamorphism in the Aegean. Typical lithologies include quartz-mica schists, commonly with intercalations of meta-carbonates or meta-basic lenses. HP-LT mineral assemblages are best preserved in northern Pelion with epidote-blueschists and lawsonite-blueschists. This study provides new insights into both the sedimentary provenance and tectonic affinity by integrating U-Pb detrital zircon (DZ) data with structural context. We also utilize metamorphic zircon rim overgrowths and apatite U-Pb geochronology to refine the timing and conditions of HP-LT metamorphism for both Ossa and Pelion.

The DZ provenance and maximum depositional age (MDA) data strengthen the pre-subduction tectonic relationship between Pelion, Ossa, and the CBU. DZ results reveal at least four metasedimentary tectonic affinity groups, defined by consistent provenance populations coupled with MDA interpretations. Zircon MDAs show protolith deposition from Permo-Carboniferous to Late Cretaceous. Original younger-on-older relationships are preserved in the context of internal unit geometries (a structural dome in Ossa and antiforms in Pelion), providing evidence for coherent underplating within the subduction interface. In Ossa, the tectonic evolution is constrained by U-Pb zircon data from an overlying Carboniferous basement with Triassic granitic intrusions, and by underlying autochthonous Eocene flysch. In Pelion, tectonic relationships are defined by U-Pb zircon data from underlying Carboniferous and Triassic basement.

Depth-profiling analysis of metamorphic zircons and apatite U-Pb geochronology shed light on the metamorphic history of HP-LT rocks. We determine peak HP-LT metamorphism in the late Paleocene – early Eocene for Ossa and Pelion blueschists, which is coeval with CBU HP-LT metamorphism. Temperature conditions are constrained (<450°C) by the lack of both garnet growth and apatite recrystallization. These new data show that the Ossa and Pelion blueschists are lateral equivalents of the CBU, based on stratigraphic ages, provenance signatures, tectonic affinity, and subduction metamorphism history. However, the Ossa and Pelion HP-LT rocks appear to have experienced lower peak metamorphic conditions compared to the CBU, as indicated by metamorphic mineral assemblages, zircon rims, and apatite U-Pb thermochronometry, and may suggest the exhumation of these tectonic windows from shallower depths. This study provides an important new correlation of Neo-Tethyan HP-LT subduction complexes in Greece to inform paleogeographic and geodynamic reconstructions of the eastern Mediterranean.