Correlative microscopy, geochronology, and atom probe tomography of metamorphosed zircon

Once thought to be a rare occurrence, rocks that preserve evidence of ultrahigh-pressure (UHP) metamorphism are now associated with nearly every major Phanerozoic orogen on Earth (Gilotti, 2013). The identification of UHP metamorphism in crustal rocks depends largely on the formation and preservation of coesite and/or diamond, but these minerals do not commonly retain information regarding the timing of metamorphism or the pressure-temperature (P-T) path. As an additional complication, most rocks retaining evidence of UHP metamorphism have been fully recrystallized during exhumation, thereby overprinting evidence of the P-T path. Although pseudosection modeling can be used to predict peak assemblages, accurate results require knowledge of the bulk rock geochemistry during prograde to peak conditions, which is commonly unknown in recrystallized rocks. In light of these challenges, this study re-examines zircon—a robust, refractory accessory mineral found in many crustal rocks—as a key mineral for extracting information about the timing and P-T path of UHP rocks. The metamorphosed zircon grains featured in this study are found within garnet-kyanite metapelites from the diamond-bearing Rhodope orogen of eastern Greece. Correlative microscopy, geochronology, and atom probe tomography suggest that zircon preserves evidence of original crystallization as well as glimpses of the entire P-T path. These data underscore the importance of correlative analysis of refractory minerals from metamorphic rocks to gain insight about the often-cryptic prograde path of high-grade metamorphic rocks.