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Seismic Structure, Crustal Architecture and Tectonic Evolution of the Anatolian-African Plate Boundary and the Cenozoic Orogenic Belts

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The modern Anatolian-African plate boundary is represented by a north-dipping subduction zone that is part of a broad domain of regional convergence between Eurasia and Afro-Arabia since the latest Mesozoic. A series of collisions between Gondwana-derived ribbon continents and trench-rollback systems in the Tethyan realm produced nearly E-W-trending, subparallel mountain belts with high elevation and thick orogenic crust in this region. Ophiolite emplacement, terrane stacking, high-P and Barrovian metamorphism, and crustal thickening occurred during the accretion of these microcontinents into the upper plates of Tethyan subduction rollback systems during the late Cretaceous-early Eocene. Continued convergence and oceanic lithospheric subduction within the Tethyan realm were punctuated by slab breakoff events following the microcontinental accretion episodes. Slab breakoff resulted in asthenospheric upwelling and partial melting, which facilitated post-collisional magmatism along and across the suture zones. Resumed subduction and slab rollback-induced upper plate extension triggered a tectonic collapse of the thermally weakened orogenic crust in Anatolia in the late Oligocene-Miocene. This extensional phase resulted in exhumation of high-P rocks and medium- to lower-crustal material leading to the formation of metamorphic core complexes in the hinterland of the young collision zones. The geochemical character of the attendant magmatism has progressed from initial shoshonitic and high-K calc-alkaline to calc-alkaline and alkaline affinities through time, as more asthenosphere-derived melts found their way to the surface with insignificant degrees of crustal contamination. The occurrence of discrete high-velocity bodies in the mantle beneath Anatolia, as deduced from lithospheric seismic velocity data, supports our Tethyan slab breakoff interpretations. Pn velocity and Sn attenuation tomography models indicate that the uppermost mantle is anomalously hot and thin, consistent with the existence of a shallow asthenosphere beneath the collapsing Anatolian orogenic belts and widespread volcanism in this region. The sharp, north-pointing cusp (Isparta Angle) between the Hellenic and Cyprus trenches along the modern Anatolian-African plate boundary corresponds to a subduction-transform edge propagator (STEP) fault, which is an artifact of a slab tear within the downgoing African lithosphere.