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Late Palaeozoic-Cenozoic assembly of the Tethyan orogen in the light of evidence from Greece and Albania

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The objective here is to use the geology and tectonics of a critical part of the Tethyan orogen, represented by Greece and Albania, to shed light on the tectonic development of Tethys on a regional, to global scale, particularly the history of convergence during Late Palaeozoic to Cenozoic time.
For Carboniferous time much evidence suggests that the Korabi-Pelagonian crustal unit as exposed in Albania and Greece formed above a northward-dipping subduction zone along the Eurasia continental margin, with Palaeotethys to the south. However, there is also some evidence of southward subduction beneath Gondwana especially from southern Greece and central southern Turkey. Palaeotethys is inferred to have closed in Europe as far to the east as the longitude of Libya, while remaining open beyond this. There is still uncertainty about the Pangea A-type reconstruction that would restore all of the present units in the area to within the E Mediterranean region, versus the Pangea B-type reconstruction that would require right-lateral displacement of exotic terranes, by up to 3,500 km eastwards. In either reconstruction, fragments of the Variscan collisional orogen are likely to have been displaced eastwards (variable distances) in the Balkan region prior to Late Permian-Early Triassic time. From ∼Late Permian, the Greece-Albania crustal units were located in their present relative position within Tethys as a whole.
From the mid-Permian, onwards the northern margin of Gondwana was affected by crustal extension. A Mesozoic ocean (Pindos-Mirdita ocean) then rifted during Early-Middle Triassic time, culminating in final continental break-up and seafloor spreading during the Late Triassic (Carnian-Norian). Subduction-influenced volcanics of mainly Early-Middle Triassic age probably reflect the extraction of magma from sub-continental lithosphere that was enriched in subduction-related fluids and volatiles during an earlier, ?Variscan subduction event. The existence of Upper Triassic mid-ocean ridge-type igneous rocks, known locally in Albania and Greece, points to rifting of a Red Sea-type oceanic basin rather than a back-arc basin related to contemporaneous subduction. After initial, inferred slow spreading at an Upper Triassic, rifted ocean ridge and spreading during the Early Jurassic, the ocean basin underwent regional convergence. Subduction was initiated at, or near, a spreading axis perhaps adjacent to an oceanic fracture zone. The Jurassic supra-subduction zone-type ophiolites of both Greece and Albania largely relate to melting of rising asthenosphere in the presence of volatiles (water) that originated from subducting oceanic lithosphere. High-magnesian boninite-type magmas that are present in both the Albanian and Greece ophiolites and some underlying melanges reflect remelting of previously depleted oceanic upper mantle. Localised MOR-type ophiolites of Late Middle Jurassic age, mainly exposed in NE Albania, were created at a rifted spreading axis. The amphibolite-facies metamorphic sole of the ophiolites was mainly derived from oceanic crust (including within-plate type seamounts), whereas the underlying lower-grade, greenschist facies sole was mainly sourced from the rifted continental margin. The melange, dismembered thrust sheets and polymict debris flows ("olistostromes") beneath the ophiolites formed by accretion and gravity reworking of continental margin units. The in situ radiolarian chert cover of the ophiolites in northern Albania is overlain by polymict debris flows ("olistostromes"). Pelagic carbonate deposition followed during Tithonian-Berriasian time and then restoration of a regional carbonate platform during the Cretaceous. Exhumation of deeply buried parts of the over-ridden continental margin probably took place during the Early Cretaceous. Structural evidence, mainly from northern Greece (Vourinos, Pindos and Othris areas), indicates that the ophiolites, the metamorphic sole, the accretionary melange, and the underlying continental margin units were all deformed by top-to-the-northeast thrusting during Late Middle-Early Late Jurassic time. However, such kinematic evidence is not obviously replicated in Albania, where there are reports of ∼southwest-directed (or variable) emplacement. Remaining Pindos-Mirdita oceanic crust subducted ∼southwestwards during Late Cretaceous-Eocene time, while oceanic crust continued to form in the south-Aegean region at least locally during Late Cretaceous time.
During Early Cenozoic time the Pindos-Mirdita ocean closed progressively southwards, triggering mainly southward progradation of turbidites derived from the over-riding Korabi-Pelagonian microcontinent. Smaller volumes of sediment were also derived from the Apulia (Adria) continent. The Mesohellenic Trough of Greece

and its counterpart in Albania evolved from an Eocene fore-arc-type basin above subducting oceanic lithosphere to a thrust-top basin as continental crust continued to underthrust during the Oligocene after final closure of the Pindos-Mirdita ocean. Miocene and Plio-Quaternary successor flexural foredeeps developed in response to continuing regional plate convergence. The preferred tectonic alternatives are assembled into a new overall tectonic model, which in turn needs to be tested and developed in the light of future studies.

Reference: Robertson, A.H.F. Tectonic development of Greece and Albania in the context of alternative reconstructions of Tethys in the Eastern Mediterranean region during Late Palaeozoic-Cenozoic time. International Geological Review, in press.