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A new integrated tectonic model for the Mesozoic-Early Cenozoic subduction, spreading, accretion and collision history of Tethys adjacent to the southern margin of Eurasia (NE Turkey)

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A major Tethyan suture zone (İzmir-Ankara-Erzincan-Kars Suture Zone) borders the southern margin of Eurasia throughout the Pontides. In eastern Turkey the suture zone includes a range of redeposited terrigenous and volcanogenic sedimentary rocks, pelagic sedimentary rocks and also igneous/metamorphic rocks. The igneous rocks are mostly basaltic blocks and thrust sheets within melange, plus relatively intact, to dismembered, ophiolitic rocks (oceanic crust).

Two alternative hypotheses have been developed and tested during this work:

1. The suture zone preserves a single Andean-type active continental margin associated with northward subduction, accretion and arc magmatism during Mesozoic-early Cenozoic time;

2. The suture zone preserves the remnants of two different subduction zones, namely a continental margin subduction zone (as above) and an intra-ocean subduction zone (preferred model).

To determine the age of the oceanic crust, relevant to both hypotheses, zircons were extracted from basic ophiolitic rocks (both intact and dismembered) and dated by the U/Pb method (U238/U236) using an ion probe at Edinburgh University. This yielded the following results for the intact ophiolites (Ma): plagiogranite cutting sheeted dykes of the Refahiye ophiolite (east of Erzincan), 183.6$\pm$1.7 (2σ); isotropic gabbro from the Karadağ ophiolite (northeast of Erzurum), 179.4$\pm$1.7 (2σ). In addition, dismembered ophiolites gave the following ages: gabbro cumulate (Bayburt area), 186.2$\pm$1.4 (2σ), gabbro cumulate (N of Horasan), 178.1$\pm$1.8 (2σ). Furthermore, two samples from a kilometre-sized (arc-related) tonalite body, mapped as cutting a thrust sheet of ophiolitic isotropic gabbro in the Kırdağ area, yielded ages of 182.1$\pm$3.2 (2σ) and 185.1$\pm$3.0 (2σ) Ma. We infer that the ophiolitic and related magmatic arc rocks formed by spreading in a supra-subduction zone setting during the late Early Jurassic (Pliensbachian-Toarcian). This amends former assumptions of a Late Cretaceous age for the E Pontide ophiolites, with important implications for alternative tectonic hypotheses.

The two-subduction-zone hypothesis is supported by sedimentological and structural studies of the volcanic-sedimentary melange and of the sedimentary thrust sheets within the suture zone. Geochemical studies of oceanic basaltic rocks in the melange and also new biostratigraphic dating of radiolarites and calcareous microfossils within pelagic and redeposited deep-sea/slope sediments add to the picture. Taken together, the evidence suggests the former existence of both an oceanic and a continental margin subduction complex that are now amalgamated within the suture zone.

We propose the following tectonic hypothesis: Fragments of oceanic basaltic lithologies and their deep-sea sedimentary cover accreted to form a Jurassic-Cretaceous intra-oceanic subduction complex. Terrigenous and arc-derived volcaniclastic gravity flows and pelagic carbonates accumulated in a continental margin forearc basin, mainly during the Cretaceous. Subduction melange was first emplaced over the distal Eurasian margin during the Late Cretaceous owing to thickening of the accretionary prism. During suturing, the continental margin forearc basin was emplaced southwards over the oceanic-derived accretionary wedge. The Eurasian continental margin was imbricated and thrust northwards as collision proceeded. Final closure of the adjacent Tethys took place prior to late Middle Eocene. This was followed by marine transgression and the accumulation of non-marine to shallow-marine sediments, including Nummulitic limestones.

Regional correlations suggest that the double subduction zone hypothesis, notably involving Jurassic intra-oceanic spreading, is applicable to >1000 km of the Eurasian margin, specifically the Lesser Caucasus and possibly also the Central Pontides.