



Ophiolites of the Alps-Carpathians-Dinarides orogen system: how many oceans?

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Based on a recently compiled tectonic map of the Alps-Carpathians-Dinarides orogenic system, characterized by extreme changes along strike, including changes in subduction polarity, we discuss possible links between the Alpine Tethys and Neotethys. Alpine Tethys and Neotethys denote two groups of oceans that opened in Permian (?) to Mesozoic times, i.e. during the break-up of Pangea. Alpine Tethys denotes all the oceanic realms, which have a direct kinematic link to ocean floor spreading in the Central Atlantic. Neotethys is used for all the oceanic realms that opened in the vicinity of Paleotethys that separated Gondwana from Laurussia in earlier (Permian?, Triassic) times and which were located in an area east of the future Western Alps. The opening of the oceanic basins of Neotethys had no direct kinematic link to the opening of the Alpine Tethys. In the contrary, some of them (i.e. the Dinaric ophiolites) were closed by obduction in Late Jurassic times and in the kinematic context of the opening of the Central Atlantic. Alpine ophiolites typically form sutures. Many of the Neotethyan ophiolites in the Balkan area were either obducted (e.g. Vardar ophiolites) or incorporated as blocks into *mélange* formations (e.g. the remnants of the Meliata ocean) during Late Jurassic tectonism. Later they were affected by out-of-sequence thrusting during Cretaceous and Tertiary orogenies, which makes paleogeographic reconstructions rather difficult.

We attach the following oceanic realms to the Alpine Tethys: Valais, Rhenodanu-

bian and Magura units, which form a northern branch, and Piemont-Liguria-Vahicium-Pieniny klippen belt units, which form a southern branch of the Alpine Tethys. Both these branches are separated by the Briançonnais terrane of the Western Alps and possibly by smaller analogous terranes found as relics in the Pieniny klippen belt of the Western Carpathians. We propose that these elements of the Alpine Tethys extend into the Inacovce-Kriscevo unit of Eastern Slovakia and Ukraine, the flysch units referred to as Pienides in northern Romania further into the Szolnok flysch in the subsurface of the Pannonian basin. This same ophiolitic belt is proposed to follow the Mid-Hungarian fault zone and to connect with the Sava zone, a belt of ophiolitic, magmatic and metamorphic rocks that stretches between Zagreb and Belgrade. The Sava zone, which represents the easternmost branch of the Alpine Tethys according to our compilation, joins the Western Vardar zone of the Neotethys, at least spatially and in terms of the present-day map view. The Ceahlau-Severin ocean of the Eastern Carpathians, which ends eastwards in a dead-end, probably represents a separate branch of the Alpine Tethys.

The remnants of the Triassic Meliata ocean, which are part of Neotethys are only preserved as blocks within Jurassic-age ophiolitic mélangé formations. Such mélangé formations are found in the Eastern Alps, Western Carpathians, Bükk Mountains, Dinarides and Hellenides. The remnants of the Jurassic parts of what we consider one and the same oceanic basin, also part of Neotethys, (Darno-Szavarskö ophiolites of the Bükk Mountains; Dinaric, Mirdita and Western Vardar ophiolites of the Dinarides), were obducted onto the passive continental margin of Apulia. The Eastern Vardar Zone was also part of the same Neotethys ocean but connects with the South Apuseni and Transylvanian ophiolites in present-day map view, rather than with the Sava zone.

We conclude that (1) none of the branches of the Alpine Tethys and Neotethys can be followed further to the east into the North Dobrogea orogen, although such connections are proposed by many paleogeographical reconstructions. Ultimately, the branches of Alpine Tethys and westernmost Neotethys found in the Alps-Carpathians-Dinarides orogenic system can only be followed eastwards into Turkey via the Dinarides and Hellenides. Furthermore, all the oceanic domains. (2) We propose that all ophiolitic remnants of Neotethys found in the area considered were part of one and the same oceanic basin.