



## **New data from the Vardar suture zone in the Republic of Macedonia (FYROM) used to test alternative models of Jurassic ophiolite emplacement and Neotethyan evolution in the Balkan region**

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The debate concerning the emplacement of the Jurassic Balkan ophiolites has recently intensified with an origin in a Pindos-Mirdita ocean originally to the south, and in a Vardar ocean more to the north both being advocated. Here, we focus on a critical but long overlooked segment of the Vardar suture zone that is exposed in the Republic of Macedonia (FYROM). We have carried out nine traverses across the Vardar suture zone from north to south through Macedonia allowing alternative hypotheses to be tested.

Ophiolitic rocks overlie a continental margin succession that can be correlated with the eastern part of the Pelagonian zone and with the eastern/central Almopias zone (~western Vardar zone) in northern Greece. The succession is also similar to the Drina-Ivanjica continental margin unit in former Yugoslavia. The suture zone experienced Alpine (Early Cenozoic) polyphase isoclinal folding and thrust imbrication generally towards the west/southwest. The structural history can be correlated with the more westerly parts of the Pelgonian/Korabi zone in Macedonia and northern Greece.

The Alpine structure can be backstripped to reveal the following earlier tectonic development: Precambrian and Palaeozoic units including granitic rocks (part of the Korabi-Pelagonian continent) were regionally metamorphosed and exhumed, followed by Triassic rifting, siliciclastic deposition and the construction of a subsiding Jurassic carbonate platform (locally unstable). The platform later subsided abruptly, associated with the accumulation of thin (< 10 m) red ribbon radiolarites and redeposited carbonates. Although generally not well preserved, radiolarites at one locality (S of Veles) yielded a diagnostic assemblage of Middle Callovian to Early Tithonian age. The succession terminates with strongly sheared terrigenous turbidites and shales. This was directly followed by the emplacement a laterally persistent (>200 km N-S) unit of sheared blocky serpentinite (mainly harzburgite). In a few areas the sheared serpentinite is underlain or intercalated with thin (tens of metres) ophiolite-derived debris flows (e.g. including gabbro, diabase and basalt). After emplacement the ophiolitic rocks (<500m thick) were subaerially eroded with the local formation of Fe-Ni deposits. The margin then submerged, with initial development of small corallgal build-ups, coupled with carbonate redeposition. This was followed by siliciclastic deposition (with minimal ophiolitic detritus) and the renewed construction of a carbonate platform (Tithonian?), mainly preserved as proximal slope facies. A thick mixed terrigenous-carbonate, mainly turbiditic sequence (hundreds of metres thick) of Cretaceous age accumulated above this. Late Cretaceous pillow basalts are reported in some areas. Intense deformation followed during latest Cretaceous-Early Cenozoic time, related to final closure of Neotethys in the Balkan region.

In contrast, the eastern part of the Vardar zone in Macedonia and northern Greece (eastern Almopias & Peonais zones) documents a different tectonic evolution. The northern margin of the Vardar ocean represented by the Serbo-Macedonian continent exhibits Jurassic northward subduction, arc magmatism and marginal basin formation (e.g. to form the Guevgueli ophiolite), followed by final closure of the ocean during Late Cretaceous-Paleogene time.

There is little evidence that a complete section of Jurassic oceanic lithosphere was ever emplaced over the eastern margin of the Korabi-Pelagonian continent in Macedonia or adjacent areas. The thin serpentinite melange contrasts strongly with e.g. the Vourinos and Pindos ophiolites in Greece, where complete ophiolites were emplaced together with continental margin and metamorphic sole units. The evidence is more consistent with the ophiolitic rocks in the Vardar zone of Macedonia representing the furthest travelled, frontal parts of oceanic lithosphere emplaced from a separate Pindos-Mirdita ocean, originally to the south. However, a local origin from a Vardar ocean originally further north cannot be excluded because the structures related to initial ophiolite emplacement were largely obliterated by the intense Alpine deformation.