Post-folding bending of the Silesian nappe, Western Outer Carpathians (Poland)

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The Western Outer Carpathians are a north-verging fold-and-thrust belt composed mostly of Lower Cretaceous through Lower Miocene flysch. The belt comprises several nappes. One of these nappes, the Silesian nappe, extends along the whole belt and a portion of it is the object of this study. The study area is located in the Dunajec River valley. In this area the Silesian nappe forms a bend, convex towards the NNE. West from the bend, the map-scale fold axes are oriented W–E, whereas east from the bend they are oriented NW–SE. The strata in the study area range from Early Cretaceous to Oligocene in age. Folding and thrusting within the discussed part of the Silesian nappe were completed before the Upper Badenian time (15 Ma). The study area has been subdivided into 14 structural domains. These domains are limited by tectonic contacts. Strata orientations were measured separately for particular domains, for each domain at least 40 measurements. The total number of measurements is 1122. The stereoplots of strata orientation for particular domains are generally coherent. Poles to stratification form either single girdles or single ellipsoids. Moreover, the reconstructed fold axes are plunging shallowly, generally less than 10° (max. 17°). These features indicate that the fold axes result from a single folding. However, the orientation of reconstructed fold axes differ considerably between particular domains from N–S to NW–SE, through W–E (predominant), to WSW–ENE. It appears that considerable differences in orientation of the reconstructed fold axes among particular domains may result from individual rotations of these domains. The rotations, in turn, could be related to the bending of the Silesian nappe. The bending involved extension which could result in breaking the bend into blocks (domains) and individual rotations of these blocks. In this interpretation, the very different orientations of fold axes within particular domains result from dispersal of a single pre-bending fold set. It appears, therefore, that the bending of the Silesian nappe took place after completing of folding and thrusting within this nappe, during the latest Badenian or later.

Correlation and tectonic significance of Mesozoic ophiolites in the Dinarides, Albanides and Hellenides

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Mesozoic ophiolites occur in two sub-parallel belts running down the spine of the Dinarides, Albanides and Hellenides. Key questions are: When did rifting occur to form the ocean basins? In what tectonic setting did the ophiolites form and how and when were they emplaced?

The outer ("external") belt is the more simple of the two. There is extensive rift volcanism in the Early–Mid Triassic, followed by probable spreading in the Late Triassic (N Greece). Spreading in the Late Permian is unlikely in view of the absence of Permian deep-water continental margin sediments (e.g., Pindos–Olonos zone, W Greece), or Permian deep-water basic igneous rocks in melanges. Spreading at a mid-ocean ridge (MOR) setting in the early Late Jurassic is evidenced by the age of radiolarian cover sediments of the westerly ophiolites of Albania (Mirdita zone). The largest ophiolites (e.g., easterly Mirdita ophiolites; Albania) show clear lithological and geochemical evidence of formation above a subduction zone, and are also of early Late Jurassic age based on radiolarian ages. Less well dated ophiolites in N Greece (Pindos, Vourinos) also formed in an above-subduction zone setting. Early displacement (late Middle Jurassic) within the ocean basin is indicated by ubiquitous formation of sub-ophiolitic metamorphic soles (e.g., Zlatibor, Serbia; Euboea, Greece).

The inner ("internal") belt is much more heterogeneous. In N Greece there is evidence of widespread Permian bimodal rift-related volcanism (Serbo–Macedonian zone). In Serbia it was suggested that the Vardar zone is a long-lived Palaeotethyan ocean basin, but definite evidence is lacking. There is evidence of Triassic rifting and development of a passive margin in N Greece (Serbo–Macedonian Zone) with fragments of Triassic MORB and radiolarites (Almopias Zone). Also in N Greece there is excellent evidence of development of a Jurassic Andean-type continental margin arc and back-arc basin (Paikon arc and Gevgueli Ophiolite). The Gevgueli Ophiolite had formed by late Middle Jurassic time based on the age of radiolarian cover sediments. In N Greece the Vardar Zone is a Jurassic continental margin arc and back-arc basin (Paikon and Gevgueli Ophiolite). The Vardar Zone apparently closed by the Late Jurassic shallow-water carbonate cover. In N Greece the Vardar Zone apparently closed by the Late Jurassic, whereas the basin still remained open further south, where there is no evidence of Late Jurassic metamorphism or collision (Argolis). In N Greece the Vardar Zone then reopened in the Early-Mid Cretaceous to form a small MORB-type ophiolite, probably a strike-slip pull-apart basin. The Vardar Zone in Serbia was apparently also dominated by strike-slip during the Cretaceous.

In the Late Cretaceous additional (small?) ophiolites formed by spreading above a subduction zone in S Greece.