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The role of “en bloc” rotations and oroclinal bending in shaping the Western Outer Carpathians based on paleomagnetic and magnetic anisotropy observations

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The Western Outer Carpathians are built up from Lower Cretaceous through Lower Miocene flysch sediments, which deposited partly at the southern margin of stable Europe, partly in front of the ALCAPA megatectonic unit of the Pannonian basin. In the process of southward subduction of the European plate below the ALCAPA, an accretionary wedge started to form in the Paleogene and was flatly trusted over the sedimentary fill of the Carpathian foredeep during the Miocene. The western Outer Carpathian nappe pile formed during two stages of thrusting, the first directed towards the NW, the second towards the NE (both in present co-ordinates, observations made in the Polish segment). This raised the question whether the succession of differently verging thrusts results from far-field clockwise rotation of the stress field or “en bloc” counter-clockwise rotation of the Western Outer Carpathians. In addition, the significance of oroclinal bending in the formation of the Carpathian arc (classical model) was to be tested, as an alternative to the model which explains the “oroclinal bending” by the dominance of NW directed thrusts in the western and NE directed ones in the eastern segment of the Western Outer Carpathians. In order to answer these questions, paleomagnetic and magnetic anisotropy investigations were carried out in two nappes, the Magura (originally front of the ALCAPA) and the Silesian (originally belonging to the southern margin of stable Europe). The Magura nappe was sampled in Poland at a large number of localities distributed geographically, while sampling concentrated on three areas in the Silesian nappe, one in the western (Czech), the second in the central and the third in the eastern segment (both in Poland). Stan-

dard paleomagnetic and magnetic susceptibility anisotropy analysis was carried out on the samples which were mostly taken from marly members, subordinately from silty or fine-grained sandy beds. The results are the followings. Characteristic remanence (ChRM) was isolated for 14 (out of the sampled 32) late Eocene-Oligocene localities from the Magura nappe. The ChRMs are of post-folding age. The overall-mean paleomagnetic direction indicates 54° "en bloc" counter-clockwise rotation with respect to the present north. The magnetic fabric is foliated. Lineation directions are fairly well clustered on locality level, but locality mean lineation directions are spread from 30-210° to 150-330°, with no systematic change from west to east. Twenty Oligocene localities (out of the sampled 23) yielded good paleomagnetic results from the Silesian nappe, most of them with pre-folding remanence. In the western segment, the indicated rotation is 75° in the counter-clockwise sense and the angle is 45° in the central and eastern segments, respectively. Magnetic fabric is foliated. Lineation directions cluster on locality level and group fairly well within the central and eastern segments, respectively. Lineations in both segments are roughly east-west oriented, while the characteristic orientation in the western segment is NE-SW. The above results suggest that the Western Outer Carpathians suffered an about 50° "en bloc" counter-clockwise rotation, after the Oligocene. It follows that the change in stress field direction from NW-SE to NE-SW during the Miocene is apparent. Neither the paleomagnetic nor the magnetic lineation directions differ in the central and eastern segment. The western segment is different. Both the paleomagnetic and the magnetic lineation results imply somewhat larger counter-clockwise rotation here than further to the east. It seems, however, that not bending, but extra counter-clockwise rotation within a left lateral wrench corridor (at the margin of the Bohemian Massif) is responsible for the observations.