Paleostress evolution of the Manín Unit in western Slovakia: reconstruction based on kinematic analysis of multiple fault structures

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Our investigation was focused on the kinematic analysis and palaeostress reconstruction of the brittle structures of the Manín Unit cropping out in the Middle Váh River Valley in Western Slovakia. This originally Central Carpathian unit has become a part of accretionary prism of the front of Central Carpathian block where it was incorporated into the Pieniny Klippen Belt. Later, it was deformed again during the younger phases of the Alpine Orogeny together with the Outer Carpathians. Paleogeographically, the Manín Unit is considered to be the most external part of the Tatric sedimentary area, on an individual paleogeographic zone between Tatricum and Klippen zone (Andrusov, 1972). Alternatively, it is a nappe of Fatricum affiliation in the Vysoká development (Maheľ, 1978). Structural analysis of brittle deformation that affected the Jurassic–Lower Cretaceous rocks of the Manín Unit at five main localities (Butkov, Tunežice, Mojtín, Manín and Skalica) was carried out based on the interpretation of palaeostress states. We have employed the program Win_Tensor for the computation of stresses and the separation of the faults into homogenous groups. Relative superposition of individual paleostress states was derived from field structural relationships; their stratigraphic age was estimated mainly by comparison with other published data from the adjacent south-western parts of the Western Carpathians (e.g., Fodor, 1995; Kováč et al., 1994; Králiková et al., 2010; Pešková et al., 2009; Vojtko et al., 2010). Palaeostress analysis in the Manín Unit revealed the existence of six different palaeostress fields acting in the period from the Palaeogene to Quaternary. The oldest deformation phase (pre-late Eocene) is characterized by compression in the W–E direction that was generated during the strike-slip to dextral transpressional tectonic regime. This event was accompanied by the formation of the dextral faults trending in the SW–NE and dominating over the sinistral faults. N–S trending oblique-slip reverse faults generated in a pure compressive regime, are superimposed on older fault structures. Next deformation stage (Egerian–Eggenburgian) is characterized by the WNW–ESE oriented SHmax, recorded by a great number of SW–NE striking oblique reverse faults. The strike-slip faults are mostly dextral features oriented SW–NE, whilst the sinistral strike-slip faults trend NNW–SSE. The third deformation stage (Ottnangian–Early Badenian) is represented by faults generated by a compressional regime with the NNW–SSE maximum horizontal stress axis SHmax. It resulted in formation of the conjugate strike-slip faults, including the NNE–SSW oriented sinistral strike-slip faults that predominate over the dextral faults. For this event the formation of multiple reverse faults is typical. Compression continued during the Middle–Late Badenian with SSW–NNE oriented SHmax axis. Generally, the number of reverse faults decreased and the number of normal faults increased. The sinistral strike-slip faults oriented ENE–WSW prevail over the dextral strike-slip faults as a result of the next transtensional tectonic regime combining strike-slip movement with oblique extension. The fifth deformation stage (Sarmatian–Pannonian) reflects the next change of the tectonic regime that occurred during the WSW–ENE compression, where dextral N–S faults are dominating. The numerous normal faults indicate a primary role of NW–SE oriented extension. The last deformation phase (Pliocene-Quaternary) is characterized by a number of conjugate normal faults as the result of a purely extensional tectonic regime with the NW–SE oriented Shmin axis. The existence of many normal faults is likely caused by the relaxation of compressive tectonic stresses in the area. The reconstructed history of the palaeostress field orientations and rotations, partitioned into six principal deformation stages in the Manín Unit, is largely corresponding to the palaeostress reconstructions performed in neighbouring areas, and in fact in the entire Western Carpathian segment of the ALCAPA microplate.

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