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Kinematic history of the frontal part of the Carpathians fold-and-thrust belt in eastern Poland and origin of its curved shape (so-called ‘ Przemyśl Sigmoid‘): Insights from integrated anisotropy of magnetic susceptibility and structural analyses

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Orogenic systems commonly show significant curvatures, both in the regional extent of the whole mountain belt but also at the scale of individual orogen units, where the trends of folds ant thrusts are remarkably bent in map view. We present results from the northern Carpathian orogenic belt that in the Eastern Poland changes gradually its regional trend from E-W to NW-SE. In detail, in the Polish-Ukrainian border area, frontal part of the foreland fold-and-thrust belt forms the complex curved structure called traditionally ‘Przemyśl Sigmoid‘. The ‘Sigmoid‘ is developed within the Skole Unit (composed of Upper Cretaceous to Lower Miocene sediments) that override the frontal Stebnik Unit (including Lower Miocene sediments). Both the Skole and Stebnik tectonic units are thrusted over Miocene siliciclastic deposits of the Carpathian Foredeep. Our interdisciplinary studies are focused on understanding the evolution of the ‘Sigmoid‘ structure applying: anisotropy of magnetic susceptibility (AMS), analysis of cartographic and borehole data along with field structural studies. AMS samples were collected from curved Skole Unit, sediments of wedge-top basins sealing the Skole Unit leading-edge thrust and from the Stebnik Unit. In gray-green sandstones and siltstones the AMS is mostly defined by the orientation of paramagnetic minerals, wherase reddish siltstones imply the co-effect of para- and ferromagnetic (hematite, magnetite) minerals. AMS ellipsoids are predominantly oblate (more planar in red siltstones) with a bedding-parallel foliation implying a sedimentary mineral alignment. In most of sites maximum AMS axes are reasonably well grouped, showing best clustering in sites located within sub-vertically strata from the imbricate fan of the Skole Unit. The magnetic lineation is usually parallel to the local fold axis orientation, thus confirming its tectonic origin. Borehole data reveals the western limits of the Stebnik basin with significant decrease of sediment thickness in the ‘ Sigmoid‘ area. The integrated datasets reveal the multistage origin of the ‘ Sigmoid‘ structure. We suggest that both the thrust curvature displayed by the Skole Unit and the original geometry and thickness variations of the Lower Miocene foreland basin are related to the pre-existing NE-SW trending basement fault. The inherited extensional structure controlled the development of lateral and oblique ramps within the Skole detachment plane during subsequent shortening, leading to the progressive formation of the ‘Sigmoid‘ during foreland-ward transport and internal deformation of the thrust-sheets. The peculiar map-view shape of the curved Skole Unit, in turn, resulted in a dramatic lateral variation of accommodation space associated with lithospheric flexure at its front. The accommodation space was minimum in the western (salient) area and maximum in the eastern (recess) area, where the main depocentre of the Early Miocene Stebnik basin developed. The margins of the Stebnik basin were also affected by important gravitational phenomena, with the development of slumps and slide sheets derived from the neighbouring Skole Unit. The final shortening episodes resulted in the incorporation of the Stebnik foreland basin sediments into the thrust belt, leading to the development of the Stebnik Unit; its leading-edge thrust forms the thrust front of the Carpathian orogen in this area.