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Alongstrike geometry variations of the Carpathian thrust front east of Tarnów (SE Poland) as intersection phenomenon related to thrust-floor palaeotopography

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Structural geometry of the Miocene (Badenian-Sarmatian) Carpathian orogenic front between Tarnów and Pilzno was investigated, using borehole and 2D and 3D seismic data. In line with some earlier studies by other authors, but in much more comprehensive way, our study reveals details of the alongstrike changing structural geometry of the Carpathian orogenic front and offers a model of its tectonic evolution. At places the frontal thrust of the Carpathians is blind and accompanied by well developed wedge tectonics phenomena. Elsewhere it is emergent at the surface and shows an apparently simple structure. The base of the fold-thrust zone rests on a substratum with highly variable palaeotopography, which includes a major palaeovalley incised in the Mesozoic basement to a depth exceeding 1 km. The palaeovalley floor was covered with salt-bearing evaporites at the time when the thrusting took place.

The wedge tectonics phenomena include backthrusts and a prominent crocodile structure. The tectonic wedge is formed by stacked thrust-slices of the Cretaceous-to-Oligocene flysch of the Skole nappe. This wedge has forced a basal Miocene evaporitic layer (including salt) to split into two horizons (1) the lower one, which acted as a tectonic lubricant along the floor thrust of the forward-moving flysch wedge, and (2) the upper one, along which the Miocene sediments of the Carpathian foredeep were underthrusted by the flysch wedge. This resulting crocodile structure has the flysch wedge in its core, a passive roof of Miocene sediments at the top and tilted Miocene strata at its front, defining a frontal homocline. A minor triangle zone, cored with deformed evaporites, has formed due to backthrust branching at the rear of the frontal monocline.

At other places, the Carpathian flysch and its basal thrust, emerge at the surface. The flysch must have once also formed a wedge there, but was mostly removed by erosion following its elevation above the present-day topographic surface on the frontal thrust.

The Skole flysch units overlie a relatively thin zone of deformed Miocene evaporitic series that covers autochthonous clastic Miocene sediments of the inner parts of the Carpathian foredeep. The sediments are southerly dipping at a shallow angle below the Outer Carpathian nappe structure.

Our study indicates that the lateral variations in the structural geometry at the thrust front of the Carpathian orogen are due to different levels of erosional truncation that were controlled mainly by a predeformational palaeotopography of the base of the Carpathian foredeep. At the same time, the wedge tectonics phenomena owe their formation to the limited lateral extent of the evaporitic layer and its facies changes.

At erosionally lowered locations of the foredeep's base, represented by the deep palaeovalley of Pogórska Wola, the Carpathian thrust front is a fully preserved, subsurface structure, concealed below the Miocene molasse of the foredeep. In areas where the pre-thrusting erosion was not so efficient (outside the palaeovalley), the Carpathian orogenic front is emergent at the surface. We infer that the originally existent flysch tectonic wedge, splitting the evaporites at its front, was thrusted to upper levels and then eroded at such locations.