

Combination of Cross-Section Balancing and Subsidence Analysis as a Key to Viable Structural Model of the Late Paleozoic Malochwiej Anticline (Lublin Basin, South East Poland)

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ABSTRACT

Cross-section balancing and restoration techniques combined with subsidence analysis were applied in order to develop refined structural model of one of the key structural elevations known from the Lublin Basin, the Malochwiej Anticline. This structure is located in SE part of the Lublin Basin. Complex tectonic evolution of the Lublin Basin includes Late Proterozoic rifting, Cambrian-Ordovician passive margin stage, Silurian lithospheric flexure related to Caledonian collision, Bretonian (latest Devonian – earliest Carboniferous) thick-skinned reverse faulting and uplift, and regional Variscan (Late Carboniferous) compression. Bretonian and Variscan tectonic phases were followed by regional erosional events. Seismic profiles crossing the Malochwiej Anticline show thin-skinned fault-related fold. First-order thrust is rooted in Silurian shales which acted as a regional detachment level. Well data provided information on presence of two major stratigraphic gaps: Middle Devonian - Tournaisian (not discernible on seismic data) and Westphalian - Kimmeridgian (clearly imaged by seismic data). Taking into account presence of these two stratigraphic gaps refined structural model of the Malochwiej Anticline was constructed. Subsidence analysis was performed using BasinMod 1D software, using input data on thickness of individual stratigraphic units, numerical ages defining time intervals between the upper and lower boundary of each stratigraphic unit, and petrophysical parameters. Model was calibrated with measured vitrinite reflectance and porosity data. Subsidence analysis showed that ca 1 km of Mid-Upper Devonian and ca 3 km of Carboniferous strata has been eroded. Construction of the balanced cross-section was based on the following assumptions: (1) bed-length conservation for Devonian-Carboniferous strata and (2) constant area for Silurian shales, acting as detachment level. Combined structural and subsidence analysis showed that the Malochwiej Anticline should be regarded as a complex structure which underwent not one, as initially thought, but two compressional events: Bretonian, which resulted in thick-skinned basement reverse faulting, and Variscan, related to thin-skinned folding and thrusting restricted to the Silurian-Carboniferous sedimentary cover. Obtained results clearly illustrate that in case of complex tectonic structures integrated analysis including subsidence analysis and cross-section balancing yields much more reliable results.