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STRESZCZENIE

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„Mechanizmy subsydencji neoproterozoiczno-
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na zachodnim skłonie kratonu wschodnioeuropejskiego”

“Subsidence mechanisms of the Neoproterozoic-lower Palaeozoic sedimentary basins of the western slope of the East European Craton”

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Abstract

Tectonic subsidence history was analysed for the Ediacaran-Lower Palaeozoic Peri-Tornquist system of sedimentary basins, including the Baltic Basin, the Lublin-Podlasie Basin, and the Volyn-Podillya-Moldavia Basin. The analysis were conducted by performing 1D backstripping for 85 wells or synthetic section, located in SW Scandinavia, Baltic countries, northern and eastern Poland, Western and SW Ukraine, Moldova and NE Romania. Tectonic subsidence curves are analysed here with the aim to reconstruct possible tectonic mechanisms governing the basin origin and subsequent development, while rate of sediment deposition is interpreted in terms of activity of sediment source area. During backstripping analysis, an isostatic load was removed, with assumption that sedimentary loads were locally compensated according to Airy isostatic principles, and compaction effects were restored. Changes in palaeobathymetry of the basin over time were also included in calculations.

Tectonic subsidence history is coherent across the studied area, however, the analysed basins evolved in time, both in terms of its geometry and tectonic control on its subsidence. The development of the Peri-Tornquist system of sedimentary basins commenced with an event of relatively rapid tectonic subsidence in the latest Ediacaran, which was followed by systematically decreasing rate of subsidence during the Cambrian and Ordovician. The observed pattern of subsidence is characteristic of thermal sag of rifted basins, where a syn-rift phase is expressed by rapid tectonic subsidence, mainly within tectonic extensional grabbens, whereas subsequent post-rift basin development is governed by cooling of the lithosphere resulting in systematically decreasing tectonic subsidence rate, coeval with the lateral expansion of the basin.

The late Ediacaran syn-rift tectonic subsidence increased towards the SW, i.e. towards the edge of the East European Craton (EEC), where the Ediacaran rift zone was located. At that time, a rift developed along the whole SW margin of the EEC from Scandinavia to the Black Sea. The rifting was initiated with the emplacement of volcanic rocks, mainly basalts, in the zone of intersection of the Peri-Tornquist system of sedimentary basins with the Orsha-Volyn Aulacogen. The rifting is also evidenced by presence of large extensional grabens, revealed by deep seismic data interpretation in the Lublin region and the Danish shelf of the Baltic Sea. Development of large system of the late Ediacaran extensional basin was related to the latest stages of break-up of the Precambrian super-continent Rodinia/Pannotia and ultimately the formation of the Tornquist Ocean.

The latest Ediacaran to Middle Ordovician tectonic subsidence pattern was characteristic of post-rift thermal sag stage of extensional basins. Such interpretation is also confirmed by the observed increase of lateral extend of the analysed sedimentary basins in time, characteristic of thermal sag mechanism. The SW margin of the newly formed Baltica, including the studied area, became a passive continental margin. At that time sedimentation rates in the studied basins were systematically decreasing, expressing decreasing activity of the sediment source areas.

The post-rift subsidence of the passive margin was interrupted by the late Cambrian uplift and erosion. This process was presumably related to a far-filed effect of contractional events or intra-plate stresses. An alternative interpretation was also considered, which assumed that the uplift was an expression of docking of the Małopolska block to Baltica.

Since Late Ordovician, a gradual change to a collisional tectonic setting is observed across the SW margin of Baltica. This is indicated by a systematic increase in subsidence rate from Late Ordovician

to late Silurian or Early Devonian, creating subsidence curves with convex shapes typical of foreland basin development. The maximum rate of tectonic subsidence in the western Baltic Basin reached up to 500 m/My in the Late Silurian time. The Late Ordovician to late Silurian/Early Devonian phase of the development of Peri-Tornquist system of sedimentary basins is interpreted here as a flexural foredeep related to a Caledonian collision zone located further to the SW. In the Baltic Basin, the Silurian foredeep model is also supported by deep seismic data illustrating seismic horizons onlaping eastwards, i.e. outwards of the collision zone.

Since Late Ordovician the rate of detritus deposition also increased with time in all the analysed basins, reaching in the Late Silurian in the western Baltic Basin maximum values up to 1000 m/My. Such a high deposition rates requires very active sediment source area, which in this case was located in the Caledonian collision zone. This nature of the provenance area is confirmed by isotope dating of detrital mica, indicating Caledonian metamorphism, presumably of orogenic nature, in the sediment source area. The regional facies distribution of the Upper Ordovician and Silurian, with the open marine mudstone to sandstone dominating in the western parts of the basins and carbonates riming the basins from the east, is coherent with the foredeep basin model. The concept of convergence and collision of Avalonia and Baltica is also confirmed by palaeomagnetic analysis and provenance studies. Convergence-related subduction is evidenced by common presence of K-bentonites, derived form subduction-related volcanic island arc.

The prominent diachronism of the initiation of the foredeep basin development at a scale of whole SW margin of Baltica is coherent with the model of oblique collision of Avalonia and Baltica. This refers to initiation of the foredeep development, the starved basin phase, the main phase of rapid supply of detritus from the west, and the termination of foredeep basin development. The lower thickness of the Caledonian foredeep sedimentary fill in the Volyn-Podillya-Moldavia Basin (VPMB) compared with the Lublin-Podlasie Basin and Baltic Basin might indicate a more distal (south-eastward) position of the VPMB relative to a Caledonian collision zone and a tectonic load associated.