Factors controlling a depositional architecture in synorogenic Outer Carpathian basins – an example of Oligocene-age successions from the Fore-Magura Unit, Poland

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A Fore-Magura Unit is strongly tectonically-engaged tectonic unit of the Polish Outer Carpathians, sandwiched between Magura and Silesian nappes. Due to poor and sparse exposure of the Fore-Magura Unit, which is covered by the Magura Nappe, there has been no comprehensive interpretation of depositional systems of the Fore-Magura Basin (Eocene–Oligocene), a part of the Paratethys realm. Therefore, in order to broaden our knowledge about depositional conditions in this part of the Outer Carpathian basins, two turbidite sequences (Szczawa and Klęczany) were subjected to detailed lithofacies and sedimentological analysis.

The 100 m thick Szczawa section is predominantly composed of thin and medium thick turbidite sandstones associated with co-genetic turbidite mudstones, which thickness greatly exceeds that of underlying sandstone. The latter ones show another peculiar features, like opposite palaeocurrent directions between base and top of a bed, mud-rich banded and heterolithic structures, and combined-flow bedforms, including small-scale hummocky-type structures. All those sedimentary features reflect deposition from mud-rich low-density turbidity currents enclosed within small confined basin, which prevent each flow from further down-current propagation, and eventually resulted in trapping (ponding) of the whole flow within confinement, a process associated with flow reflections and internal Kelvin-Helmholtz waves propagation (Siwek *et al*., 2023). This mini-basin can be situated on the southern flank of the Fore-Magura Basin, i.e., on the slope of the Fore-Magura Ridge (Siwek *et al*., 2023).

The 170 m thick succession at Klęczany is composed of thick-bedded amalgamated sandstones, grading into sandstone-mudstone turbidite sequences. The former reflect deposition from high-density turbidity currents and hybrid flows, and are stacked into a few to over ten metres thick tabular lobes, and can be interpreted as lobe axis or distributary channel deposits. These lobes are often topped by so-called 'bypass' facies indicating the moment a lobe attained a critical thickness which prevented the accommodation of new deposit, thus heralding a feeder channel avulsion. The recurring process of lobe building and feeder channel avulsion resulted in compensational stacking of subsequent lobes (Piazza & Tinterri, 2020). The upper part of the Klęczany section reflects deposition from low-density turbidity currents and aggradation of turbidite beds into upward-thickening sequences resulting from lateral compensation and/or forward progradation of subsequent lobes. Considered as a whole, the Klęczany succession is fining upward, and shows decrease of sand net-to-gross, accompanied by increase of more distal facies. Therefore, that depositional system can be situated within single submarine base-of-slope fan featured by retrogradational stacking pattern.

Ponded turbidite beds, together with their whole inventory of sedimentary structures, are an evidence of the crucial influence of structural confinement on unrestricted flow propagation on the seafloor. The presence of structural confinement on the basin slope may have been associated with regional compression and tectonic activity of the Outer Carpathian basins. In the case of the Klęczany section, short-term autocyclicity is manifested in compensational lobe stacking pattern and cyclic feeder channel avulsions. A long-term variability, probably covering the whole Fore-Magura realm, can be identified with one sequence stratigraphy cycle – from forced regression resulting from sea-level falling stage to sea-level lowstand, reflected in the transition from amalgamated massive sandstones to sandstone-mudstone turbidite sequences (Catuneanu, 2006). Alternatively, the uplift-denudation cycle due to tectonic activation of source area (Mutti *et al*., 2003) can be considered as an explanation of retrogradational stacking pattern of the Klęczany Fan, with eustatic sea-level fall involved (Pszonka *et al*., 2023).

To conclude, the regional and local changes of depositional conditions in deep-water basins can be related to tectonics, as well as to eustatic short- or long-term sea-level changes, or combination of both, and can give the readable rock record in sedimentary successions accumulated especially in synorogenic marginal basins (Pszonka *et al*., 2023). These include foreland-type Outer Carpathians basins during Oligocene times, which were located in the Central Paratethys isolated from the Tethys Ocean during Eocene-Oligocene geotectonic reconstruction of the Circum-Carpathian realm.

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References

Catuneanu O., 2006. *Principles of Sequence Stratigraphy*. Elsevier, Amsterdam.

Mutti E., Tinterri R., Benevelli G., di Biase D. & Cavanna G., 2003. Deltaic, mixed and turbidite sedimentation of ancient foreland basins. *Marine and Petroleum Geology*, 20(6–8): 733–755. https://doi.org/10.1016/j.marpetgeo.2003.09.001.

Piazza A. & Tinterri R., 2020. Cyclic stacking pattern, architecture and facies of the turbidite lobes in the Macigno Sandstones Formation (Chattian-Aquitanian, northern Apennines, Italy). *Marine and Petroleum Geology*, 122: 104704. https://doi.org/10.1016/j.marpetgeo.2020.104704.

Pszonka J., Wendorff M. & Godlewski P., 2023. Sensitivity of marginal basins in recording global icehouse and regional tectonic controls on sedimentation. Example of the Cergowa Basin, (Oligocene) Outer Carpathians. *Sedimentary Geology*, 444: 106326. https://doi.org/10.1016/j.sedgeo.2022.106326.

Siwek P., Waśkowska A. & Wendorff M., 2023. Mud-rich low-density turbidites in structurally-controlled intraslope mini-basin: The influence of flow containment on depositional processes and sedimentation patterns (Szczawa, Oligocene, Polish Outer Carpathians). *Sedimentology (Early View)*. https://doi.org/10.1111/sed.13095.