

**LITHOFACIAL DEVELOPMENT OF THE UPPER JURASSIC  
AND LOWER CRETACEOUS DEPOSITS IN THE DĄBROWA TARNOWSKA-  
DEBICA AREA BASED ON THE 3D SEISMIC INTERPRETATION**

**Abstract**

The main subject of this dissertation is the reconstruction of the history of deposition and facial development of the Upper Jurassic and Lower Cretaceous deposits occurring in the basement of the Carpathian Foredeep, based on the data available from boreholes and on 3D seismic. The research area is located in the central part of the Carpathian Foreland, between two cities: Dąbrowa Tarnowska in the north-west and Dębica in the south-east.

The new 3D seismic survey "Jastrząbka-Żarówka" made in 2015 as well as the drilled in the same year and recognizing full profile of the Mesozoic sediments Osice-1 deep borehole allowed for much better recognition and documentation of many details of the geological structure of this previously poorly recognized area.

The sedimentation of the studied carbonate formations of the Carpathian Foreland during the Late Jurassic and the Early Cretaceous took place in the shelf zone of the northern, passive margin of the Tethys Ocean. A characteristic feature of the Upper Jurassic sediments is their high facial diversity, mainly due to the presence of biohermal complexes and sets of layered marly-limestone sediments.

Chapter 2 presents the details of the geological structure of the studied area, including the lithological development, applied lithostratigraphic divisions, palaeogeographic frameworks as well as the tectonic development of the Carpathian Foreland in particular geological epochs. Chapter 3 discusses both the history of research and the current state of knowledge regarding the Upper Jurassic and Lower Cretaceous carbonate sediments of the Carpathian Foreland.

Chapter 4 contains the lithological characteristics of the studied carbonate sediments, considering lithostratigraphic units. This characteristic is based on macroscopic examination of the available core material as well as on the well logs analysis. This chapter also contains lithostratigraphic profiles of selected deeper boreholes from the research area (Osice-1 and Nieczajna-4) as well as from its close vicinity (Żukowice-39 and Oleśnica-3). These lithostratigraphic profiles contain well logs (gamma and resistivity) and lithology interpreted from well logs, core intervals, fauna and flora assemblages, lithostratigraphic units and the estimated age of the studied formations. These profiles document the current state of knowledge on lithostratigraphy and facies development of the Upper Jurassic as well as of the Upper Jurassic/Lower Cretaceous boundary in the research area. In order to document the lithostratigraphic members of the Early Cretaceous age the lithostratigraphic profile of Wiewiórka-4 borehole has been attached, this well having been fully cored within the Lower Cretaceous part of profile.

Chapter 5 features the microfacial and micropalaeontological characteristics of the studied carbonate sediments. Basing on the results of many years research and literature data possibilities of determining the age of every lithostratigraphic unit have been discussed.

Chapter 6 presents the results of the seismic 3D image analysis ("Gruszów-Nieczajna" and "Jastrząbka-Żarówka" seismic surveys) made on the basis of selected seismic attributes. As part of the work the following attributes have been discussed: *RMS Amplitude, Envelope, Instantaneous phase, Dominant frequency, Instantaneous bandwidth, Apparent polarity, Relative acoustic impedance, First derivative, Iso-frequency component, Time Gain, Chaos, Variance (Edge method), and Local flatness*. The conducted analysis of the 3D seismic image, based on the use of selected seismic attributes, allowed to obtain additional important information regarding both the lithological development and the spatial range of sediments of individual lithostratigraphic units, at the same time facilitating the detailed location of fault zones. By basing on the interpretation of the seismic record within the studied rock complex, the occurrence of angular unconformity, disturbance and deformation zones related to synsedimentary tectonic as well as probable sediment gravity flows have also been documented.

Chapter 7 presents lithofacial cross-sections constructed along selected seismic cross-sections and an analysis of the Upper Jurassic biohermal complexes distribution in relation to the morphology of the Jurassic base surface. An analysis of distribution of organic buildups belonging to the Huge Sponge-Microbial Bioherms Series and interpreted indirectly from seismic image indicates two main areas of their occurrence, i.e. the Gruszów region in the NW part of the studied area where a quite extensive biohermal complex occurs; its exact range is difficult to be determined due to later regional dolomitization processes, and the Osice area located in the central and NE part of the analyzed seismic survey where a complex of several very tall buildups with steep edges was found.

Chapter 8 is devoted to the issue of the depositional history of the Late Jurassic - Early Cretaceous sedimentary basin of the Carpathian Foreland as well as to discussion of the role of the most important factors affecting the facies distribution in the research area. It has been shown that the characteristic feature of a large part of the Jurassic sediments is strongly diachronic nature of the distribution of facies controlled by varying bottom relief of the sedimentation basin as well as by some associated with synsedimentary tectonics local factors.

The Sponge-Globuligerinid Series beginning the profile of the Upper Jurassic sediments and representing the deepest sedimentation stage in the open shelf conditions is characterized by a relatively high homogeneity of lithology in the whole Carpathian Foreland area. The biohermal facies development zones are associated with a large horst element of NW-SE extent. The Paleozoic basement of this segment can be distinguished by a number of tectonic blocks separated by fault zones and forming a fragment of the Caledonian-Variscan tectonic system. The Osice biohermal complex had developed over the elevated zone composed of several smaller tectonic elements, while the Gruszów biohermal complex had developed on a large, elevated part of the horst zone. There is a single tectonic block in the Paleozoic basement of this zone, with culmination in the Gruszów-1 borehole area. The intensively developing Gruszów and Osice biohermal complexes were more and more affecting successive deposition of the Late Jurassic sedimentary basin in the studied area. Those biohermal complexes were

the source of the material redeposited into deeper parts of the sedimentary basin. On seismic profiles in the SE neighbourhood of the Osice biohermal complex there appears a characteristic high amplitude record including the entire reflection package of variable dip angles. Frequent polarity changes visible within this zone in the *Apparent polarity* attribute as well as the extremely variable range of values the *Relative acoustic impedance* attribute prove strong lithological differentiation of this rock complex.

In the Tithonian, during the sedimentation of the Coral-Oncolite Series there was clear unification of the sedimentation conditions in the entire Carpathian Foreland area, mainly due to disappearance of the bottom relief diversity. At the same time there occurred another stage of dislocation reactivation, as evidenced by angular unconformity found throughout the area of the analyzed seismic survey as well as distinct erosion traces of older sediments associated with this unconformity.

The deposits of the Lower Shellbed-Oolite Series scattered throughout the research area represent various types of shallow-water sedimentation environments (including tidal, lagoon and barrier zones) that developed in the Carpathian Foreland area on the borderline between the Late Jurassic and the Early Cretaceous. The sedimentation environment of the Marly-Shellbed Series dated to the Berriasian can be described as extremely shallow-water, with lagoon facies and under influence of brackish environments.

The sediments of the last two series of the Lower Cretaceous (i.e. Mudstone-Limestone and Upper Shellbed-Oolite Series) represent the shallow-marine facies associated with marine transgression that took place in the Valanginian.

The supposed effects of the Late Jurassic tectonic activity, i.e. angular unconformity and visible deformations of rock layers in the next to fault zones have been interpreted and documented. Those type of deformations are manifested by the breaking of the continuity of seismic reflections and by the presence of flexure systems distributed in the close vicinity of the fault zones. Deformation structures observed in the seismic image as well as large share of sediments interpreted as redeposited in the Upper Jurassic profile clearly indicate synsedimentary activity of the fault zones.

Presented depositional history of the Late Jurassic - Early Cretaceous sedimentary basin of the Carpathian Foreland combined with macroscopic examination of the available core material, microfacial and micropalaeontological analysis of individual lithostratigraphic units and with interpretation of the seismic image allows for comprehensive characterization of the analyzed formations and makes possible the indication of processes that have had the greatest impact on the current character and preservation of the studied rock series.