Defining “Sweet Spots” of the Upper Jurassic Unconventional Hydrocarbon System in Central Part of the Mid-Polish Trough Using Seismic Inversion, Seismic Attribute Analysis and Seismic Stratigraphic Modelling

Lukasz Slonka[1], Piotr Krzywiec[1], Marta Mulinska[2], Tomasz Rosowski[2], Michal Malinowski[3], Marta Cyz[3], and Paulina Krakowska[4]

[1]Institute of Geological Sciences, Polish Academy of Sciences
[2]Strzelecki Energia Sp. z.o.o
[3]Institute of Geophysics, Polish Academy of Sciences
[4]AGH University of Science and Technology

Abstract

The Permian to Cretaceous Mid-Polish Trough was filled with several kilometers of Permian and Mesozoic sediments, including Upper Permian evaporites, and was completely inverted in Late Cretaceous - Paleogene times. The presence of thick salts gave rise to the development of a complex system of salt structures. Salt pillows and diapirs started to form in early Triassic, triggered at least in part by regional basement faulting. In the Late Triassic, some of the salt pillows reached diapiric stage. After their further growth in Jurassic to Early Cretaceous times, salt structures were compressionally reactivated during regional inversion of the Mid-Polish Trough. Continuous growth of salt structures strongly controlled Mesozoic depositional systems, with thinner sedimentary cover characterized by generally shallower facies developed above salt structures, and deeper facies located within the intervening synclines. The most complex salt structures are known from the central segment of the Mid-Polish Trough. In this area, Upper Kimmeridgian - Lower Tithonian shales (Paluki Fm.) are up 130m thick, with TOC's up to 4.5%. Oil in open fractures has been frequently noted in the Upper Tithonian carbonates located above these shales. Newly acquired high-resolution 2D seismic data together with reprocessed legacy data and well data, including geochemical logs and cores measurements, were analyzed to determine lithological and thickness variations and facies changes of the Upper Jurassic intervals. Synthetic seismograms were analyzed in order to understand seismic response of various lithologies and facies. Litho-facies lateral extent was studied using seismic inversion. Lithology prediction was deployed using model-based post-stack seismic inversion algorithm. Complex trace attributes were analyzed in order to determine lateral and vertical lithological changes of the studied Upper Jurassic succession. Seismic inversion results proved that deeper facies, including organic-rich shales, are thickening toward the center of the synclines located between salt structures, and that shallower facies (carbonates) tend to thicken towards the margins of the salt-controlled sub-basins. 1D & 2D seismic stratigraphic modelling helped to understand relationship between the TOC variations and seismic wave field. Obtained results, combined with tectonic analysis, allowed for better definition of the "sweet spots" of the Upper Jurassic unconventional hydrocarbon system in the study area.