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The Dependence of Carbonate Pore Geometry on Fossils: Examples from Zechstein, Poland

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Abstract : Carbonate porosity can be deceptive in the aspect of hydrocarbon exploration due to pore geometry variations, which are to some extent controlled by fossils. Therefore, the main aim of this paper was to assess the dependence of pore geometry and reservoir quality on fossils. The Permian Zechstein Limestone (Ca1) carbonates from the Brońsko Reef, located on the Wolsztyn Ridge in West Poland, were examined. Seventy meters of drill cores were described along with well log examination and transmitted-light microscope research. The archival porosity-permeability data was utilized to calibrate the well logs and look for the potential petrophysical trends. Several organism assemblages were recognized in the reef. Its bottom was colonized by the branched bryozoans which were fragmented and dissolved leaving poorly connected molds. Subsequently, numerous bivalves and gastropods appeared and their shells were heavily dissolved to form huge, albeit poorly communicated caverns. Such pores were also typical for local brachiopod occurrences. Although the caverns were widespread, and probably linked to the meteoric dissolution or freshwater flushing, severe anhydrite cementation has destroyed the majority of pores. Close to the top of Ca1, near the center of the reef, the fossil-rich zone comprising fenestrate bryozoans, extremely abundant encrusting foraminifers, bivalves, brachiopods, gastropods and ostracods, was identified. The zone contained extremely frequent dissolution channels formed within former shells of foraminifers, which had previously encrusted the bryozoans. The deposition of Ca1 strata has ultimately terminated with a poorly porous and generally impermeable stromatolitic layer containing scarce fossils. In general, the permeability of the reef rocks studied turned out to be the highest under the presence of foraminifer-related channels. In such cases, it frequently approached 100 mD. The presence of channels and other pores gave the average effective porosity derived from shallow resistivity and helium porosimetry of around 16 and 18 %, respectively. The highest porosity (over 18 %), often co-occurring with relatively low permeability (chiefly below 20 mD) was noted for the bottommost zone of the reef, represented by branched bryozoans. This is probably owing to a large amount of unconnected bryozoan-related molds. It was concluded that fossils played a major role in porosity formation and controlled the pore geometry significantly. While the dissolution of bivalves and brachiopods resulted in cavernous porosity formation, numerous molds were typically related with the alteration of branched bryozoans, gastropods and ostracods. Importantly, the bendy dissolution channels after the encrusting foraminifers appeared to be decisive in improving reservoir quality – specifically when permeability is considered. Acknowledgment: The research was financed by the Polish National Science Centre’s project No. UMO-2016/23/N/ST10/00350.

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