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Faults within Aeolian Deposits in the Upper Rotliegend, Poland

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SUMMARY

Microimaging is a modern method of open hole logging. Imaging methods improve very fast and can be applied in all aspects of geology. Microresistivity measurements are oriented to the north, therefore the results can be presented as 3D images of rebored rocks. Microimaging can be used in the interpretation of sedimentological, structural geology and petroleum issues. It is helpful for the interpretation of detailed geology such as sedimentological features (bedding, current structures, size and shape of clasts, bioturbation, mass flow features, fluid escape structures, erosional surfaces) or structural data (natural fractures, microfaults, unconformities, induced fractures, breakouts).
Faults within the aeolian succession of the Rotliegend in Poland have so far not been studied. This fact resulted from the low resolution of seismic data for the Rotliegend succession caused by the thick overburden of the Zechstein evaporitic series. Additionally, the faults are characterized by low amplitudes, therefore their interpretation on seismic logs is much more difficult. Microimage analysis allowed interpreting fractures and faults within the Rotliegend aeolian deposits in the Fore-Sudetic Moncline. Faults can influence on the decrease of reservoir properties within the aeolian succession.

The Rotliegend deposits in the Fore-Sudetic Monocline are characterized by their high lithological and genetic variability. Apart from the prevailing aeolian deposits, the sections are composed also of fluvial deposits and, in their topmost parts, of sandstones linked with the Zechstein transgression (Aksamitowska 2003; Karnkowski 1999; Kiersnowski 1997; Nemec & Porębski 1981). The terminal phase of Rotliegend sedimentation was dominated by the sedimentation of aeolian deposits that during the Zechstein transgression underwent partial redeposition and were later cemented by a carbonate-sulphuric cement (Poszytek 2005). Rotliegend deposits in Poland have gained particular attention due to the numerous gas reservoirs occurring in the uppermost part of the succession.

Numerous faults have been recognized within the Rotliegend deposits; these faults to a considerable degree influenced facies distribution and thickness of the Upper Rotliegend deposits. The largest tectonic structure is the Poznań – Kalisz dislocation zone, with origins within the Variscan basement. Its amplitude reaches several hundreds of meters, and detailed 3D seismic interpretation allowed its precise recognition, as well as distinguishing several minor tectonic structures comprising the entire zone.

So far, various interpretations assumed that tectonic zones have relatively little influence on the formation of reservoir properties in aeolian deposits. Decrease of reservoir properties in aeolian deposits was interpreted as the result of changes in sedimentary conditions. The best reservoir properties were noted in dune deposits, in which porosity exceeds 20% and permaebility 1000 mD. Much lower reservoir properties have been noted in the inter-dune sediments, where porosity reaches 10% and permeability ca. 100 mD (Poszytek 2006). Thus, zones of decreased reservoir properties occurring within aeolian deposits have been interpreted as zones of interdune deposits that acted as lithofacies barriers for fluid migration. However, as proved in this report, significantly higher influence on the decrease of reservoir properties have faults occurring within the aeolian succession.

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Microimaging is a modern method of open hole logging. Imaging methods improve very fast and can be applied in all aspects of geology. 150 electrodes on 6 arms of the microresistivity tool can measure resistance of clastic, carbonate and sulphate rocks (XMRI tool). Microresistivity measurements are oriented to the north, therefore the results can be presented as 3D images of rebored rocks.

Microimaging can be used in the interpretation of sedimentological, structural geology and petroleum issues. It is helpful for the interpretation of detailed geology such as sedimentological features (bedding, current structures, size and shape of clasts, bioturbation, mass flow features, fluid escape structures, erosional surfaces) or structural data (natural fractures, microfaults, unconformities, induced fractures, breakouts). Additional microimaging can be used for qualitative estimation of reservoir properties through detailed characteristics of the reservoir rocks and indication of secondary porosity (open fractures, dissolution features).

Microimage analysis allowed interpreting fractures and faults within the Rotliegend aeolian deposits in the Fore-Sudetic Moncline (Fig. 1). Earlier attempts supplied unequivocal results. The data obtained by a six arm dipmeter were not satisfactory. The diversity of sedimentary structures, numerous erosional boundaries, gradual transition from interdune to dune deposits caused that univocal interpretation of fractures and faults based on dipmeter data was not possible. An example of such discrepanices is presented in Fig. 1, where a fragment of the Rotliegend succession based only on strike and dip data is interpreted. The section shows two distinct complexes of aeolian deposits. The lower is characterized by large-scale cross-stratification, dipping at 10-20° S. The upper aeolian complex reveals lower dips to the north. At 6316.7 m lies the boundary between the two complexes. Based solely on strike and dip data, the character of this boundary cannot be univocally interpreted. It may be both an erosional boundary as well as a fault. Additionally, if a fault interpretation is assumed, the nature of the fault remains unknown.

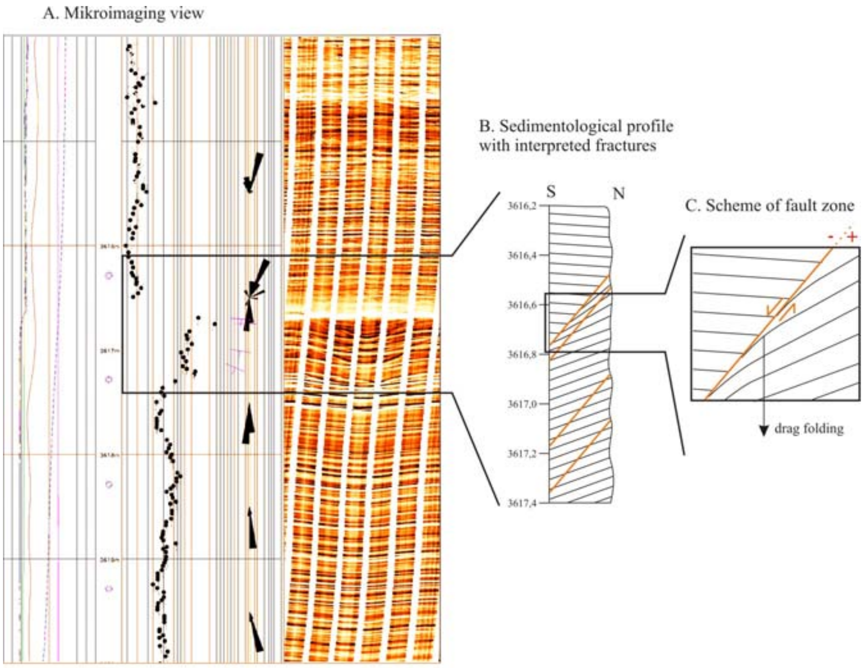

Figure 1 *Interpretatation of faults in the Rotliegend deposits based on microimaging data.*

Due to the precise visualization of geological structures, microimaging allows independent distinguishing of sedimentary and tectonic structures and their further interpretation. Microimaging allowed to interpret fractures occurring at the boundary of the two aeolian complexes. The fractures are distinctly marked on the microimages (Fig. 1a). They occur in sets and dip at ca. 55° S. Anomalously high bedding dips have been observed near the fractures, what may be interpreted as drag folding. Based on this the fault character may be interpreted; in this case it is a normal fault (Fig. 1c).
Detailed interpretation of faults and their character in aeolian deposits of the Rotliegend is indispensable in determining the presence of potential entirely or partially sealed zones along the faults.

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