Geophysical Research Abstracts
Vol. 18, EGU2016-18157-1, 2016
EGU General Assembly 2016

An integrated profile of natural fractures in gas-bearing shale complex (Pomerania, Poland): based on structural profiling of oriented core and borehole logging data.

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Natural fractures in gas-bearing shales has significant impact on reservoir stimulation and increase of exploitation. Density of natural fractures and their orientation in respect to the maximum horizontal stress are crucial for propagation of technological hydraulic fractures. Having access to continuous borehole core profile and modern geophysical logging from several wells in the Pomeranian part of the Early Paleozoic Baltic Basin (Poland) we were able to compare the consistency of structural interpretation of several data sets. Although, final aim of our research is to optimize the method of fracture network reconstruction on a reservoir scale, at a recent stage we were focused on quantitative characterization of tectonic structures in a direct vicinity of boreholes. The data we have, cover several hundred meters long profiles of boreholes from the Ordovician and Silurian shale complexes. Combining different sets of data we broaden the scale of observation from borehole core (5 cm radius), through XRMI scan of a borehole wall (10 cm radius), up to penetration of a signal of an acoustic dipole logging (several tens of cm range).

At the borehole core we examined the natural tectonic structures and mechanically significant features, like: mineral veins, fractured veins, bare fractures, slickensides, fault zones, stylolites, bedding plane and mechanically contrasting layers. We have also noticed drilling-induced features like centerline fractures and core disking, controlled by a recent tectonic stress. We have measured the orientation of fractures, their size, aperture and spacing and also describe the character of veins and tried to determine the stress regime responsible for fault slippage and fracture propagation. Wide range of analyzed features allowed us to discriminate fracture sets and reconstruct tectonic evolution of the complex.

The most typical for analyzed shale complexes are steep and vertical strata-bound fractures that create an orthogonal joint system, which is locally disturbed by small-scale faults and fractures, associated with them. For regular joints, observed on borehole core, we have calculated variation of mean height and area and volume of mineralization for veins. Fracture density variation reveals good correlation with lithological shale formations which are comparable with Consistent Mechanical Units differentiated based on detailed lithological profiling and geophysical data (see Pachytel et al., this issue).We have also proposed a new method of a rose diagram construction presenting strike of fractures taking into account their size and angular error bar in strike determination. Each fracture was weighted with its length or aperture and an angular error was included by blurring the less credible records. This allowed for more precise adjustment of fracture sets direction in comparison to conventional diagrams without weighting procedure.

Recently, we are processing acoustic dipole logs for anisotropy analyses aiming in comparison with density of fracture sets. Our study, which is conducted in the frame of ShaleMech Project (within Blue Gas Program) is in progress, thus the presented results should be considered as preliminary.