Brittleness Prediction From Seismic Data – A Case Study From the Lower Paleozoic Shales in Northern Poland

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ABSTRACT

There are many parameters that should be taken into account when planning wells and completions in the unconventional plays. It is also vital that the reservoir zones are brittle. Here, we applied a workflow that allowed us to differentiate brittle and ductile rocks of the Lower Paleozoic shale play in Northern Poland (Baltic Basin) from surface seismic data. We start from the brittleness evaluation using well logs at the borehole location by applying both: 1) elastic moduli, and 2) mineral content-based methods. The four wells located in our seismic survey have P-wave sonic, S-wave sonic and density logs available as well as mineralogy measurements from mineralogical logging tools. As the well log based brittleness gives us information only near the borehole, we estimate brittleness of the reservoir in three dimensions at seismic scale by integrating well logs and set of rock-elastic property volumes that are calculated based on the simultaneous AVO inversion results. For elastic seismic brittleness estimation we apply the combination of Poisson's ratio and Young's modulus, whereas for mineral contents-based seismic brittleness we use a proximal support vector machine algorithm (PSVM). By using PSVM, we obtain a classification pattern between rock-elastic properties and mineral-based brittleness that is next applied to the inverted rock-elastic property volumes. The main problem with this method is related to the limited number of available wells to train the algorithm and validate it, as well as the classification itself. Mineralogical brittleness predicted from seismic shows more details as compared to the mechanical one. However, because of the low resolution of the input seismic data as well as low thickness of the target intervals, we are able to obtain the satisfactory results only for the lower reservoir (Upper Ordovician Sasino formation). The Lower Silurian Jantar formation is not thick enough and for most of the survey falls below seismic resolution. This work has been funded by the Polish National Centre of Research and Development (NCBR) within the Blue Gas project (No BG2/SHALEMECH/14). Data were provided by the PGNIG SA. We thank Oil and Gas Institute – National Research Institute for well data analysis. We thank the AASPI consortium (University of Oklahoma) for the license to use their proprietary software and CGG GeoSoftware for the donation of the Hampson-Russel Strata and AVO software.