INTEGRATION OF MICROSEISMIC AND SEISMIC DATA

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Introduction

The scope of microseismic research is usually limited to the study of induced and/or triggered seismic phenomena resulting from stimulation processes of liquid mineral deposits and induced and excited at sites of fluids injection to lithosphere layers for their storage, disposal and utilization. In this approach, these are all quakes caused by these processes, both induced, i.e. arising directly because of injection into rock layers, as well as triggered. The microseismic quakes, which are recorded during the exploitation of crude oil, natural gas and geothermal energy, are an expected phenomenon and in this case also desirable, provided that the released energy will not reach the size that could pose a threat. Their presence is a direct evidence of development of a fracture network resulting from injection of liquid into the rock mass and thus creating propagation paths for fluids being exploited.
The essence of exploration for unconventional deposits is to determine the optimal location of the borehole for the hydraulic fracturing process. Locations of microseismic events can provide indirect information about the size of the fractured zone and the direction of development of the resulting fracture network (Eisner, et al., 2010). An important element in its interpretation is the determination of the uncertainty of the location of epicentres, as well as the identification of errors resulting from the used method of acquisition (Maxwell & Deere, 2010).

Results

Dataset used in this study was obtained during a hydraulic stimulation of layers prone for unconventional gas accumulations in Silurian and Ordovician layers in Peribaltic Syneclize. Stimulation was done by PGNiG in 2016 in two horizontal wells (W2Hbis and W3H) spanning up to 2 [km] from the monitoring well and both where attempting to explore parts of the reservoir. Wells are in a centre of a high-quality reflection seismic survey that during research project was reprocessed. Analysis of seismic data was done with special emphasis on preservation of relative amplitudes, leading to a reliable estimation of petrophysical parameters during seismic inversion. In the vicinity of both trajectories it was possible to obtain geomechanically parameters utilizing prestack simultaneous inversion. On the same dataset a study that tackle geometrical description of reflections was done, based on geometrical attributes like most positive, negative and mean curvature, semblance and estimation of local dip and azimuths.
Microseismic data was recorded in both wells utilizing identical monitoring array that was planned to minimize location uncertainties as well as cost of the acquisition itself. The array was design utilizing seismic modelling, where different scenarios have been tested. The overall detection threshold was higher than expected due to lower attenuation than assumed in the simulation phase. Processing of the downhole data was done in two variants, one assuming an isotropic and one anisotropic model. Initial values of anisotropy parameters have been estimated based on the dipole sonic log. Estimation of moment magnitudes was preceded by an attenuation study. Knowledge of moment magnitudes was used as a normalization parameter, so it was possible to filter dataset based on the estimated detectability level, making the obtained catalogue complete.
In this study we present possibilities of joint interpretation of microseismic monitoring and reflection seismic to investigate the connection between spatiotemporal distribution of the microseismic events and parameters derived from active seismic data. While in a reference study, about 70 km to the North, a correlation between distribution of events, and their characteristics, with reflection seismic has revealed that stimulation as done

in small scaled discontinuity. In this case it was revealed that distribution of events has correlation with changes of geomechnical parameters (Fig. 1.) in subsurface, that can be well seen but also changes the D value (Grassberger,1983) of the microseismic clouds. Based on those results it can be concede that connection of the geological and seismic model with the results of microseismic monitoring is an important source of knowledge about the development of the hydraulic fracturing process.

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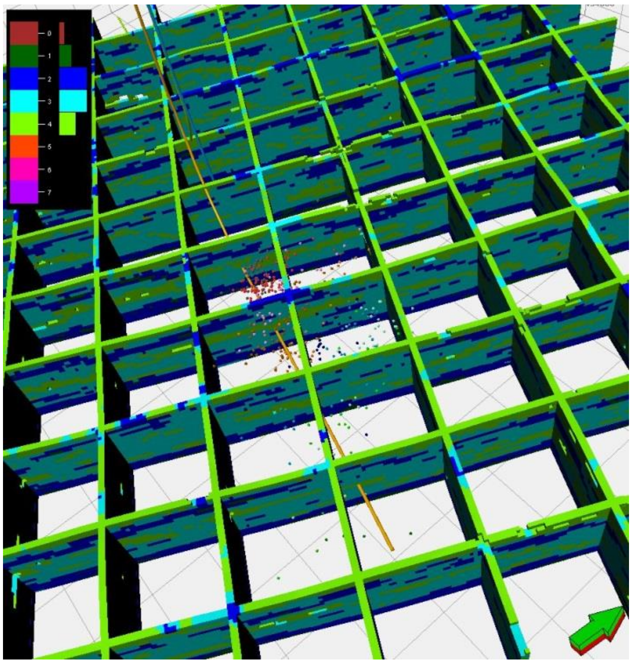

Figure 1. *Fence diagram near W2Hbis. Colour scale represents the result of classification based on the probability analysis distinguishing classes of "fracability" in the LMR space (Pasternacki, 2016), where higher describe layers more prone to fracturing.*

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