



ASSESSING THE INFLUENCE OF THE SEISMIC ACQUISITION PARAMETERS ON SEISMIC DATA QUALITY – THE WIERZBICA 3D AGH SEISMIC EXPERIMENT

Jan BARMUTA¹, Monika KORBECKA¹, Justyna SOWIŃSKA-BOTOR¹, Wojciech MASTEJ¹,
Krzysztof DZWINEŁ², Arkadiusz BUNIAK²

¹AGH – University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, al. Mickiewicza 30, Krakow, Poland, jbarmuta@agh.edu.pl

²Orlen Upstream, ul. Bielańska 12, Warsaw, Poland

Introduction

Unconventional reservoirs often require more detailed and accurate seismic imaging. However, due to the economic aspect, the vital point is to reduce costs of seismic surveys without significant loss on data quality. So far seismic imaging of the Ordovician – Lower Silurian shale complex, considered as a target for “shale gas” deposits, was poor, mainly due to low acoustic impedance contrasts within the Silurian interval as well as inappropriate design of seismic surveys. The experimental Wierzbica 3D AGH seismic survey was carried out to test the ability of seismic method to image intra Silurian stratification and subtle structural features as well as to quantify the influence of the acquisition parameters, i.e. shot and receiver lines spacing, shot points and receivers offsets on seismic data quality. We have tested the processed seismic data quality based on signal-to-noise ratio (SNR), effectiveness of the wavelet extraction procedure, seismic-to-well accuracy and reliability of seismic attributes.

Samples and methods

The basic acquisition scheme of the Wierzbica 3D AGH seismic survey envisaged 120 m shot line and receiver line spacing, while shot point and receiver point offsets equal 20 m and 40 m respectively. During the processing phase selected shots/receivers points or whole shot/receivers lines were filtered out to simulate different acquisition pattern. As a result 21 different seismic cubes were produced during the processing phase. We have chosen seven of them differing in shot lines and receiver lines spacing (Tab. 1) to evaluate influence of this parameter on seismic data quality. For each seismic cube the following procedures were performed:

1. the SNR was calculated using the coherence method (White 1973) within a time gate encompassing the Lower Paleozoic sedimentary complex,
2. the synthetic seismogram was created using the theoretical Ricker wavelet and borehole data from the Stręczyn-OU1 well located in the center of the seismic survey, and further, the cross-correlation value was used as an indicator of the seismic data quality,
3. based on the borehole and seismic data the wavelets were extracted and used for synthetic seismogram generation. The cross-correlation value was again used as a gauge of seismic data quality,
4. using established workflow and parameters (Barmuta et al. 2017) a complex structural attribute was calculated and automatic fault extraction was applied for each cube. The number, size and strike and dip attributes of extracted fault patches were then analysed and compared for each cube.



Table 1. Basic acquisition parameters for tested versions (cubes) of the Wierzbica 3D AGH seismic survey. Shot point spacing for all cubes equals 40 meters and bin size 20x20 meters. Processing workflow was identical for all cubes.

		Shot line spacing [m]		
		120	240	360
Receiver line spacing [m]	120	Cube 1	Cube 12	Cube 6
	240	Cube 12A	Cube 2	
	360	Cube 5		Cube 3

Results

Results of the SNR calculation reveals that there are almost no significant differences between cubes' pairs 12A–12 and 5–6. However, cube 6 exhibits slight shift towards higher SNR values. The cross-correlation values calculated for synthetic seismograms based on theoretical Ricker wavelet also indicate that cubes 12 and 12A and 5 and 6 are almost equal. The results of the wavelet extraction procedure was comparable for all seven versions. The seismic attributes analysis shows that number of fault patches increase for cubes with lower SNR, while histograms of dip azimuth show lower dispersion for cubes with higher SNR.

Conclusions

Within the range of tested parameters the equivalence of shot lines and receiver lines spacing is noticed. Slightly better results of the cube 6 compared with the cube 5 may be linked to the higher regularity of receiver points location. Based on our results we suggest that shot points or even shot lines may be successfully replaced by receivers without loss in data quality.

Acknowledgements

The works were finance by Polish National Center for Research and Development grant under the Blue Gas – Polish Shale Gas Program (GAZLUPSEJMS). Additionally Jan Barmuta, and Wojciech Mastej were financially supported by Departments' Statutory Works.

References

- Barmuta J., Hadro P., Dzwinel K. 2017. Determination of fracture distribution based on seismic attributes and geomechanical modelling: Acta Mineralogica-Petrographica, 32, 614 4–5.
- White R.E., 1973. The estimation of signal spectra and related quantities by means of the multiple coherence function, Geophysical Prospecting 21, 660-703.