

Title of doctoral thesis: **Determination of the quality factor  $Q$  from microseismic events induced during the hydraulic fracturing process and evaluation of its applicability in microseismic data processing**

### **Abstract**

An important factor affecting the energy loss of a propagating seismic wave in a geological medium is the value of attenuation, which is related to the physical characteristics of the medium in which the wave propagates. The quantification of attenuation in a geological medium can be expressed by the quality factor  $Q$ .

The main objective of the presented dissertation, entitled "Determination of the quality factor  $Q$  from microseismic events induced during the hydraulic fracturing process and evaluation of its applicability in microseismic data processing" is the determination of the quality factor  $Q$  in Silurian and Ordovician strata in the Baltic Basin, and use of this parameter in the author's methodology of analysis of the effectiveness of the surface network, monitoring the process of hydraulic fracturing.

The studies involved the processing of microseismic data recorded during hydraulic fracturing of the Lubocino 2H and Wysin 2H/2Hbis wells. Monitoring of hydraulic fracturing of these wells was carried out with the use of both borehole and surface networks. Processed microseismic data recorded by monitoring networks placed in deep boreholes (Lubocino-1 and Wysin-1) were used for the estimation of quality factor  $Q$  in fractured layers. Quantitative information on attenuation of geological medium expressed as a value of  $Q$  was then taken into account in comparison of the effectiveness of networks from the Lubocino-1 and Wysin-1 wells. Additionally, the value of  $Q$  parameter was taken into account in the assessment of the effectiveness of surface network, monitoring the process of hydraulic fracturing in the Lubocino 2H well.

The Quality factor for P-wave and S-wave in the Lubocino 2H well are 60 and 90, respectively, while in the Wysin 2H/2Hbis well - 100 and 124. It was found that lower attenuation (higher value of  $Q$ ) in formations fractured in the Wysin

2H/2Hbis well was one of the key elements in relation to increasing distance of recorded microseismic events. It was found that conducting surface microseismic monitoring of hydraulic fracturing within the Lower Paleozoic basin is difficult, due to the i.e. large depth of fractured formations, the presence of thick highly attenuating Zechstein strata, and a significant thickness of loose postglacial sediments building the near-surface layer. Surface monitoring network in star geometry is not recommended.

*Keywords: attenuation, microseismicity, shale gas, quality factor*

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