# ESTIMATION OF THE QUALITY FACTOR BASED ON THE MICROSEISMICITY RECORDINGS FROM NORTHERN POLAND

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The range of the hydraulic fracturing process can be described using microseismic event locations. The most common method for the recording of microseismicity is using either surface or downhole monitoring network (Maxwell et al., 2010, Duncan and Eisner, 2010). Microseismic data not only provides information about the size and development of the fracture network but also brings additional information on medium properties as the seismic waves travel through the reservoir (e.g., Grechka and Yaskevich, 2014).
One of the fundamental properties of the reservoir which can be recovered from observed microseismic events is seismic attenuation. This parameter can be estimated using VSP data (e.g., Rutledge, 1989) or estimated from sonic logs (e.g., Leiner, 2014 ). Eisner et al. (2013) proposed to use the peak frequency of observed microseismic arrivals to invert attenuation from microseismic datasets and applied it to surface and downhole monitoring.
Eisner et al. (2013) showed that attenuation factors Qp and Qs for P- and S-waves, respectively can be estimated from the peak frequency of observed microseismic events measured at downhole or surface receivers. These factors can be estimated from the simple equation:

$$Q = \pi f_{peak} \Delta t \, , \qquad (1)$$

Where $f_{peak}$ is peak frequency of the corresponding seismic wave and the $\Delta t$ is traveltime of the corresponding seismic wave from the microseismic event to the receiver. This equation is generally valid in a heterogeneous medium. Determining accurate measurements of attenuation factor Q by using peak frequency method relies on two parameters: traveltime $\Delta t$ which is dependent on assumed velocity model and peak frequency measured at the receivers.
To measure the peak frequency ($f_{peak}$) we can use either Fast Fourier Transform (fft) or half-period measurement. Wcisło and Eisner (2016) showed in their work that the second approach gives more reliable and consistent measurement of the peak frequency. An example of $f_{peak}$ measurement is illustrated in fig. 1.

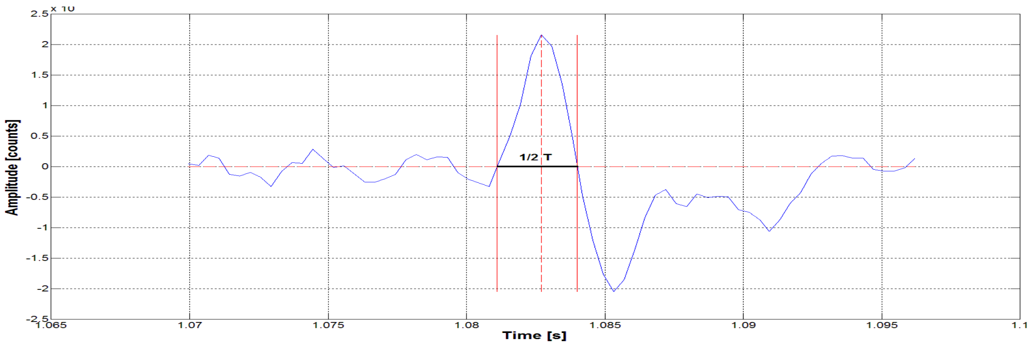


***Figure 1.*** *Particle velocity recording on a downhole instrument (horizontal component) as of strong microseismic event. The peak frequency of S wave is measured as a time interval between two zero crossings marked by the vertical red lines.*

In this study we analyze two downhole microseismic datasets recorded during hydraulic stimulation of Lubocino 2H and Wysin 2H/2Hbis wells. Based on the spectral characteristic and event locations we estimate the attenuation of the stimulated areas.
For the Lubocino dataset, we were able to obtain reliable estimates of the quality factor for the P-waves only for events from stages 1, 4 and 5 because the waveforms from stage 2 were interfered and were not suitable for inversion of the quality factor. The quality factor for the S-wave was calculated for stages 1, 2, 4 and 5 from the eastern component to consistently measure attenuation factor corresponding to the SH-wave.
The P-wave attenuation factor is lowest in stage 5 with a median value of 64, and it is higher in stages 4 and 1 at 71 and 72, retrospectively. The highest values of S-wave attenuation factors are observed in the stage 2 with a median value 93. In stages 1, 4 and 5 quality factor for S wave is similar with the average value of 72. For the dataset recorded during the stimulation of the Wysin 2H/2Hbis we were able to obtain attenuation measurements for the events from all 11 stages for both P and S waves. The mean value of the quality factor for P wave is 105 and for the S wave 125. The furthest events from the Lubocino dataset were located around 650 m away from the monitoring network, whereas furthest events from the Wysin were located 1600 m away. We conclude that significantly lower attenuation in the Wysin area is the main reason why we were able to detect events from such large distances, which is unusual for analogous reservoirs in the world (e.g. Maxwell et al., 2010).

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