Effect of the near surface layer for the microseismic monitoring – 2D modelling

Andrzej Pasternacki, Paweł Wandycz, Tomasz Maćkowski

AGH University of Science and Technology; al. A. Mickiewicza 30, 30-059 Krakow, Poland; e-mail: anpaster@agh.edu.pl, pwandycz@agh.edu.pl

Microseismic monitoring is usually used to map hydraulic fracture or stress changes in the reservoir, which is stimulated (Maxwell et al. 2010, Duncan & Eisner 2010). Examining the wave traveling through the reservoir can provide many important information on medium properties (Grechka et al. 2011) and can be used either to assess the stimulated reservoir or improve microseismic imagining. Microseismic monitoring network can be deployed either on surface or in borehole. Noise level observed on the surface network is usually 10 times higher than one observed in the receivers placed in borehole but still the detection the microseismic events by the surface array is possible (Eisner et al. 2010).

In this study, we present the results of the synthetic modeling to show qualitatively and quantitatively the influence of the near-surface layer and the effect of the attenuation in this layer for the assessment of the strength of the signal recorded by receivers placed on the surface or just below it.

For the purpose of this research, authors performed 2D seismic modeling using Tesseral software. We performed several different models, each of them in two variants. First variant included the impact of the impedance contrast of the near surface layer; in the second variant we suppressed that effect. Layer composition in models differed both in number and their properties (velocity and quality factor). In each model, we used one type of source located in 3 different places. Monitoring array was vertical and constrained with 100 geophones. First receiver was placed on the surface, and the spacing between phones was 1m. Data obtained with this procedure were then analyzed using Matlab software. For each model, we compered the relative amplitudes of the different events in both variants, and then assessed the impact of the impedance contrast in the near surface layer.

Performed modeling proved that the influence of the near surface layer is significant. We observe that the amplitude ratio between the first receivers in two variants of each model ranges from 1.5 to almost 2, regardless of the depth of the source. Signal enhancement is the function of the impedance contrast, and does not depend on the attenuation in the near surface layer. However, attenuation does not influence the enhancement of the signal, very low quality factor in the shallow layers highly influences the strength of the arriving waves.

This study is a part of work founded by The Polish National Center for Research and Development in the Program Blue Gas, project entitled "Appraisal of microseismic monitoring techniques of hydraulic fracturing and development of optimal processing and interpretation methodologies"(acronym: SHALEGASMICROS).

REFERENCES

Duncan P. & Eisner L., 2010. Reservoir characterization using surface microseismic monitoring, *Geophysics*, 75, 75A139–75A146.

Eisner L., Hulsey B.J., Duncan P.M., Jurick D., Werner H. & Keller W.R., 2010. Comparison of surface and borehole locations of induced seismicity. *Geophysical Prospecting*, 58, 809–820.

Grechka V., Singh P. & Das I., 2011. Estimation of effective anisotropy simultaneously with locations of microseismic events. *Geophysics*, 76, WC143–WC155.

Maxwell S., Rutledge J., Jones R. & Fehler M., 2010. Petroleum reservoir characterization using downhole microseismic monitoring. *Geophysics*, 75, 75A129–75A137.