Non-invasive removal of noise from seismic recordings



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Seismic Data Processing



- Introduction
- Description of the method
- Application to real data
 - Ground roll elimination
 - Airblast elimination
 - Guided waves elimination
 - Elimination of the external coherent noise
 - Industrial noise elimination
- Test of efficiency with synthetic data
- Conclusions



- Seismic acquisition is entering more difficult surface conditions
- Clauses of acquisition contracts, together with real terrain conditions set new challenges to be met
- Recent standards applied by geologists working with seismic data become similar to environment in geomechanical workshops: perfect seismic wavelet, precisely migrated wavefield, amplitudes reconstructed to be related solely to geology
- GT technology to eliminate noise from seismic recordings fulfils these requirements.



Onshore seismic data processing with task to reconstruct true amplitude relations, in the examined interval, needs dedicated approach to eliminate the unwanted noise.



Coherent Noise

- Linear noise I (connected with seismic crew)
 - Direct wave
 - Airblast
 - Ground roll
 - Guided waves
 - Side-scattered
- Linear noise II (external noise sources)
 - other seismic crews
 - cultural noise
 - other ...
- Multiple reflections

- Random Noise - random cultural noise (human and animal activities)
- wind, rain,
- earthquakes,

- ...











Some features of the observed seismic waves:

- The level of amplitudes and the amplitude variations in time and space,
- The waves frequency ranges and the frequency variations in time,
- Direction of the wave with reference to seismic line,
- Shapes of reflections which intertwined with noise.

In land seismic data acquisition the large geophone patterns are often used. This approach usually partially eliminates the strong surface wave, however destroys coherency of the residual noise and influences amplitudes of the useful reflections

Presented method does not require, even considers to be harmful, large-size geophone patterns.



Advanced methods which eliminate the unwanted waves and leave useful signal untouched are called **<u>non-invasive</u>**.

Such approach allows to remove unwanted waves from seismic data with full preservation of **amplitude relations** for the horizons covered by high amplitude noise.

The core of this technology are **hybrid or/and cascade methods** of obtaining noise model in different domains, adaptive adjustment of these models to the real data, and subtraction from properly scaled input traces









Seismic data with noise. (Data with true amplitude relations)	
Sort domain 1 Extraction of noise model – 1 Extraction of residual noise model – 1 	Collection of noise models - scaled and shaped to the original data
•••	Adaptive noise subtraction
Sort domain n Extraction of noise model - n Extraction of residual noise model - n	Direct filtrations if needed
	Seismic data without noise. (Useful seismic signal is untouched

Diagram – the non-invasive method idea.





Scheme – noise improvement procedures for hybrid modeling





Adaptive subtraction the noise from the seismic wave field - example



Ground roll elimination















↓ ■















Airblast elimination



What does attenuation mean?



"Almost" make the difference















Guided waves elimination















External coherent noise elimination

- other seismic crew











Hybrid modeling





Industrial noise elimination







Quantitative results on synthetic data

Effectiveness of the presented approach to the noise elimination has been carried out on synthetic data.

Amplitude along two horizons, before and after noise removal, was estimated.



↓ ■ ↓







Rejestracja sejsmiczna – dane modelowe po usunięciu zakłócenia.

Synthetic seismic record after ground roll elimination – amplitude analysis along reflections



- Interactive and iterative procedures, and non-standard approach based on the cascade methods and hybrid modeling, allow to obtain noise models in different domains, to perform adaptive adjustment of these models to the real data, and to subtract them from input traces in the <u>non-invasive way</u>
- Modern methods of noise elimination at processing, bring efficient support to acquisition step
- The GT offered processing technology eliminates noise ensuring that wavelet processing and seismic migration produce results free of any unwanted impact. That allows to reconstruct, with high precision, amplitudes related directly to geology
- Advanced methods of noise elimination are interactive and time-consuming. However, costs of their application is much below relevant costs at he acquisition stage.



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