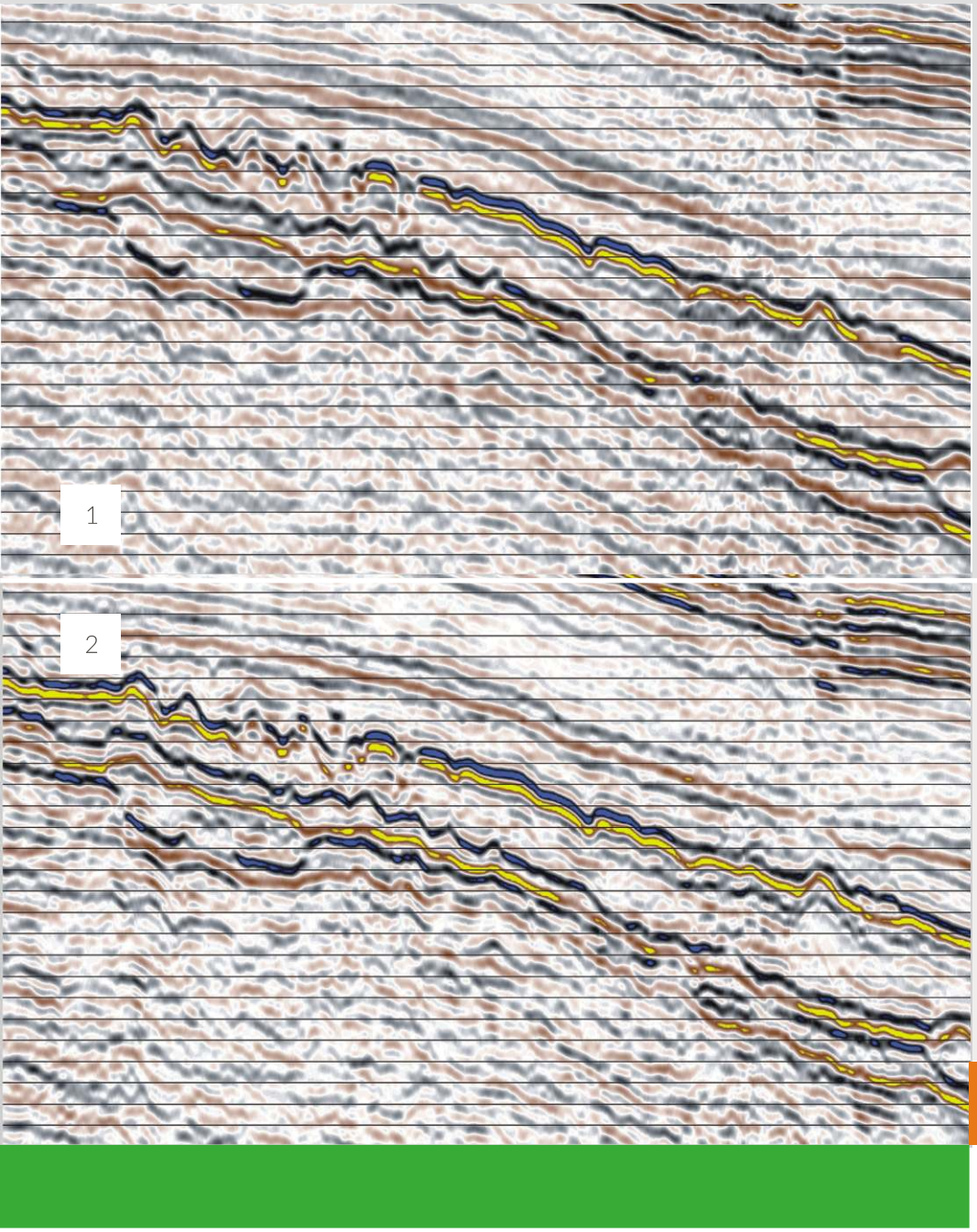


1 - Conventional seismic section
2 - Section after IWS processing

INTERACTIVE WAVELET SHAPING (IWS)
GROUND FORCE CORRECTION (GFC)

HIGH RESOLUTION TECHNIQUES FOR LAND SEISMIC PROCESSING

GEOFIZYKA TORUŃ
GRUPA PGNiG

GT PROCESSING SOLUTIONS

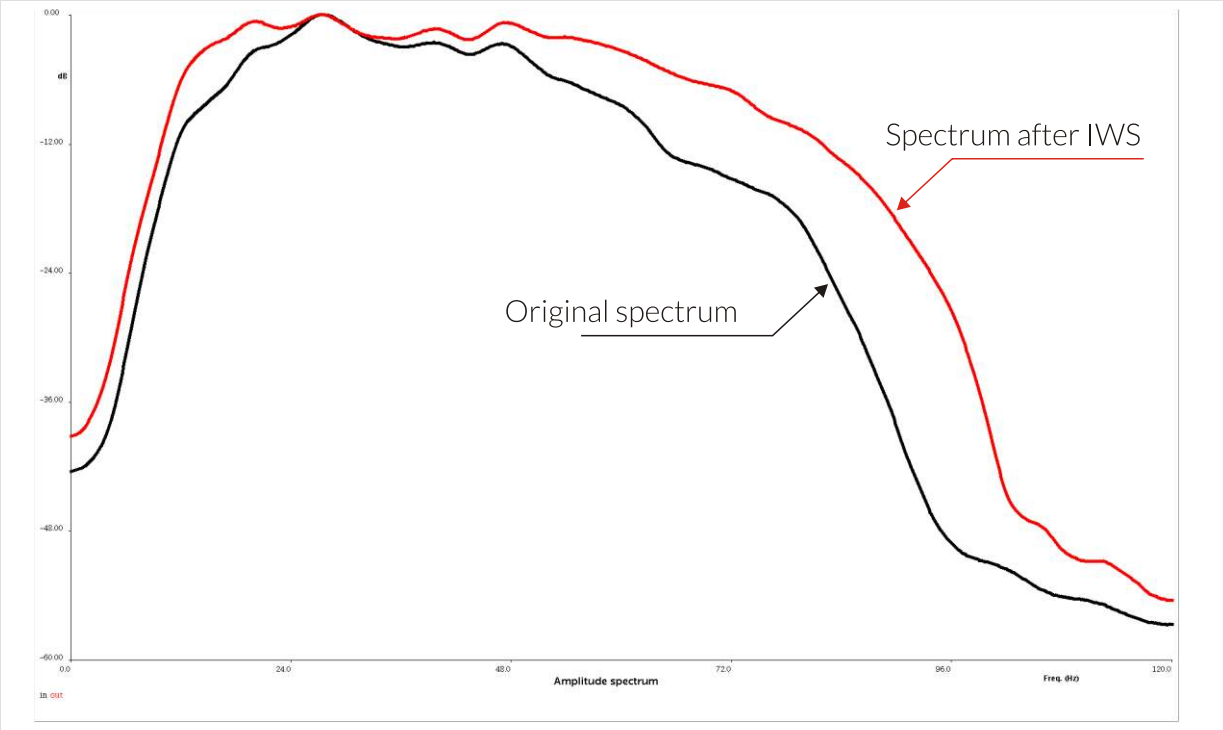
INTERACTIVE WAVELET SHAPING (IWS)

GROUND FORCE CORRECTION (GFC)

Interactive Wavelet Shaping (IWS) is a procedure consisting of:

- Interactive analysis of seismic matching to well reference data
- Selection of a method of broadening spectrum of seismic data
- QC and possible interactive residual shaping of the wavelet
- Application of designed operator(s) to seismic and well-based final approval

Shaping operators are designed with a purpose to get a narrow wavelet with reduced side lobes' reverberations. As a result, vertical resolution, S/N ratio and interpretability of seismic data are significantly improved.



An example of how IWS changes amplitude spectrum

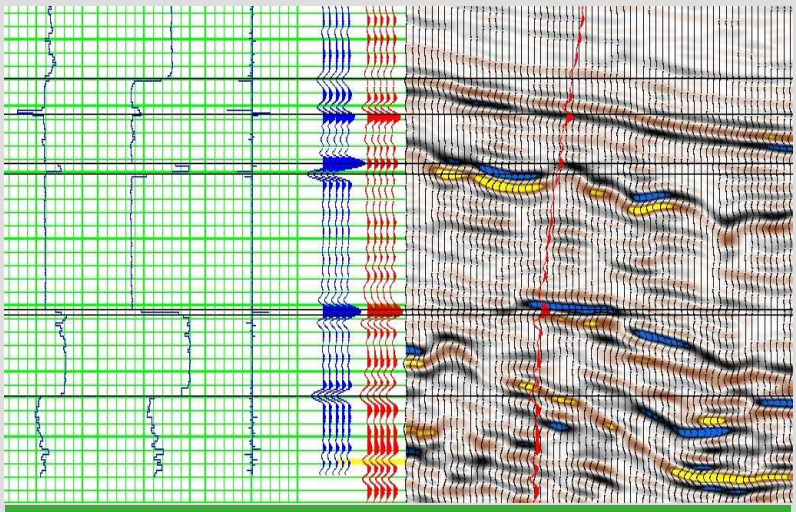
Screen dump of interface of the interactive software is pictured above. The graph illustrates broadening of the spectrum with the application of the IWS method. Input spectrum is marked in black, with spectrum after application of the IWS procedure marked red. The amount of broadening depends on characteristics of the input seismic data.

The IWS operator, designed to broaden amplitude spectrum, undergoes dedicated procedure and has to meet several conditions. The most important is not to introduce artefacts into the transformed seismic, thus improving spatial stability of the wavelet.

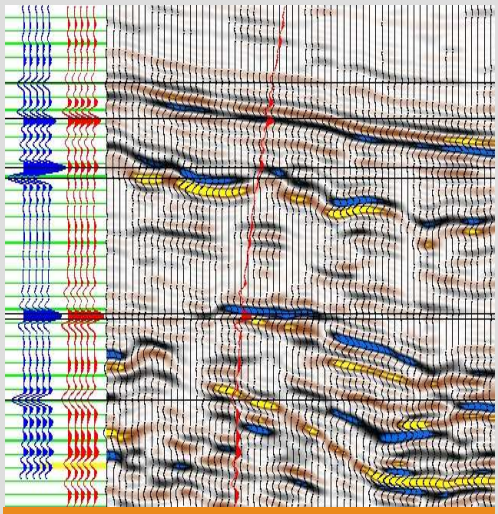
Seismic data with improved vertical resolution usually needs extra iteration of residual statics and velocity analysis. That is being performed with a focus on a new, broadened, high frequency section of the spectrum.

VSP data, featuring higher resolution than surface seismic, are important reference for seismic data transformed to higher resolution. Effectiveness of widened amplitude spectrum depends on parameters of the acquired seismic data, and, in case of land surveys, on the precision of estimated statics. When width of the spectrum becomes wider than four octaves, dispersion of seismic waves has to be accounted for as it is, for example, in Q compensation. IWS technology does exactly that. IWS technology solves interpretation targets, in cases when technical implementation of geological requirements are defined at the planning stage, and where all needed component data sets are identified and their availability is ensured, or any workaround is accepted by the client.

Synthetic seismograms confirm correctness of the IWS method. It does not only improve structural interpre-tation of seismic data, but brings amplitude distribution that is more intuitive for geologists as interference effects get reduced.



Before IWS



After IWS

Numerous elements of the seismic data workflow make up the final product which is high resolution onshore seismic: from modeling and planning, through designing techni-ques of emission and recording signal in the field, applying all relevant tools of wavelet processing, to interpretive QC and analysis of the acquired data. Information contained in this brochure focuses solely on GT's most recent implementations.

Recent GT improvements of vertical resolution in land seismic consist of three components:

- Dedicated sweeps designed during experimental acquisition
- Ground Force Correction (GFC) applied early in processing
- Interactive Wavelet Shaping (IWS) applied at the end of data processing

Dedicated sweeps are designed with a two-fold task:

- Required shape of wavelet: narrow with reduced side lobes
- Efficient deep penetration down to the geological target, hidden sometimes in the shadow of hard rock

The first condition leads to an amplitude spectrum with gentle decay towards high frequencies. The second involves non-linear sweeps, and needs input from field experiments to design software program controlling reference sweep.

Ground Force Correction (GFC) technique is based on a proprietary software applied at the very beginning of data processing. Individual (for each vib) ground force recordings make up the input. This correction is important in case of abnormal ground reactions, when differences between reference sweep and recorded ground force are noticeable. Application of a GF operator, calculated for each shot, efficiently corrects seismic wavelet obtained in the corrected raw field records. As a result, data processing is much more efficient and leads to improved stability of the wavelet and higher vertical resolution, thus improving interpretability of seismic data.

Amplitude spectra of raw sweeps

Amplitude spectra after GFC

GT recommends execution of the GFC procedure on uncorrelated seismic data.

True sweep sent to the Earth is a vibration resulting from a programmed sweep and the reaction of the soil. It is recorded for each individual vibroseis and called a ground force (GF). GT's software has been designed to transform each individual ground force into the same shape for each individual vib.

Conclusions

- Increased vertical resolution is a result of a cooperation during all steps of the seismic workflow
- The best results can be expected with a dedicated field acquisition programme
- Operations limited to data processing (IWS) can also bring added value to data interpretation