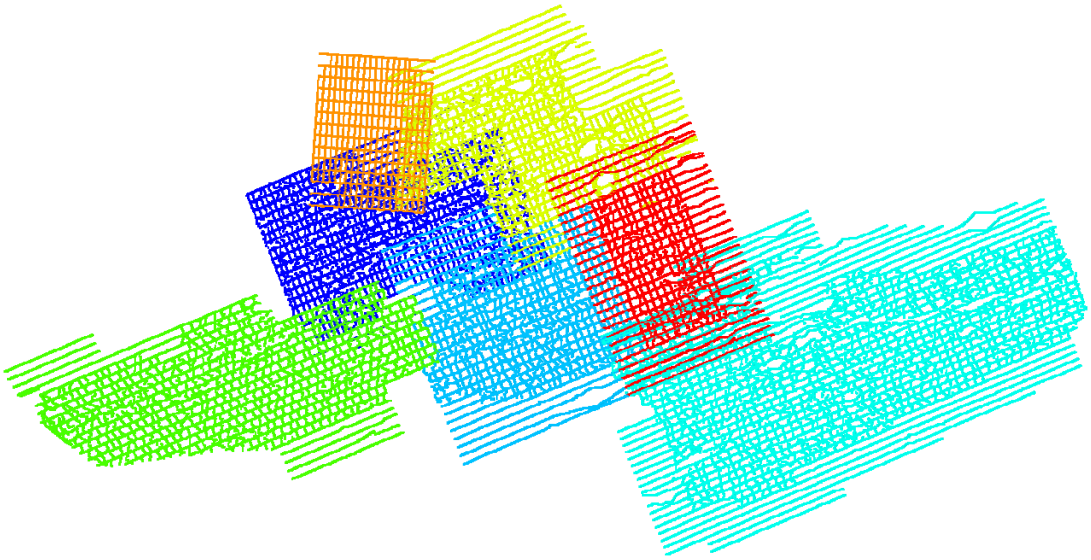
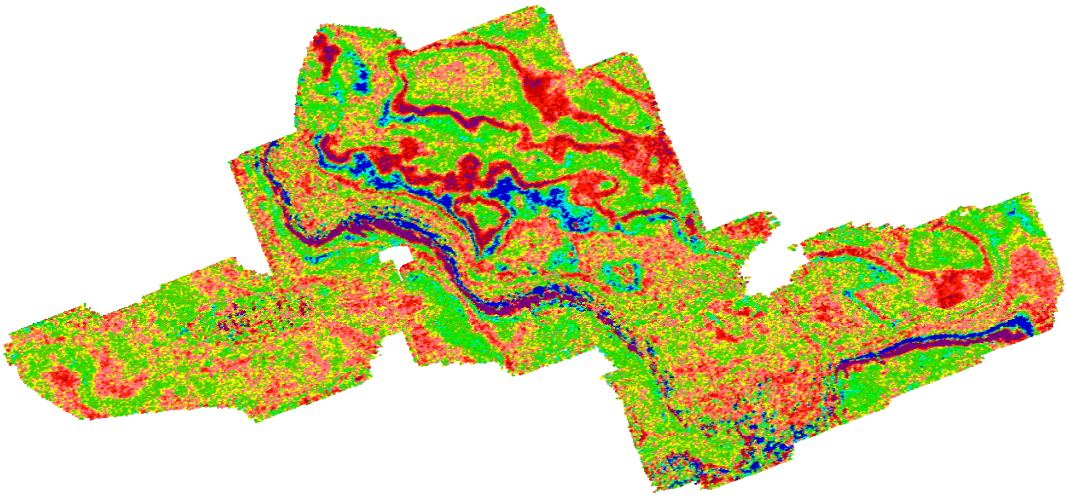
3D Pre-Stack Merging

3D Seismic research in Poland is being performed since 1994. For the time being the GT had accomplished 30 complex 3D Projects in Poland including design phase through acquisition to data processing and seismic interpretation. Introduction of 3D technology meant a new, fresh breath in geophysical research and offered results possessing much higher degree of reliability than obtained with use of 2D technology. Accuracy of bore-hole works performed on basis of geophysical data had rapidly increased. Decisions about drillings on basis of 2D works offer successful results only for 1 of 10 wells, while 9 out of 10 wells drilled on basis of 3D Data are successful. Some large oil fields – as for Polish conditions – had already been documented with use of advanced technology.
In standard procedure 3D project is preceded by reconnaissance by using 2D technique. If the data concerning oil rocks obtained by using 3D technology become confirmed by well data the area of research is being extended. Such situation occurred on BMB Field and on Kościan Block, where first successful disclosures obtained with use of 3D technology resulted in continuation of research along discovered reefs. Kościan Block was built of 8 overlapping projects, while BMB contains 7 (see below).



Data obtained in result of processing of each following 3D project overlapping with previous projects must be coherent with the data generated before and be a continuation of all earlier works. Illustration below shows timeslice through merged 3D projects on BMB field.

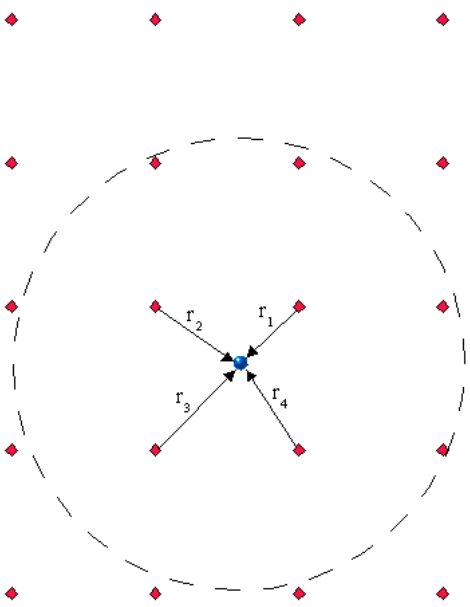


The basic element of 3D technology – spatial coherence of information from area of concern, typical for a single 3D project – can be obtained for a larger area (2 or more projects) by merging on pre-stack data processing stage.
In order to perform successful merging further extension of the following project must be considered in design phase. Proper configuration of overlapping regions must be taken into account as well as realized during acquisition.
Corresponding Technology for purpose of 3D Pre-Stack Merging had been designed and introduced in the GT Processing Center. Standard procedures available in basic processing packet did not offer full service, so they had been supported by own-made software suitable for this procedure.

Technology offers full coherence in following aspects:

- wavelet form,
- trace scaling,
- static corrections,
- kinematic corrections,
- migration.

In 3D Pre-Stack Merging all recorded data are being used for creation of causal migrated dataset. Edges of the previous project are supplemented by new data, giving in result valuable information in overlapping zone.
In some cases merged projects possess different azimuths of recording lines (difference of presumed azimuths of binning lines). In that case binning rotation (re-binning) must be performed in order to find a common azimuth of binning for merged project. Mentioned operation had to be performed on both BMB Field as well as on Kościan Block. Software used for re-binning in procedure of 3D Pre-Stack Merging bases on the following algorithm of interpolation.

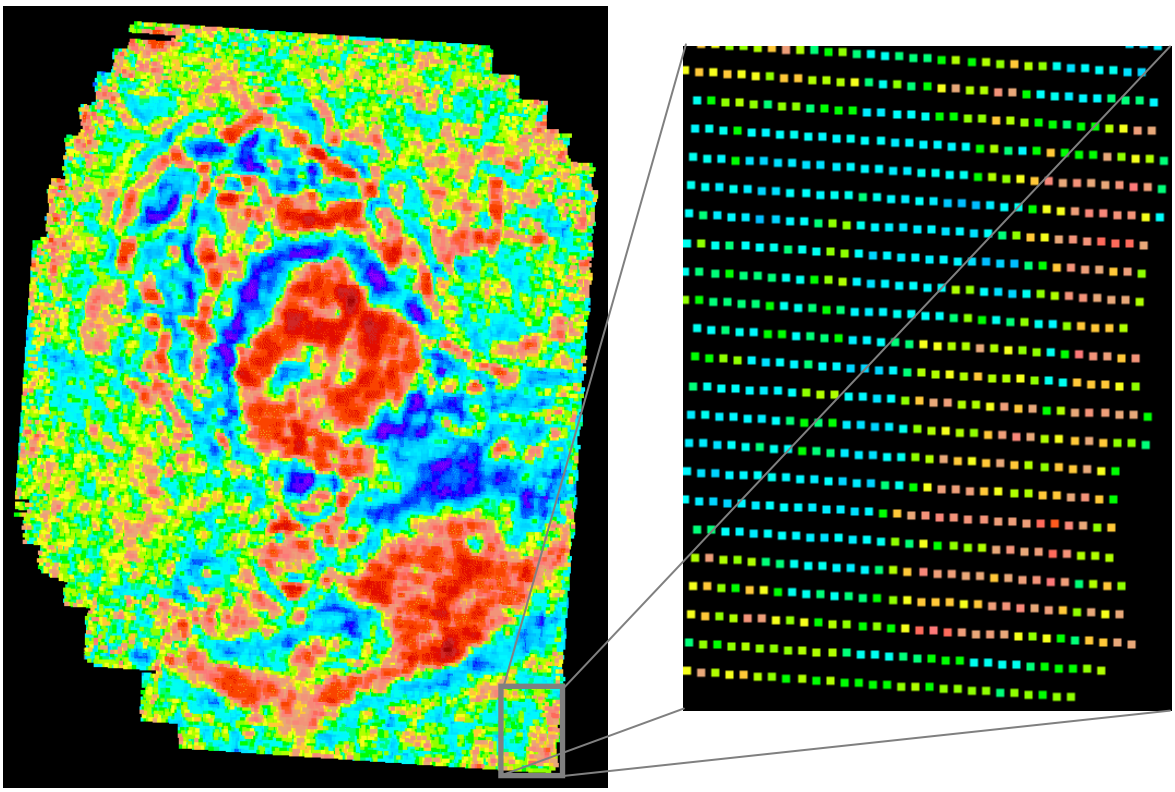


$$w_1 = 1 / r_1$$
$$w_2 = 1 / r_2$$
$$w_3 = 1 / r_3$$
$$w_4 = 1 / r_4$$

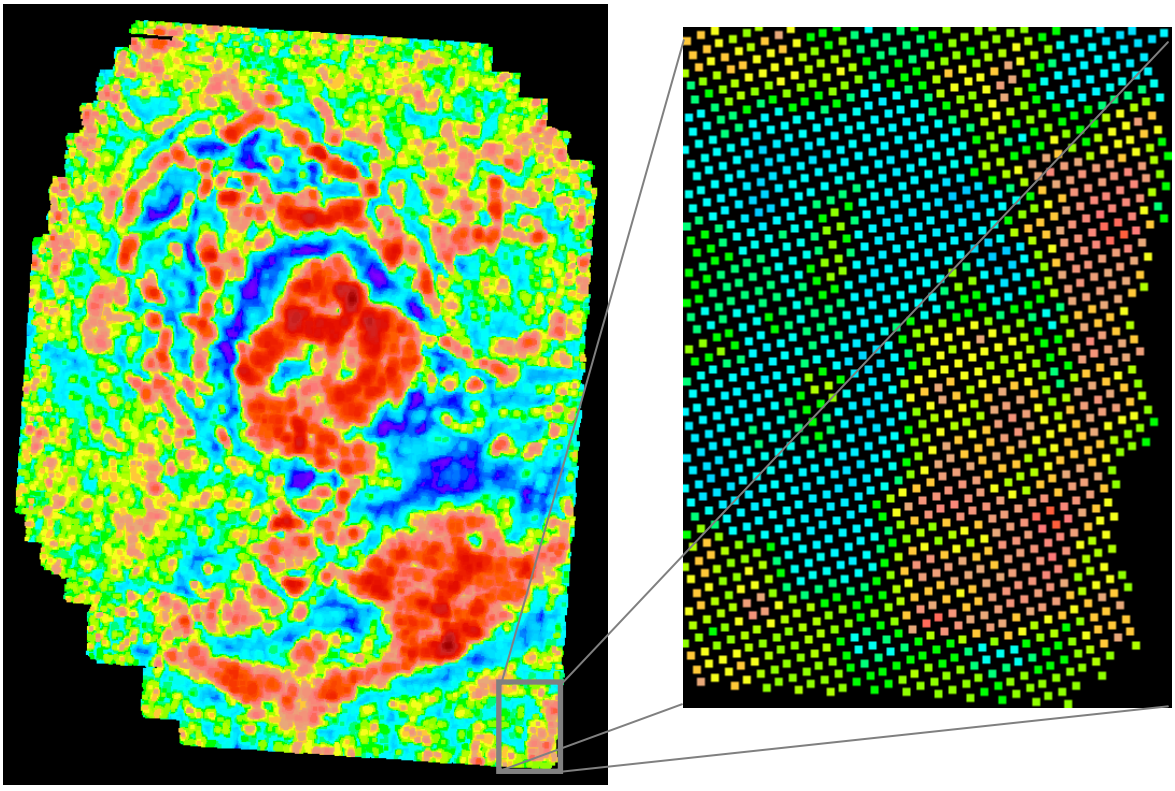
$$\Sigma w = w_1 + w_2 + w_3 + w_4$$

$$tr = tr1 * w_1 / \Sigma w + tr2 * w_2 / \Sigma w + tr3 * w_3 / \Sigma w + tr4 * w_4 / \Sigma w$$

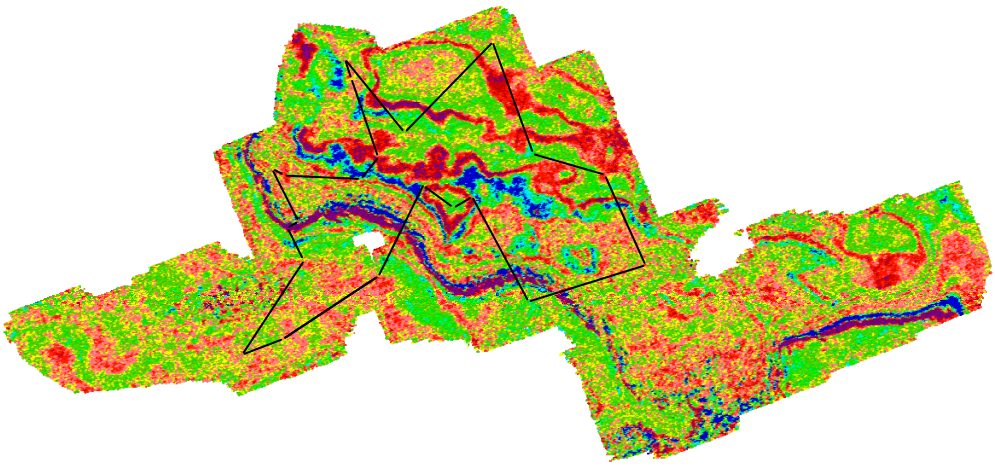
Above formula of binning offers possibility of presentation of the 3D Data (raw stack, final stack or migration) in new binning order prepared for merging.



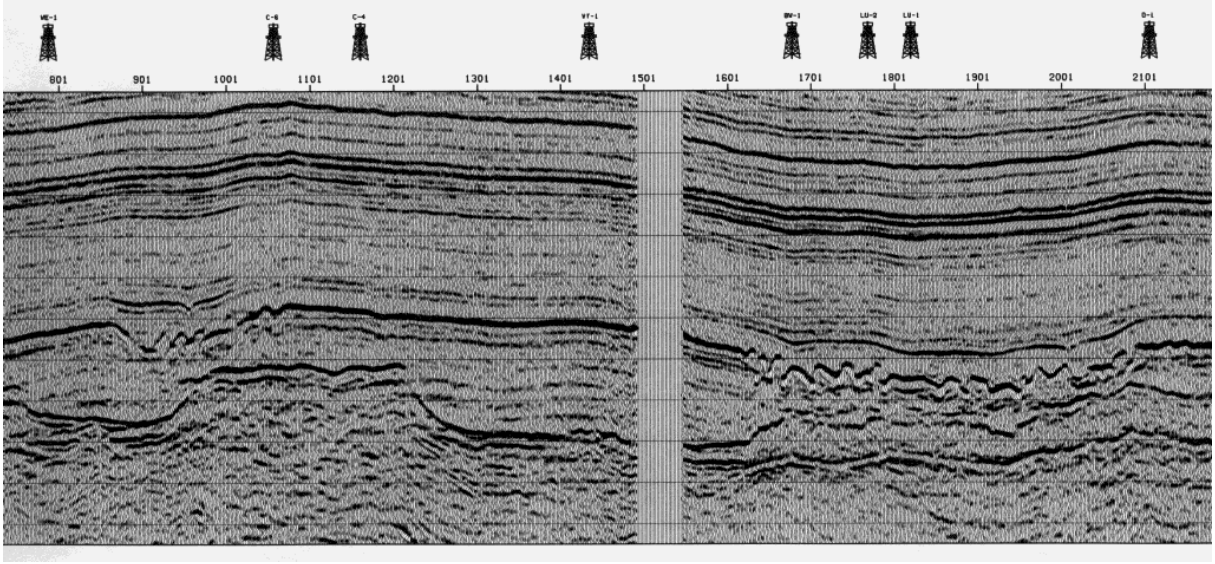
Above: timeslice through final data of the first 3D project performed on BMB Field in original binning order. Azimuth of recording lines: 93°, bin size: 25m x 50m.
Below: timeslice through the same project in final binning order, coherent with subsequent projects of this Field. Azimuth: 67°, bin size: 25 x 25m.



Presented algorithm of interpolation is also used for extraction of arbitrary lines from 3D data. Below: 2D line extracted on BMB Field connecting wells locations.



Below: fragment of 2D line extracted between wells locations on merged 3D project.



Arbitrary 2D line extracted on different processing stages allows fast verification and choice of merging parameters. This applies to following aspects:

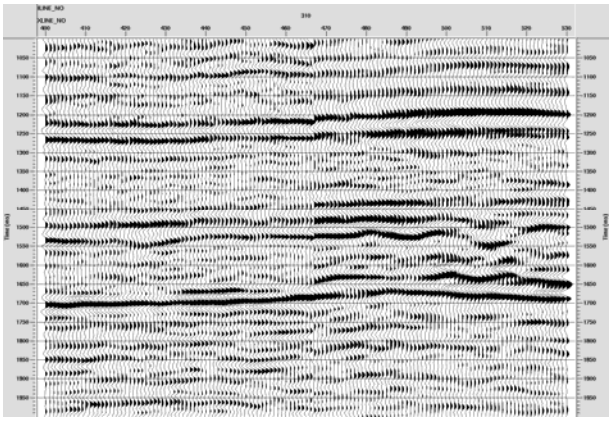
- wavelet form,
- trace scaling,
- coherence of static corrections,
- coherence of kinematic corrections.

Deterministic method of wavelet analysis, zerophasing and wavelet processing can be performed on representative limited dataset. Wavelet can be effectively controlled in area of wells location with use of such arbitrary line.
Wavelet coherence between merged projects is fundamental from the early stage of data processing. It is necessary for correct First Break Picking in order to obtain refraction static corrections coherent for each merged project.

FB Picking is thus performed only on the following data, while for previous project archival picks are used – convergence of assumptions between both parts of data is crucial at this stage.
Area of the following survey to be processed in 3D Pre-Stack Merging will then be extended in direction of previous project. Size of extension depends on configuration of overlapping zone as well as acquisition parameters for merged surveys. Merging of full records seem to be more efficient than only parts of them due to surface consistent processing, as deconvolution, trace scaling and static corrections. Stacking velocities (RMS) are supplemented in overlapping zone by archival curves from previous project. All work is performed on extended area but this method allows merging of old stacked cubes with new coherent stacked cube (cubes merged beyond the area of the new project) and performance of migration on even larger area (extended of aperture size), as well as merging of new coherent migrated cube with the previous ones.

Merging of two stacked cubes and possibility of performance 3D migration on merged data allows avoiding significant problems always connected with low fold border area in overlapping zones

Below: exemplary stacked sections after normal merging and 3D Pre-Stack Merging.



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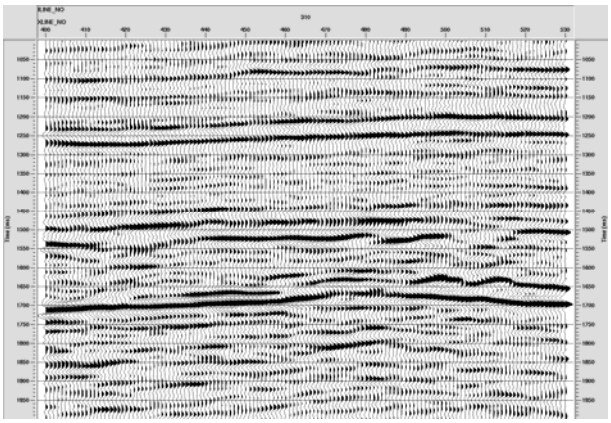

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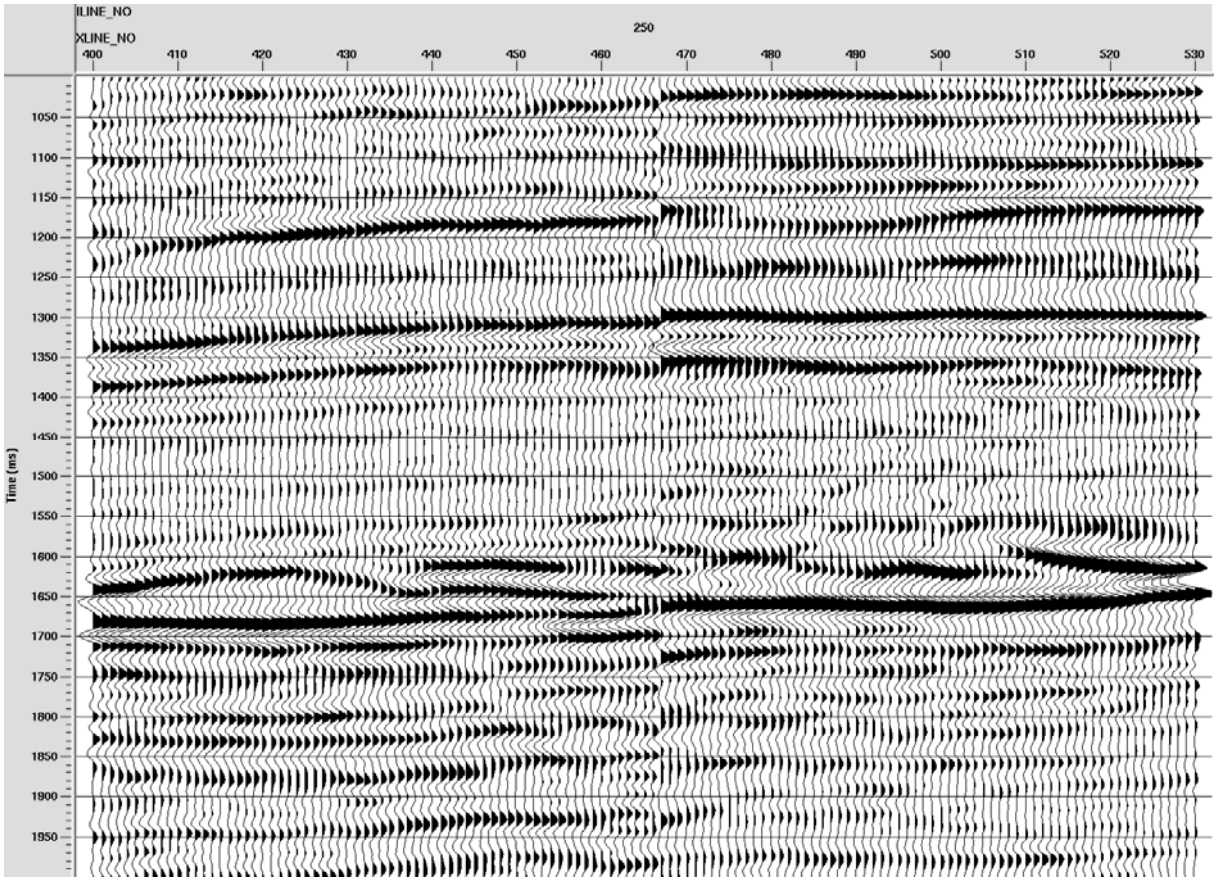

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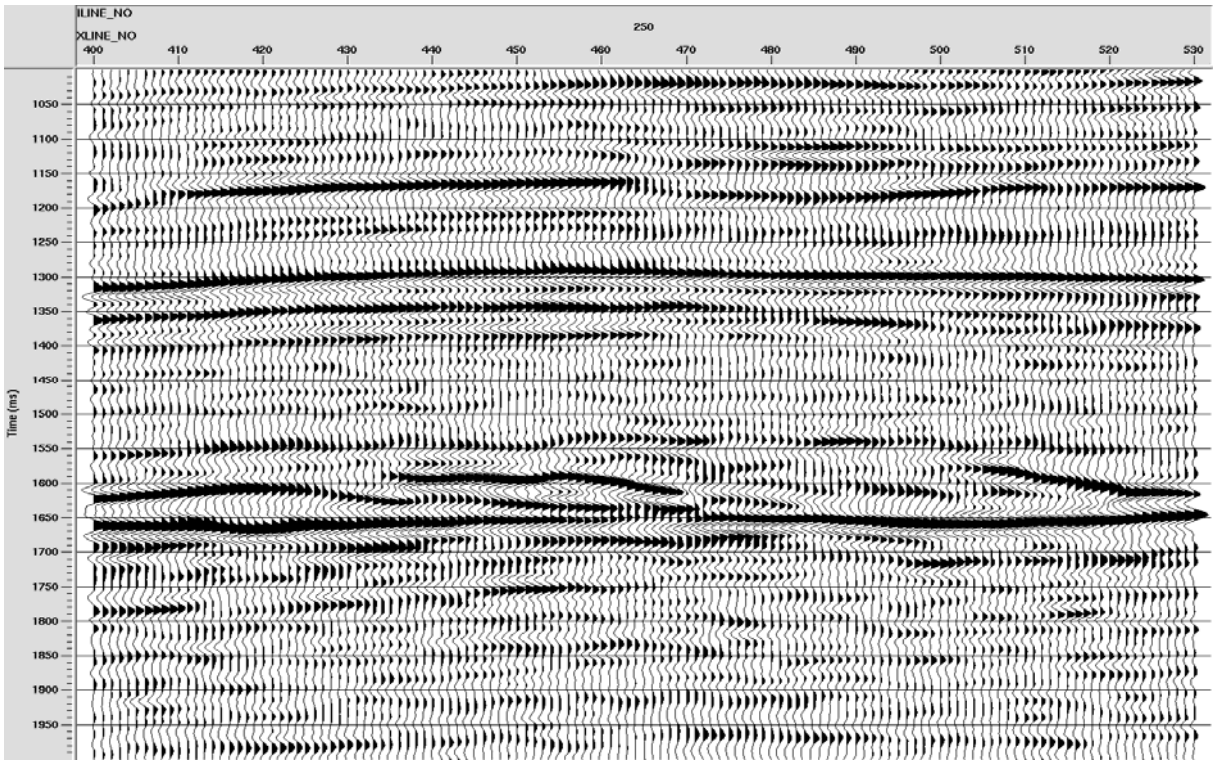

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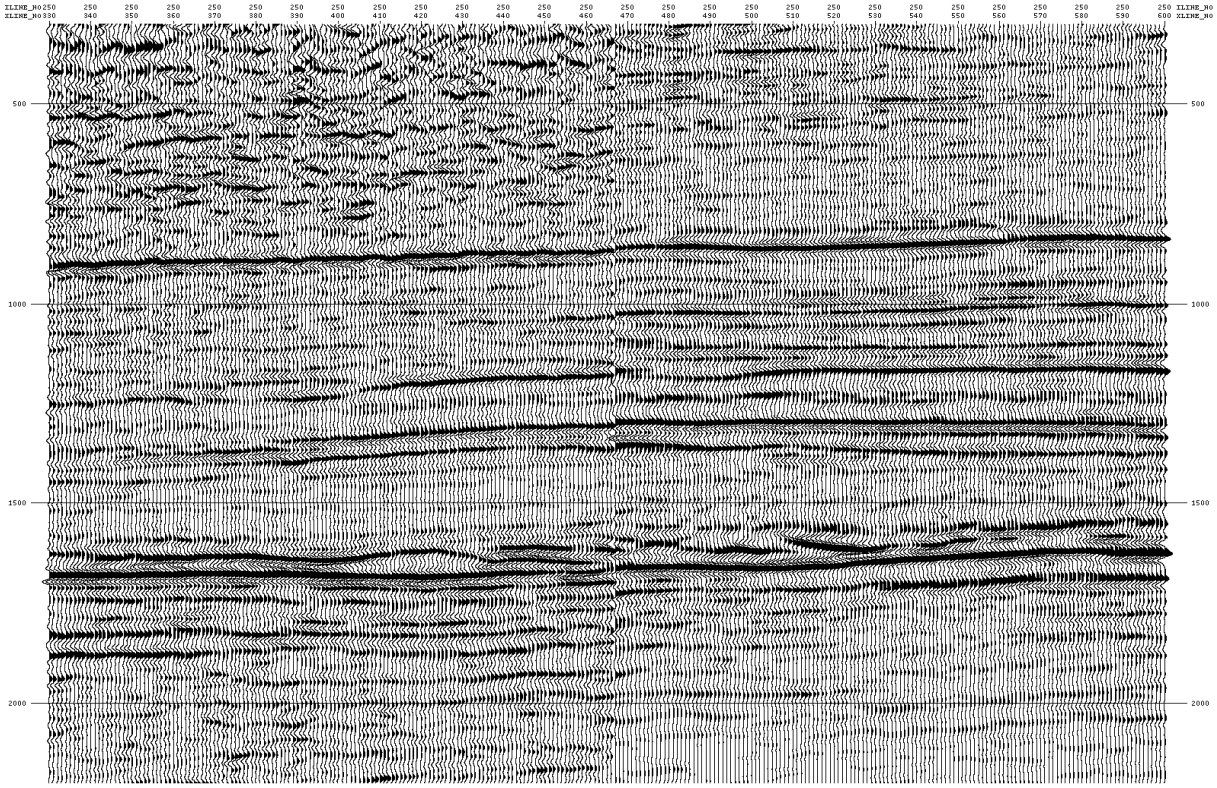

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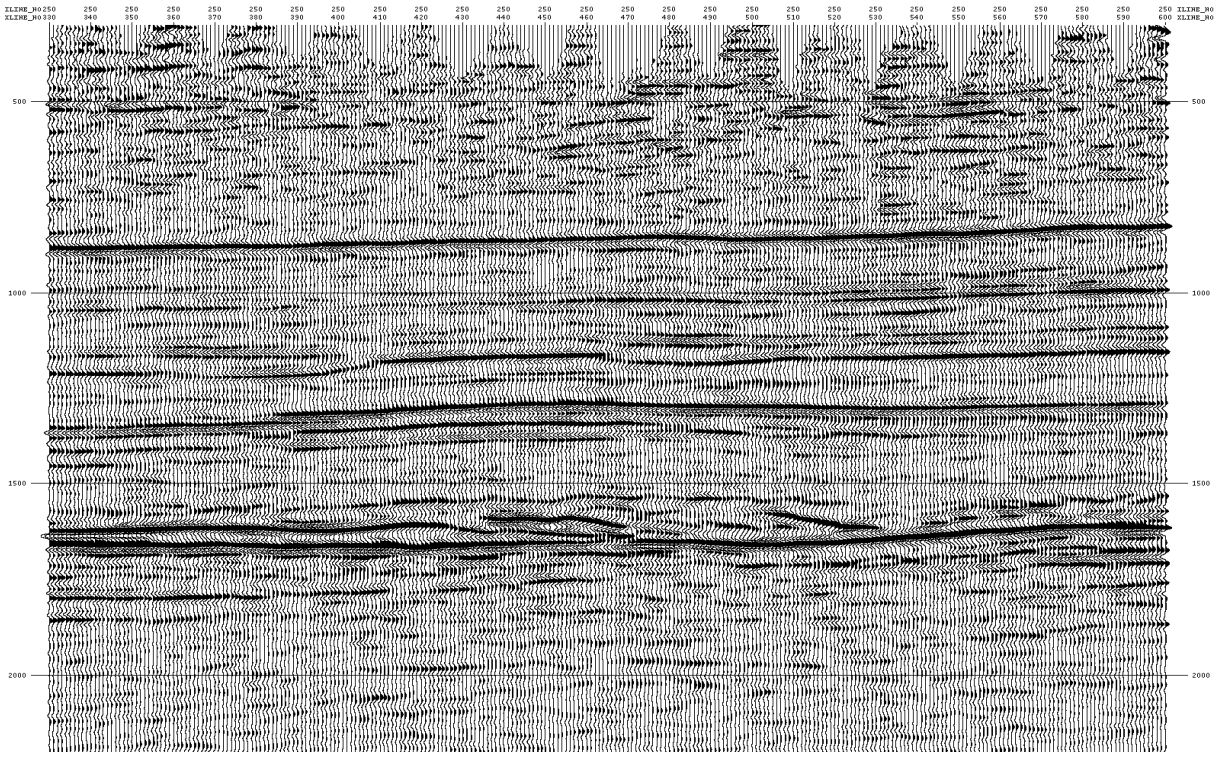

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