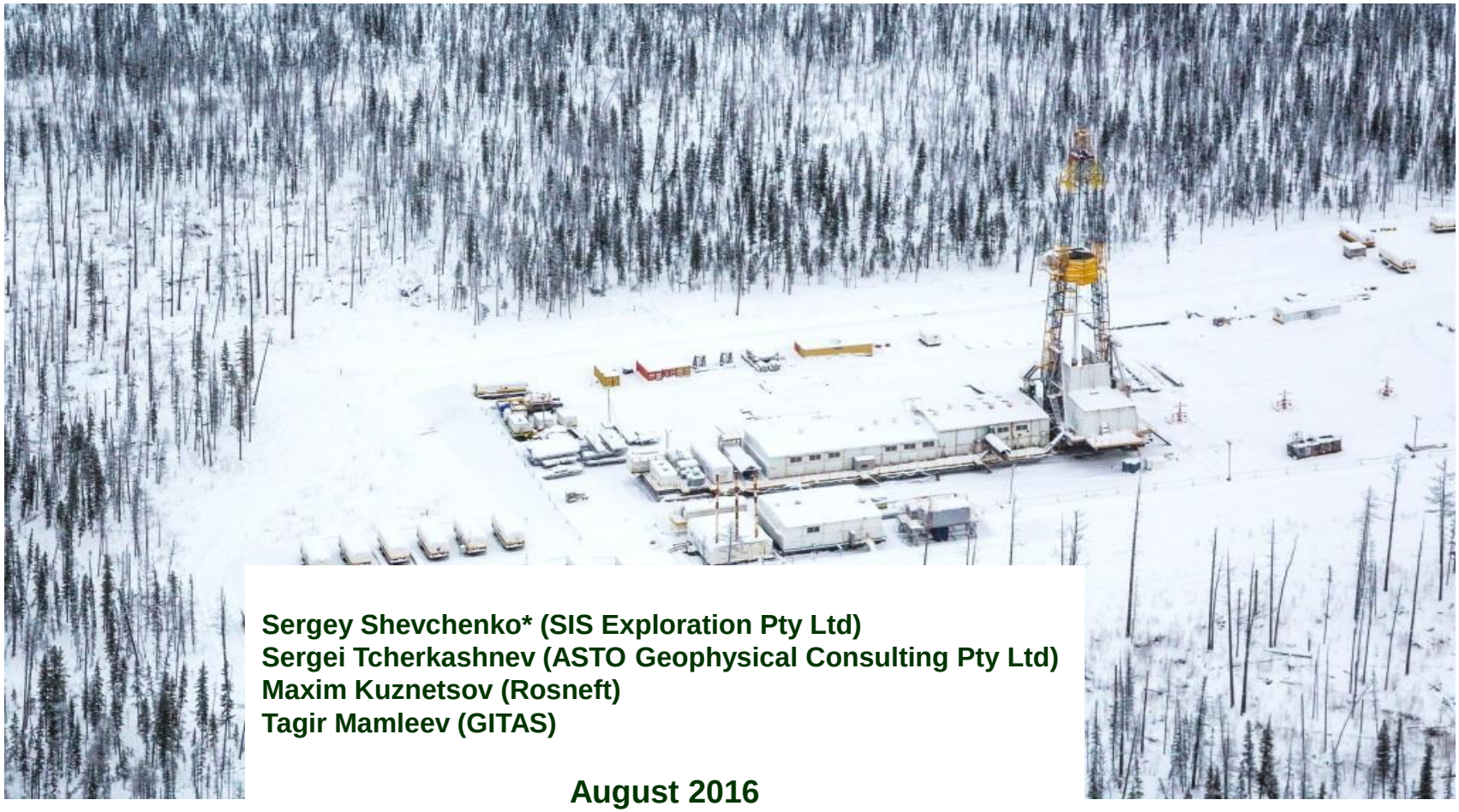
SIS Exploration

ASTO Geophysics in Partnership

Mapping of fracture zones and small faults using VSP and Cross Dipole Sonic in Eastern Siberia Carbonate Reservoir, Yurubchansky Field, Russia.



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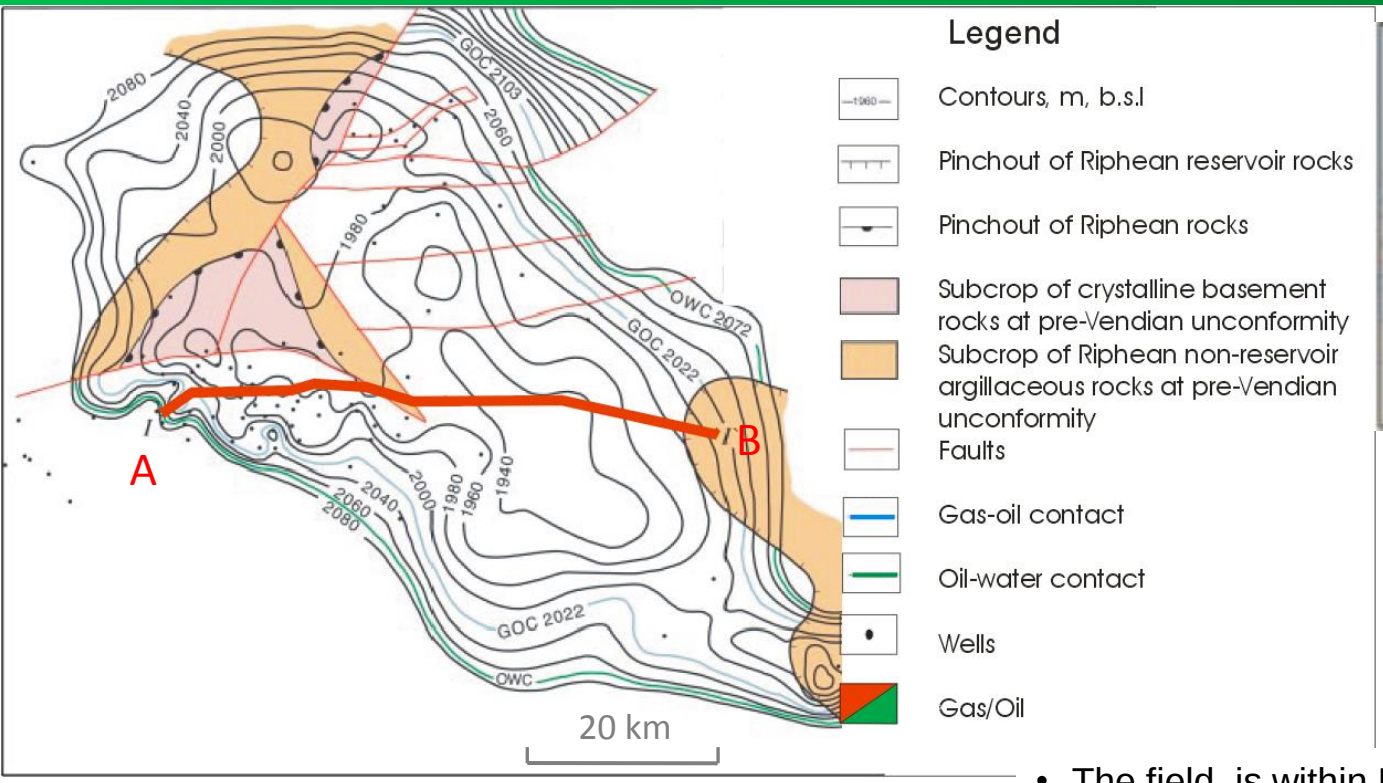
Introduction

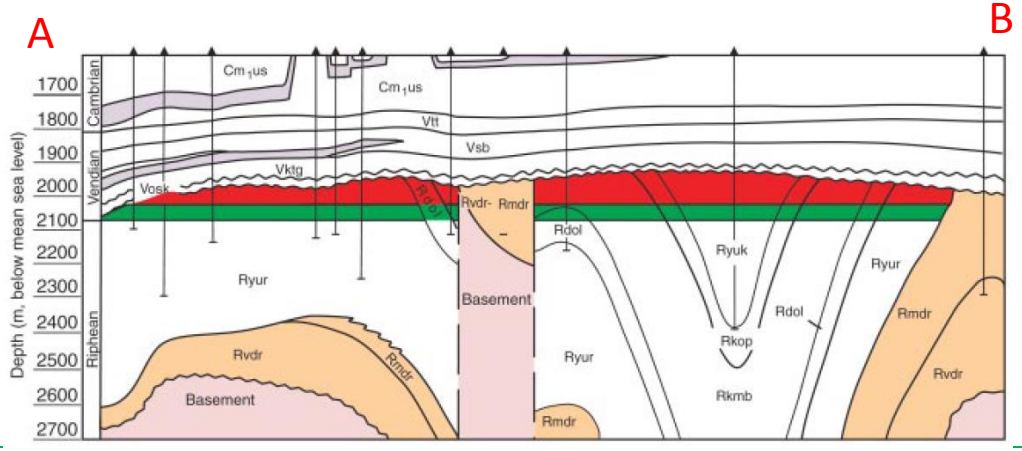
- Project objectives
- Geological settings
- Interpretation
- Conclusions and recommendations

Project objectives

- Interpretation of time migrated VSP data to identify small faults and fracture zones in the vicinity of exploration well Yur-90 within fractured carbonate reservoir at Yurubchansky Oil and Gas condensate Field.
- Tie well to seismic.
- Verify velocity model.
- Estimate Absorption parameter Q and conduct multiples analyses for 3D seismic reprocessing.
- Cross Dipole Sonic and UBI fracture detection.

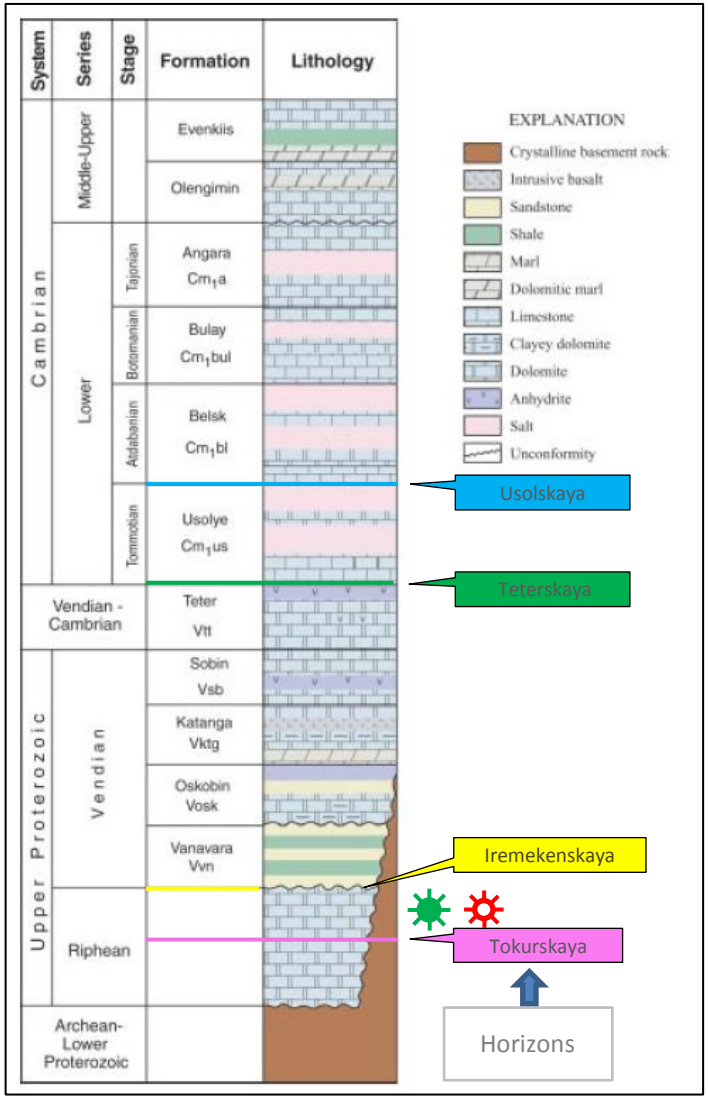
Yurubchansky giant oil and gas-condensate field in the East Siberia.





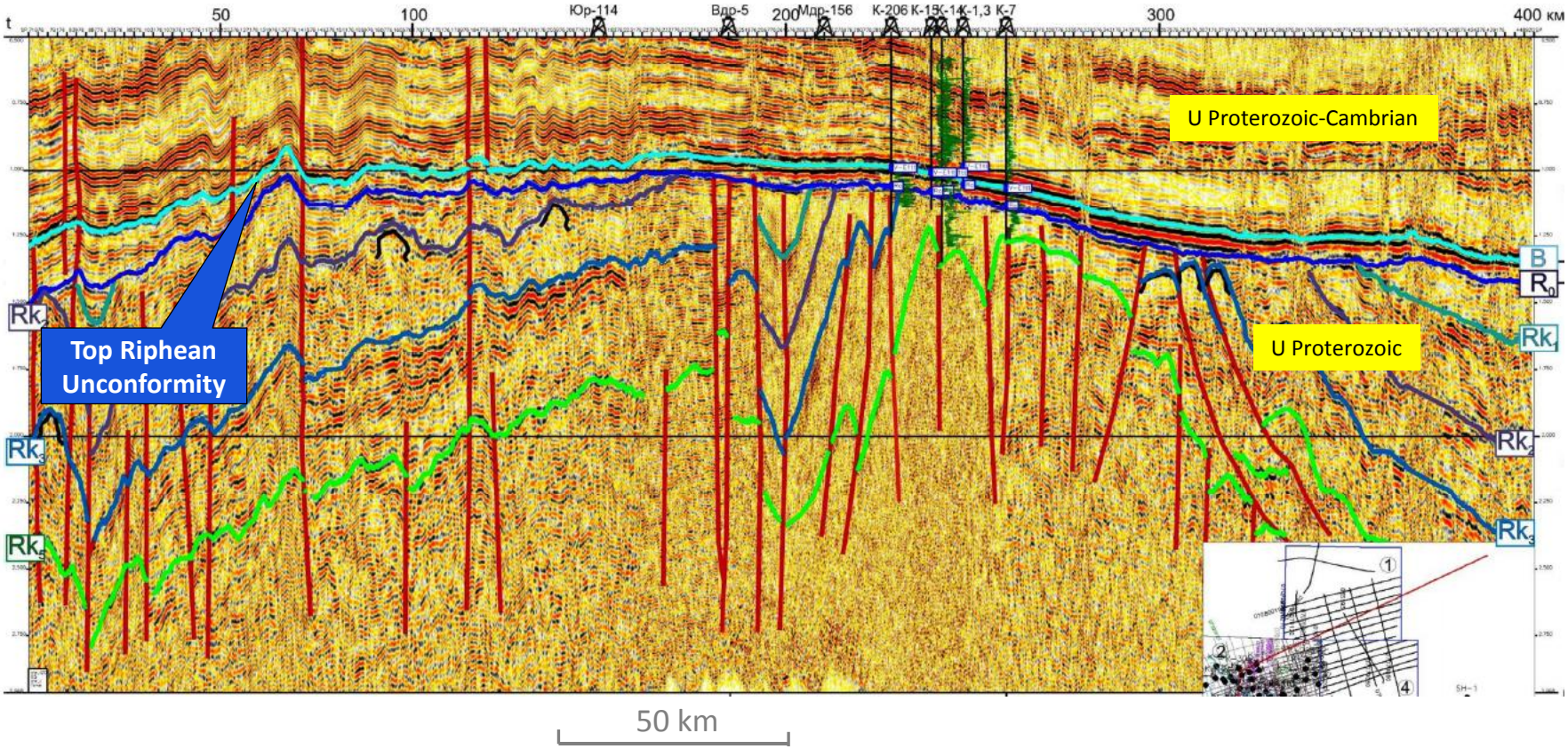
- The field is within Bakuk regional high at the Siberian Craton margin
- Low relief, structurally controlled four-way dip closure
- Area of the closure is about 5,500 sq. km
- Oil and gas column ~100 m
- Oil reserves C1-405 MMbbl, C1+C2 -1,2 Bbbl
- Gas C1+C2 - 6.5 Tcf
- Over 100 wells drilled
- Operator/Client Rossneft

Stratigraphy



- Archean-Lower Proterozoic basement
- Upper Proterozoic- Cambrian mostly carbonate and clastic strata with evaporates
- Archean shale and carbonate source rocks
- Reservoir is the Late Proterozoic(Riphean) fractured carbonates sealed with regional shale strata
- Matrix porosity of 0.1-1% enhanced by secondary up to 5.5% vuggy and fracture porosity

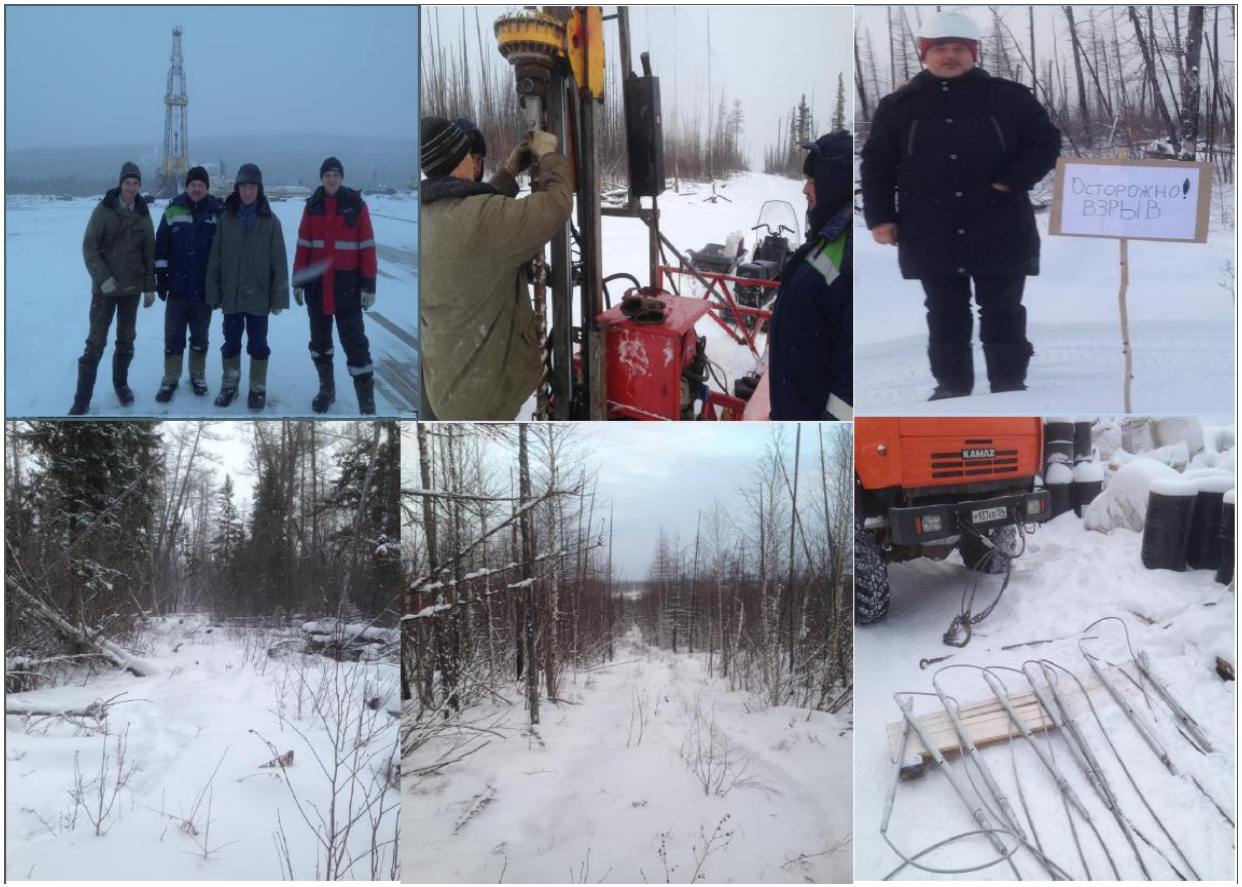
Regional structure of the Baikuk High across Yurubchansky field



Seismic Challenges in Yurubchansky Oil and Gas Condensate Field

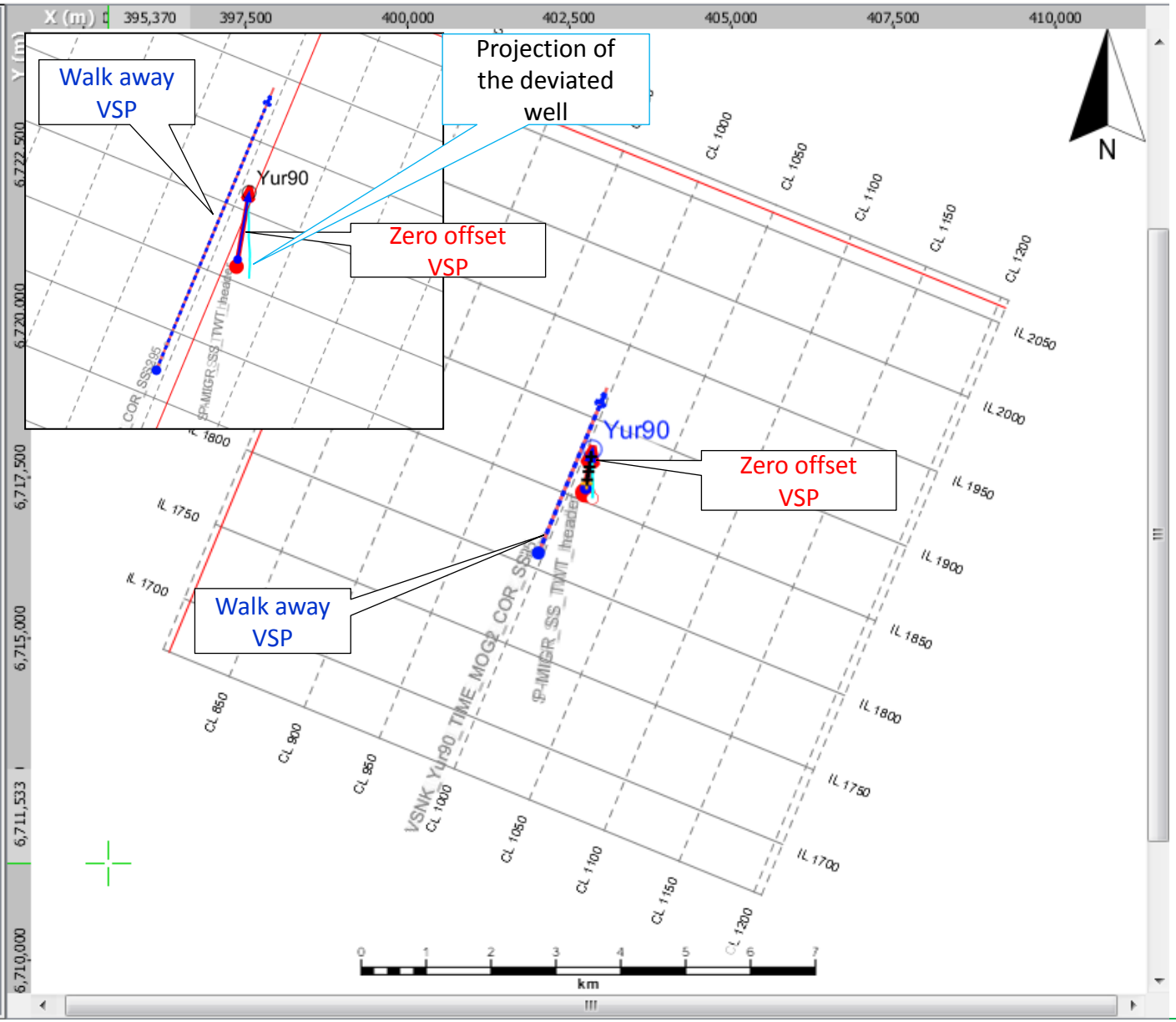
- Source signature variations - permafrost, swamps, lakes, intersecting bodies of dolerite
- Significant statics due to altitude variations from 185 m to 400 m.
- Strong multiples caused by carbonate and clastic rocks in the Riphean, Vendian-salt and pre-salt complex Precambrian interval (dolomite, limestone, dolomite, anhydrite, marl, rock salt)

Project execution

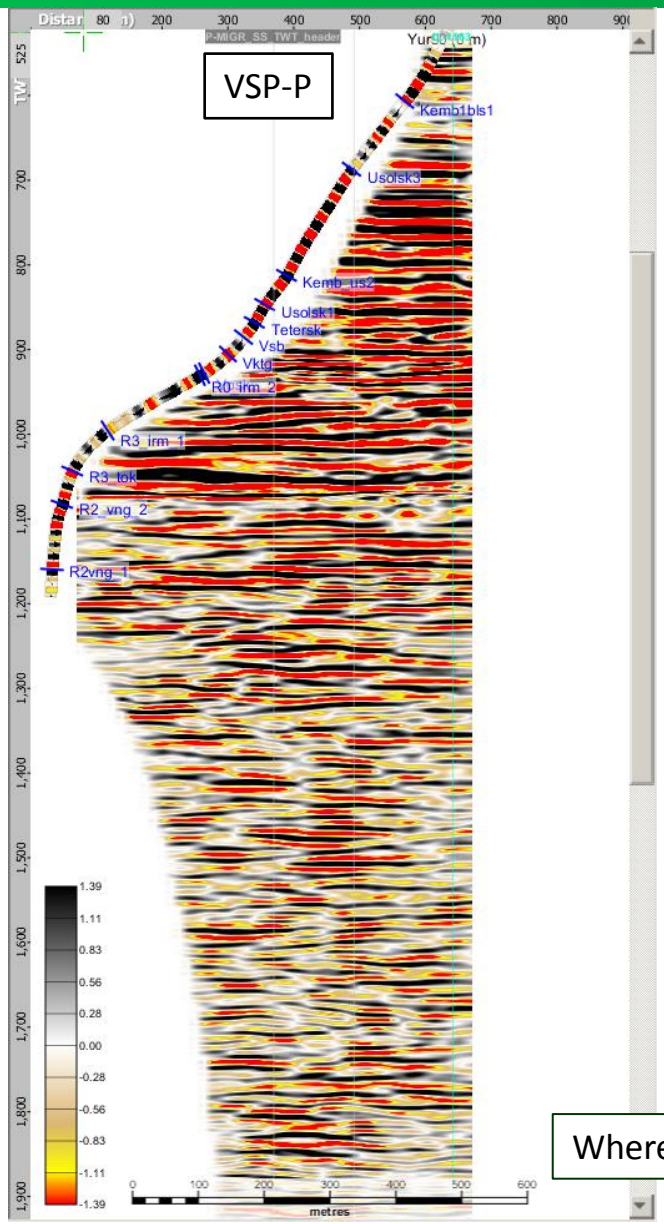


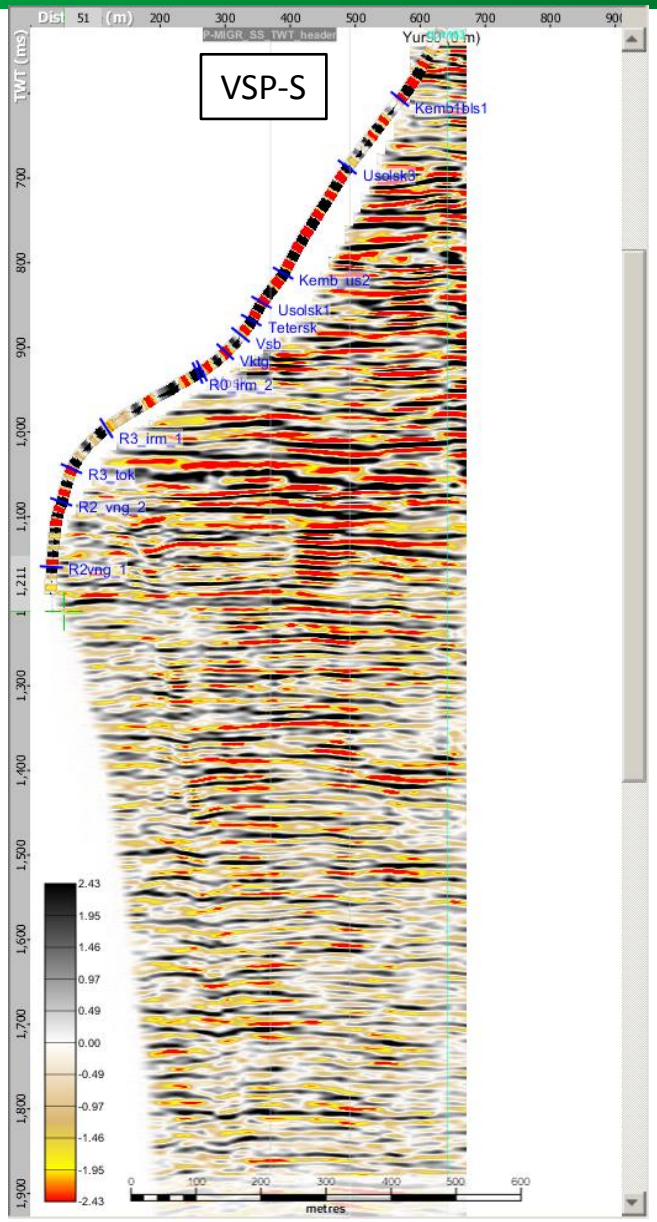
- Two profiles: zero offset VSP and walk away VSP 200 m away from the deviated well were acquired in winter 2015: GITAS
- Schlumberger: Sonic Scanner and UBI
- ASTO & Geovers: Modelling, Supervision, Sonic & VSP Processing
- SIS Exploration: VSP/Seismic Interpretation

VSP acquisition



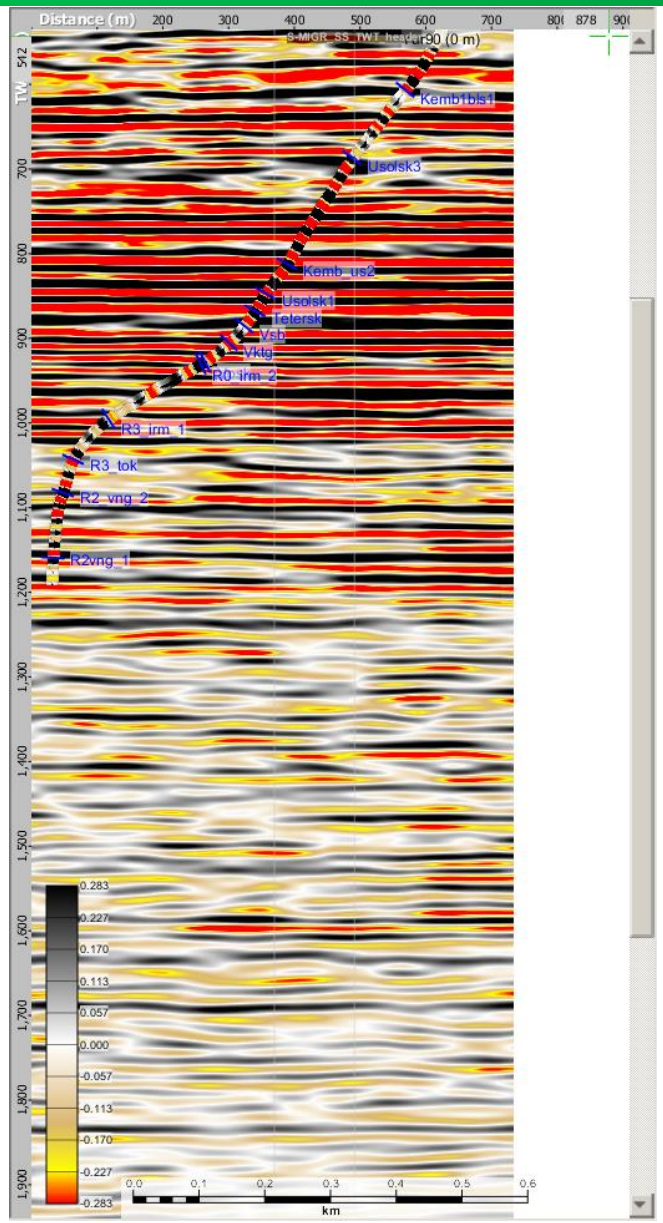
Zero offset VSP

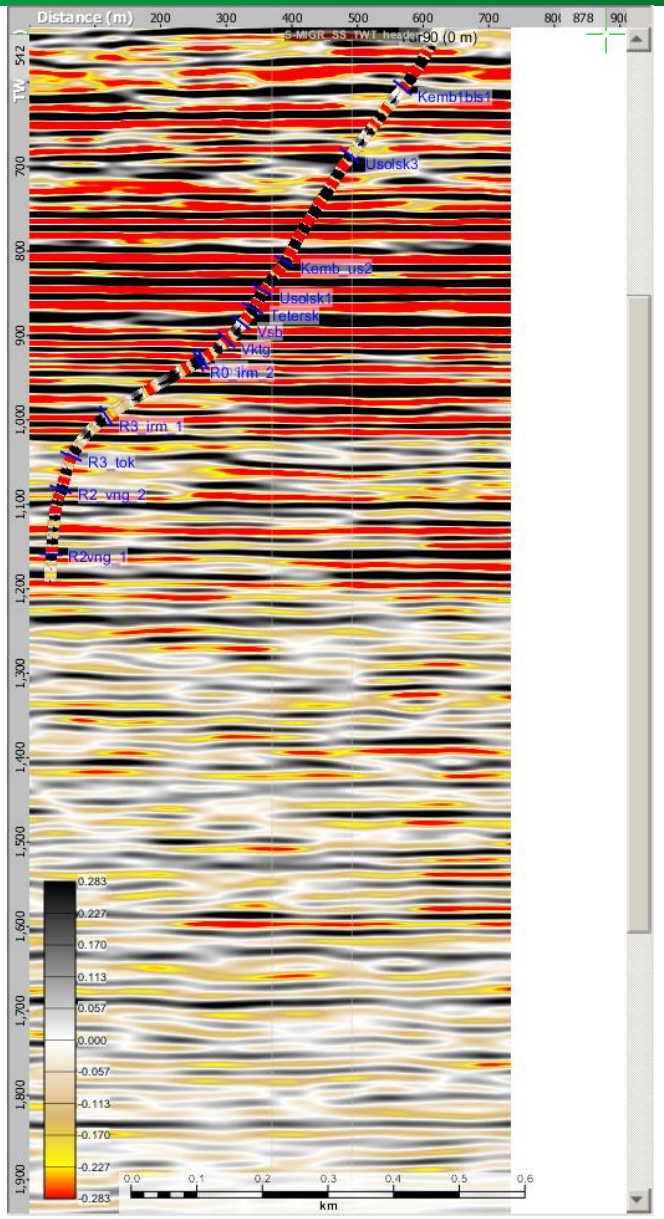




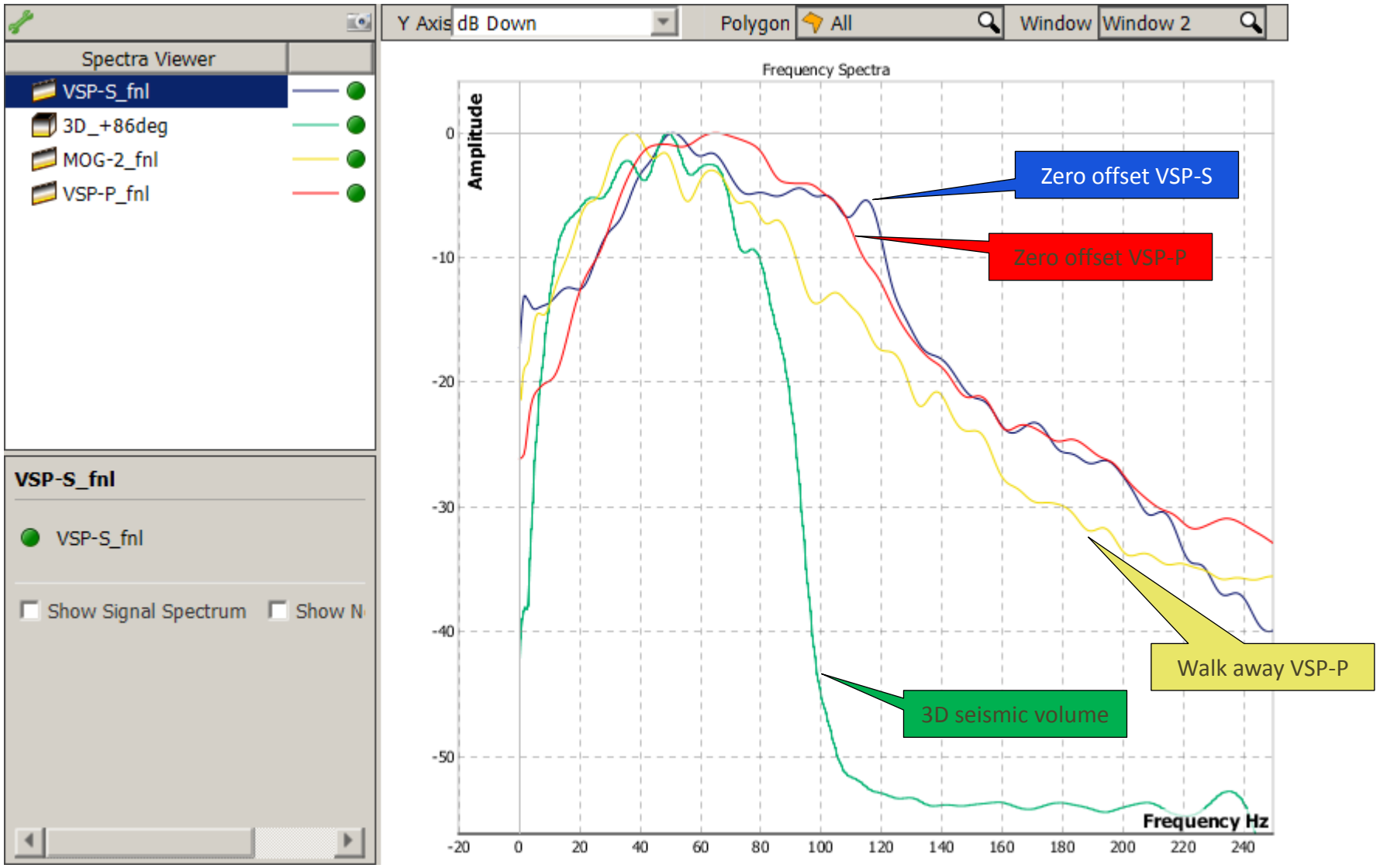
Where are the faults?

3D seismic

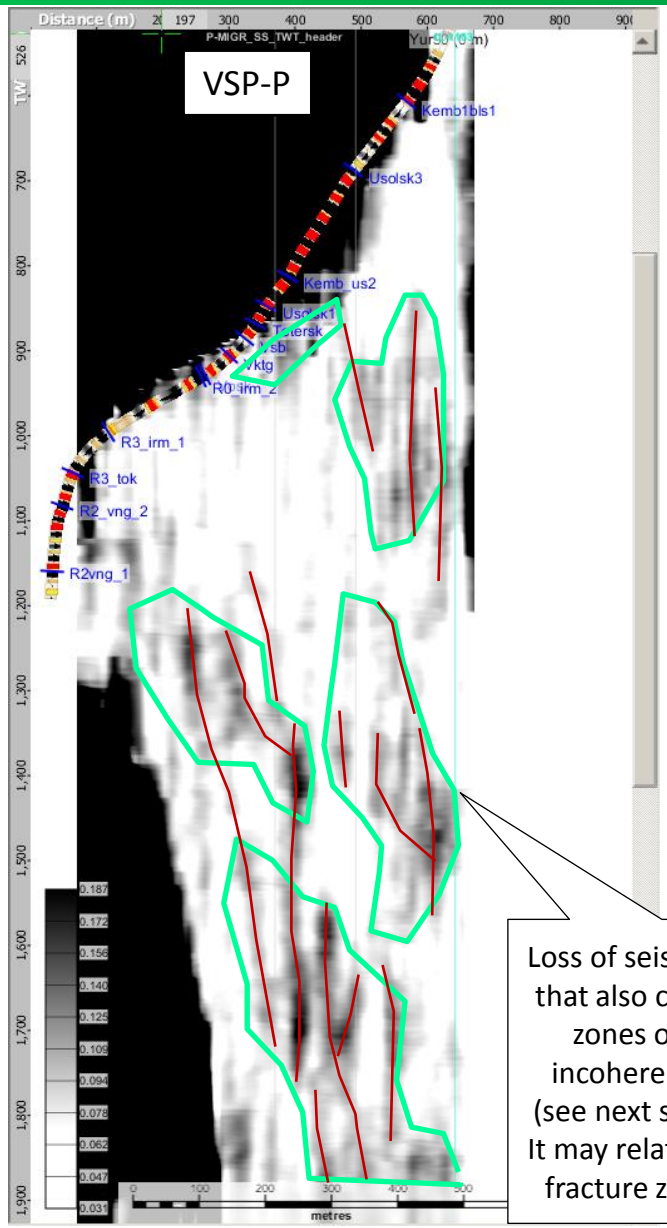

Distance (m)
S-MIGR_SS_TWT_header
90 (0 m)
Kemb1bls1
Usolsk3
Kemb_us2
Usolsk1
Telersk
Vsb
Vktg
R0_irm_2
R3_irm_1
R3_tok
R2_vng_2
R2vng_1
km


Distance (m)
S-MIGR_SS_TWT_header
90 (0 m)
Kemb1bls1
Usolsk3
Kemb_us2
Usolsk1
Telersk
Vsb
Vktg
R0_irm_2
R3_irm_1
R3_tok
R2_vng_2
R2vng_1
km

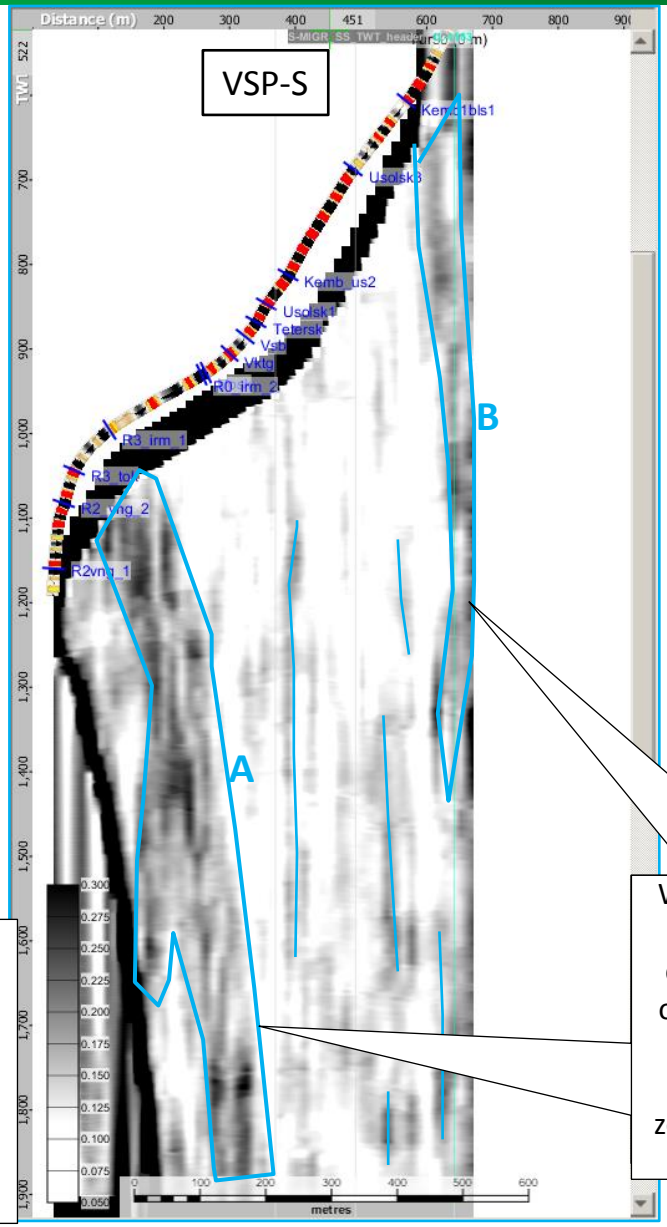
Frequency spectra



Zero offset VSP Incoherency attribute

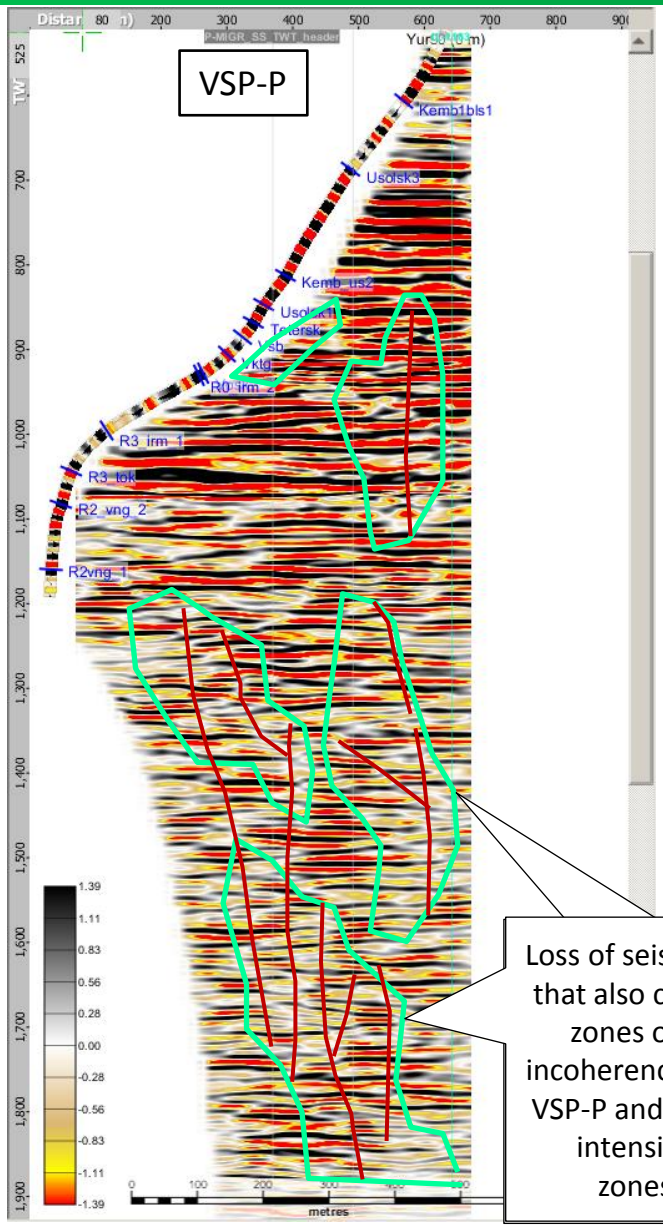


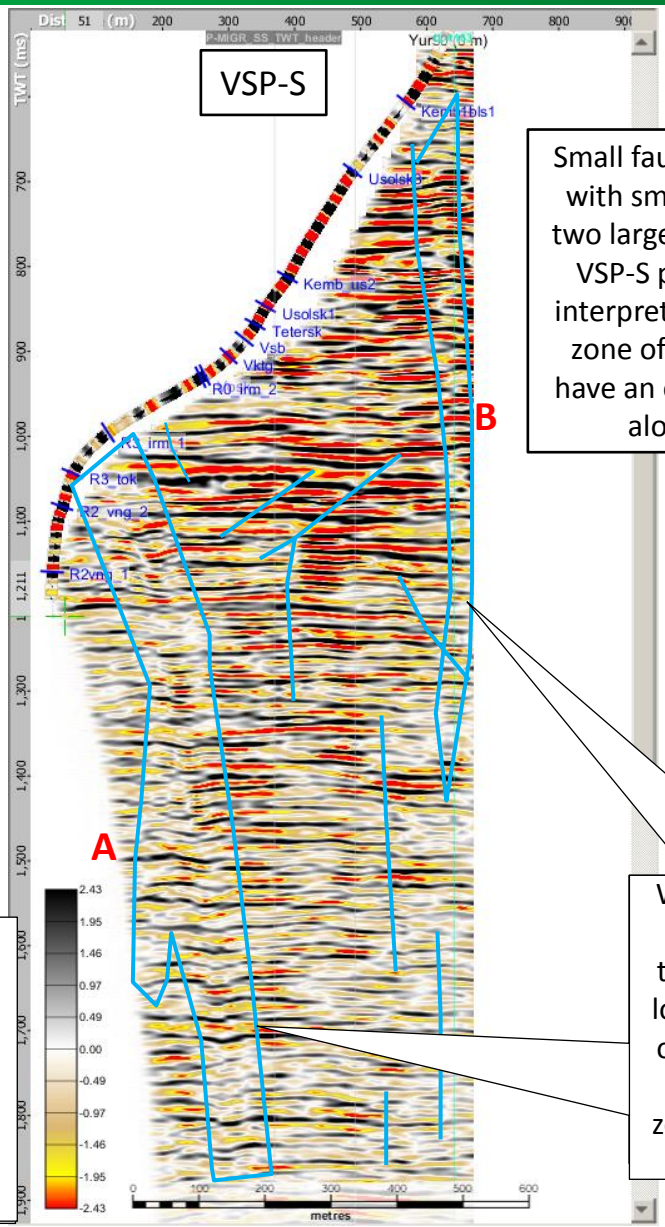
Loss of seismic continuity that also corresponds to zones of increased incoherence attribute (see next slide) on VSP-P It may relate to intensive fracture zones/faulting



Wide zones of increased incoherence attribute corresponds to the loss of seismic continuity on VSP-S It may relate to deformation zone/intensive fracturing along the faults A,B

Zero offset VSP seismic



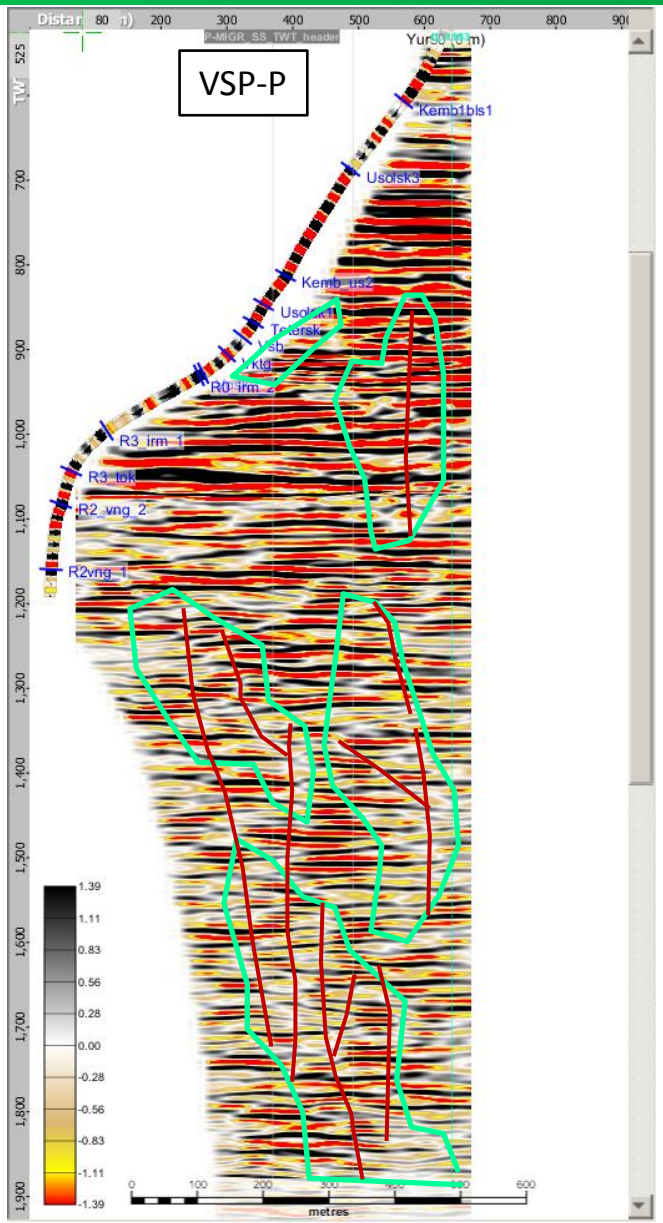


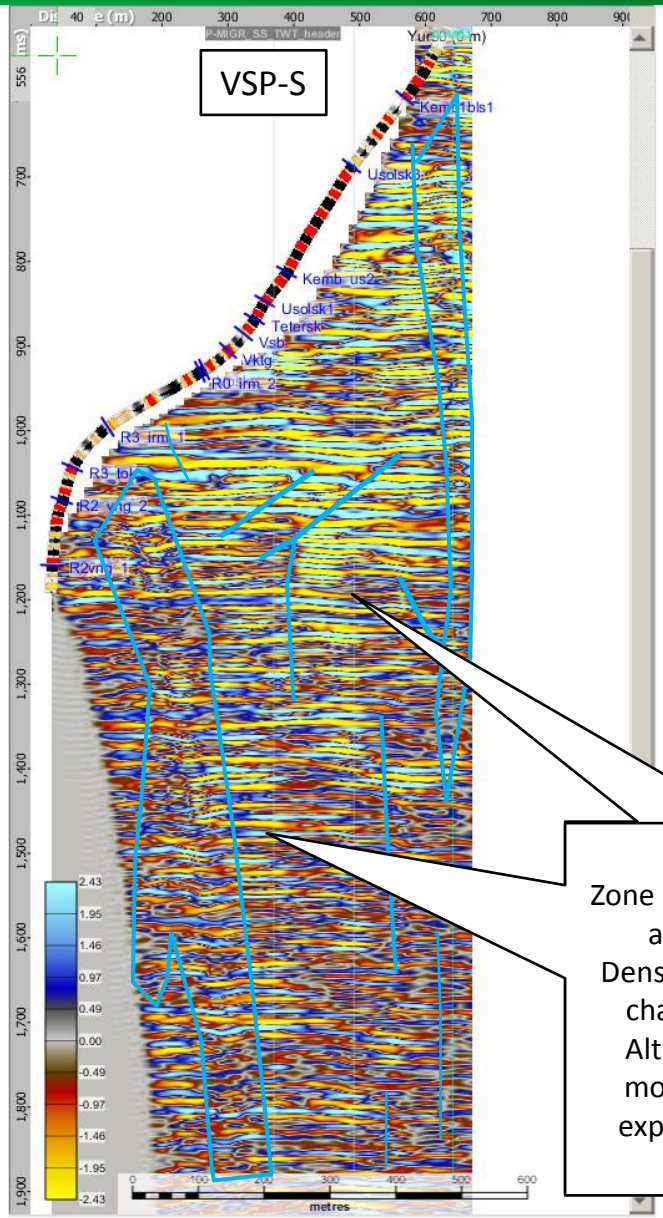
Small faults, mostly sub-vertical , with small throw of 5-15m and two large faults were mapped on VSP-S profile. The large faults interpreted as wide deformation zone of 100-150 m that could have an extensive fracture zones along the fault plane.

Loss of seismic continuity that also corresponds to zones of increased incoherence attribute on VSP-P and may relate to intensive fracture zones/faulting

Wide zones of increased incoherence attribute that also corresponds to loss of seismic continuity on VSP-S and may relate to deformation zone/intensive fracturing along the faults A,B

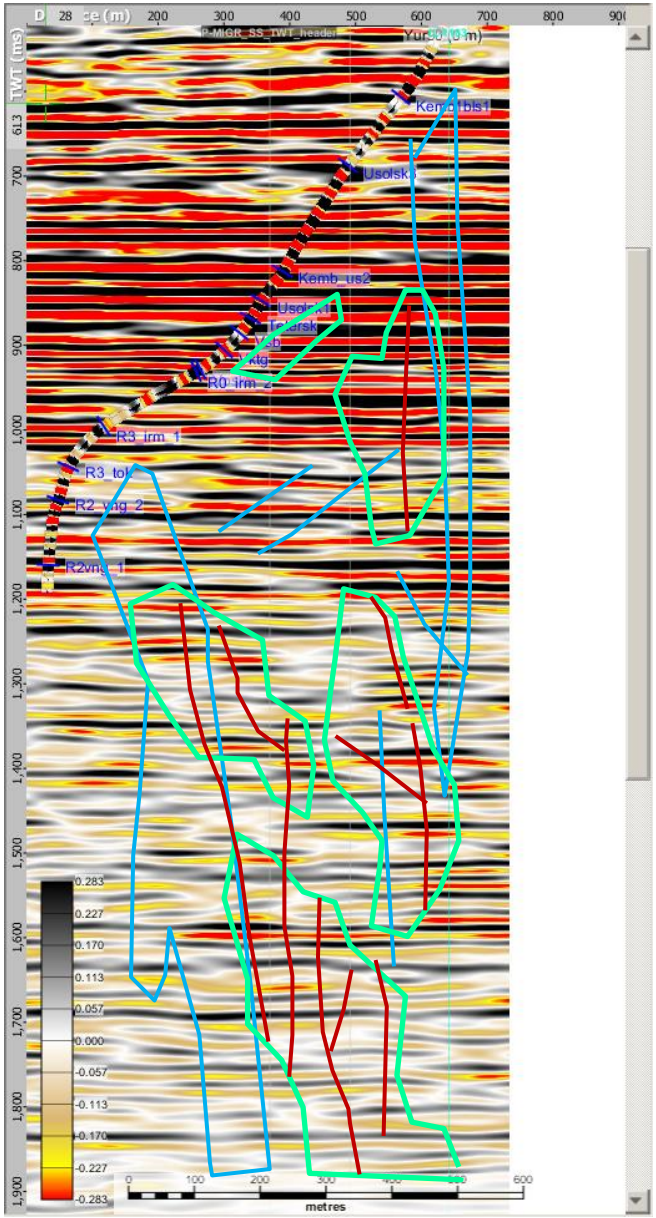
Zero offset VSP seismic

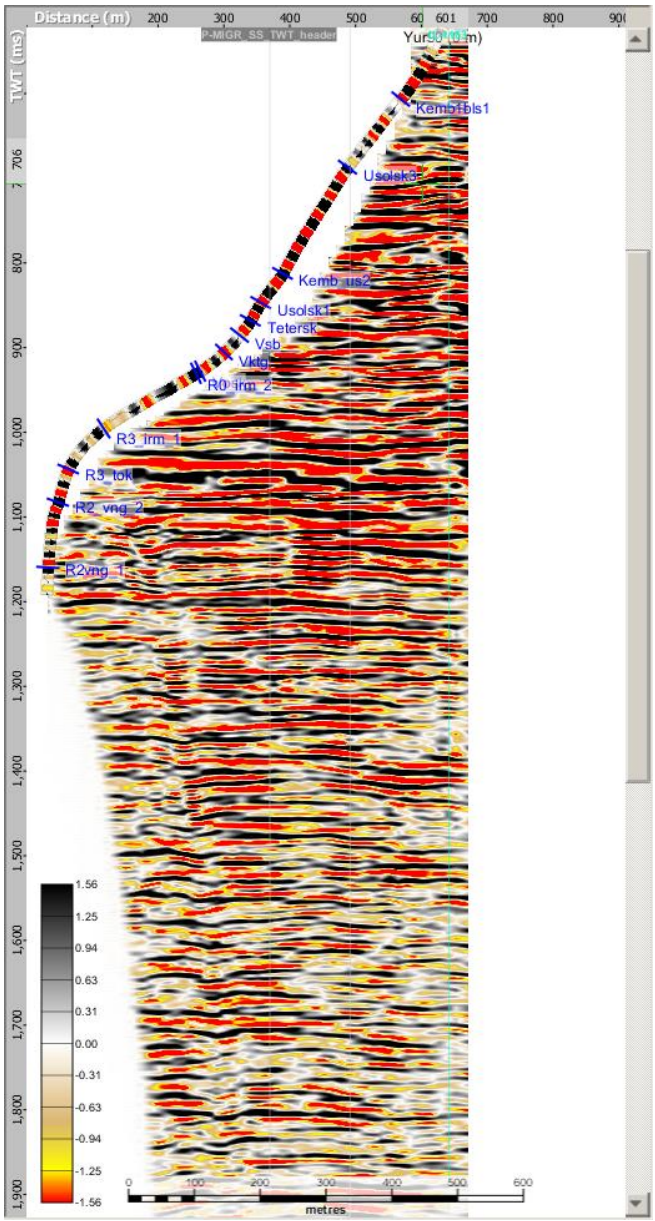




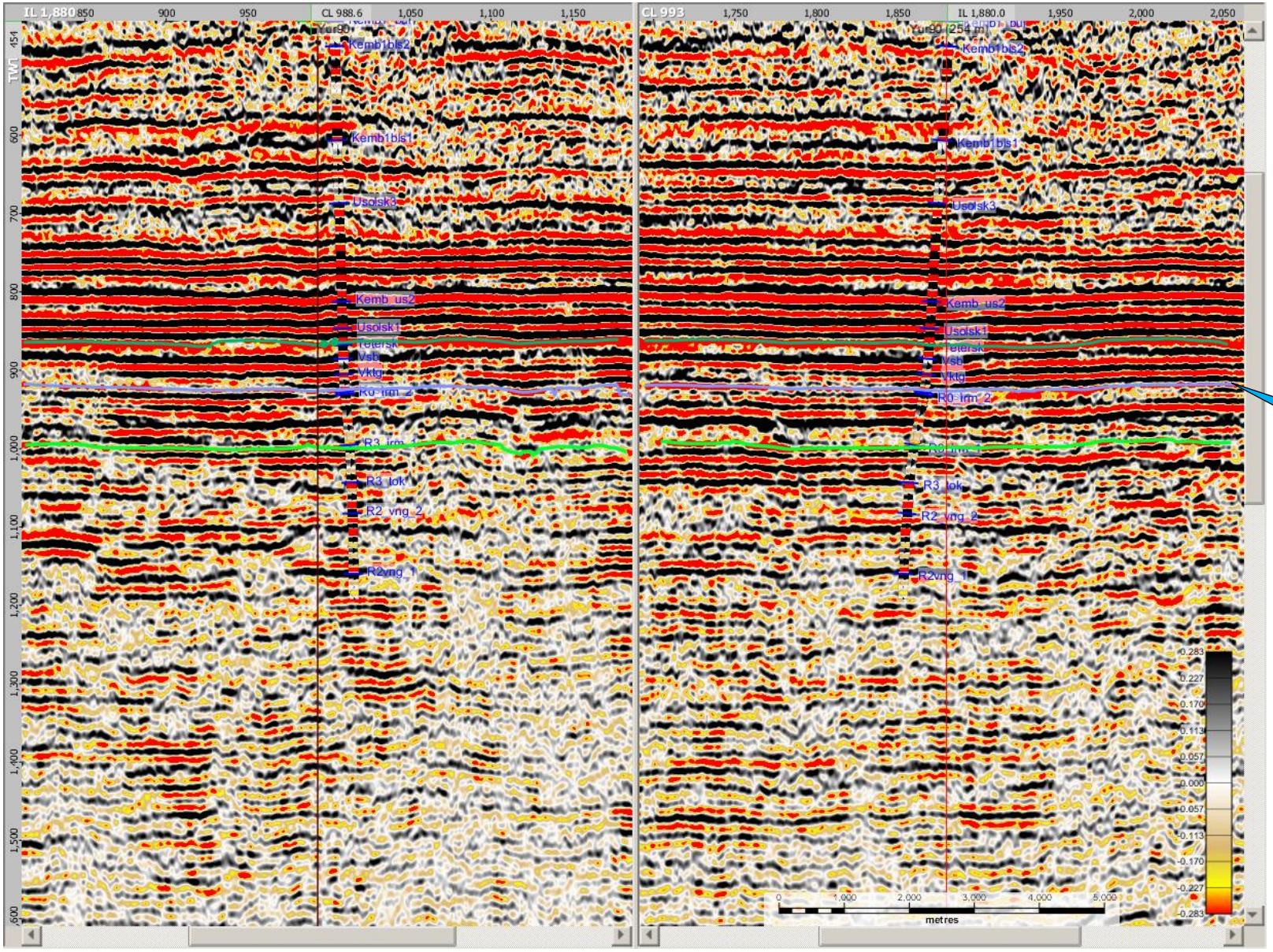
Zone of increased amplitudes along the fault plane
Density/porosity of the rock change can be a reason.
Although AVO/Inversion modelling is required to explain this phenomena.

3D seismic vs VSP-S data



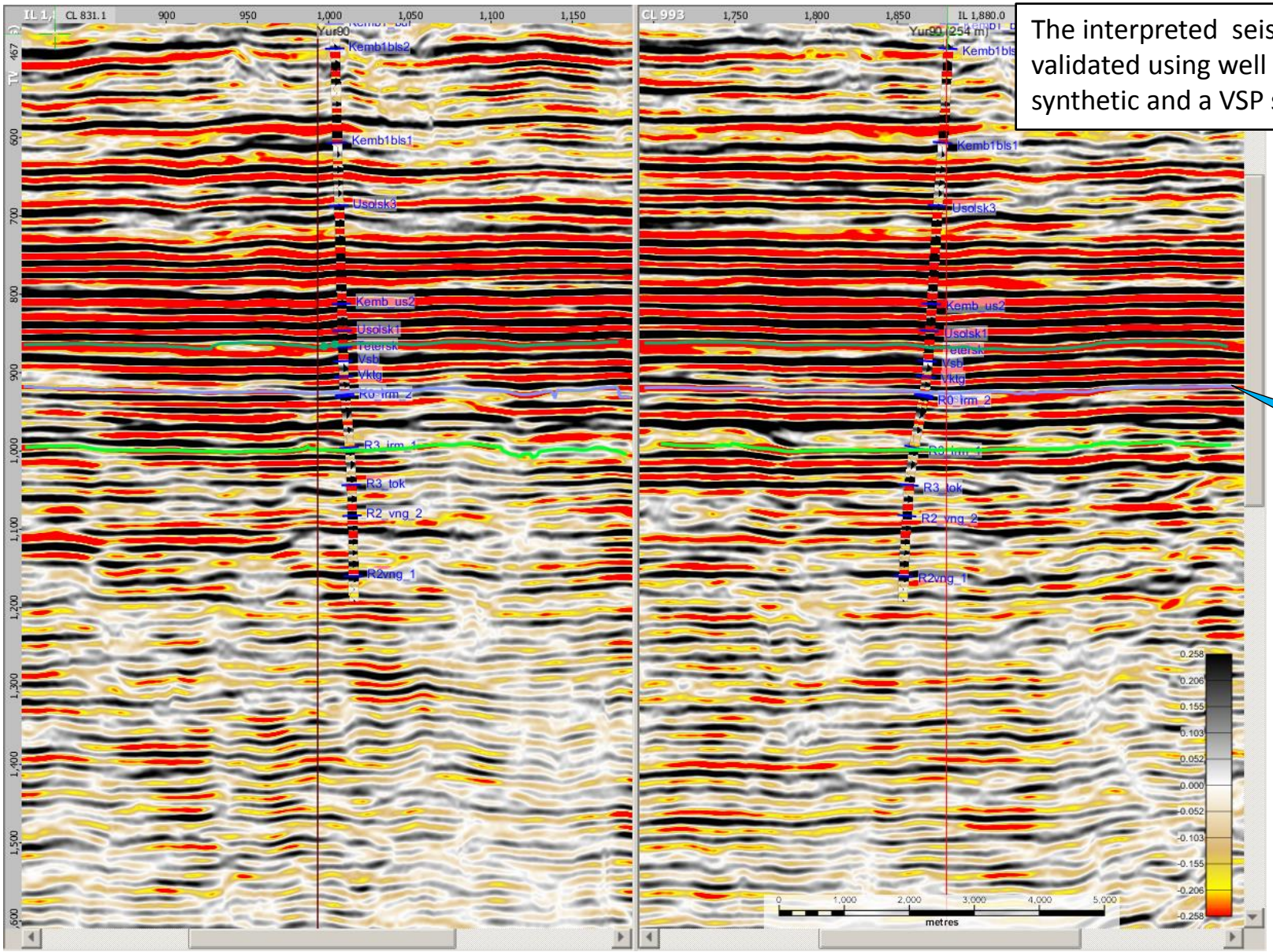


Synthetic and 3D Legacy Seismic 2009-2012



Iremekenskaya:
Top reservoir

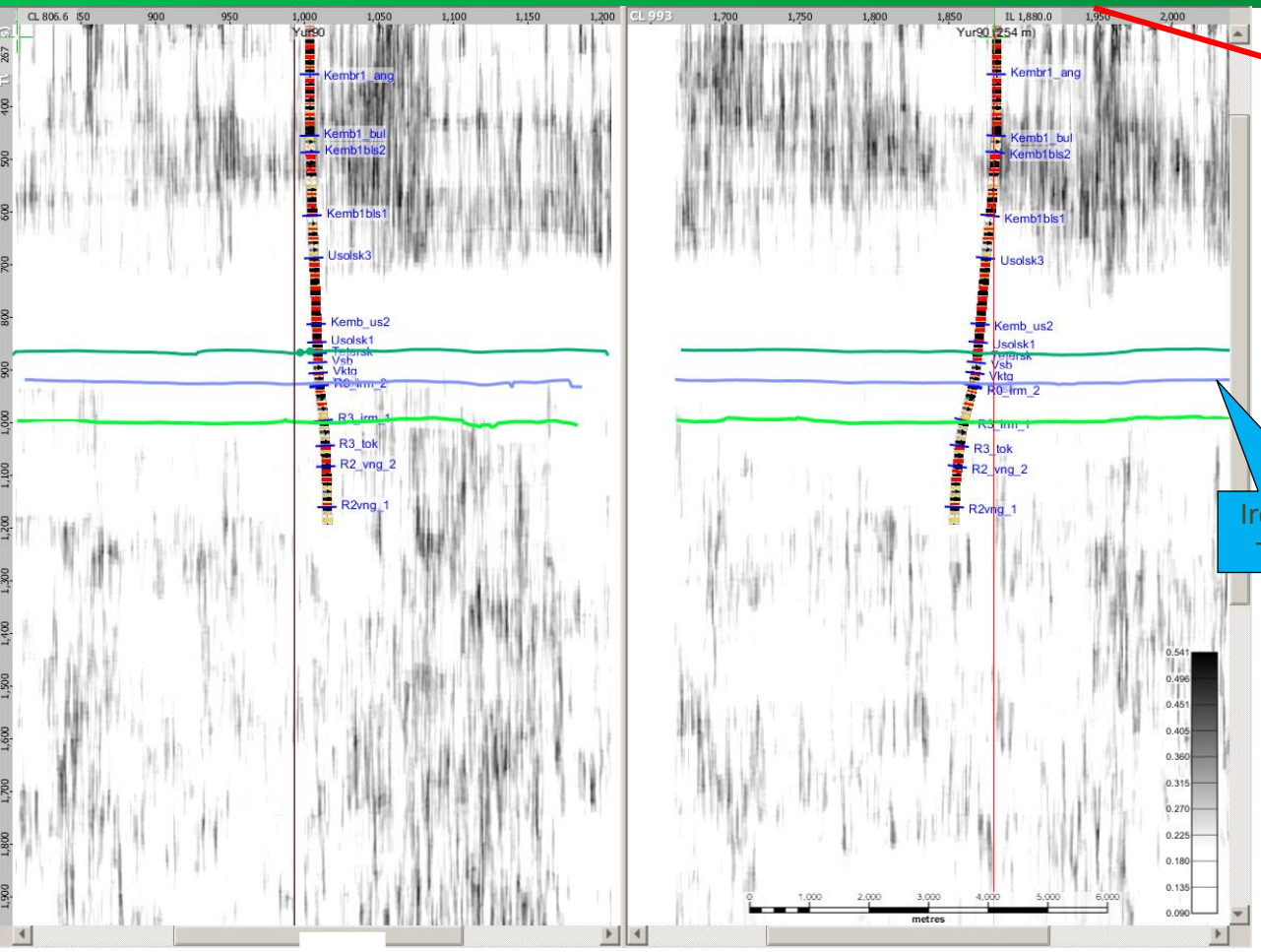
3D seismic SOF (Structurally Oriented Filter) applied

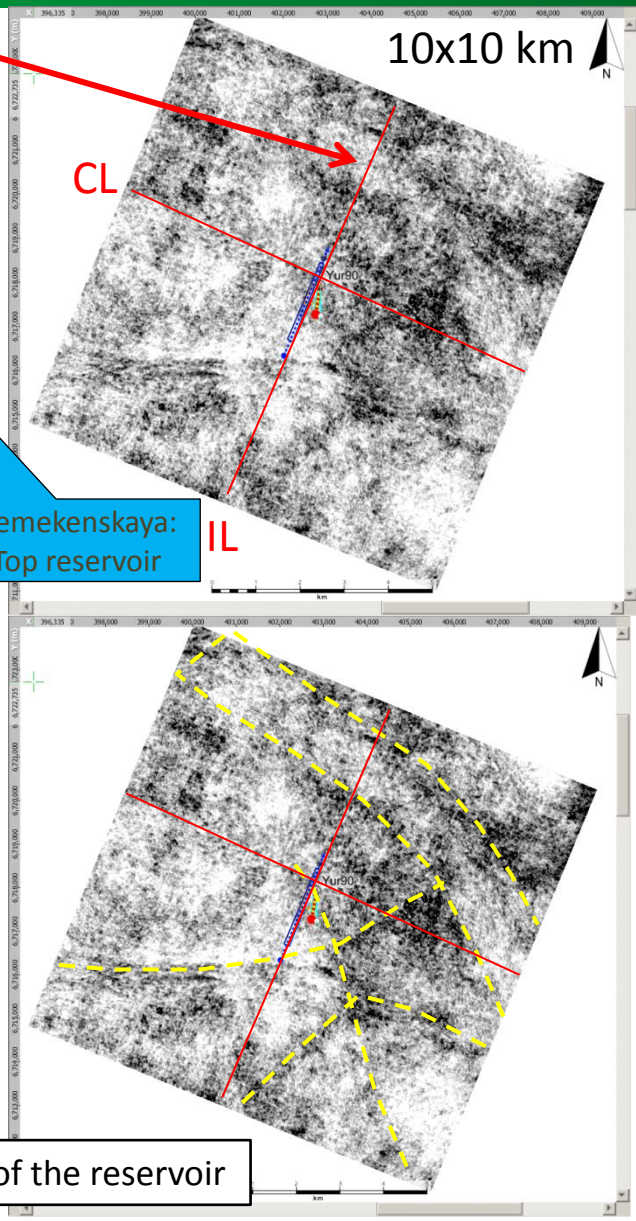


The interpreted seismic horizons weer validated using well tie analysis, synthetic and a VSP stack:

Iremekenskaya: Top reservoir

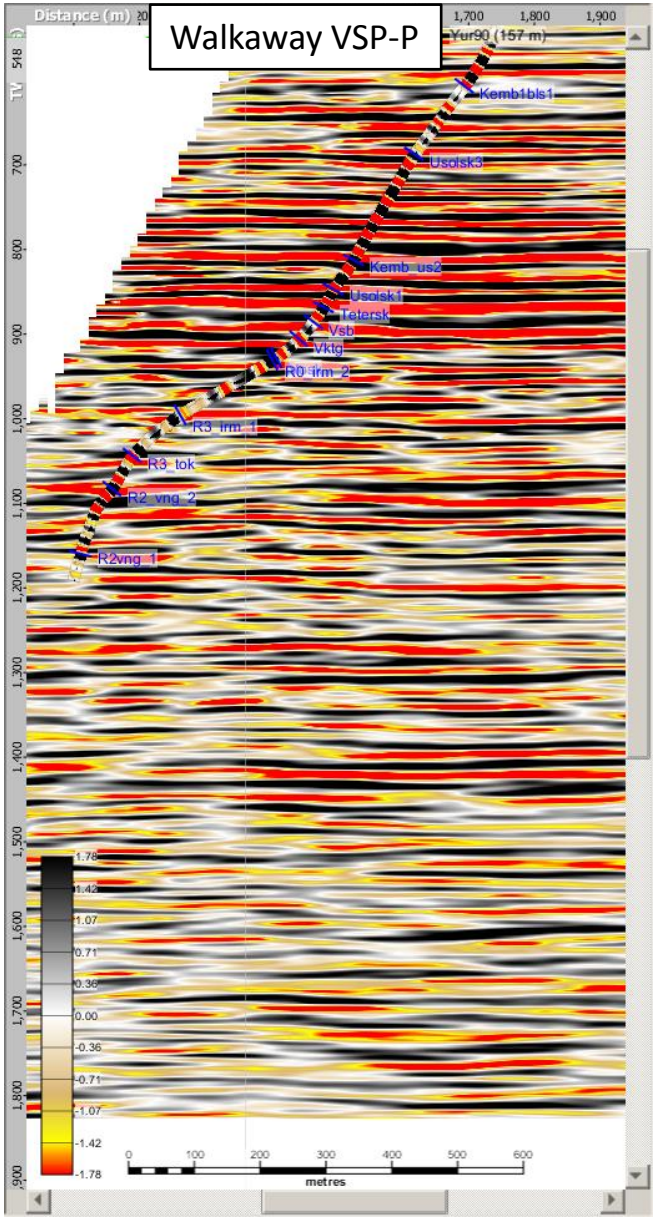
Incoherency attribute for 3D volume.

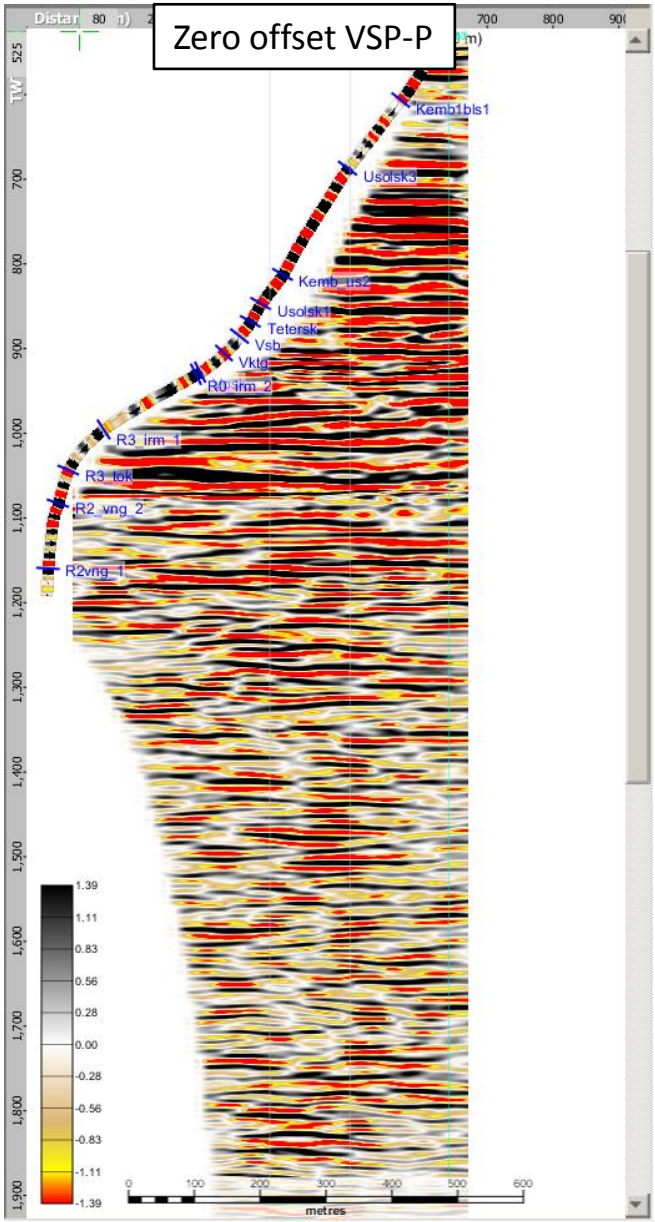




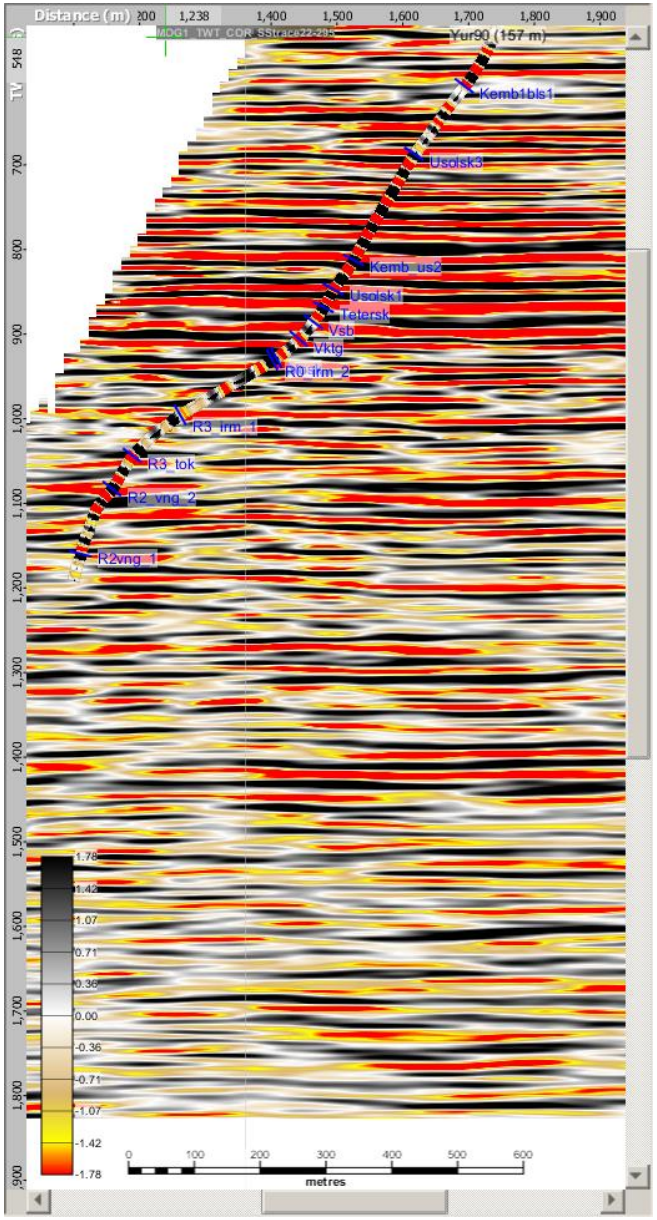
Time slice at the top of the reservoir

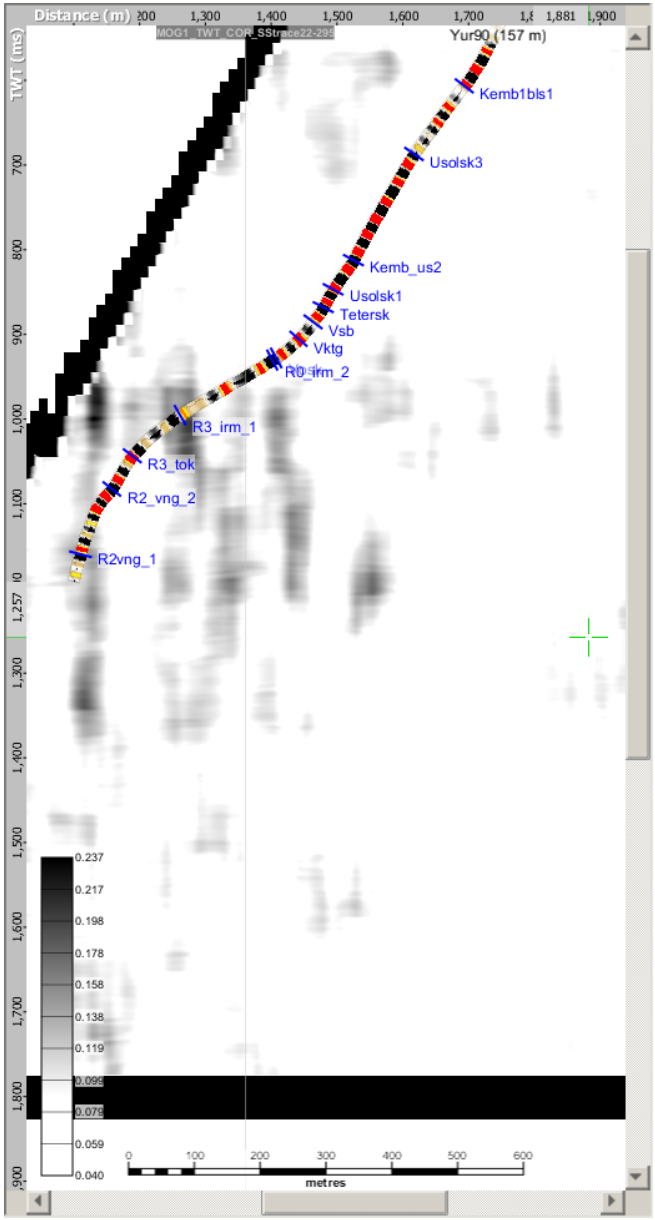
Walkaway VSP-P vs Zero offset VSP-S



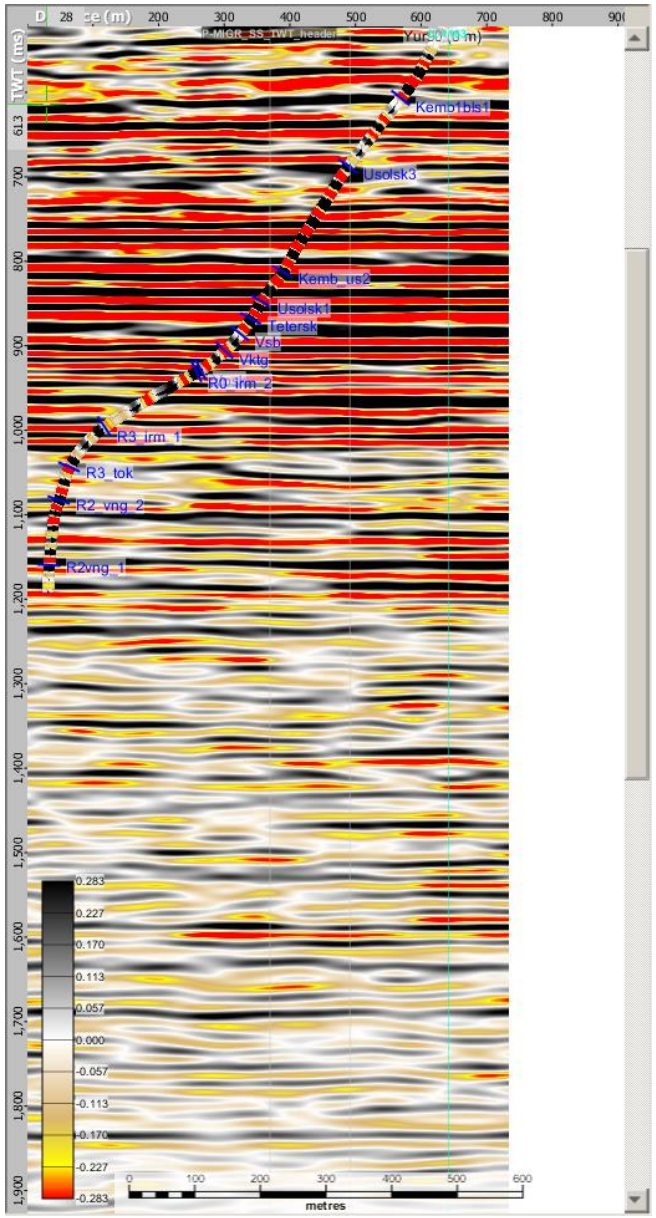


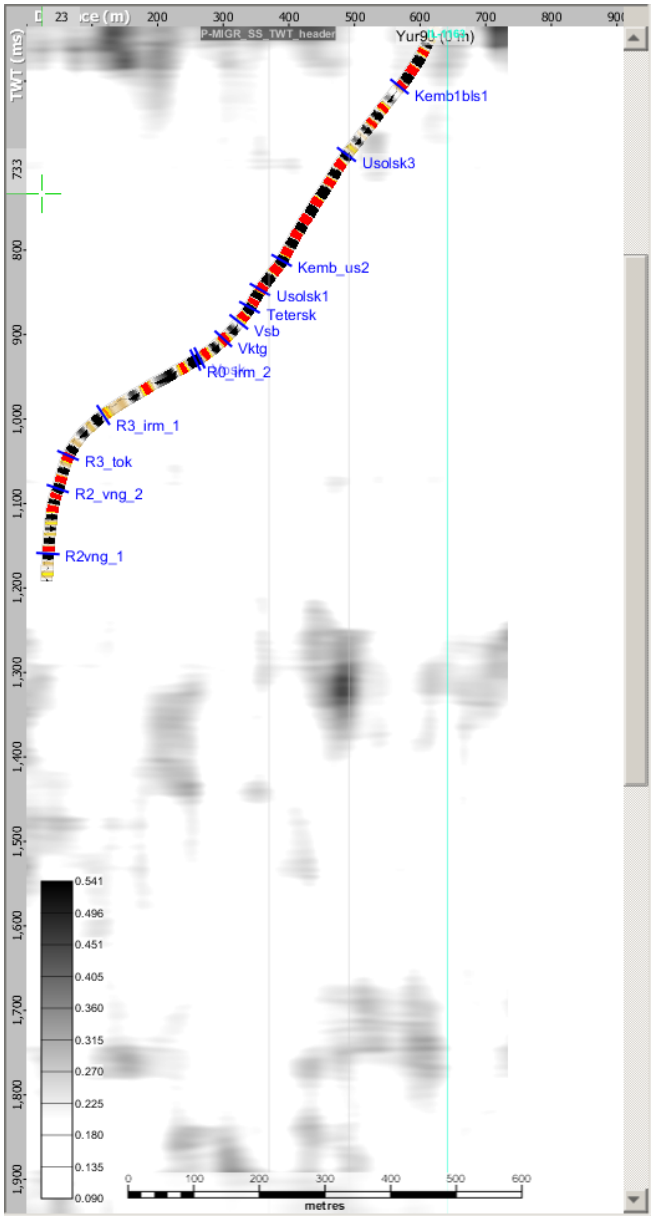
Incoherency attribute VSP-P





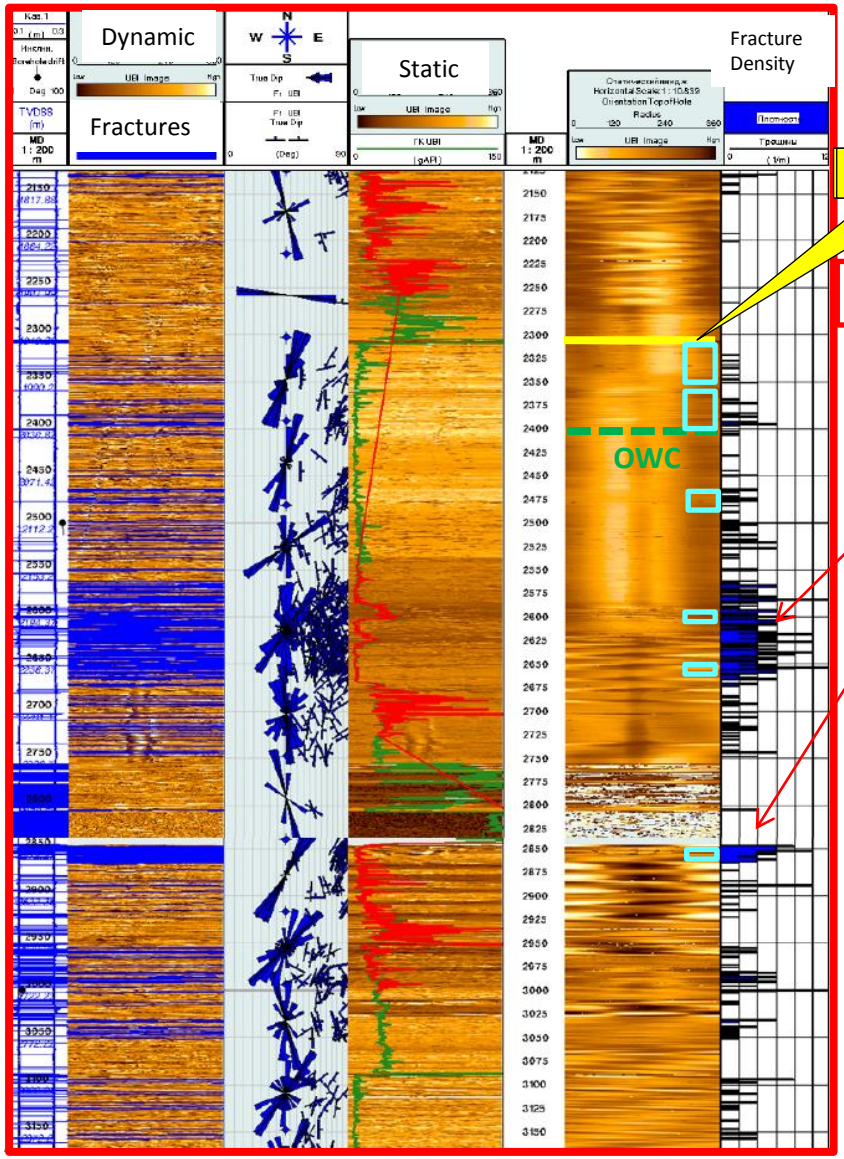
3D seismic and Incoherency attribute





Yur-90 well and VSP data

Yur-90 UBI fracture interpretation



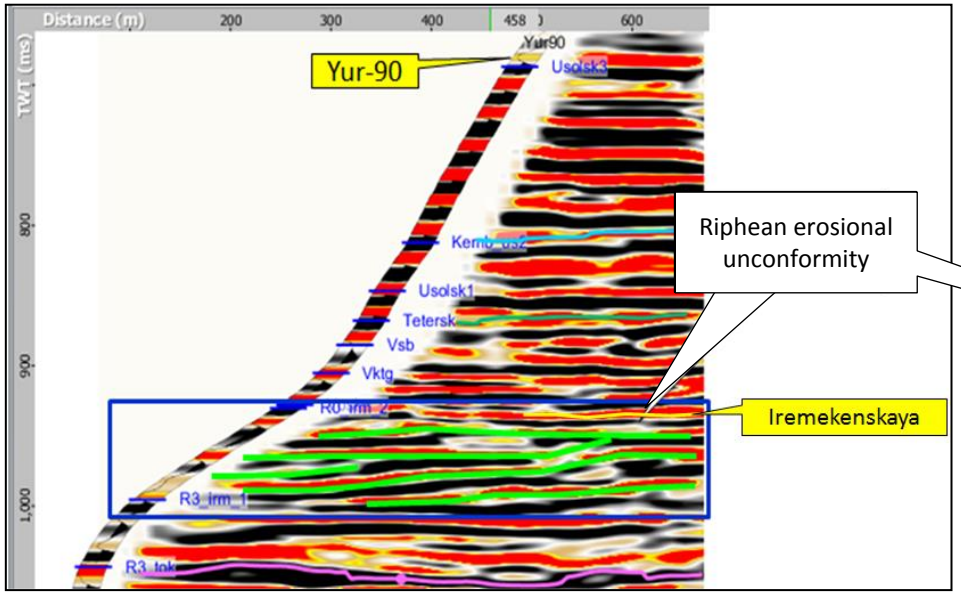
Top reservoir

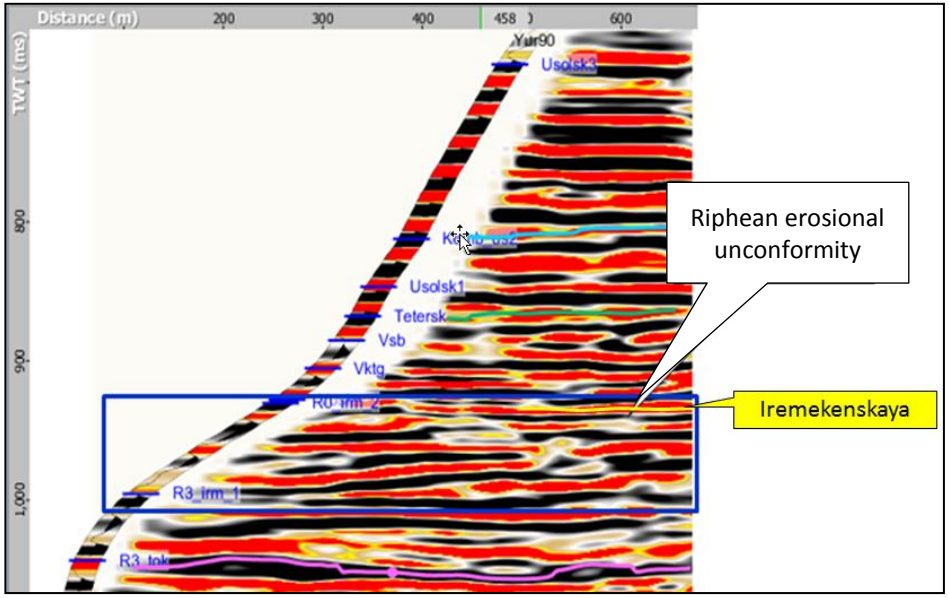
Proposed well side-track that intersects fractured zone at the top of the reservoir

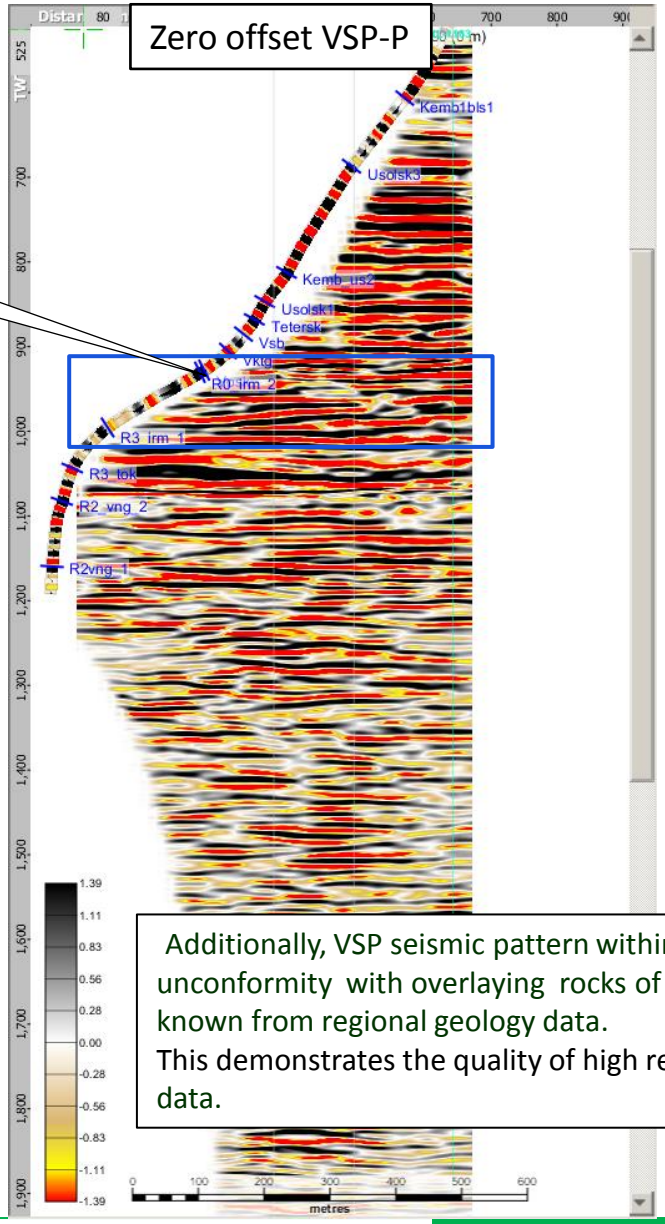
Fracture density log from Cross Dipole Sonic

Fracture zone with oil and gas shows from core (interval: 2847.1-2862.7 mMD)

Geological features on VSP seismic

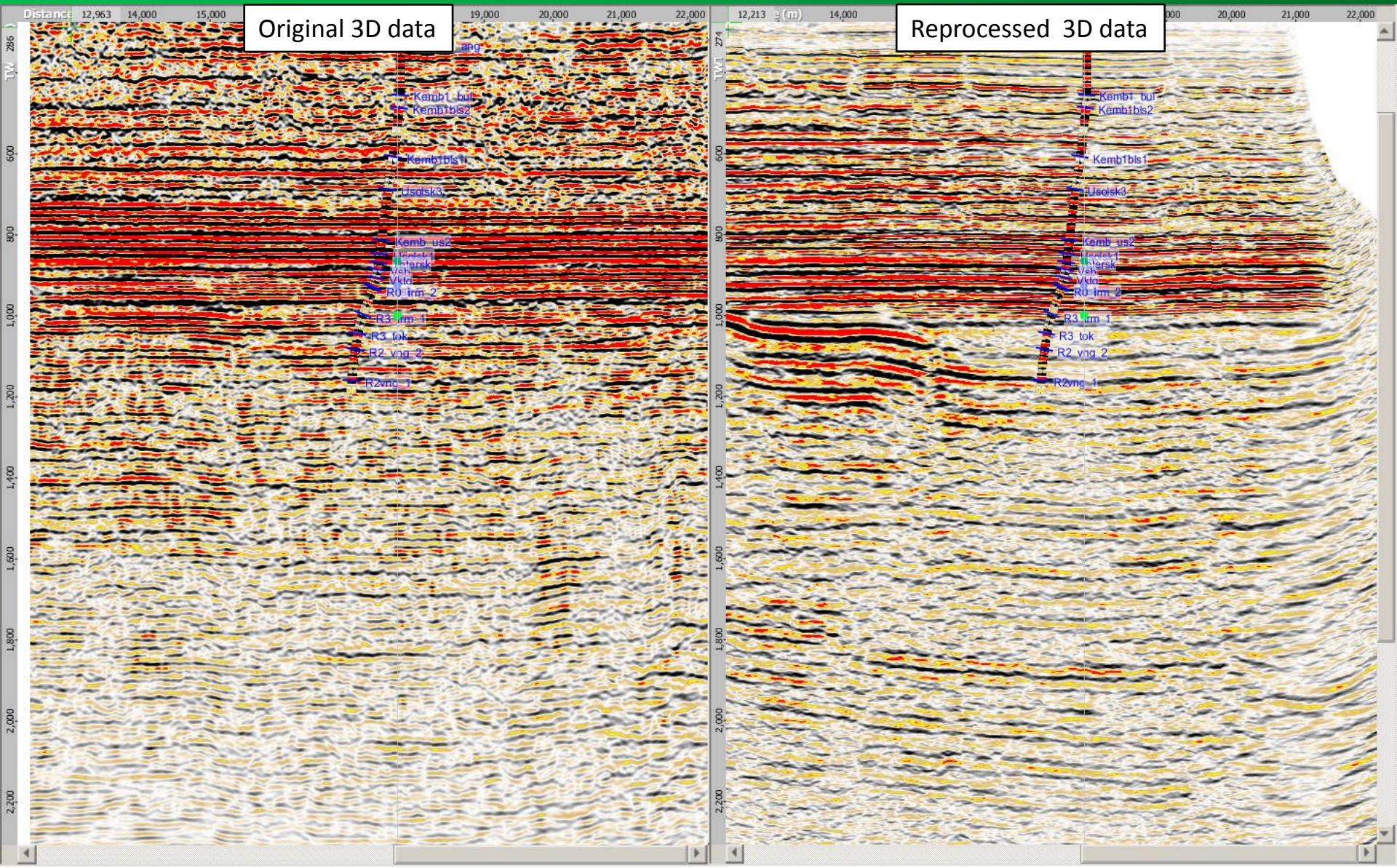






Additionally, VSP seismic pattern within Rifean unconformity with overlaying rocks of Vend and known from regional geology data.
This demonstrates the quality of high resolution VSP data.

Results of 3D seismic data reprocessing



Conclusions and Recommendations

- The higher resolution VSP data allowed to map small faults and fractured zones that correspond with well log data.
- Time migrated VSP P and S provide different rock property and therefore geological information. This can be used in seismic inversion calibration and modelling reservoir properties.
- VSP data provided valuable information for reprocessing 3D seismic.
- We recommend acquiring and processing walkaway VSP data before the well enters the reservoir. With today's technology, processing and interpretation of the walkaway VSP data can be done within a short period of few weeks. These results can be used to steer a well trajectory into interpreted geological features or "sweet spots" in the reservoirs. Alternatively, VSP can be done in a pilot hole and then side track the well based on the VSP interpretation.

Conclusions and Recommendations