NSNR
Mid North Sea High
SIP25 2020 2D Marine Reprocessing

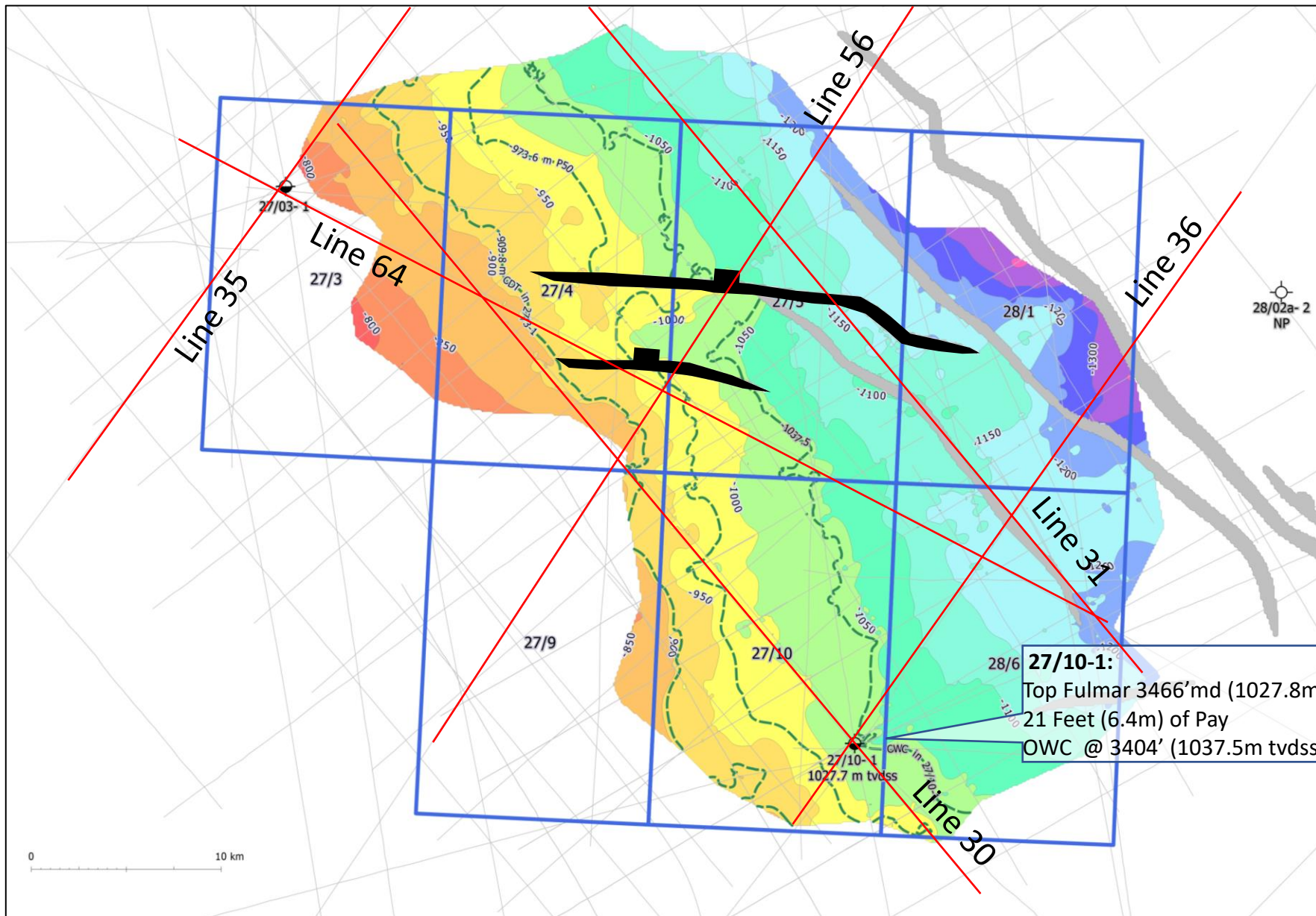**Devil's Hole Horst 2D reprocessing summary**

1st December 2020 update

Summary

SIP was contracted to provide the 2D PSTM reprocessing of 2015 OGA MNSH lines 30, 31, 35, 36, 56 and 64.

- A key objective was to improve the resolution of the seismic sections between 600 to 1200ms TWT, over the Jurassic and deeper Permian prospects. The initial reprocessing used the pre-demultiple 4ms resampled deghosted shot records processed by WesternGeco for the OGA in 2015. To further improve the resolution at target, the original 2ms field data was also reprocessed.

- Although the bandwidth of the (4ms) input data is challenged beyond the 5 to 80 Hz range, the SIP reprocessing managed to improve the low and high frequency S/N of the image. We also see a further resolution enhancement when using the original 2ms field data.

- The reprocessing has improved the detail and imaging of the target area through a combination of SIP's demultiple and velocity enhancement. The SIP demultiple is also seen to be effective to attenuate the strong low frequency reverberations in the data, that was obscuring the detail at the reservoir interval. Improvement in the low frequency signal has also reduced the strong side lobes of the wavelet.
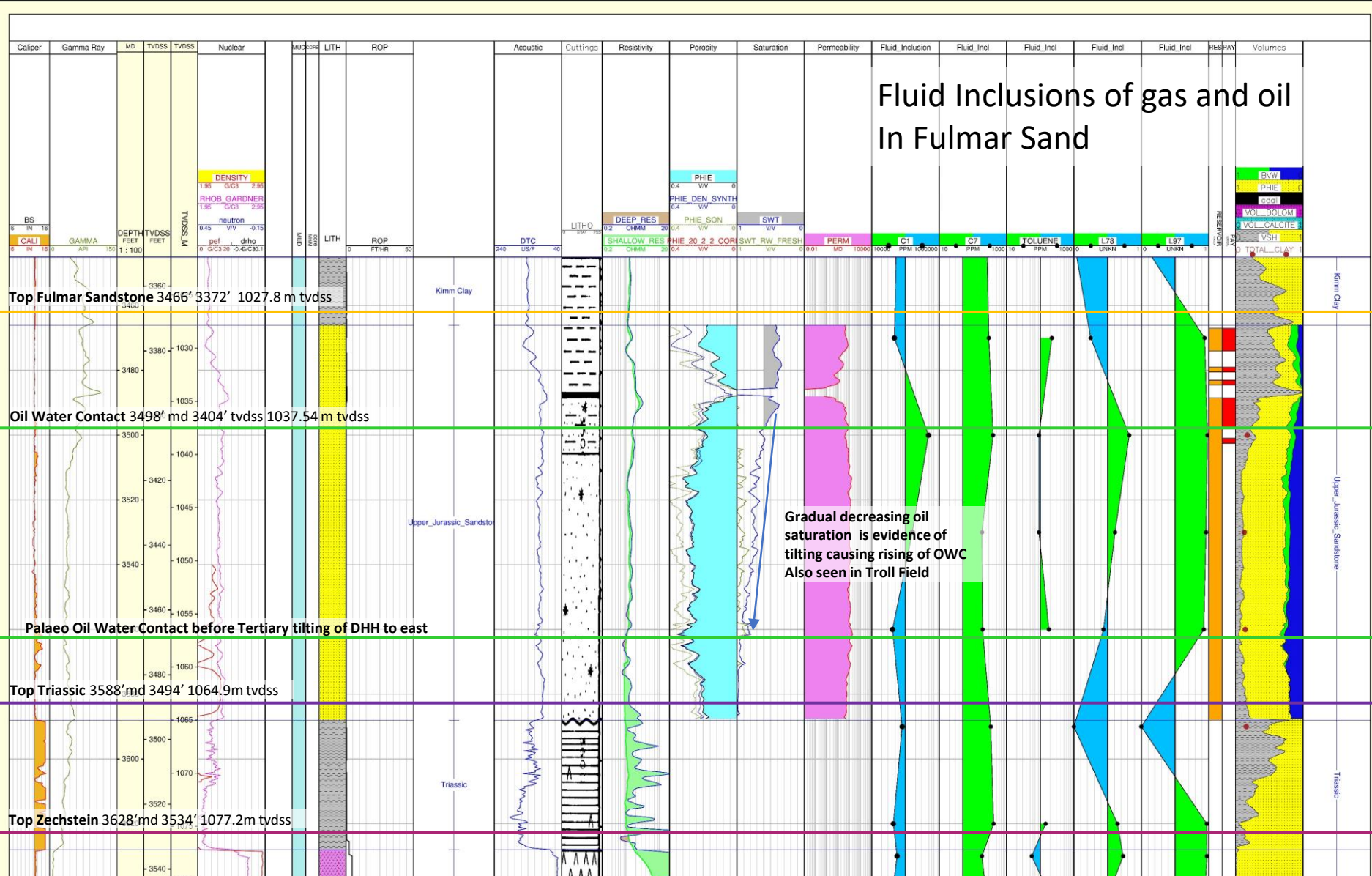
Data and processing summary

DHH Prospect Updated Top Fulmar Depth Map

27/10-1:
Top Fulmar 3466'md (1027.8m tvdss)
21 Feet (6.4m) of Pay
OWC @ 3404' (1037.5m tvdss)
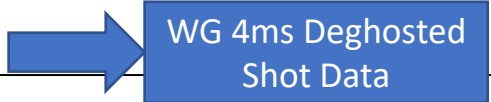
Fluid Inclusions of gas and oil
In Fulmar Sand

Top Fulmar Sandstone 3466' 3372' 1027.8 m tvdss

Oil Water Contact 3498' md 3404' tvdss 1037.54 m tvdss

Gradual decreasing oil
saturation is evidence of
tilting causing rising of OWC
Also seen in Troll Field

Palaeo Oil Water Contact before Tertiary tilting of DHH to east

Top Triassic 3588'md 3494' 1064.9m tvdss

Top Zechstein 3628'md 3534' 1077.2m tvdss

Data input description: 4ms vs. 2ms

The initial input data reprocessed by SIP was the 4ms WG deghosted shot data (Left), which had the following preprocessing steps already applied in 2015. The 2ms reprocessing was also completed (Right) by SIP. Both inputs were passed through the SIP marine 2020 reprocessing sequence (next slide).

WG 4ms Pre-Processing

1. SEG-D Field data at 2ms.

2. Enhanced data forming to attenuate low velocity noise modes and low level signal perturbations:
   - Wrap-around noise removal, SVD & Multi-scale LACONA, Trace / Shot edits, Navigation – Seismic Merge, AAA, Q Streamer Regularization, FXIIR dip filter

3. Receiver Motion Correction

4. Calibrated Source to target Designature: Debubble and Zero Phase Designature

5. **Resampling to 4 ms and trace decimation to 6.25 m i.e. Nyquist 125Hz**

6. Direct Arrival Removal

7. Denoise (AAA, SPNA)

8. Single Streamer (Receiver) Deghosting

9. Dip filter

10. Output to SEGY

WG 4ms Deghosted Shot Data

SIP 2ms Pre-Processing

1. SEG-D Field data at 2ms.

2. P190 Navigation merge

3. Trace / Shot edits

4. Swell noise attenuation and Dip filter

5. Receiver Motion Correction

6. Designature: Debubble and Zero Phase Designature

7. Direct Arrival Removal

8. Single Streamer (Receiver) Deghosting

9. Input to SIP demultiple stage **i.e. Nyquist 250Hz**

SIP 2ms Deghosted Shot Data

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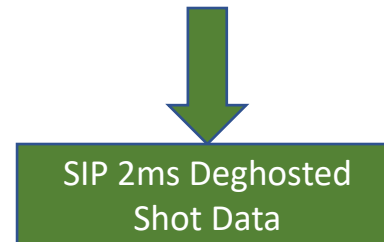
SIP Processing flow summary

Time processing
1. The 4ms / 2ms Pre-processed data inputs
2. 2D Geometry apply
3. Linear denoise
4. ePEG demultiple
5. Hi-Resolution Radon demultiple
6. Source-deghosting
7. Residual Linear denoise
8. Phase-only inverse-Q (Q=100)
9. Interactive Velocity Analysis, RMS model update for Pre-Stack Time Imaging
10. Anisotropic Pre-Stack Kirchhoff Time Migration
11. Hi-Resolution Radon demultiple
12. Residual Move-out correction
13. Linear denoise
14. Amplitude inverse-Q
15. Random denoise
16. Angle-mute and Stack
17. Gun static correction +4ms
18. DB Gain balance 4 dB/s
19. Match header geometry to 2015 processing

Frequency spectrum [4ms data]

Full stack with spectral window

Spectrum on L36 WG Full Stack – 200 to 1400ms

The data is bandlimited between 5 to ~80Hz.
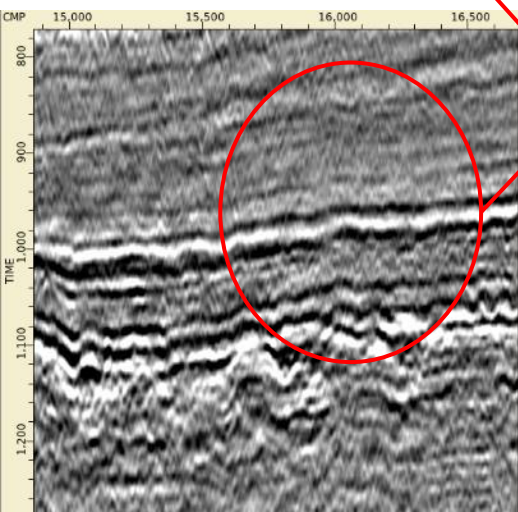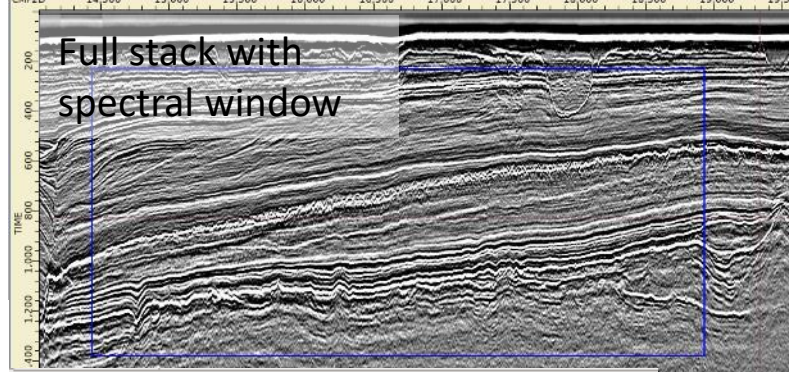
Frequencies < 5Hz are very noisy and obscure higher frequency signal of the lower amplitude reflectors

Frequencies > 80 Hz are very low in S/N with high frequency ringing, artefact and reverberations, also observed on 2ms data
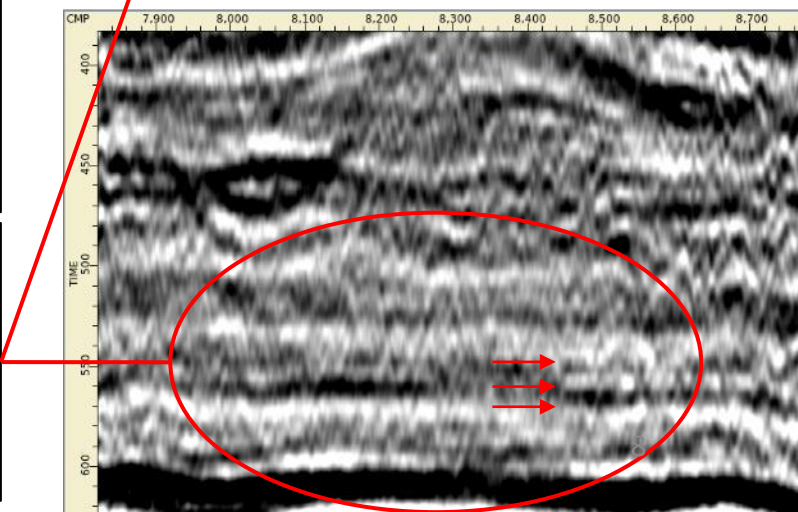
Brute stack comparison [2ms vs. 4ms]
Full bandwidth

2ms data

4ms data
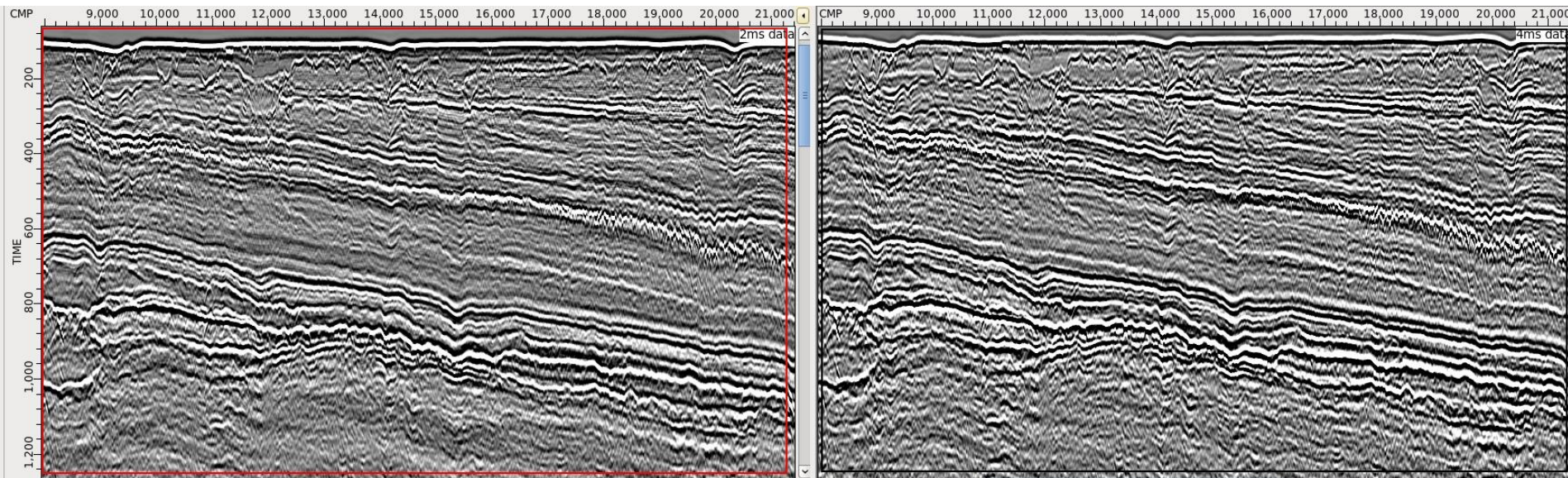
The 2ms data signal extends to ~200Hz, with low signal to noise ratio > 80Hz
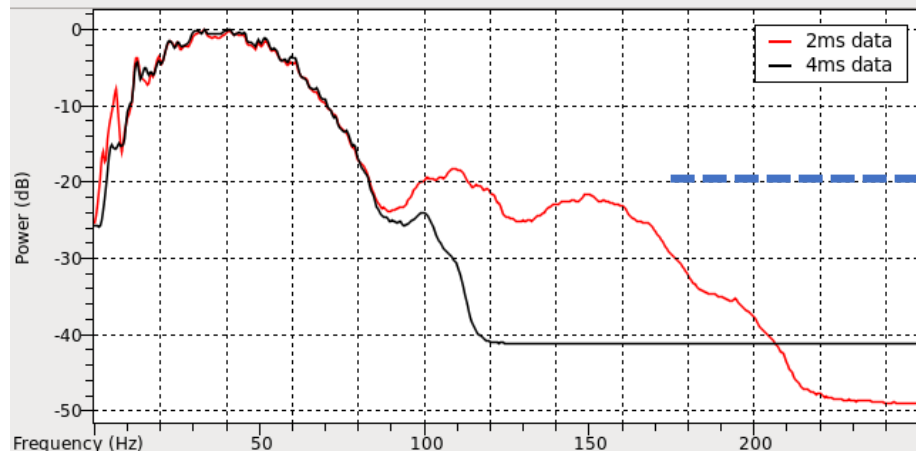
> 80 Hz @ 20dB below

SIP Results

Before demultiple

Line 36 example showing brute NMO stack <u>before</u> demultiple

Target interval

30 km
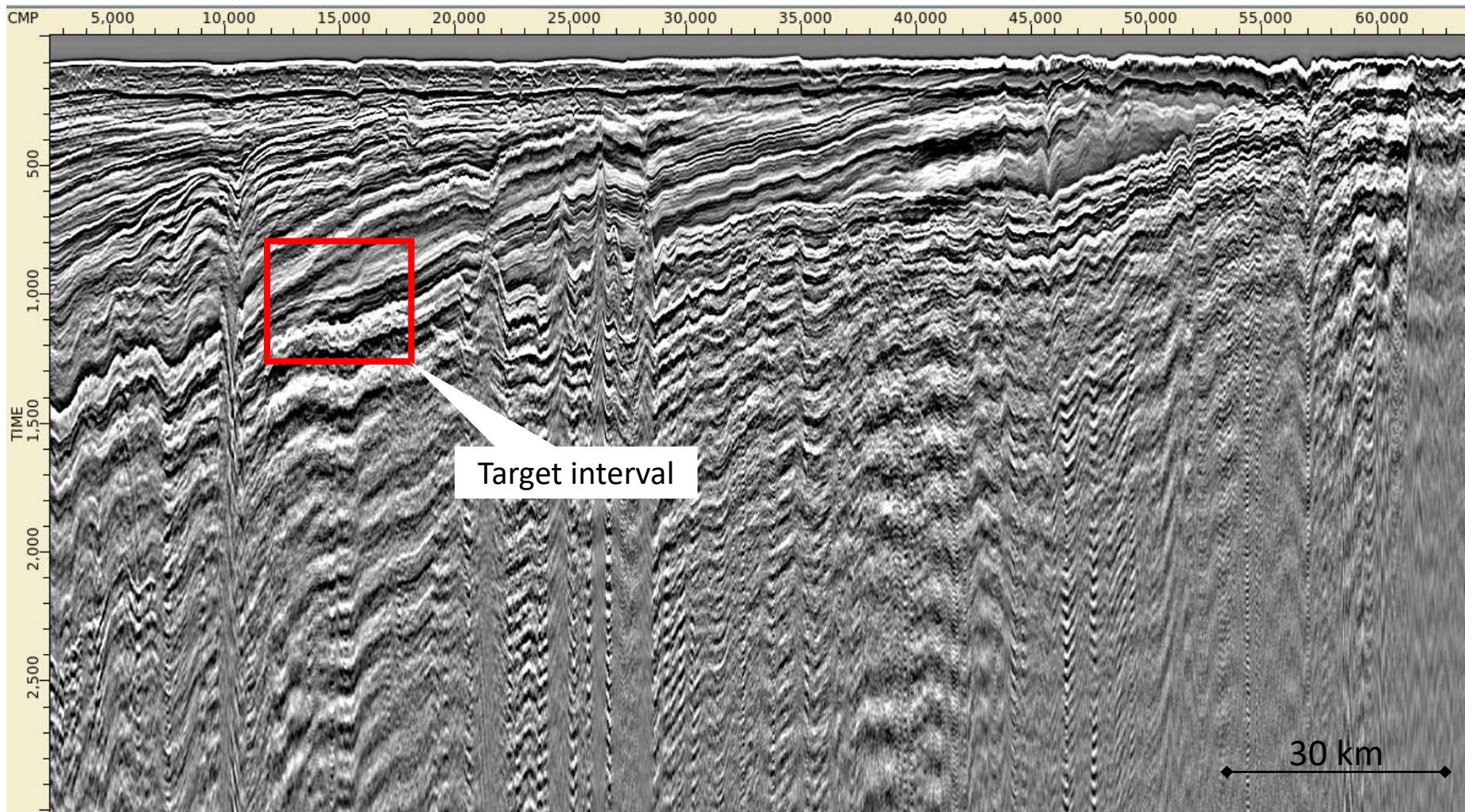
After SIP demultiple

Line 36 example showing brute NMO stack <u>after</u> demultiple

Target interval

30 km
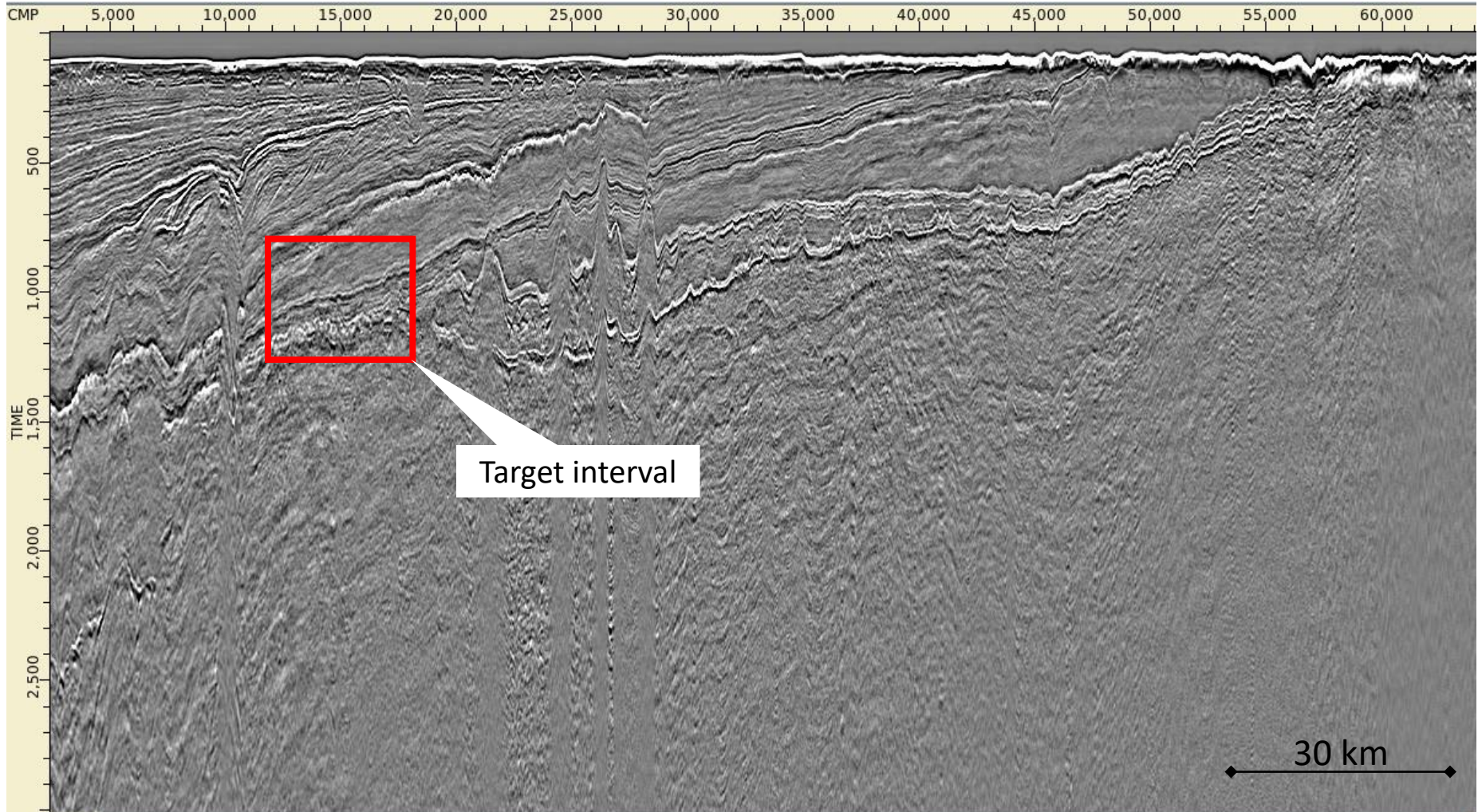
Line 30 velocity update example
Original RMS velocities
PSTM seismic with velocity overlay

27/10-01

Sonic
RMS

10 km
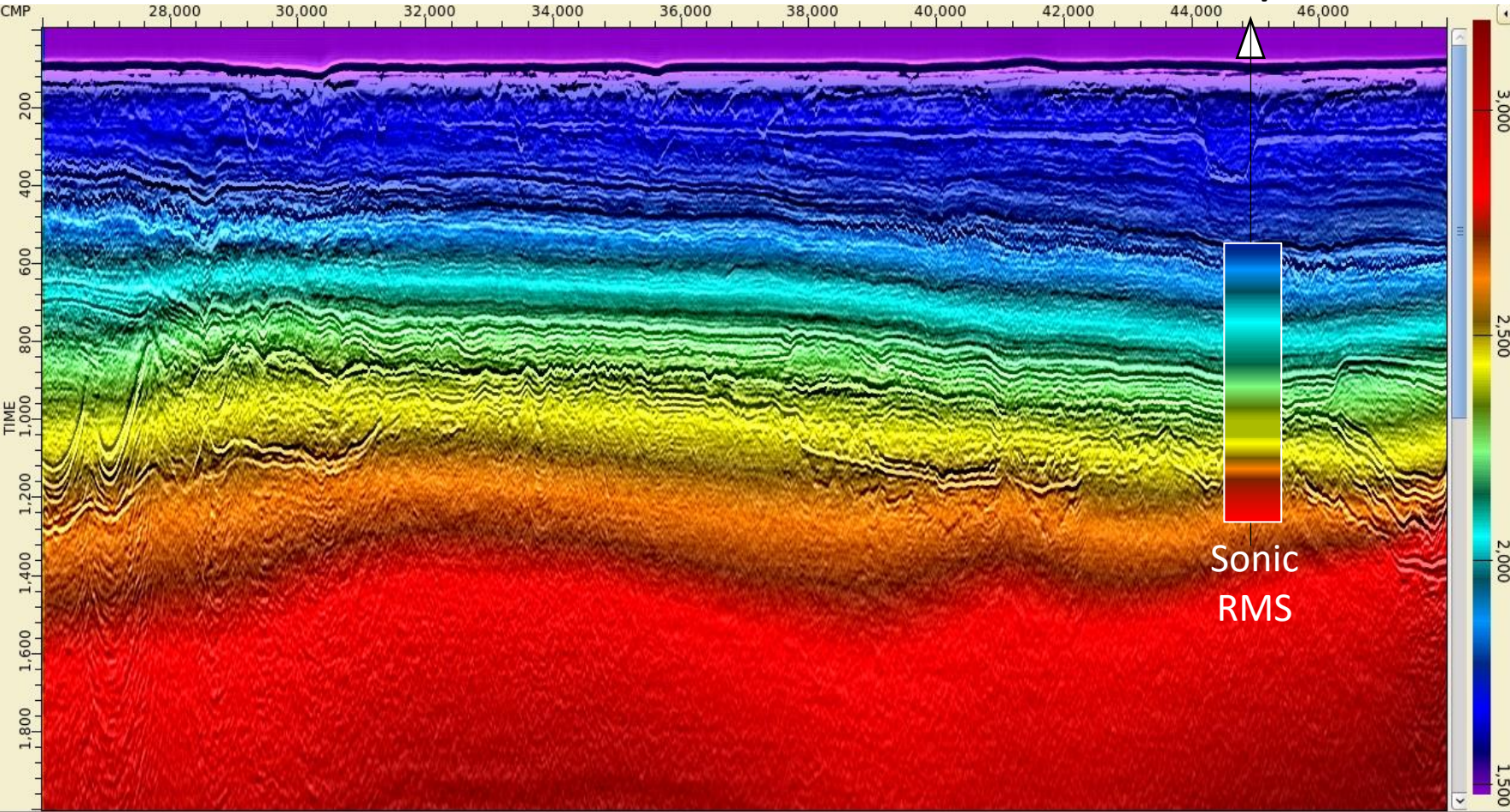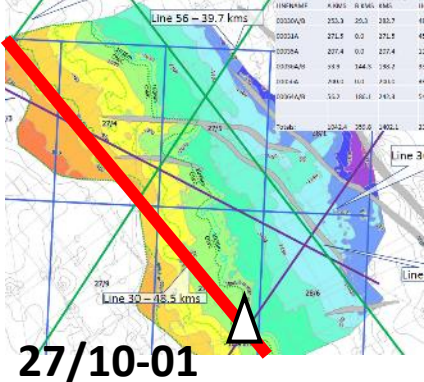
Line 30 velocity update example
Updated RMS velocities
PSTM seismic with velocity overlay

27/10-01

Sonic
RMS
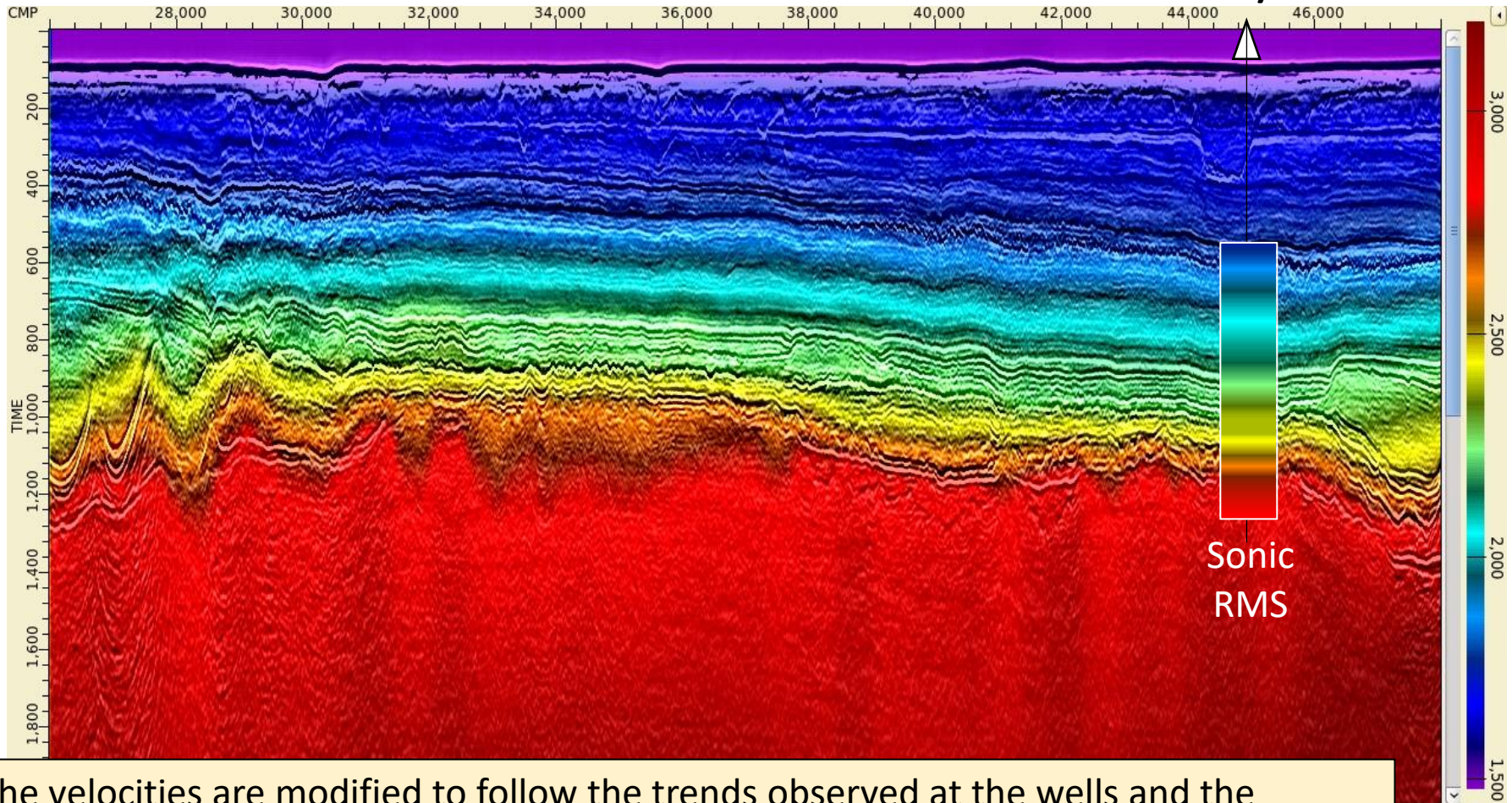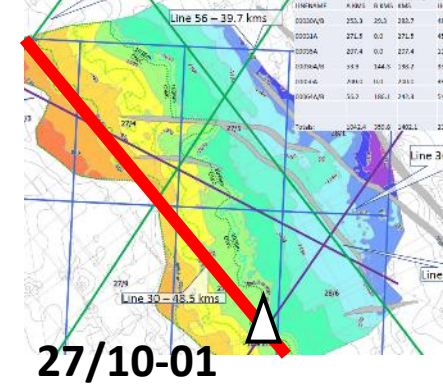
The velocities are modified to follow the trends observed at the wells and the updates are data-driven across the section to follow key lithological boundaries.

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Line 64 stack example
2015 PSTM full stack [4ms]
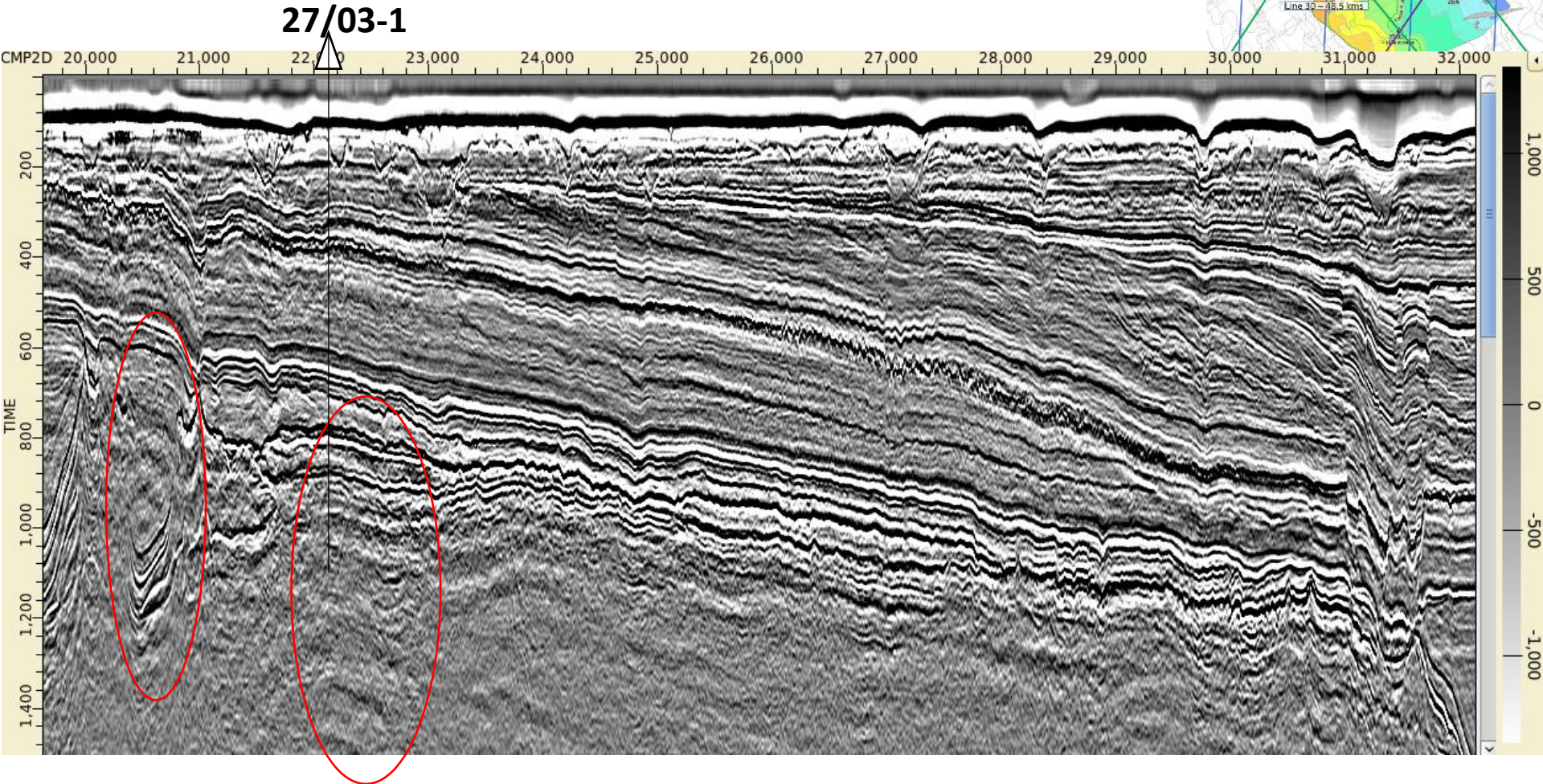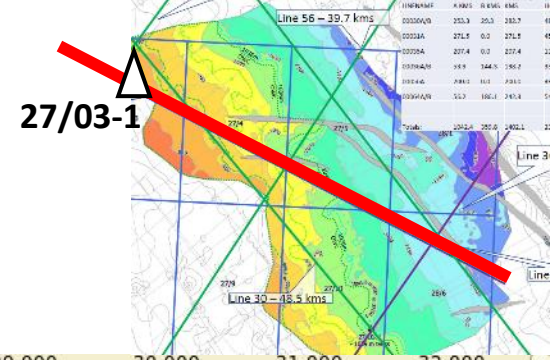
Low frequency multiple noise / reverberations in the WG stack.

Line 64 stack example
SIP 2020 PSTM full stack [4m]
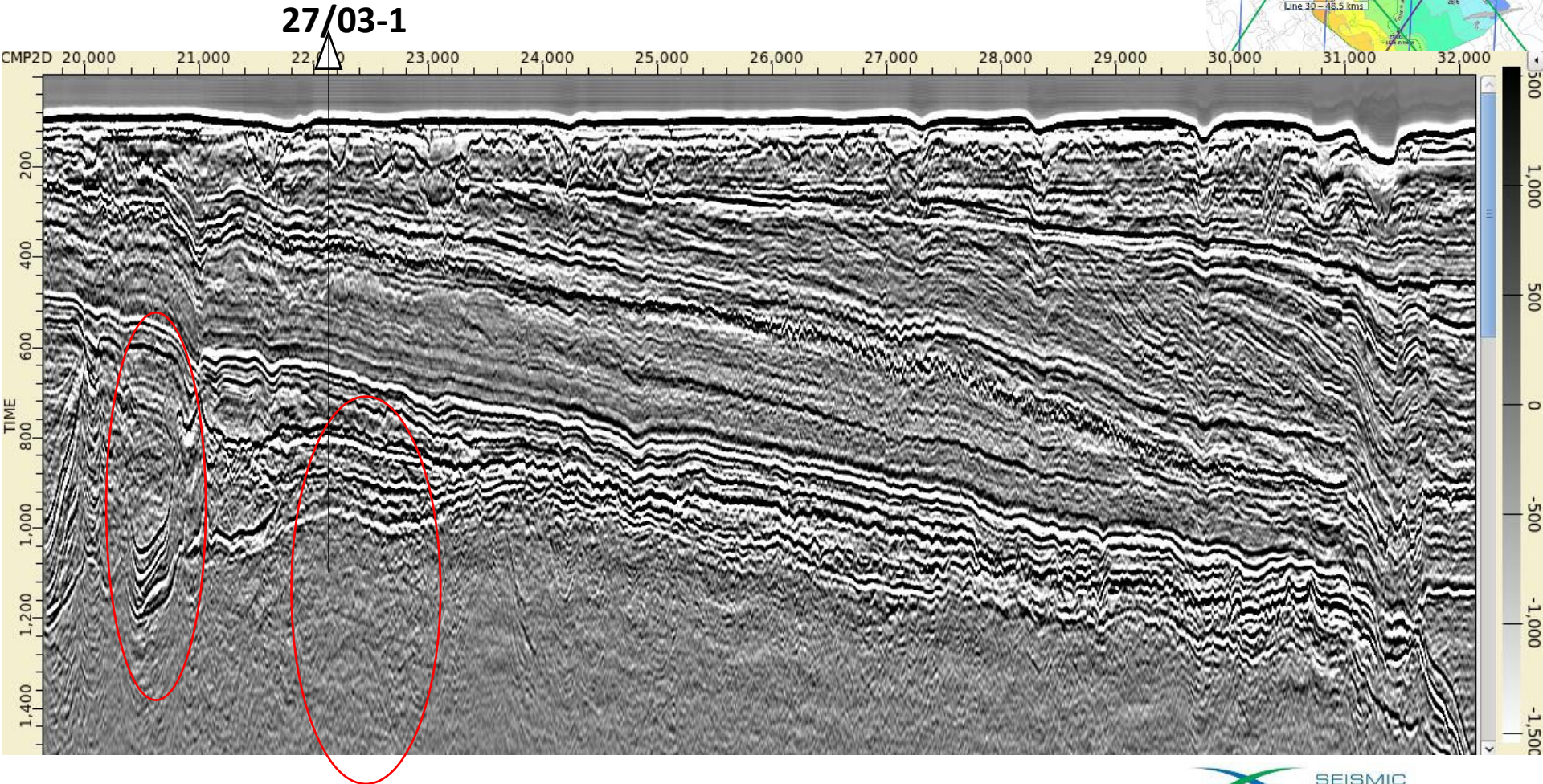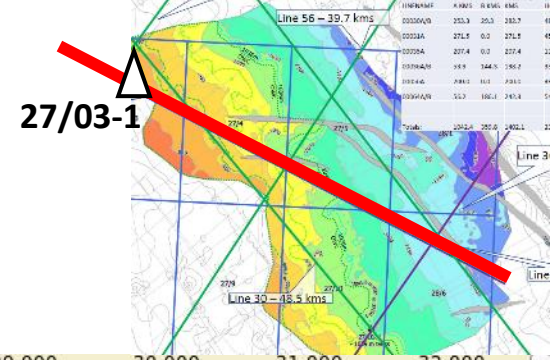
Attenuated lower frequency noise and improved resolution in the reservoir section.

2015 full stacks [4ms] at well location

Line 35

Line 64

27/03-01
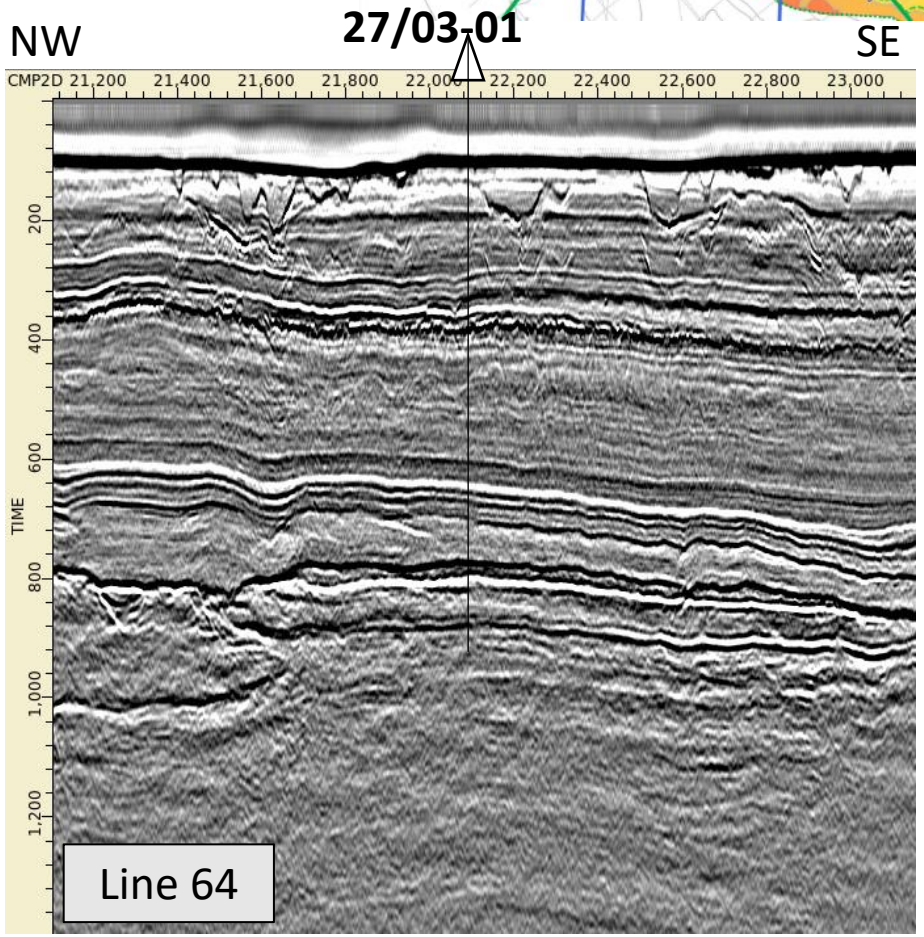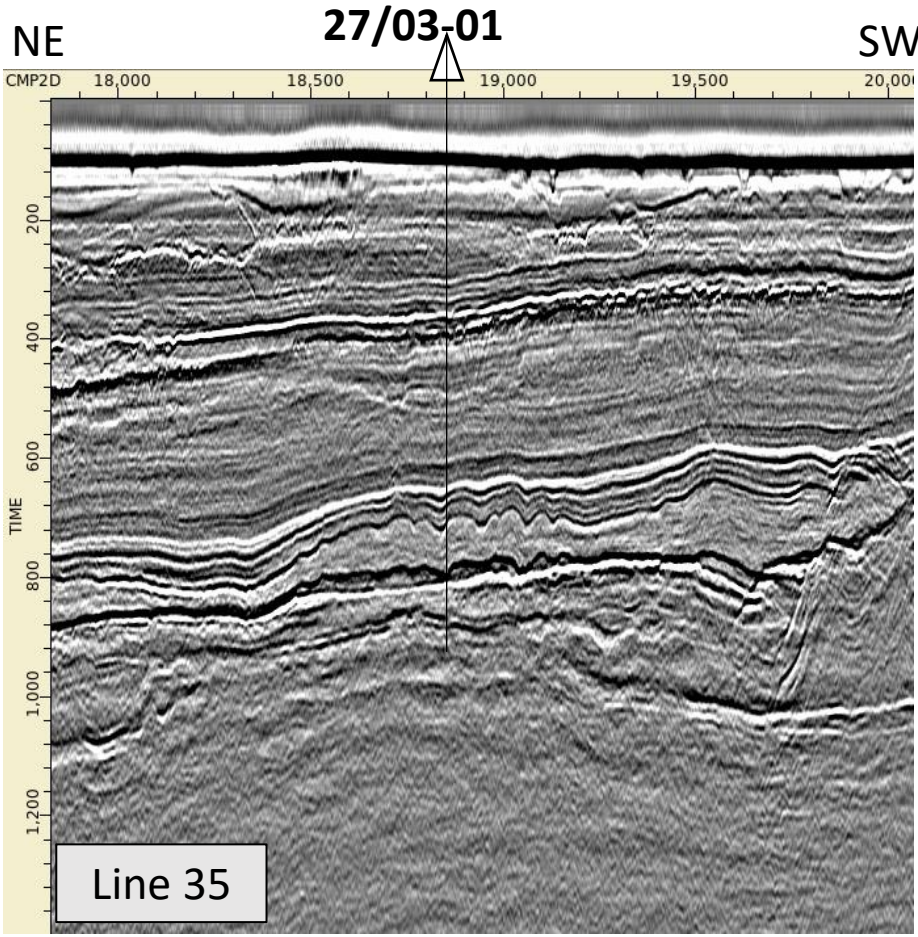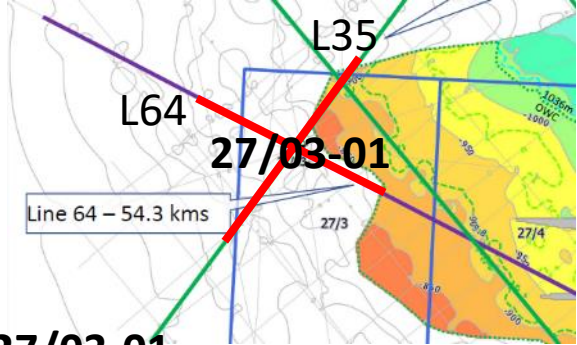
10 km

SIP 2020 full stacks [4ms]

Line 35
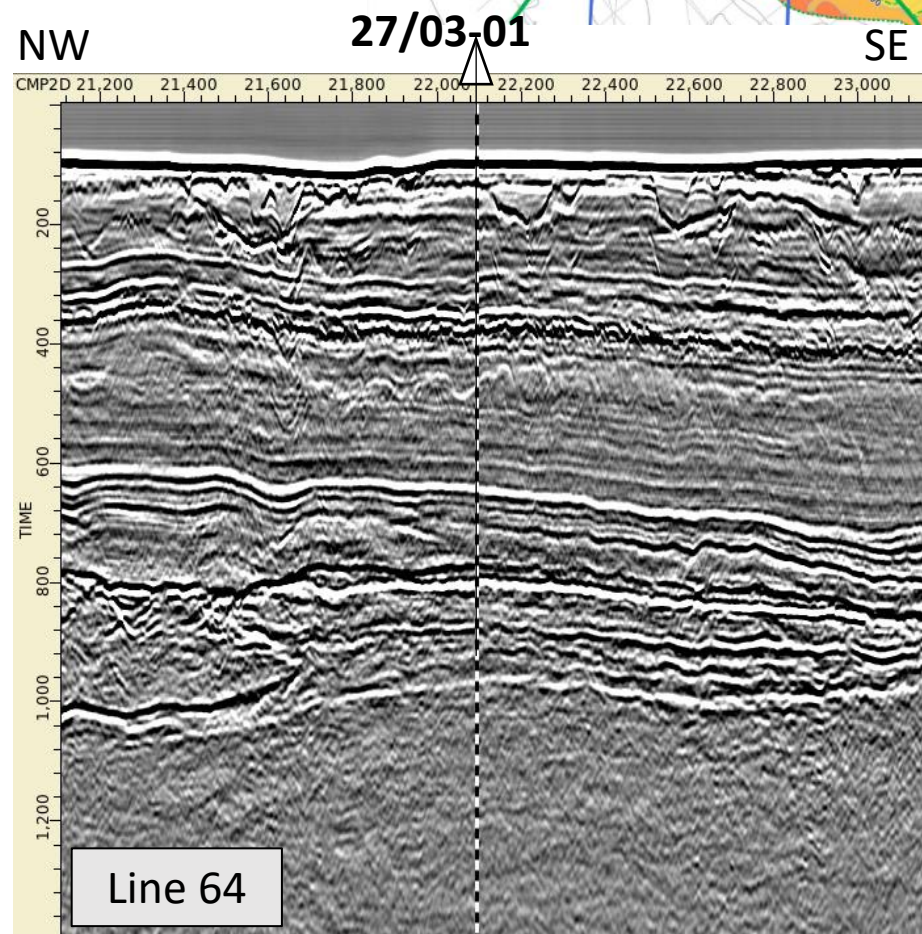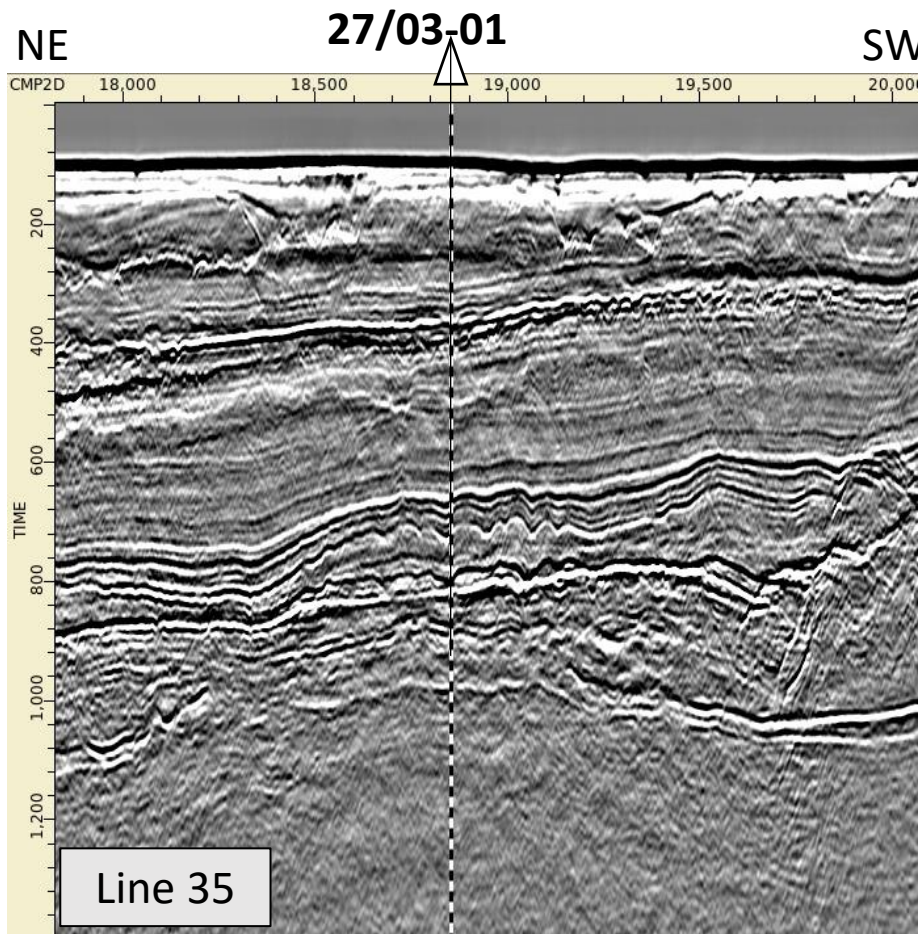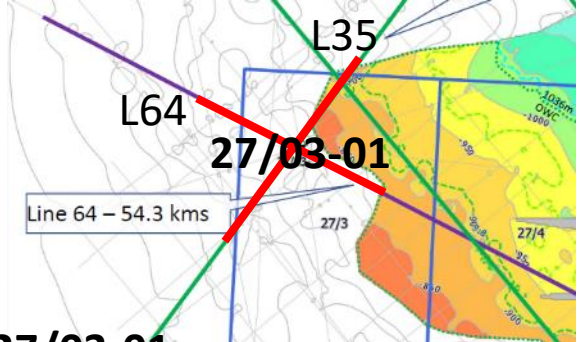
Line 64

10 km

4ms vs 2ms example: Line 64
4ms reprocessed data with horizons
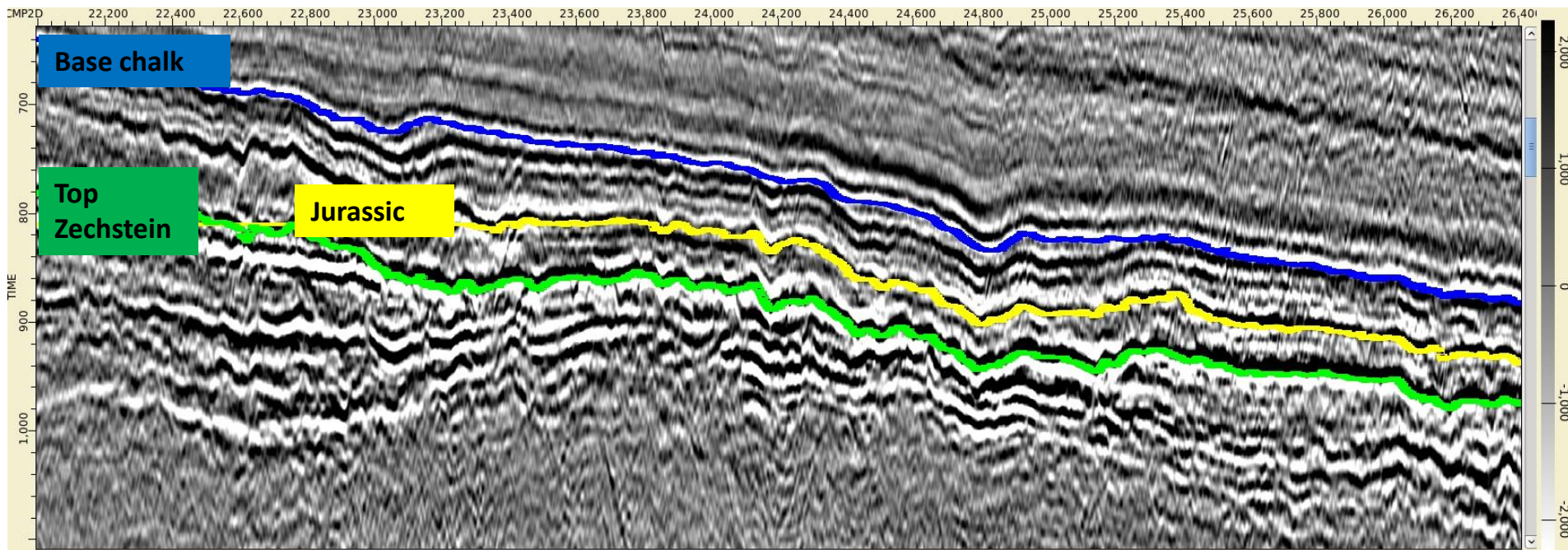
4ms vs 2ms example: Line 64
4ms reprocessed data
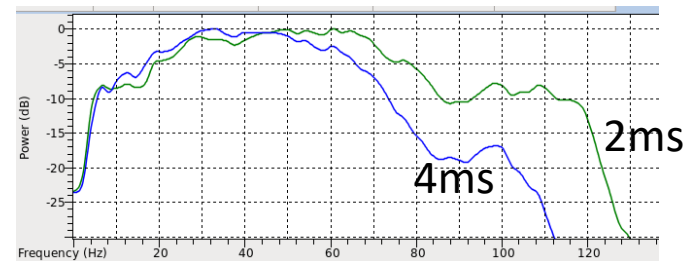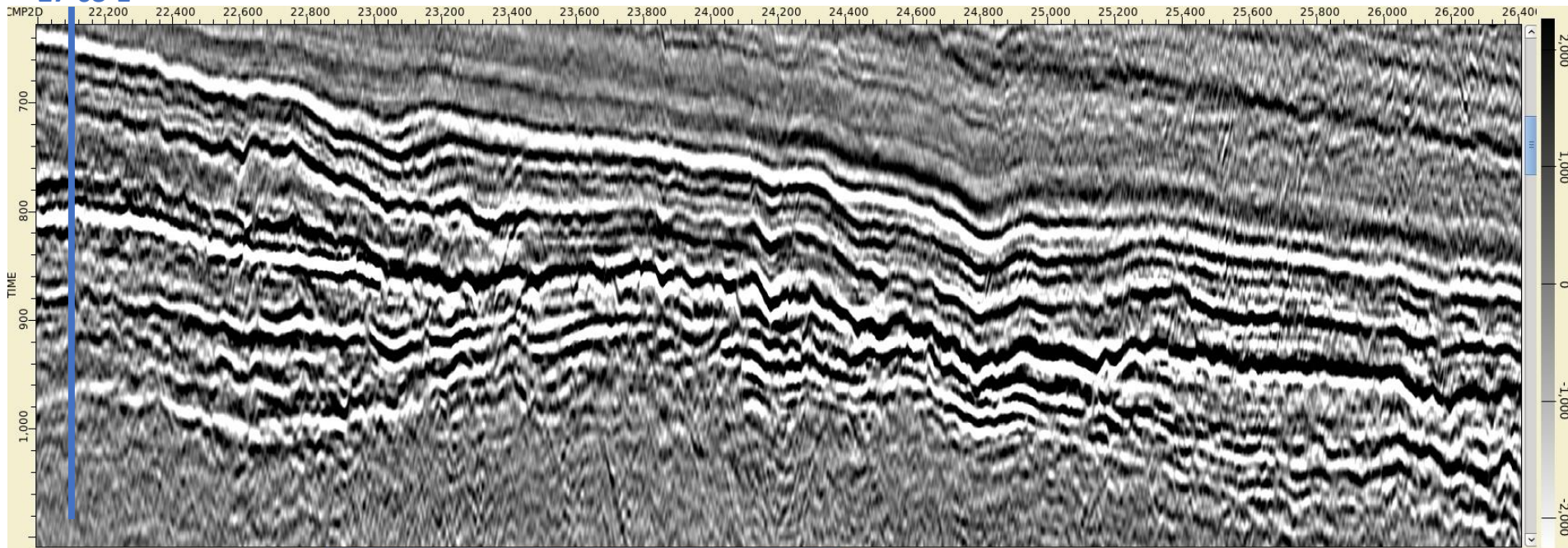
4ms vs 2ms example: Line 64
2ms reprocessed data
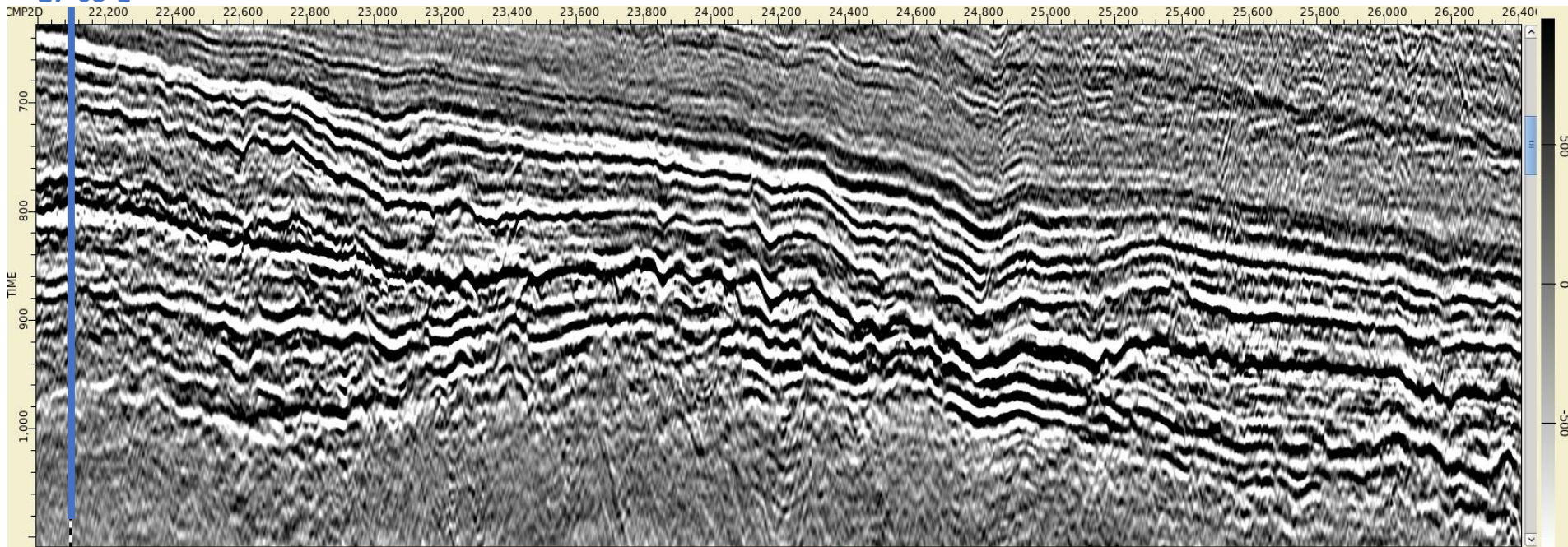
N.B the 2ms reprocessing uses the original SEG-D 2ms field records that extend to 250Hz frequency range. The bandwidth is extended to ~130Hz between 600-1200ms
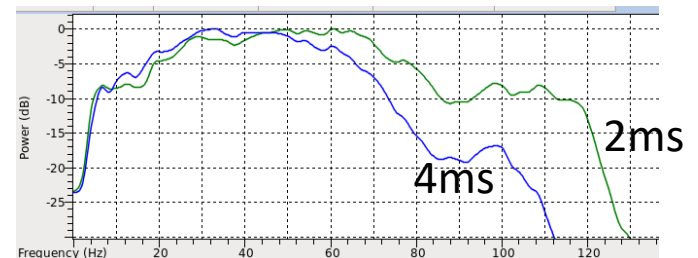
Full stack PSTM comparisons:

Zoomed 2D sections showing the comparisons between the 2015 OGA full stack with the SIP 2020 reprocessing at 4ms and 2ms.
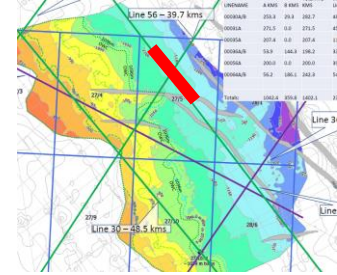
Line 30 Full Stack Comparisons

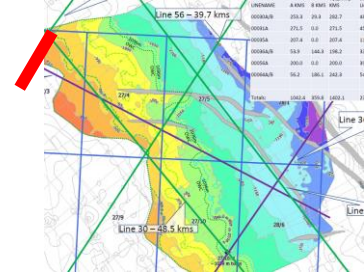2015 [4ms]   2020 [4ms]   2020 [2ms]

10 km
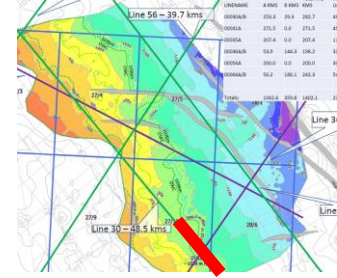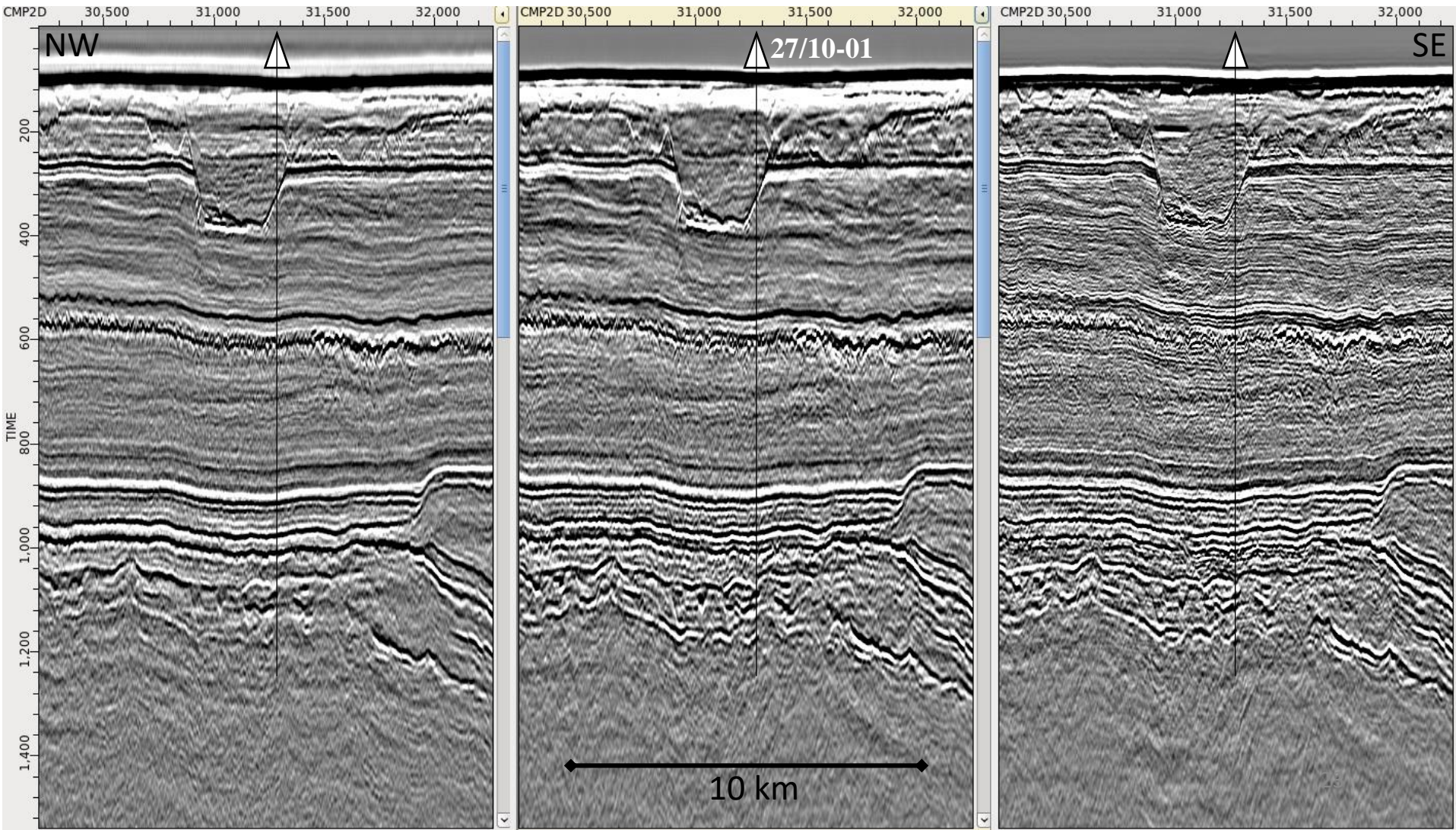
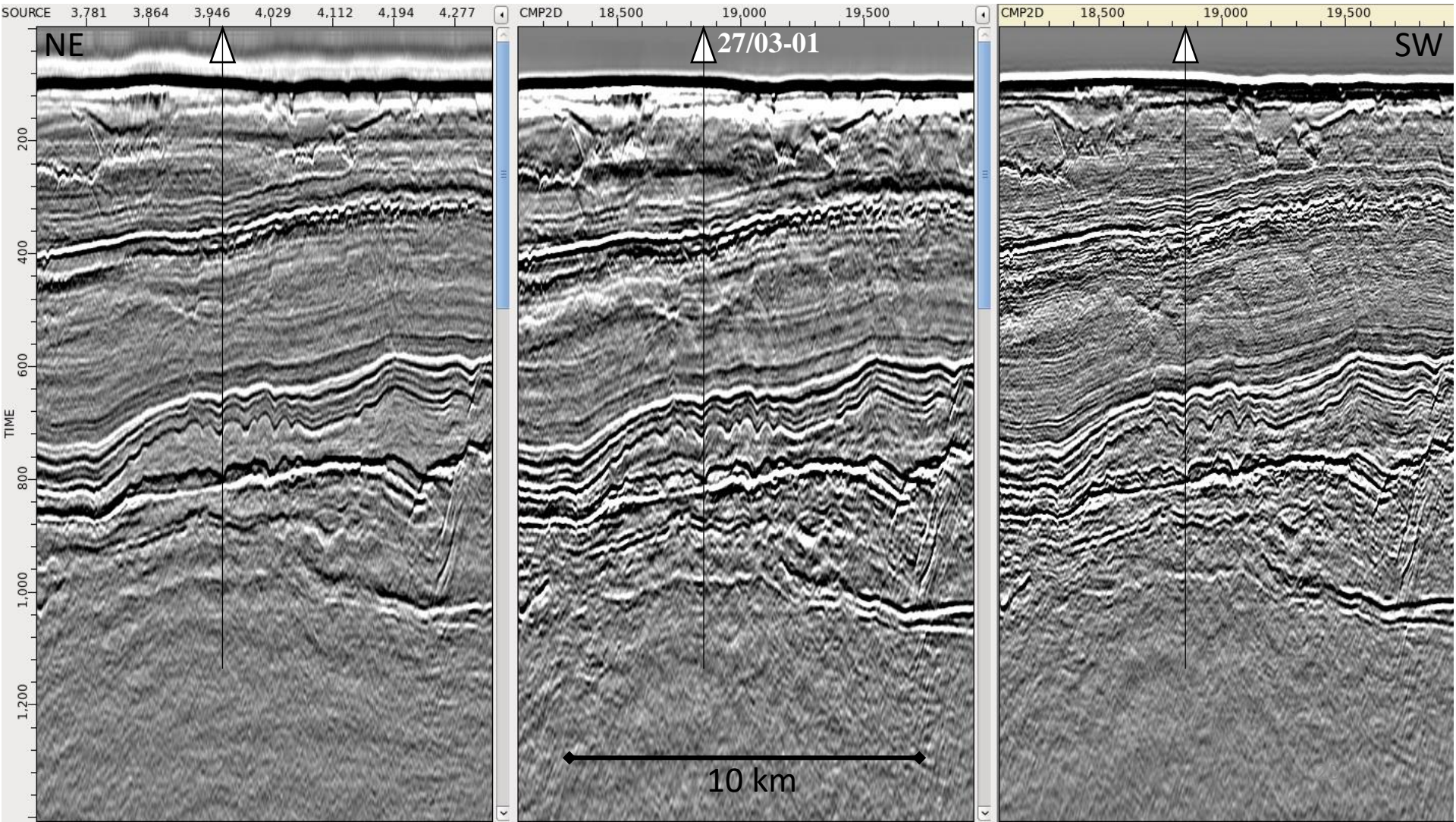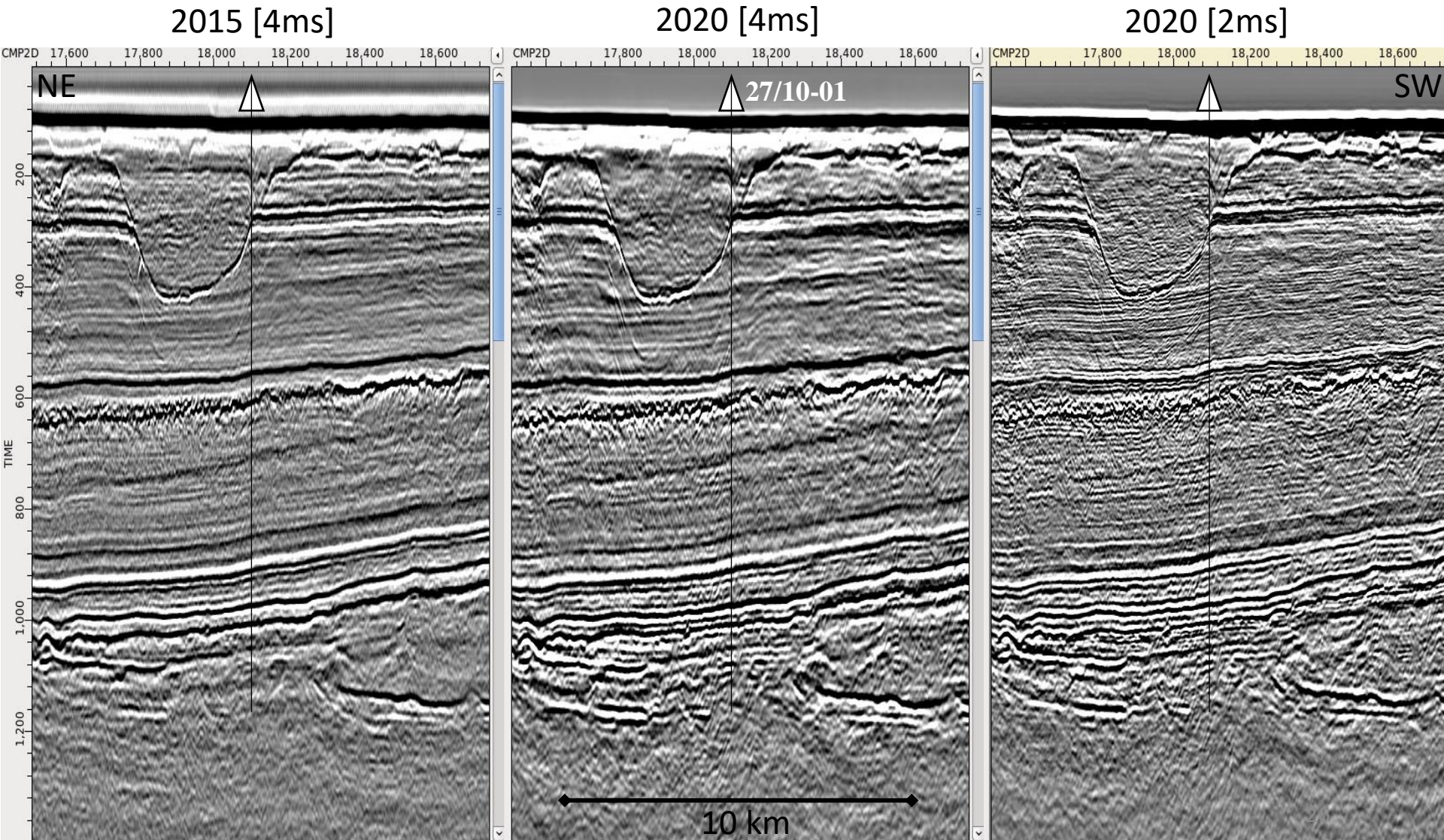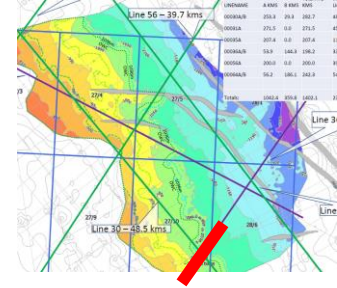# Line 31 Full Stack Comparisons

2015 [4ms]

2020 [4ms]

2020 [2ms]

10 km
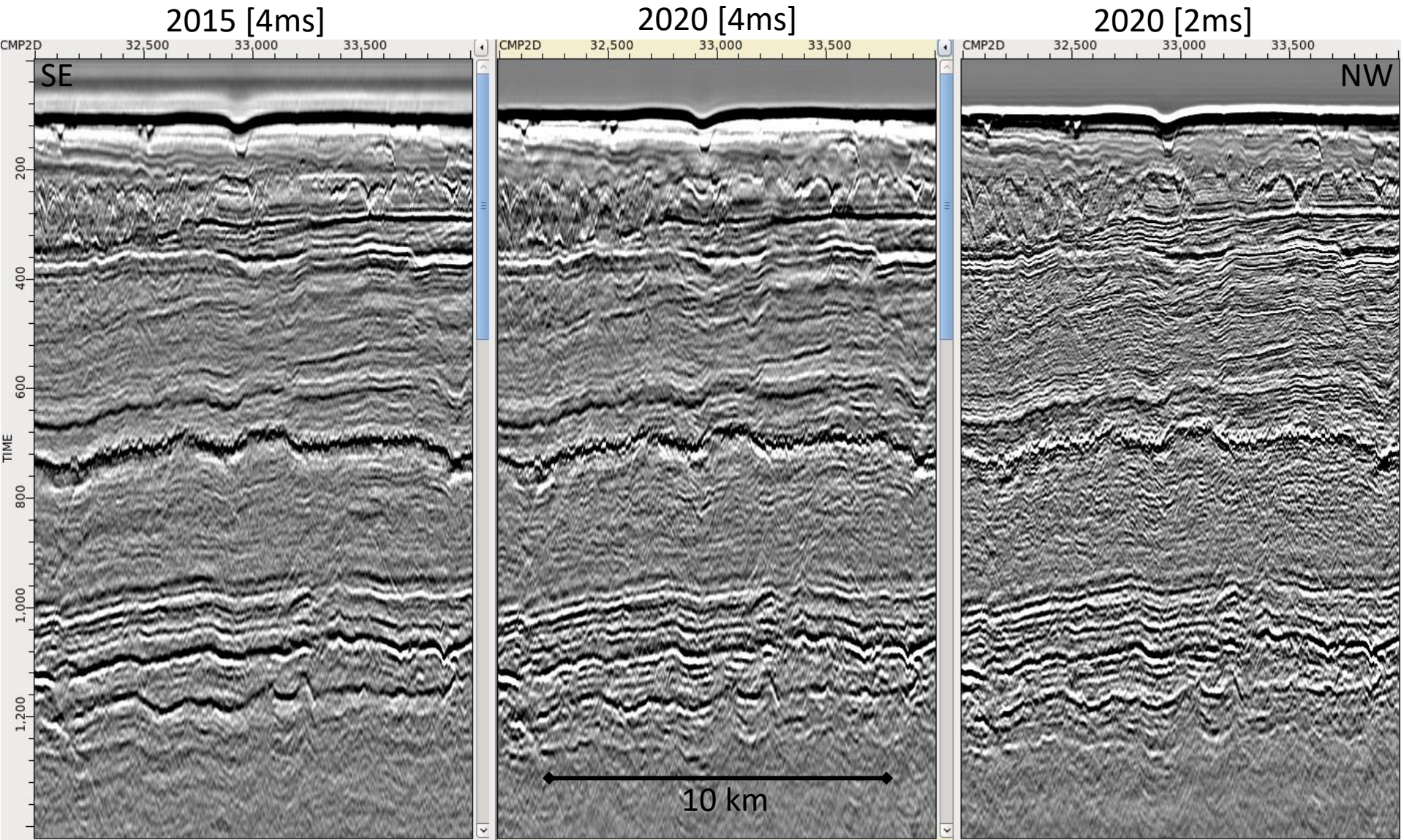
Line 35 Full Stack Comparisons

2015 [4ms]

2020 [4ms]

2020 [2ms]

Line 36 Full Stack Comparisons

2015 [4ms] 2020 [4ms] 2020 [2ms]

Line 56 Full Stack Comparisons

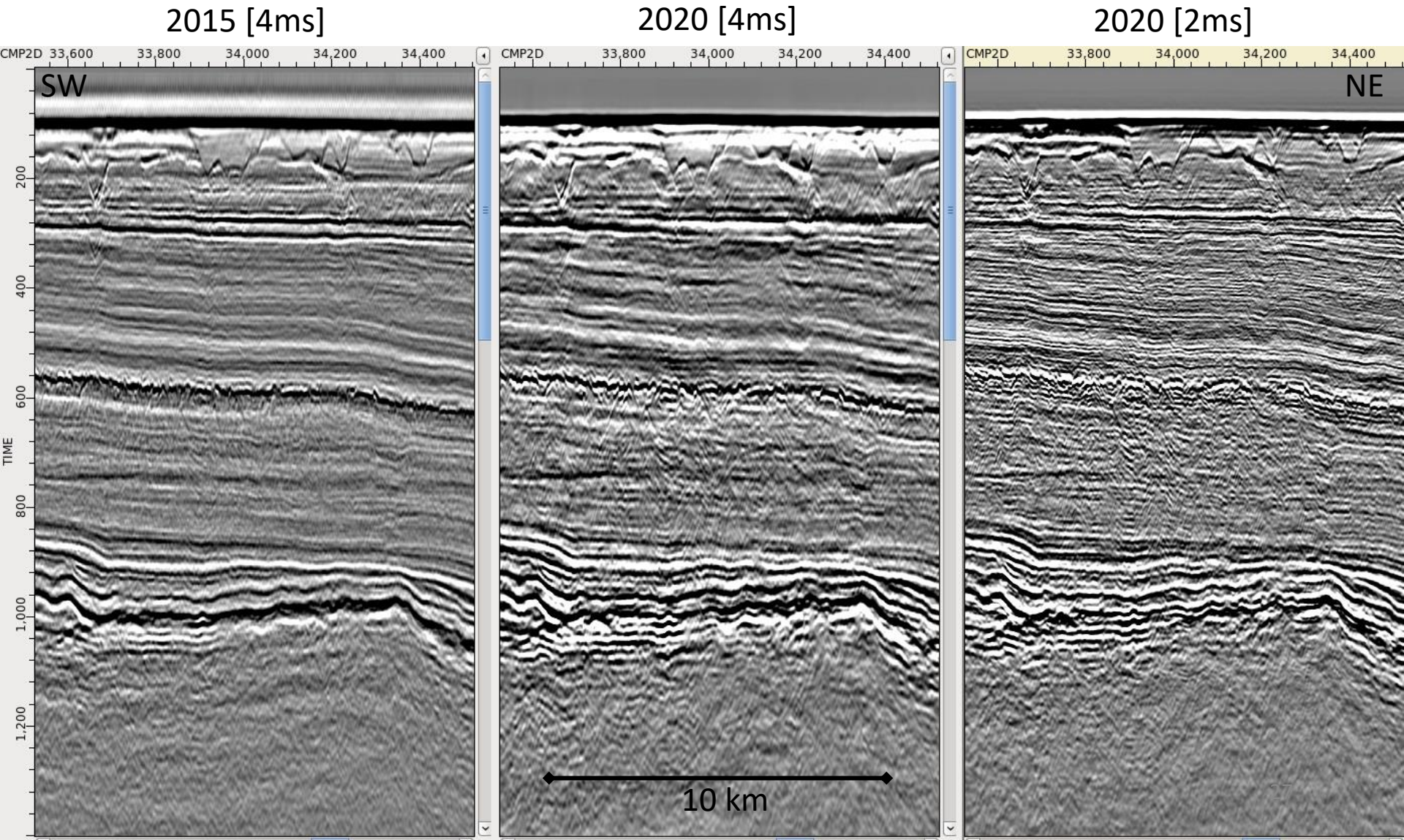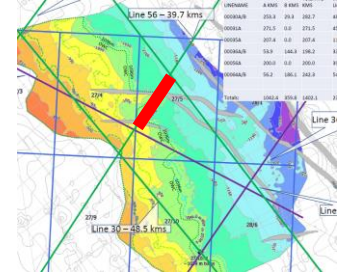# Line 64 Full Stack Comparisons

2015 [4ms]

2020 [4ms]

2020 [2ms]

27/03-01

10 km

End