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**FWI/RTM on marine open source field data
(Viking Graben line 12):
Acoustic model + LSRTM**

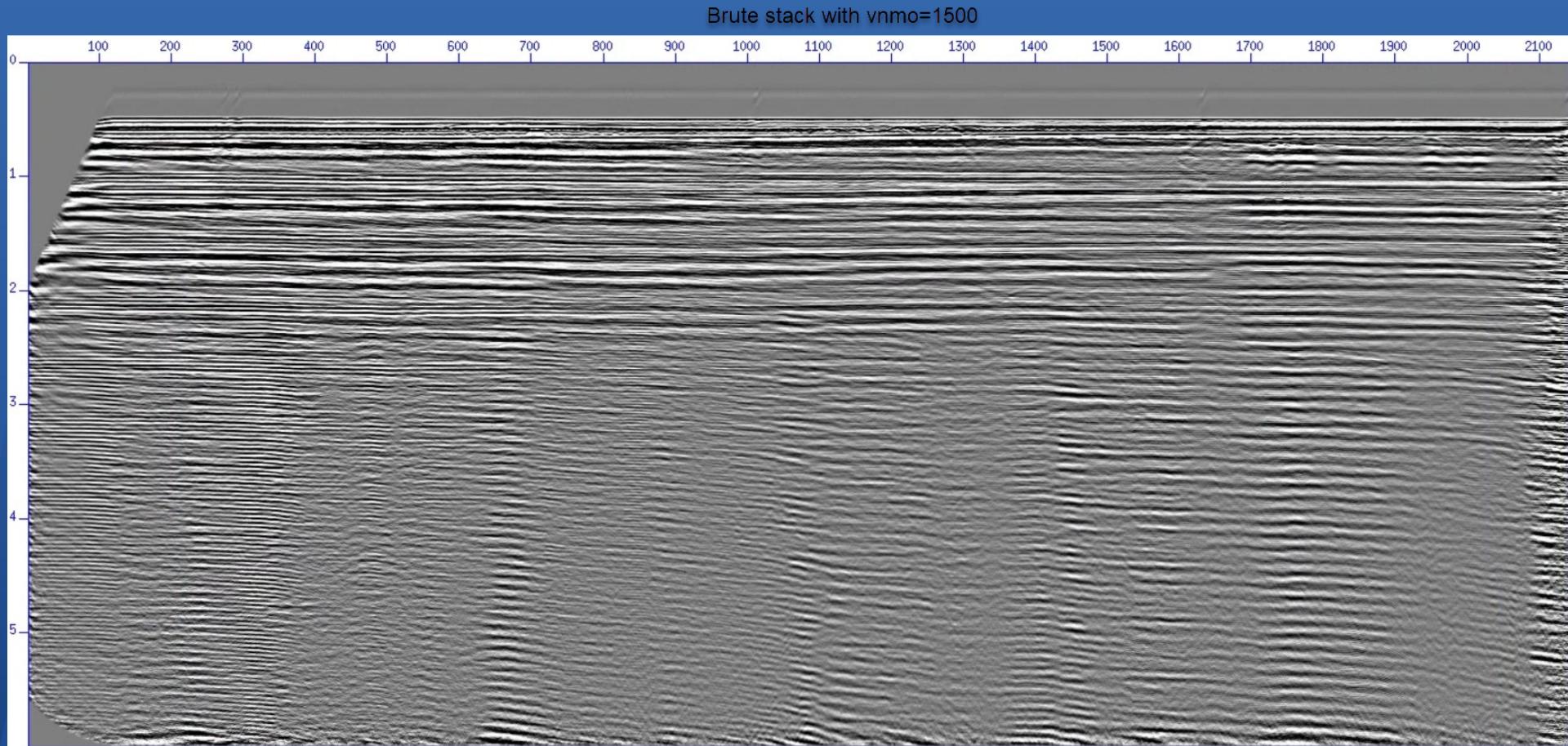
Initial Data

- Data acquired in North sea Viking Graben Line 12
- Minimal source-receiver distance: 262m
- Maximal source-receiver distance: 3237m
- Source/Receiver step: 25m
- Receivers per shot: 120
- Amount of shots: 1001
- Trace length: 6s
- Sampling rate: 4ms
- Seabed: ~355m

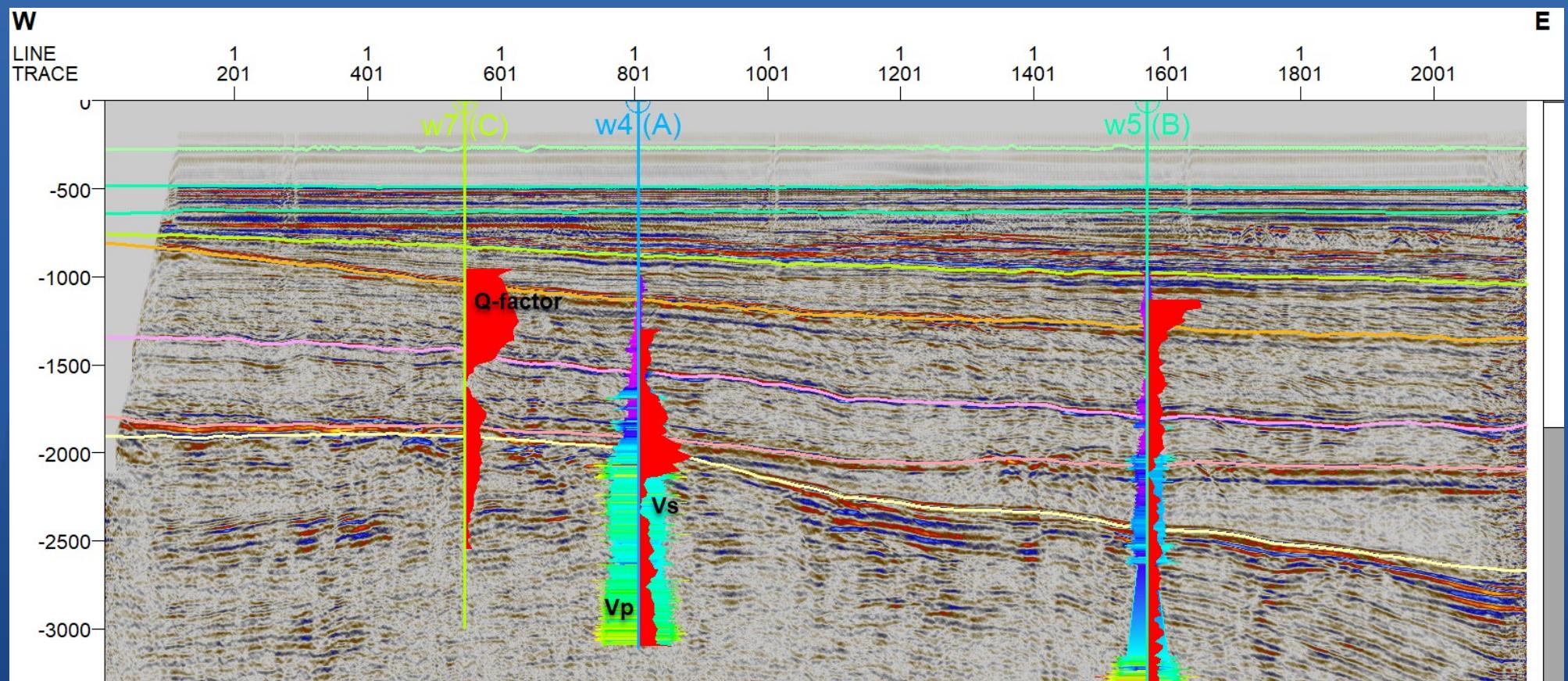
Setup

- 4 cores 8 threads 4.2 GHz
- 47 Gb RAM (computation takes less than 30 Gb, probably about 20 Gb)
- Linux Ubuntu 20.04
- JUDI v3.2.2

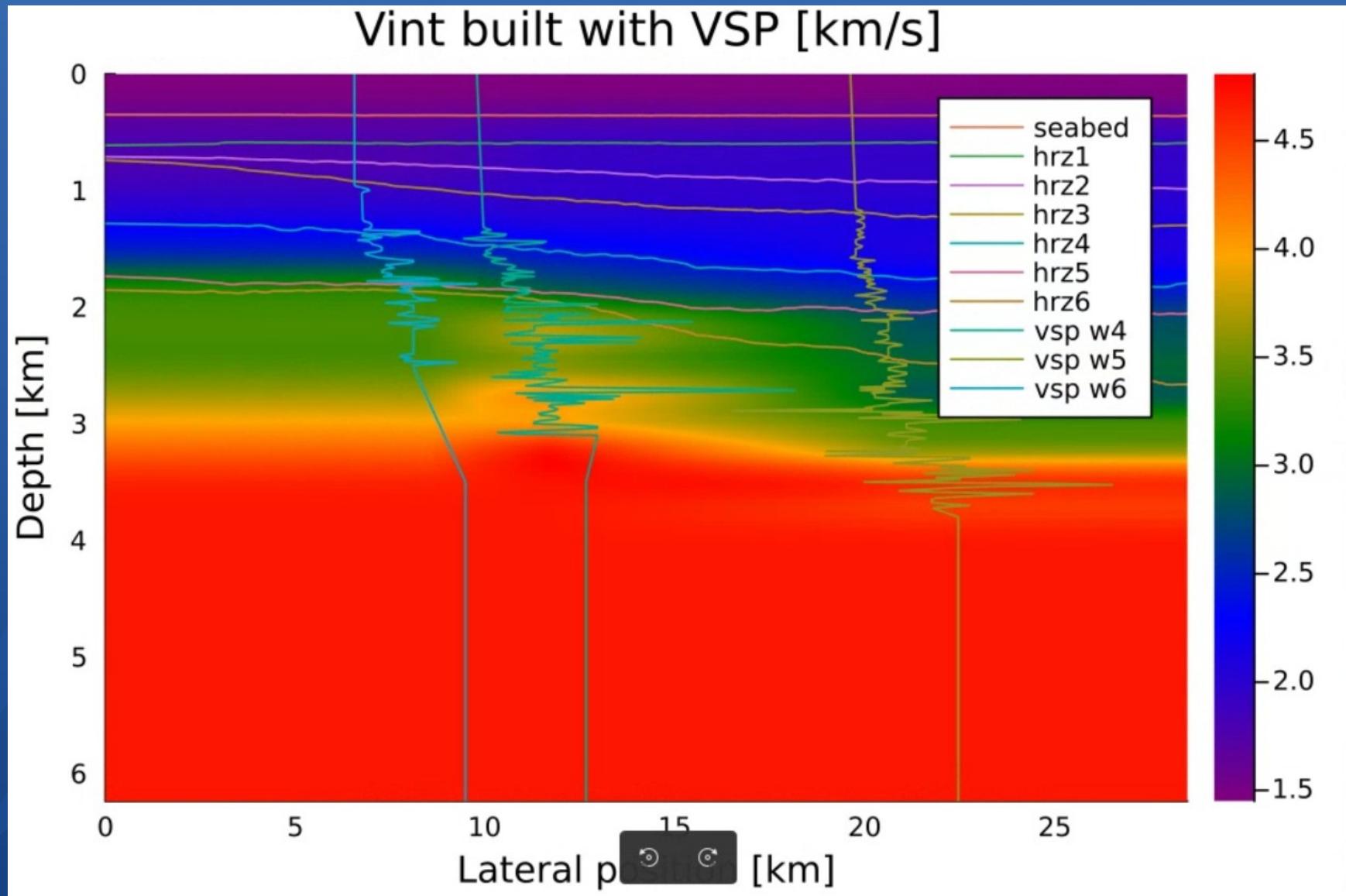
Brute stack with const velocity 1500m/s



NMO stack

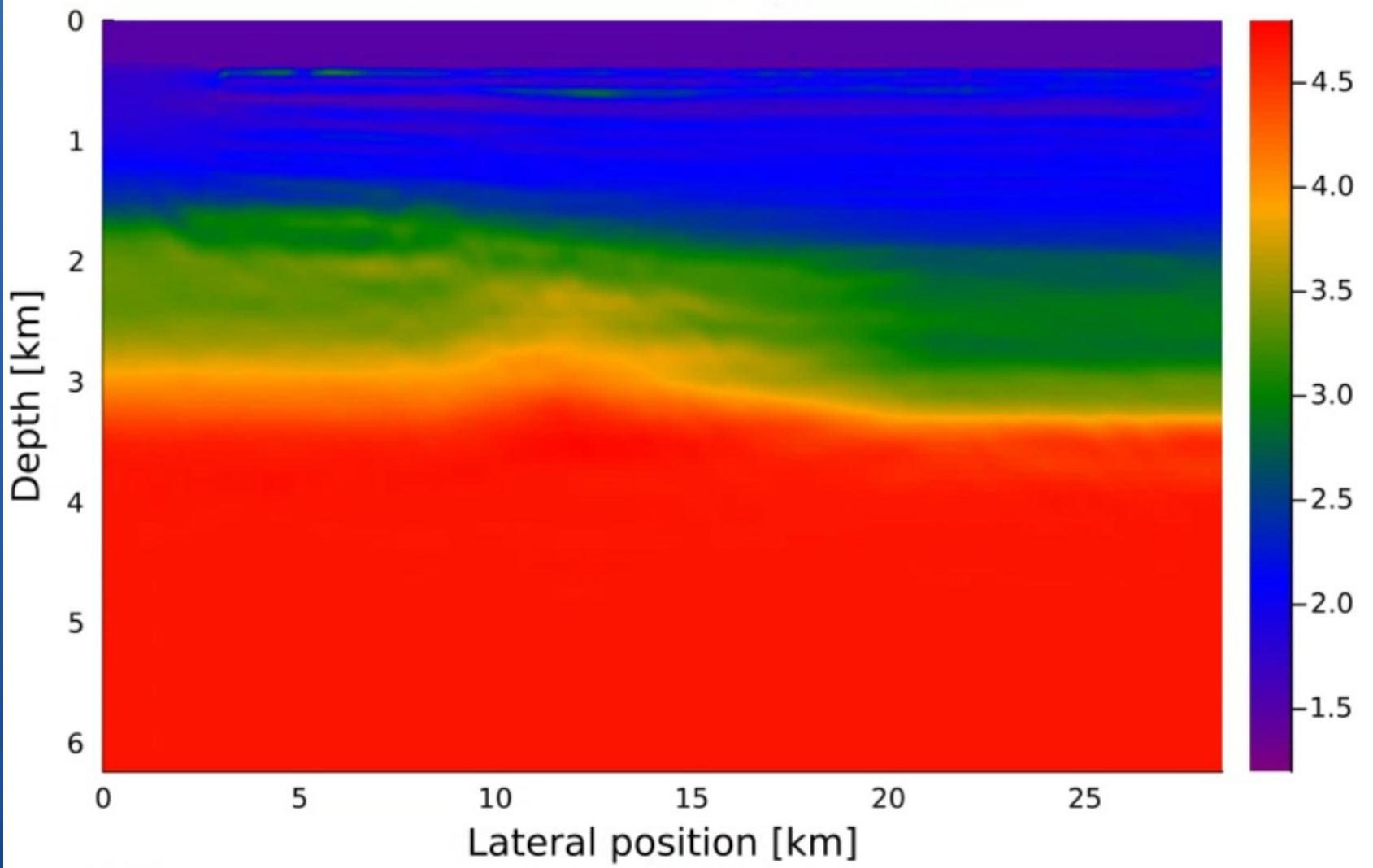


Initial velocity model



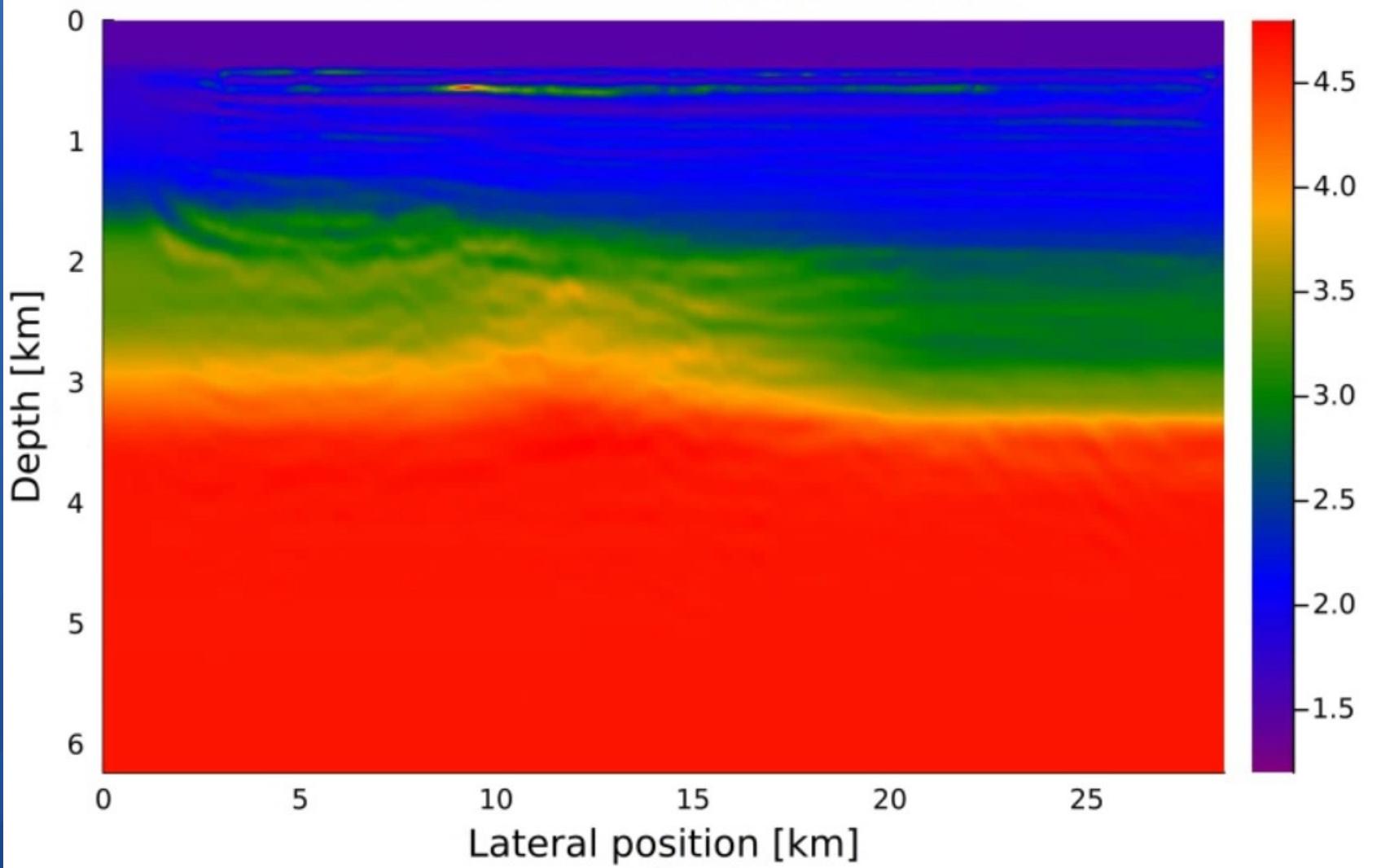
FWI: 5 Hz

FWI with L-BFGS acoustic



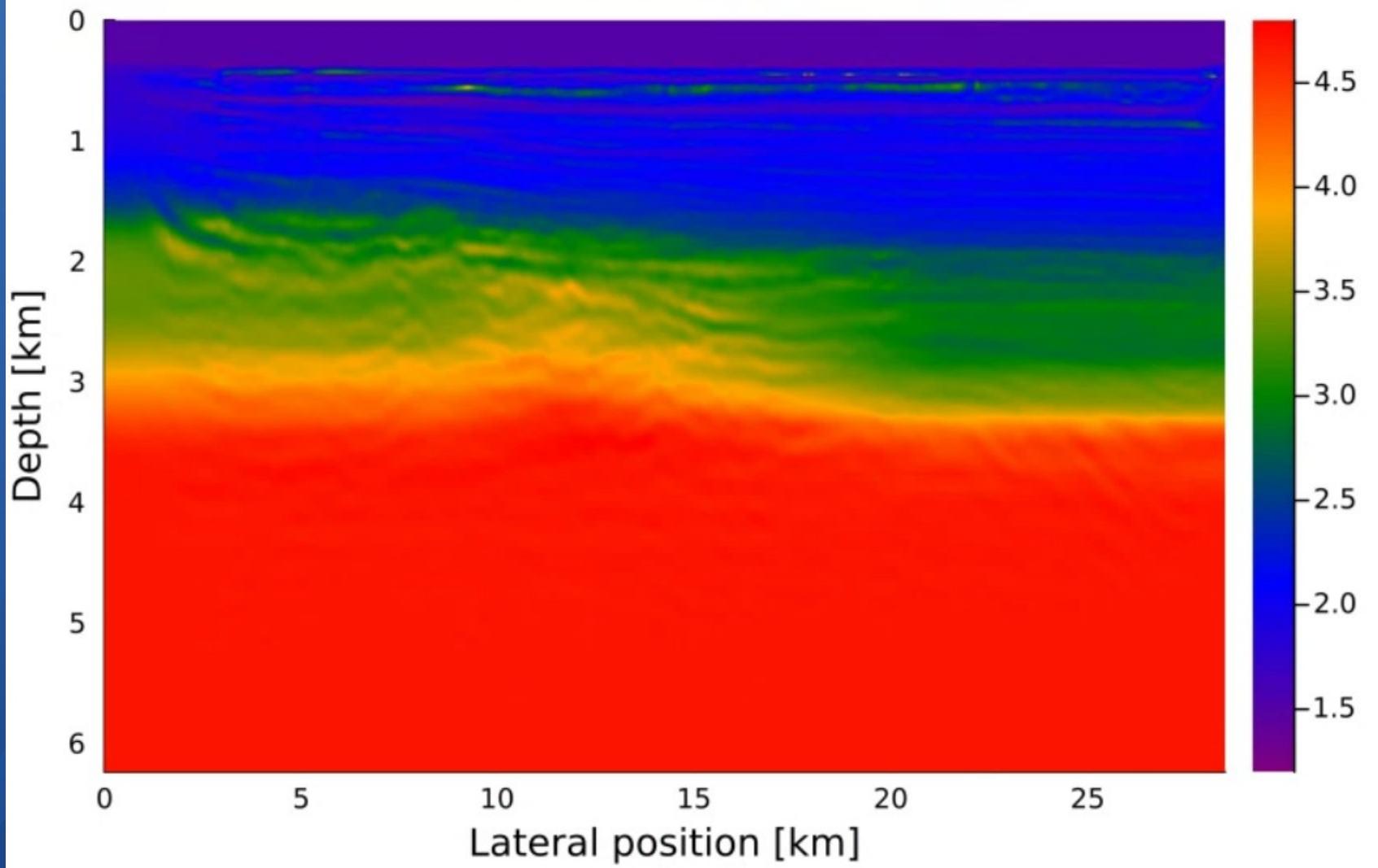
FWI: 8 Hz

FWI with L-BFGS acoustic



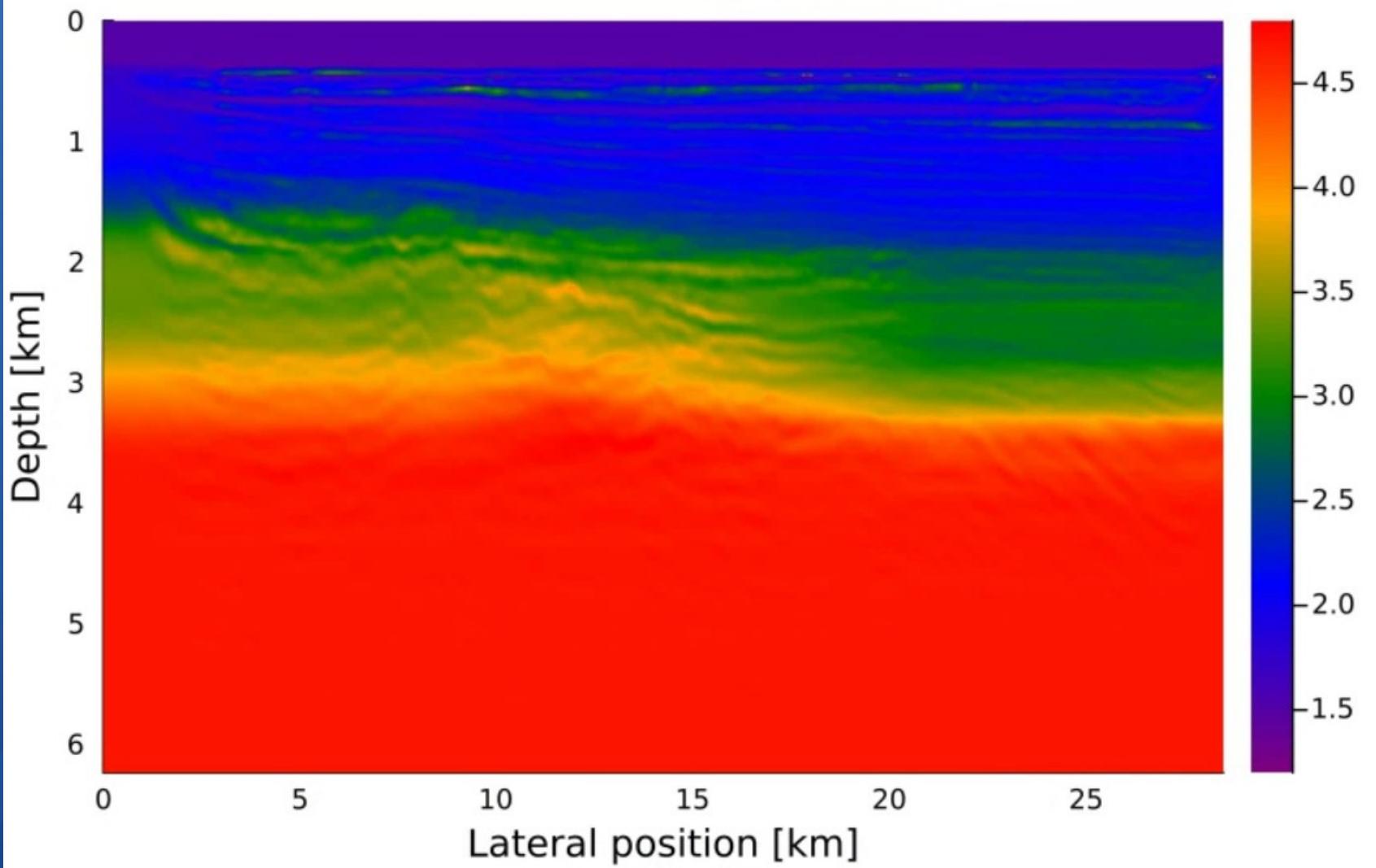
FWI: 12 Hz

FWI with L-BFGS acoustic



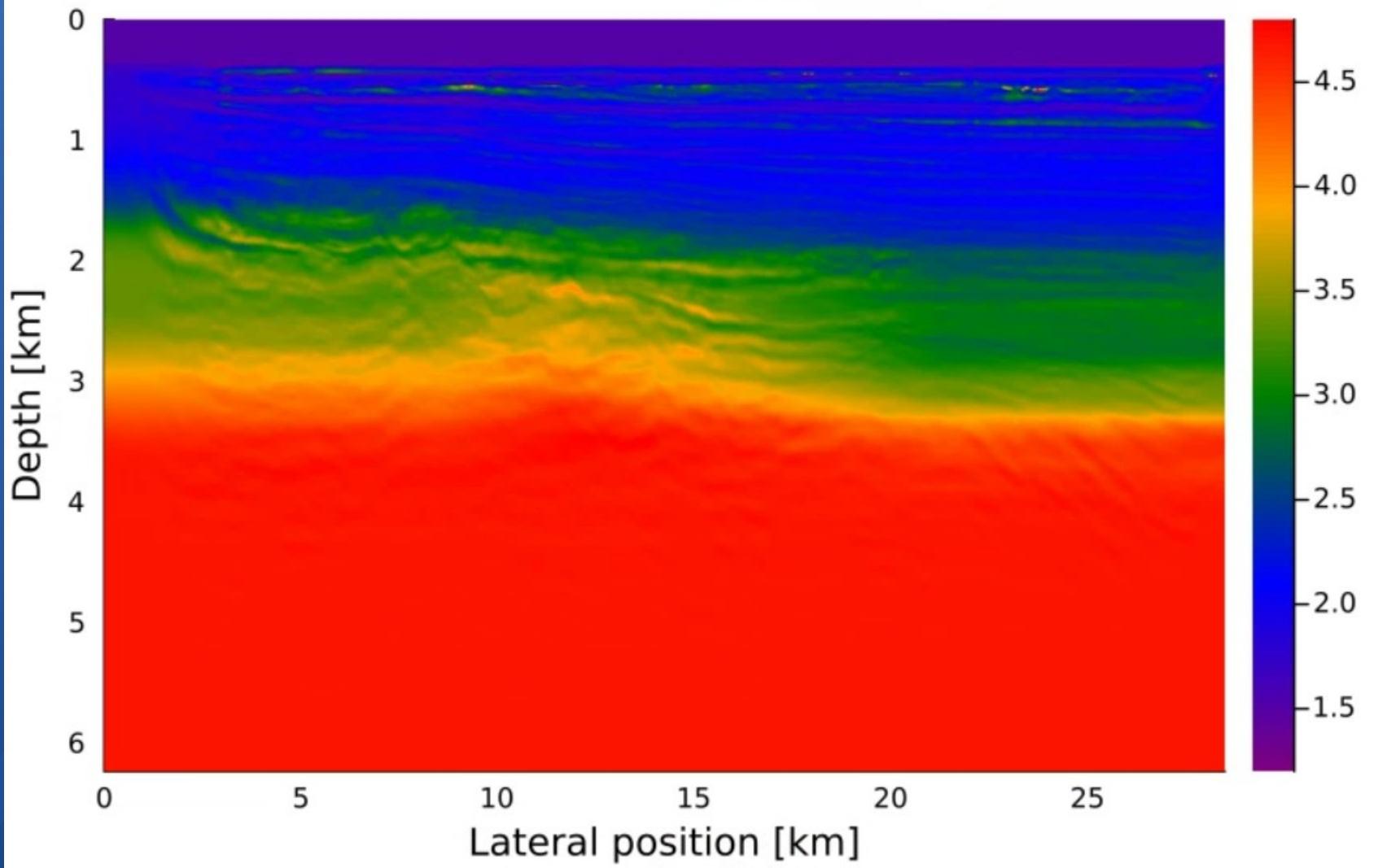
FWI: 18 Hz

FWI with L-BFGS acoustic



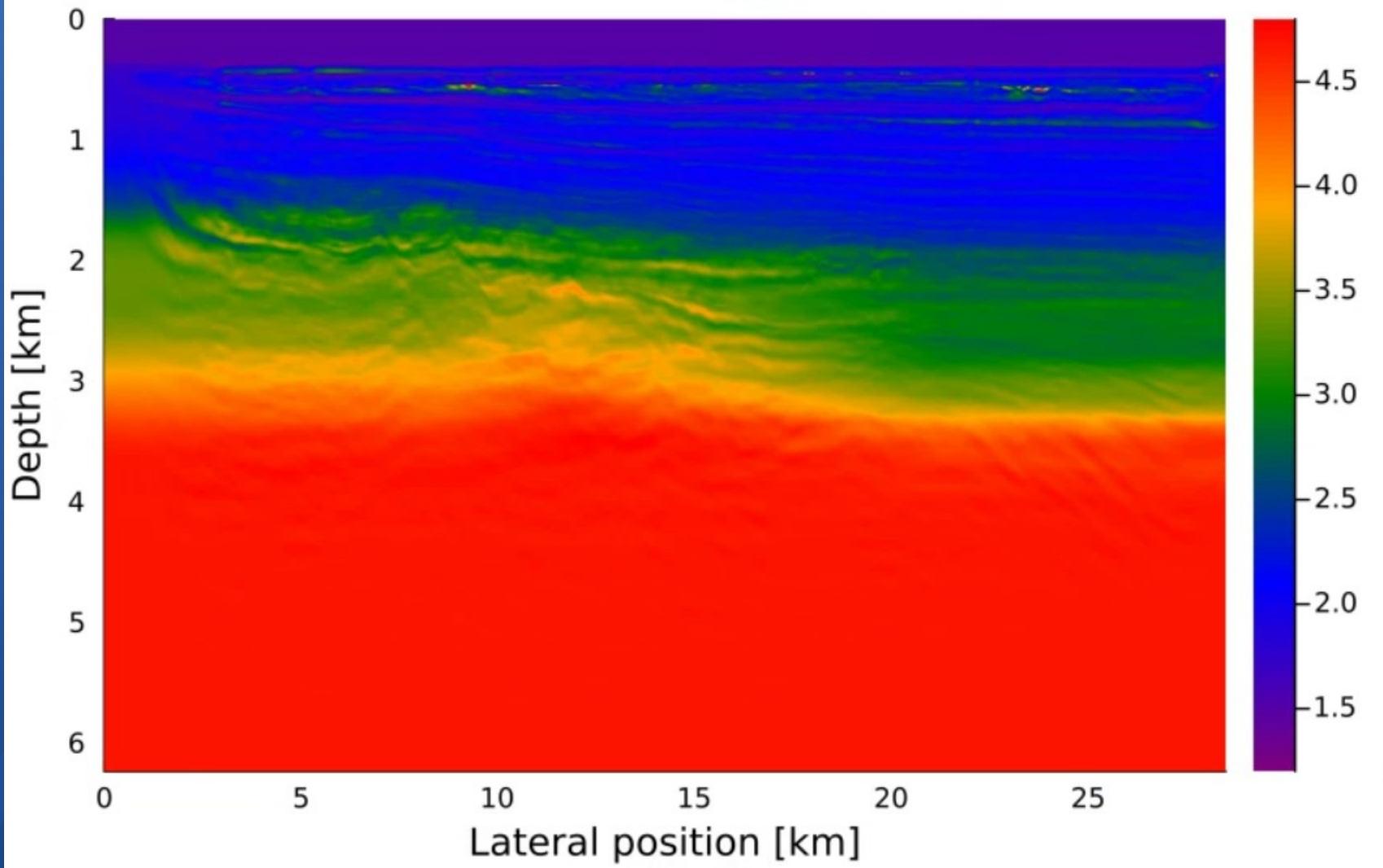
FWI: 25 Hz

FWI with L-BFGS acoustic

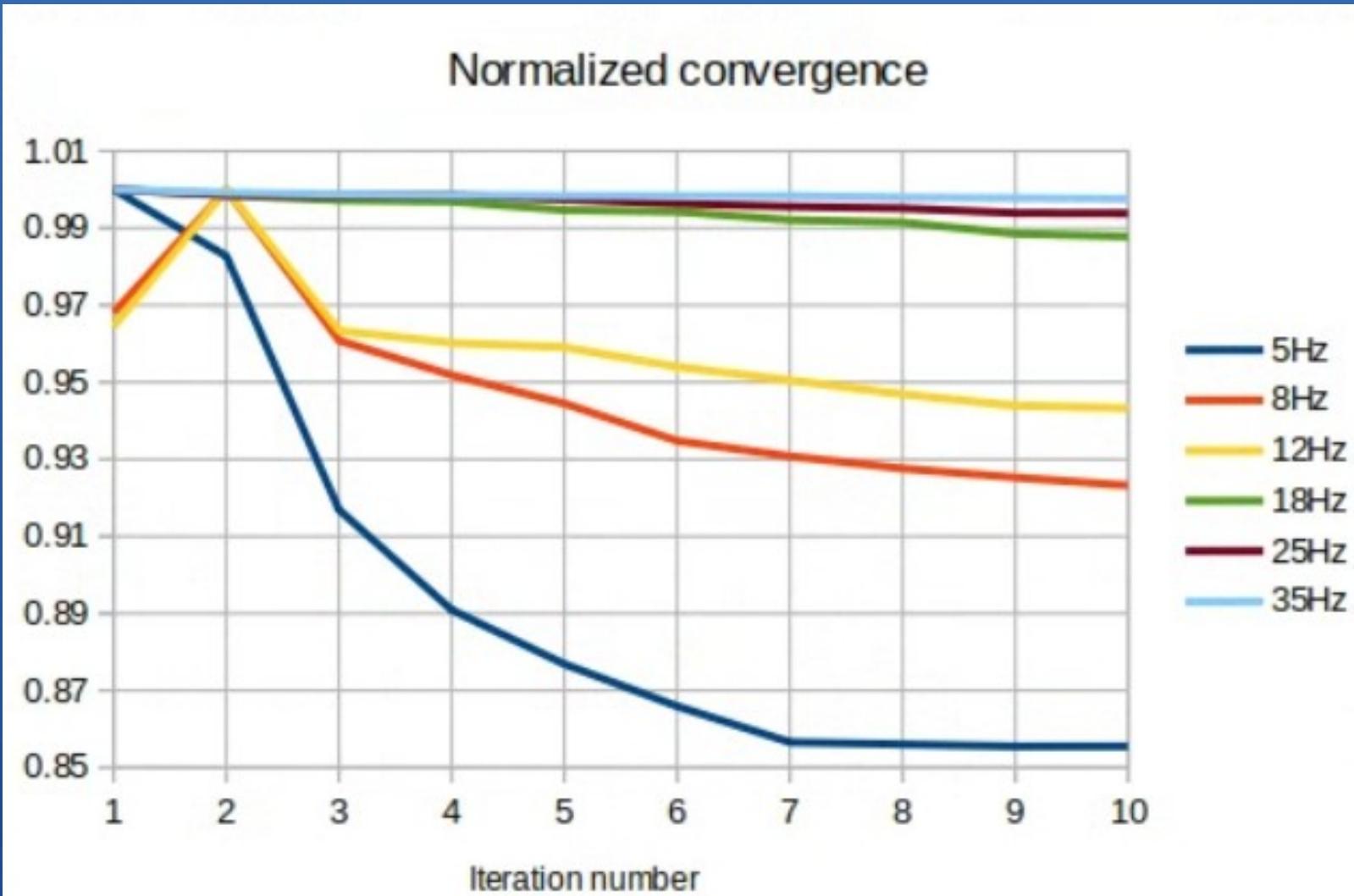


FWI: 35 Hz

FWI with L-BFGS acoustic

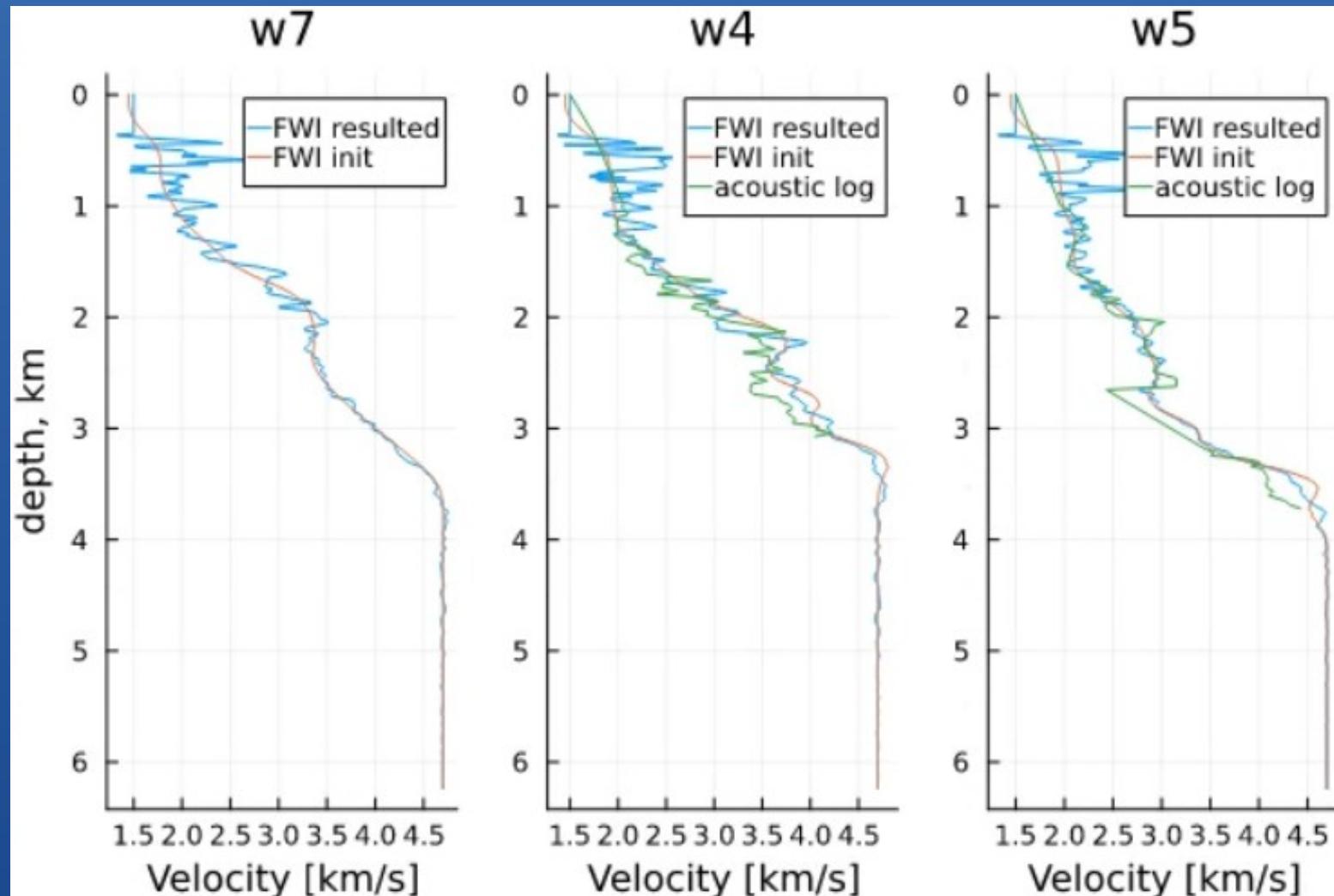


FWI convergence



FWI result comparision with well data

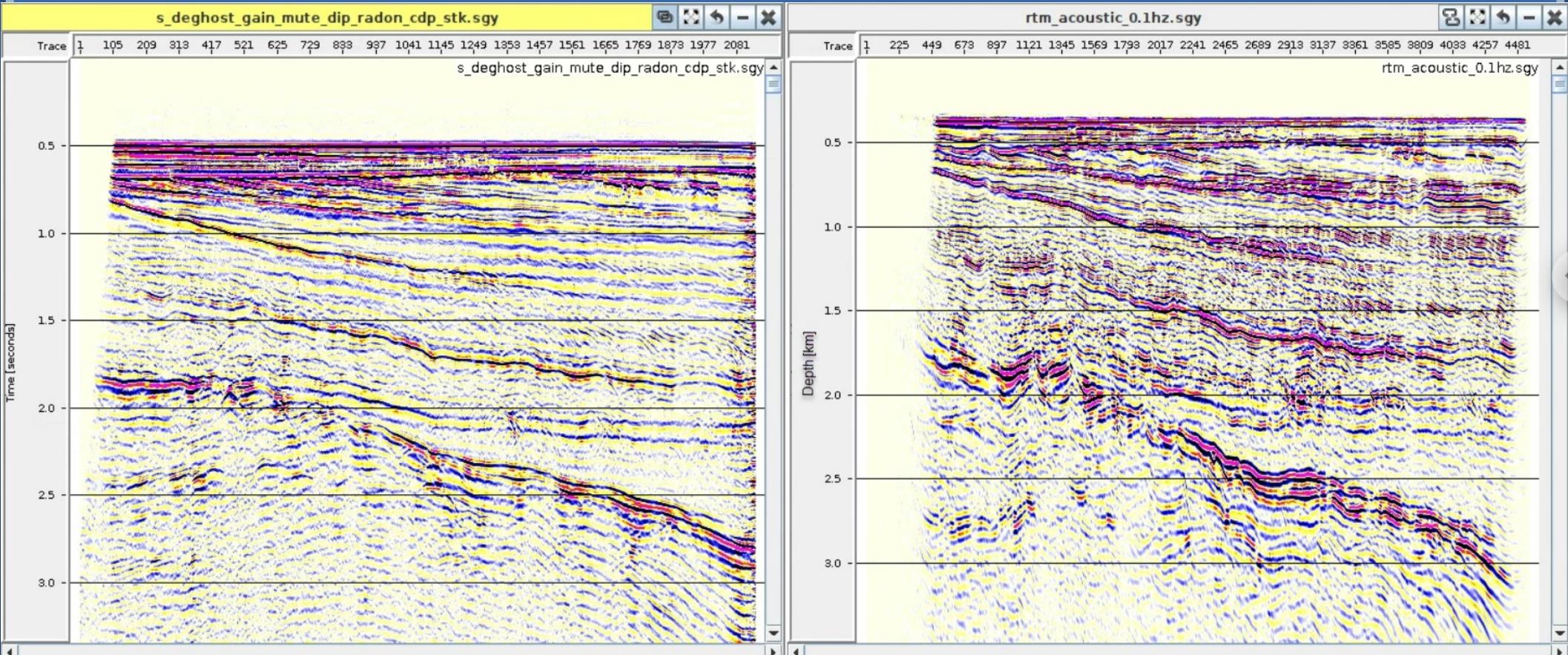
- FWI resulted – velocity from FWI results at well positions
- FWI init – initial velocity model at well positions
- Acoustic log – velocity from acoustic log



Possible reasons of FWI and well data distortion

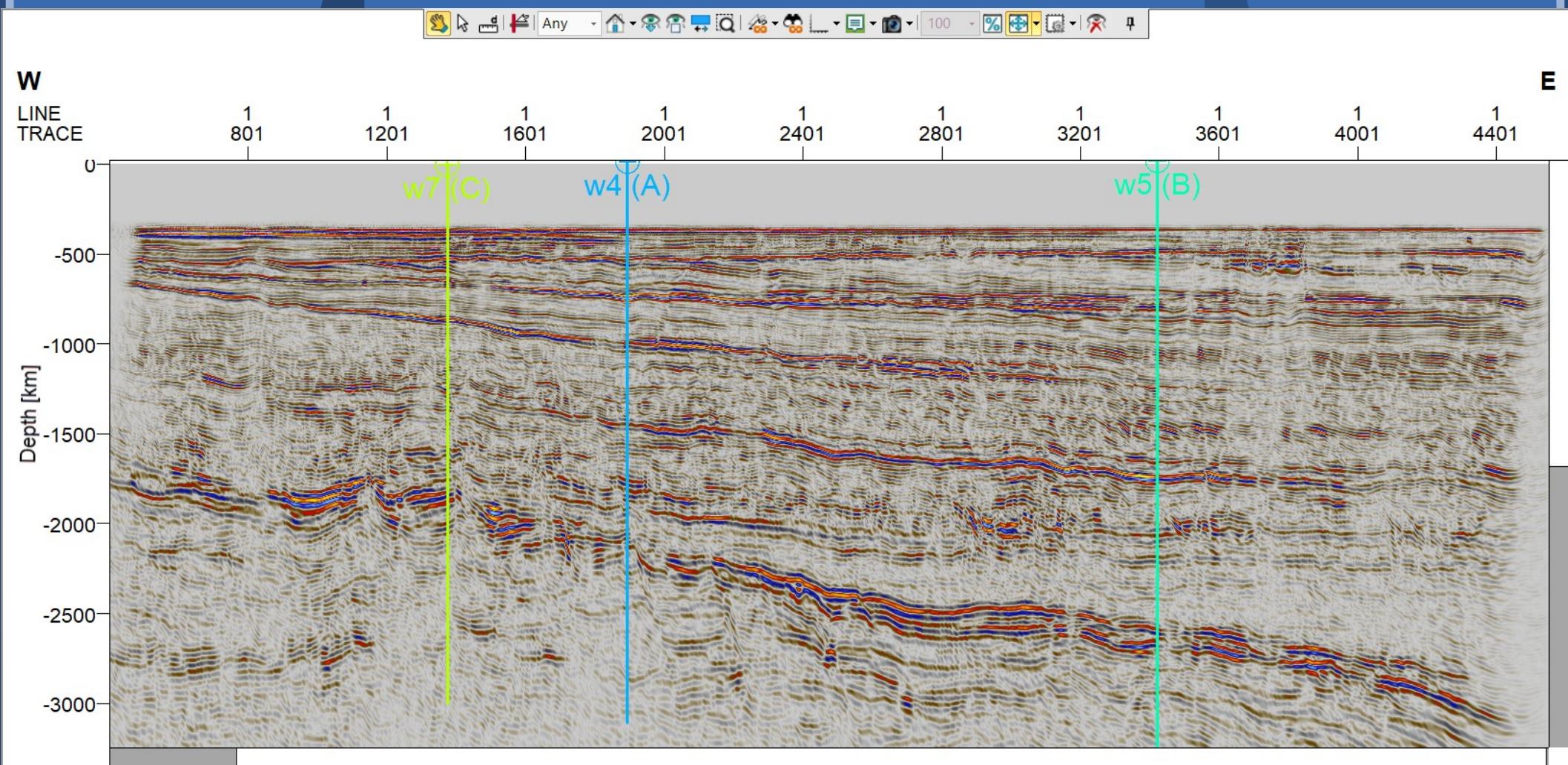
- Until 1000m there are only three measurements in wells: 0, 375, 999m
- It is 2D seismic (waves propagate in 3D)
- In marine seismic the streamer may be drift away by the marine stream
- Well positions are at some distance from seismic line and probably they are not strictly vertical

Comparision on NMO stack and RTM

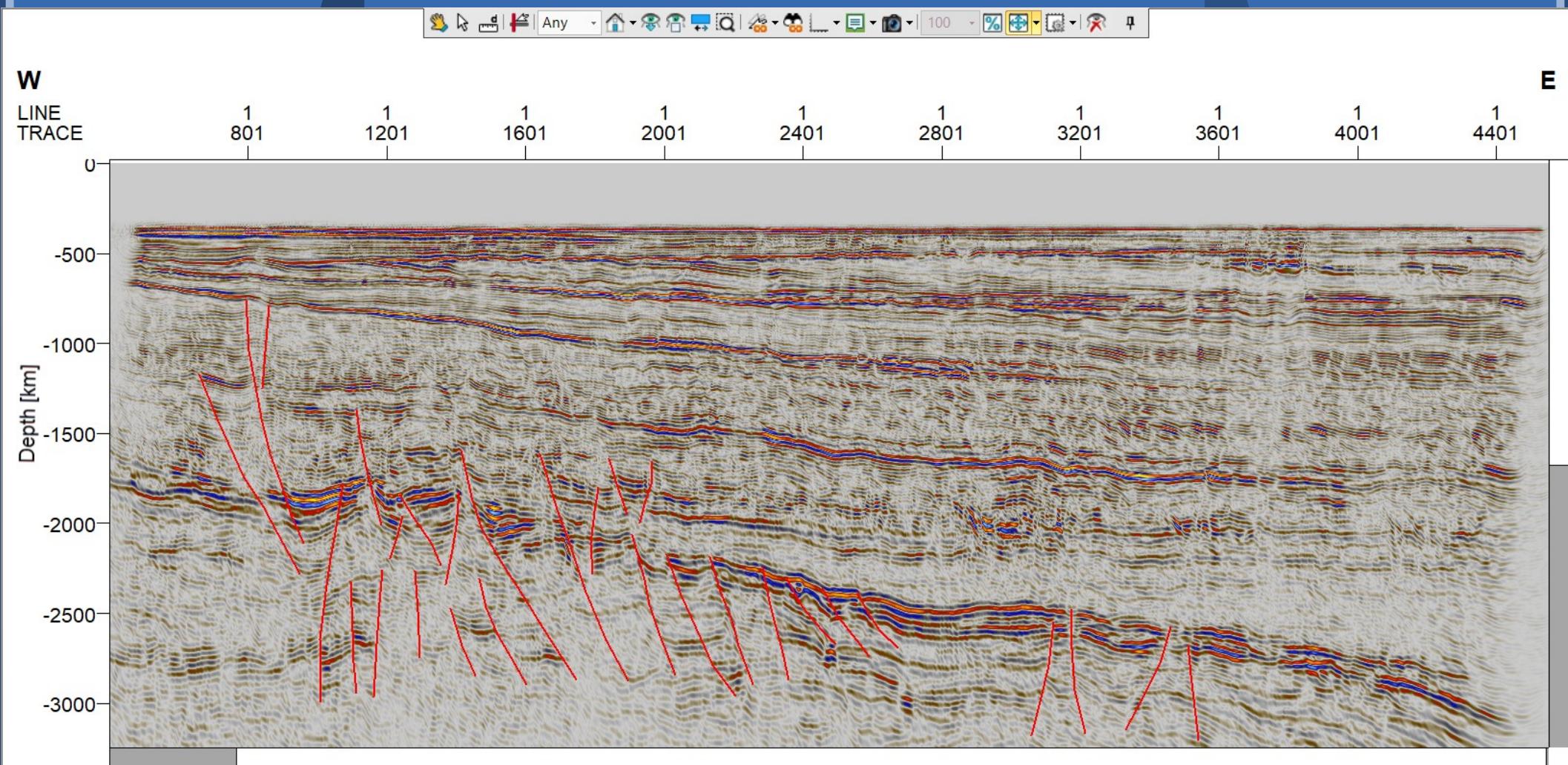


At left - NMO, at right - RTM

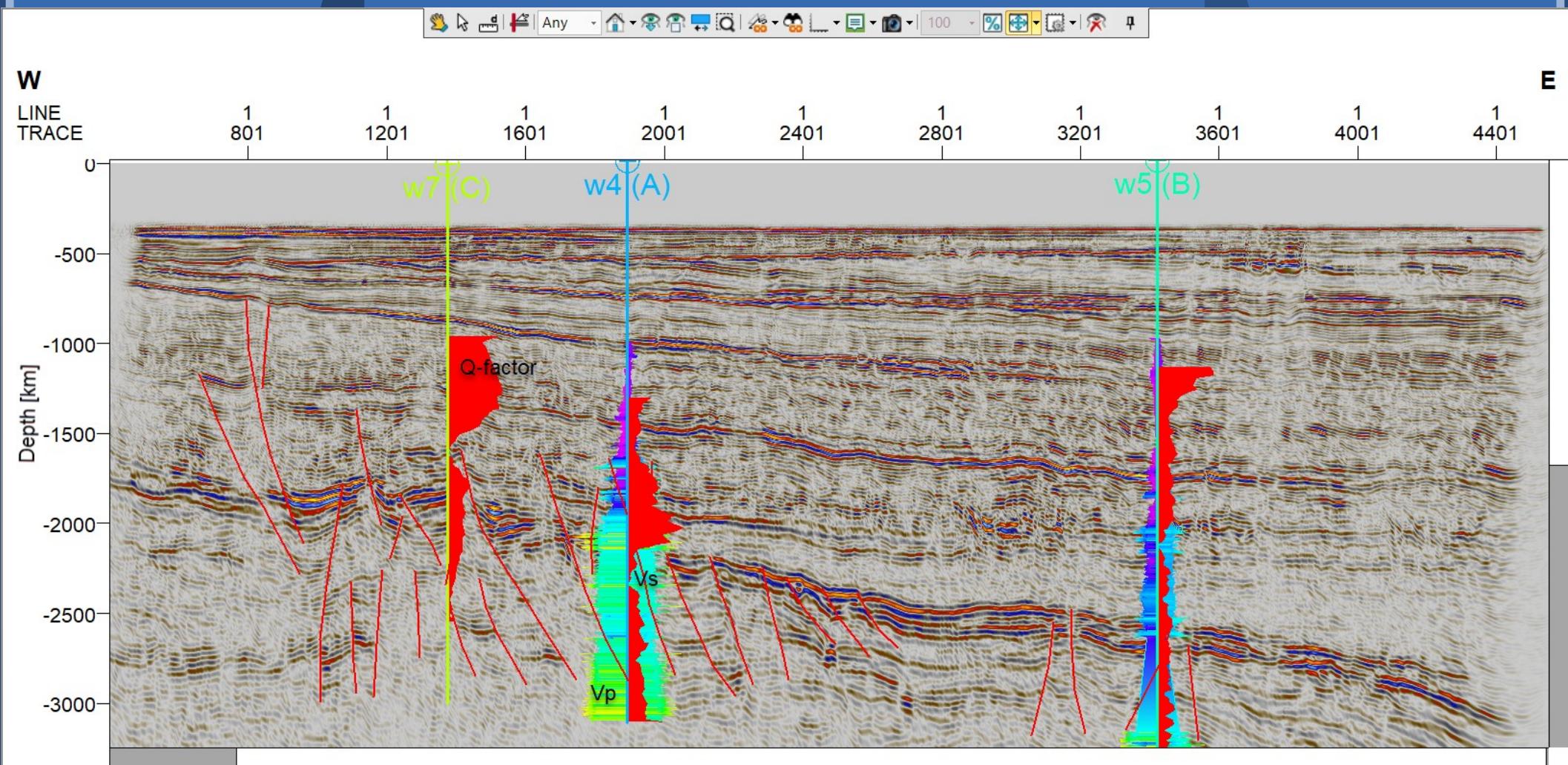
RTM



RTM



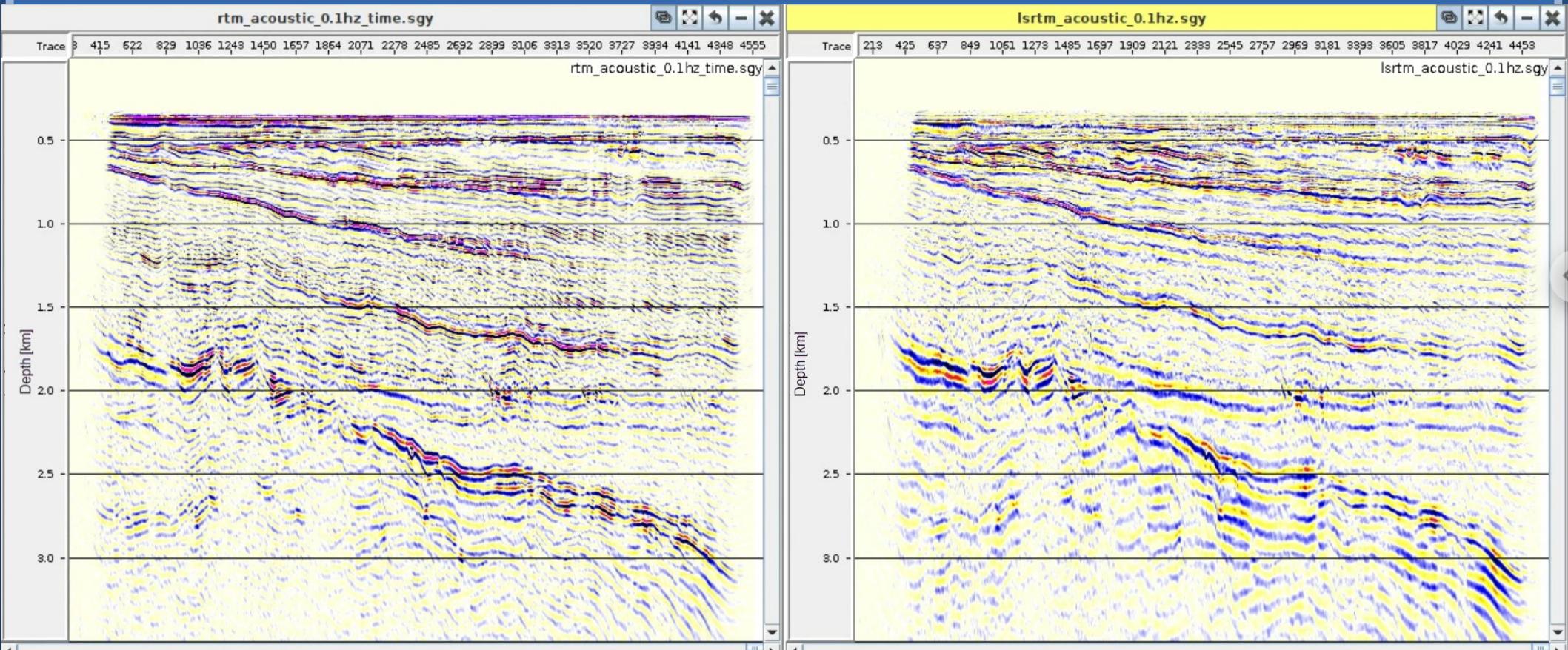
RTM



LSRTM

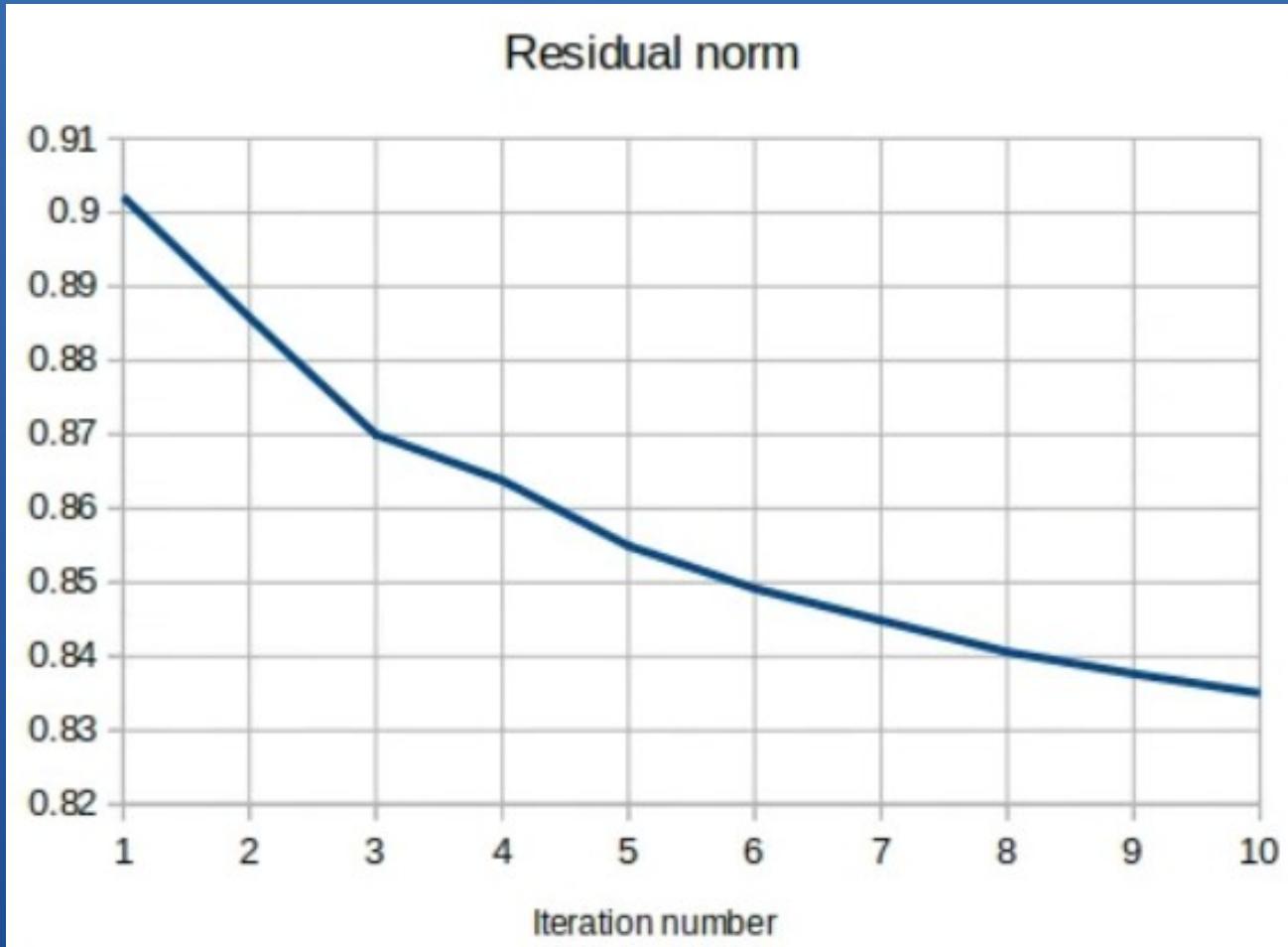
- LSRTM takes much time for computing. For the purpose of time economy LSRTM was calculated on each 3rd shot. Thus shot step was 75m.
- RTM was calculated for each shot and each third shot. This allows to compare results with LSRTM
- LSRTM 333 shots 10 iterations took 6 days.
- RTM 333 shots took 4 hours.

RTM and LSRTM (Shot step=75m)

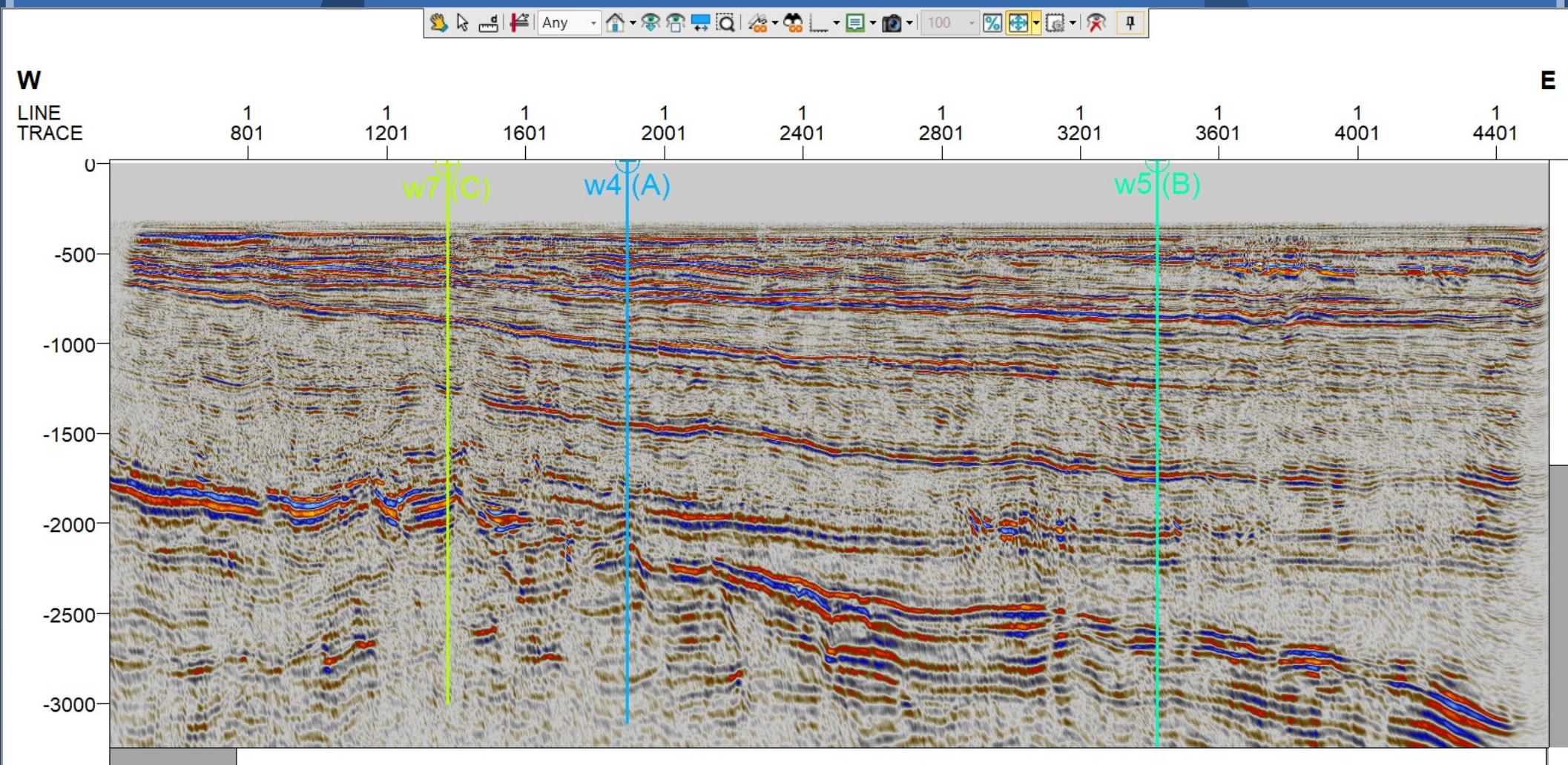


At left - RTM, at right – LSRTM
Used only each 3rd shot

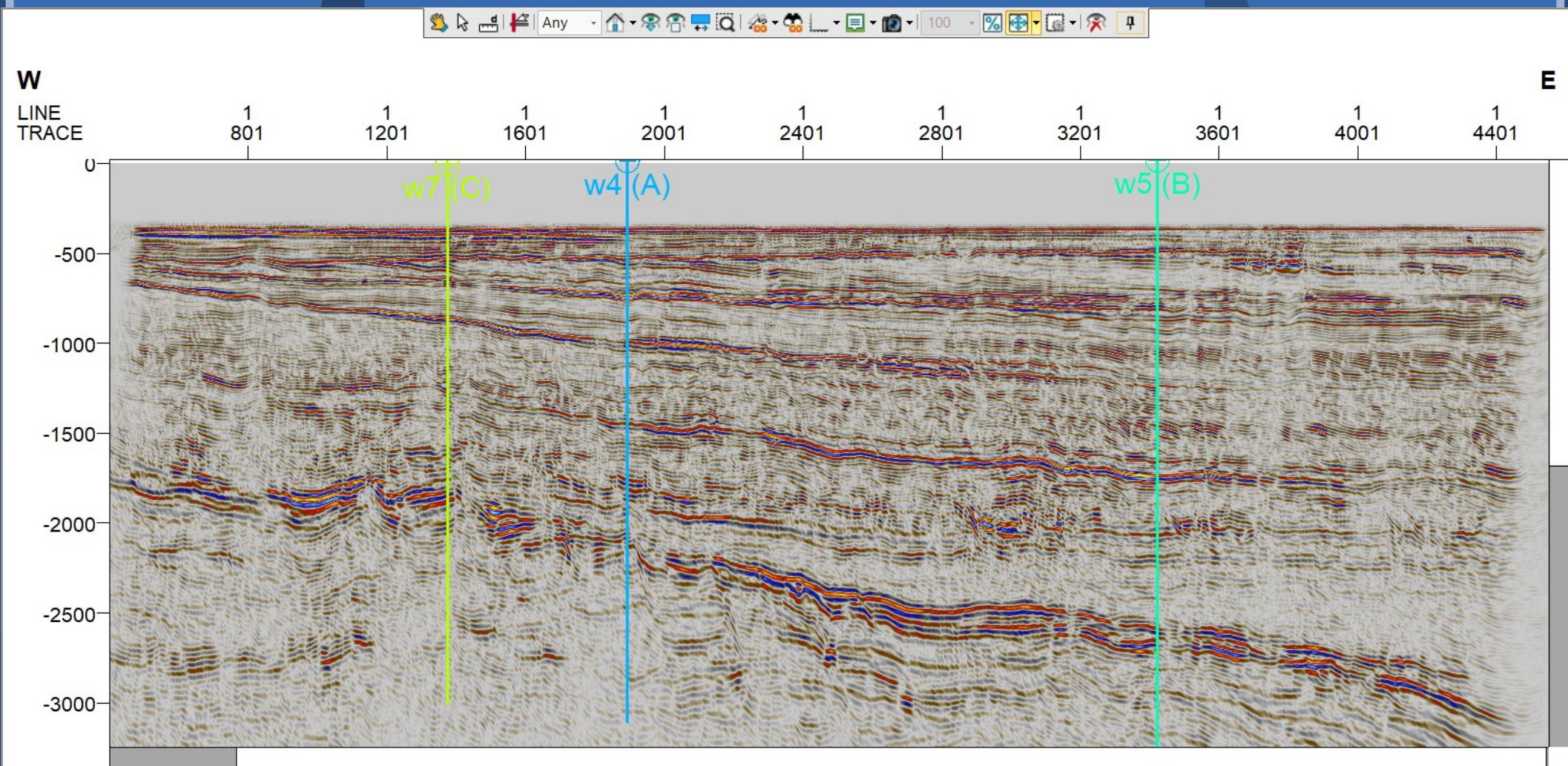
LSRTM сходимость решения



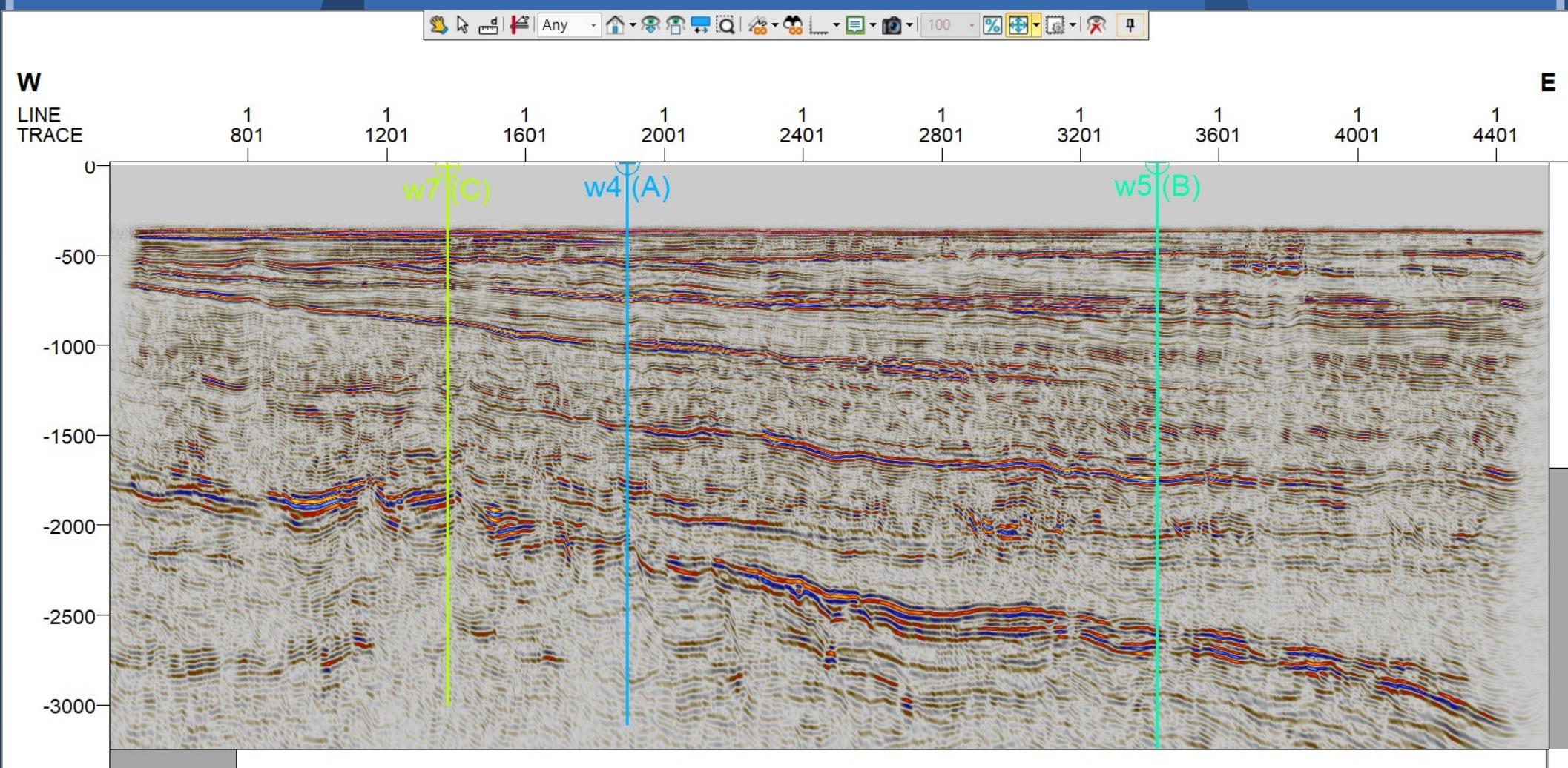
LSRTM ($\Pi B=75M$)



RTM (shot step=75m)



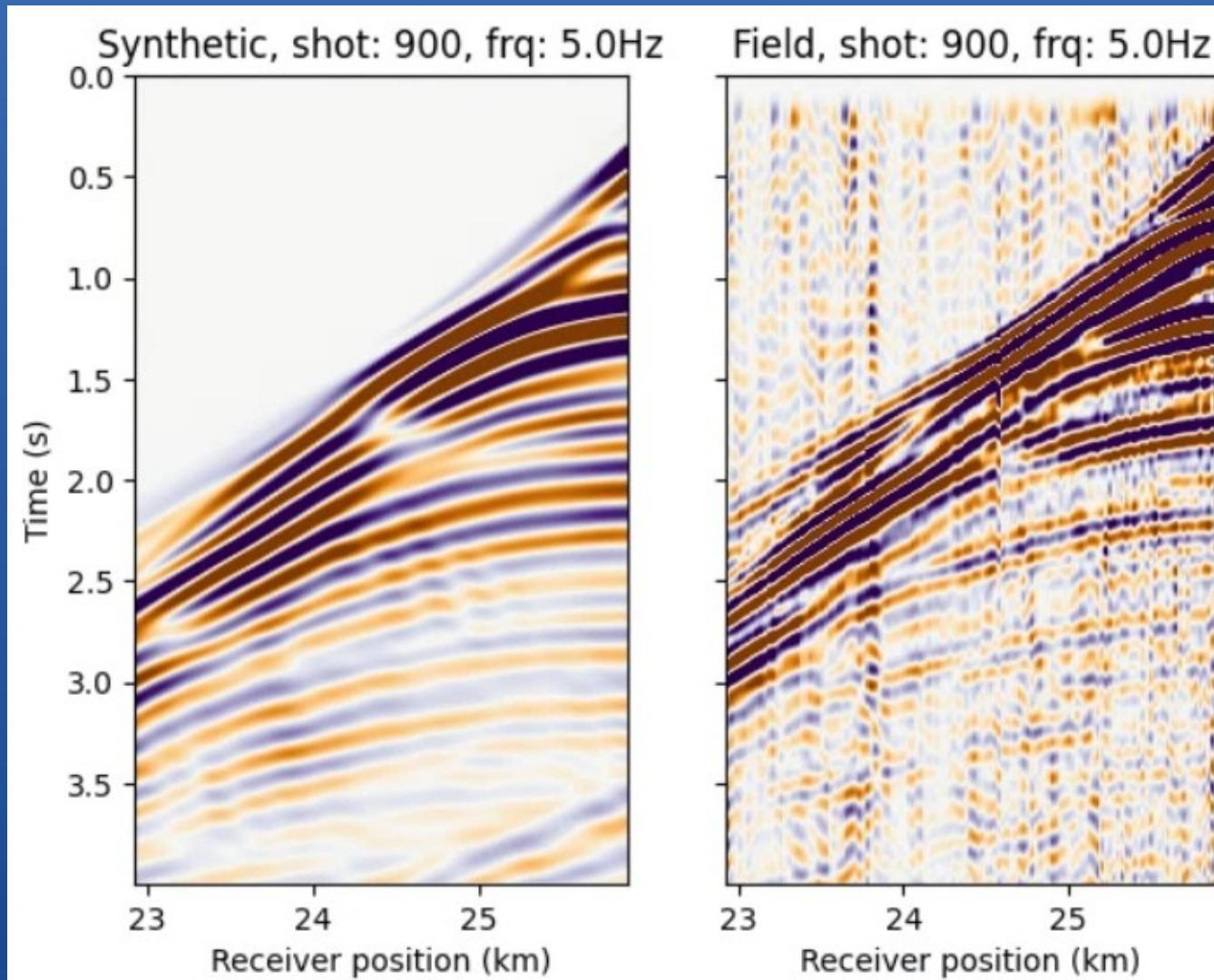
RTM (shot step=25m)



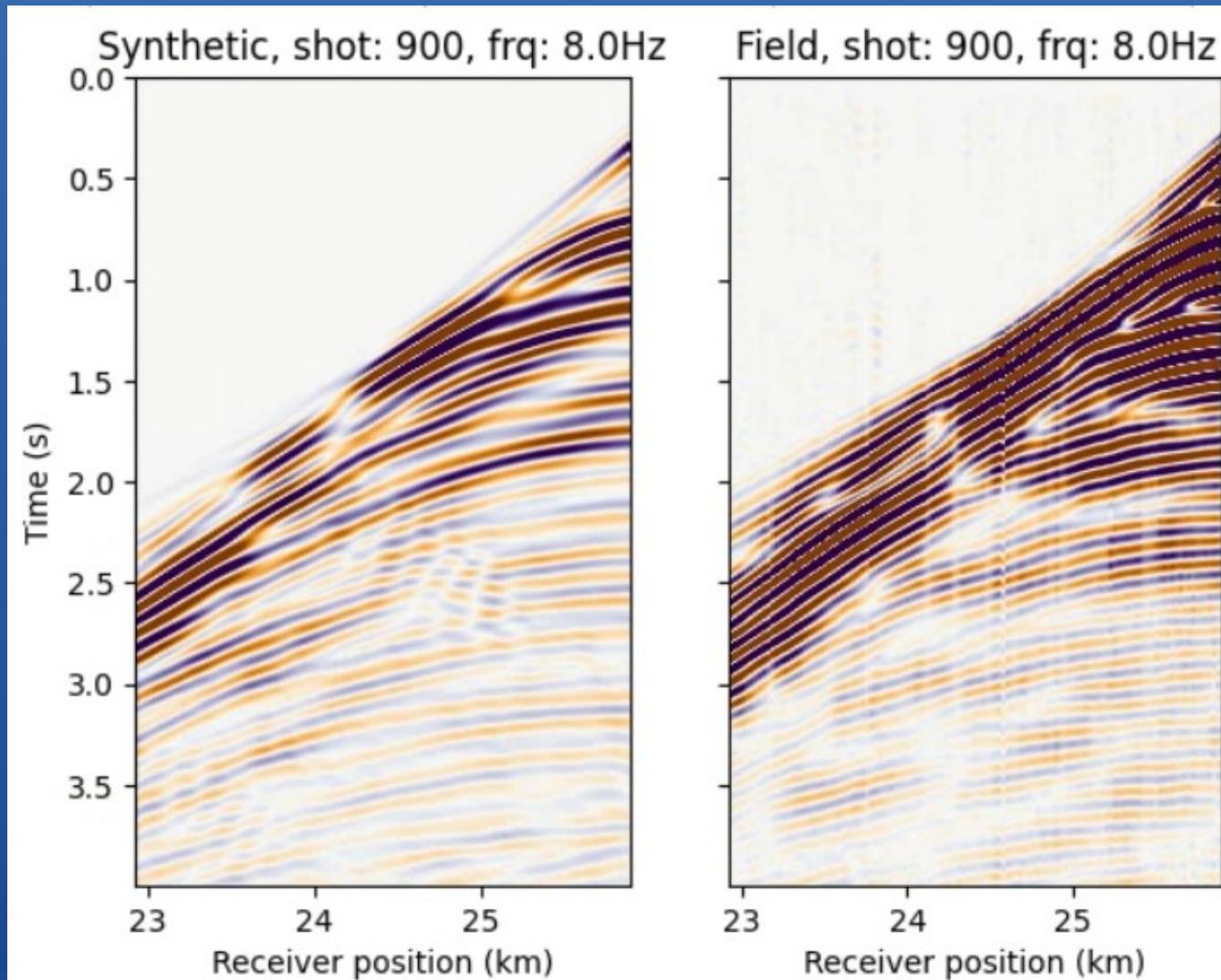
Addition

- LSRTM gives better amplitudes compared to conventional RTM. Even though conventional RTM gives higher frequency image.
- Visually there is no any difference between RTM with shot step 25m and 75m. In this case doing RTM on each shot leads to only time consumtion.

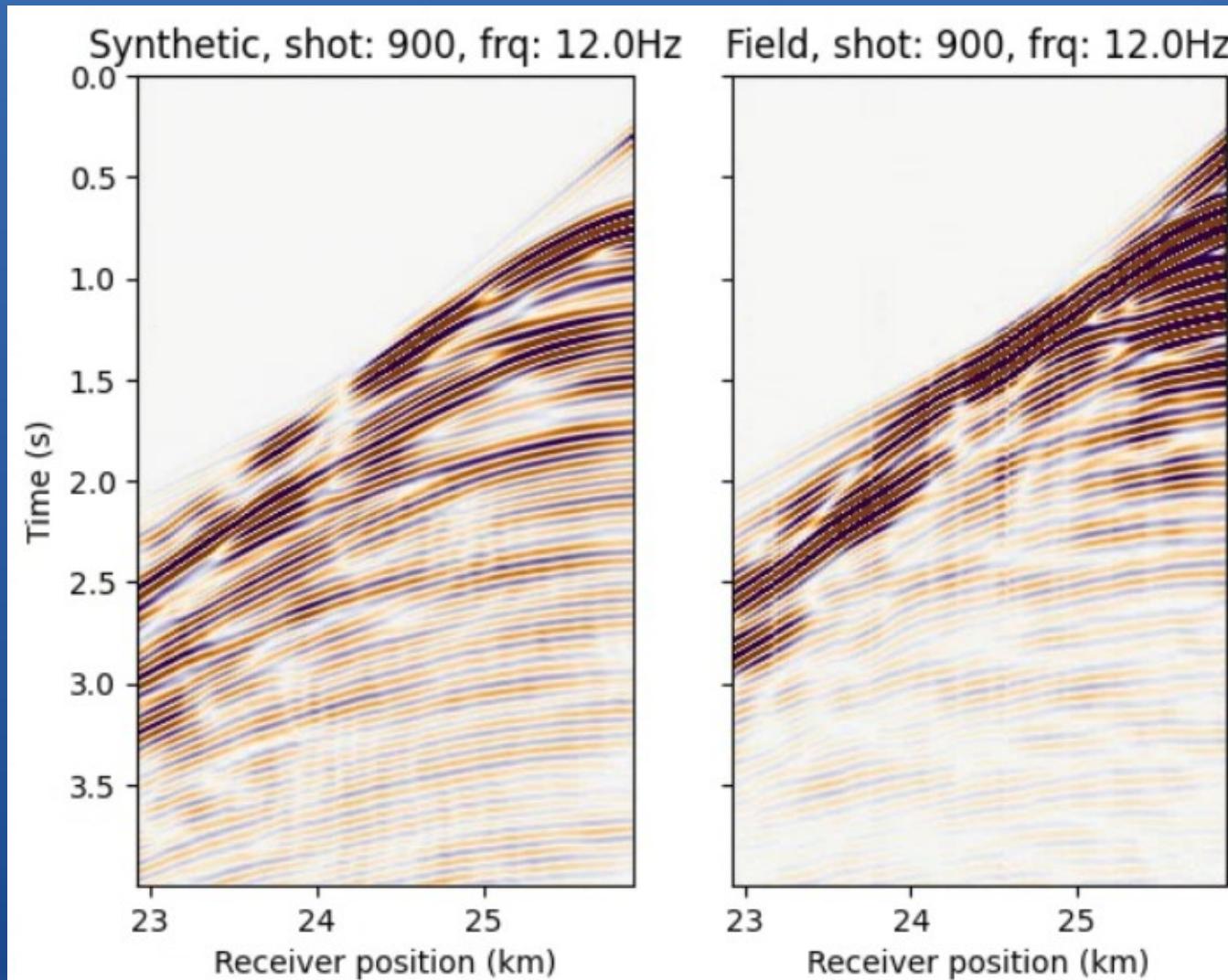
Synthetic and field seismogram comparision for shot=900 at 5Hz



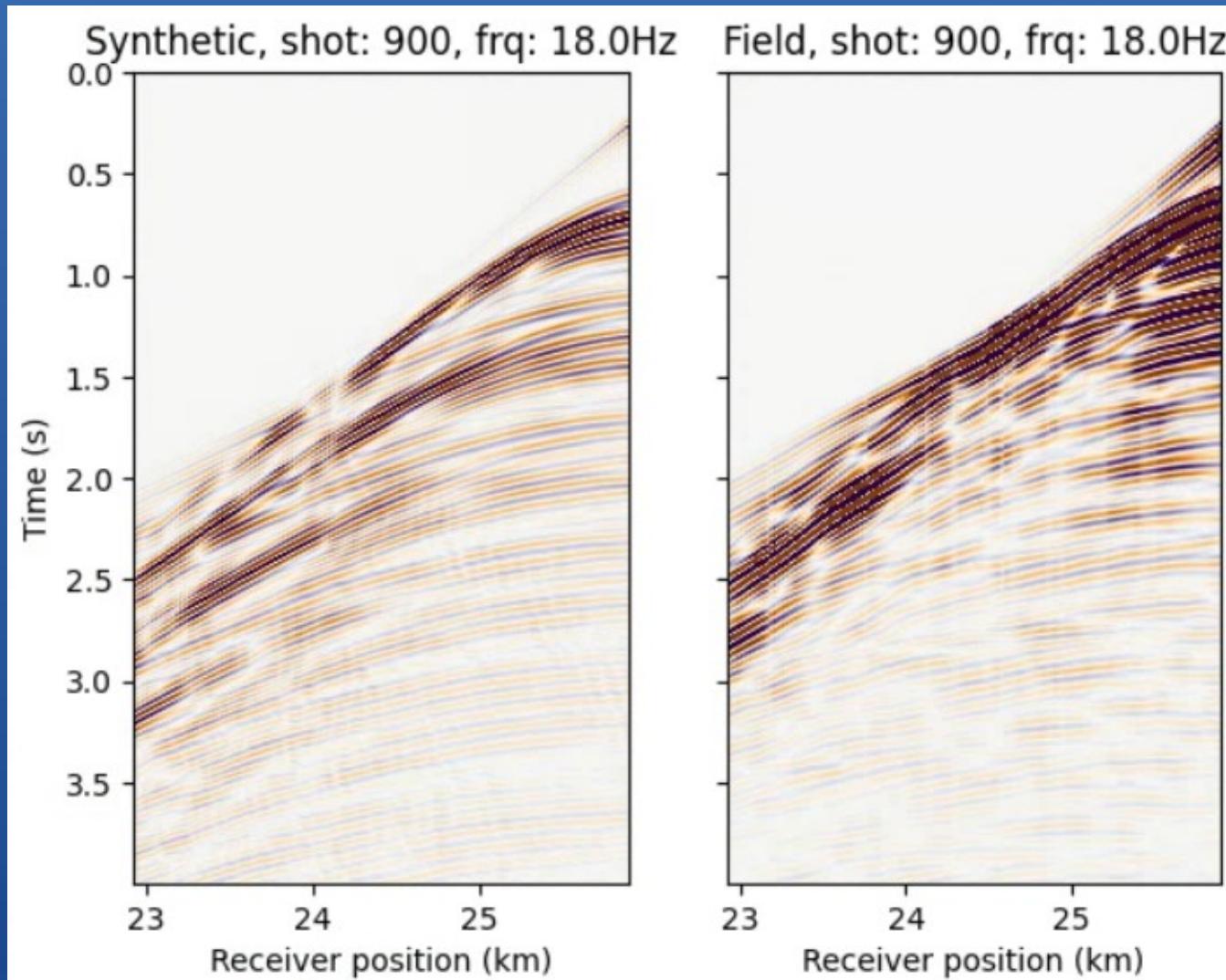
Synthetic and field seismogram comparision for shot=900 at 8Hz



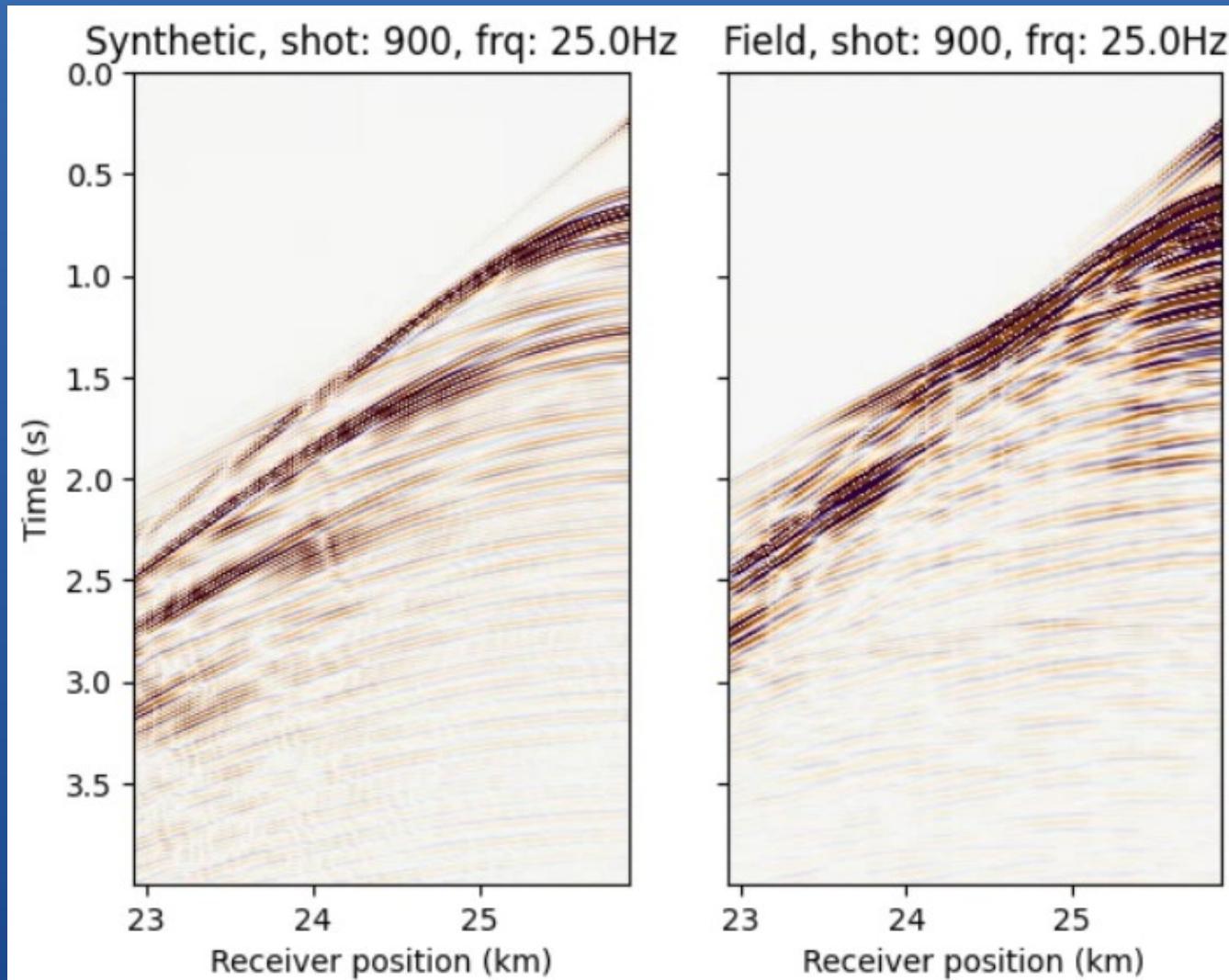
Synthetic and field seismogram comparision for shot=900 at 12Hz



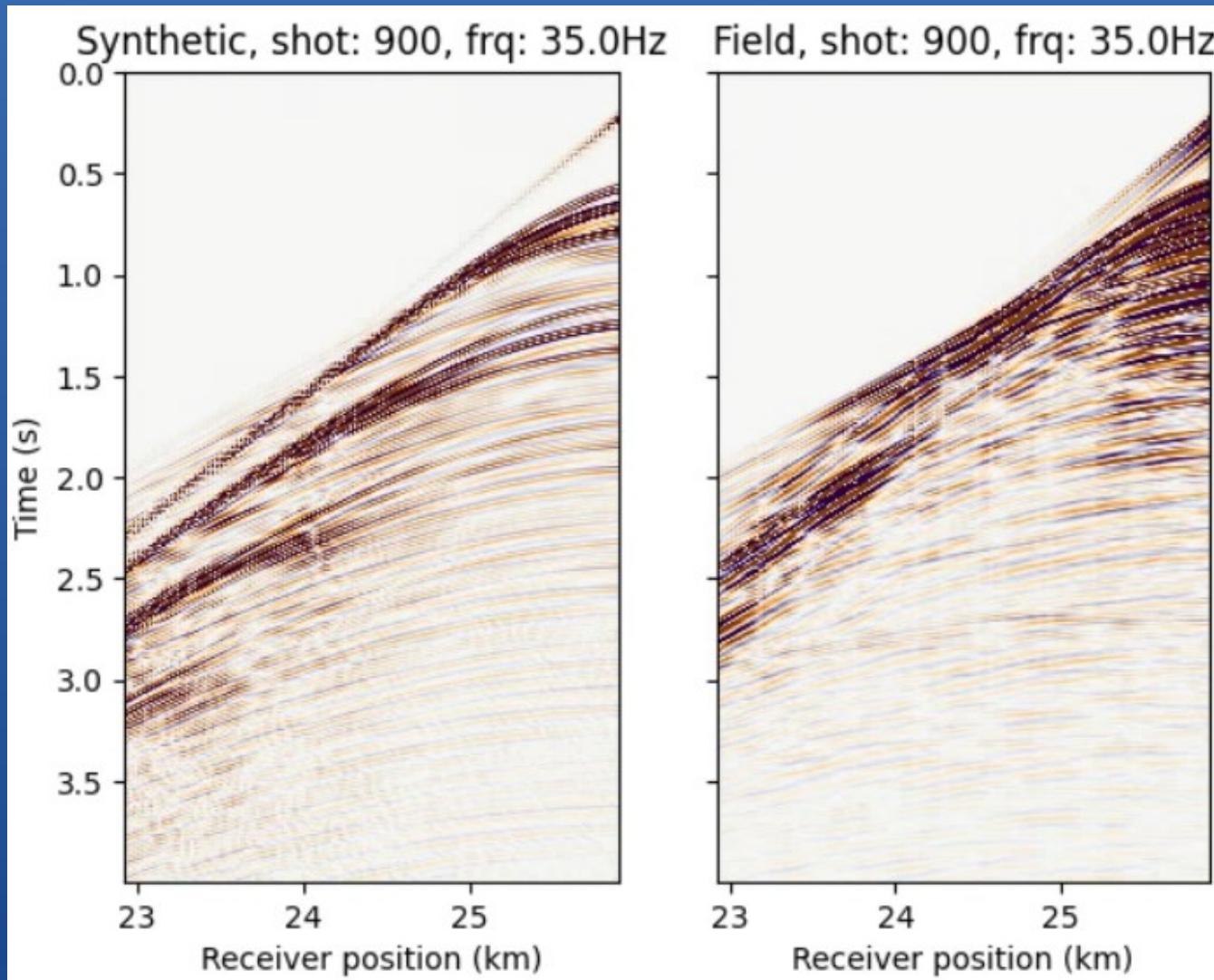
Synthetic and field seismogram comparision for shot=900 at 18Hz



Synthetic and field seismogram comparision for shot=900 at 25Hz



Synthetic and field seismogram comparision for shot=900 at 35Hz



Contacts

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