# Comparison of one- and two-step seismic inversion for Lithology and Fluid prediction

Per Røe (NR), Odd Kolbjørnsen (Lundin), Ragnar Hauge (NR)

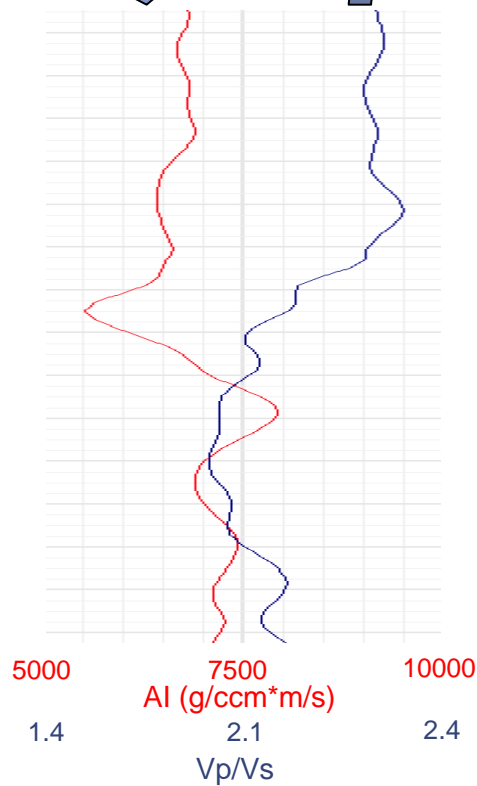FORCE Practical Rock Physics and Inversion for Exploration and Production

17/10 2017

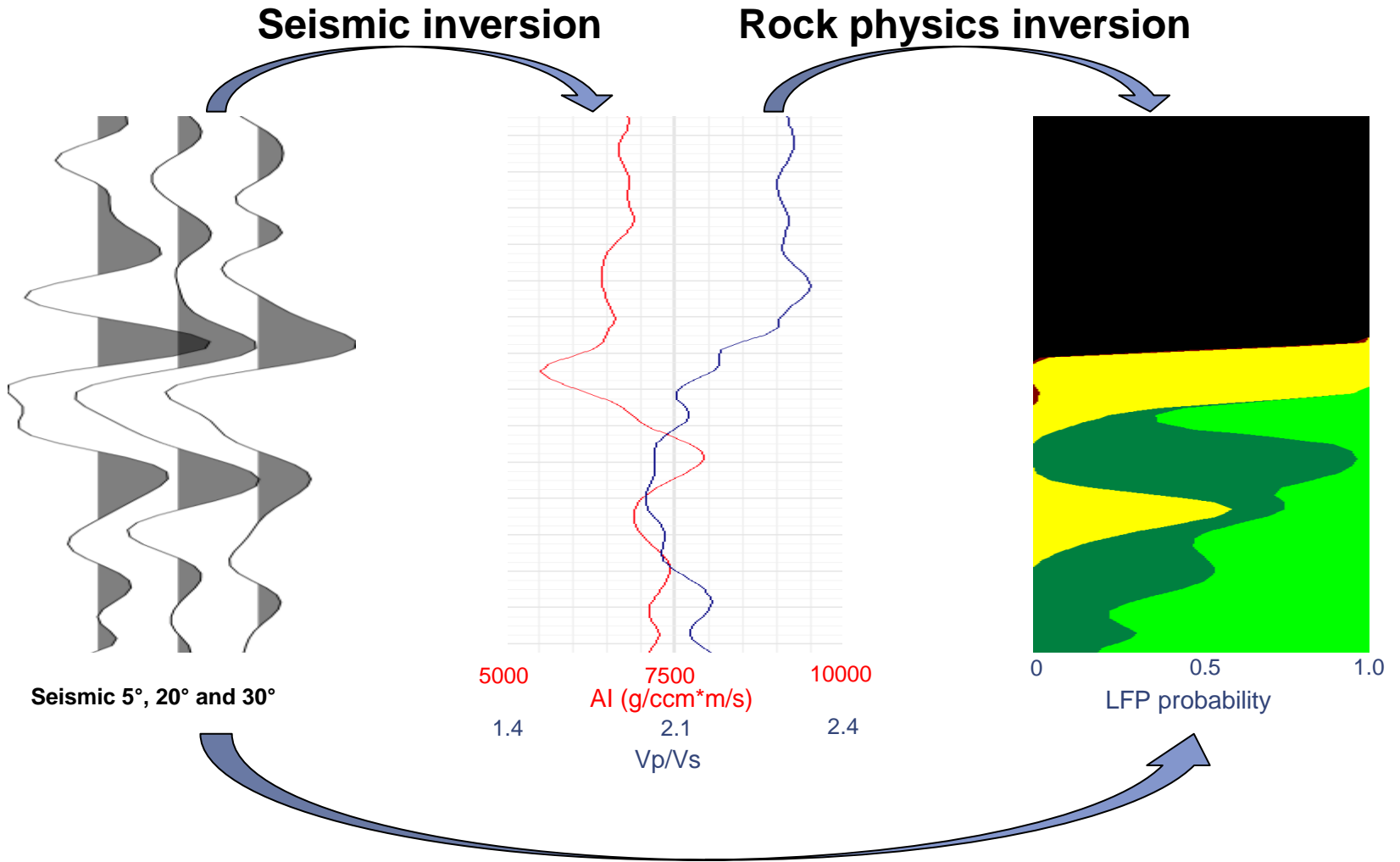# Two-step seismic LFP

**Seismic inversion**

**Rock physics inversion**

**Seismic 5°, 20° and 30°**

5000          7500         10000

AI (g/ccm*m/s)

1.4         2.1         2.4

Vp/Vs

0         0.5         1.0

LFP probability

# Two-step seismic LFP

**Seismic inversion**    **Rock physics inversion**



**Seismic 5°, 20° and 30°**

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LFP probability

# One-step seismic LFP

# Bayesian seismic inversion

Bayes rule: $p(f|d) \propto p(f) * p(d|f)$

Posterior $\propto$ Prior $*$ Likelihood(data)
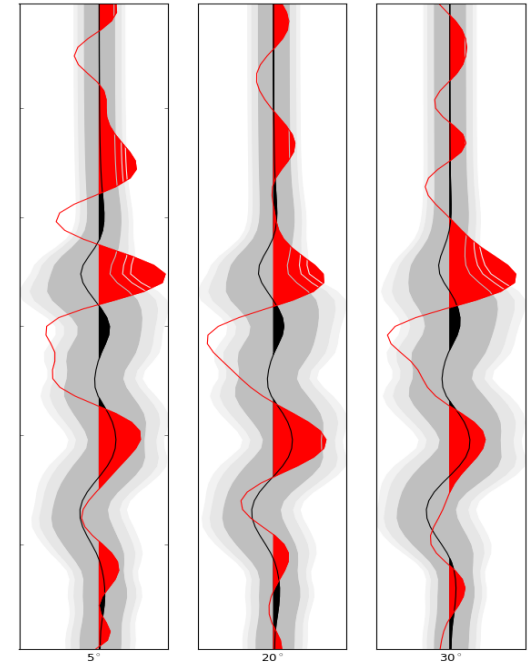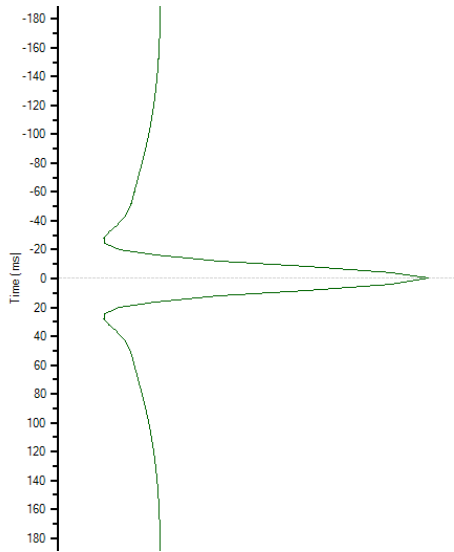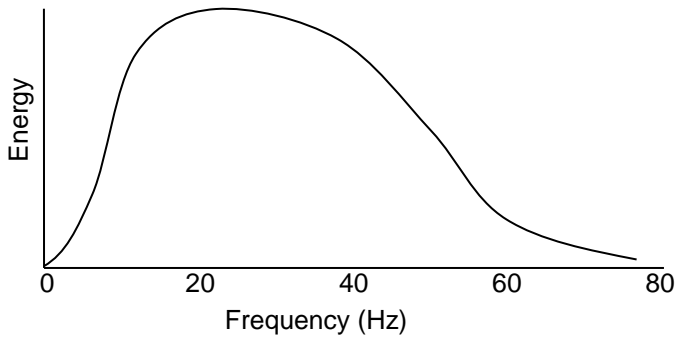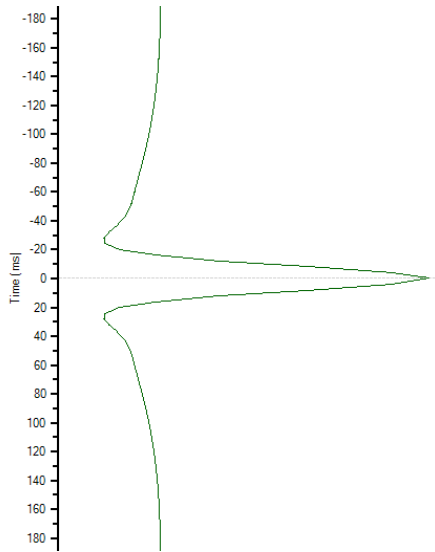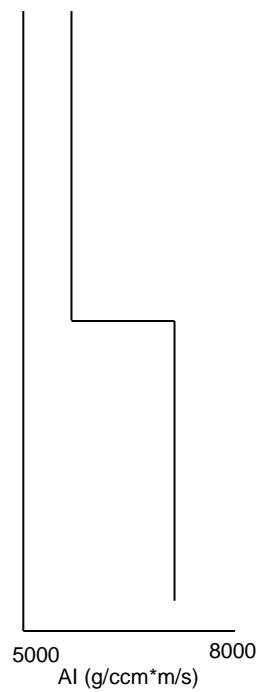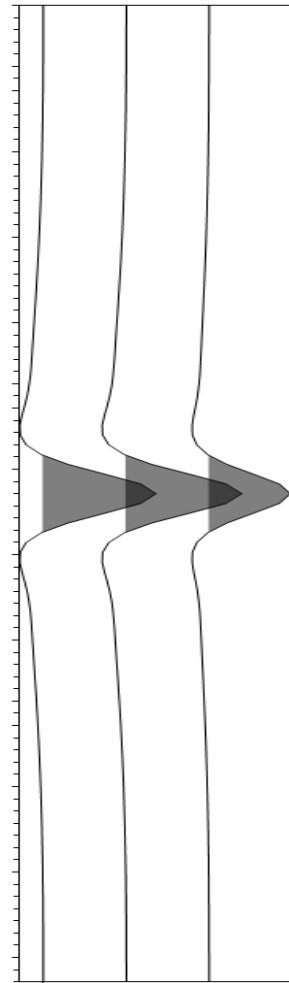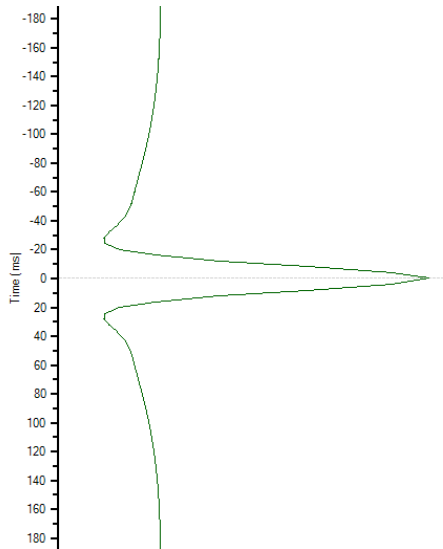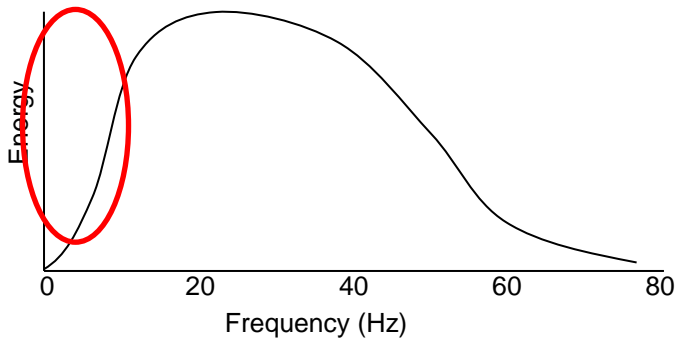


LFP probability

LFP probability

# Why do we need the prior?
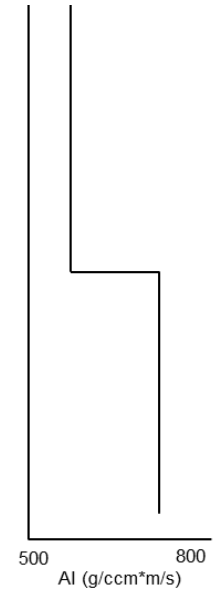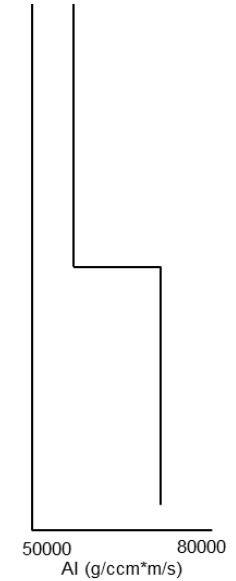


**Energy spectrum**
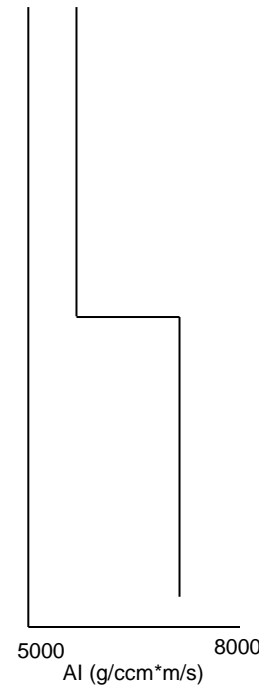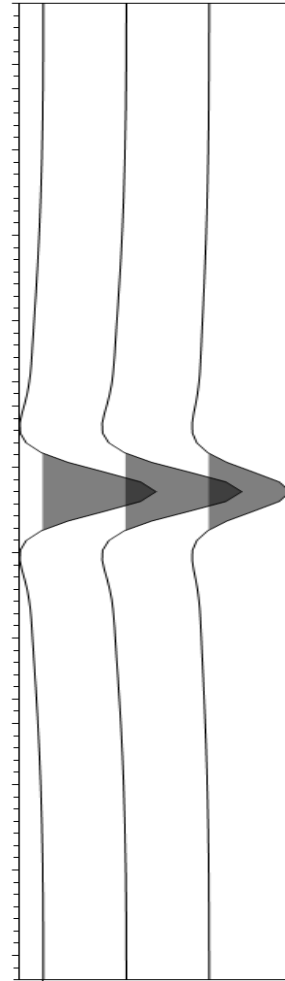
# Why do we need the prior?

**Energy spectrum**

# Why do we need the prior?

**Energy spectrum**

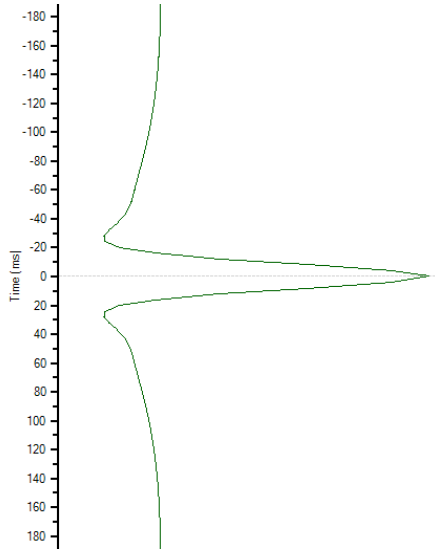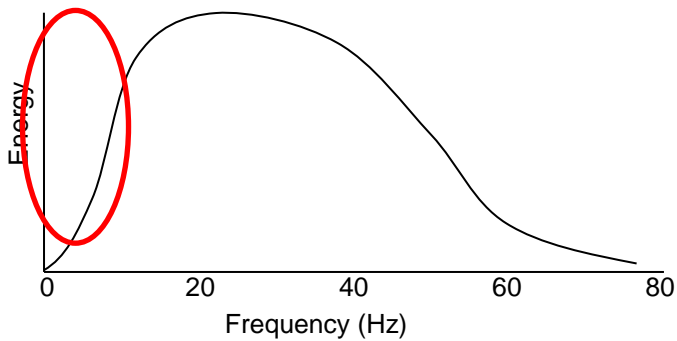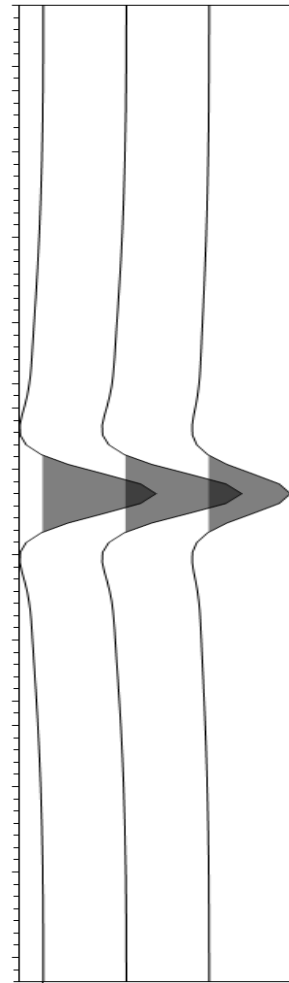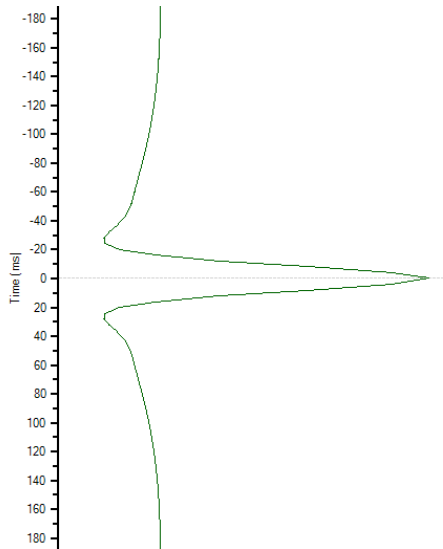Seismic 5°, 15° and 25°

AI (g/ccm*m/s)

# Why do we need the prior?



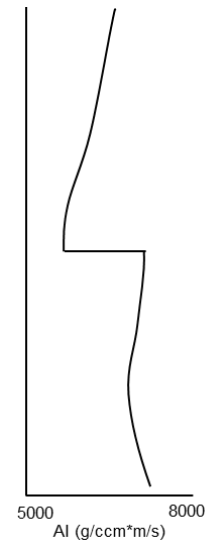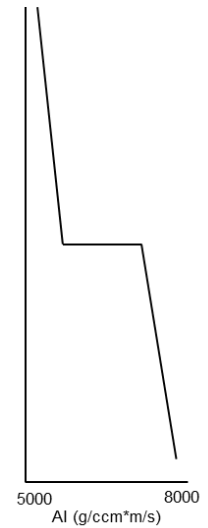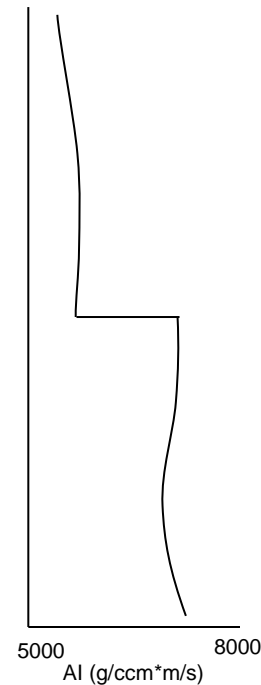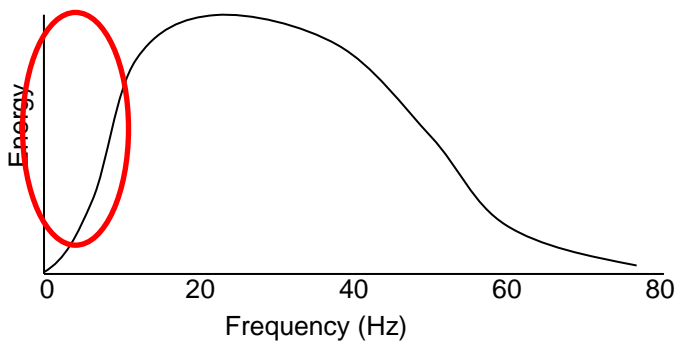**Energy spectrum**

Seismic 5°, 15° and 25°

8
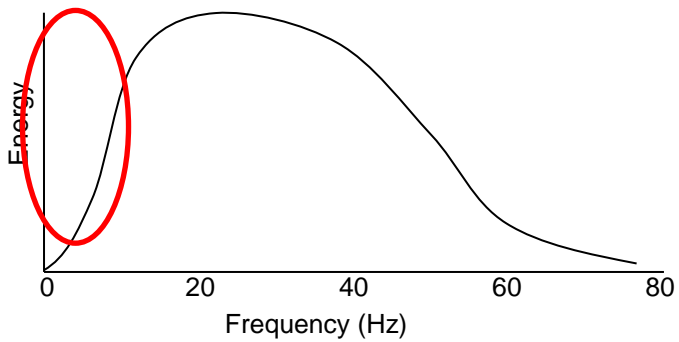
# Why do we need the prior?

**Energy spectrum**

Seismic 5°, 15° and 25°

# High-frequent information is also missing
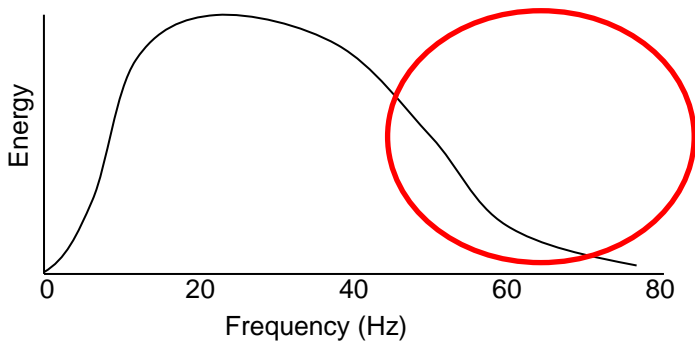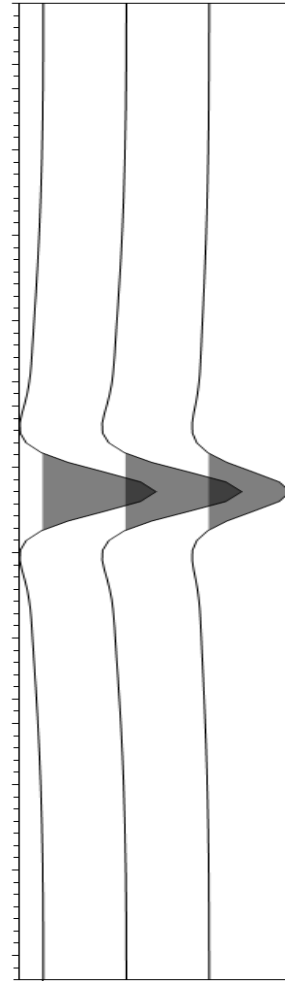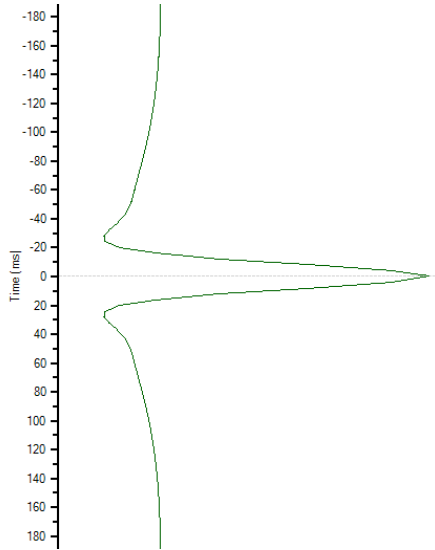


**Energy spectrum**

# High-frequent information is also missing

**Energy spectrum**
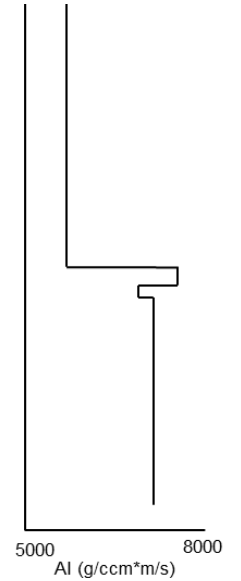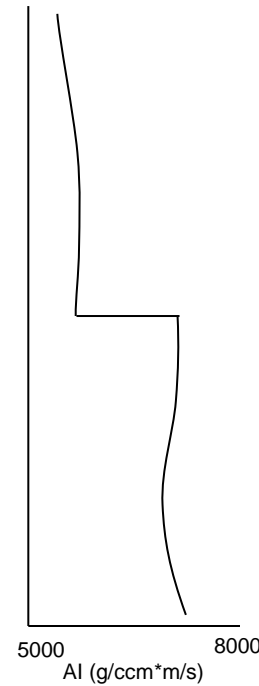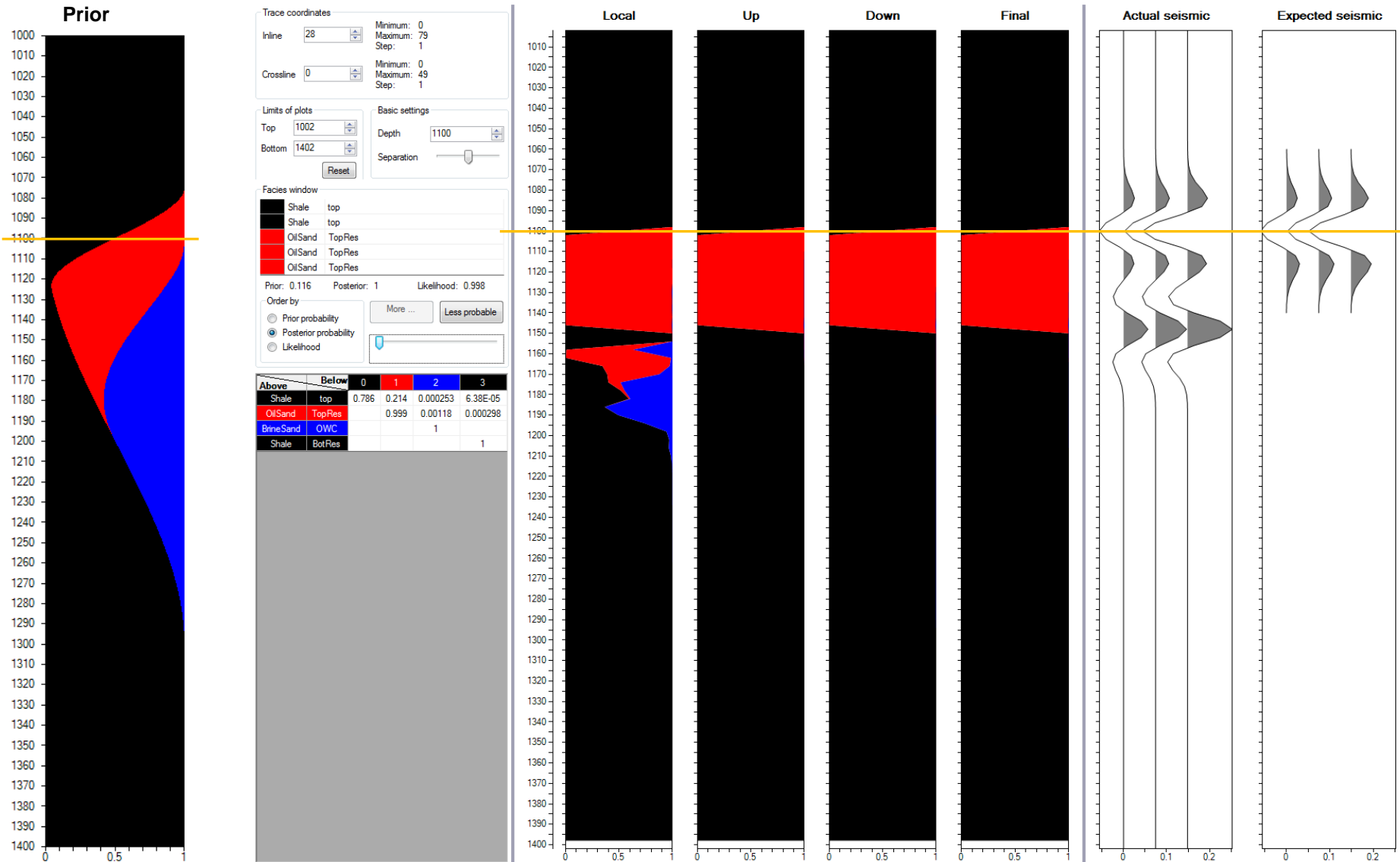
Seismic 5°, 15° and 25°
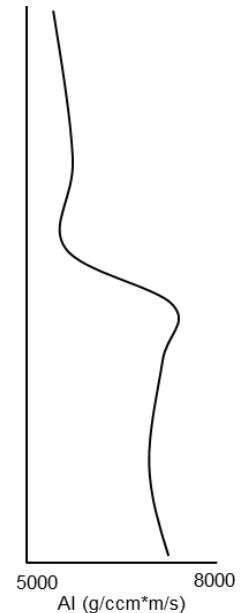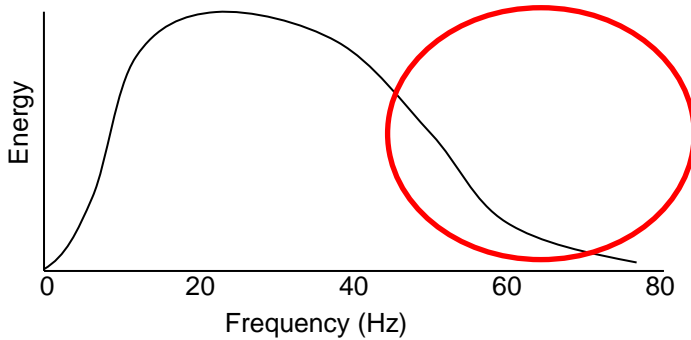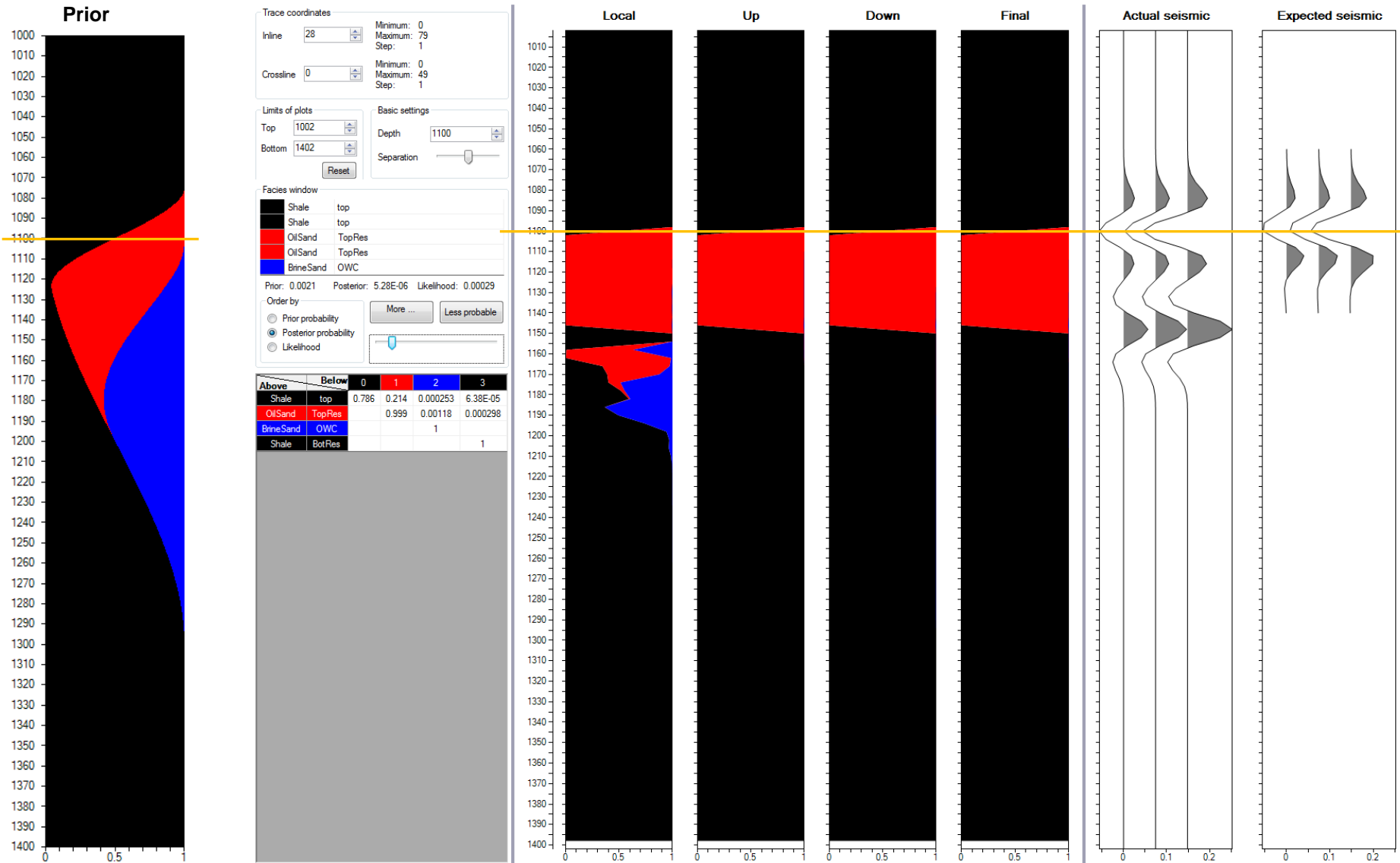
# Two-step LFP inversion (PCube)
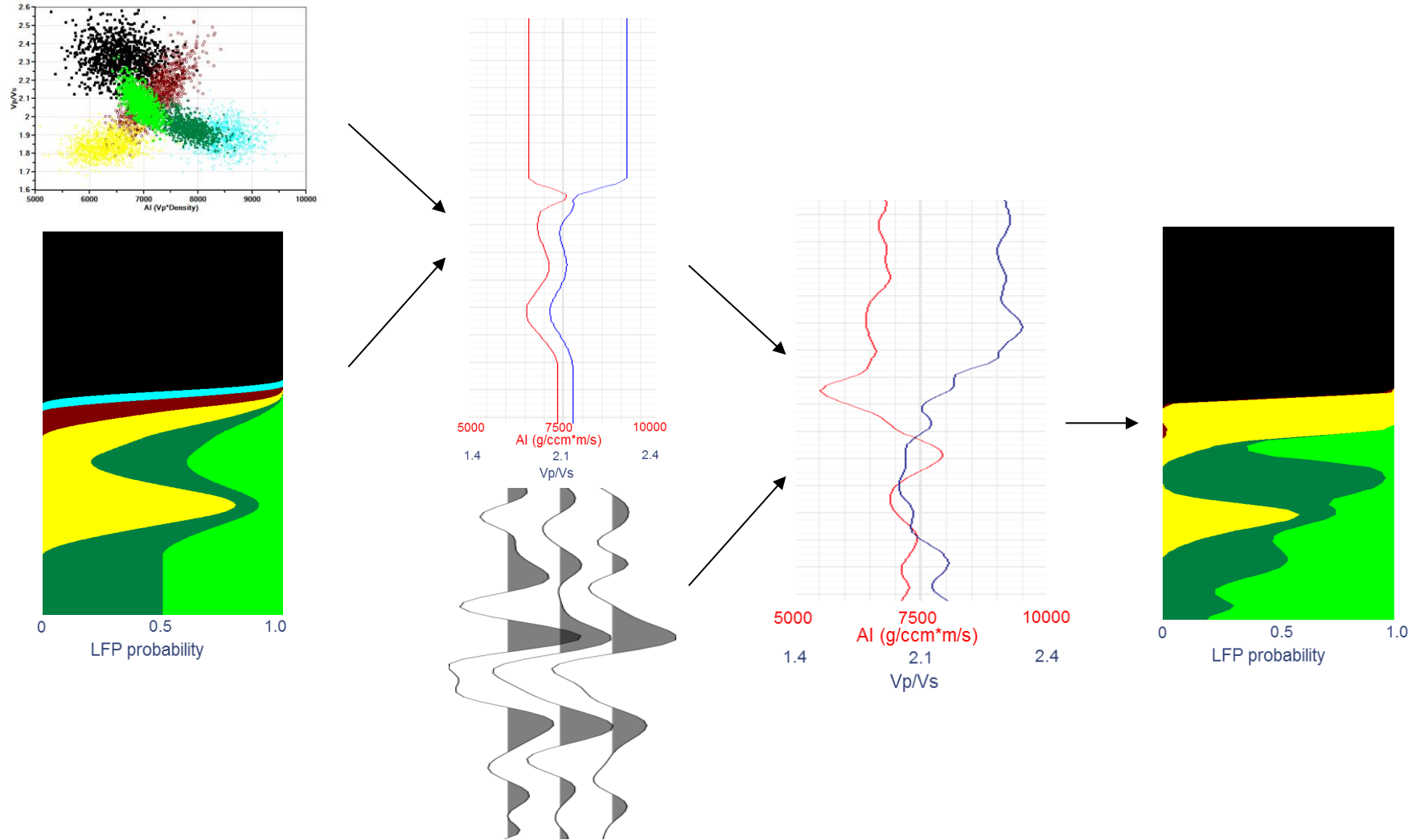


Buland et.al., 2008, *Bayesian lithology and fluid prediction from seismic prestack data*
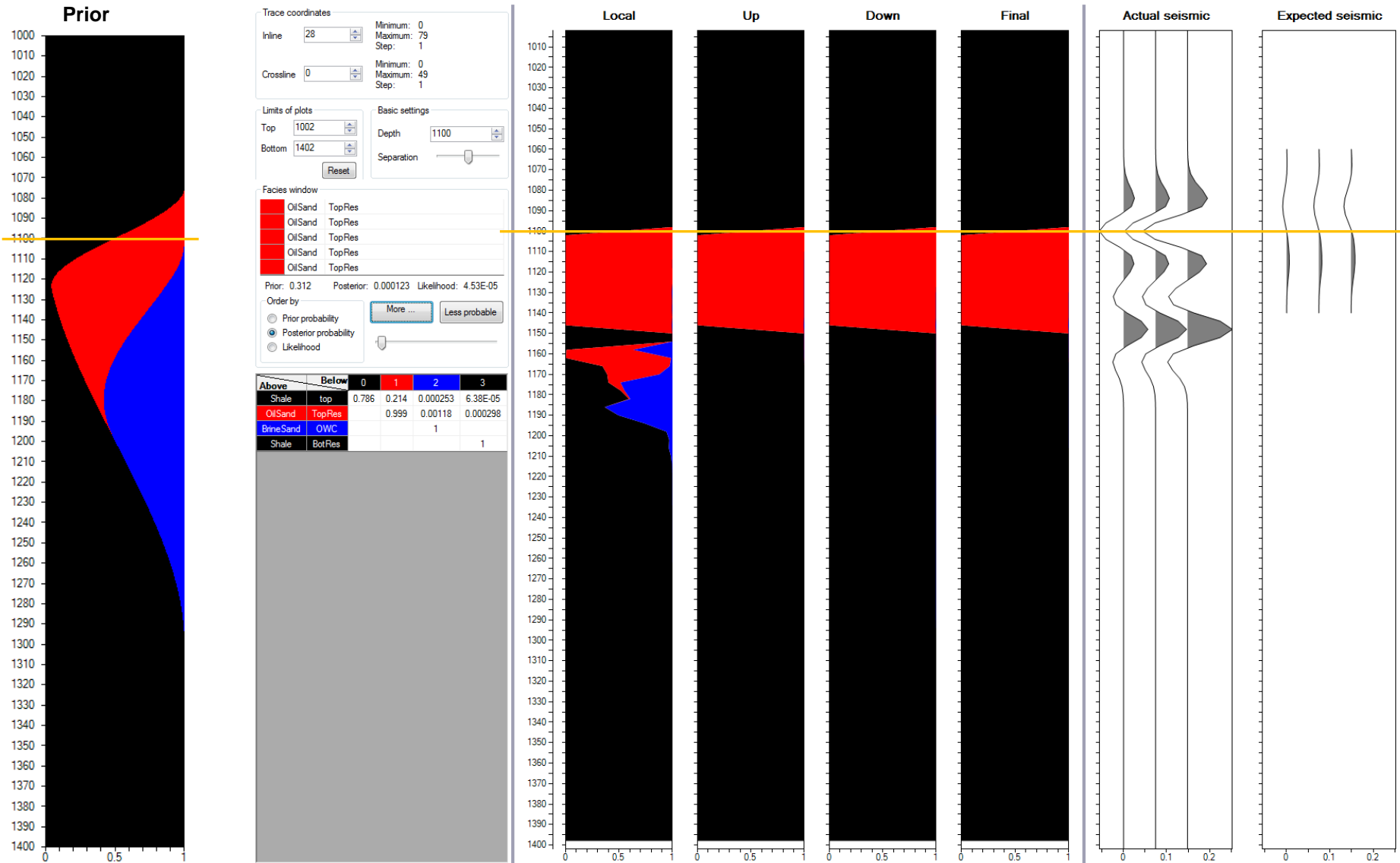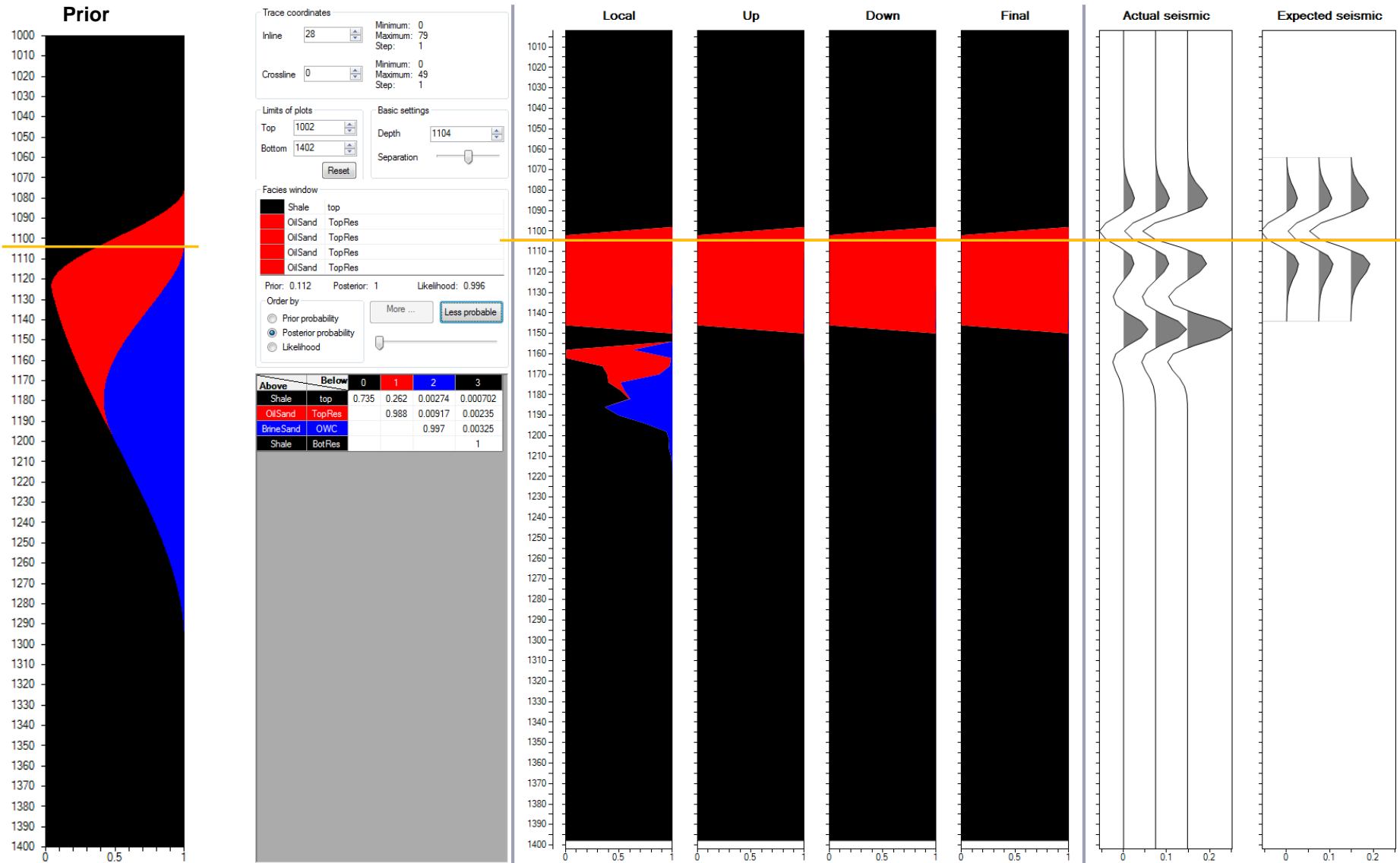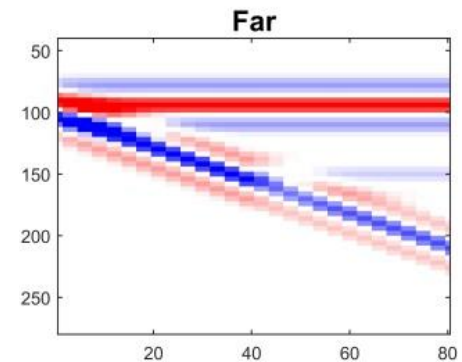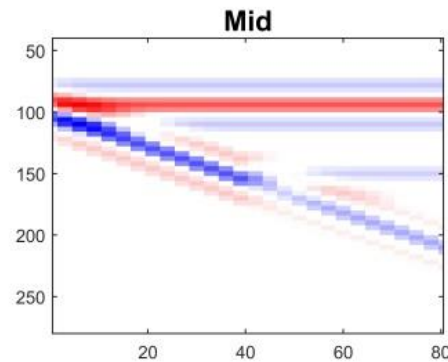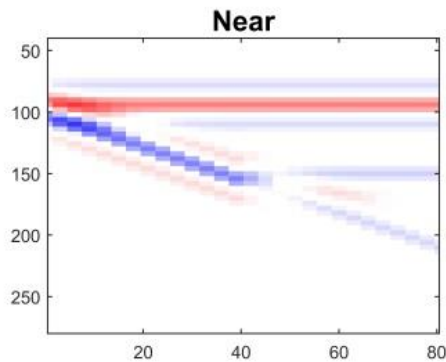
# One-step LFP inversion (PCube+)

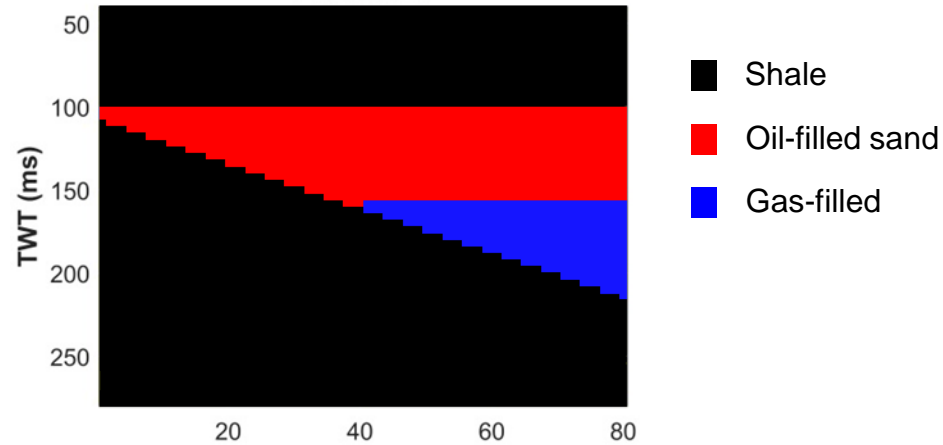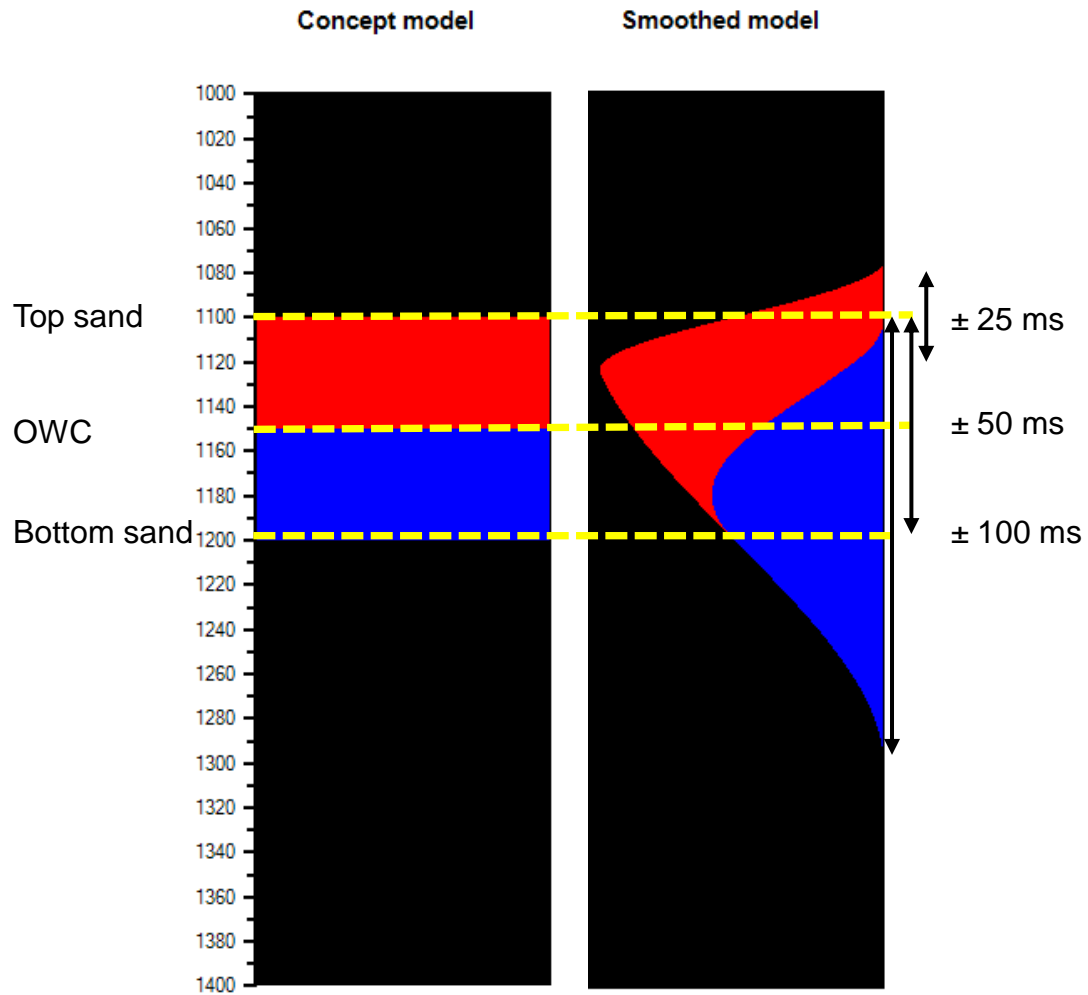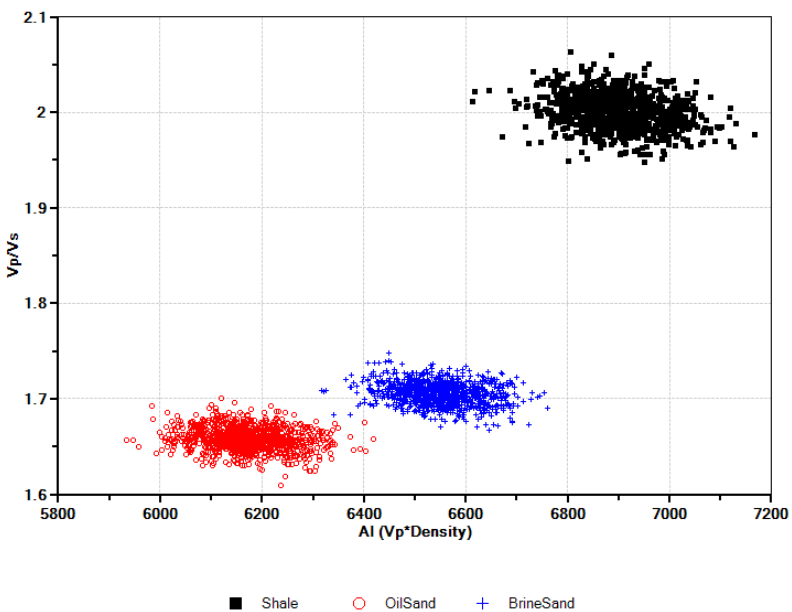# One-step LFP inversion (PCube+)

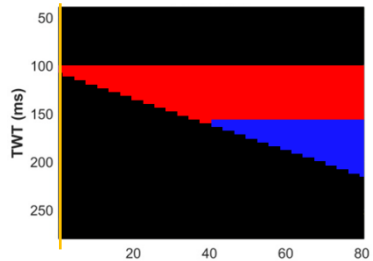# One-step LFP inversion (PCube+)

# One-step LFP inversion (PCube+)

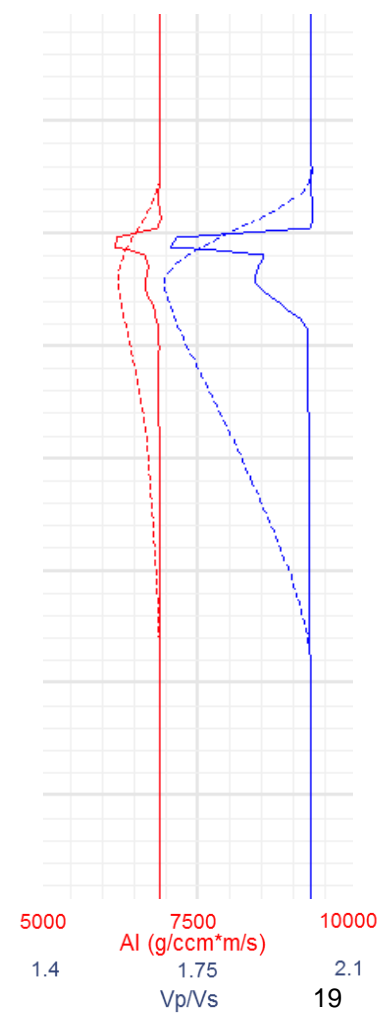# Synthetic case: Simple wedge

# Prior model



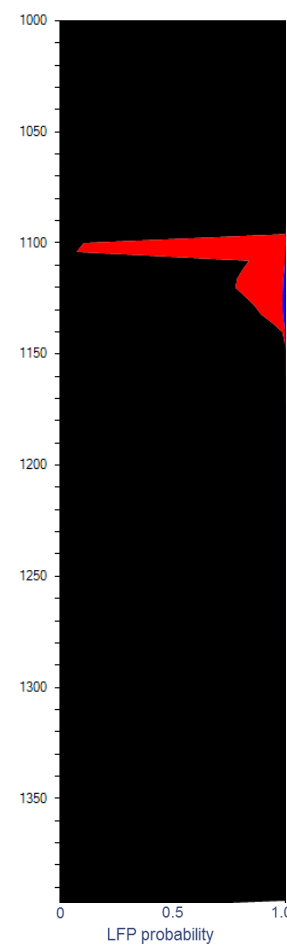

Top sand

OWC

Bottom sand

Concept model    Smoothed model

± 25 ms

± 50 ms

± 100 ms

Shale    OilSand    BrineSand

Two-step inversion

One-step inversion

Prior

Two-step inversion

One-step inversion

Prior

LFP probability

AI (g/ccm*m/s)

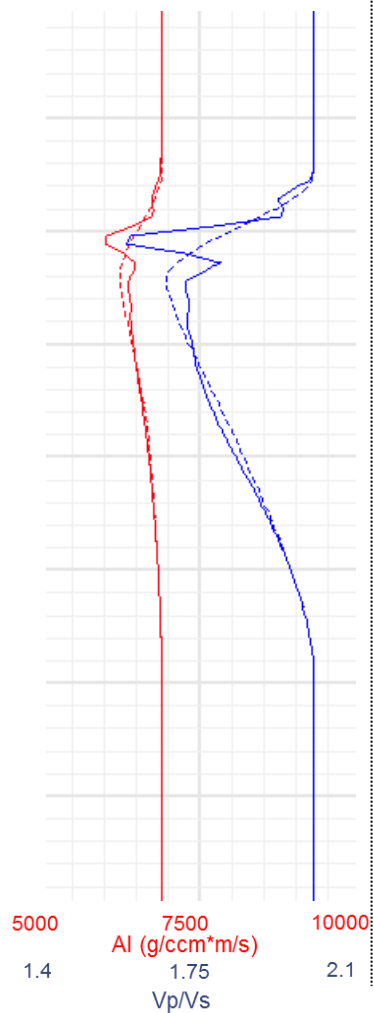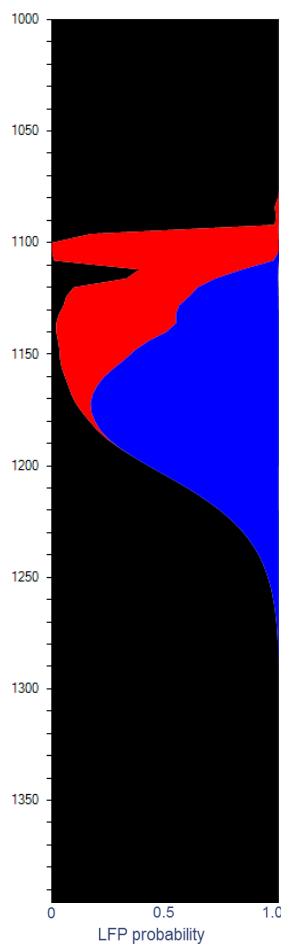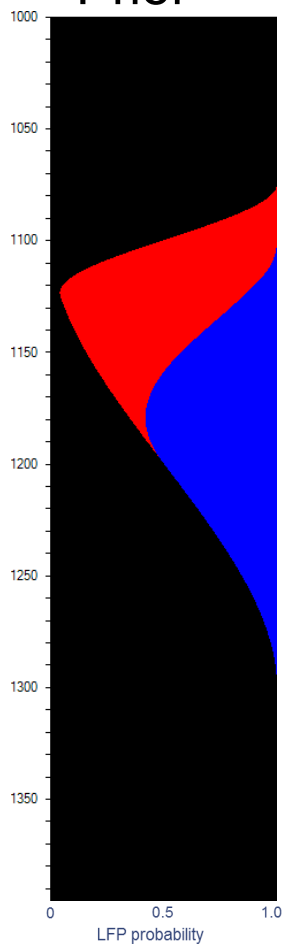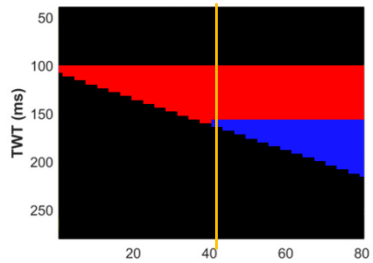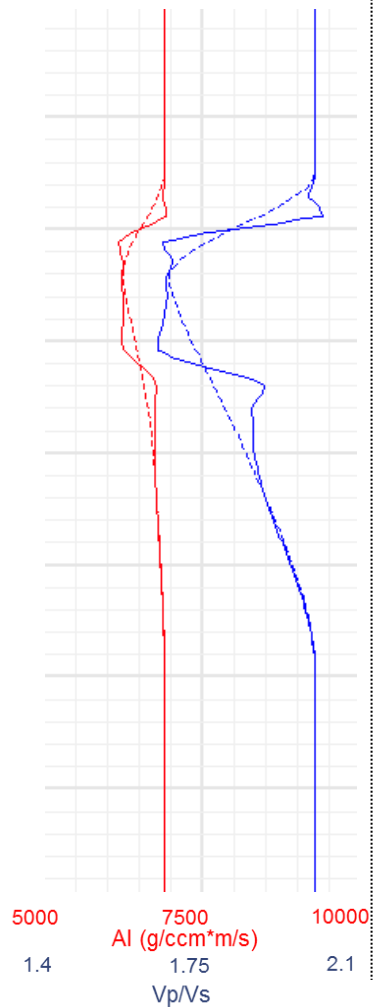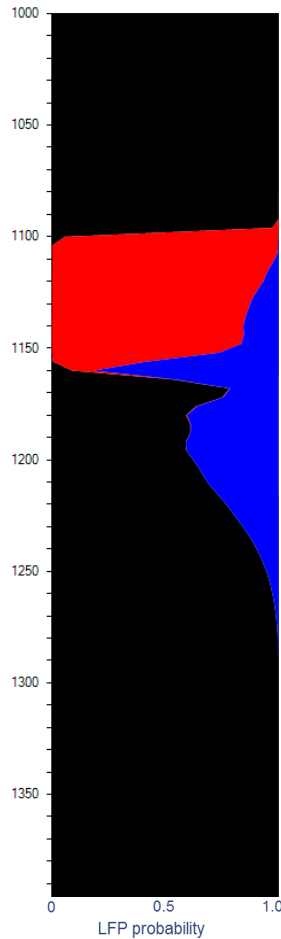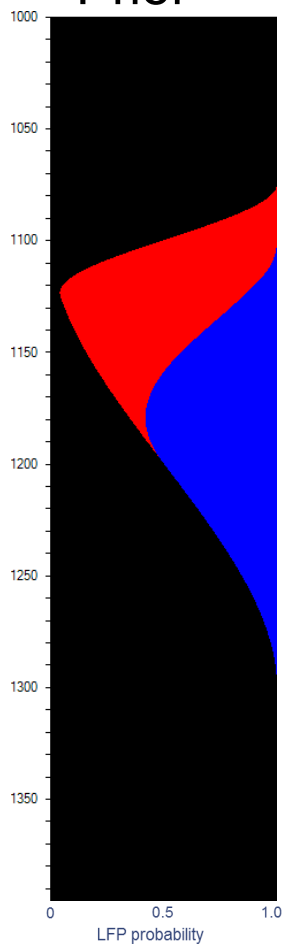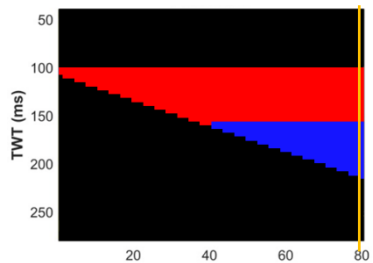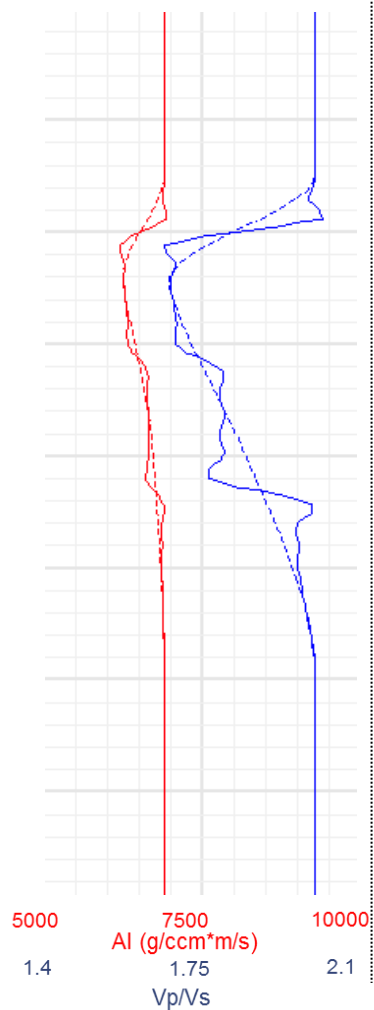Vp/Vs
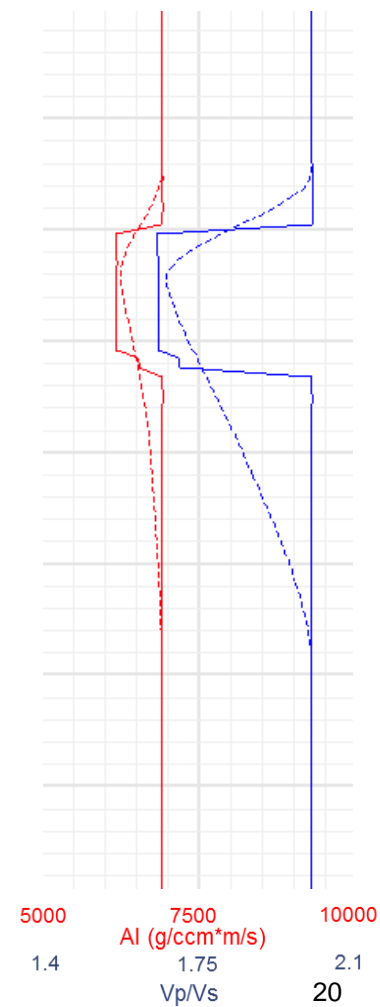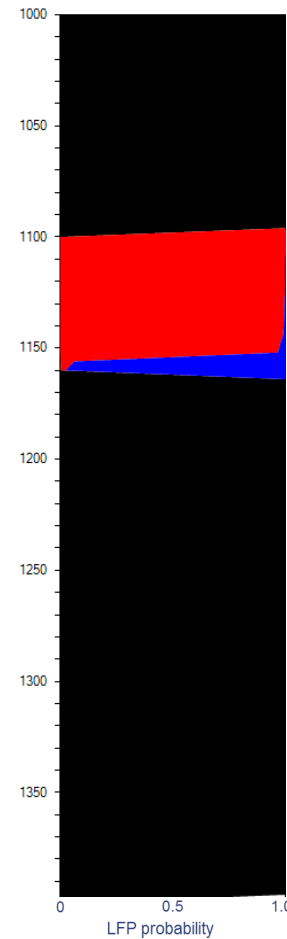
Two-step inversion

One-step inversion

Prior
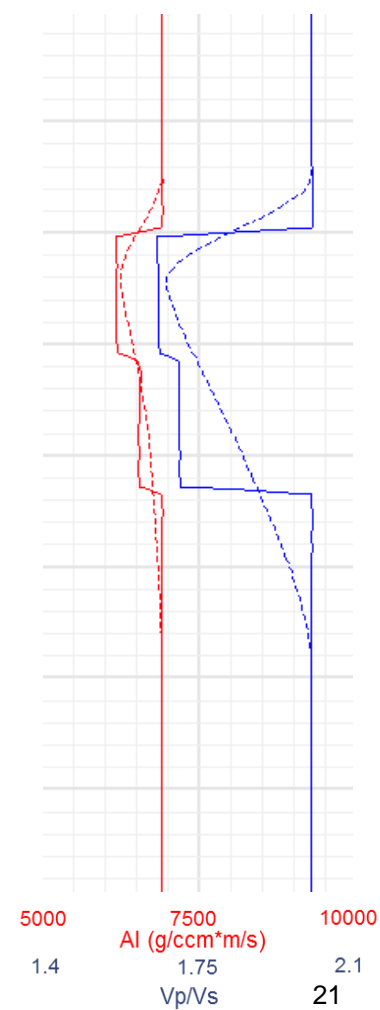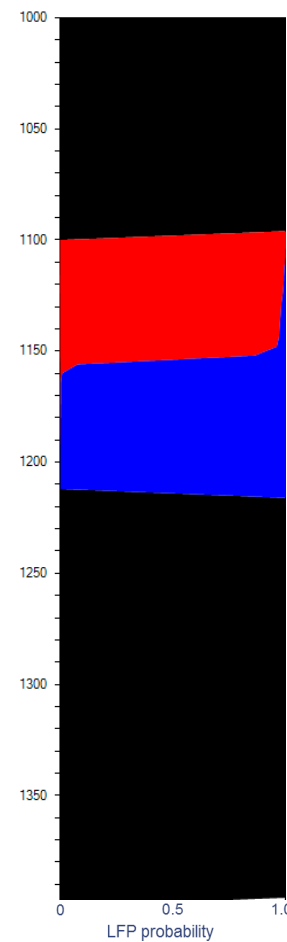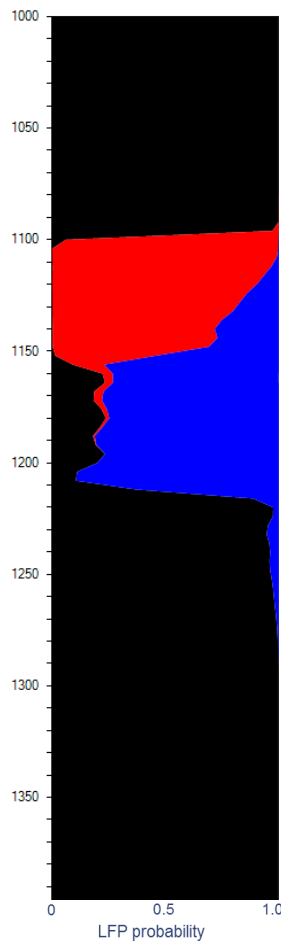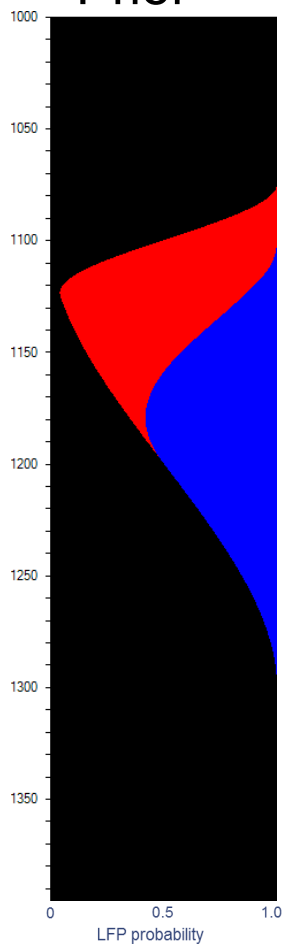
# Inversion results for wedge
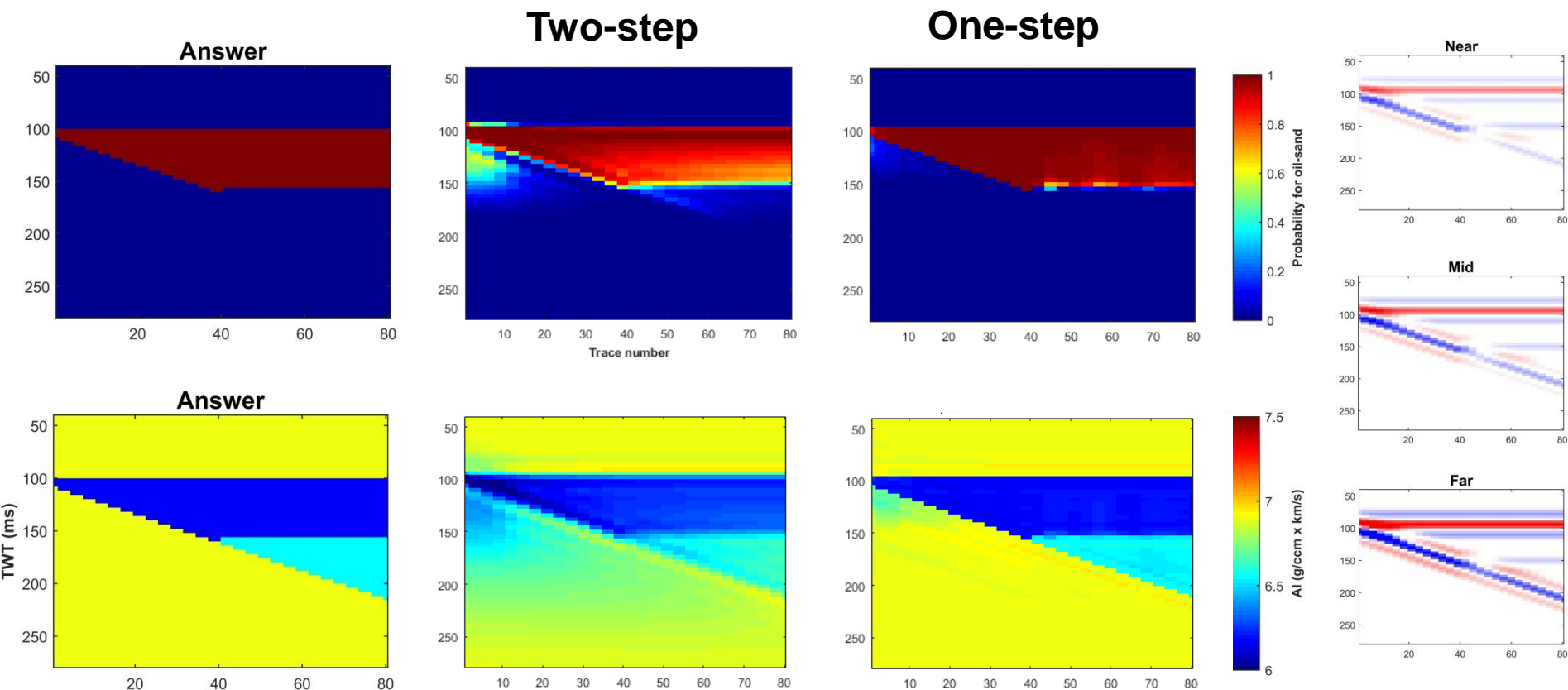
# Summary

| Two-step inverion | One-step inversion |
| --- | --- |
| Pointwise | Neighbourhood |
| No lithology or fluid ordering | Lithology and fluid ordering |
| Facies probability only | Zone and horizon probability |
| Smoother result | Can resolve details below tuning resolution |
| Less detailed background model | More detailed background model |
| Fast | Slower |

NR

# Acknowledgements

► We would like to thank to the researchers working with the GIG consortium and the sponsors of the GIG consortium:

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- Lundin

- Statoil

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