



Probabilistic 4D inversion on Draugen

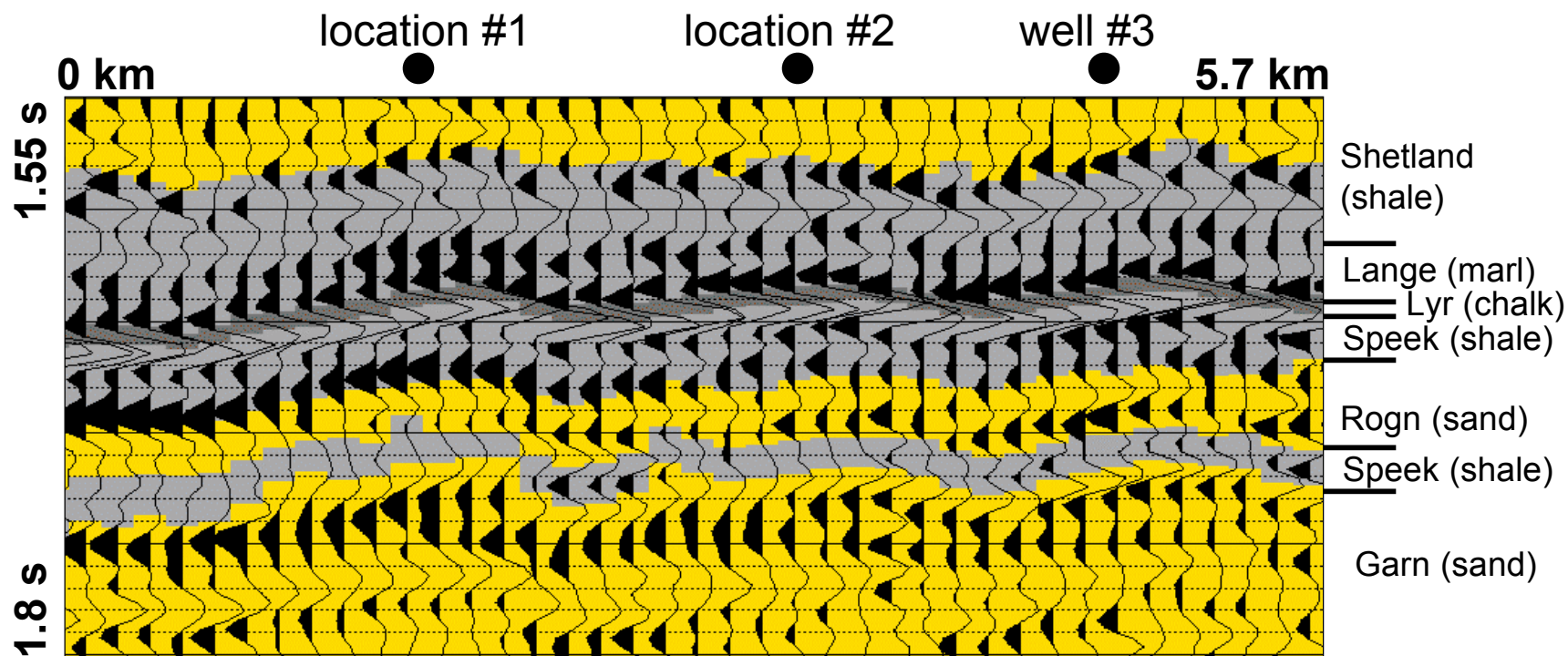
Klaas Koster

Norske Shell

Michael Glinsky and Eldon Sims

Shell E&P Technology Co.

Facies and structure for a key traverse (trk1145)



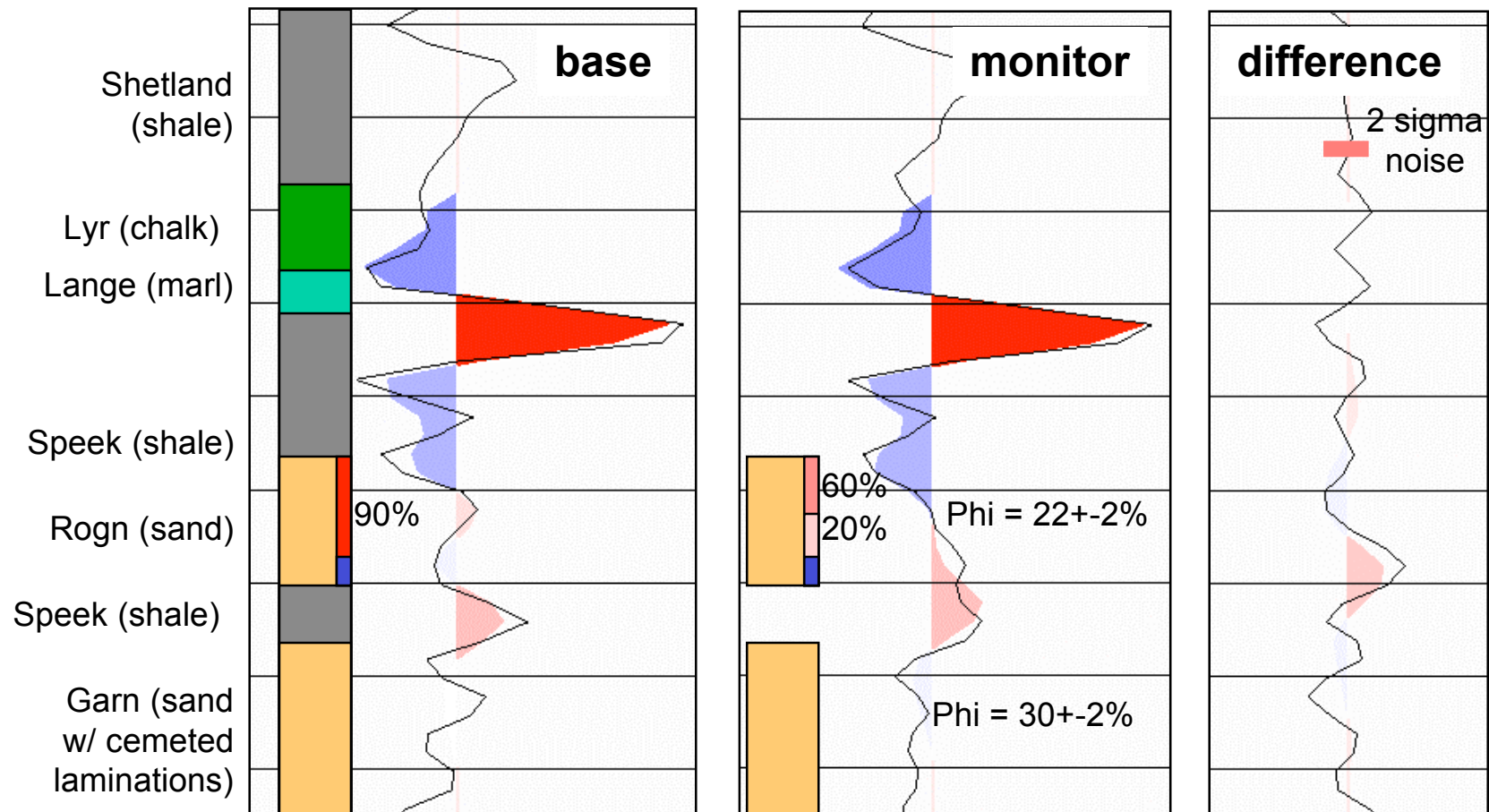
Note: rfc data, SEG polarity

What has been done



- **analysis of petrophysics**
- **stratigraphically blocked to seismic resolution**
- **built initial DepSim model (in time) from GeoCAP model w/ tune up to tie seismic**
- **first true 4D probabilistic inversion**
- **used saturation gradient and non-Gassman produced fluid substitution**

Inversion at trk 1121 bin 1531 (location #2)



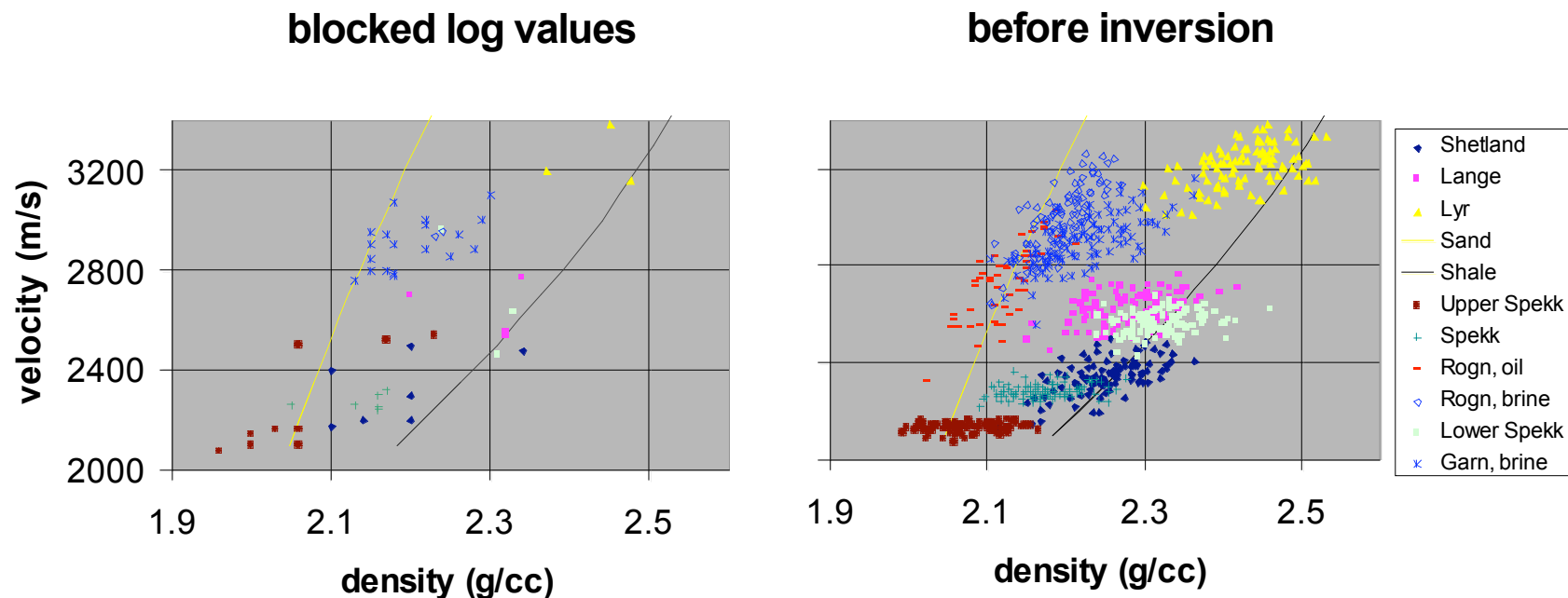
Note: black line = data, blue-red shade = synthetic

Other facts about inversion

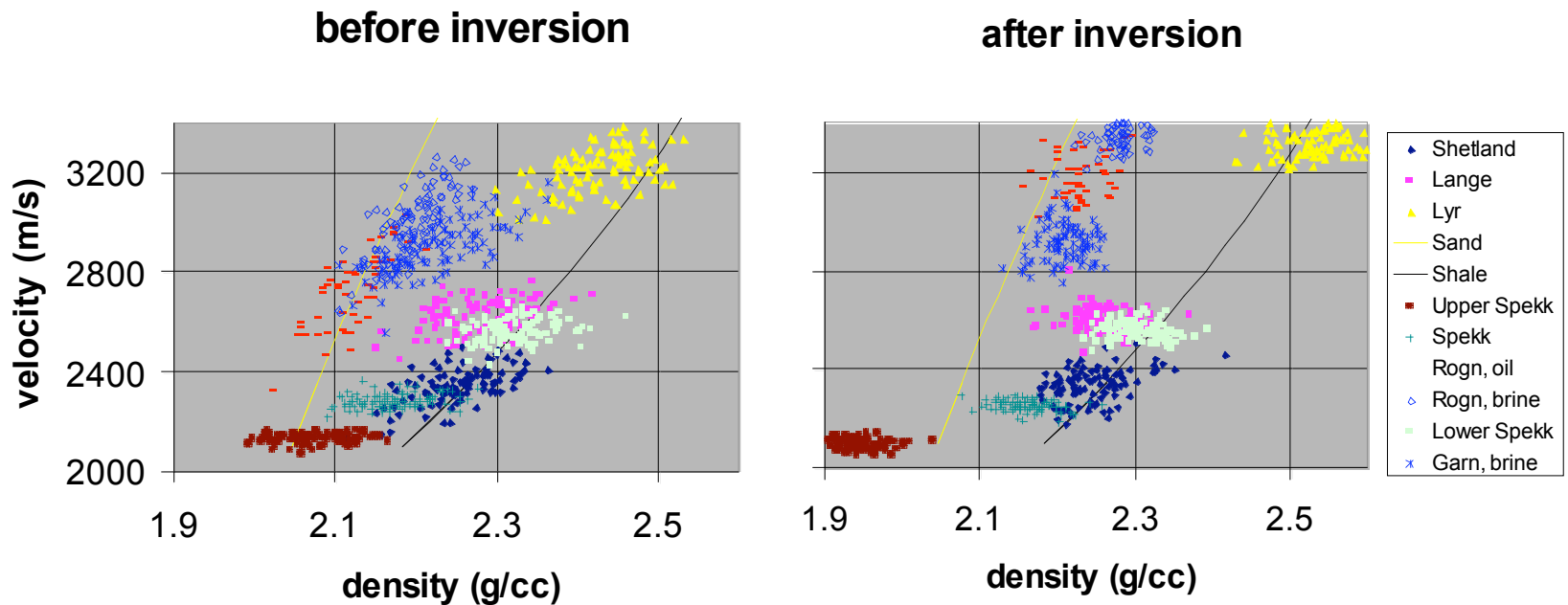


- **ties 6 wells' to within statistical error**
 - thickness
 - porosity
 - fluid fill
- **arrival times standard deviation decreased from >3 ms to <1 ms**
 - top Speek to < 0.5 ms
- **impedance standard deviation decreased 20-40%**

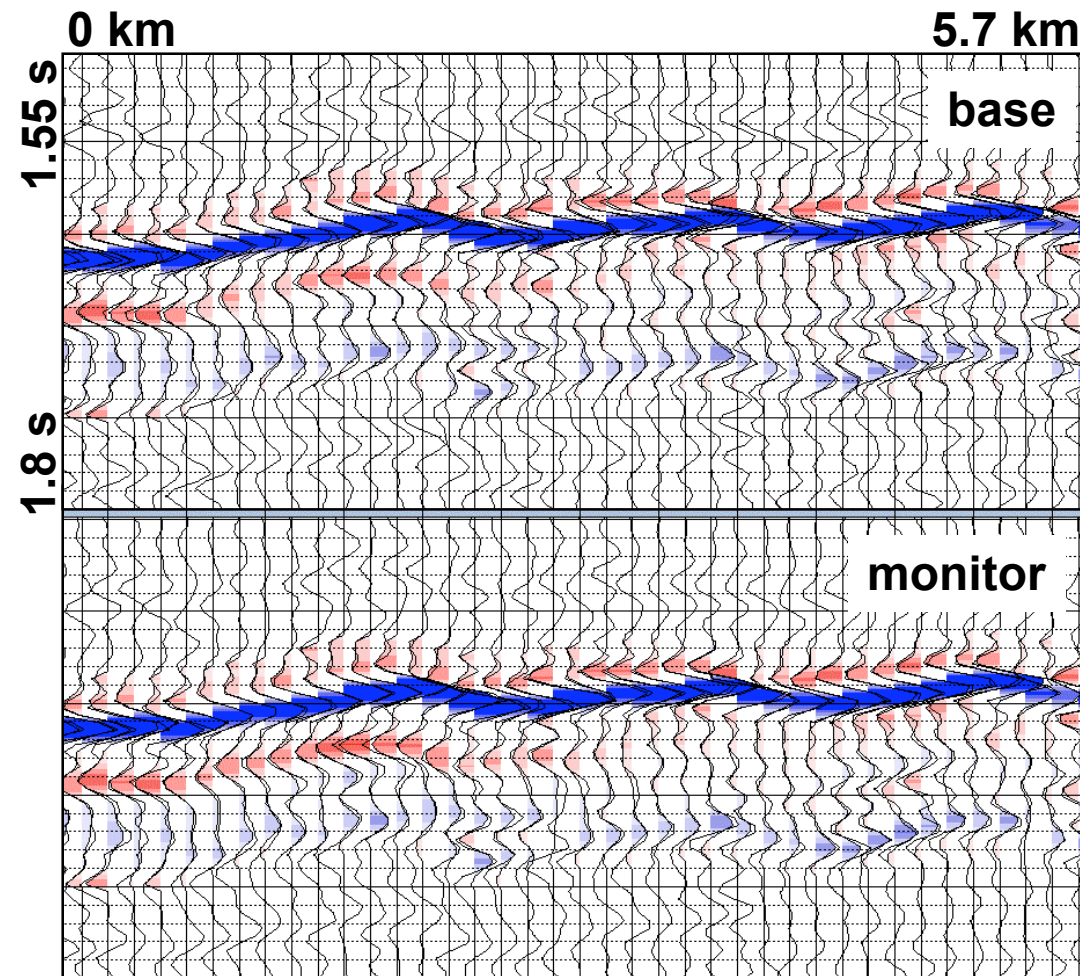
Well logs blocked at seismic resolution used to determine petrophysical trends



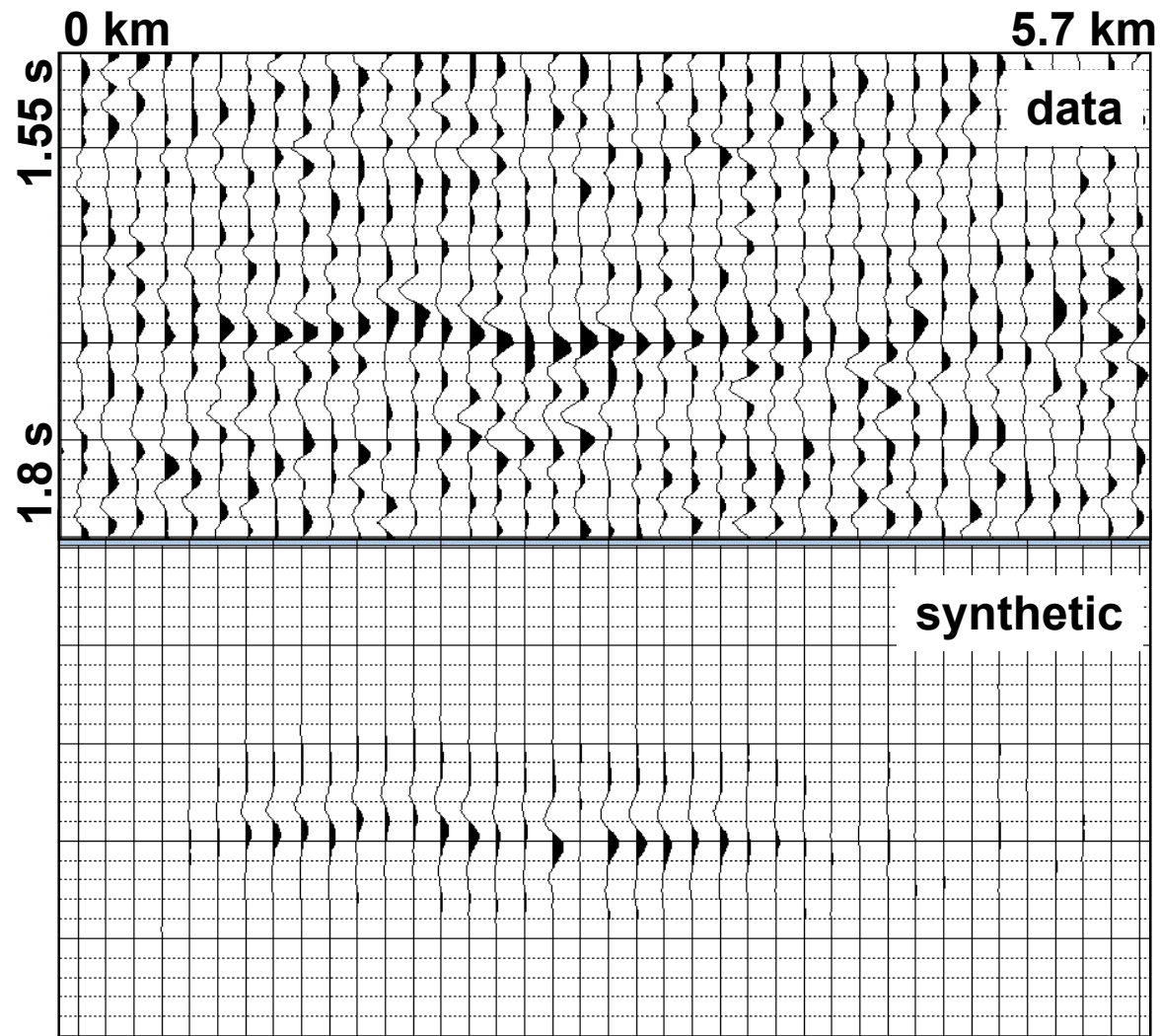
Inversion tightens clouds in density-velocity space



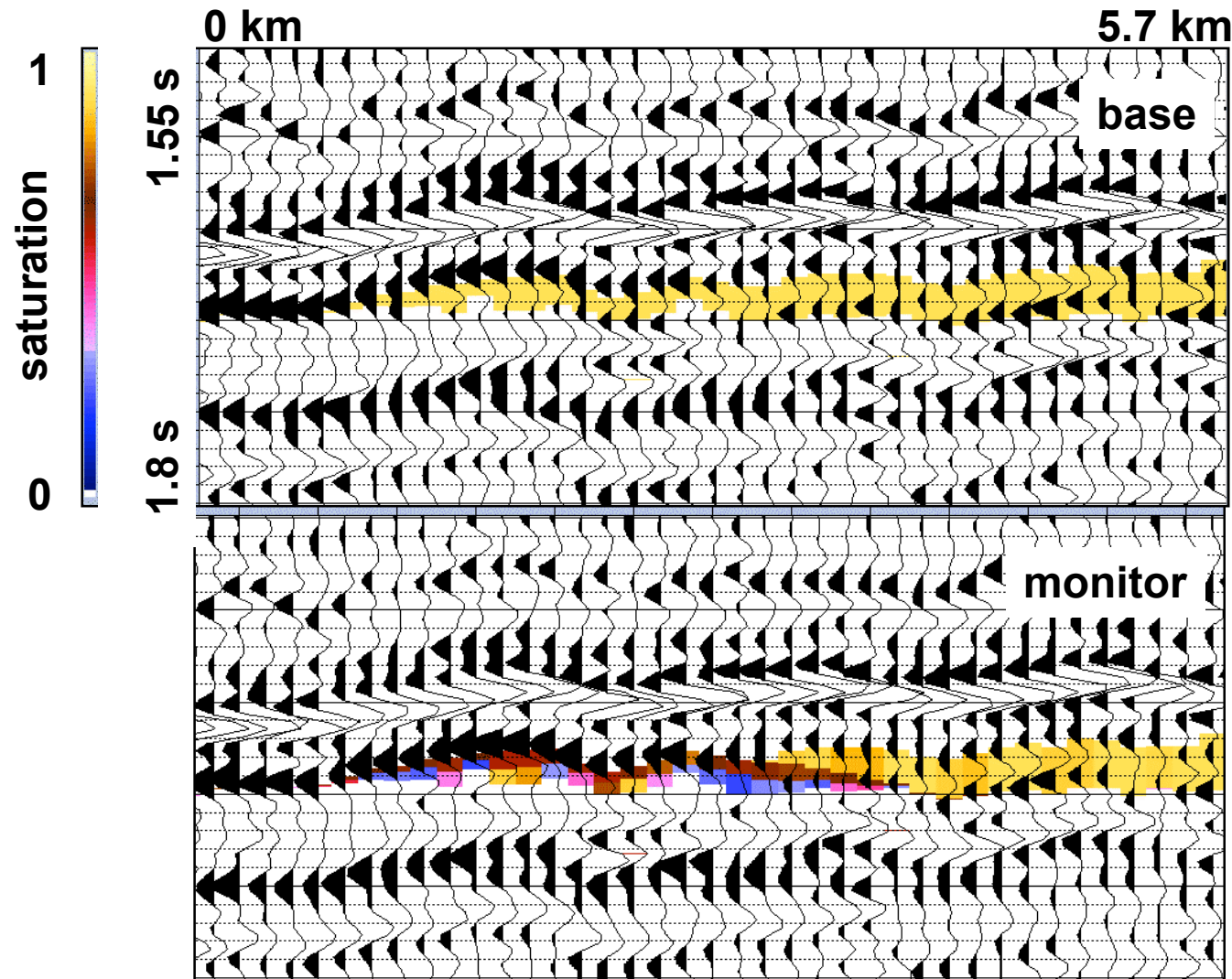
Fit of average synthetics to seismic data



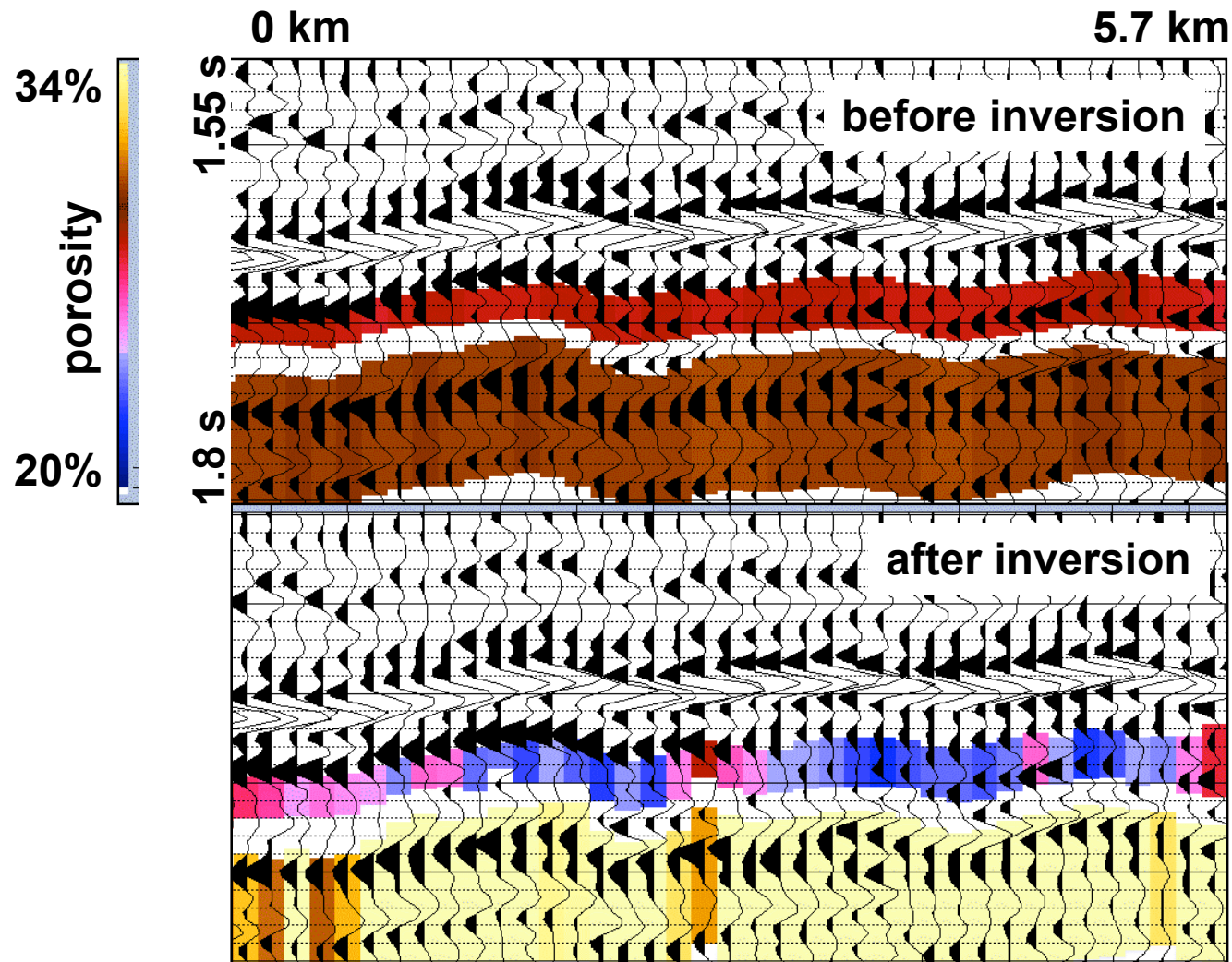
Seismic difference volumes



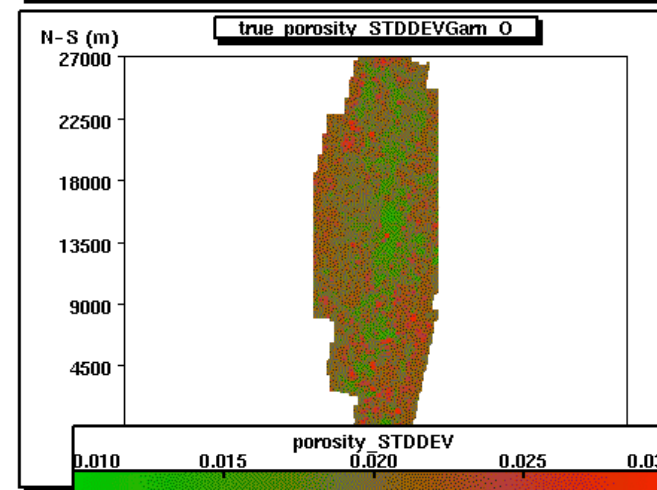
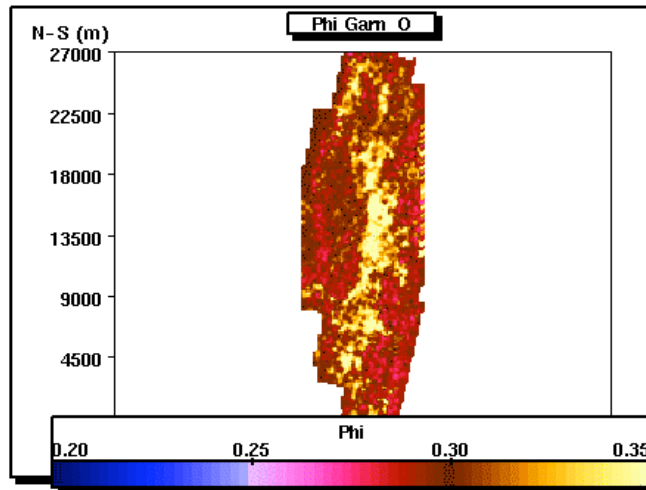
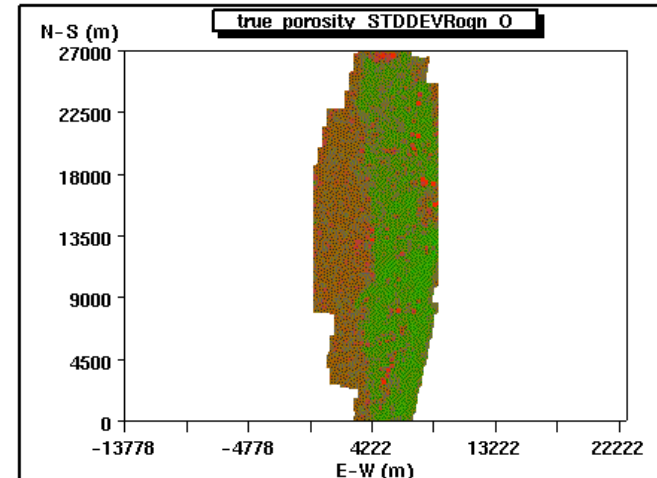
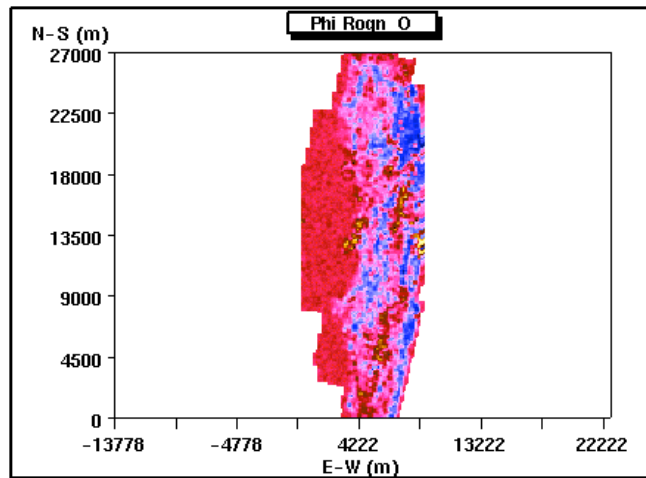
Saturations before and after production



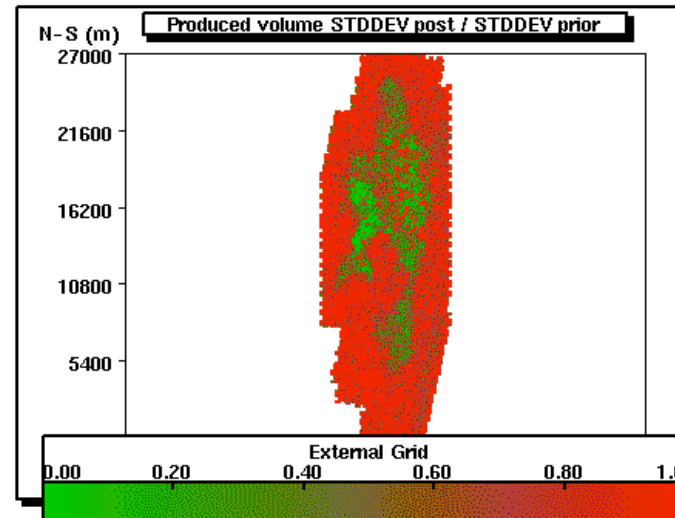
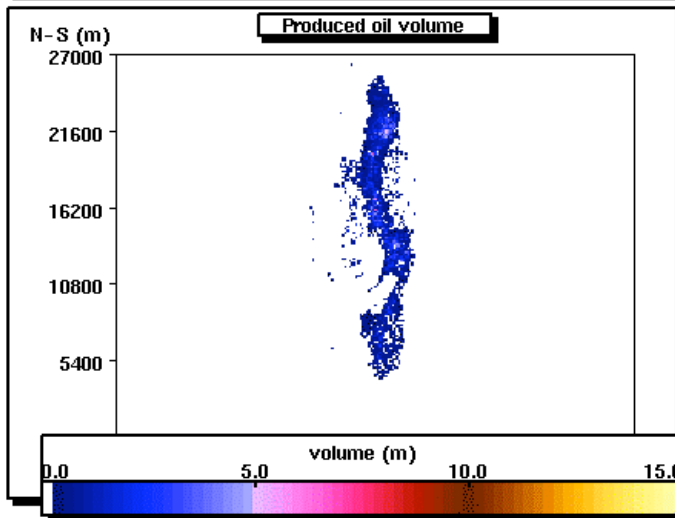
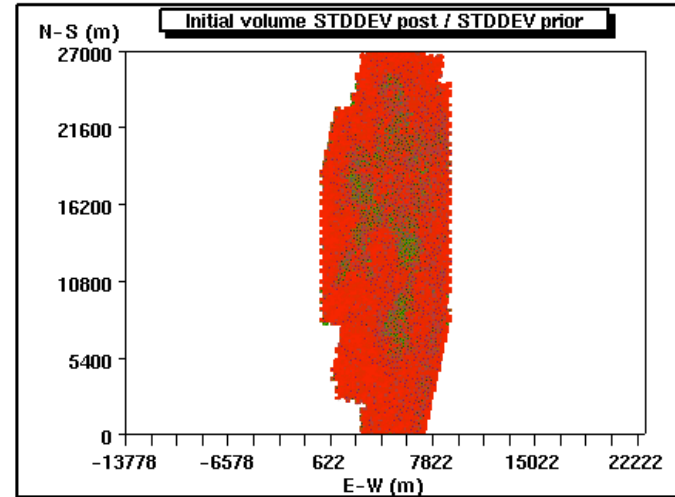
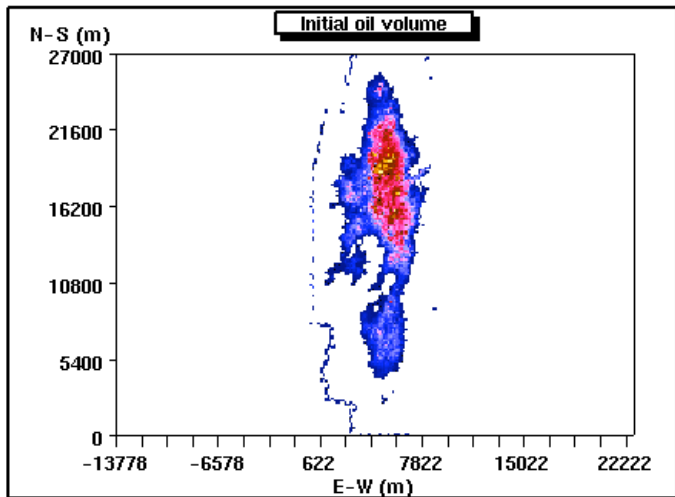
Porosity cross section before and after inversion



Porosity maps show significant structure



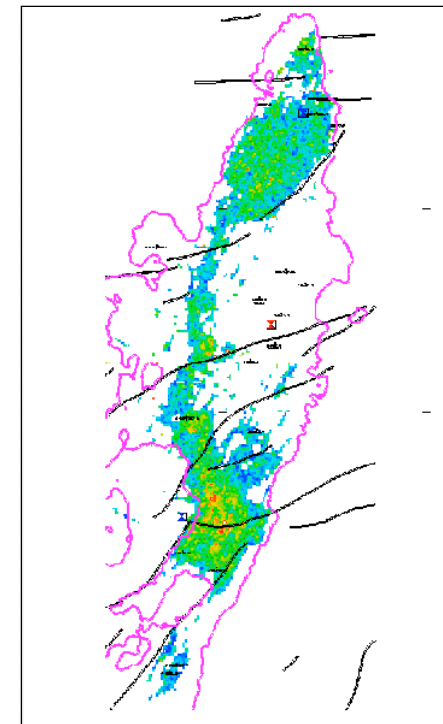
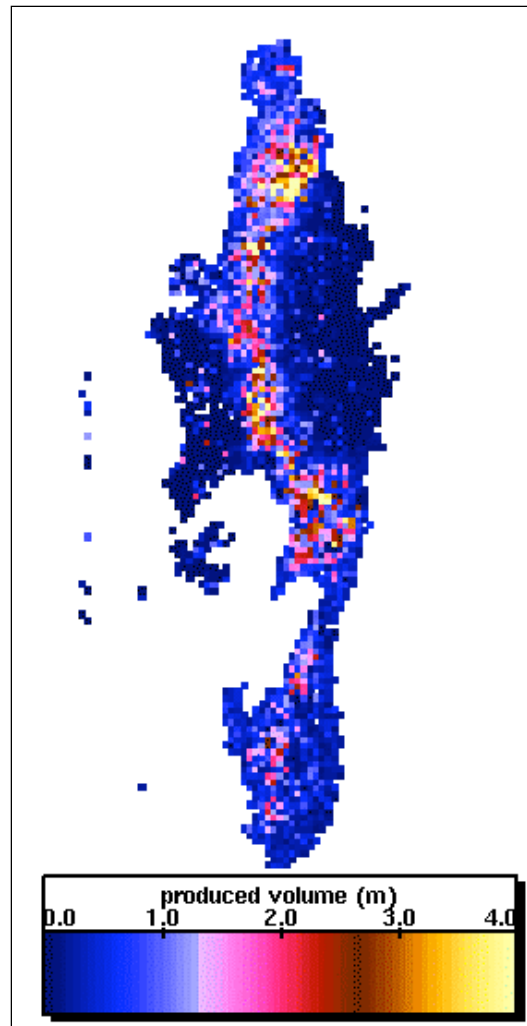
Maps of initial and produced volumes



Map of produced volume

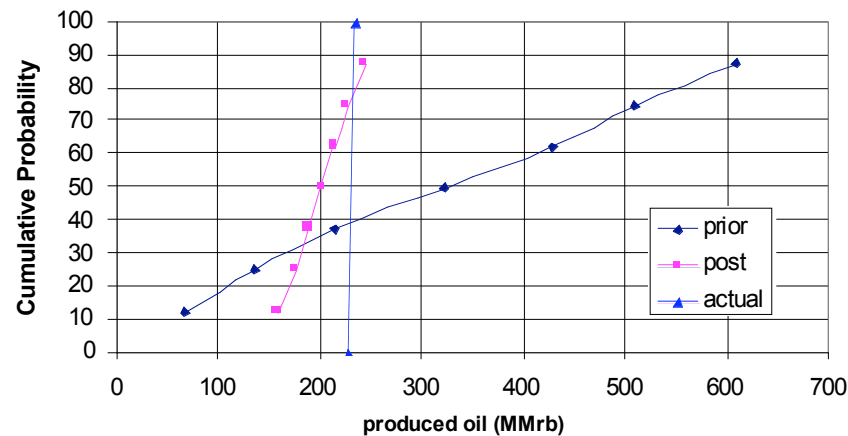
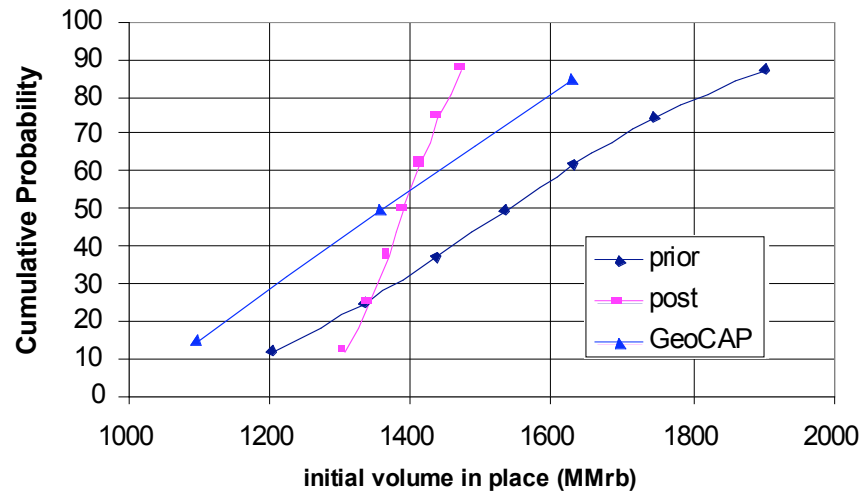


PROMISE average
produced volume,
values shown where
OIIP was > 1 m

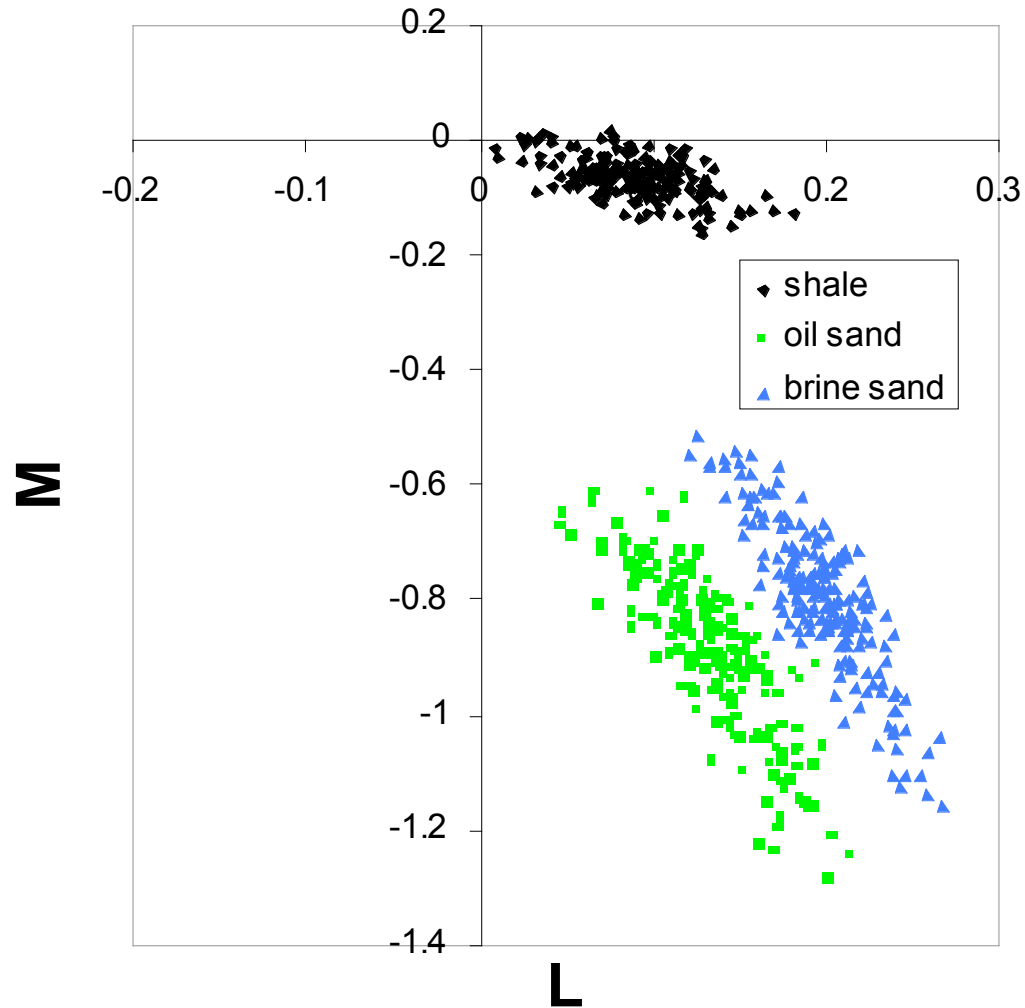


interpreted difference
with wells, faults and
original OWC; rotated
27 degrees

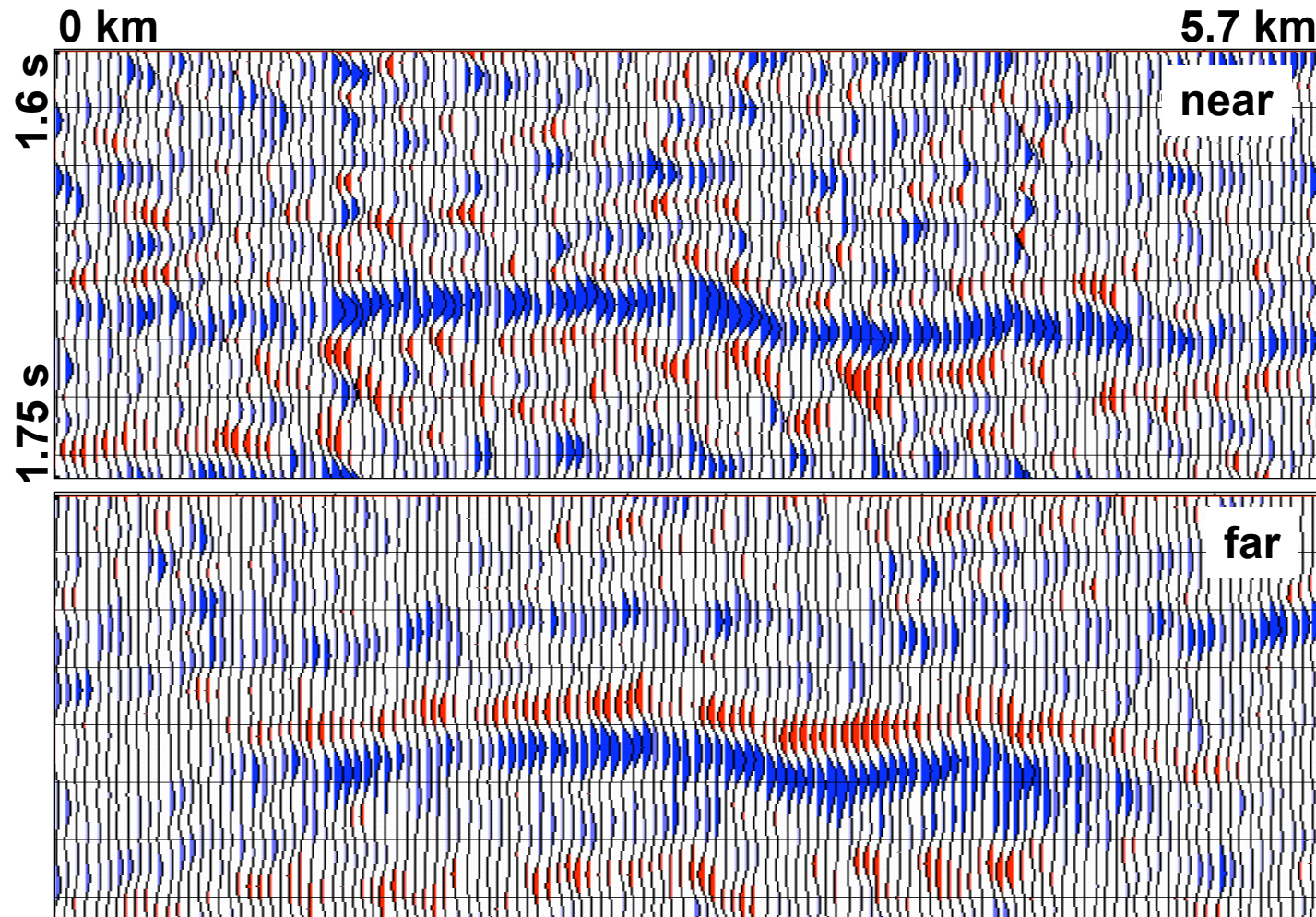
Inversion improves bounds on volumetrics



What could be the value of AVO?



What does the AVO data look like?



raw RFC difference stacks

What's ahead



- **4D-AVO, simultaneous 4 stack inversion**

Value of accelerated production



Draugen Production Rate

