Bayesian inversion whispers

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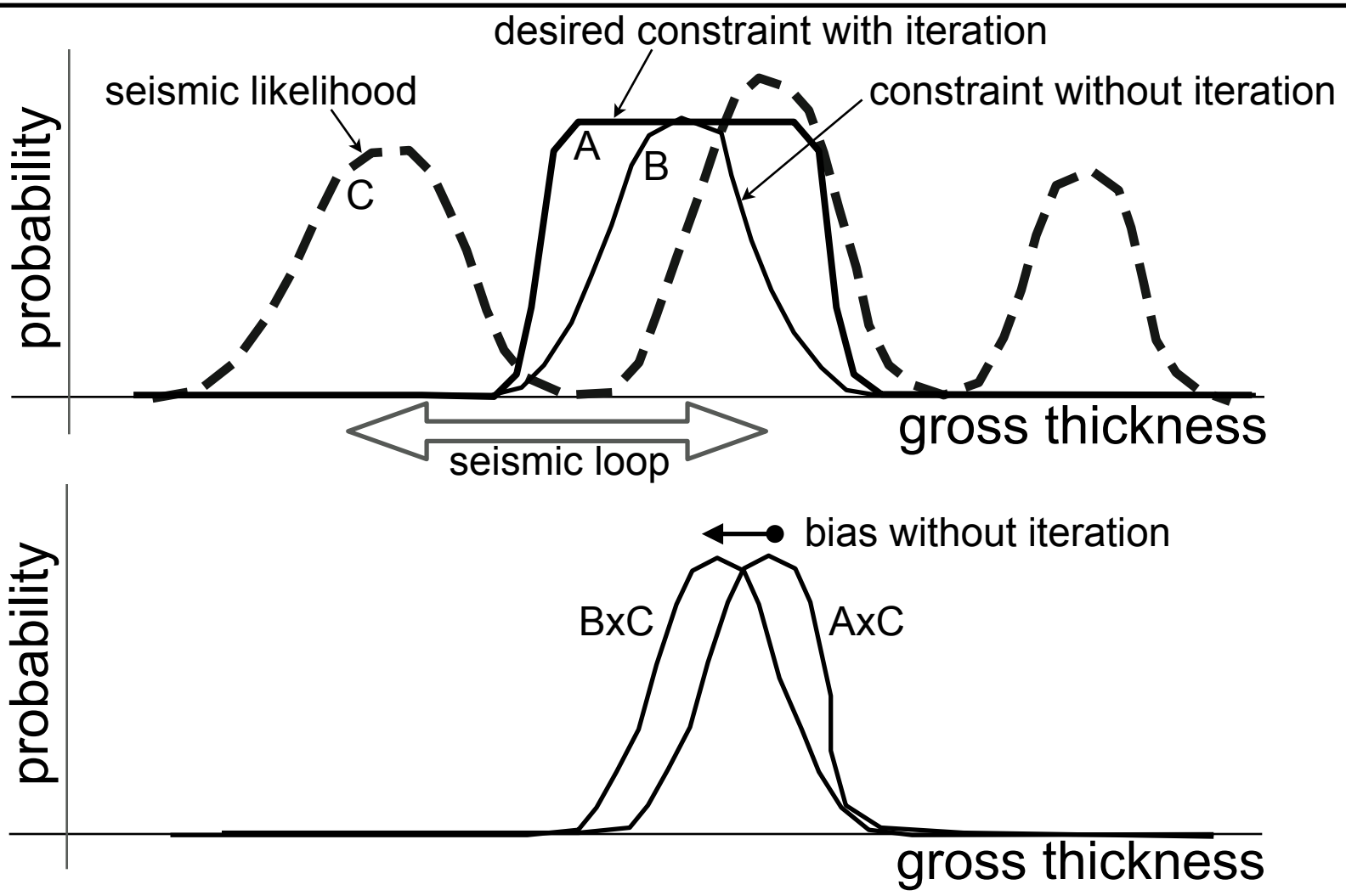
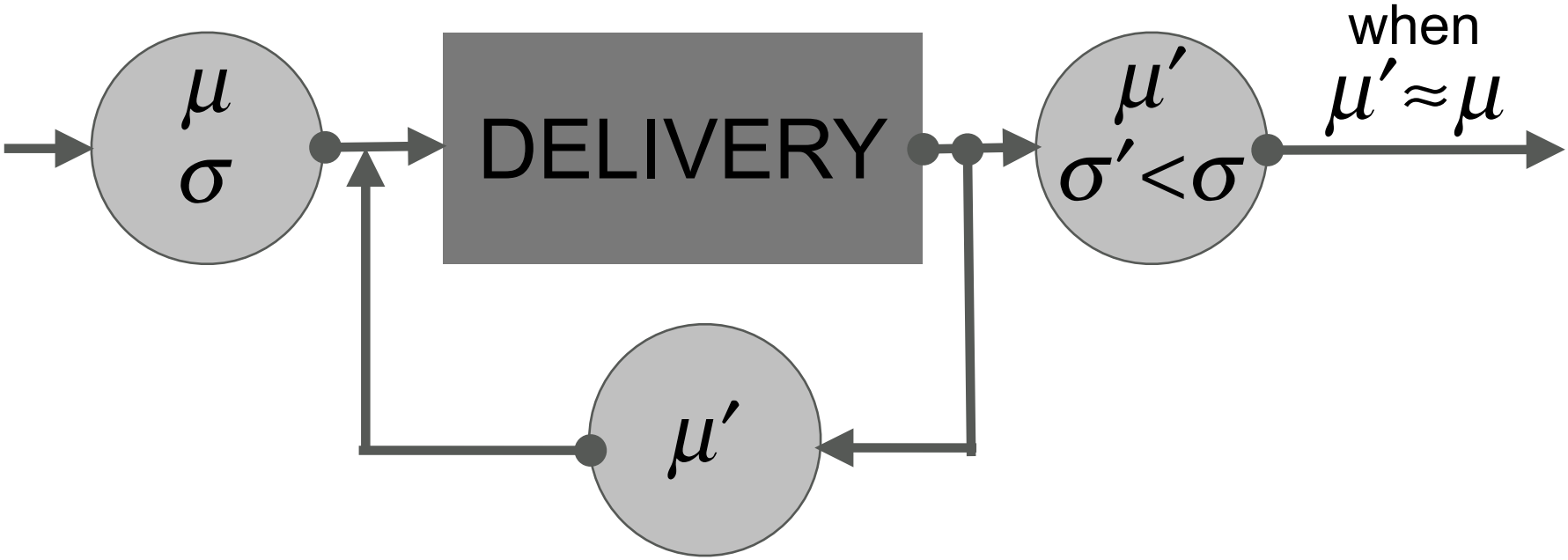
Outline

- the problem
  - how to remove the bias of pre analysis opinion when sand reflectors are near the noise level
- the solution
  - iterative Bayesian inversion, that is feed the output back in as the input (make the program consume its own droppings)
- the model
  - a soft sand wedge in a hard shale background
- the real world example
  - Glenridding, near field Stybarrow development

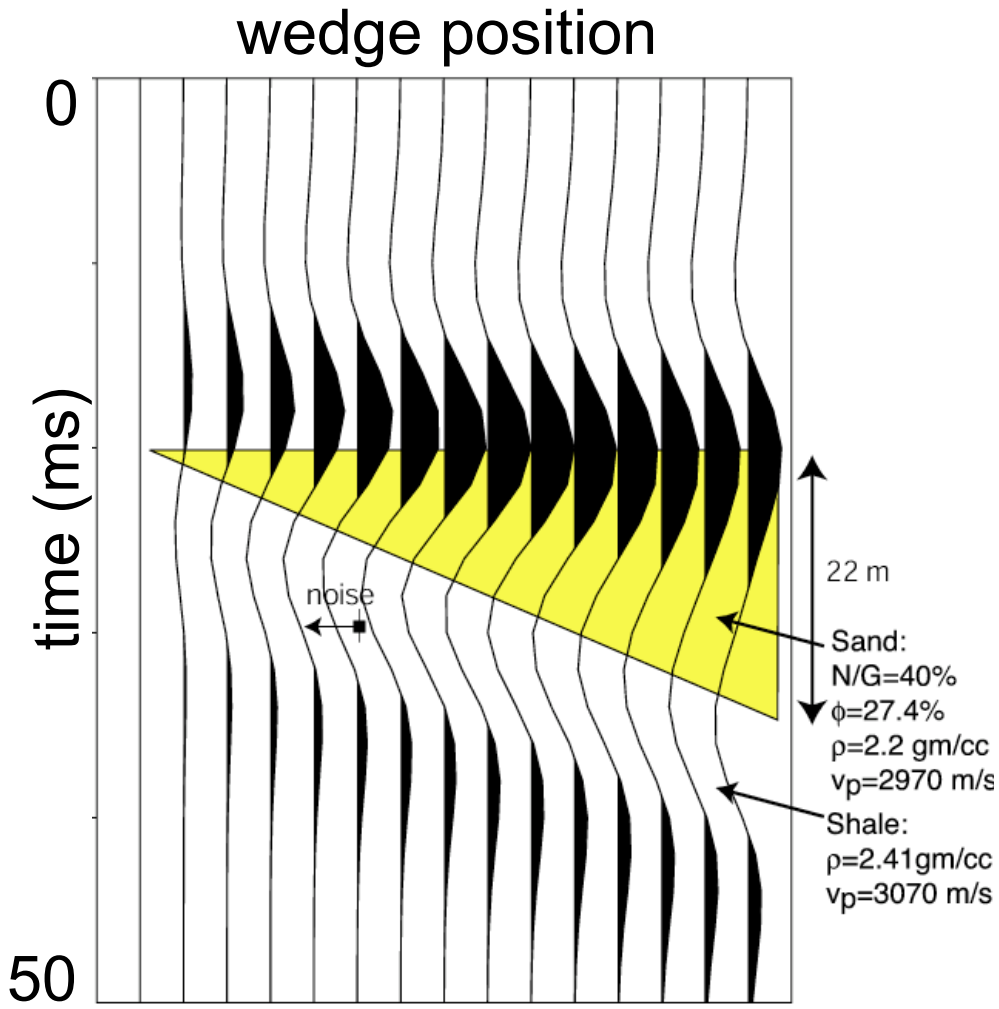
The problem


desired constraint with iteration
seismic likelihood
constraint without iteration
probability
A
B
C
gross thickness
seismic loop
bias without iteration
probability
BxC
AxC
gross thickness

The solution

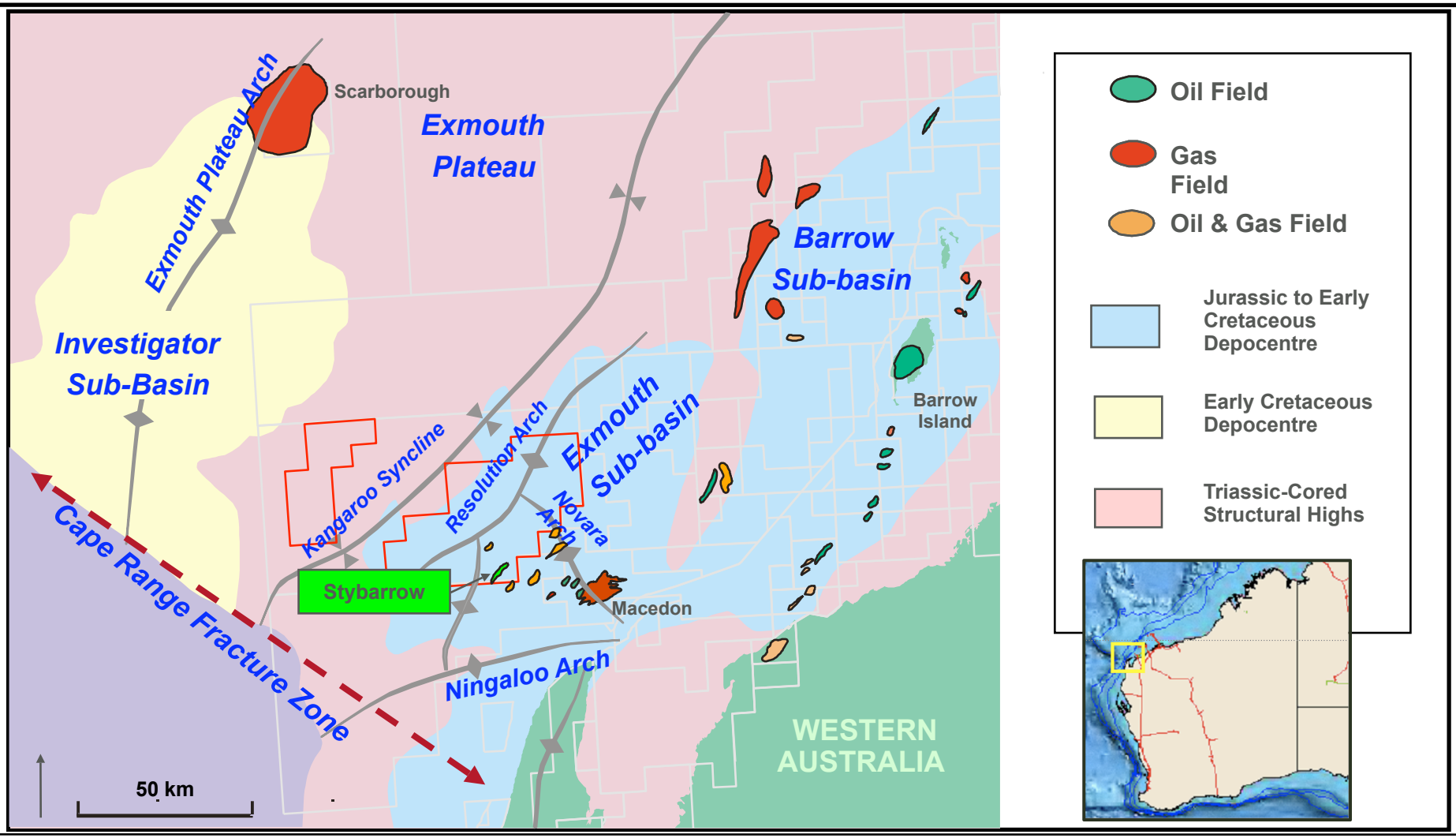


The model

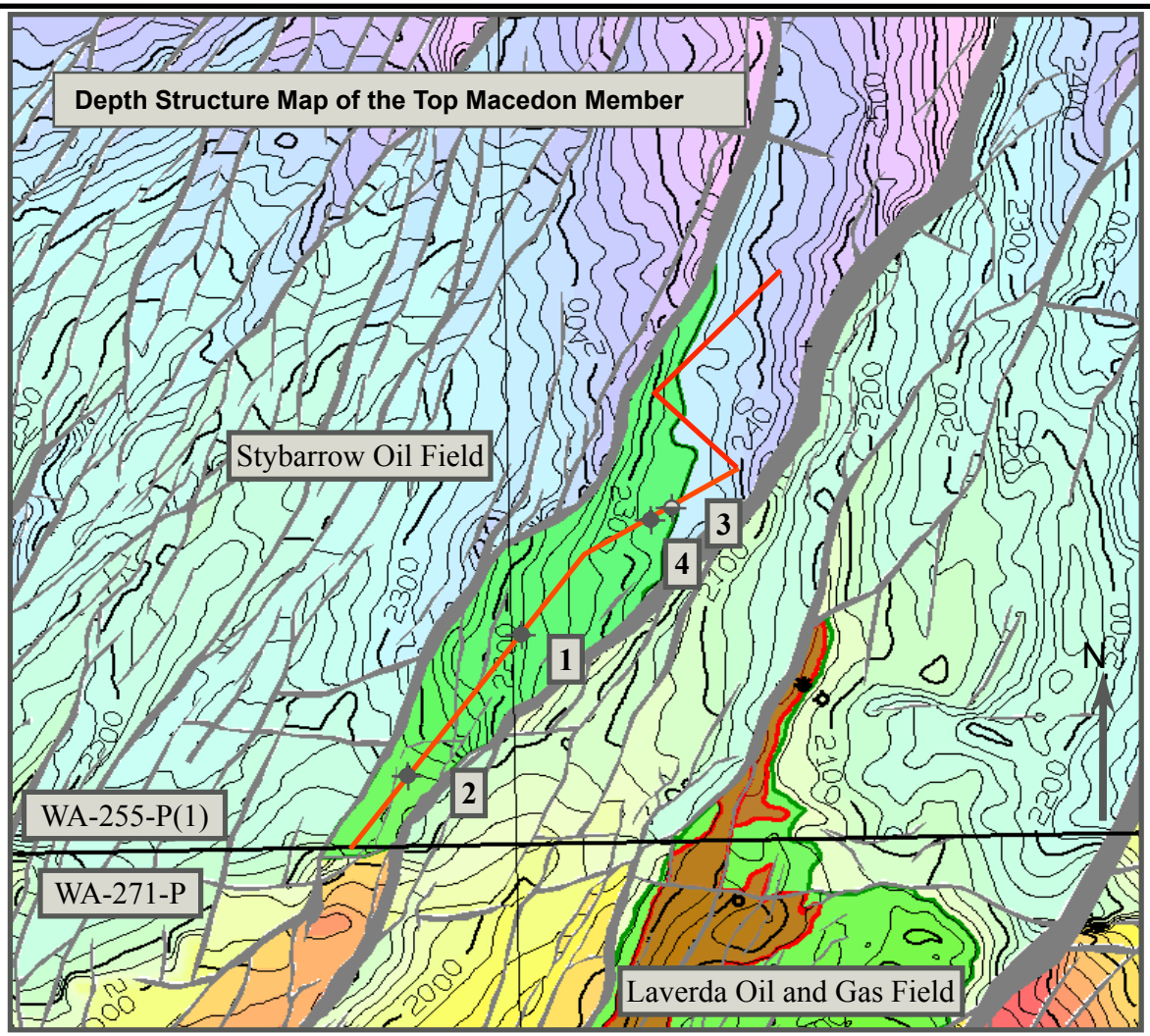

wedge position
0
time (ms)
50
noise
22 m
Sand:
N/G=40%
ϕ=27.4%
ρ=2.2 gm/cc
vp=2970 m/s
Shale:
ρ=2.41gm/cc
vp=3070 m/s

Iterative inversion on wedge model converges to correct result

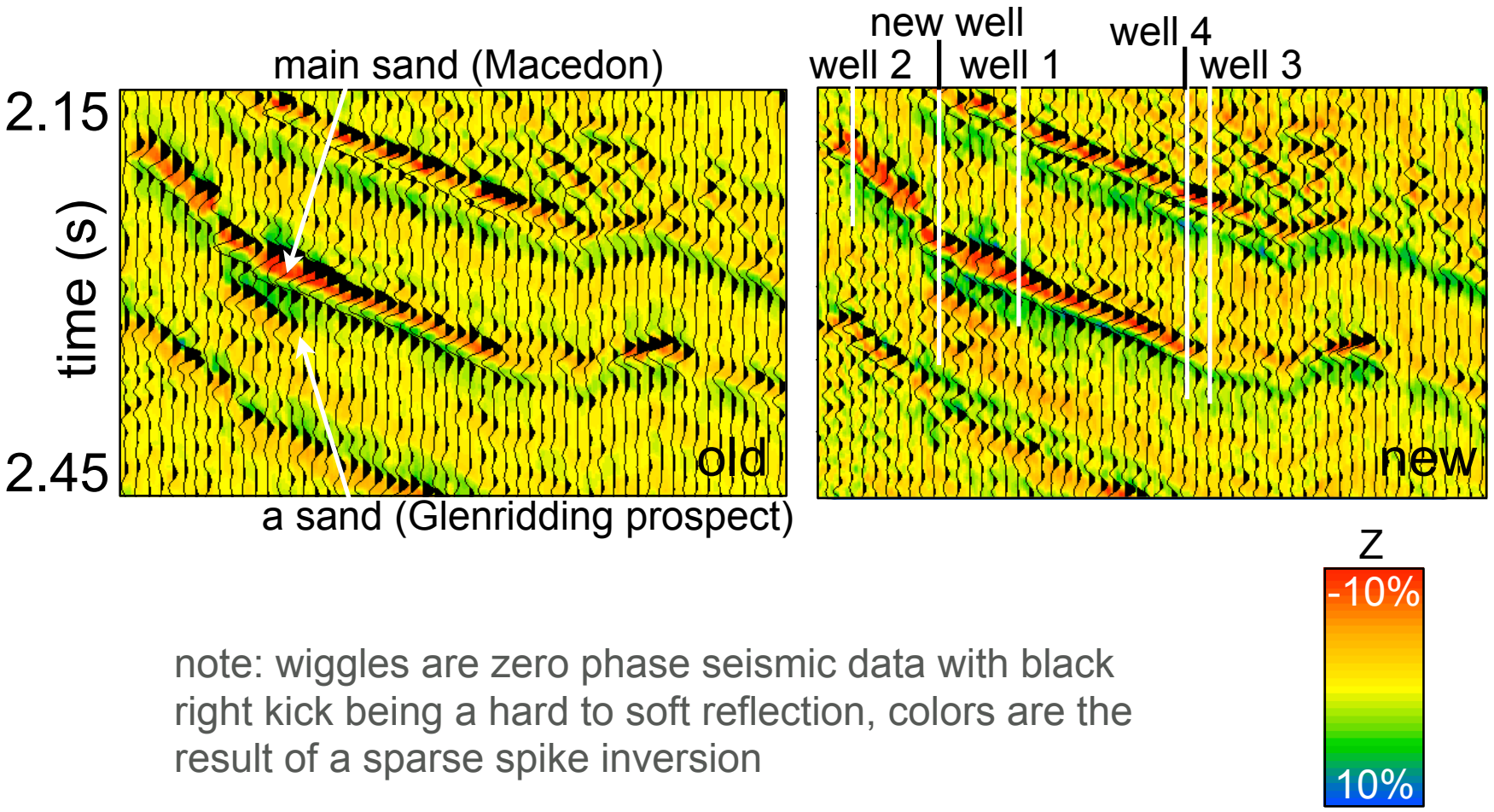
The real world example



Map of Stybarrow field showing arbitrary cross section

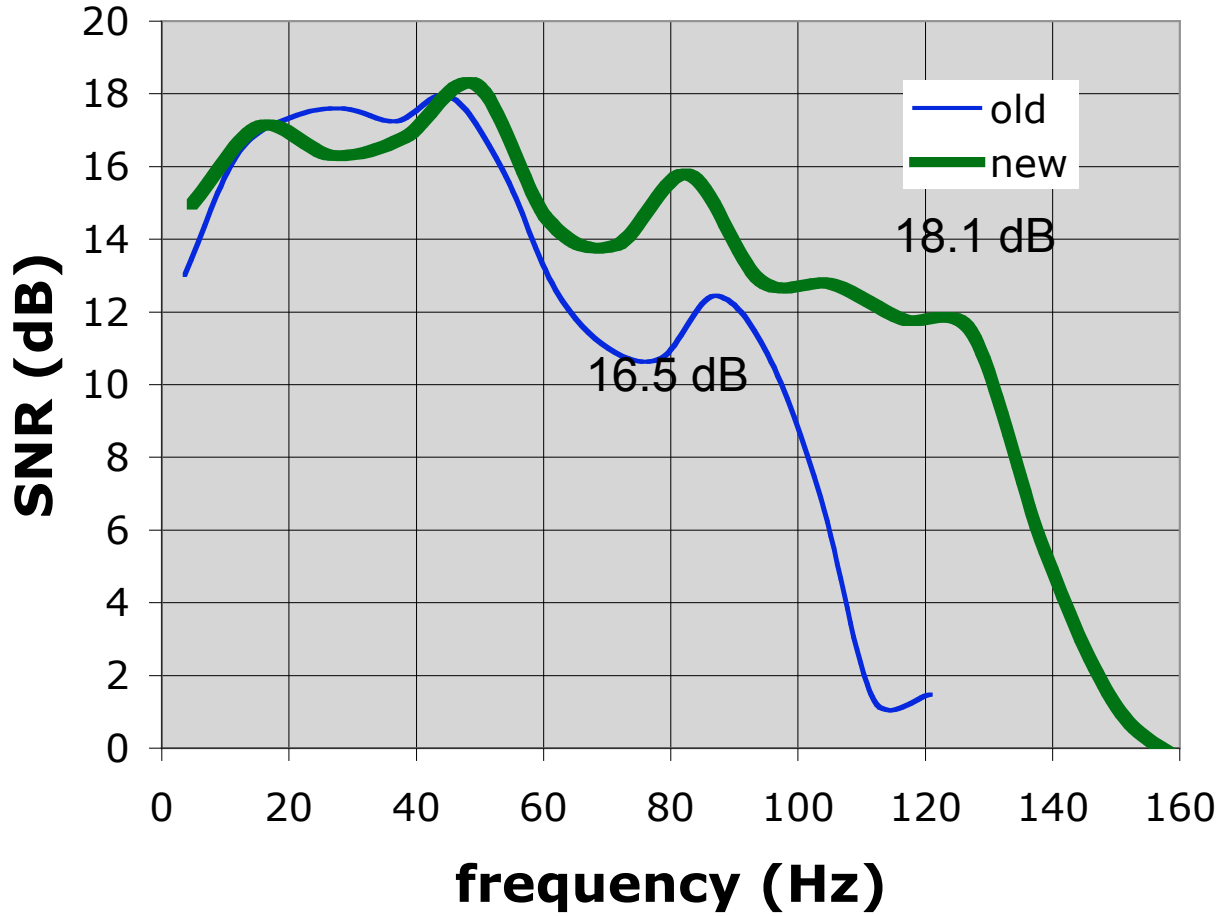


Arbitrary cross section through Stybarrow field

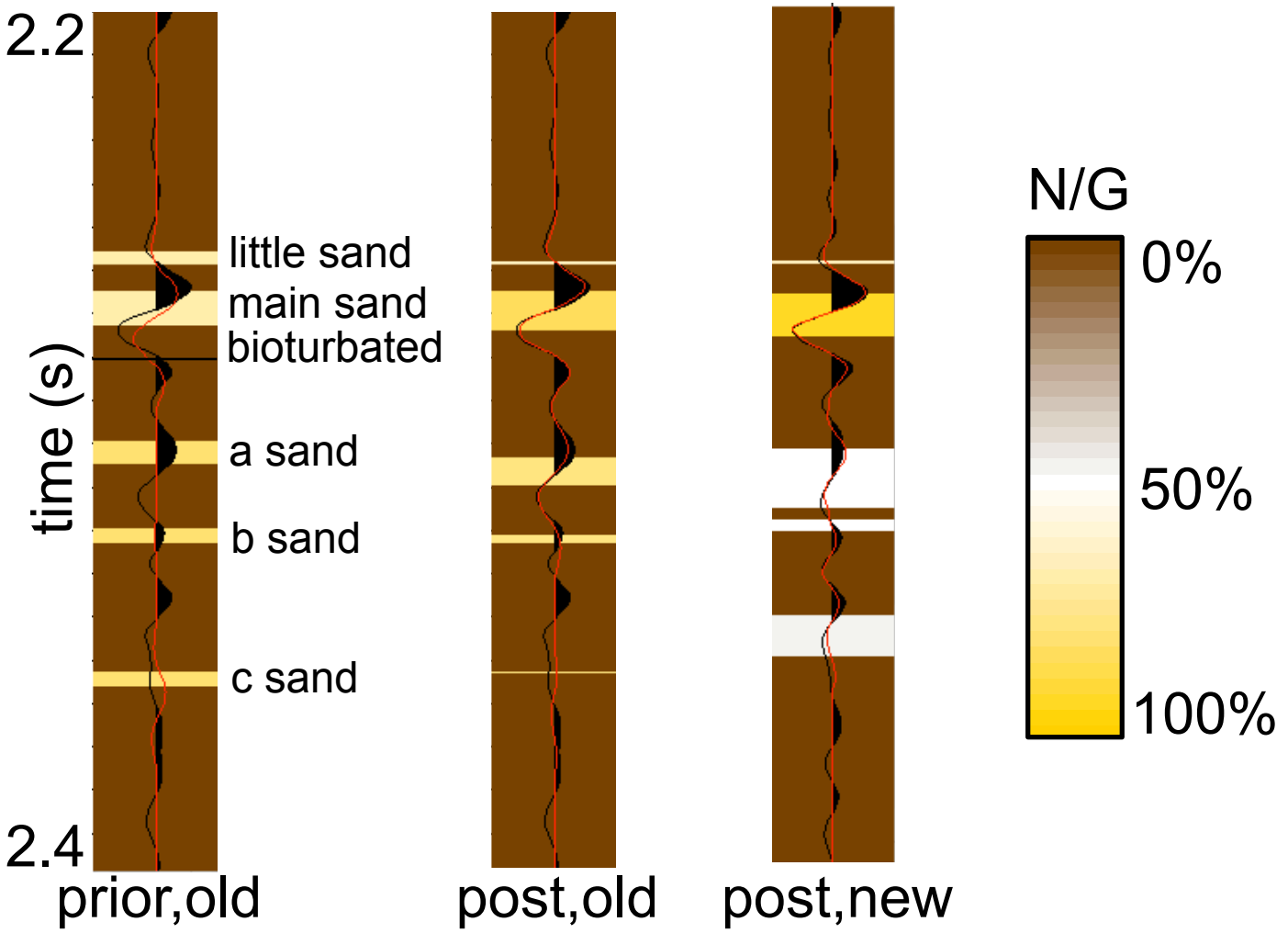


note: wiggles are zero phase seismic data with black right kick being a hard to soft reflection, colors are the result of a sparse spike inversion

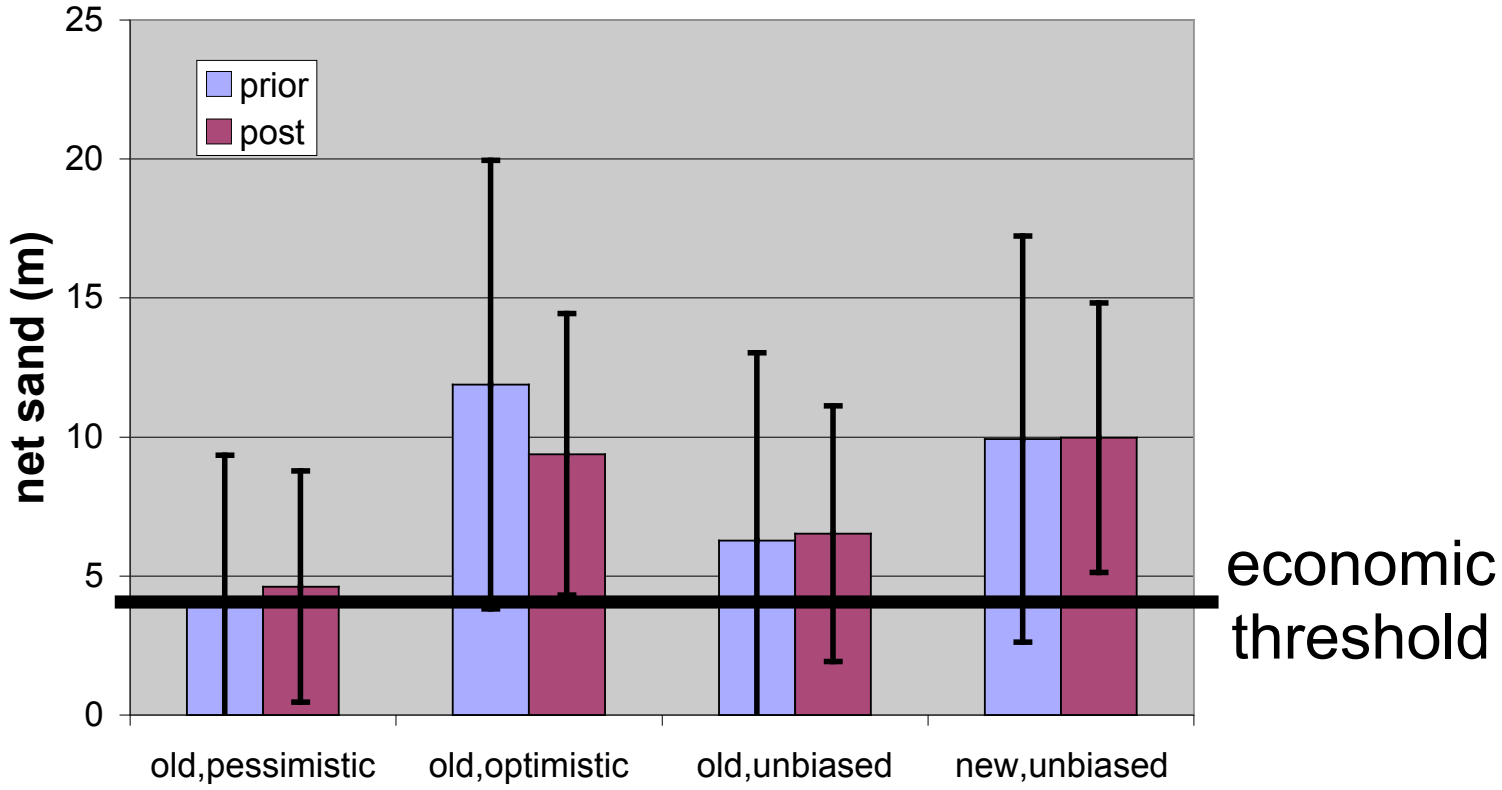
Reprocessed data has more useful bandwidth



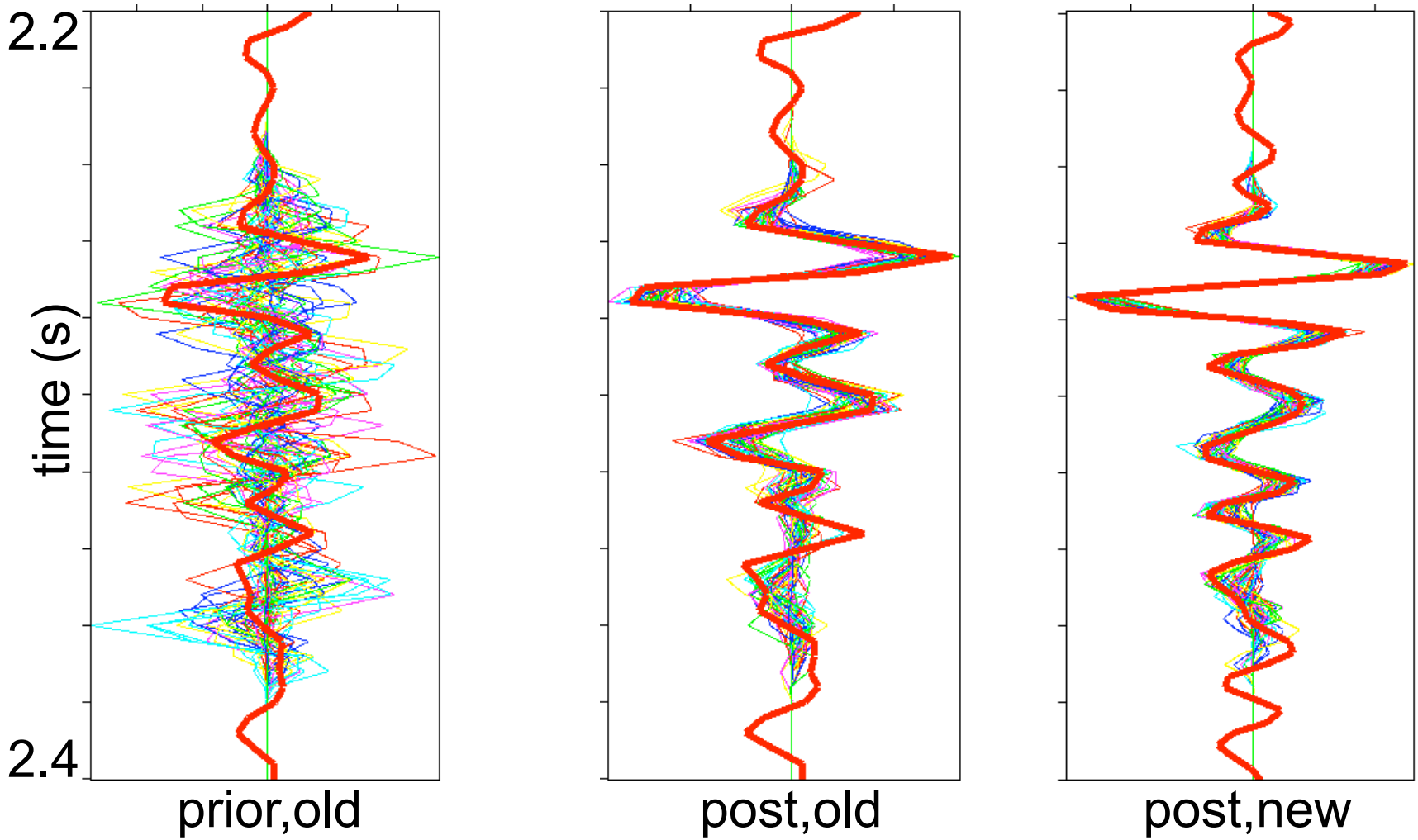
Mean models before and after inversion



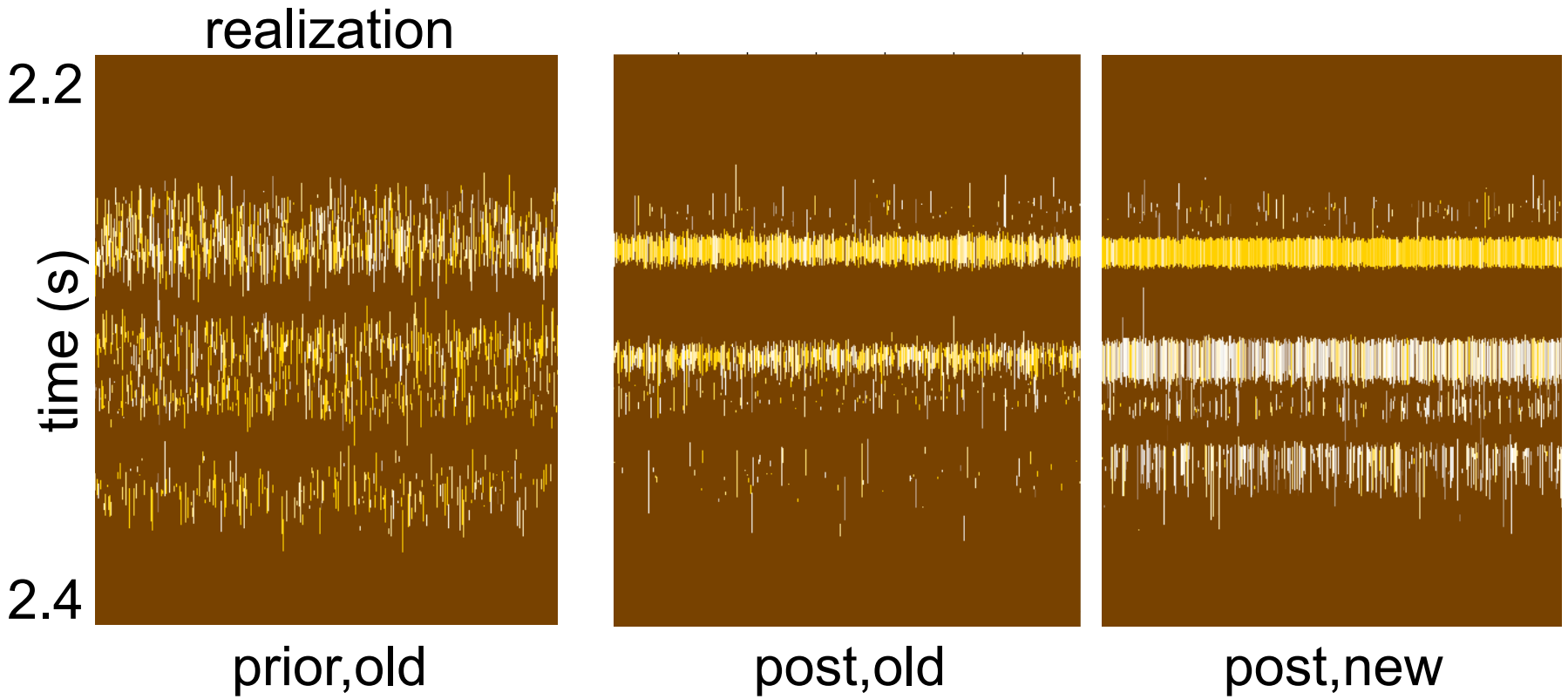
Iterative inversion along with reprocessing of data show high probability economic volume



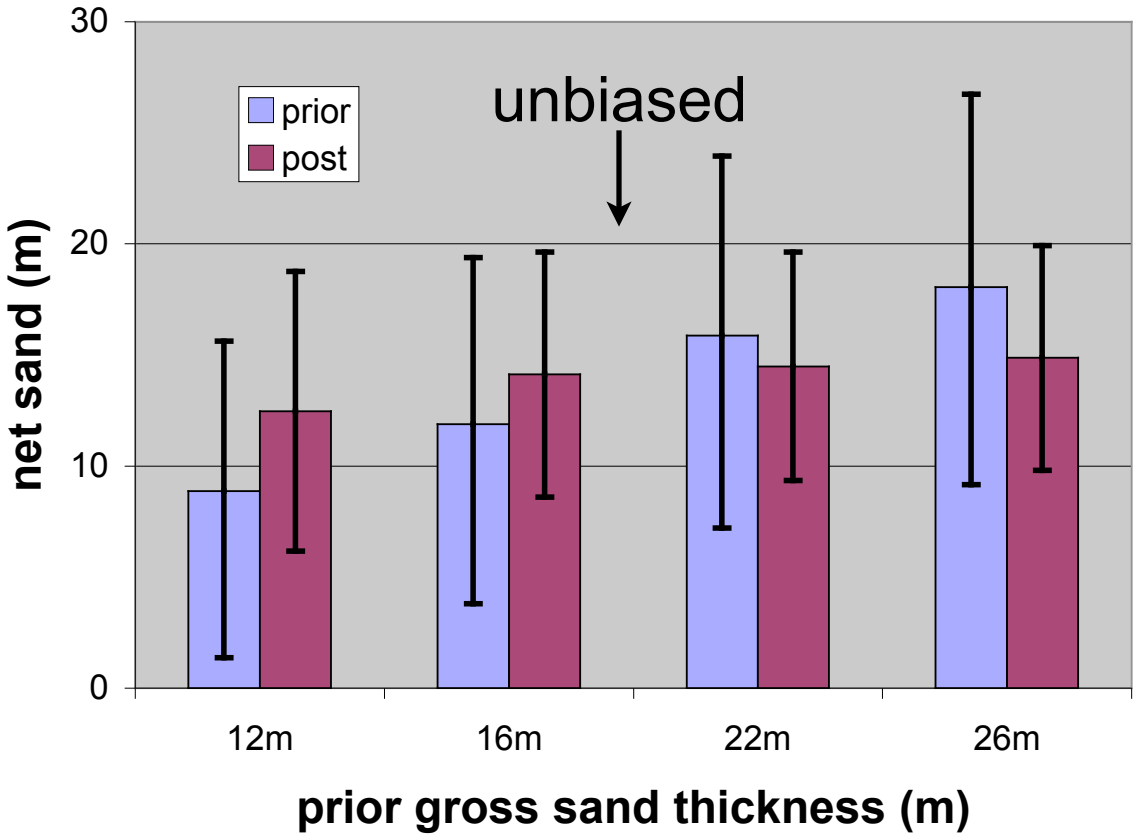
Inversion causes model synthetic to match seismic to within noise level



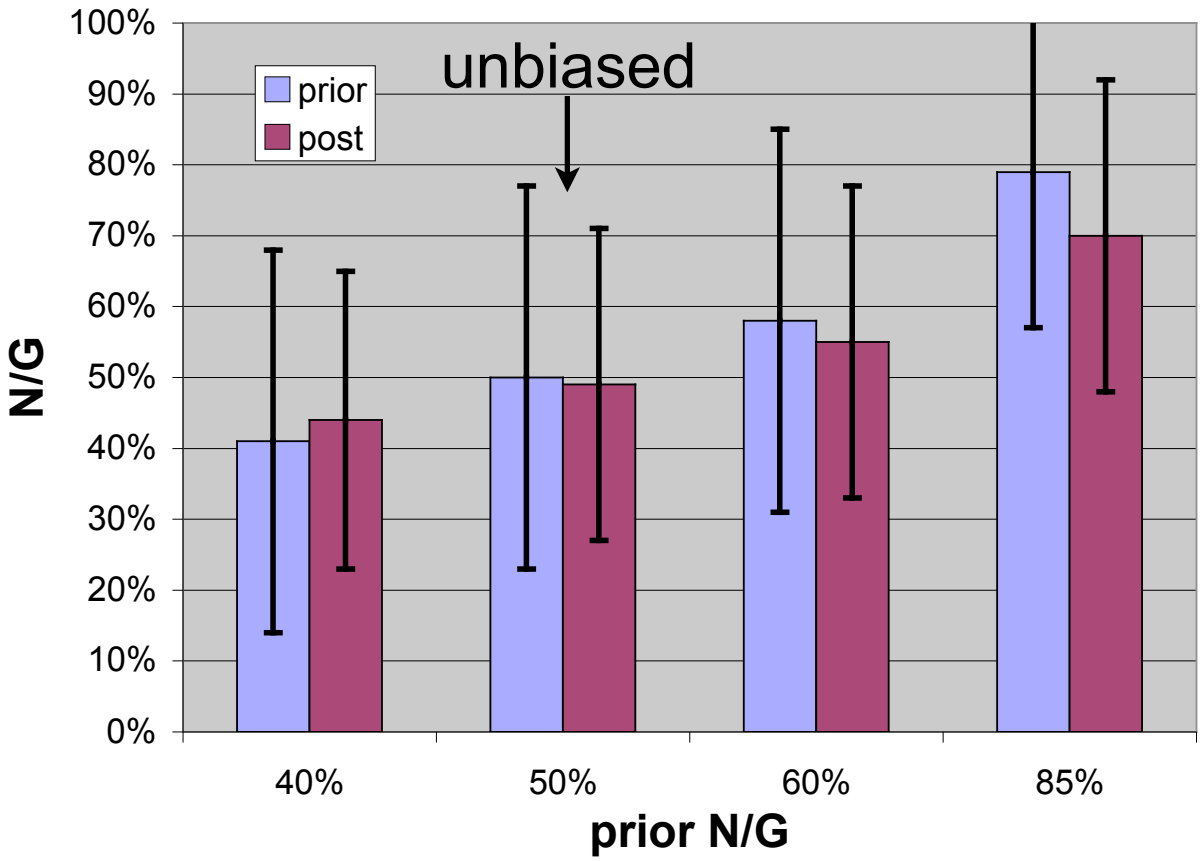
Reprocessing of data reduced the uncertainty and brought Glenridding into focus



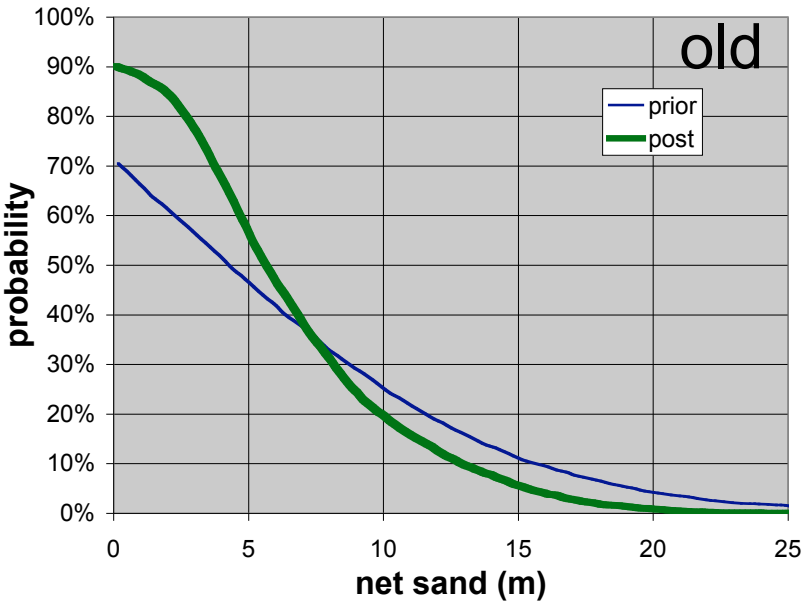
How iterative inversion determines gross thickness

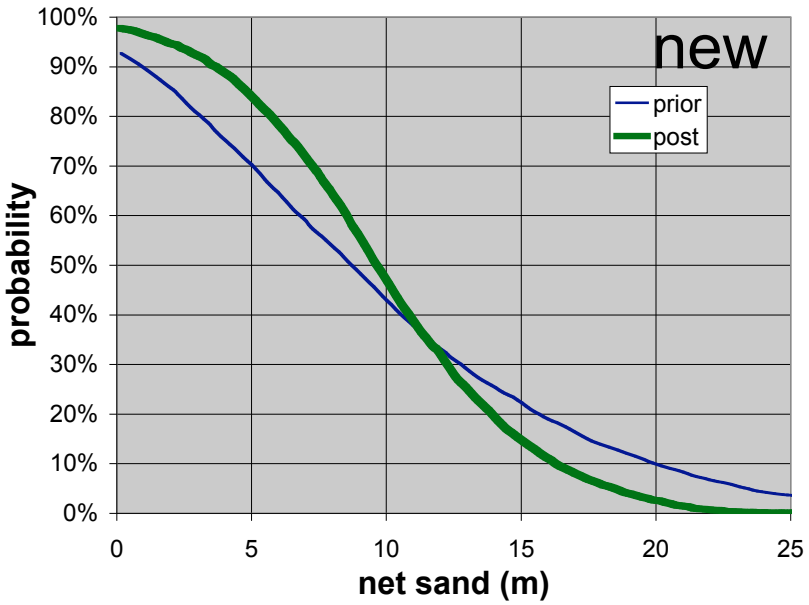


How iterative inversion determines N/G



Reprocessing of data lead to more optimistic net sand distribution



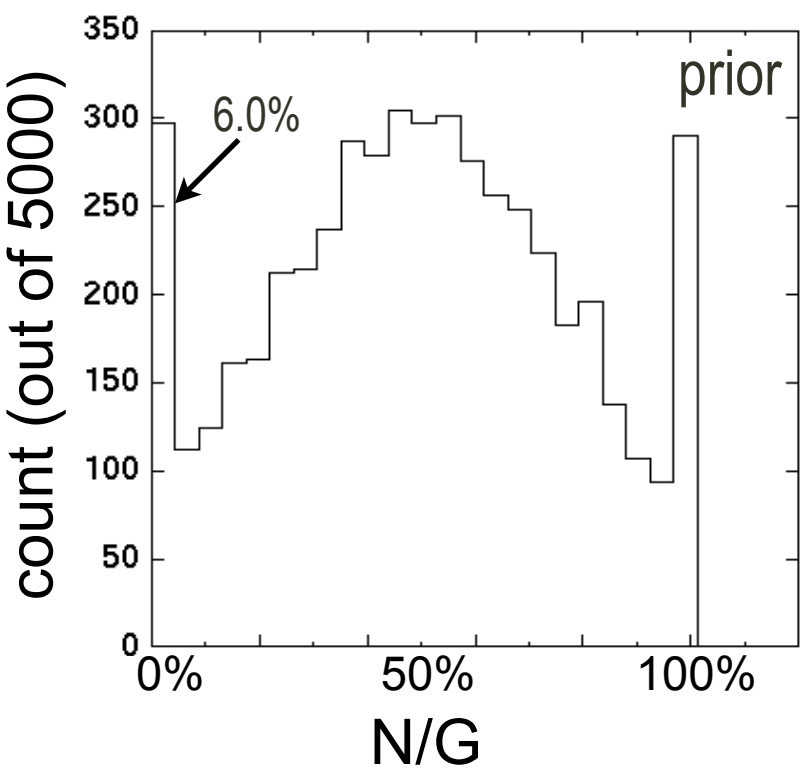


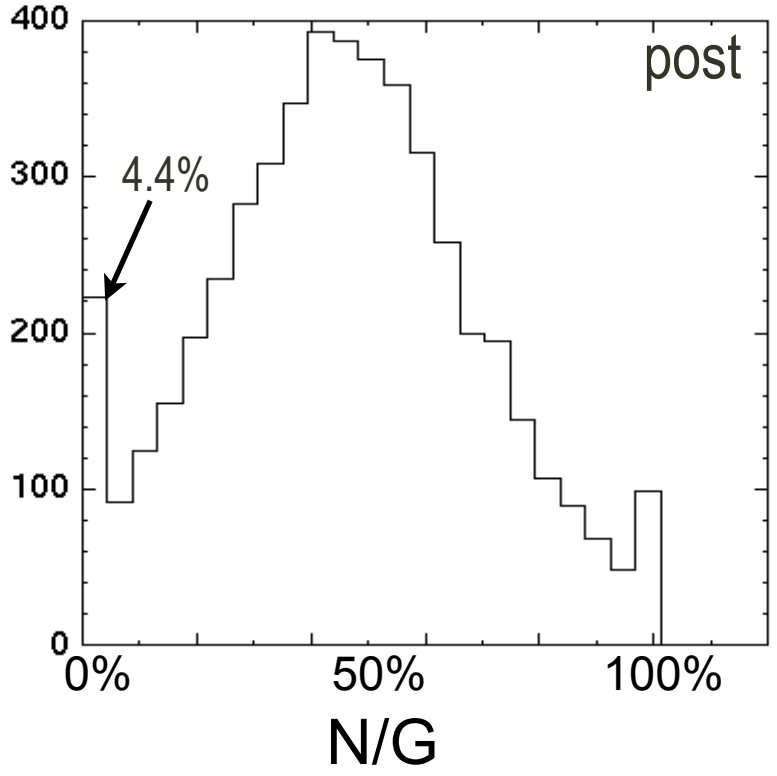
Results of the well

- found more than 13 m of soft shale
- median gross thickness of 19 m with standard deviation of 7 m
- 300 m/s slower than expected, two standard deviations

???

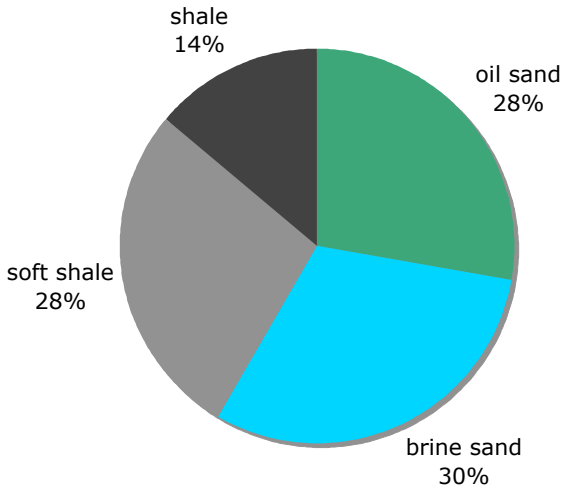
N/G distribution dominated by prior





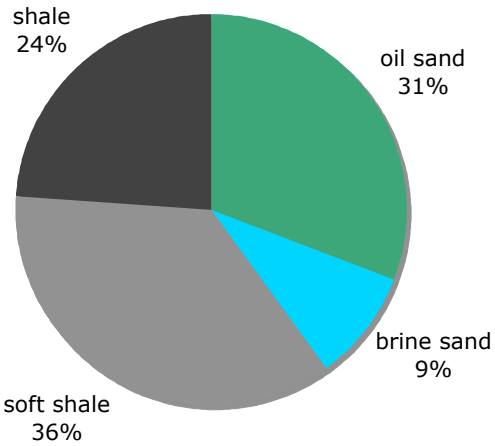
Risk alternate models

post inversion assuming equal priors



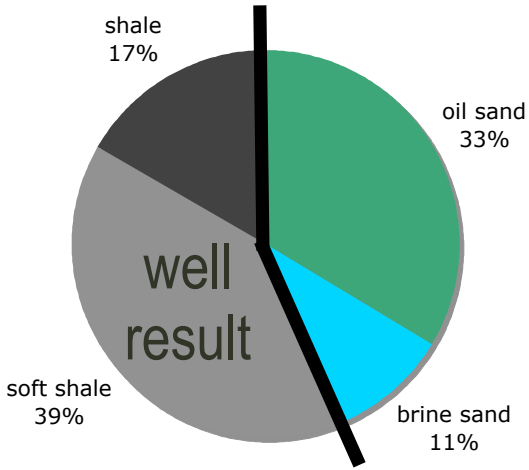
(i.e., what the seismic is telling us)

prior



(from previous well results, geology, and petroleum systems)

post



Conclusions

- iterative Bayesian inversion removes the bias of pre analysis opinion when sand reflectors are near the noise level
- Reprocessing of data significantly improved the bandwidth of the data and was instrumental in showing the high probability of economic volume of oil for Glenridding
- always important to consider alternate models and risk them