Geologic lithofacies identification using seismic wavelet transformation

Moshe Strauss and **Micha Sapir** (Nuclear Research Center, Negev, Beer Sheva, Israel)

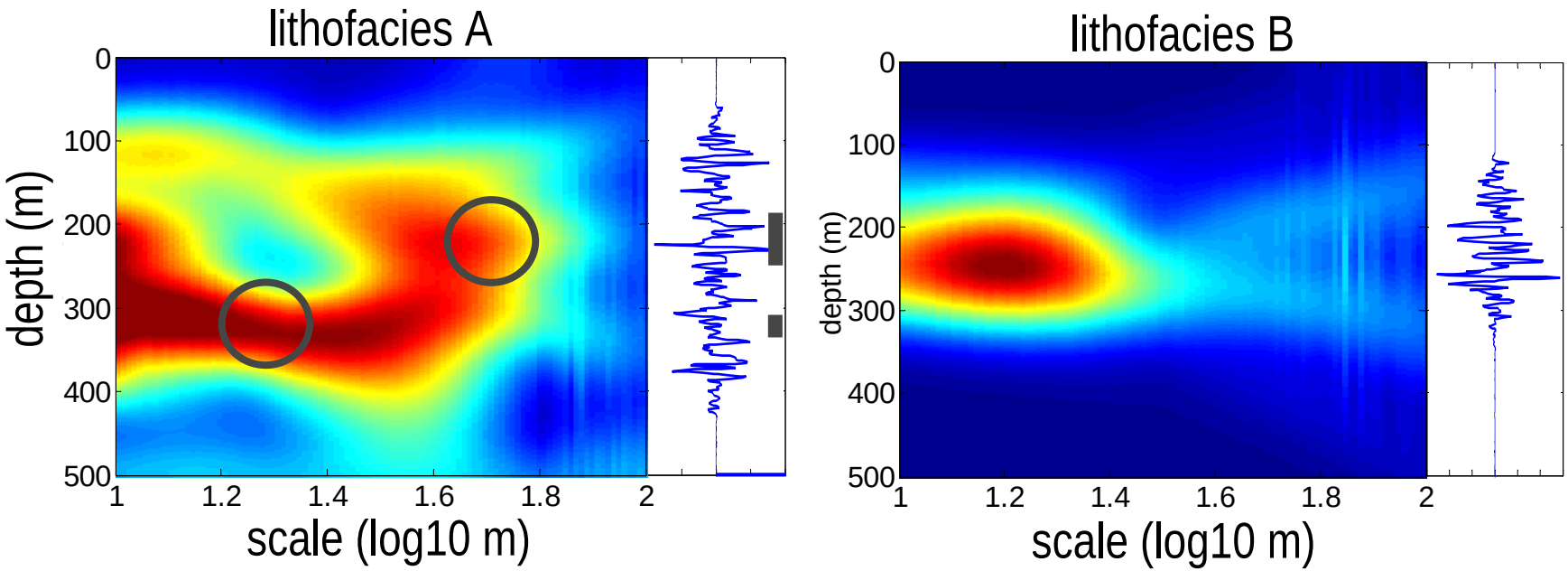
Michael Glinsky* and **Jesse Melick** (BHP Billiton Petroleum, Houston, Texas)

gtech.pethou.bhp.com.au

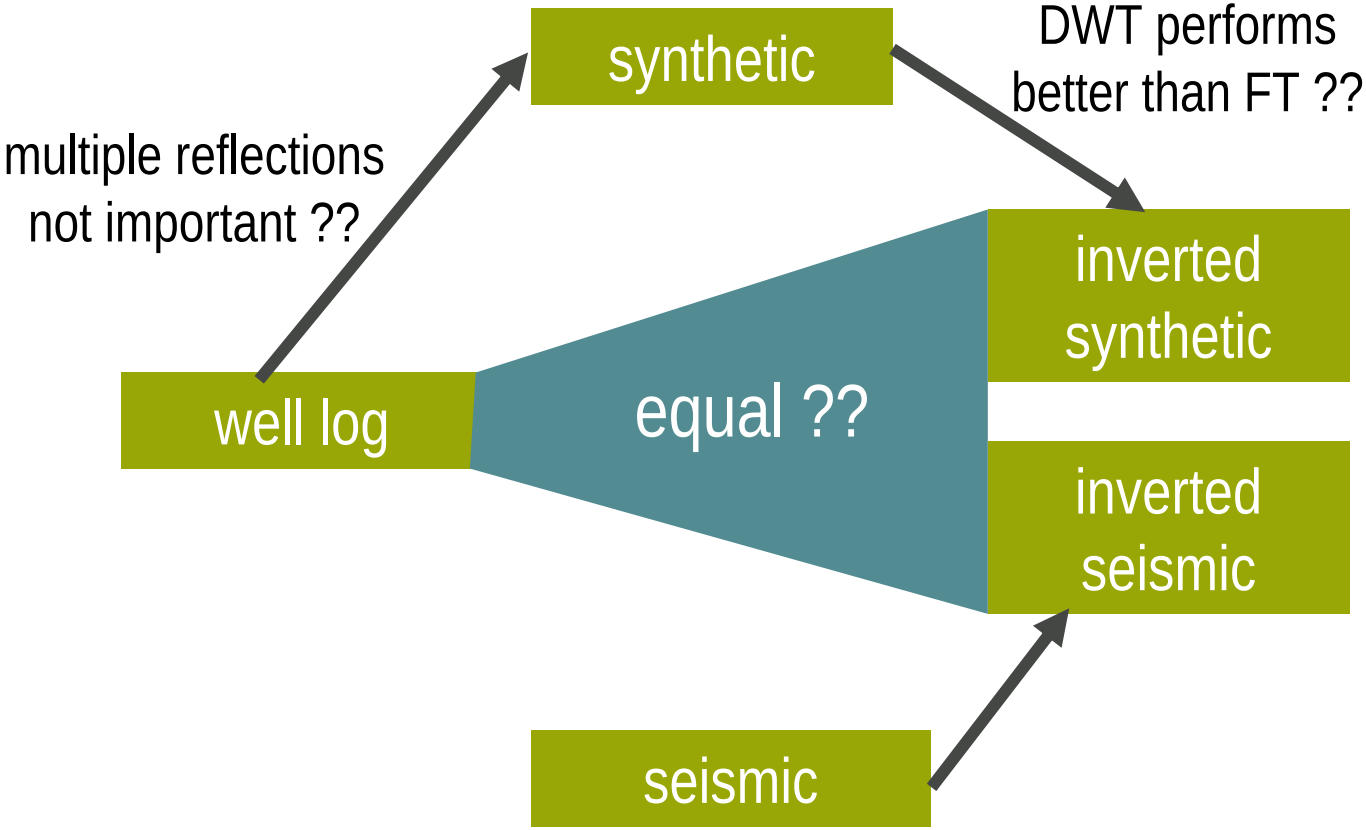
Questions for us to answer

- Is there more information in our seismic data?
  - Another constraint
- Can we find the science behind “attributes”?
  - Forward and inverse model
  - Quantitative
  - AVO analysis vs. amplitude attributes

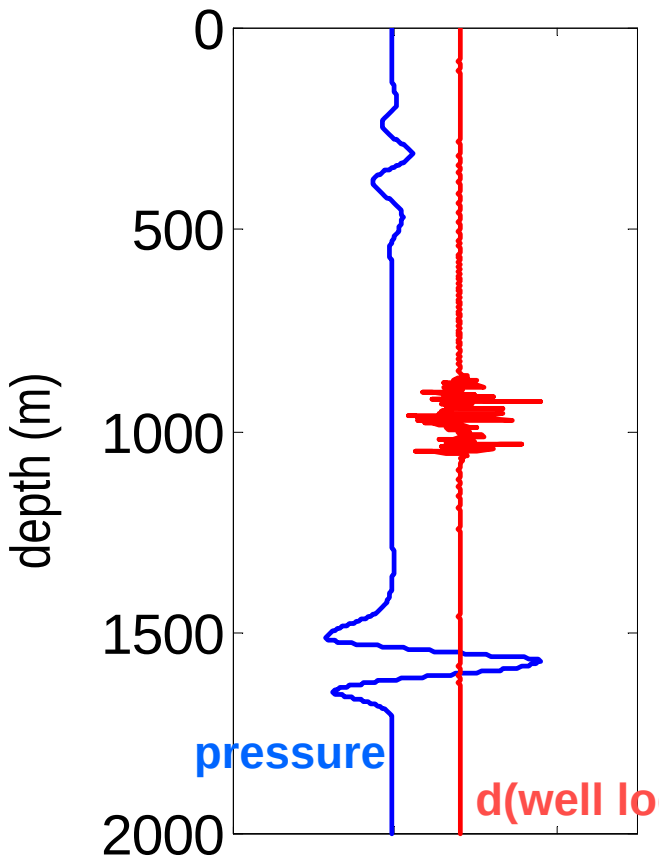
There is multiscale structure in seismic reflectors, can we detect it?



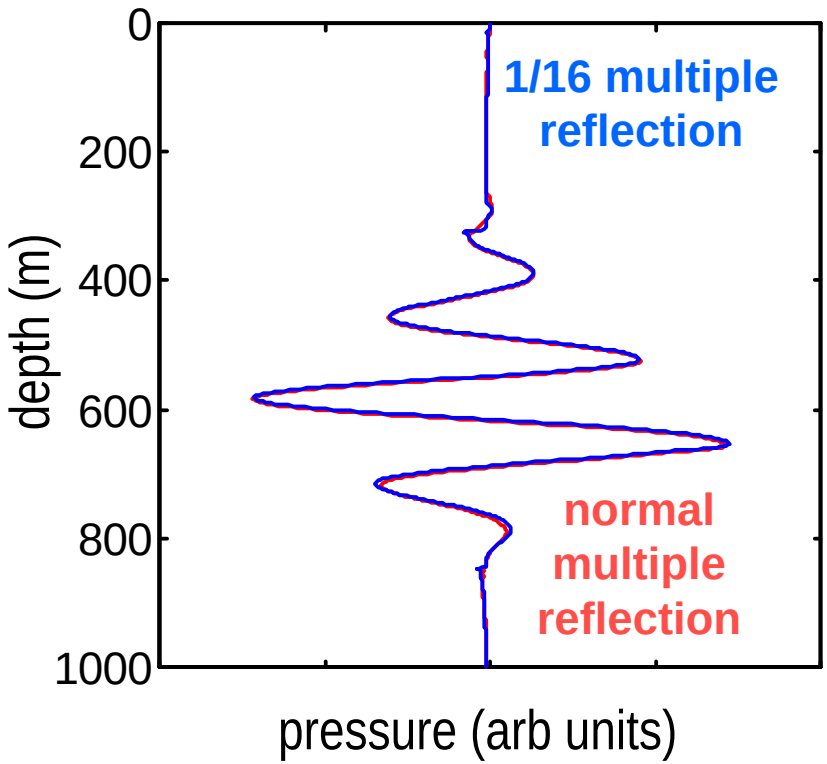
Development of a forward and inverse model

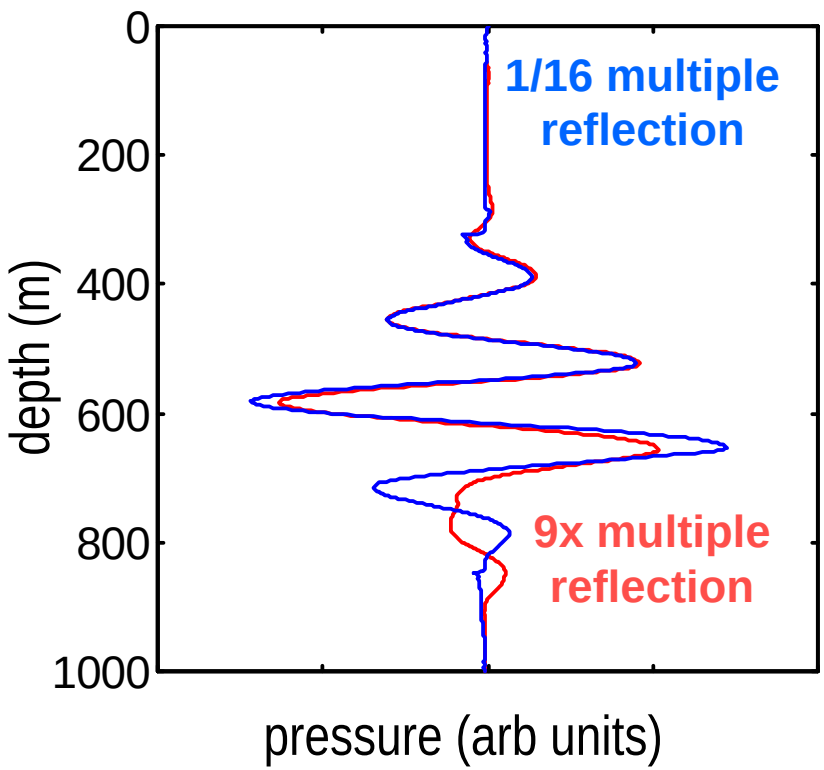


Forward acoustic model is used

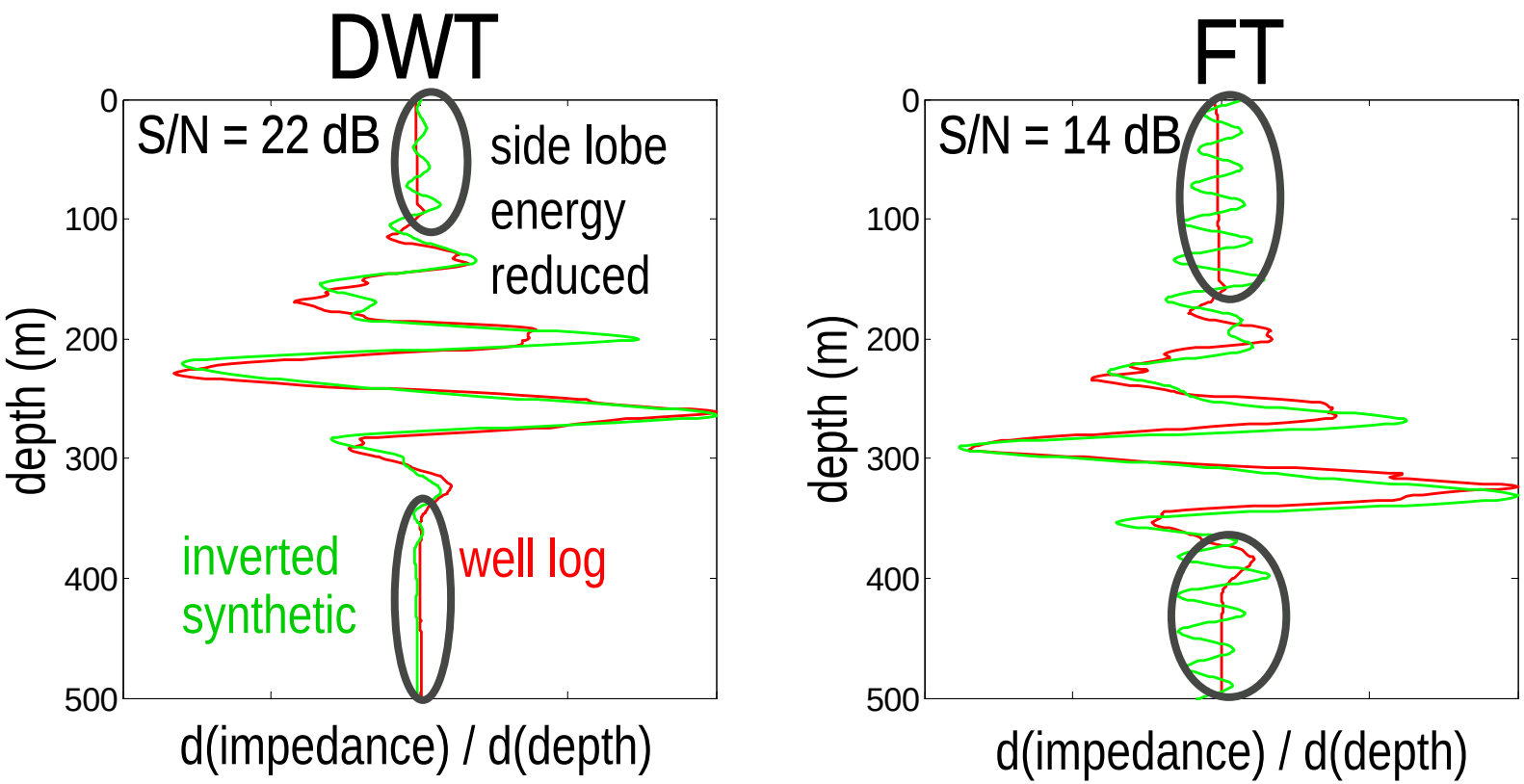


Multiple reflections can be neglected enabling a linear inverse model

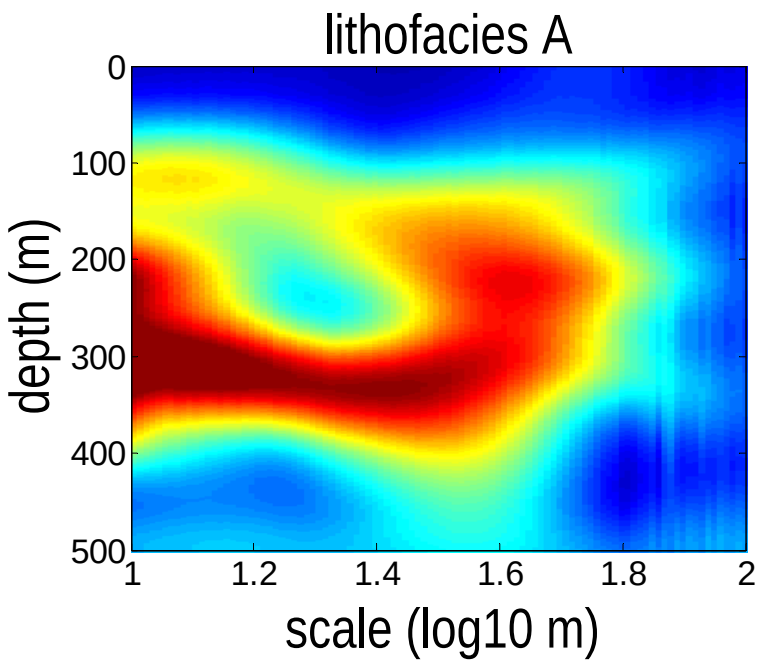


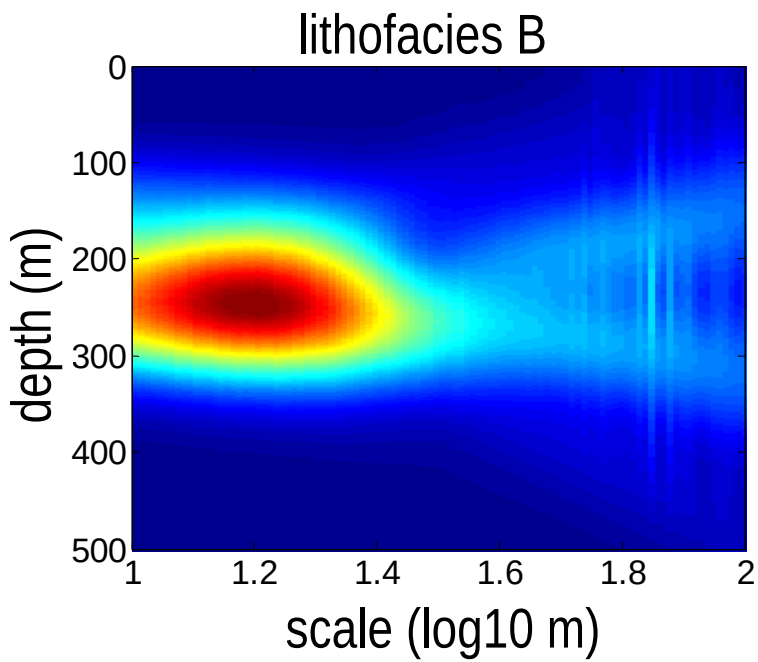


Discrete wavelet transform is a better implementation of inverse model than FT

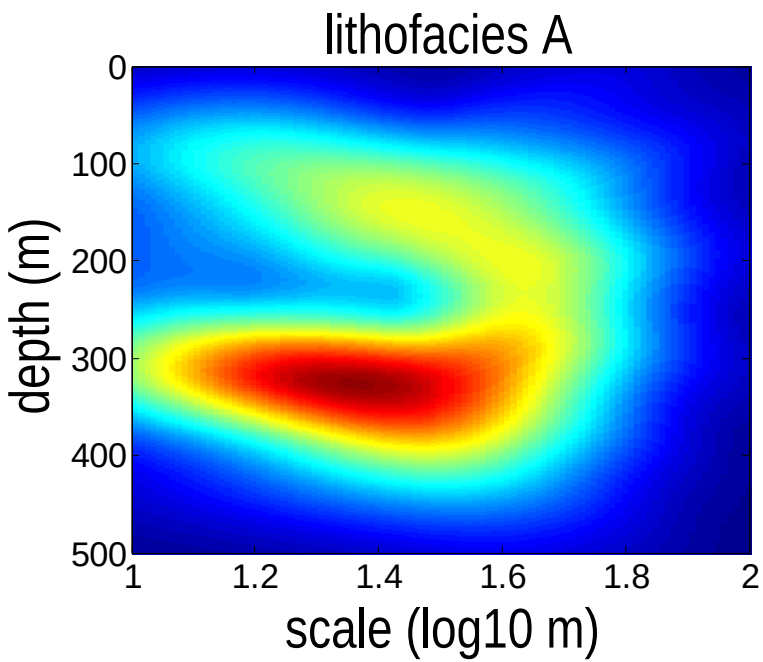


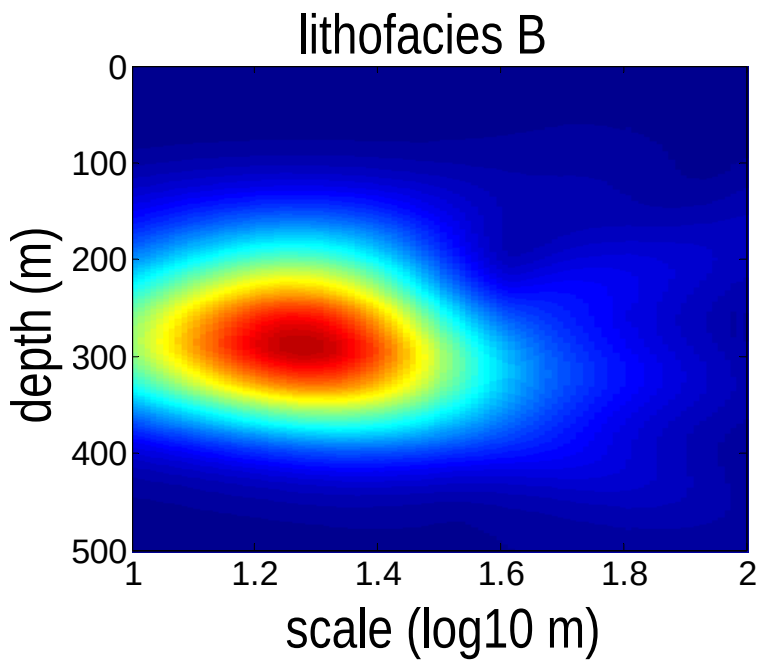
Start with the well log



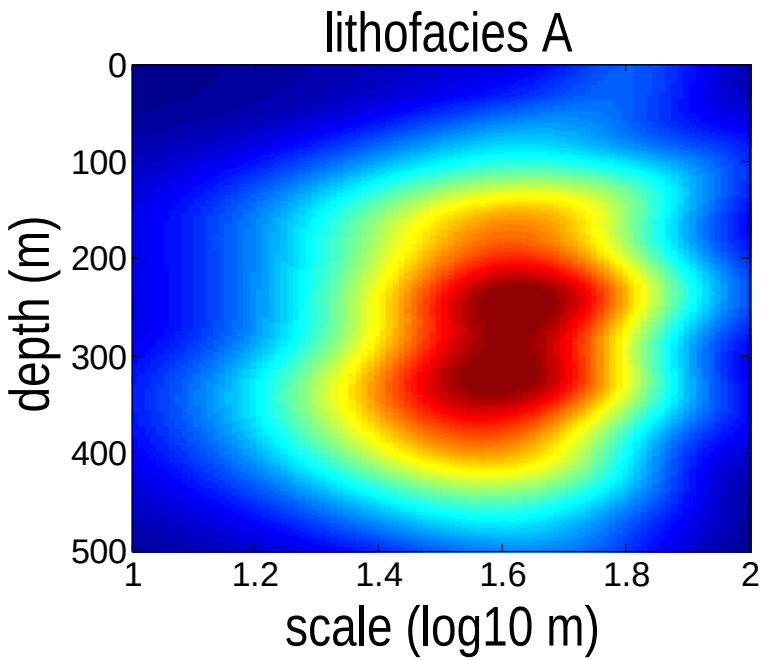


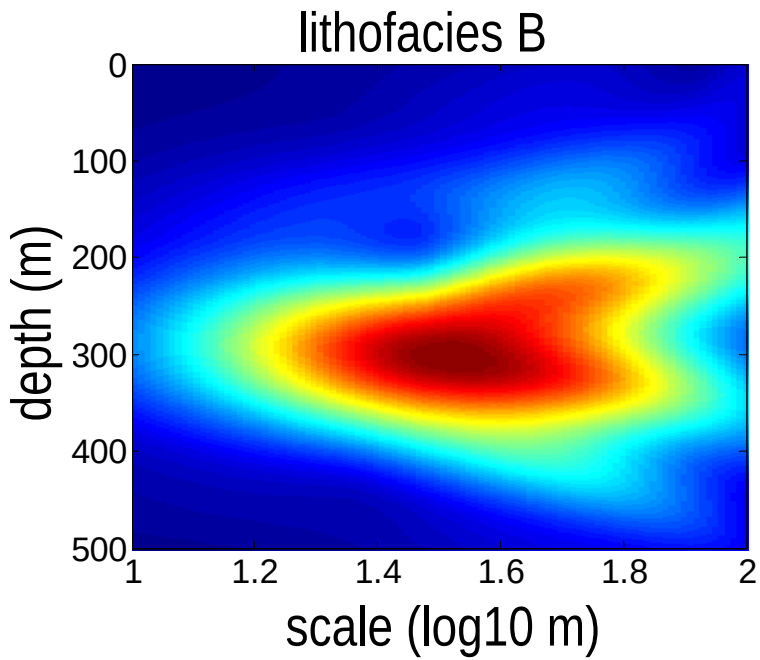
20 Hz synthetic shows differences



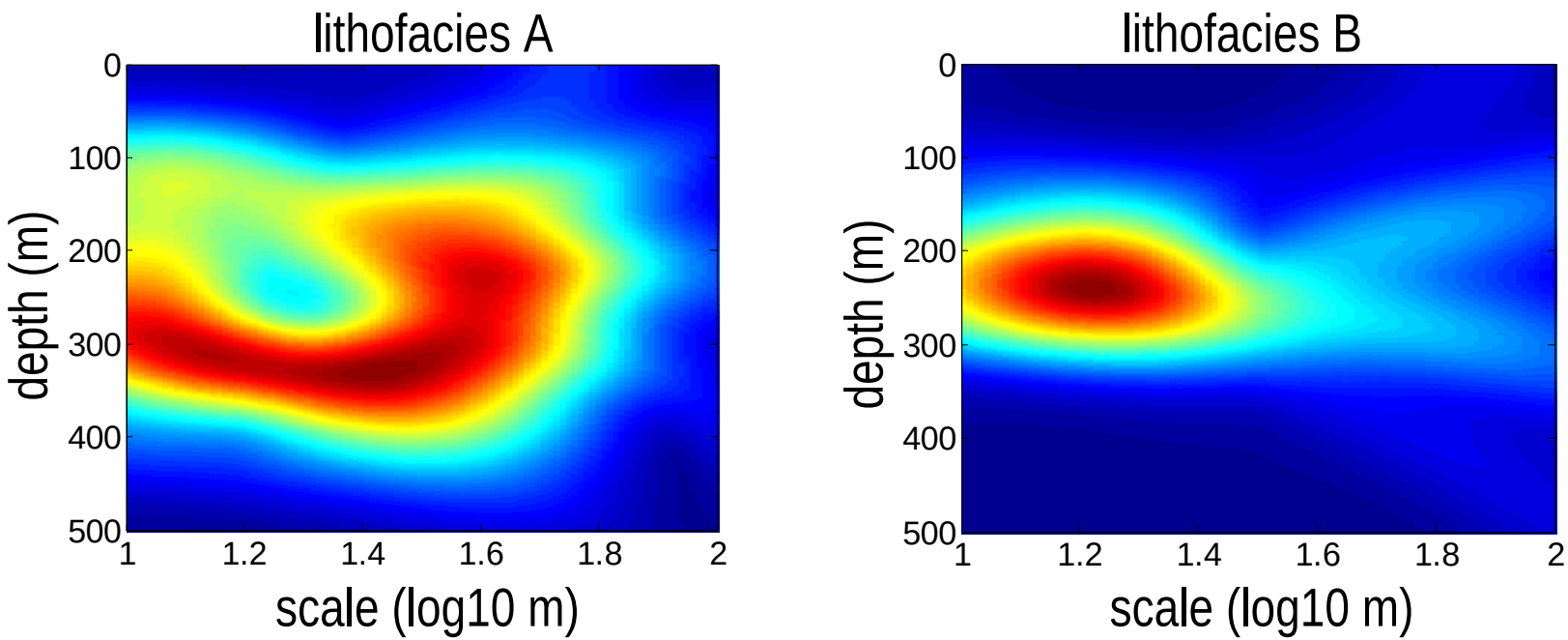


10 Hz synthetic also shows differences, even though geology is 60 Hz

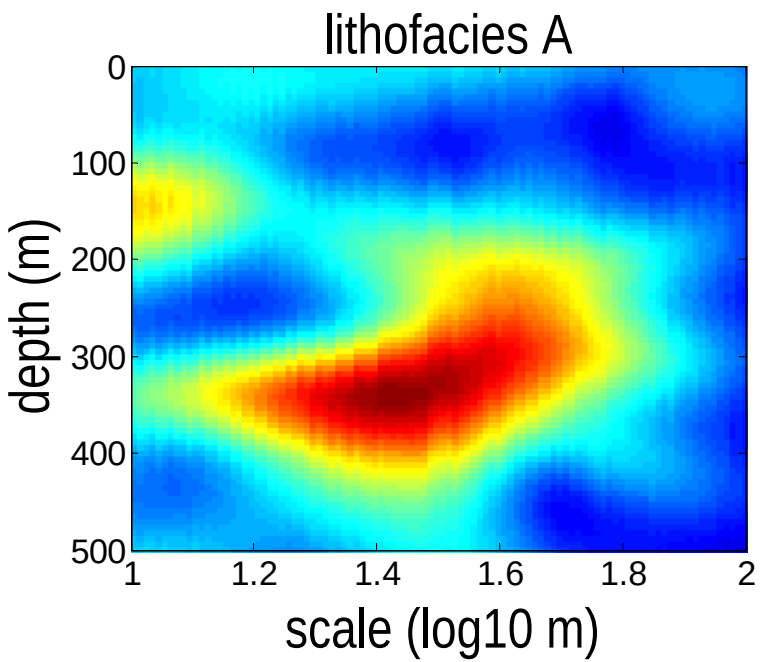


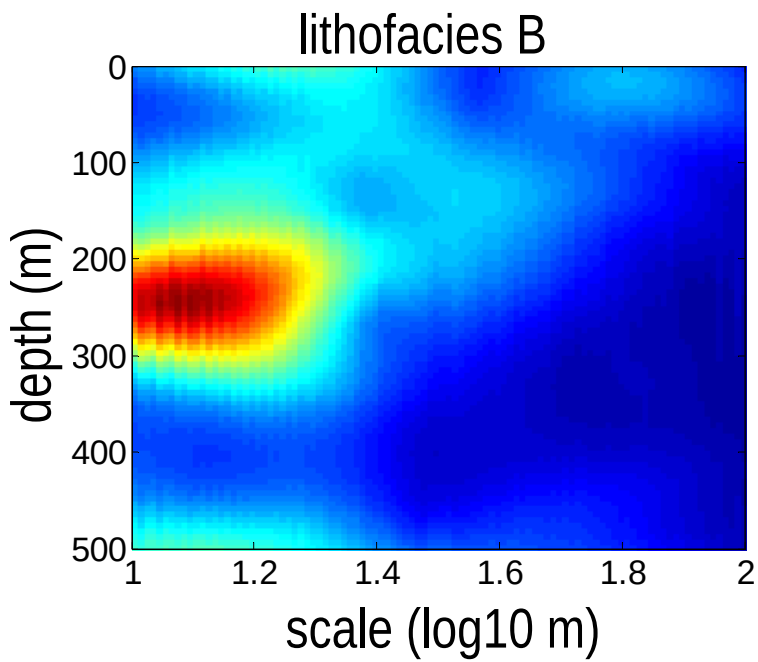


Linear inversion of 20 Hz synthetic recovers well log spectrum

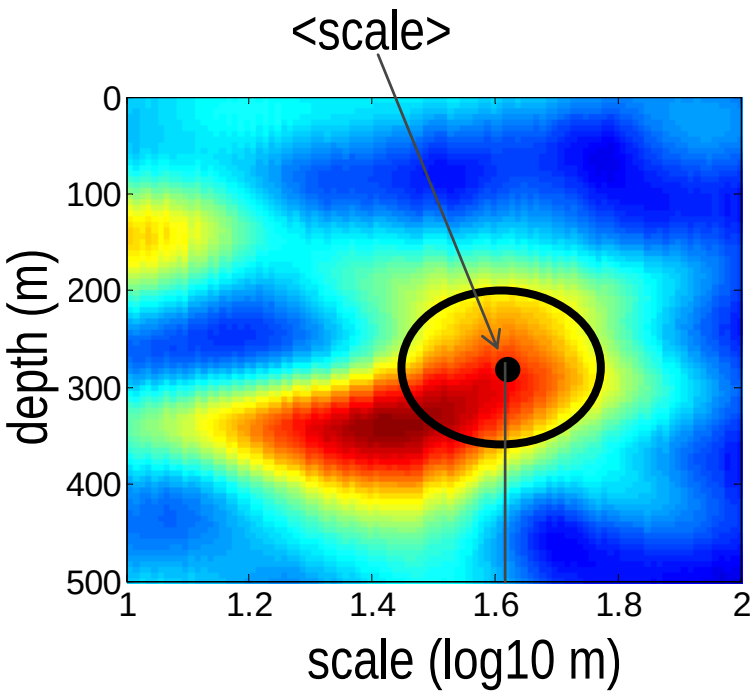


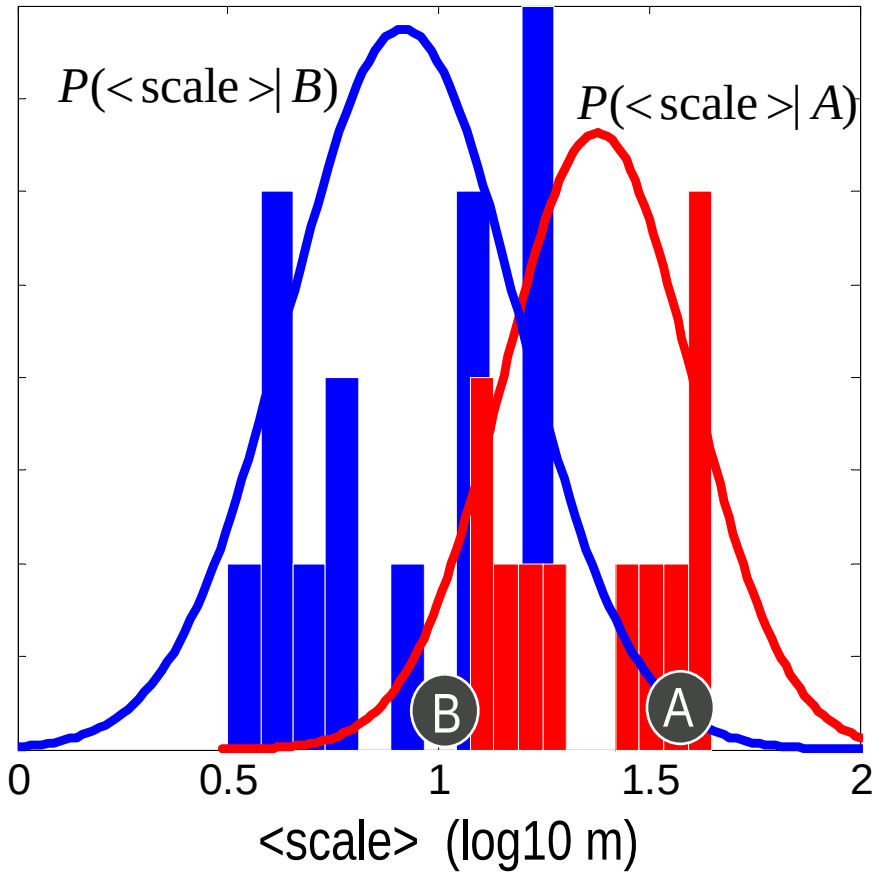
Linear inversion of real seismic data also recovers well log spectrum





Analysis of many wells shows difference in average scale of lithofacies A and B





A quantitative estimate can be made of the probability of lithofacies group

lithofacies A	lithofacies B	
1.60	1.00	**<scale>**
95%	23%	**P(A | <scale>)**

$$P(A|<\text{scale}>) = \frac{P(<\text{scale}>|A)}{P(<\text{scale}>|A) + P(<\text{scale}>|B)}$$

(Bayesian inversion)

Things to remember

- Geologic lithofacies can be quantitatively identified by the wavelet decomposition of the reflection
  - appears to be robust, works on data where standard quantitative interpretation does not work well
- 10 Hz data identifies 60 Hz geologic beds
- One does not need to consider multiple reflections in the inversion
- Discrete wavelet transform (DWT) performs better than Fourier transform (FT) for the inversion (deconvolution)

We would like to acknowledge for their help: Bruce Asher, Gillian Apps, Chris Lerch and Val Lincecum

Updated extended abstract available at:
www.oplnk.net/~glinsky/tech_papers

THE END

Linear inversion of 10 Hz synthetic recovers well log spectrum