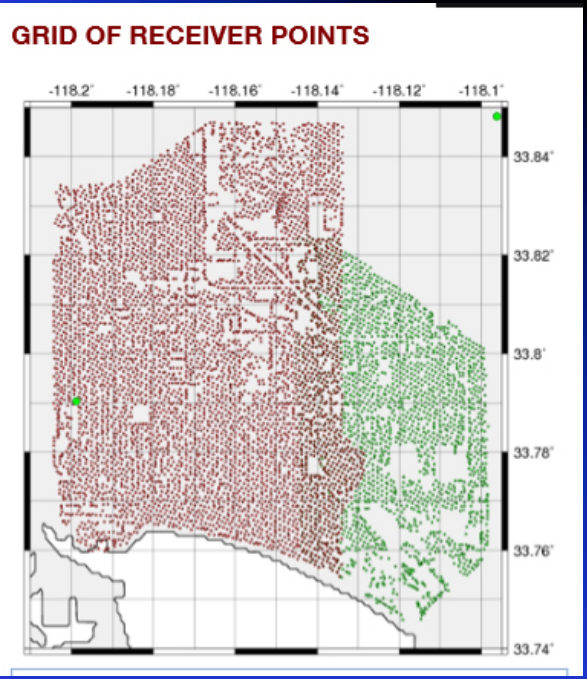
Reflection Imaging of the Deep Crust with Oil Exploration "Noise"



Long Beach Oil Exploration Survey

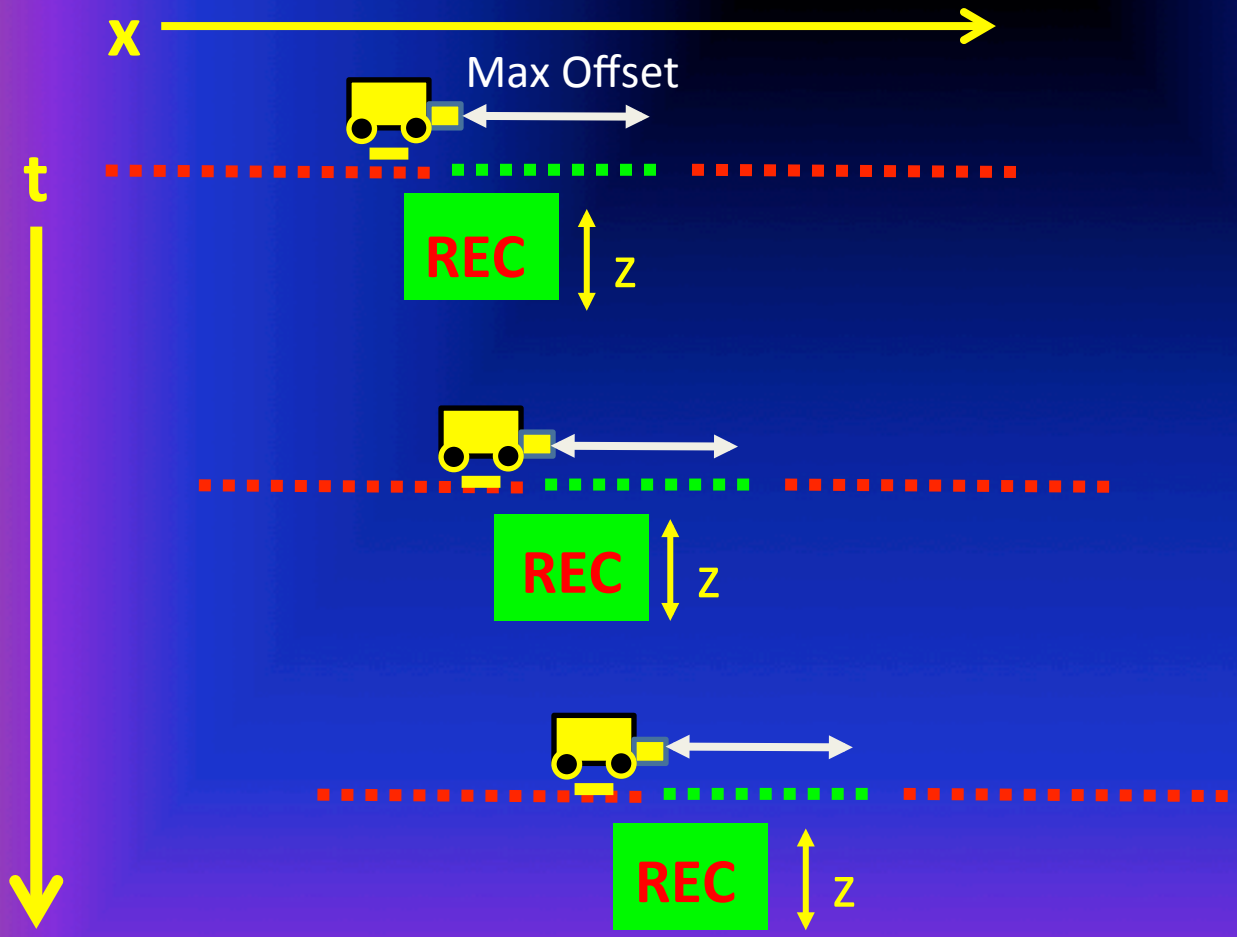
http://www.nodalseismic.com/videos

Larry D. Brown, Anastasia Cabolova and Diego Quiros
Institute for the Study of the Continents
Cornell University

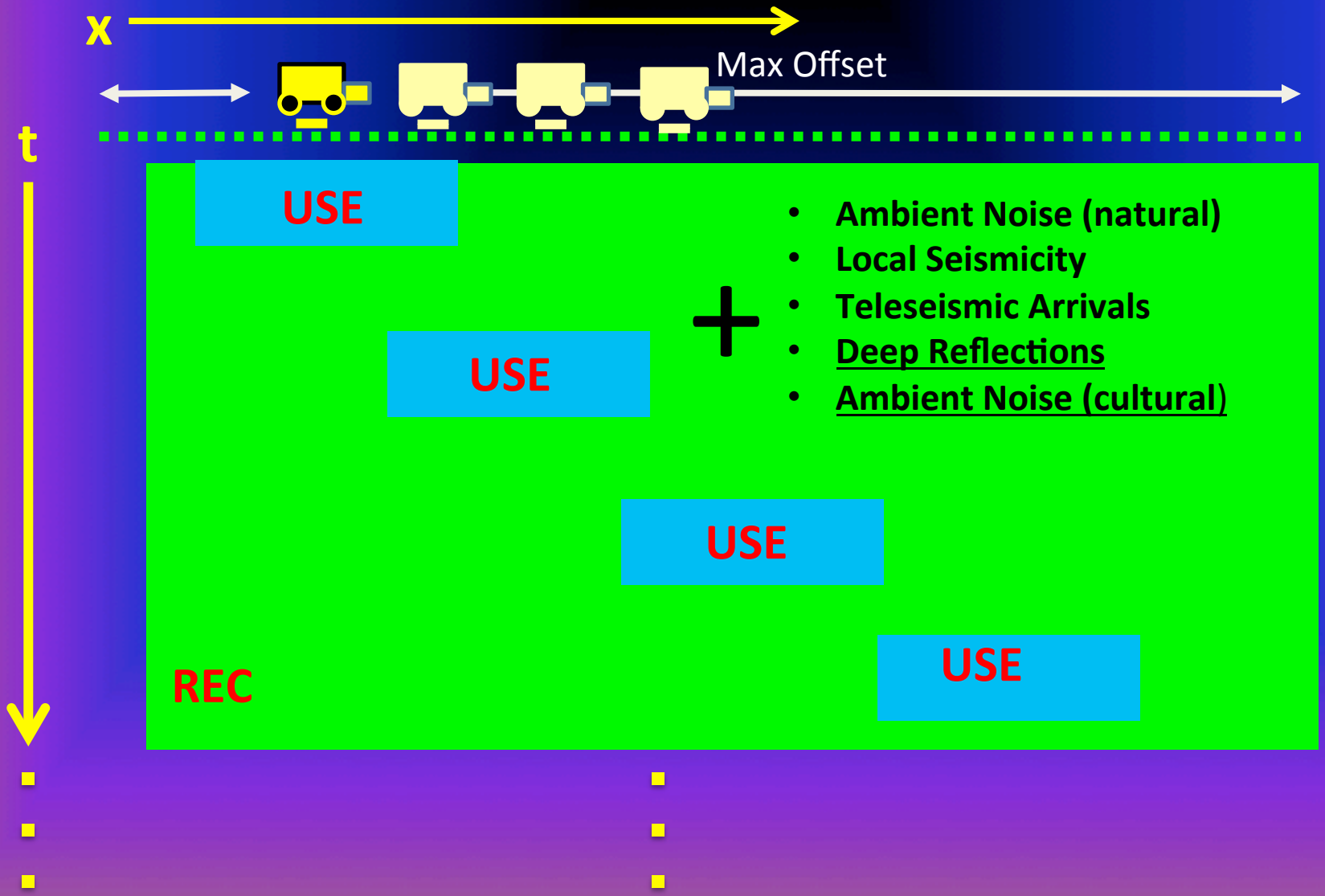
Conclusions

- Reflection imaging is powerful but expensive
- New oil industry techniques (i.e. large N, continuous recording) routinely collect "noise" that contains useful data
  - Microseismic "noise" = surface wave tomography
  - Local seismicity
  - Teleseismic arrivals
  - **Deep reflections**
  - **Cultural "noise" = body wave imaging**
- Need organization to extract, preserve, distribute this valuable "noise"

Multichannel CRP Profiling (then)

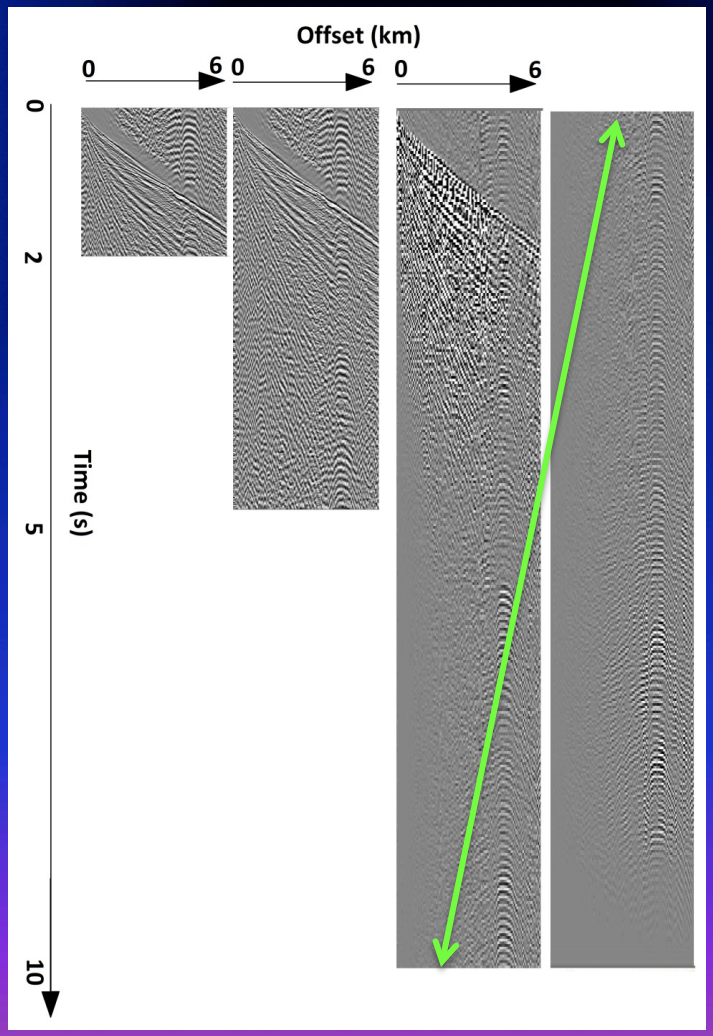


Multichannel CRP Profiling (now)

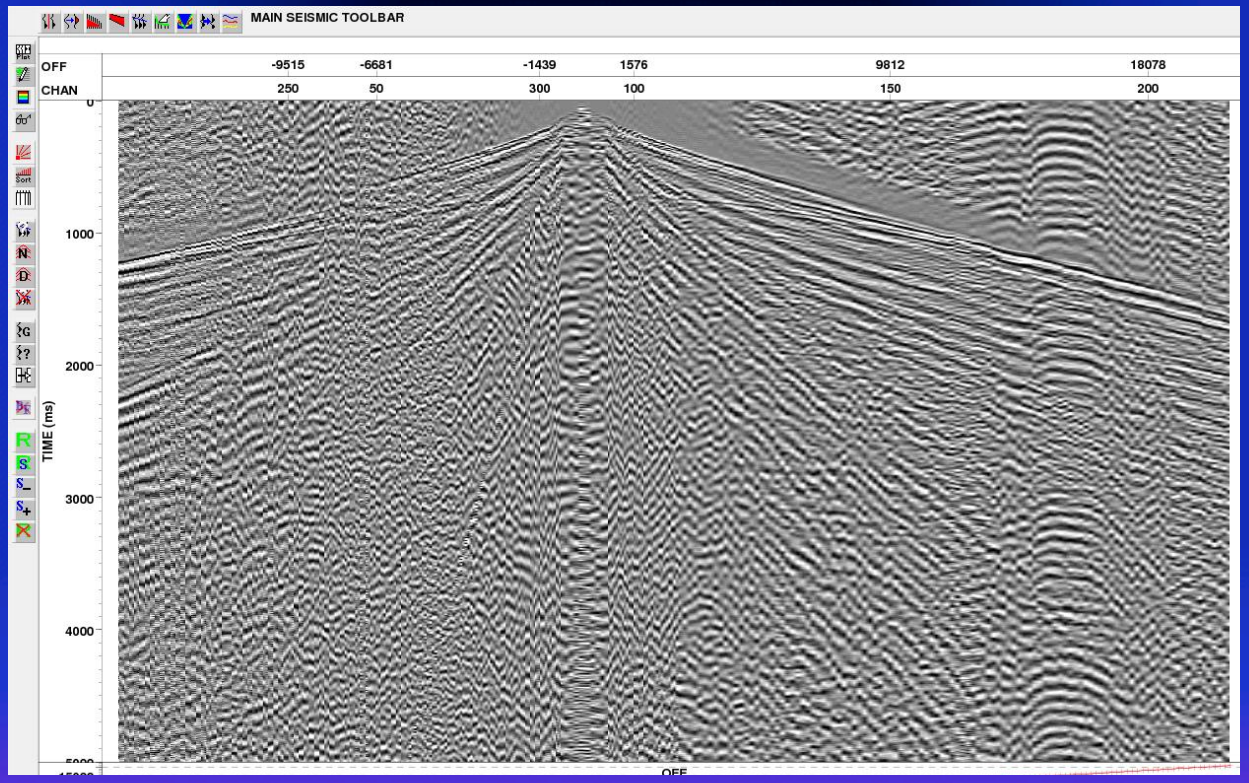


Test Dataset
Courtesy of Fairfield/Nodal Seismics

Looking deeper

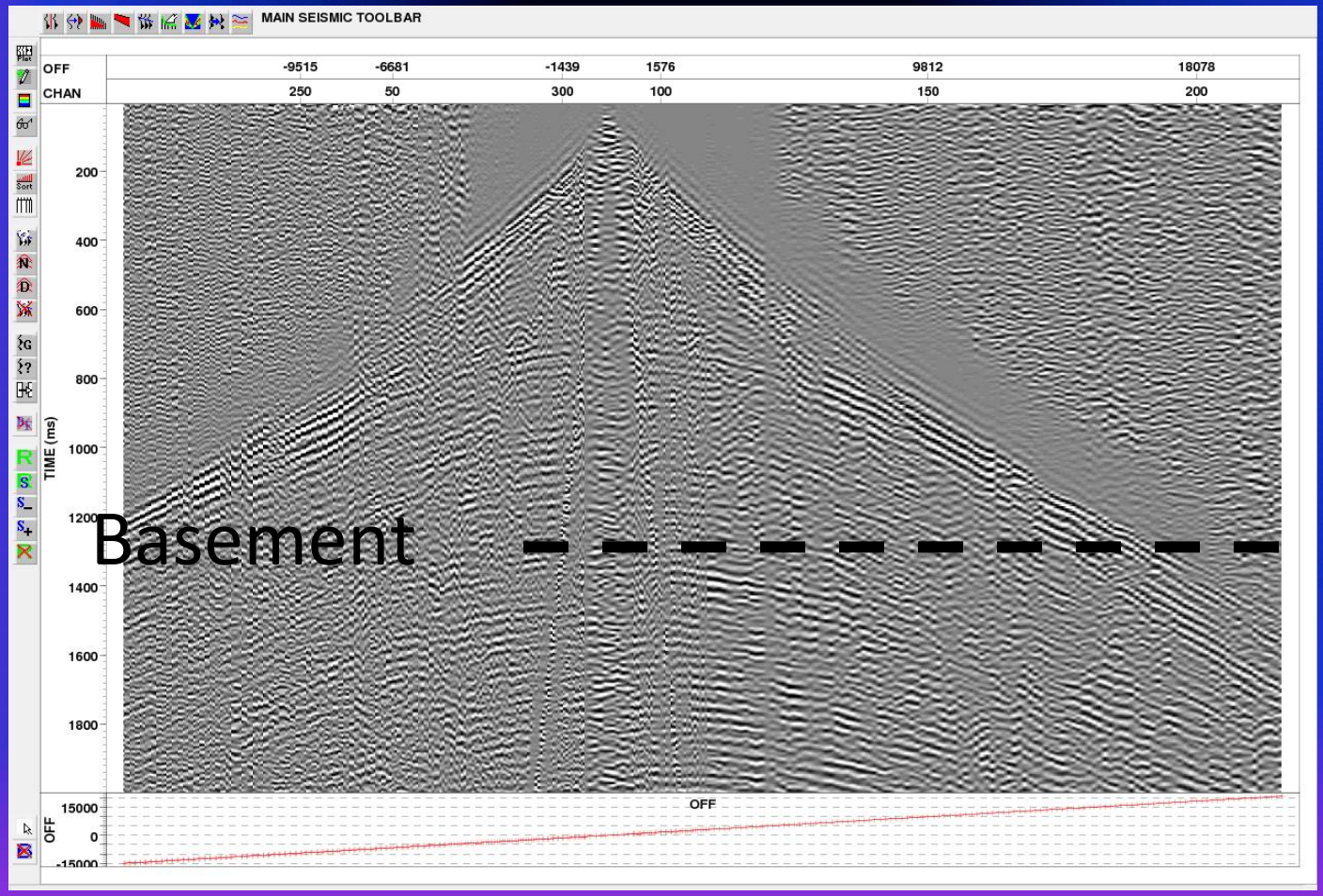


Conventional Shot Gather

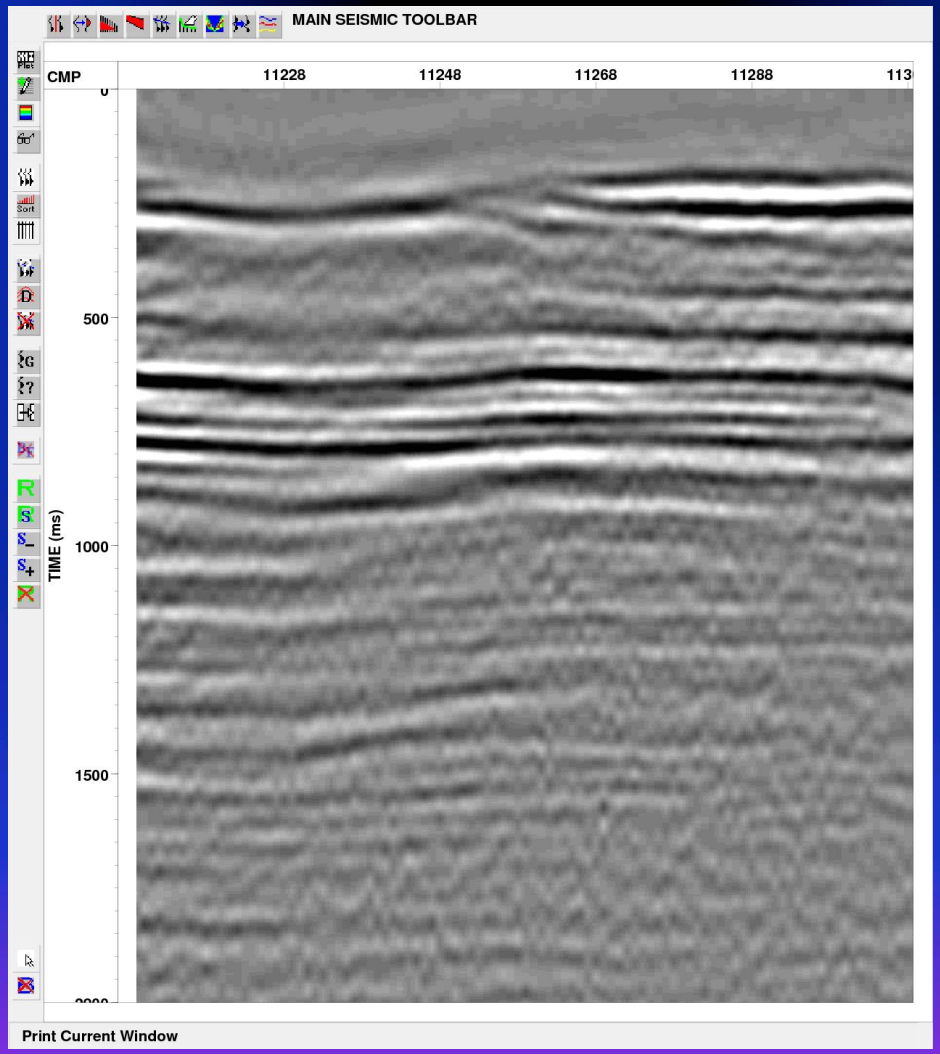


5 sec

Truncated Shot Gather



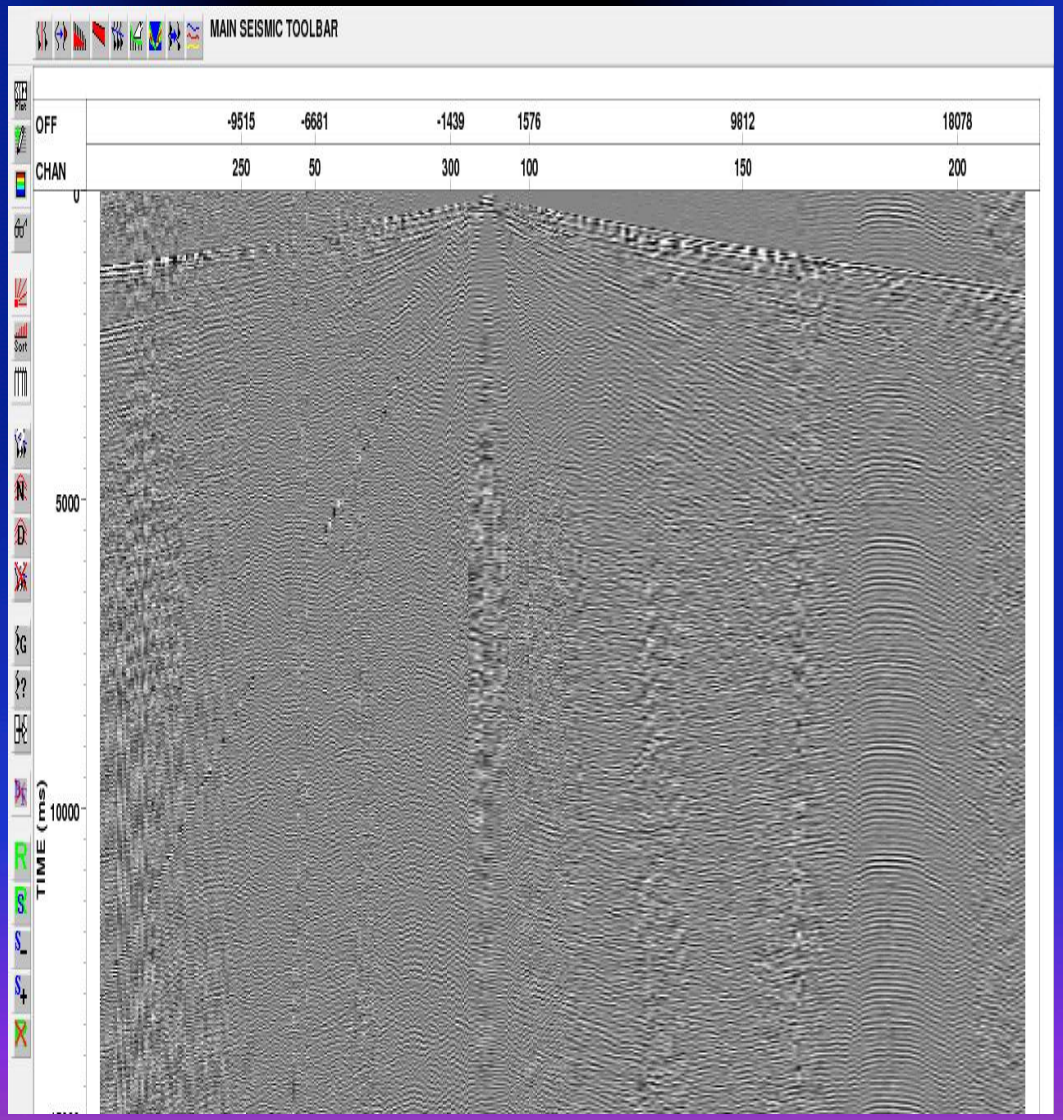
Conventional Stack



2 sec

Basement

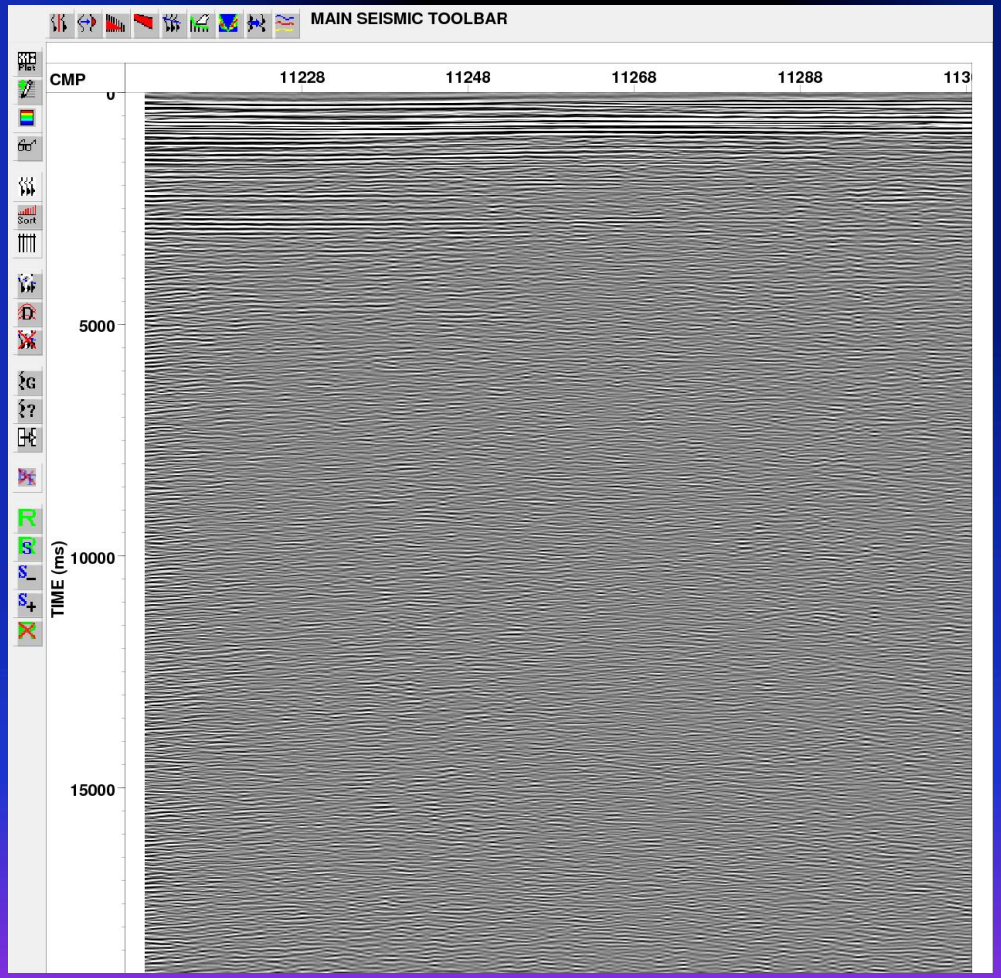
Extended Shot Gather



18 sec

Moho?

Extended Stack

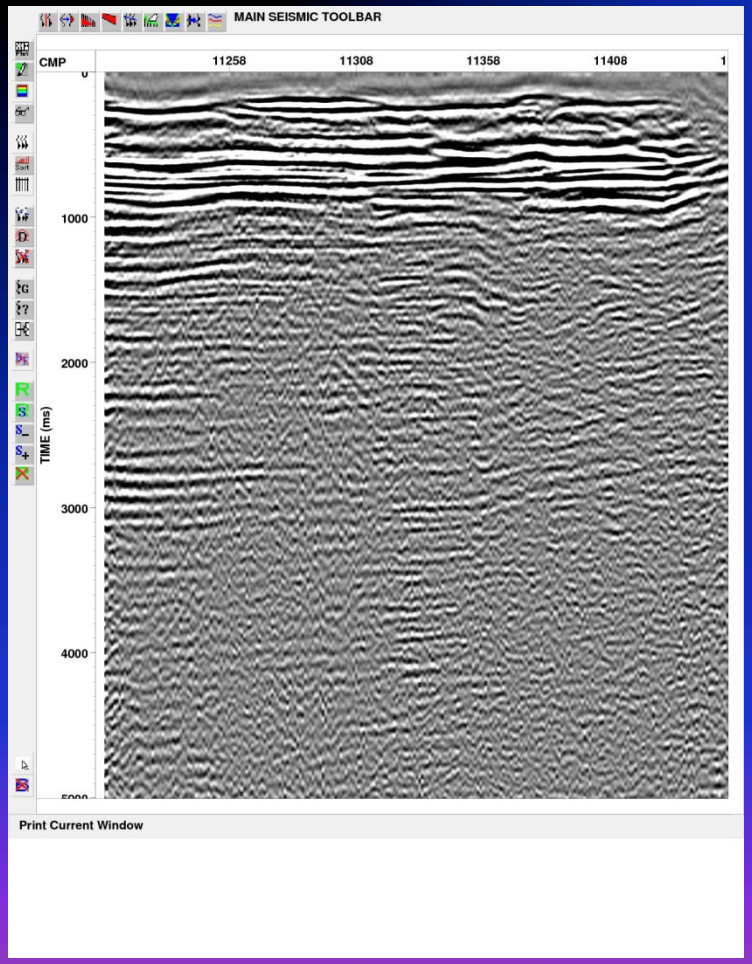


18 sec

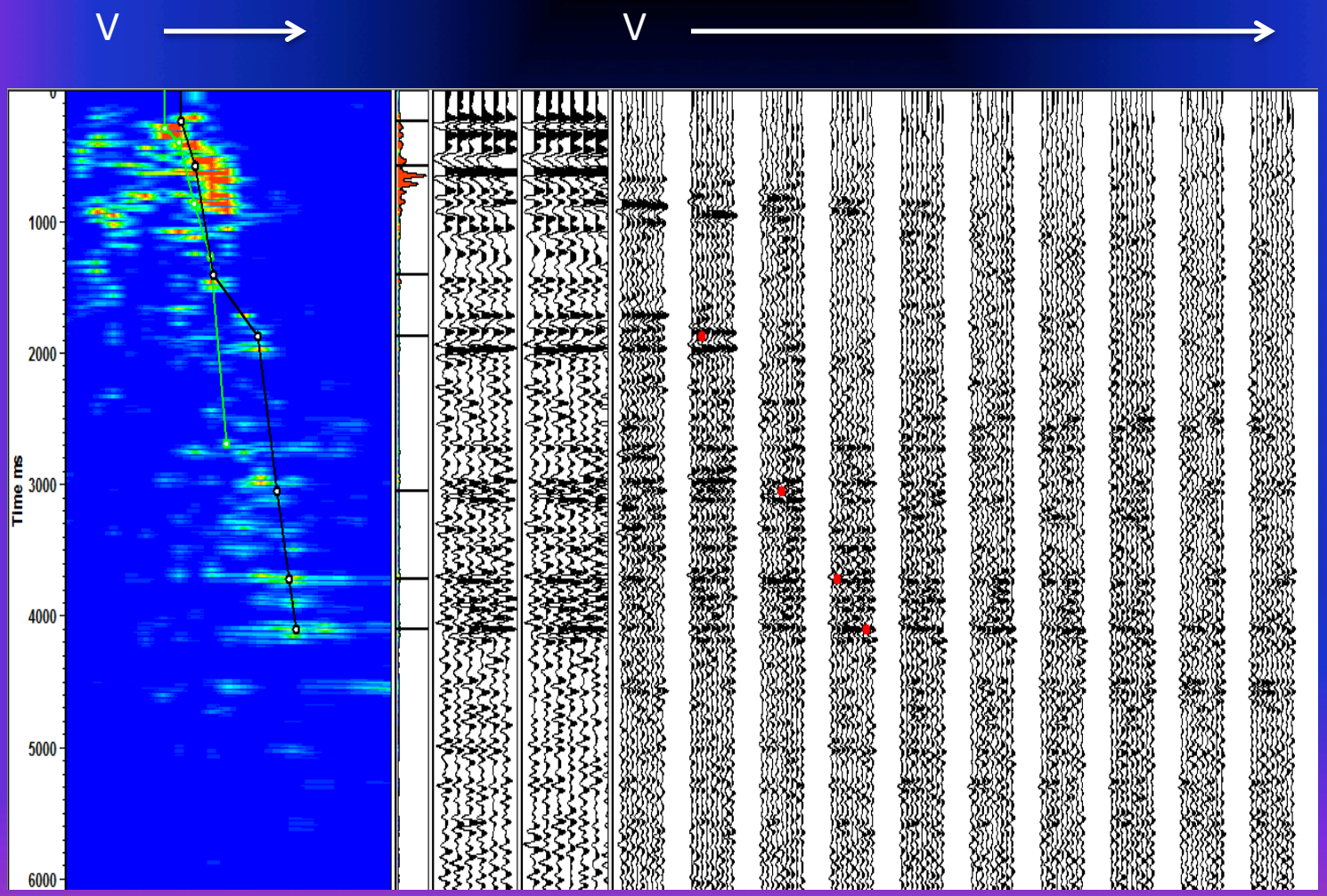
Moho?

Extended Stack (Upper Crust)

Precambrian Layering



Basement Reflections: Not Multiples

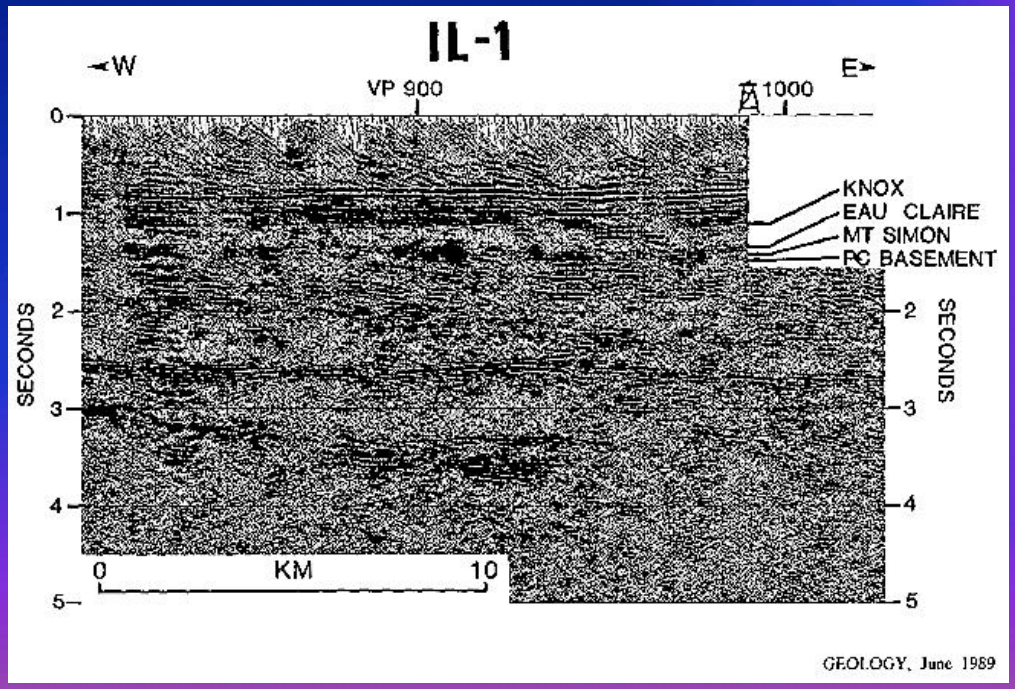


Buried Precambrian Layering US Midcontinent

Major Proterozoic basement features of the eastern midcontinent of North America revealed by recent COCORP profiling

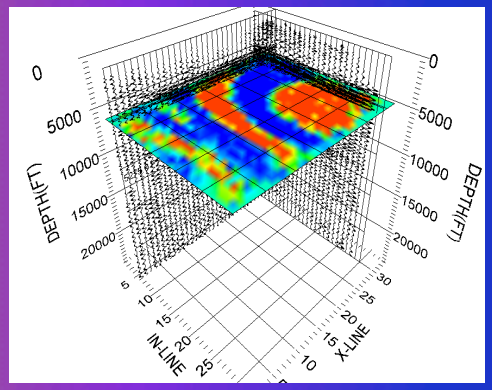
T. Pratt, R. Culotta, E. Hauser, D. Nelson, L. Brown, S. Kaufman, J. Oliver
Institute for the Study of the Continents (INSTOC) and Department of Geological Sciences, Cornell University Ithaca, New York 14853

W. Hinze
Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, Indiana 47907

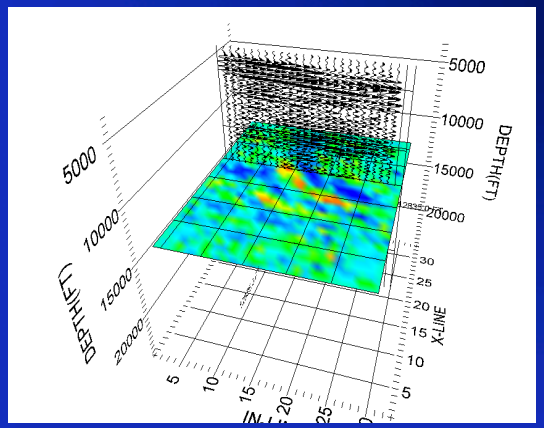


Imaging the Crust in 3D with Exploration "leftovers"

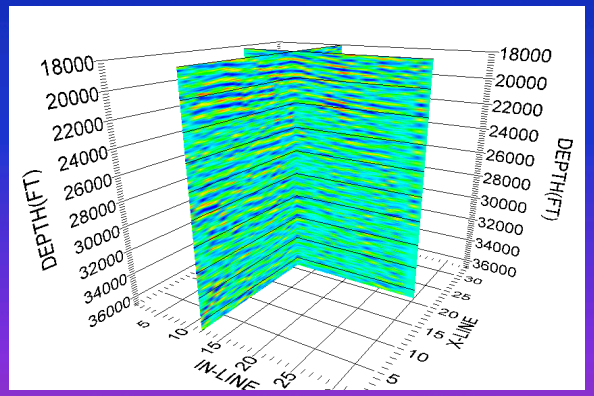
Sedimentary



Basement



Lower Crust

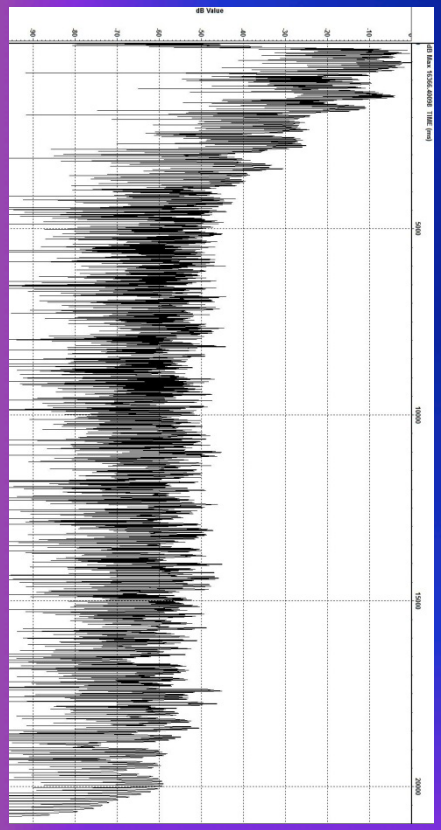


Why Basement Structure?

- Crustal structure and evolution
- Basin Evolution
- Seismogenic structures
- ***Potential reactivation zones/fluid conduits***
  - ***Induced seismicity from fluid injection***

Issues

dB



5

10

15

20

Time, sec

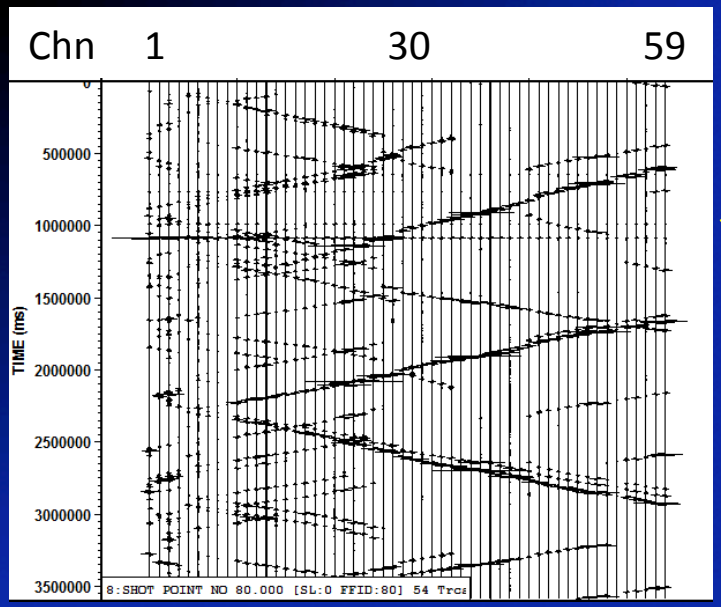
- Source strength (penetration)
- Source frequencies (wasted energy)
- Source overlap (deblending)

Serendipitous Information

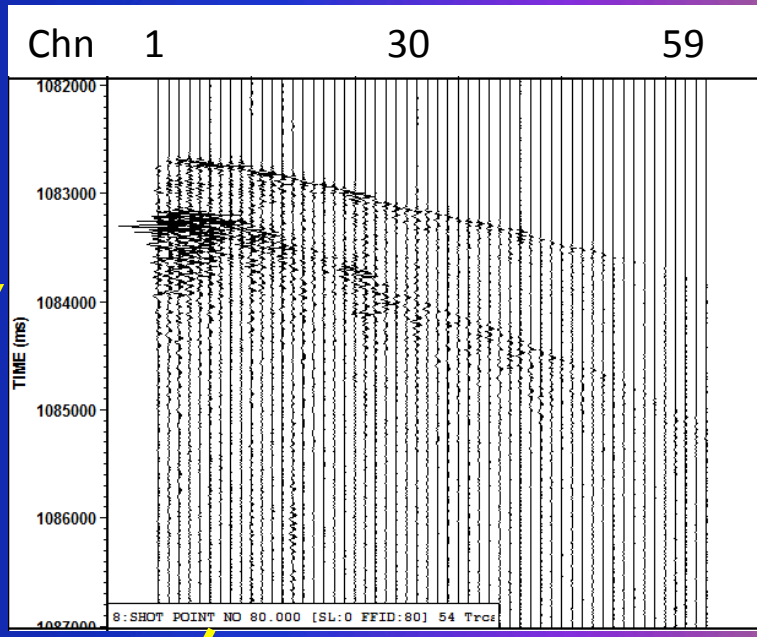
- Surface waves from ambient *natural* noise
- Deep reflections
- Microseismicity
- Surface wave imaging from ambient *cultural* noise
- ***Body wave imaging from ambient cultural noise***

AIDA QC plots

Dipping Events:
Vehicles
Flat Events:
EQs

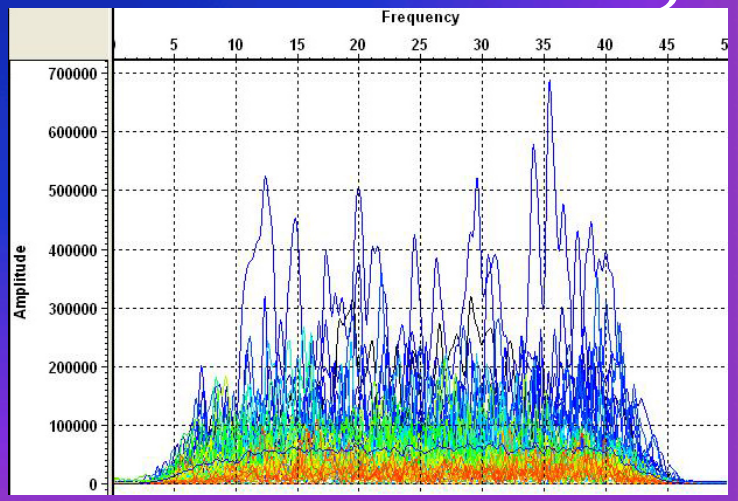


1 hour , multiple stations

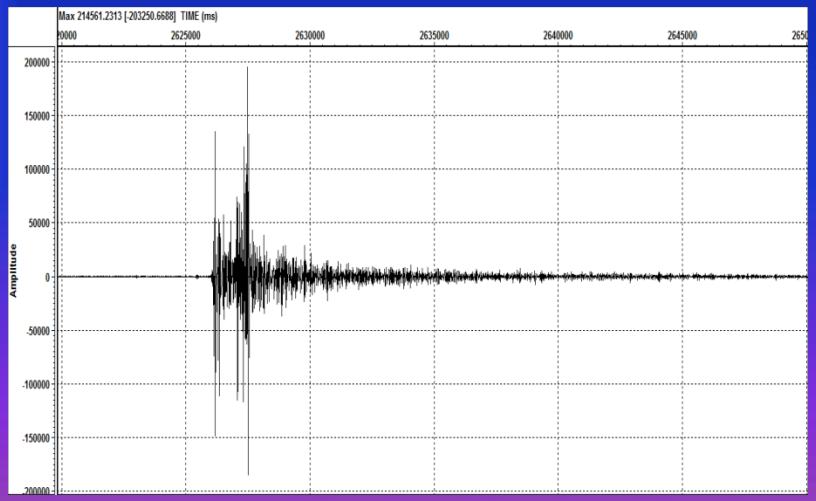


Zoom on event

0 Spectra 50 hz



EQ above, multiple stations



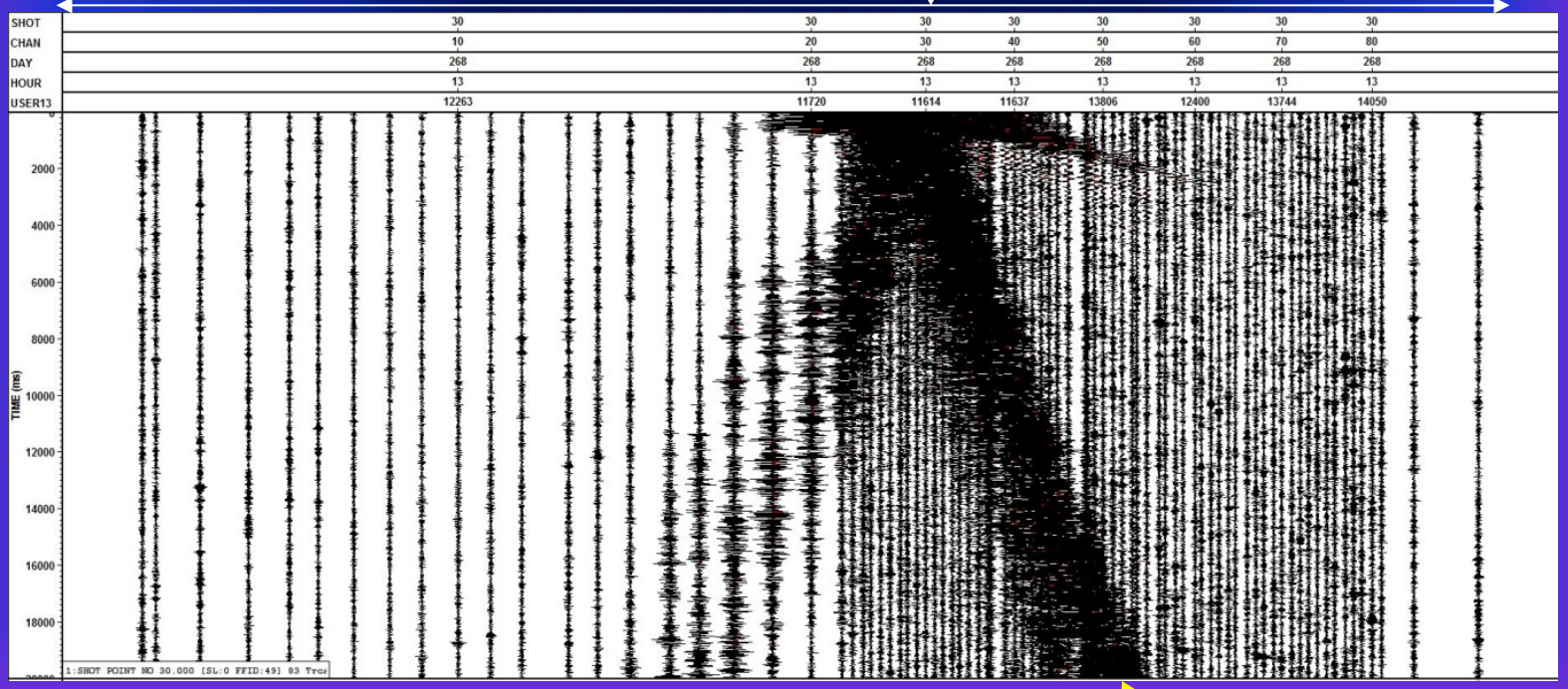
Single event, single station

Traffic Noise (Rt 13, Ithaca, NY)

Cross correlation

8 km

Virtual source

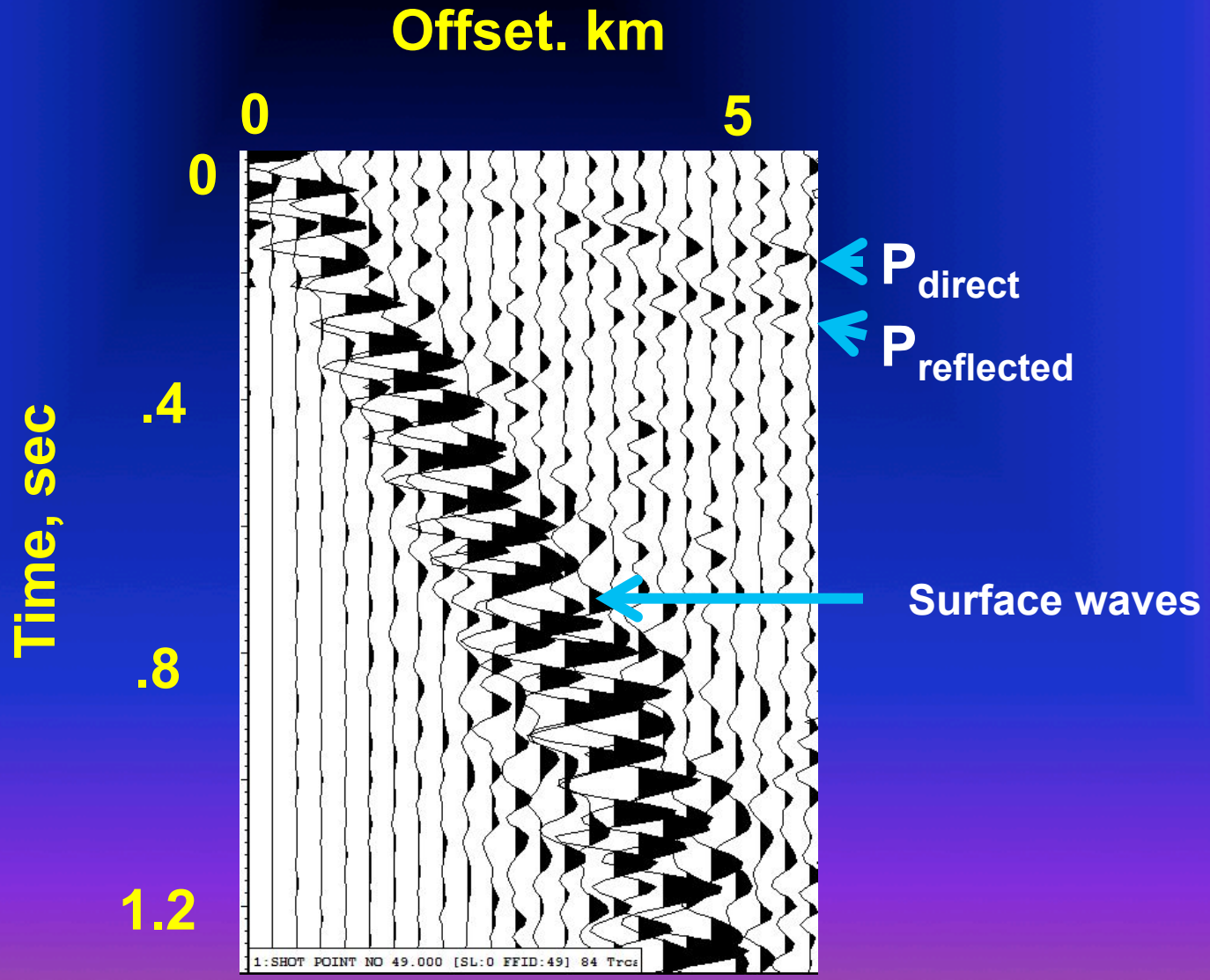


Time,m sec

55 miles/hr

Virtual Shot Gather

Traffic Noise (Rt 13 Newfield NY)



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  - Local seismicity
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  - **Deep reflections**
  - **Cultural "noise" = body wave imaging**
- Need organization to extract, preserve, distribute this valuable "noise"
- **DON'T THROW IT AWAY**

Special Thanks To

- Rob Windels
- Joe Dryer

- Dan Hollis

National Science Foundation