ONBOARD PROCESSING QC FOR AUTONOMOUS OCEAN BOTTOM NODES

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2013 SEG

Seabed GEOSOLUTIONS

SEG Society of Exploration Geophysicists
The international society of applied geophysics

Objectives of onboard QC

1. Make sure that a crew does not leave the area before they acquire enough data to achieve the objective
2. Identify problems that can be fixed during the survey by fixing equipment or modifying the survey design
3. Identify problems that can be fixed in processing

Processing fixes

- Some problems can be fixed onboard and save project turn-around-time
- Other problems require R&D resources. Early diagnosis enables early mobilization of R&D

Hand over of data, and problems

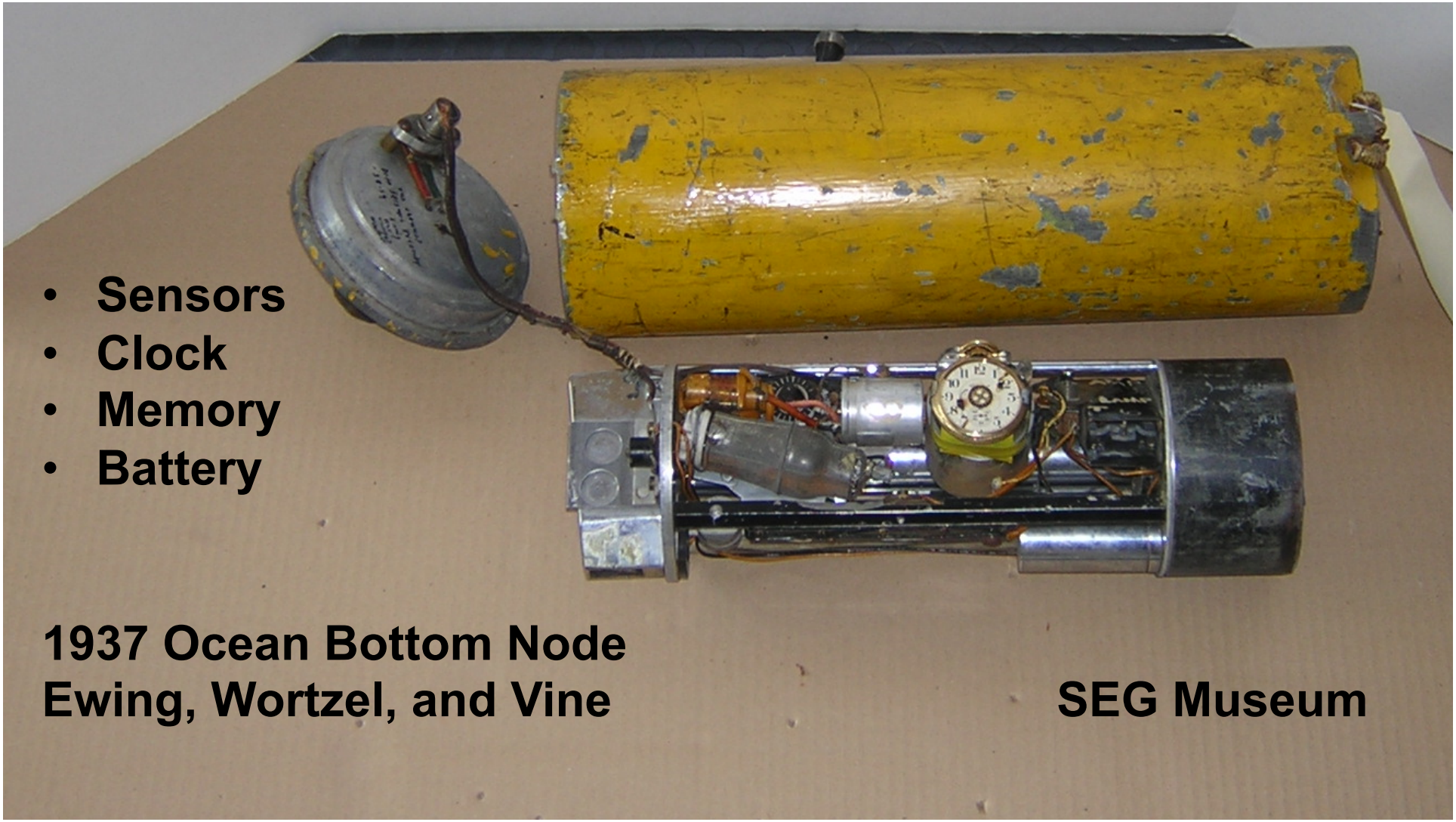
- An easy problem onboard can easily become a mystery onshore

Value in onboard QC

- **Quality assurance**
  - **Reshoot when and where needed**
  - **Minimize time and money wasted in the field if problematic data are re acquired although they can be fixed in processing**
- **Reduce project turn-around time**
  - **Early identification of problems**
  - **Processing and acquisition fixes**

Autonomous Recording

- We do not have the data until we retrieve the nodes
  - This may take 4 months
- Limited communication to the nodes
  - Acoustic modems have poor bandwidth
  - Optical modems have very short range
  - Neither enables data transfers


• Sensors
• Clock
• Memory
• Battery
1937 Ocean Bottom Node
Ewing, Wortzel, and Vine
SEG Museum

Ocean Bottom Nodes, 2012



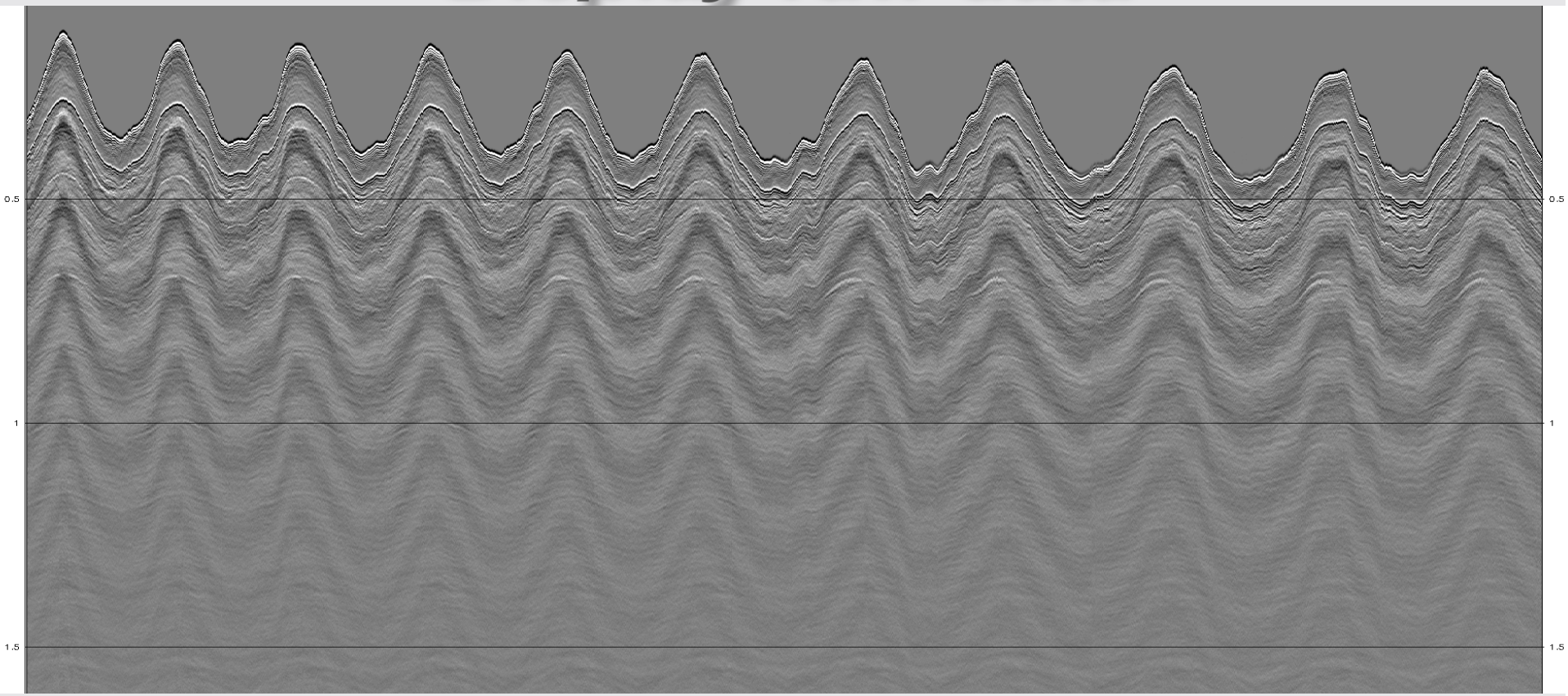
The challenge

- Limited or no communication to the nodes
- Must verify very quickly after node retrieval that the data are good—node by node
- Must verify that all nodes combined achieve the objectives
  - Sometimes pre-survey specification are too strict, sometimes too loose

Features

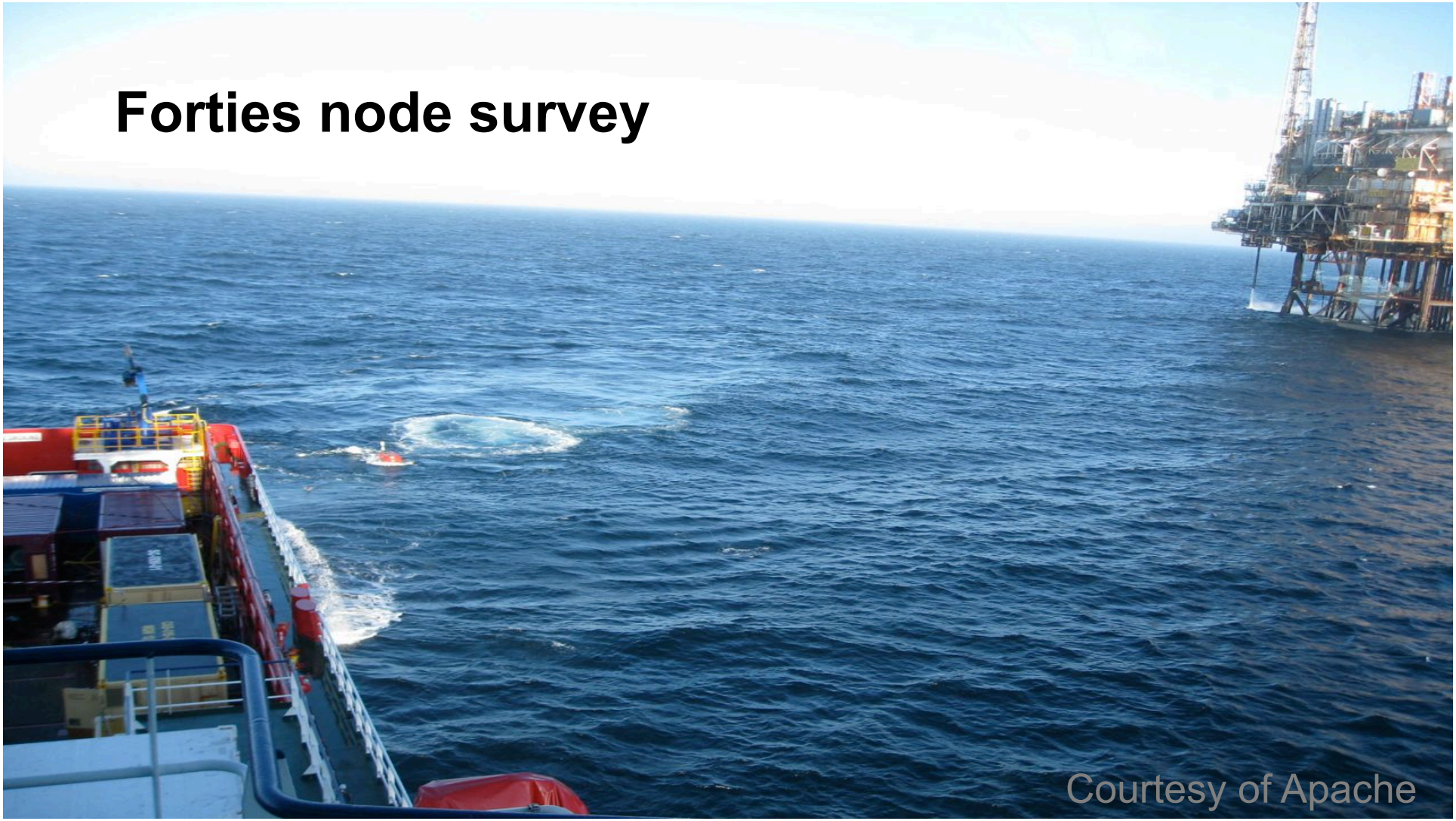
- Extensive QC
  - Signal and noises
  - Positions
  - Timing (clock drift)
- Automation
  - All nodes are checked (thousands)
- Data hand over: Reproducibility
  - Ought to be able to reproduce the onboard QC

Display raw data

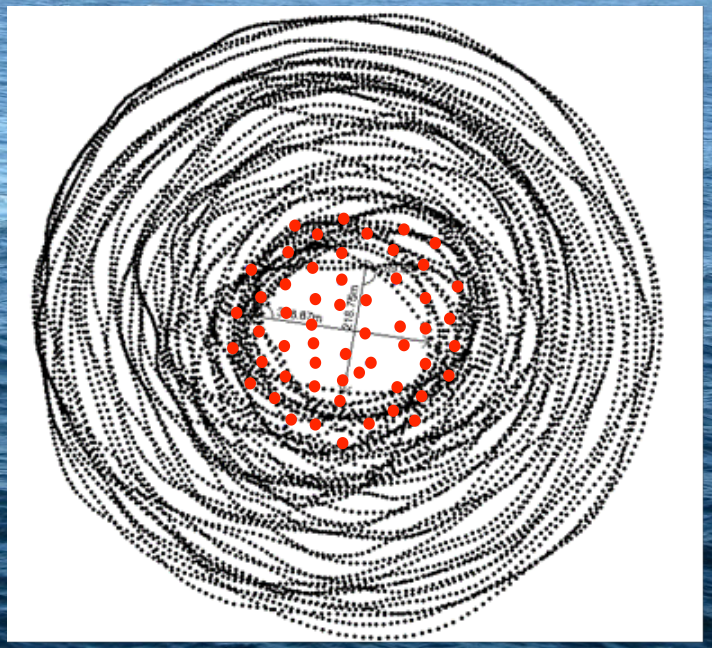


Courtesy of Apache

Forties node survey



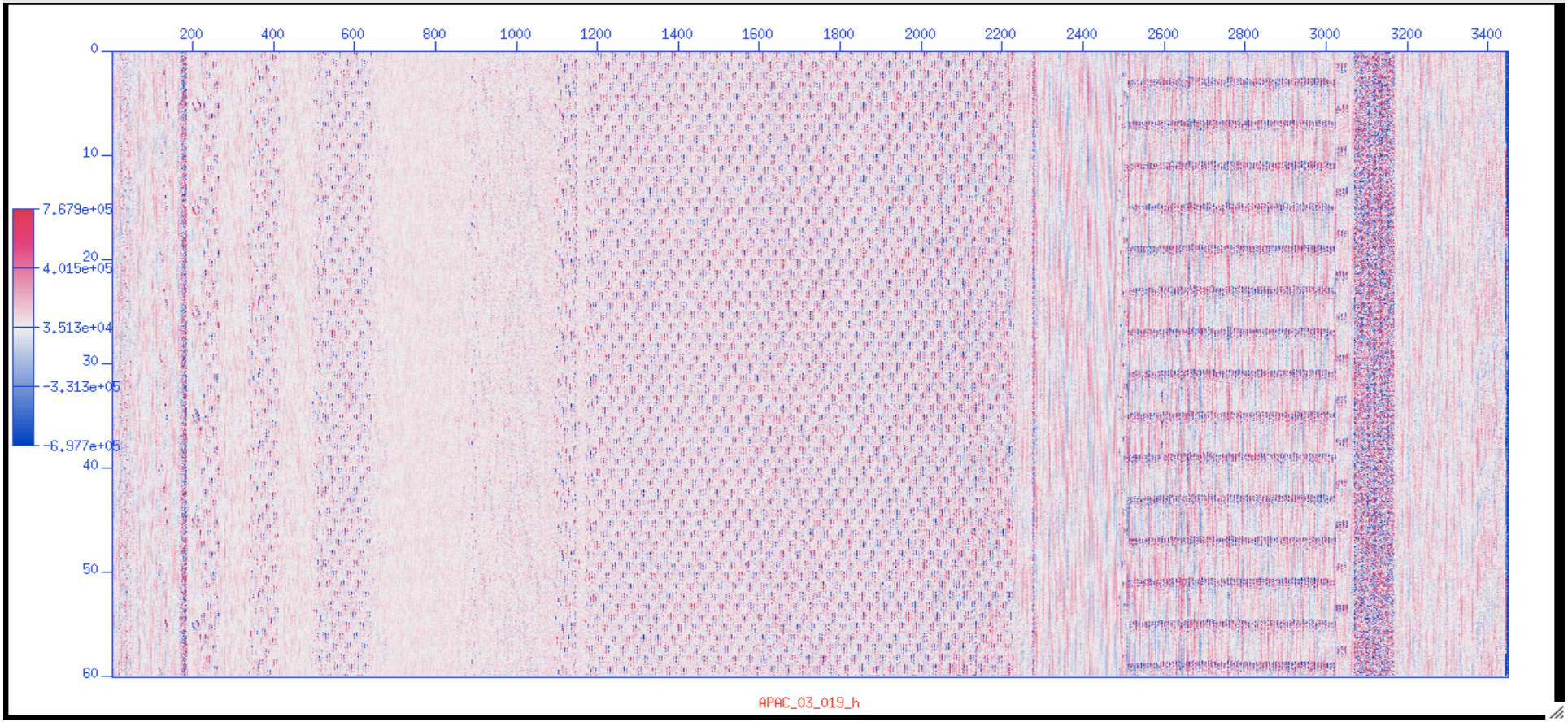
Forties node survey



Courtesy of Apache

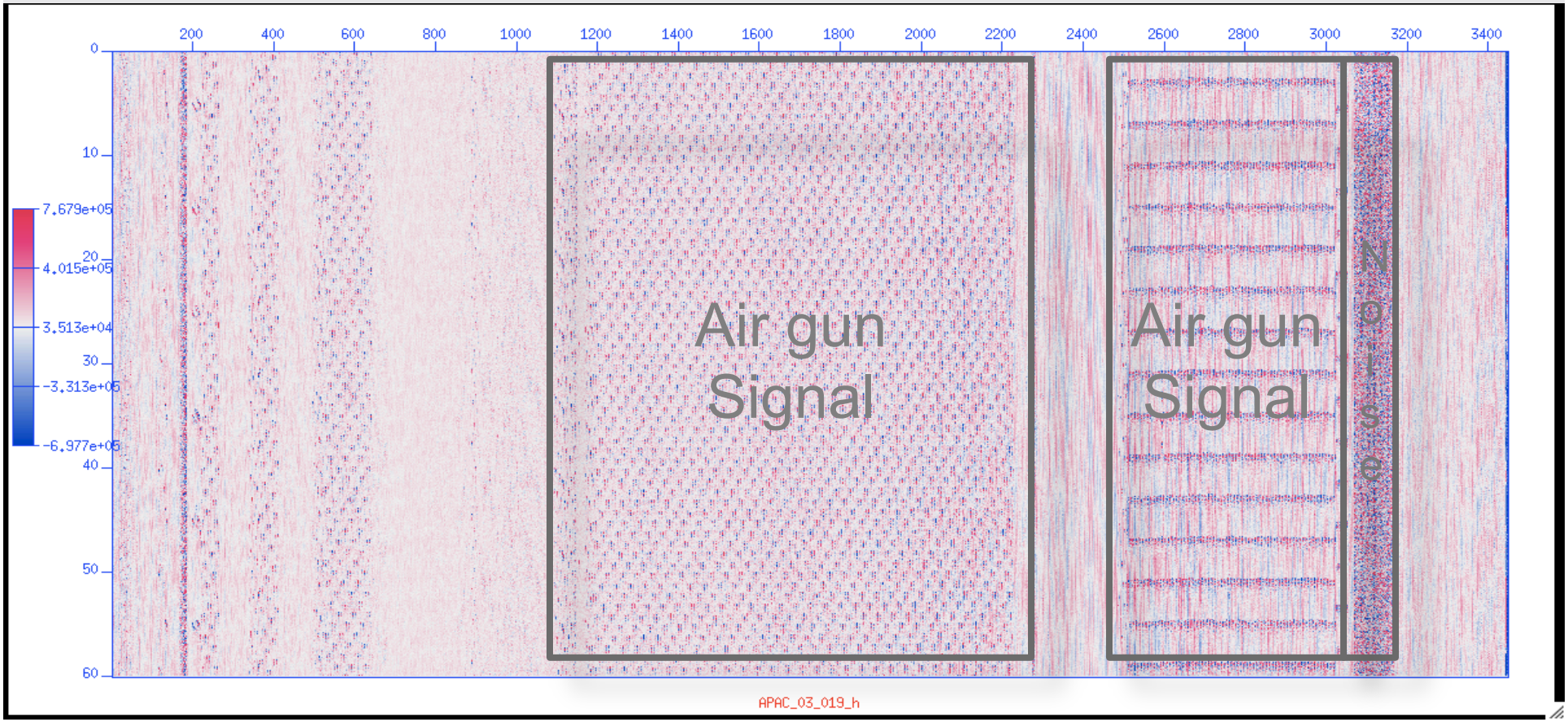
Passive data

Courtesy of Apache

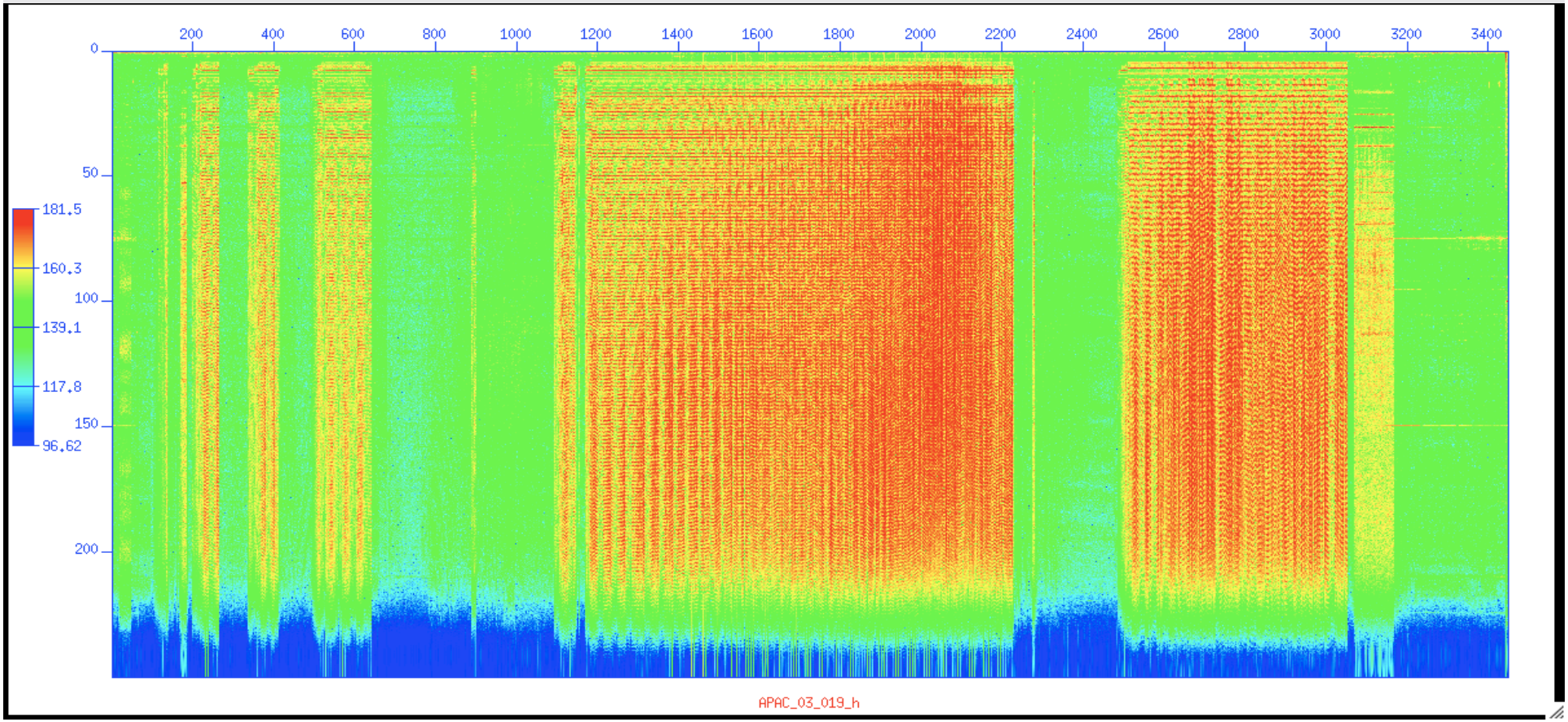


Passive data

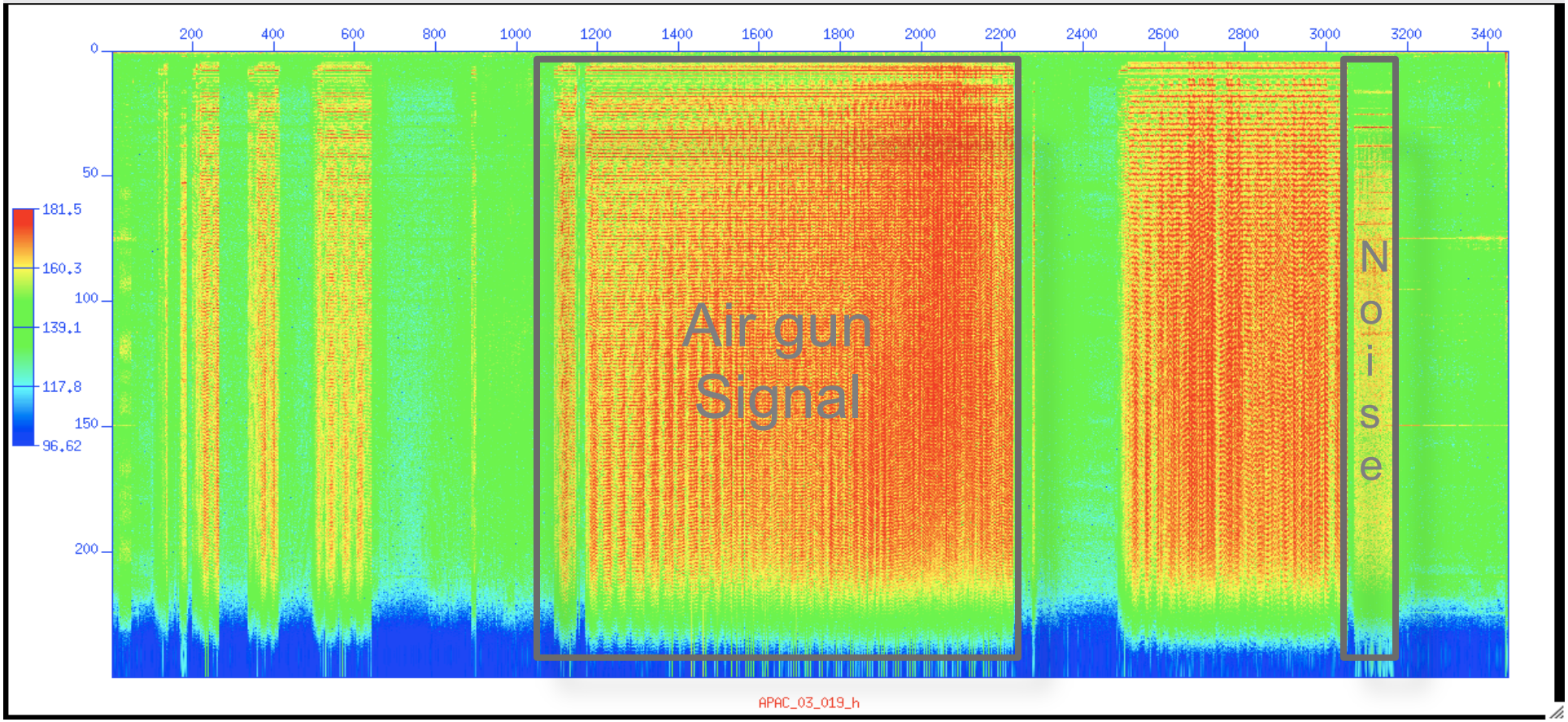
Courtesy of Apache



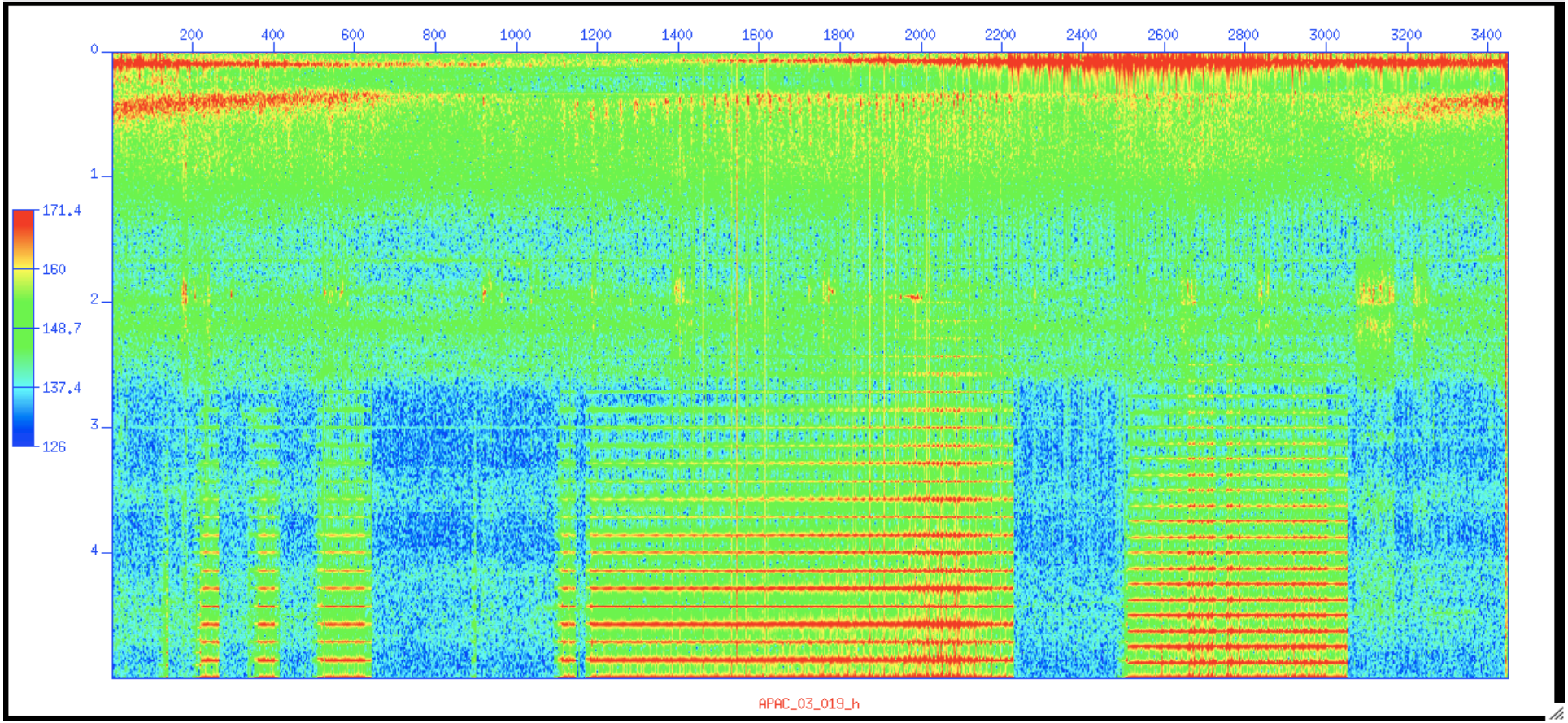
Passive data spectra 0-250Hz



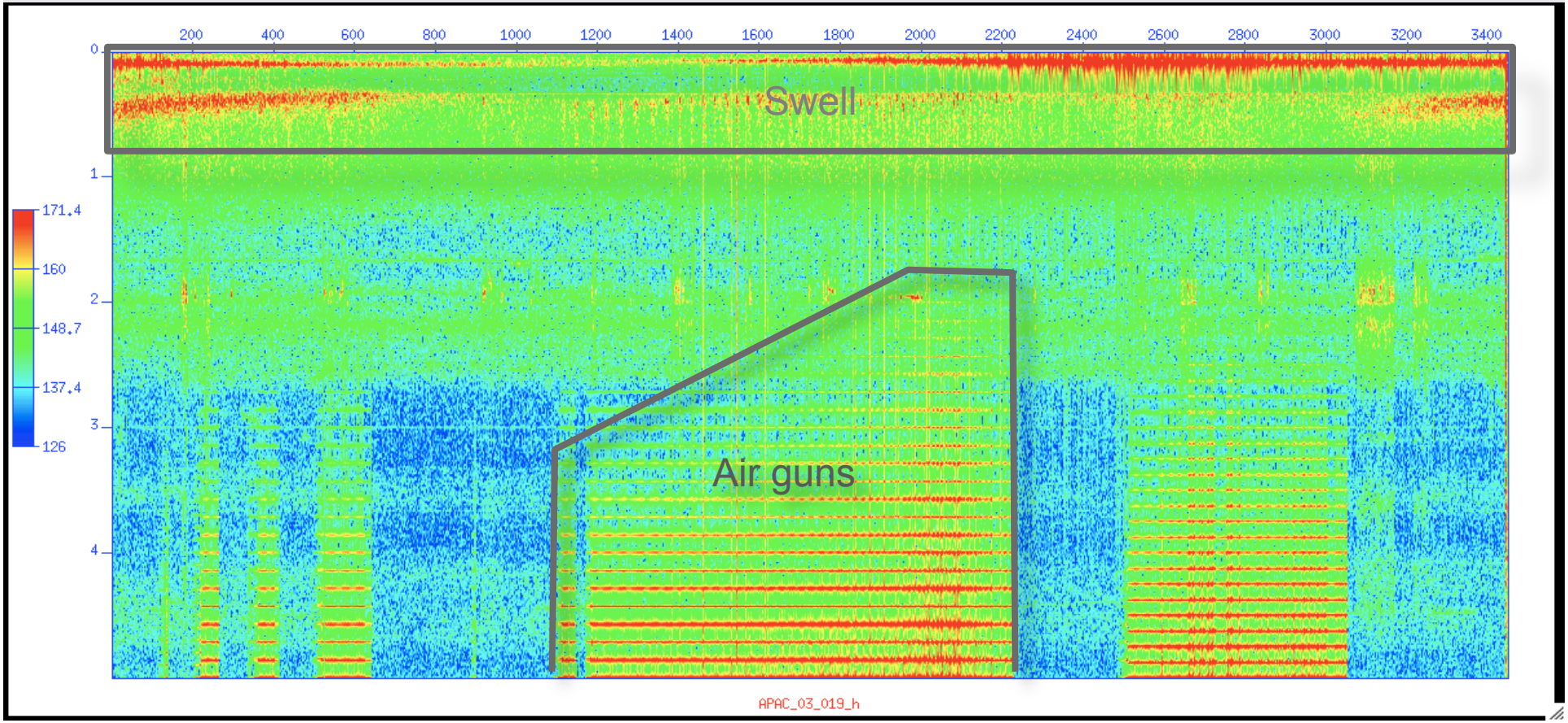
Passive data spectra 0-250Hz

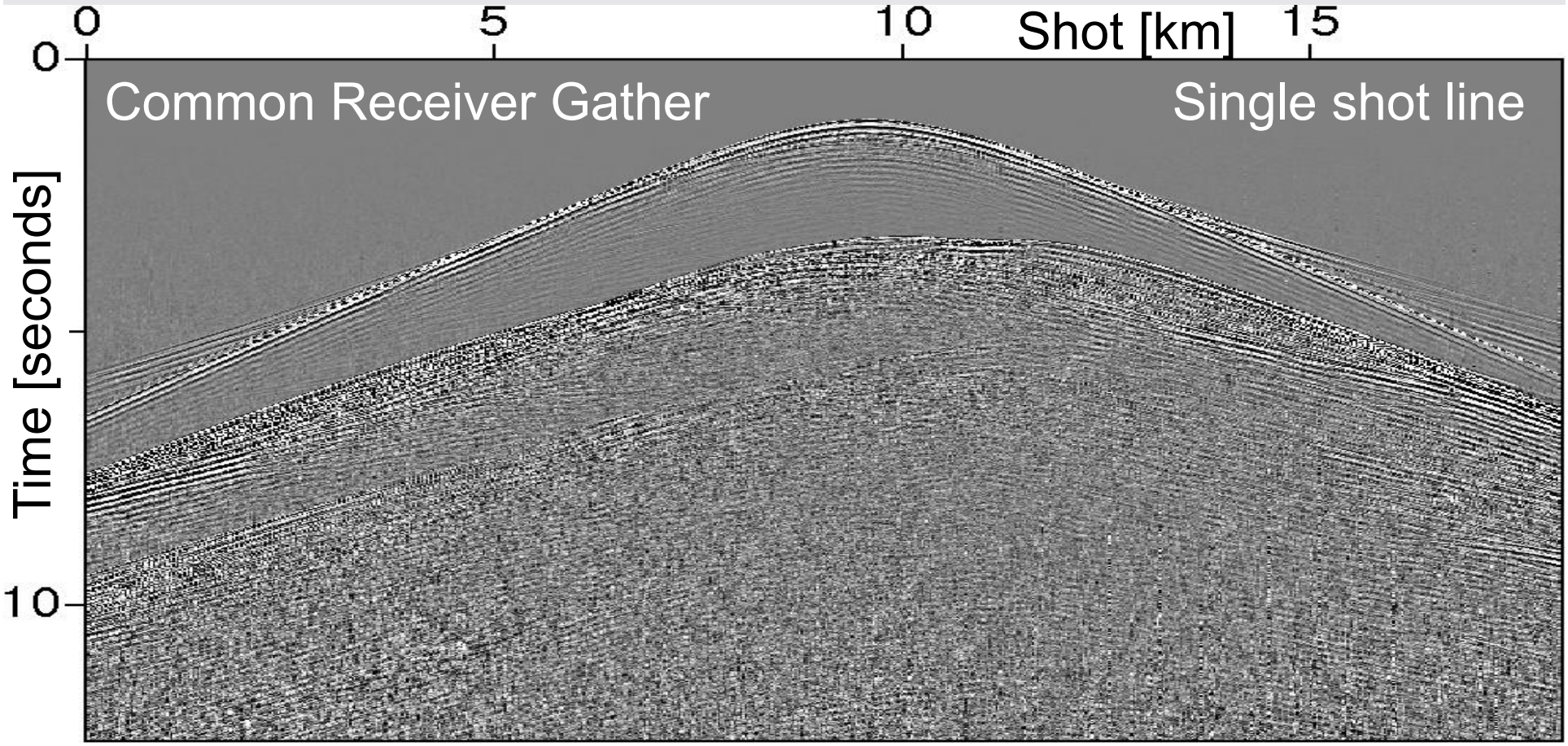


Passive data spectra 0-5Hz

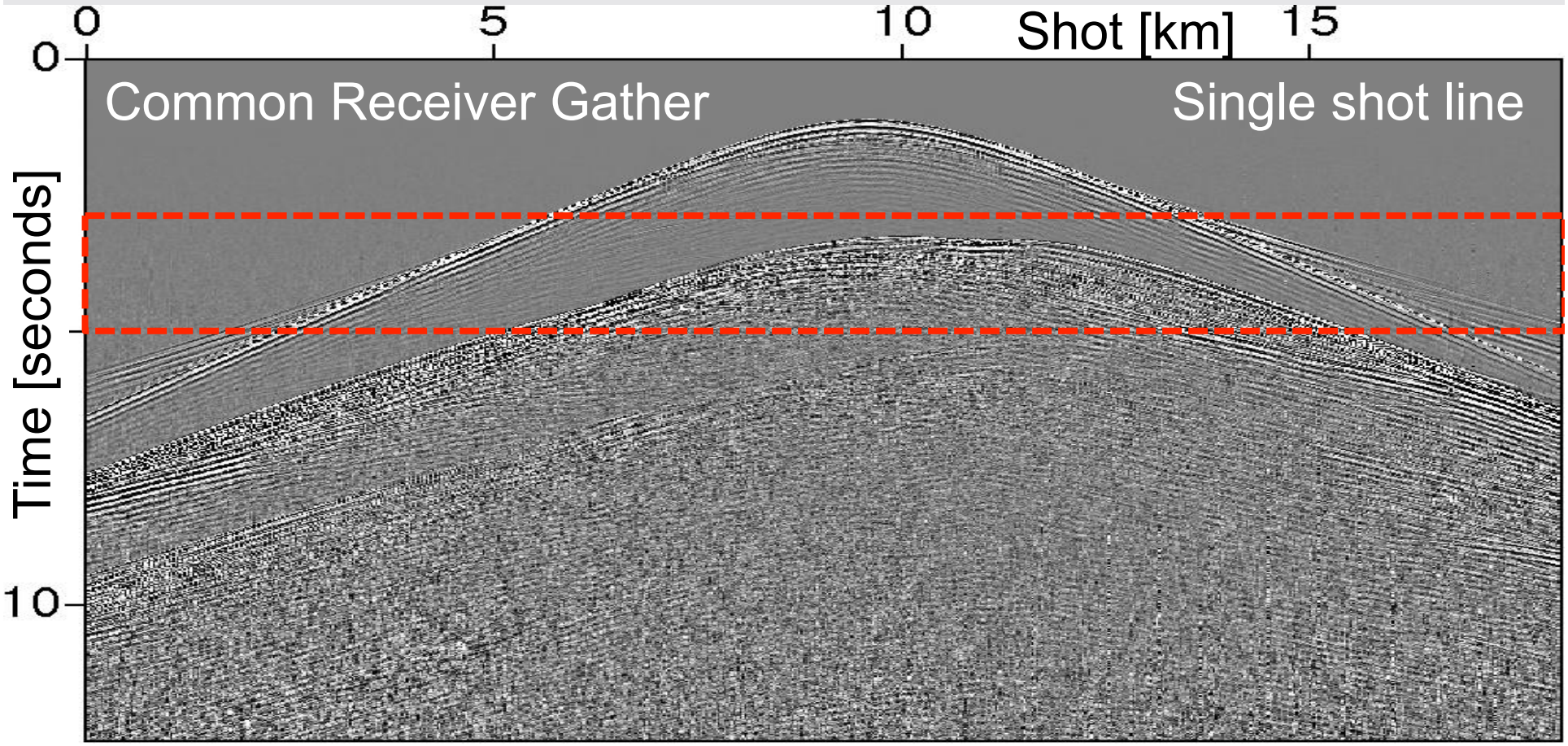


Passive data spectra 0-5Hz





Non Exclusive GoM node survey, Courtesy of Seabed Geosolutions



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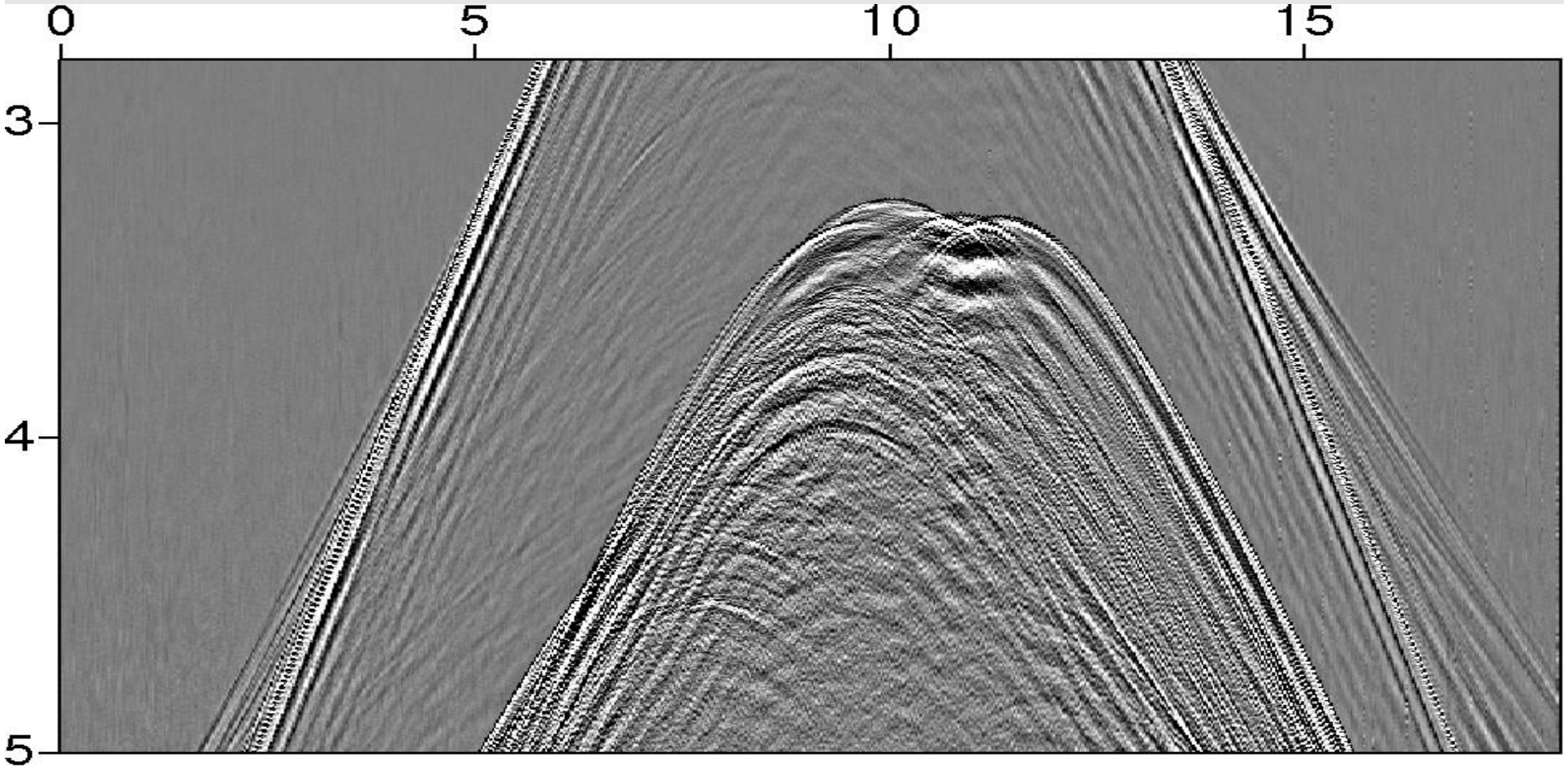
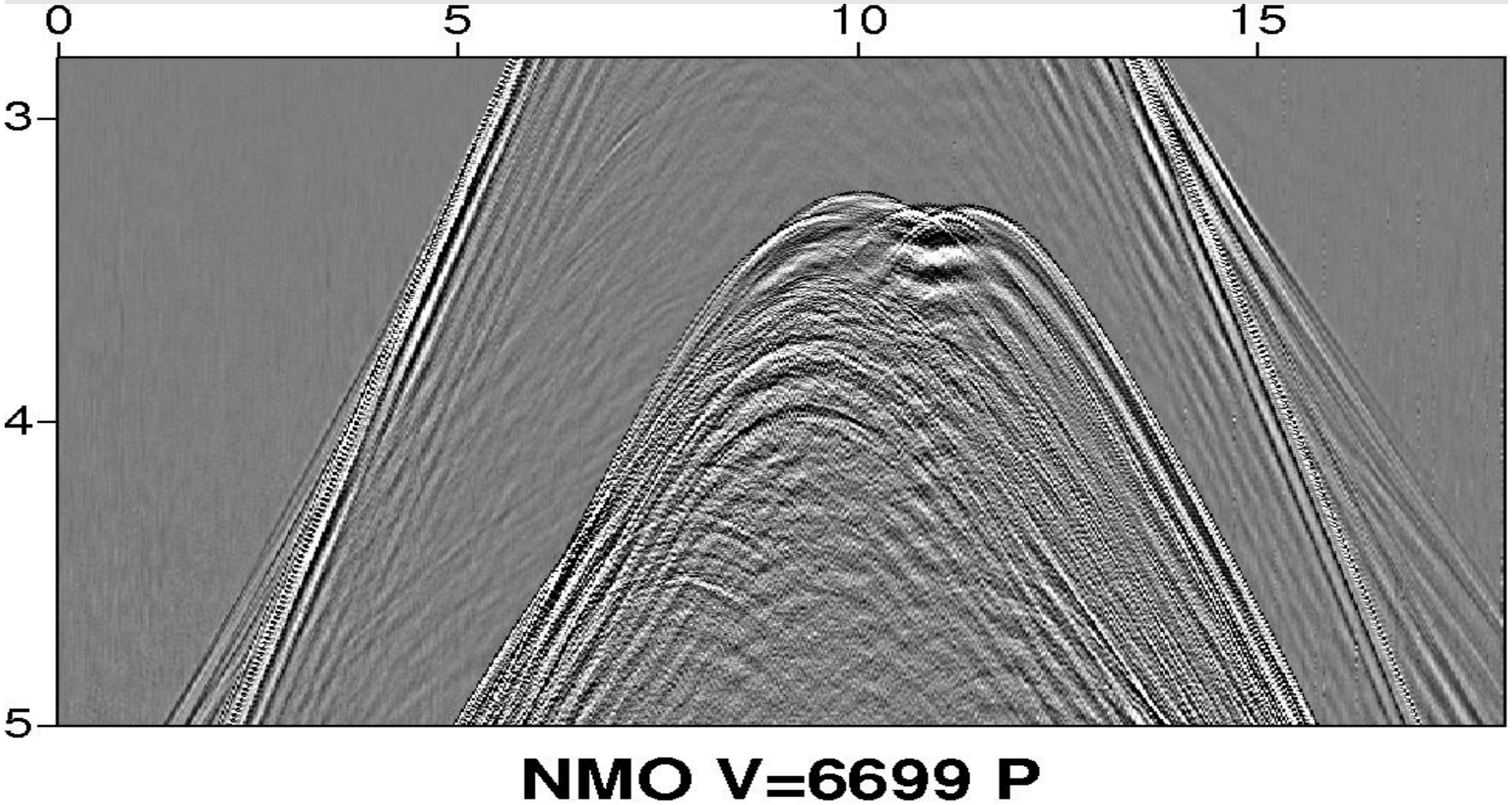


NO NMO P



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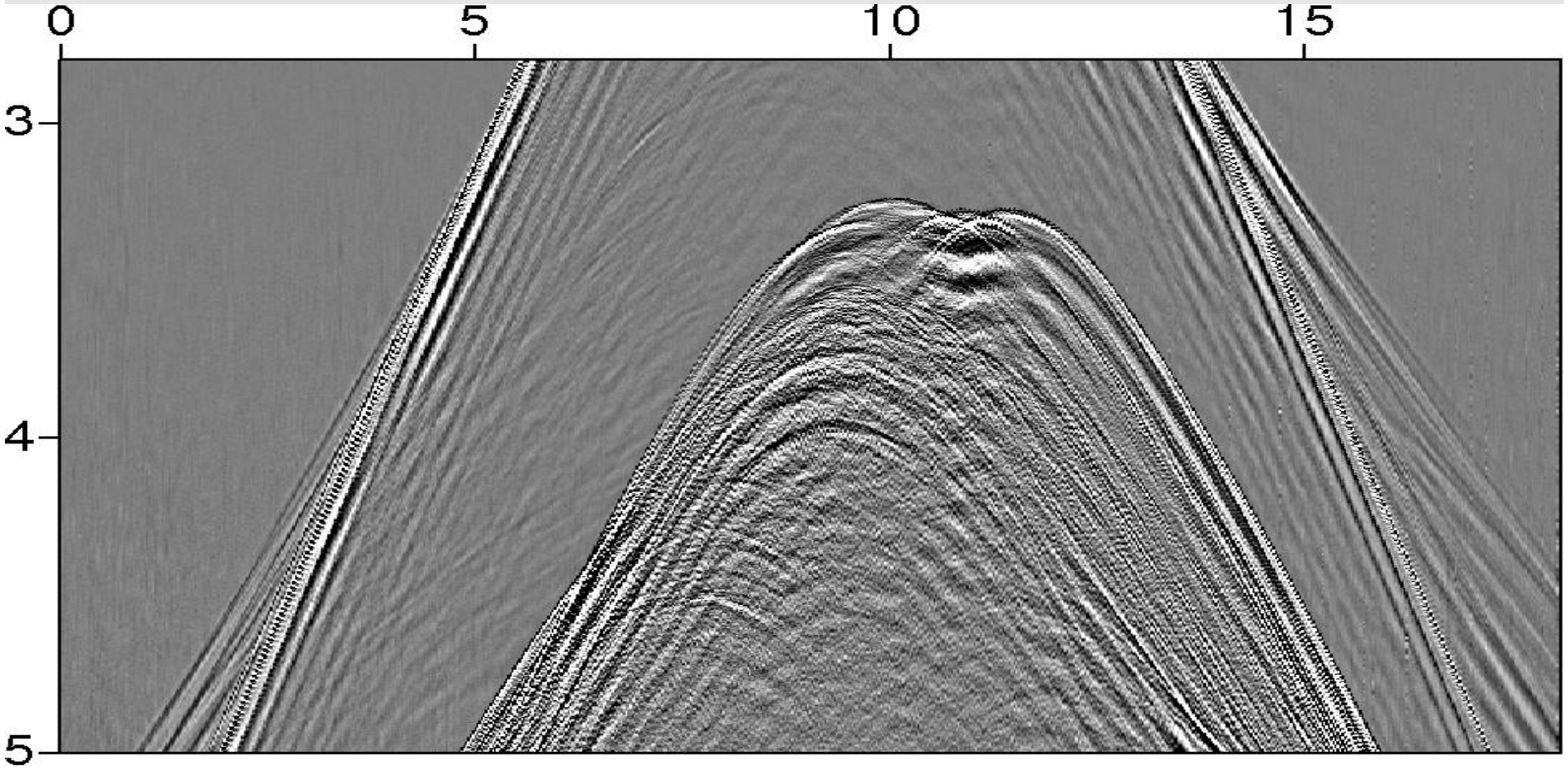

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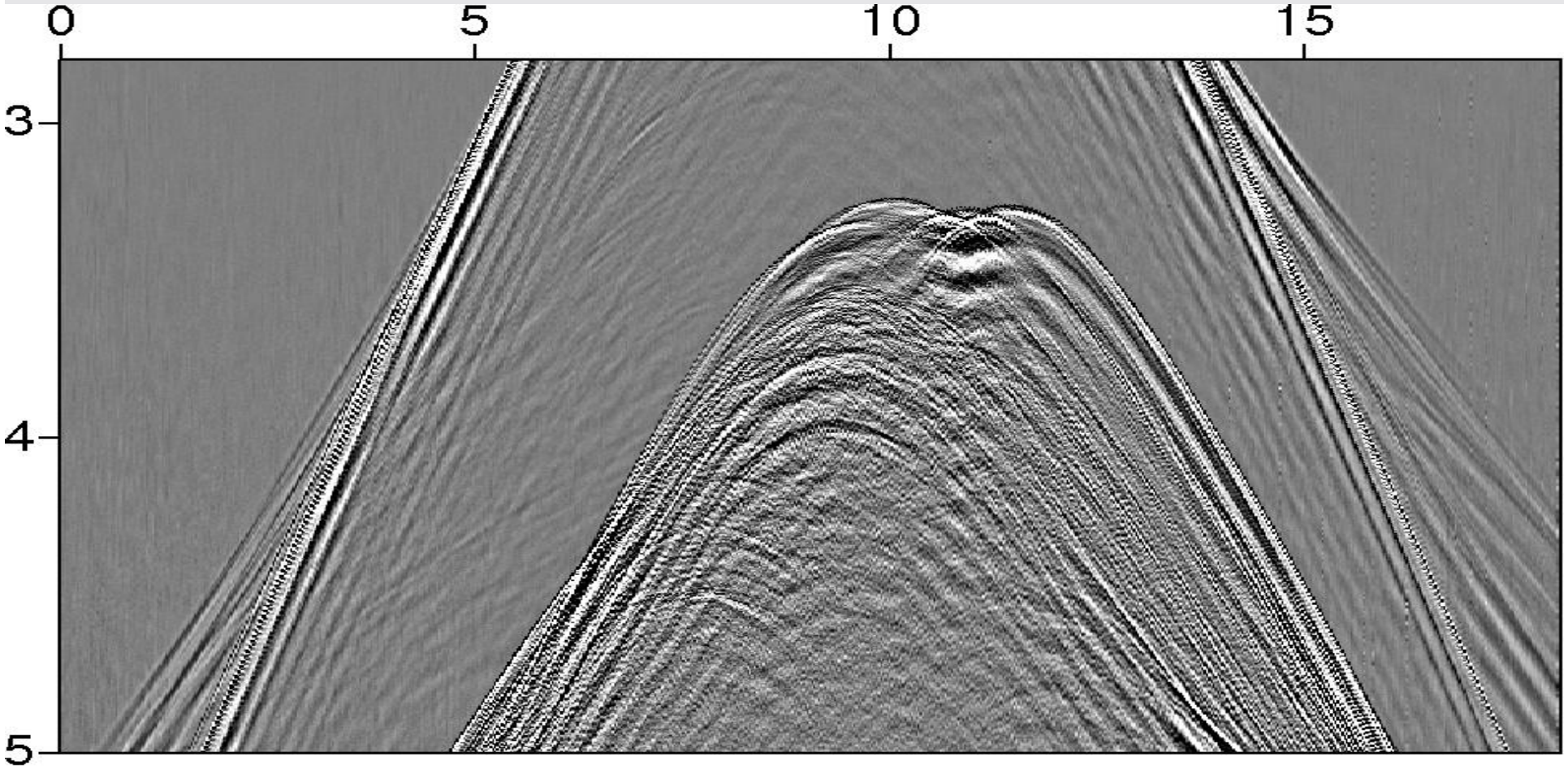

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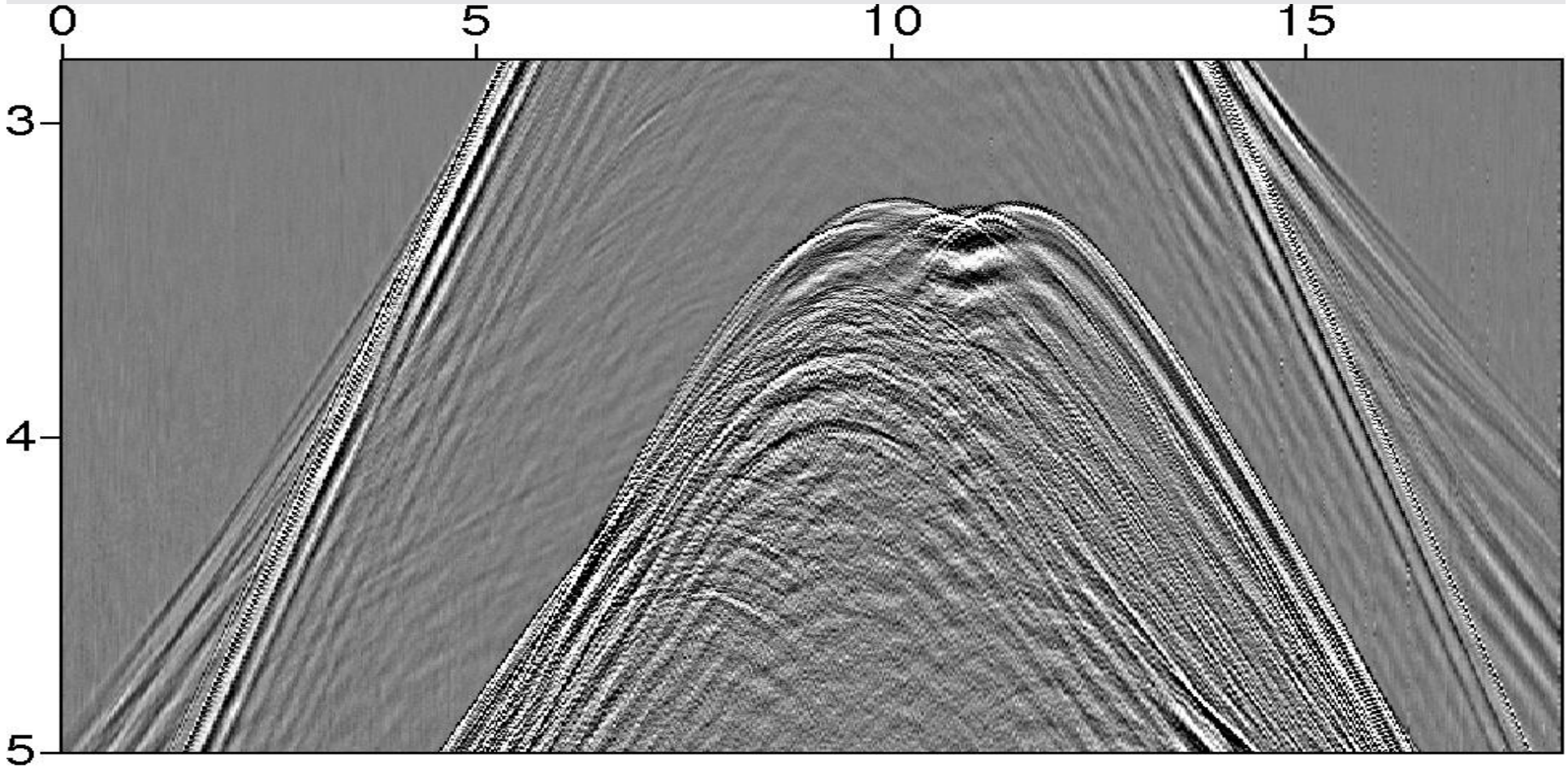

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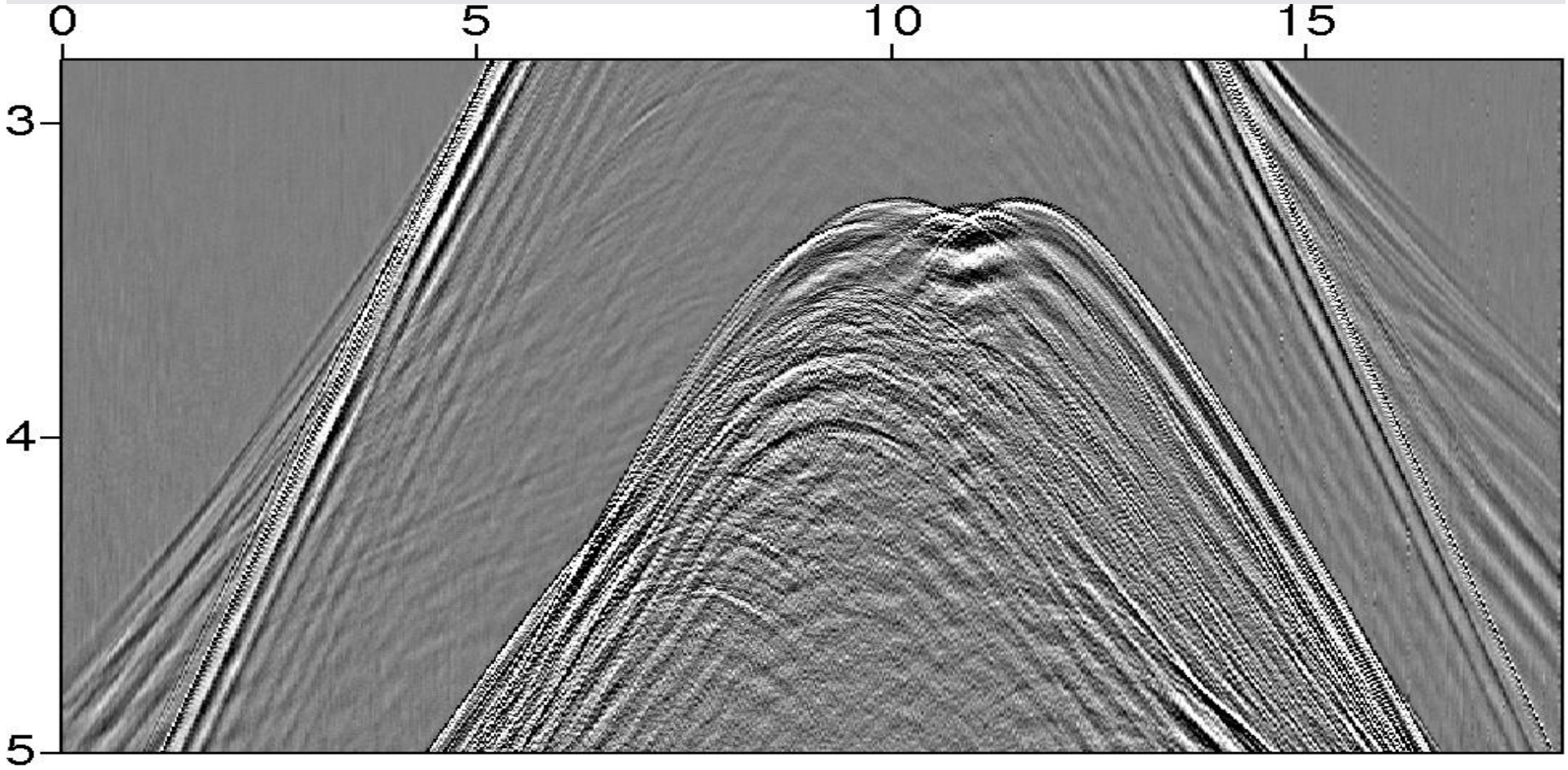

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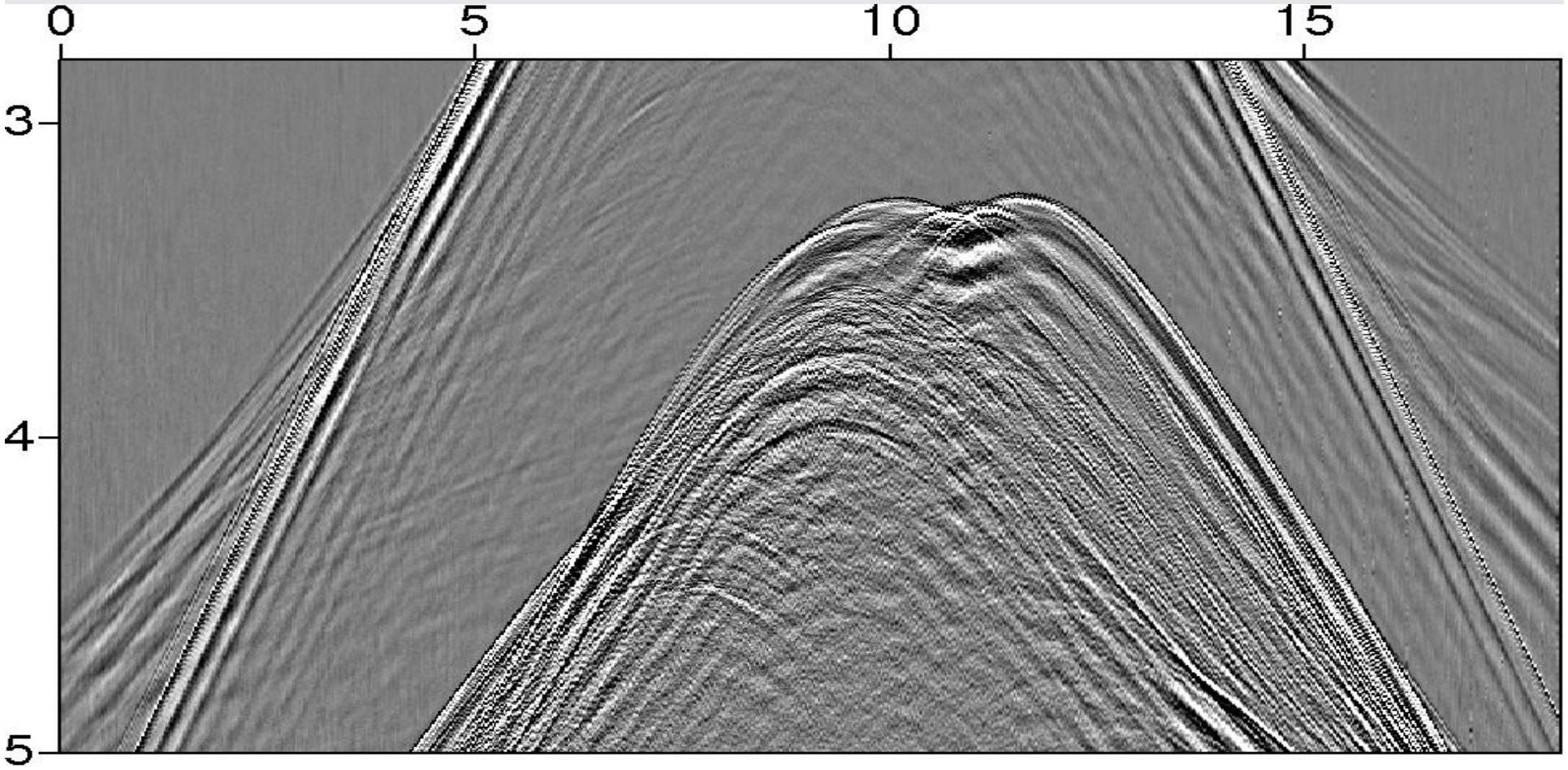

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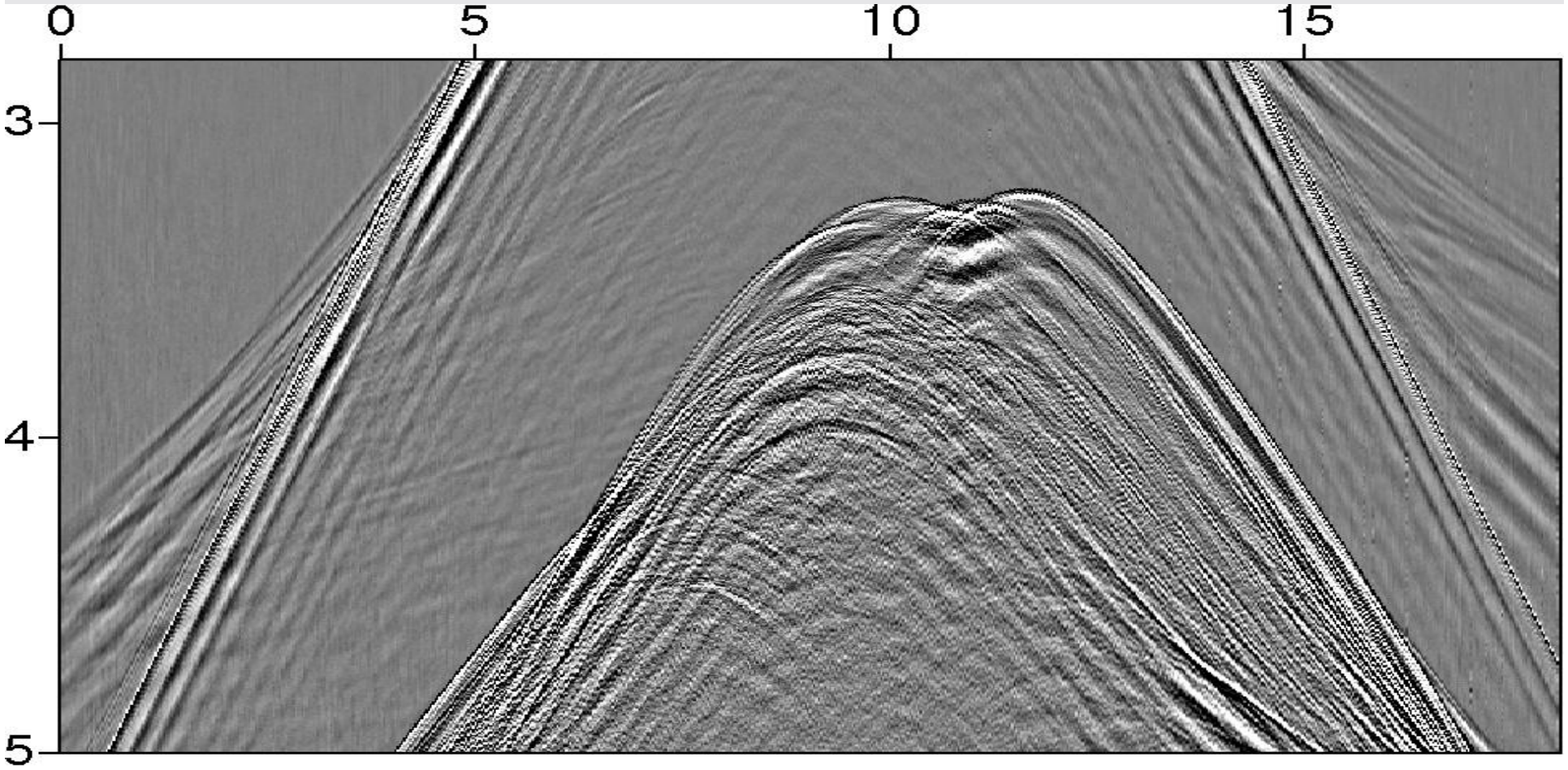

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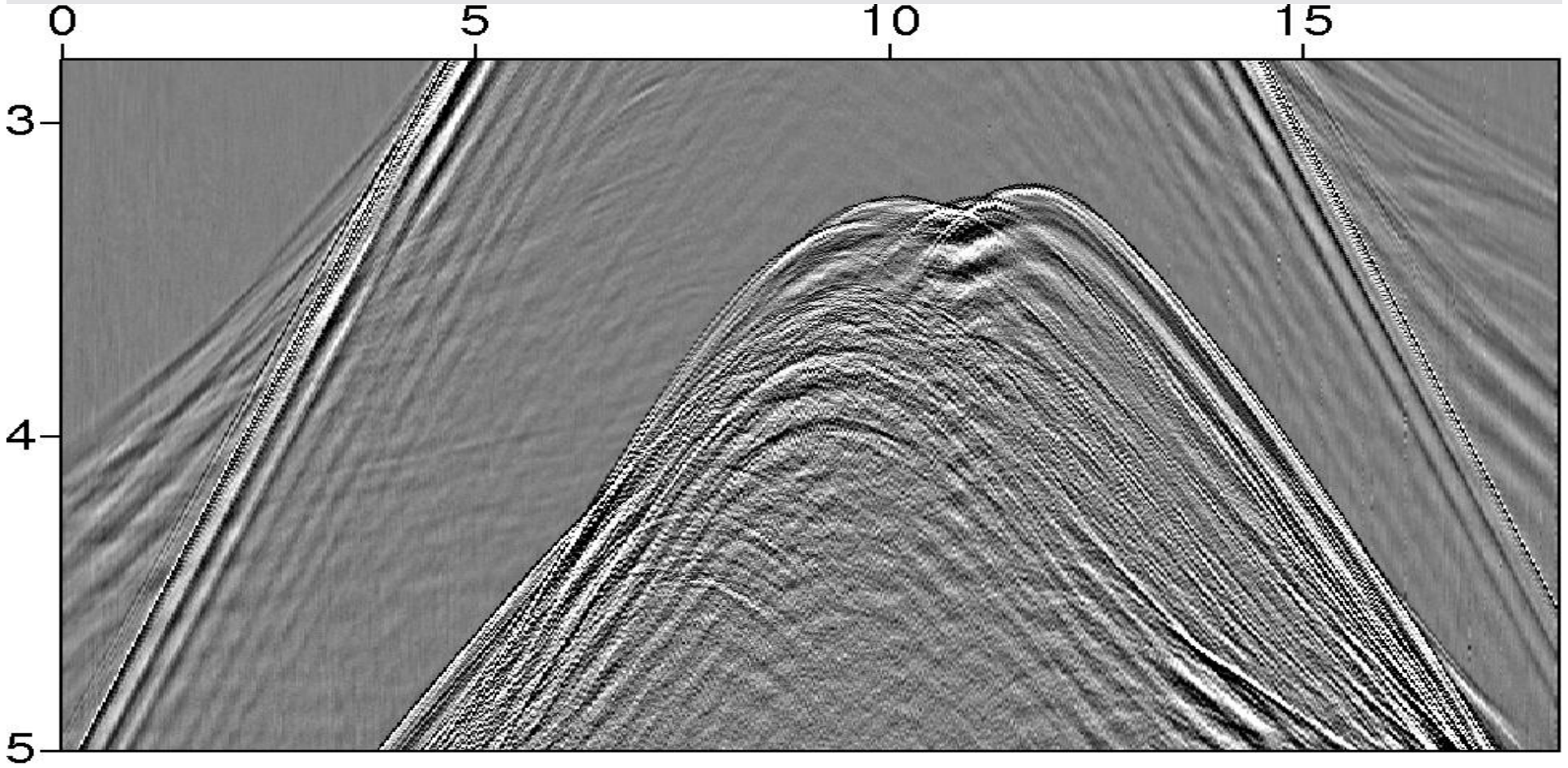

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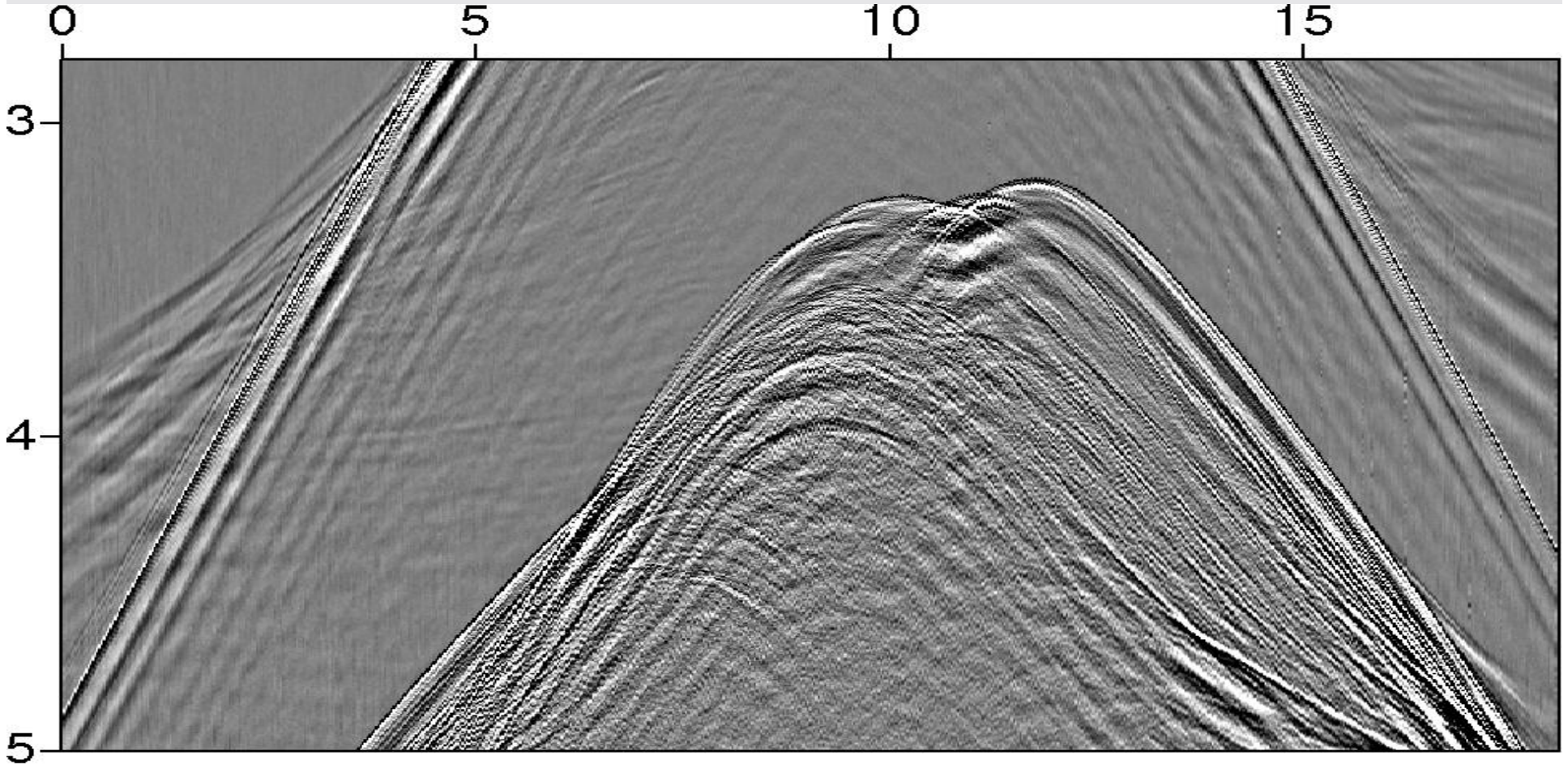

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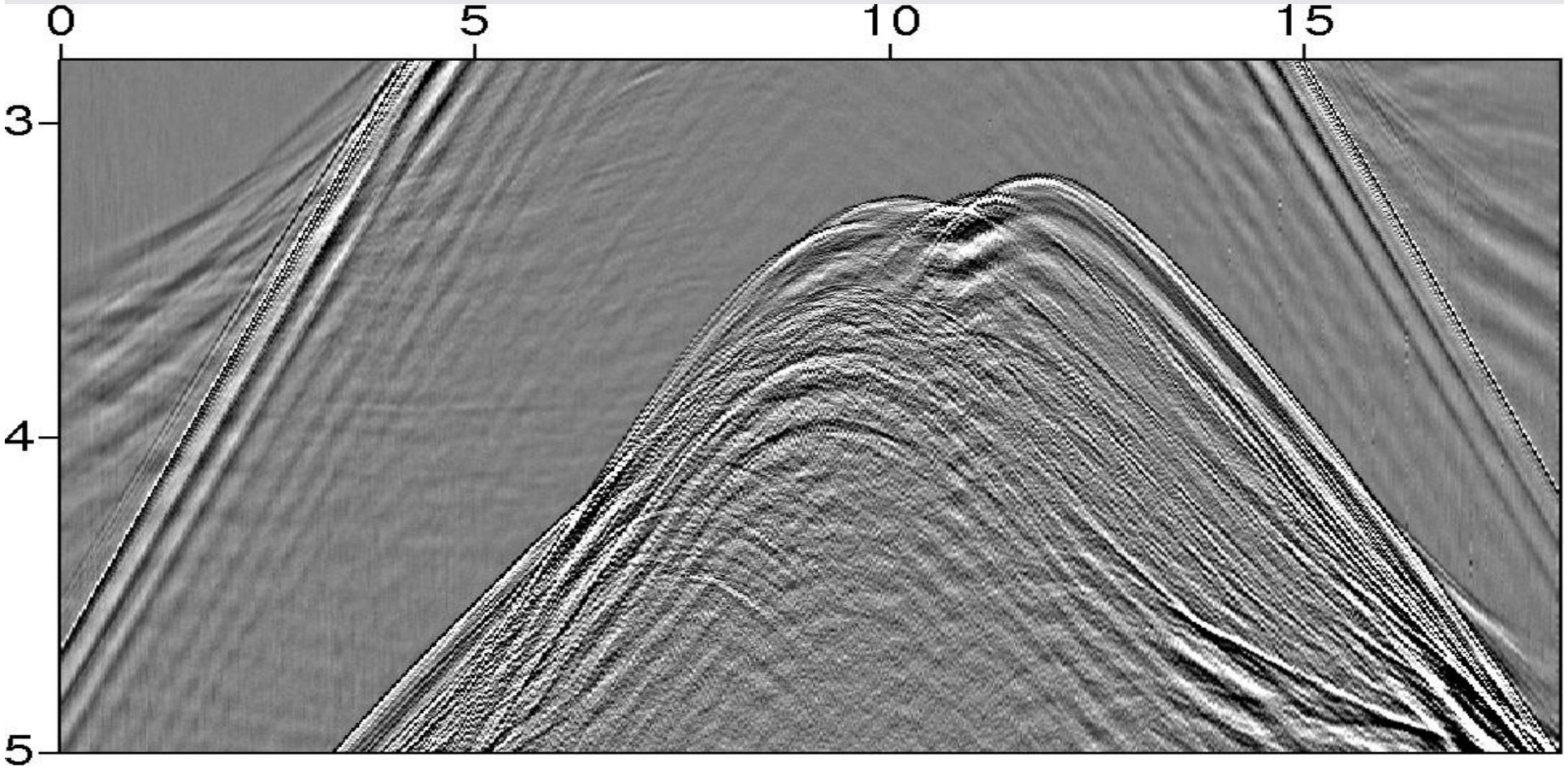

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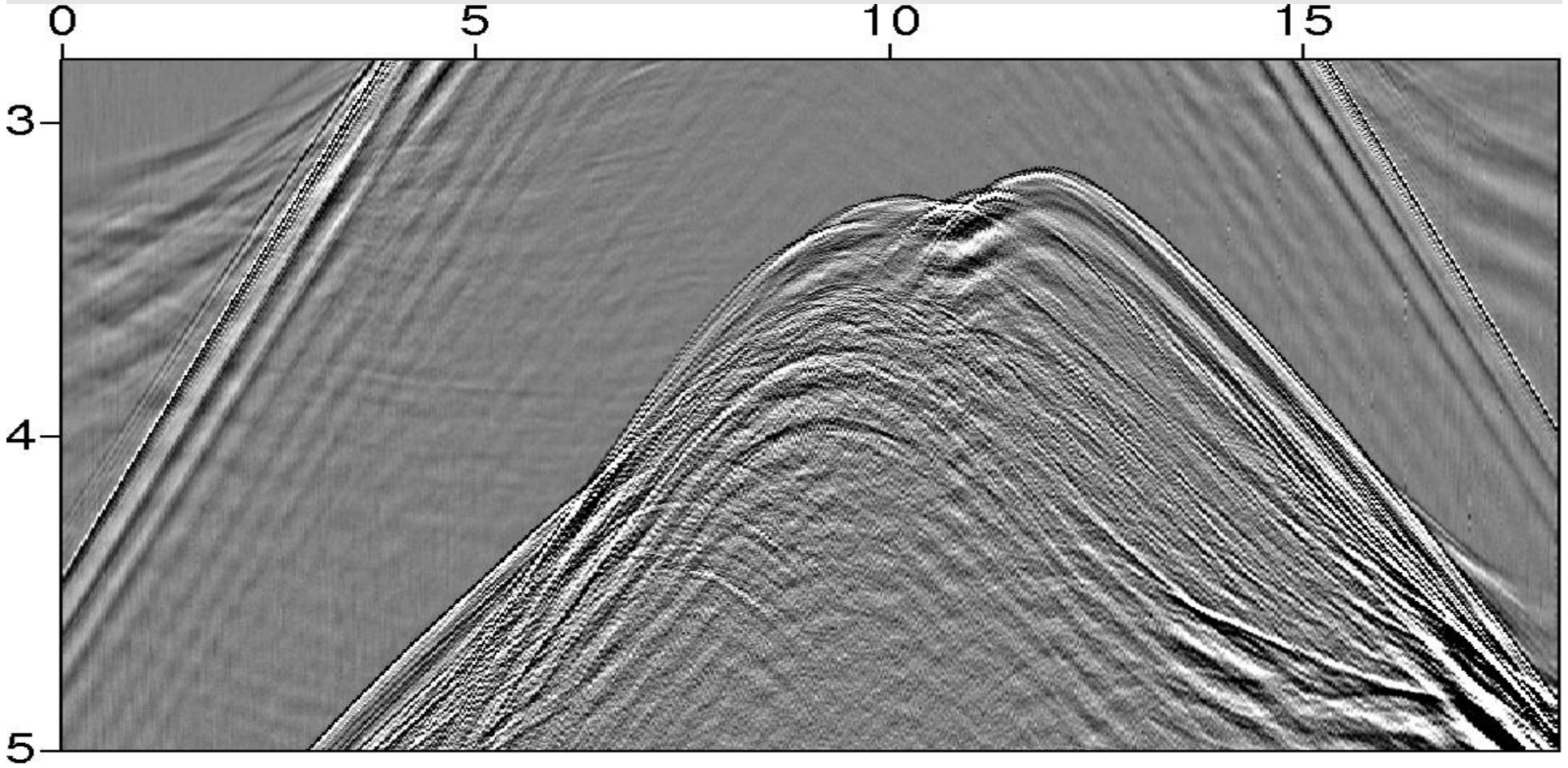
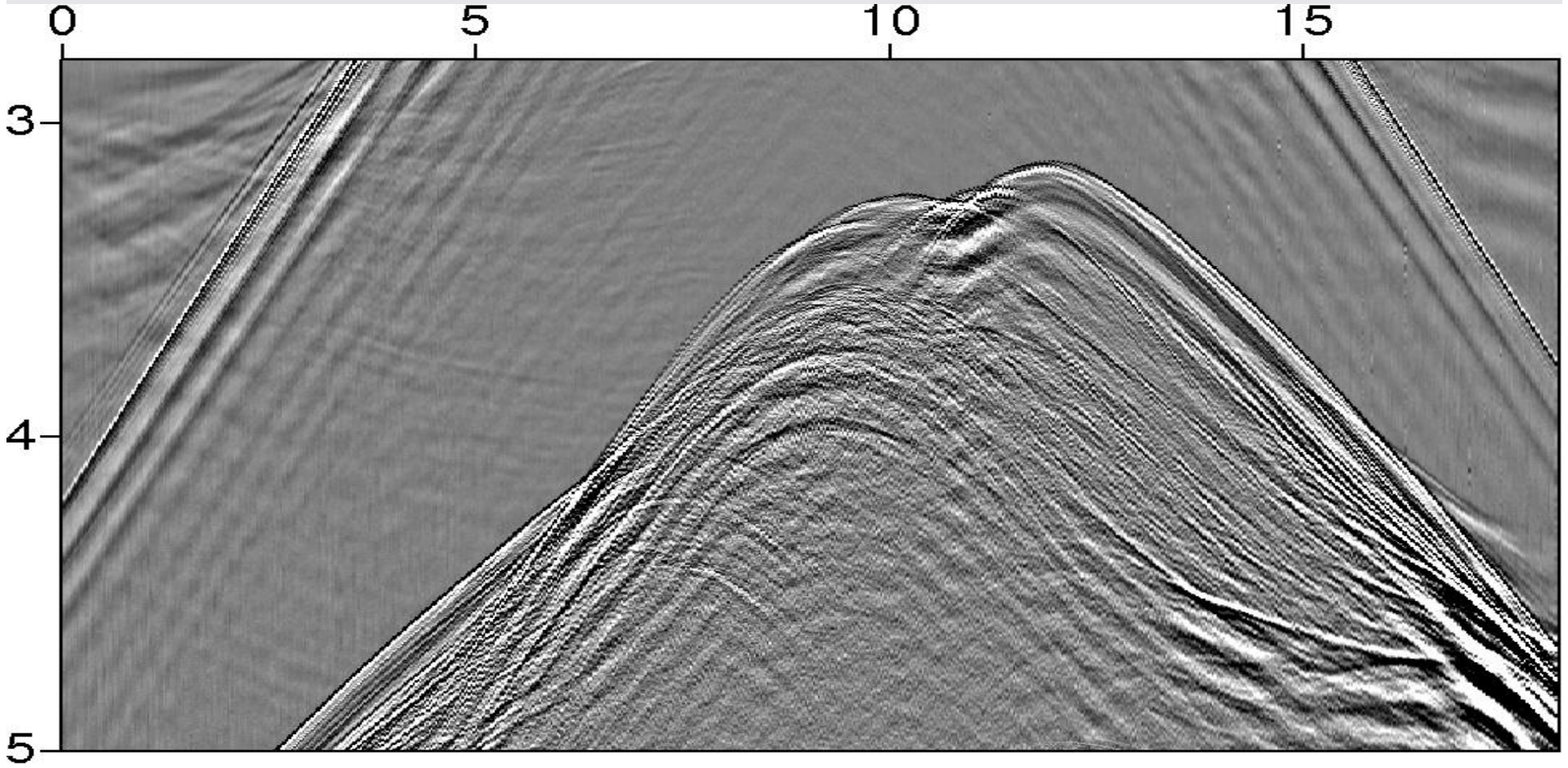


NMO V=2020 P



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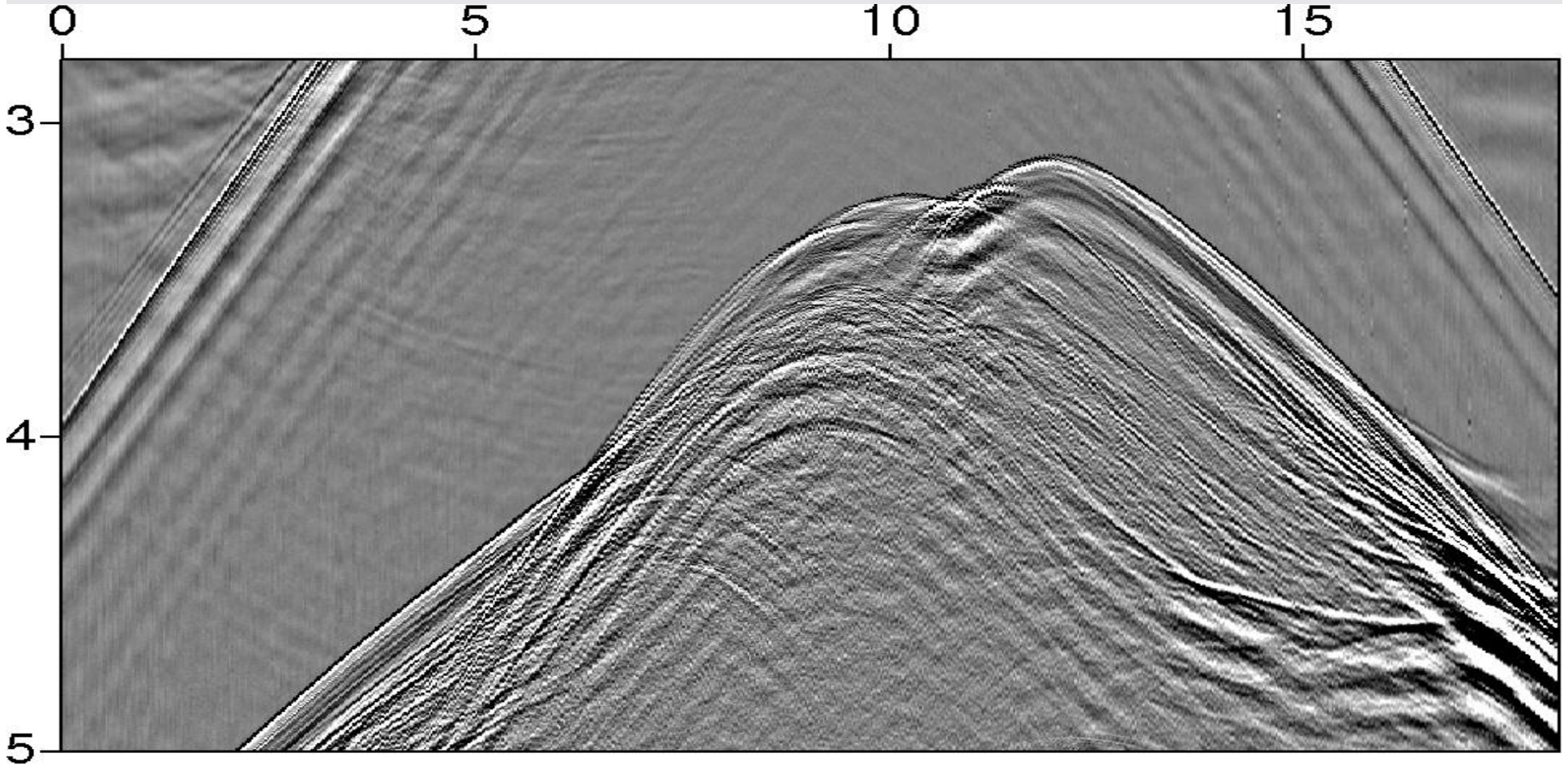

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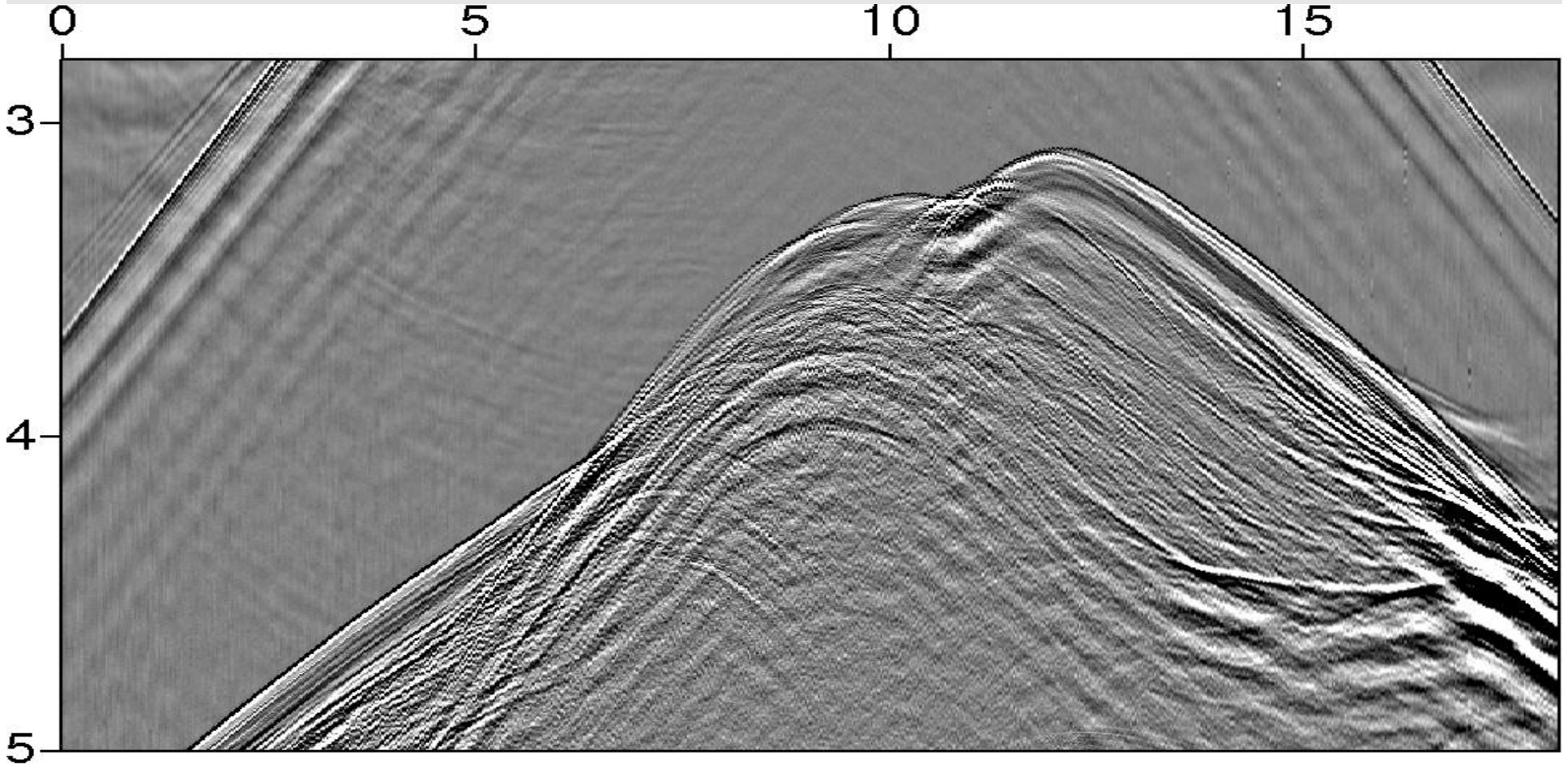

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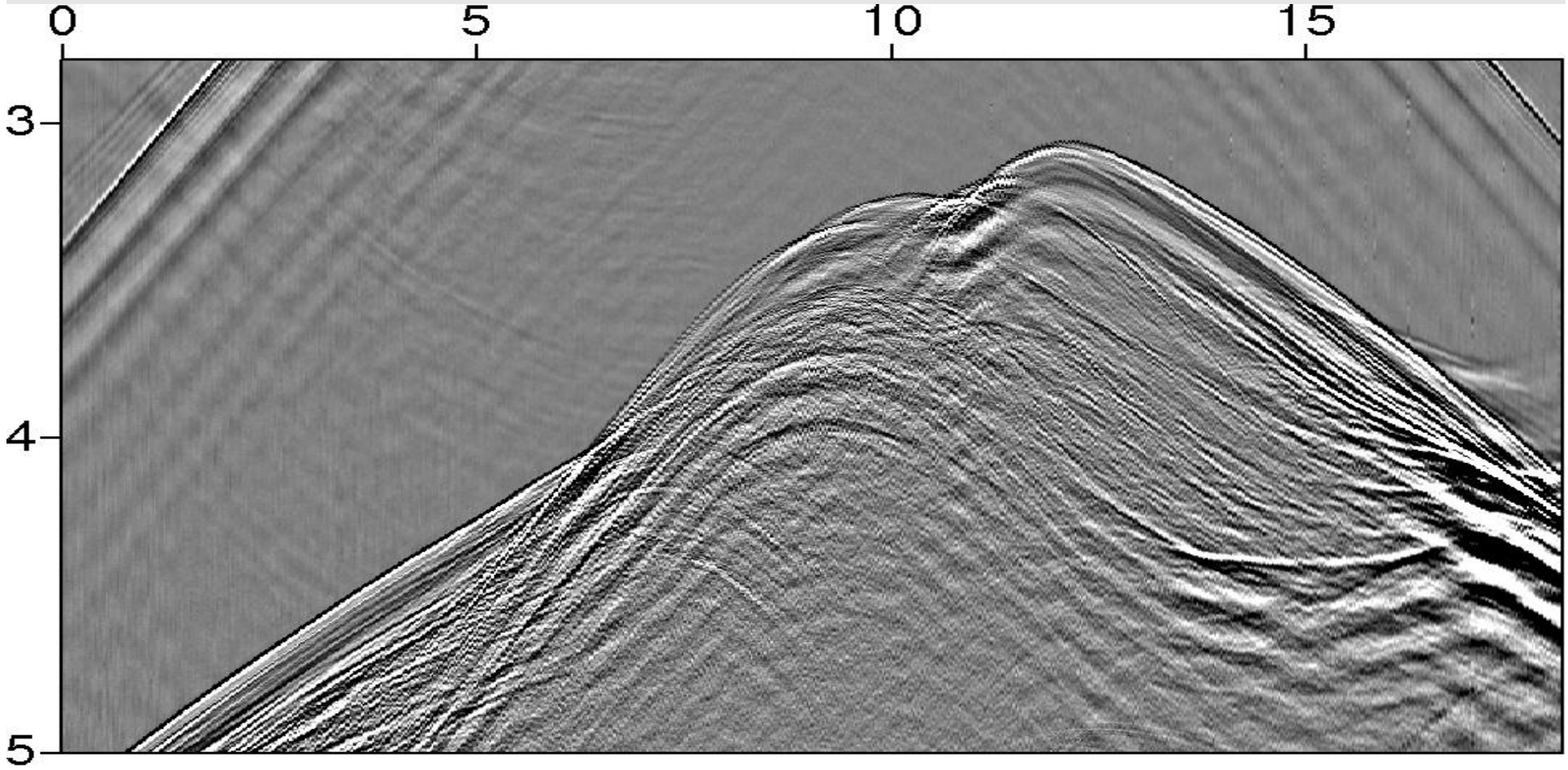

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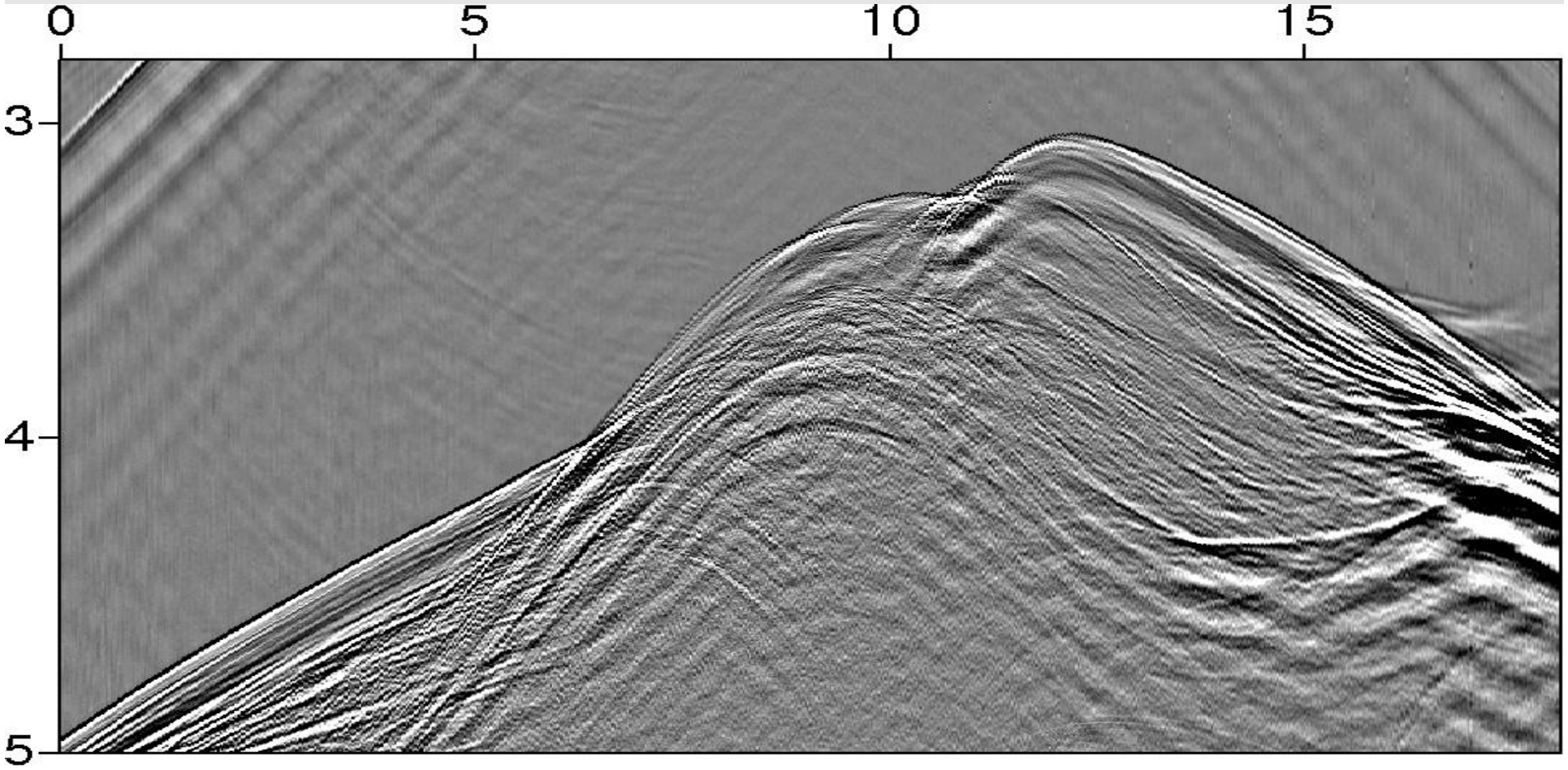

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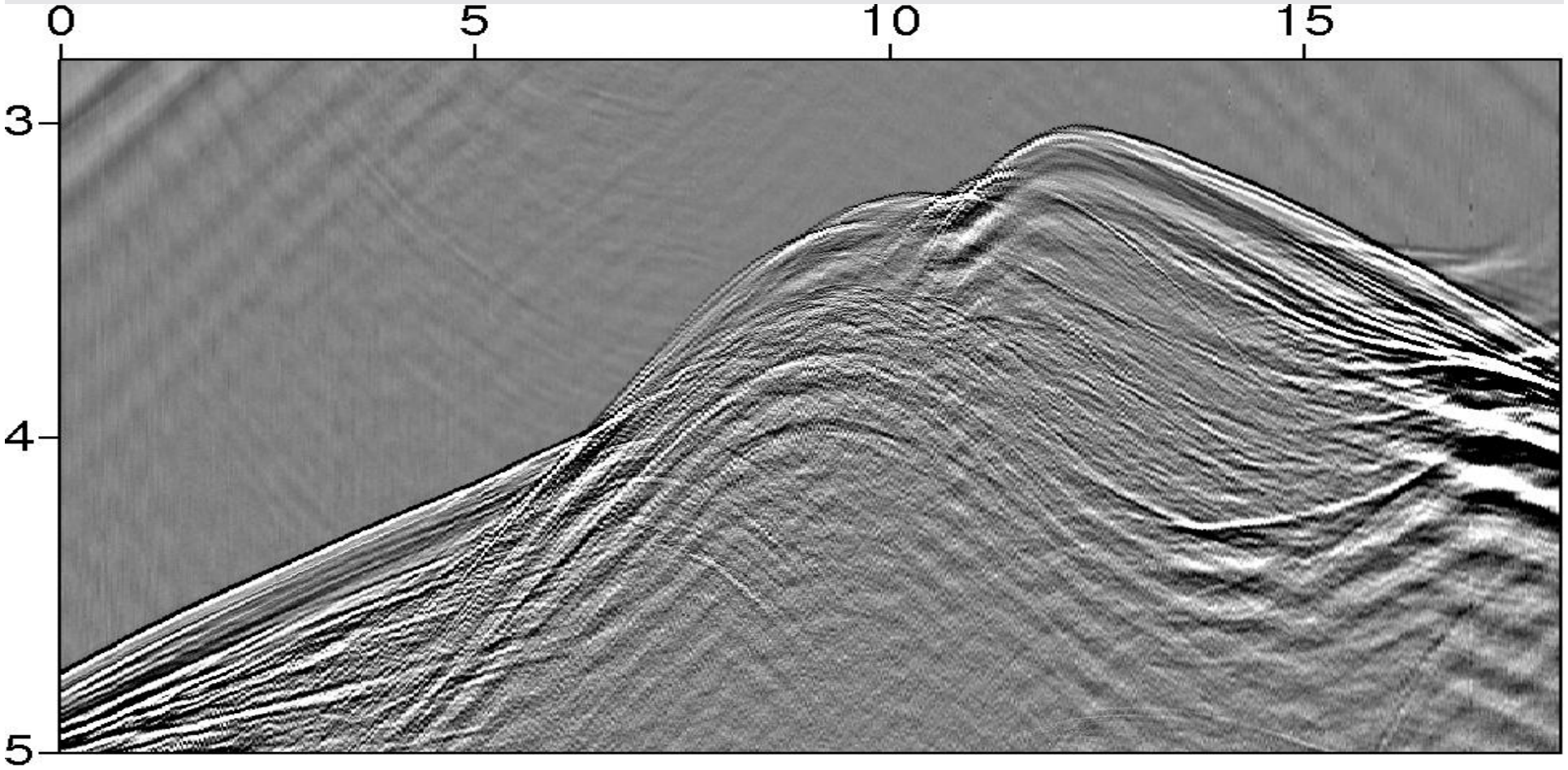

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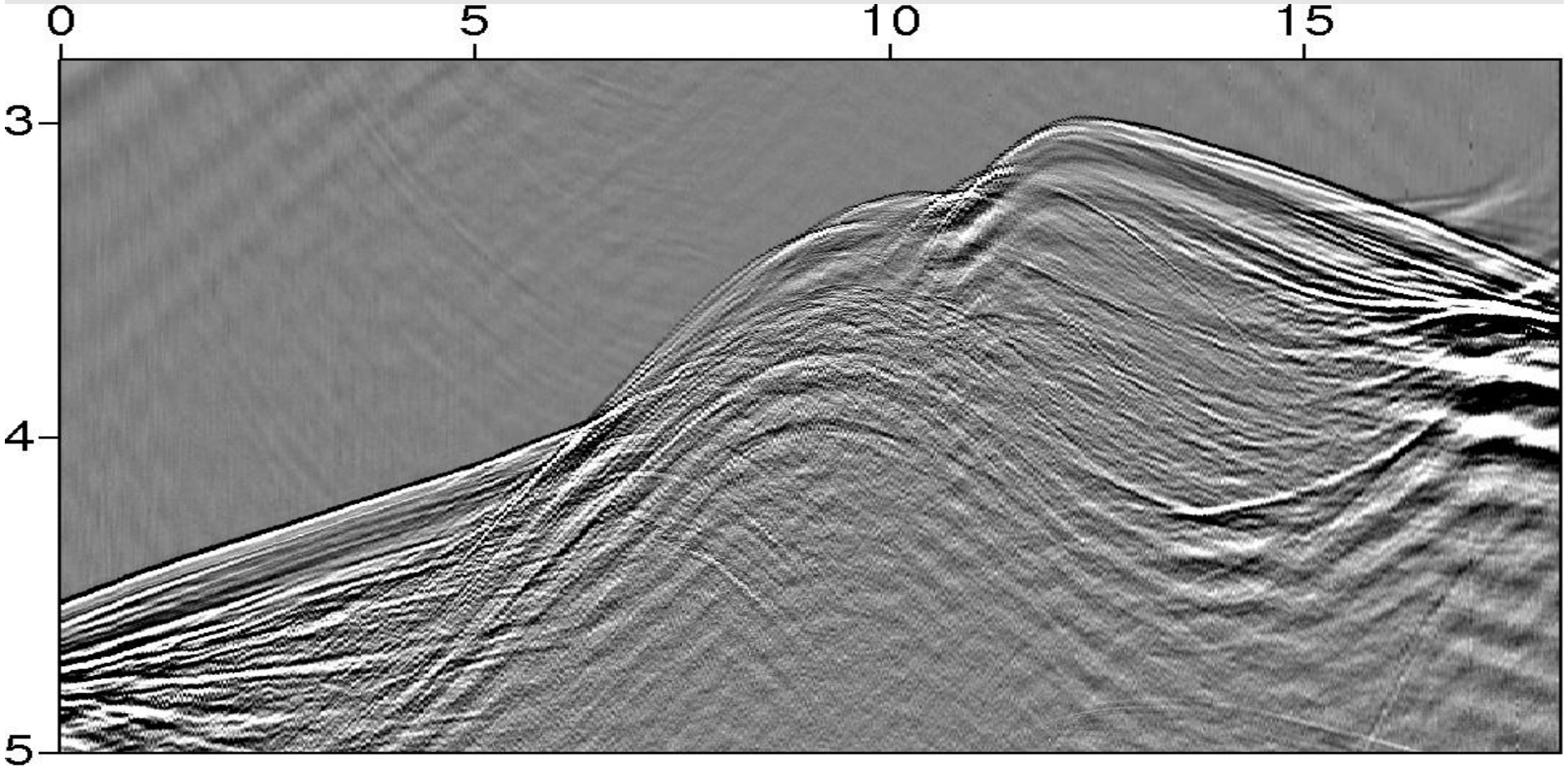

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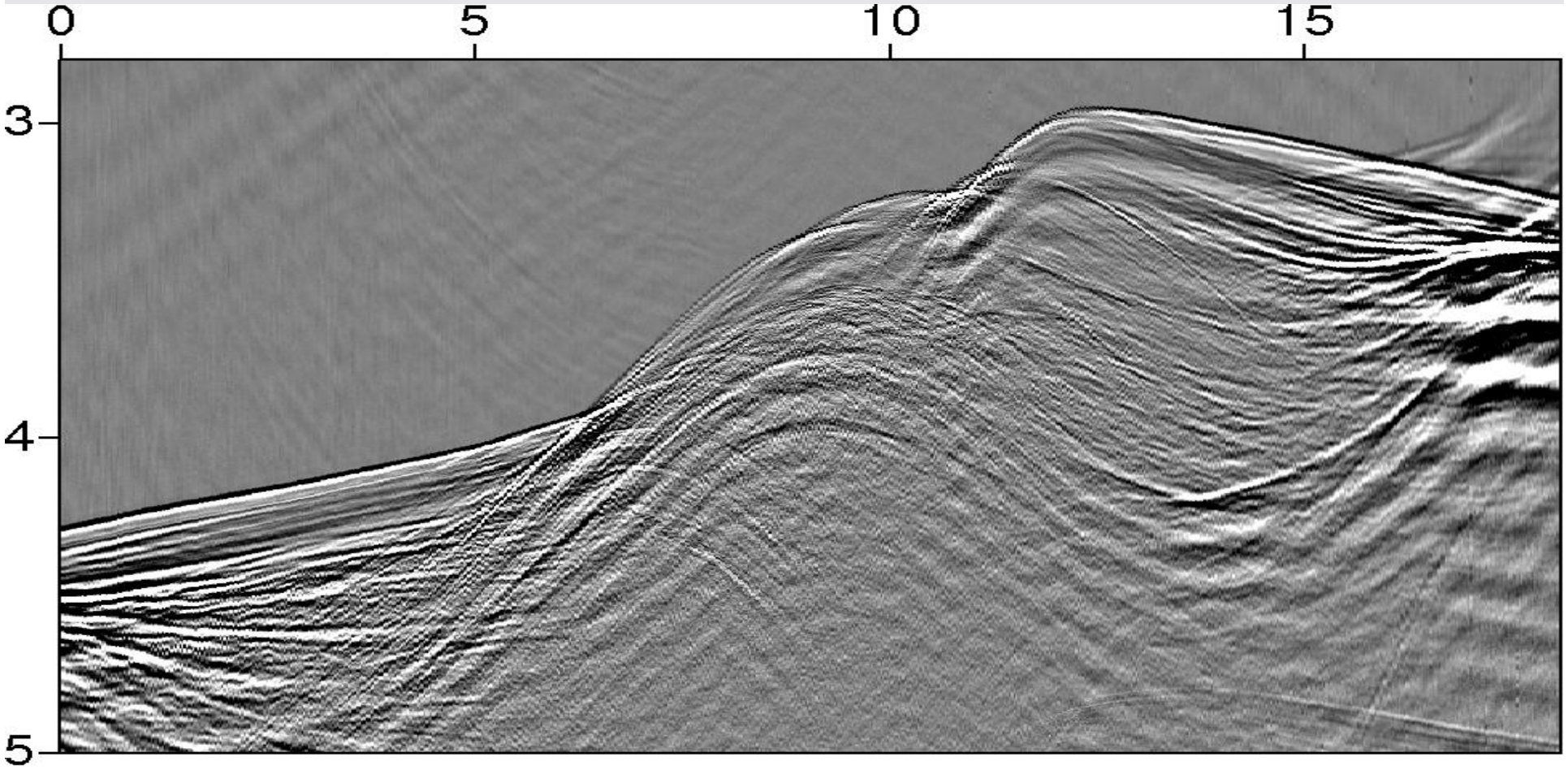

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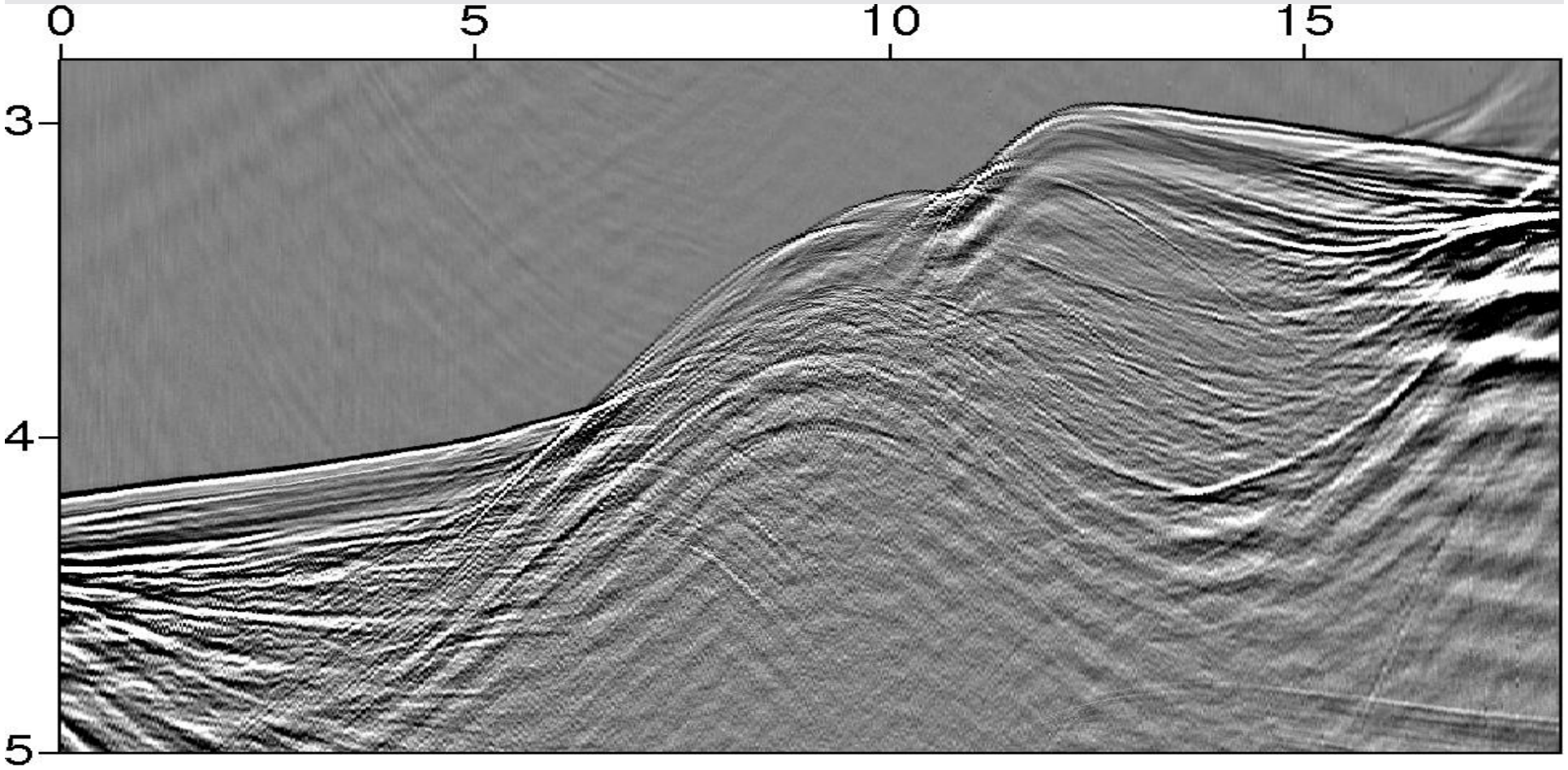

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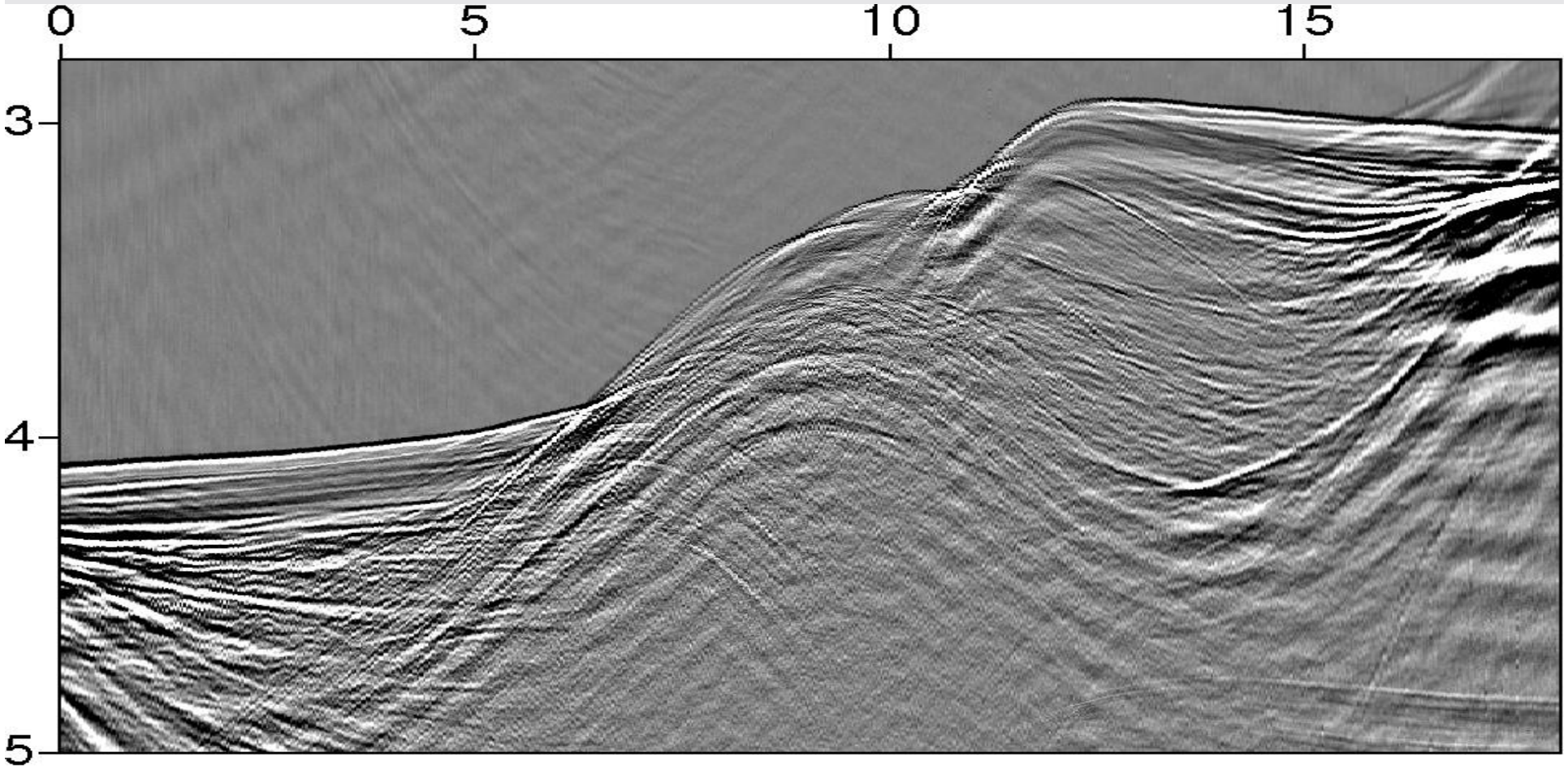

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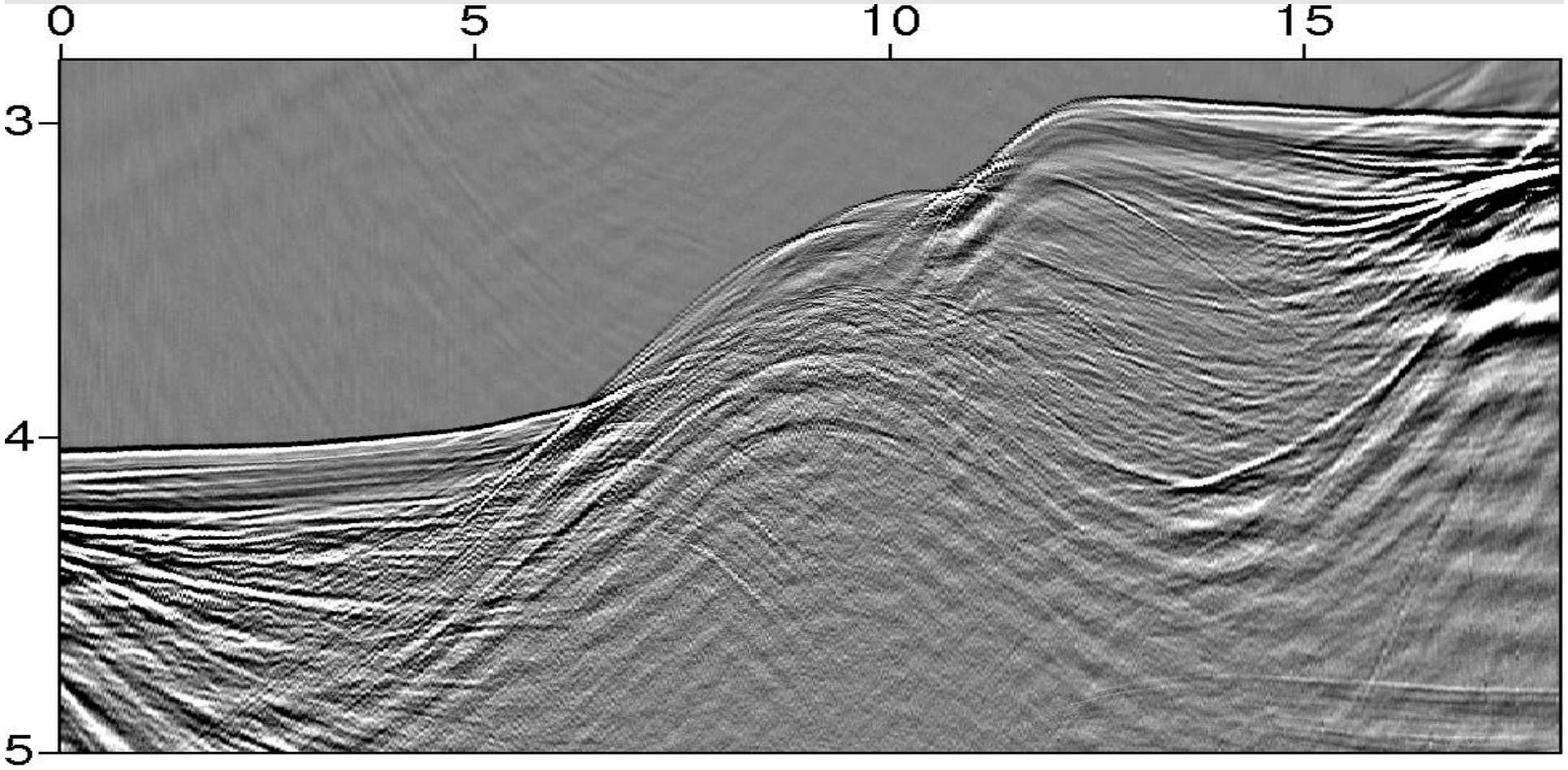
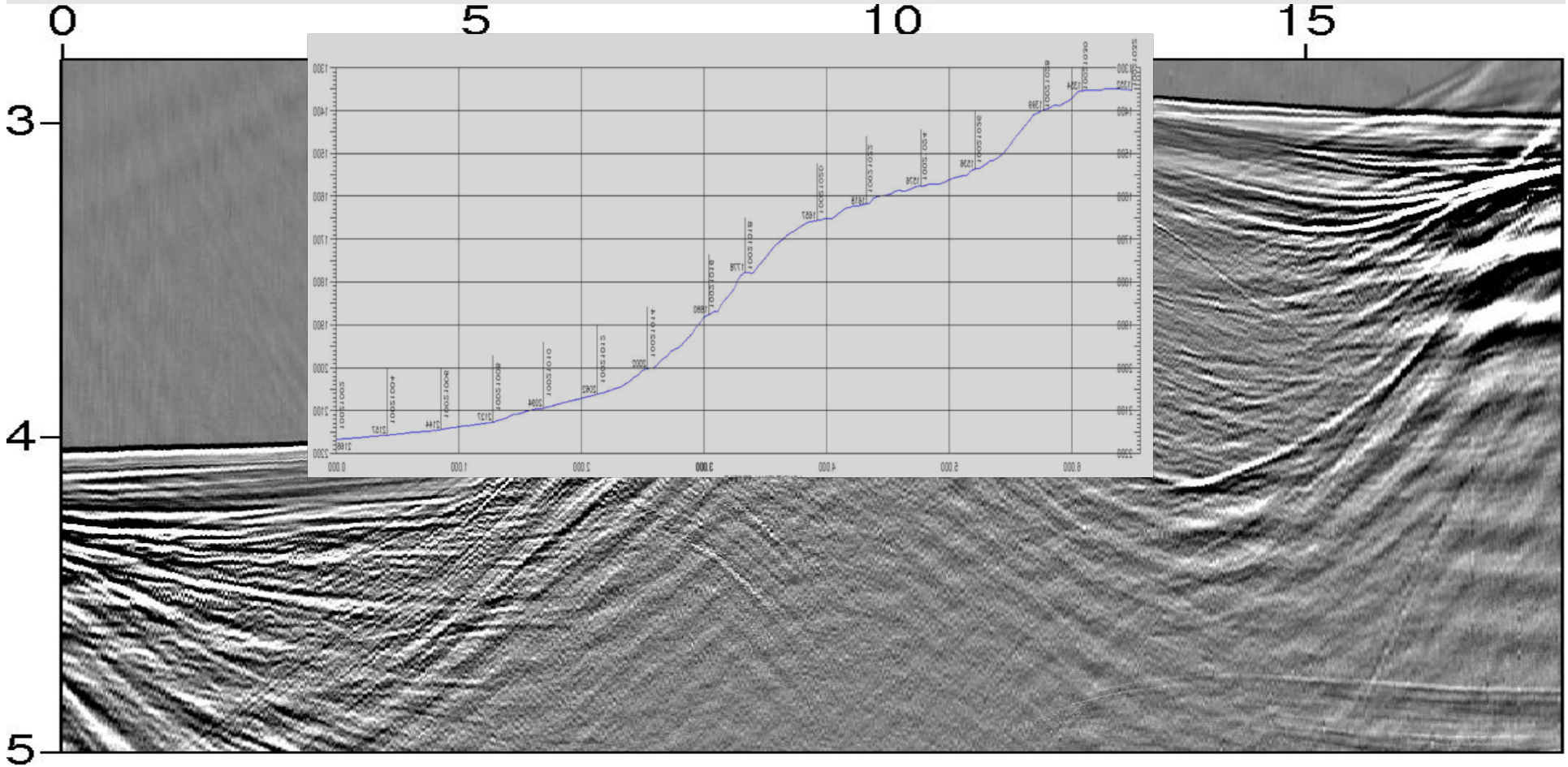


NMO V=1498 P



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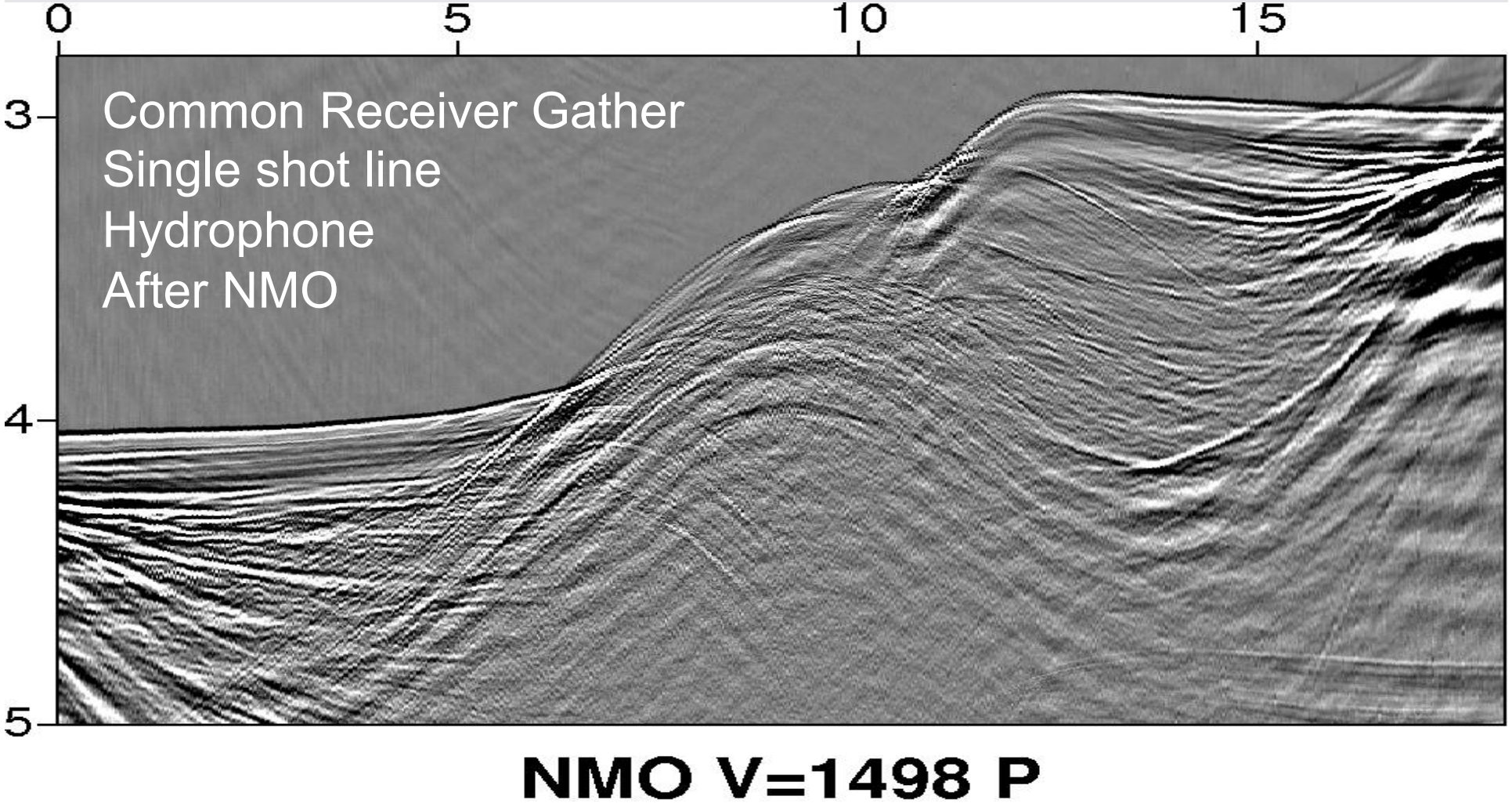
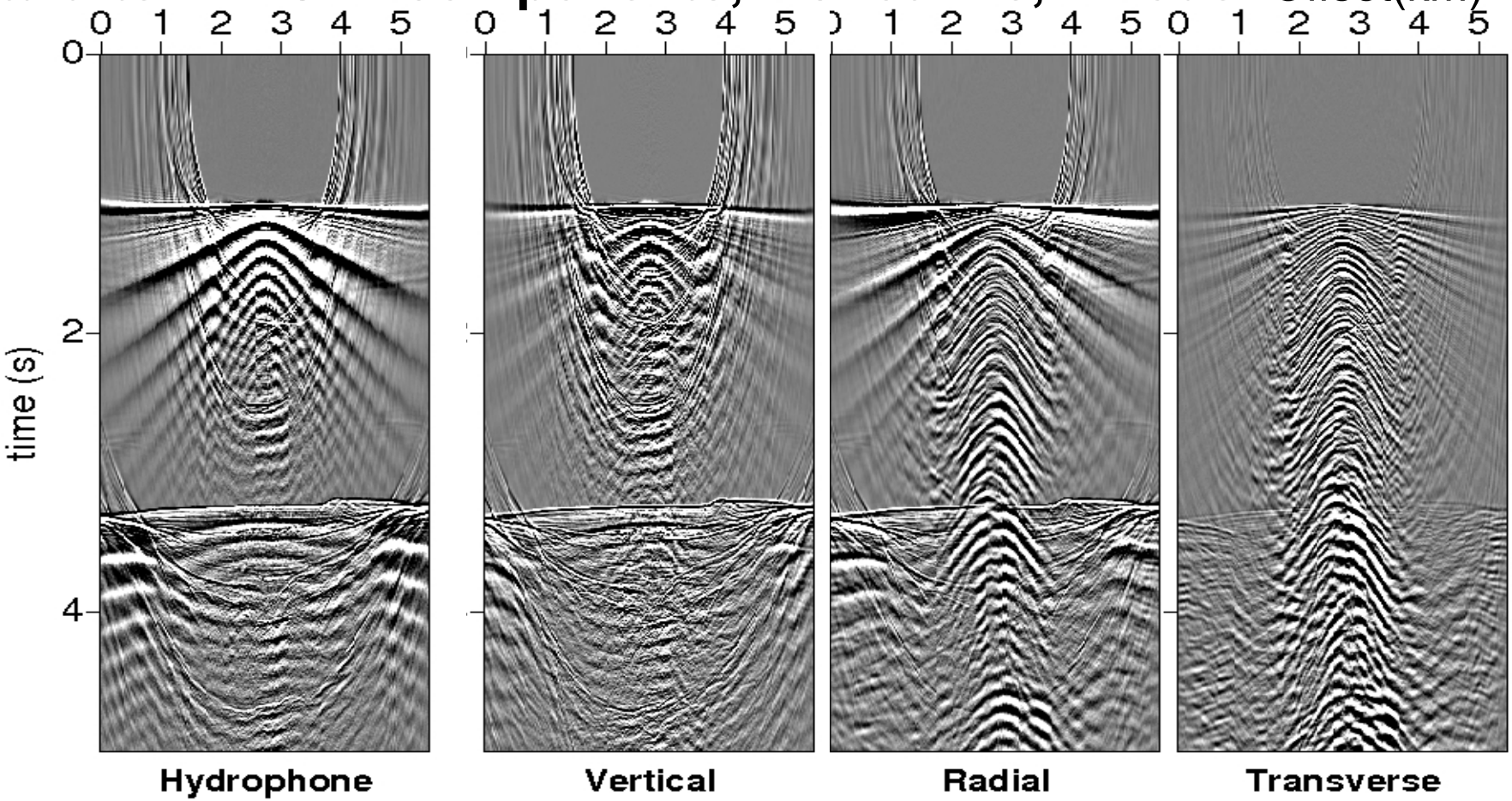

0
5
10
15
3
4
5
Common Receiver Gather
Single shot line
Hydrophone
After NMO

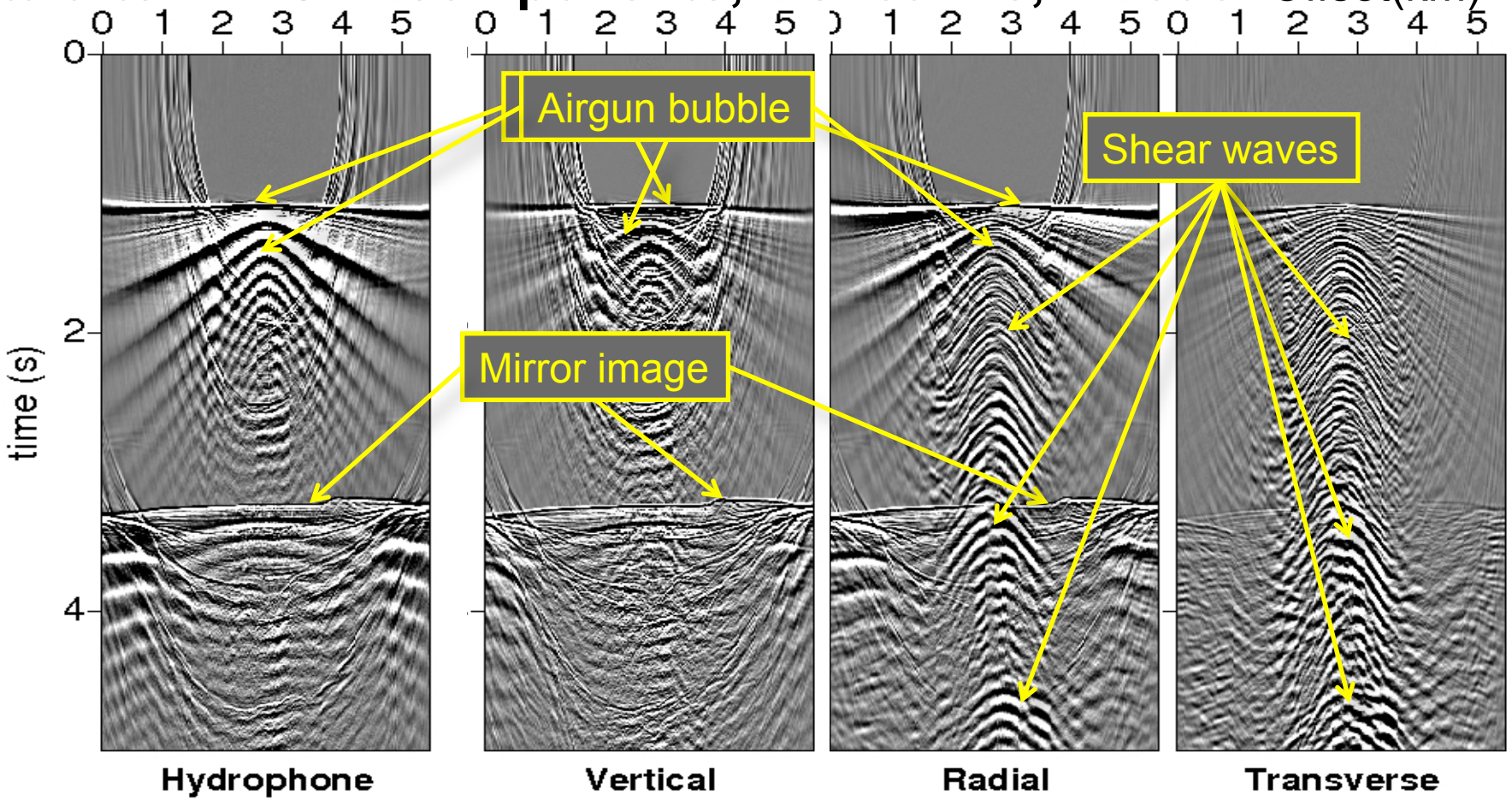
NMO V=1498 P

Data after NMO: 4 components, 1 shot line, 1 node



Non Exclusive Norway node survey, Courtesy of Seabed Geosolutions

Data after NMO: 4 components, 1 shot line, 1 node



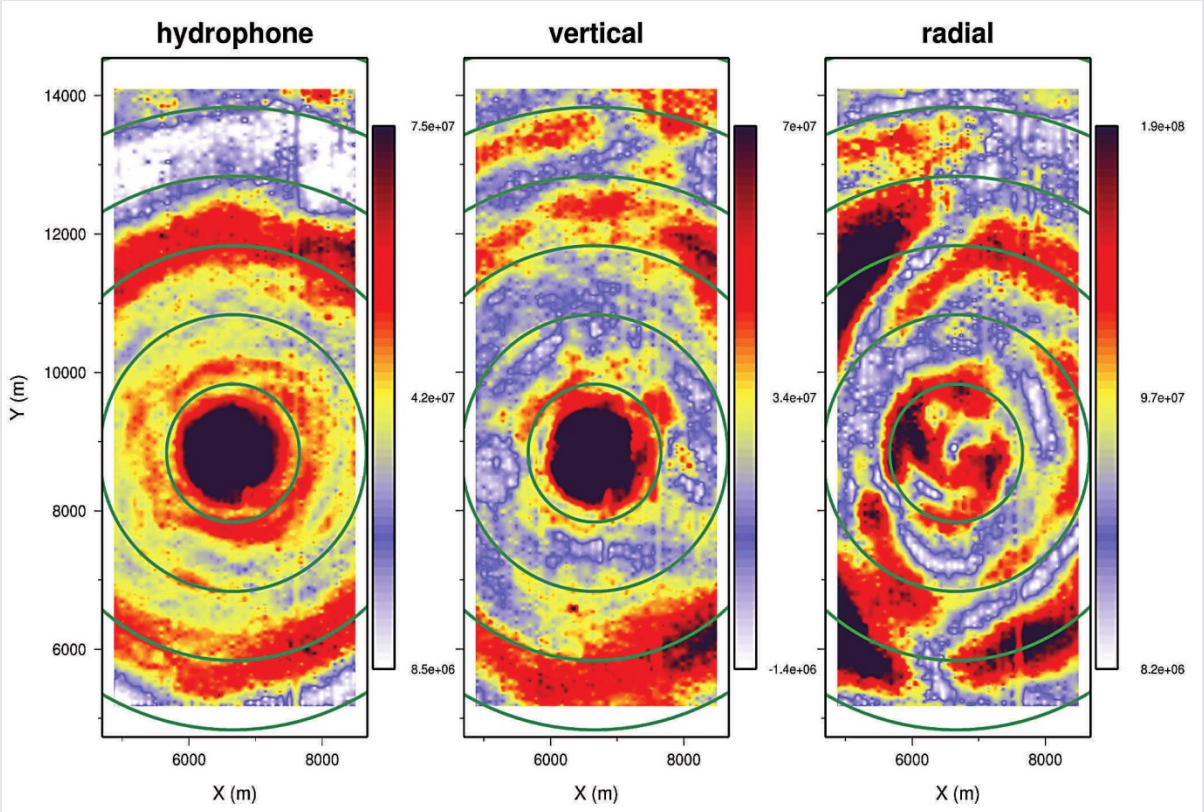
Non Exclusive Norway node survey, Courtesy of Seabed Geosolutions

Frequency slice

Data:
One node
Shot carpet
3 components

Processing:
Fourier Transform

Display:
Frequency slice map



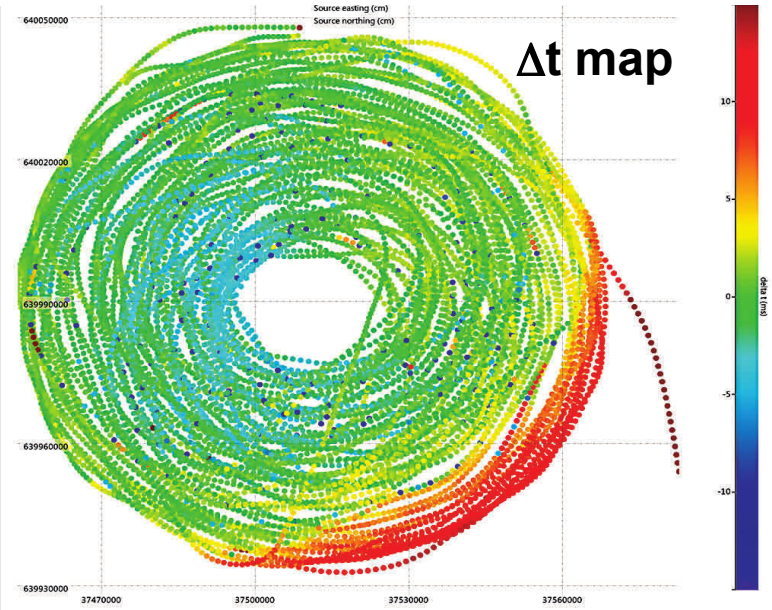
Courtesy of anonymous owner

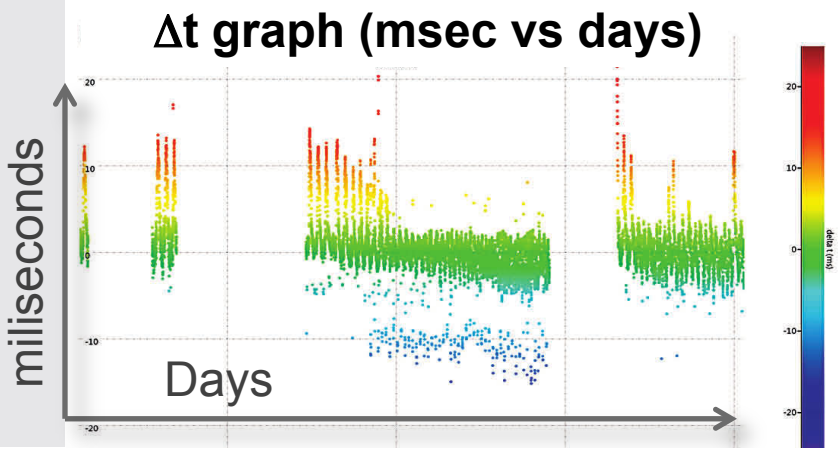
Δt: Time differences bewteen picked and calculated times

Time picked on hydrophone component

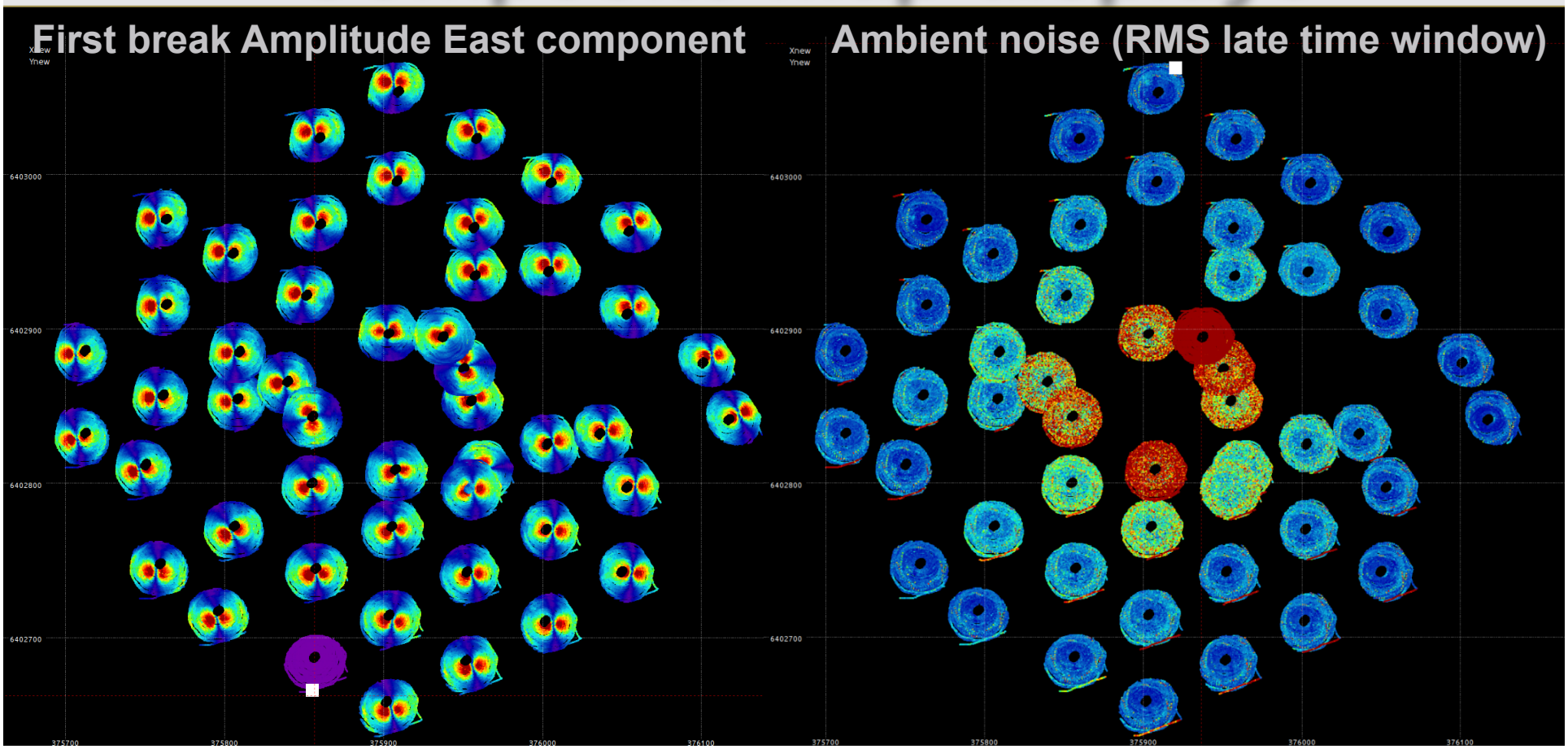
Reasons for the differences

- Clock drift (a fraction of a msec)
- Source positioning errors (~5m)
- Receiver positioning error (~1m)
- Instrument delay
- Picking bias





Composite map displays

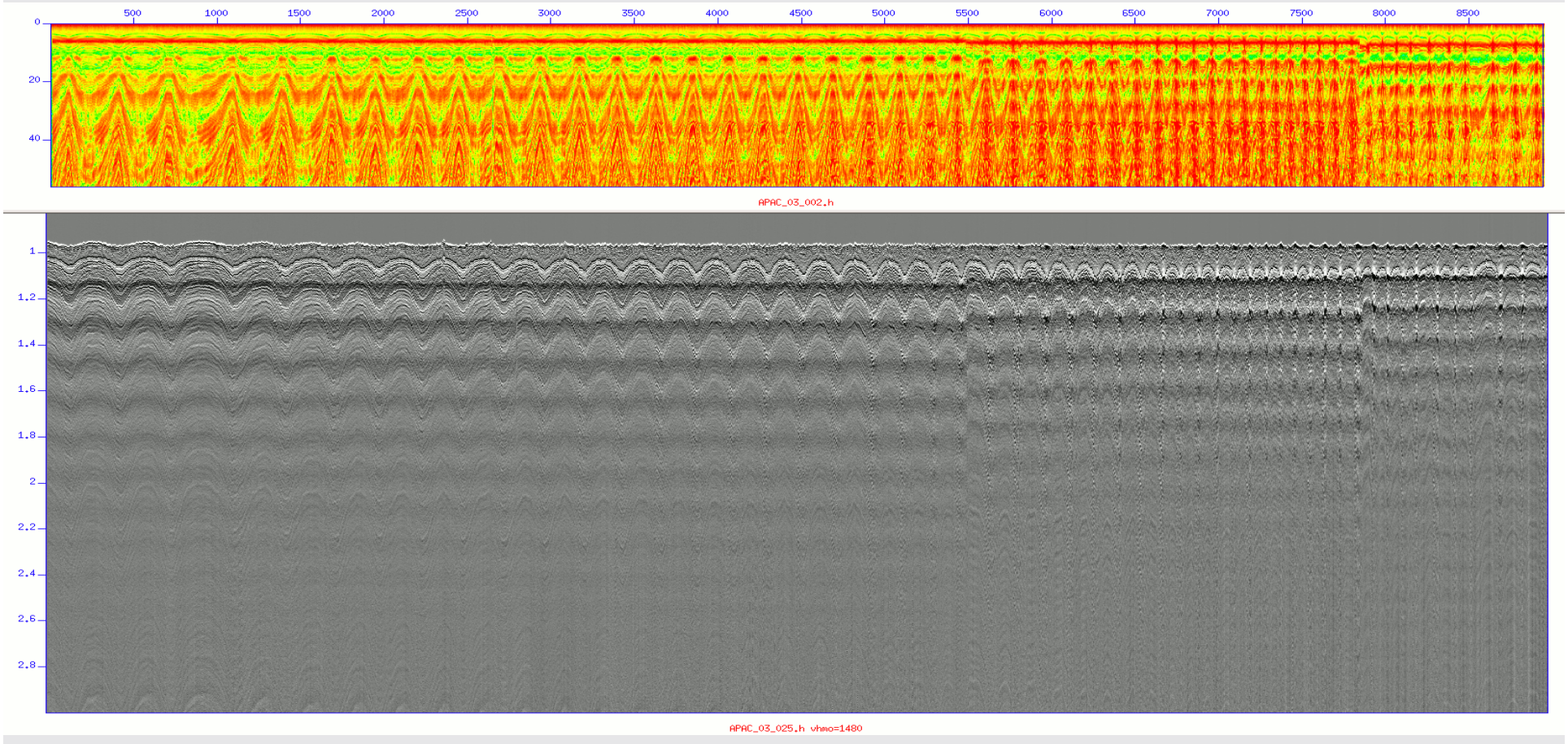


Conclusion

- Onboard data Quality Control is an essential function on a seismic crew
- Autonomous nodes more challenging
  - Limited or no communication to nodes
  - Intense data processing upon retrieval
  - Automation
  - Reproducibility

Seabed GEOSOLUTIONS

Shot QC


500
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6500
7000
7500
8000
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0
20
40
APAC_03_002.h
1
1.2
1.4
1.6
1.8
2
2.2
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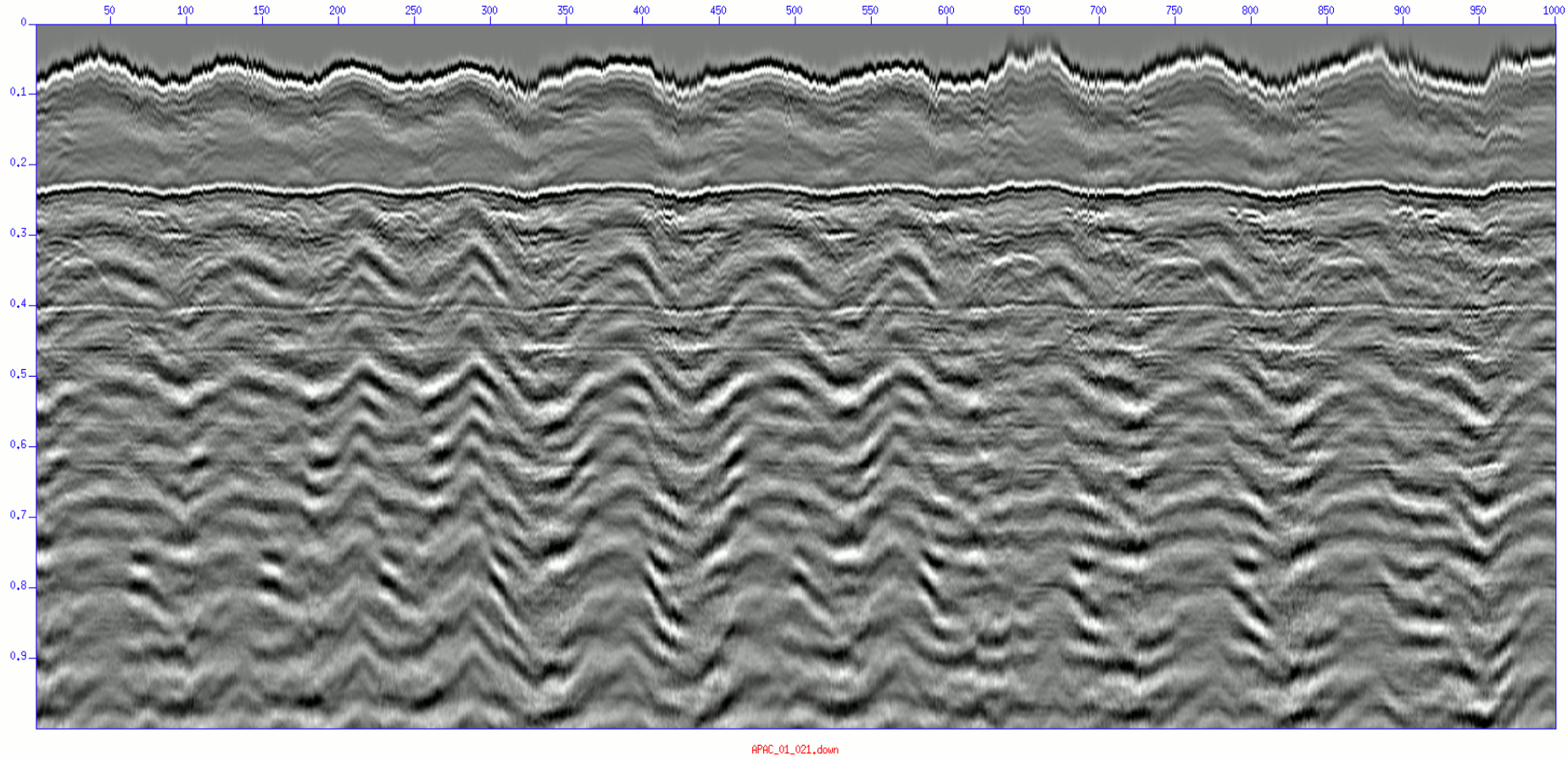
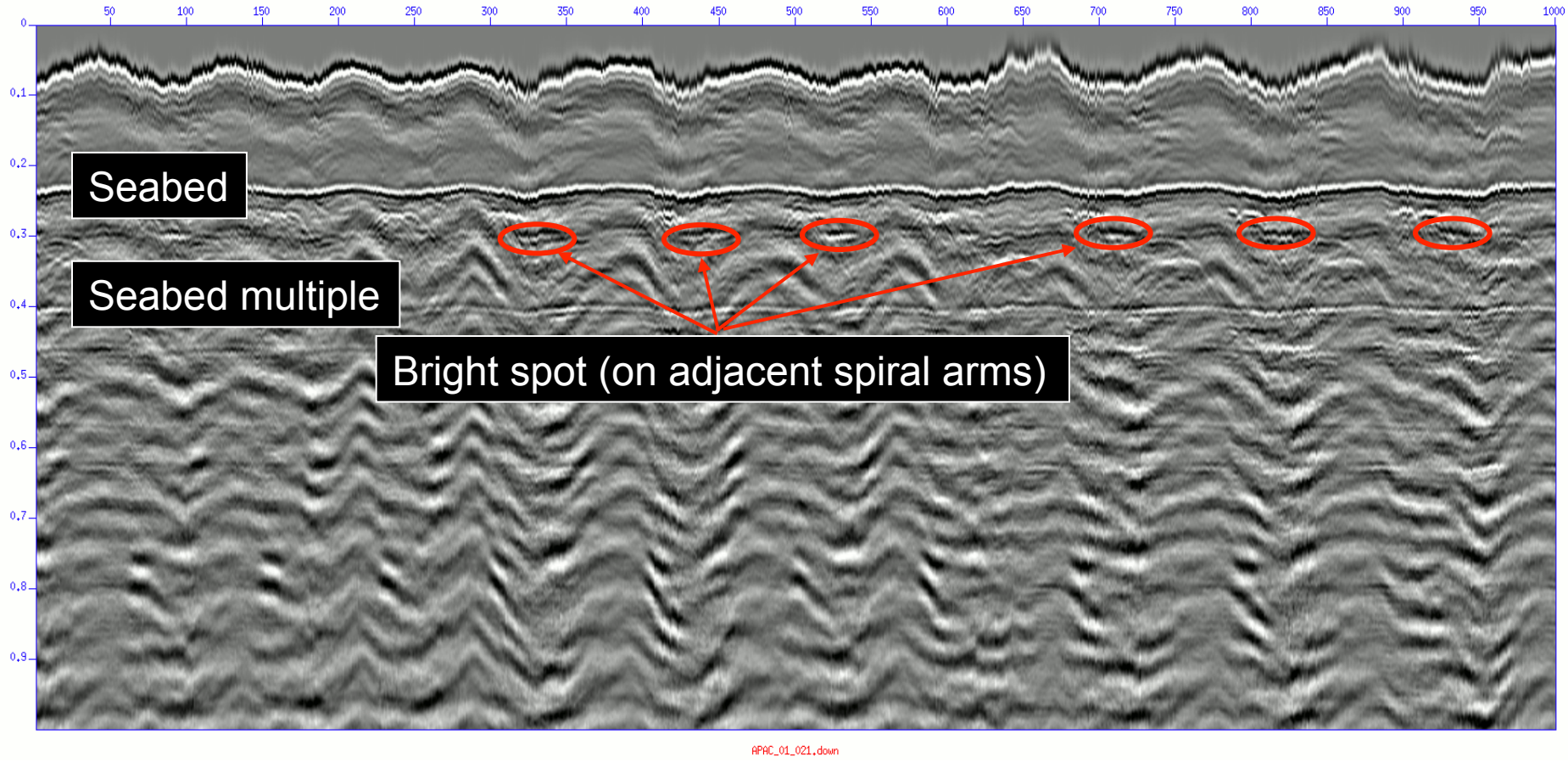
APAC_03_025.h vhmo=1480

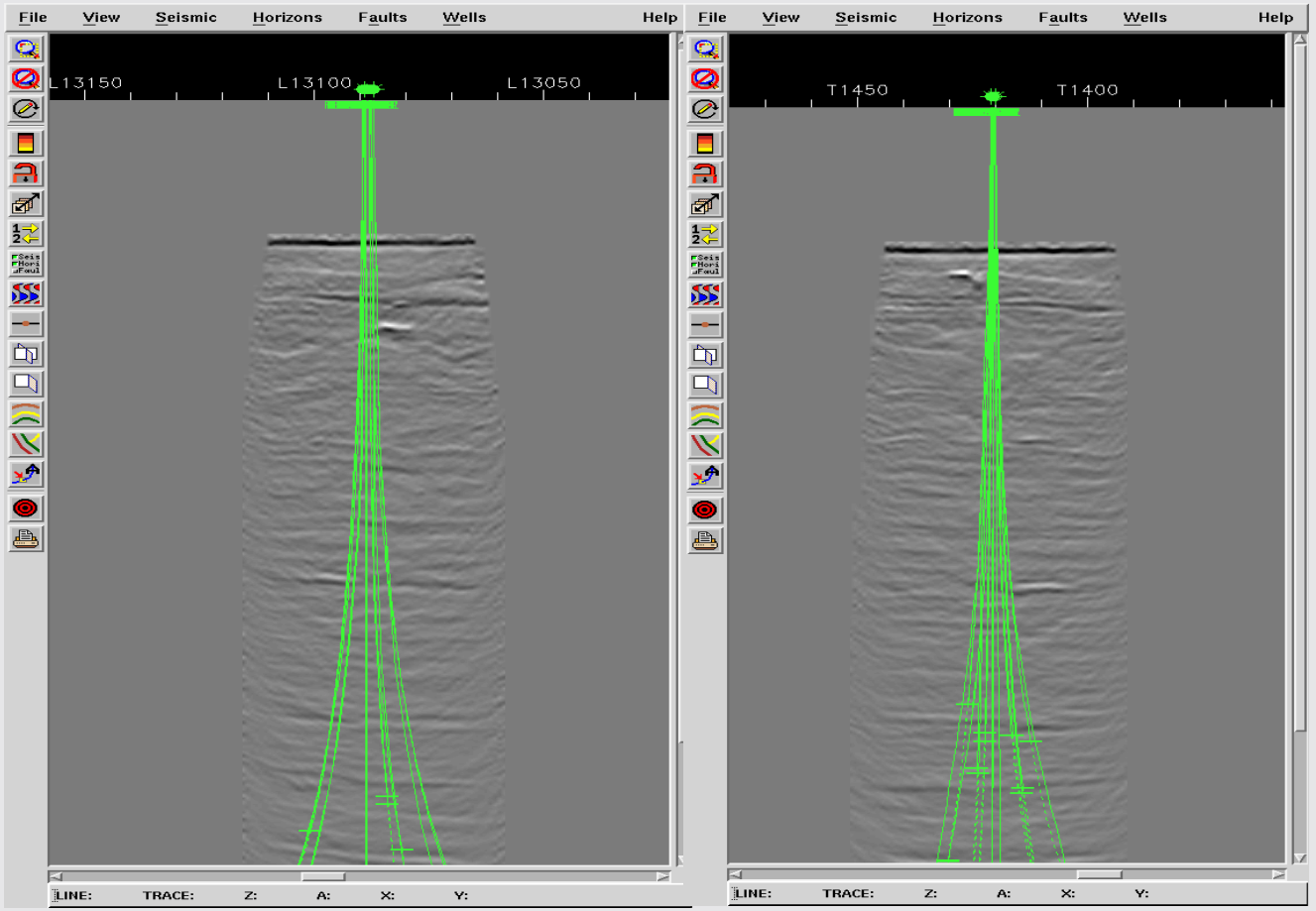
Down going after NMO



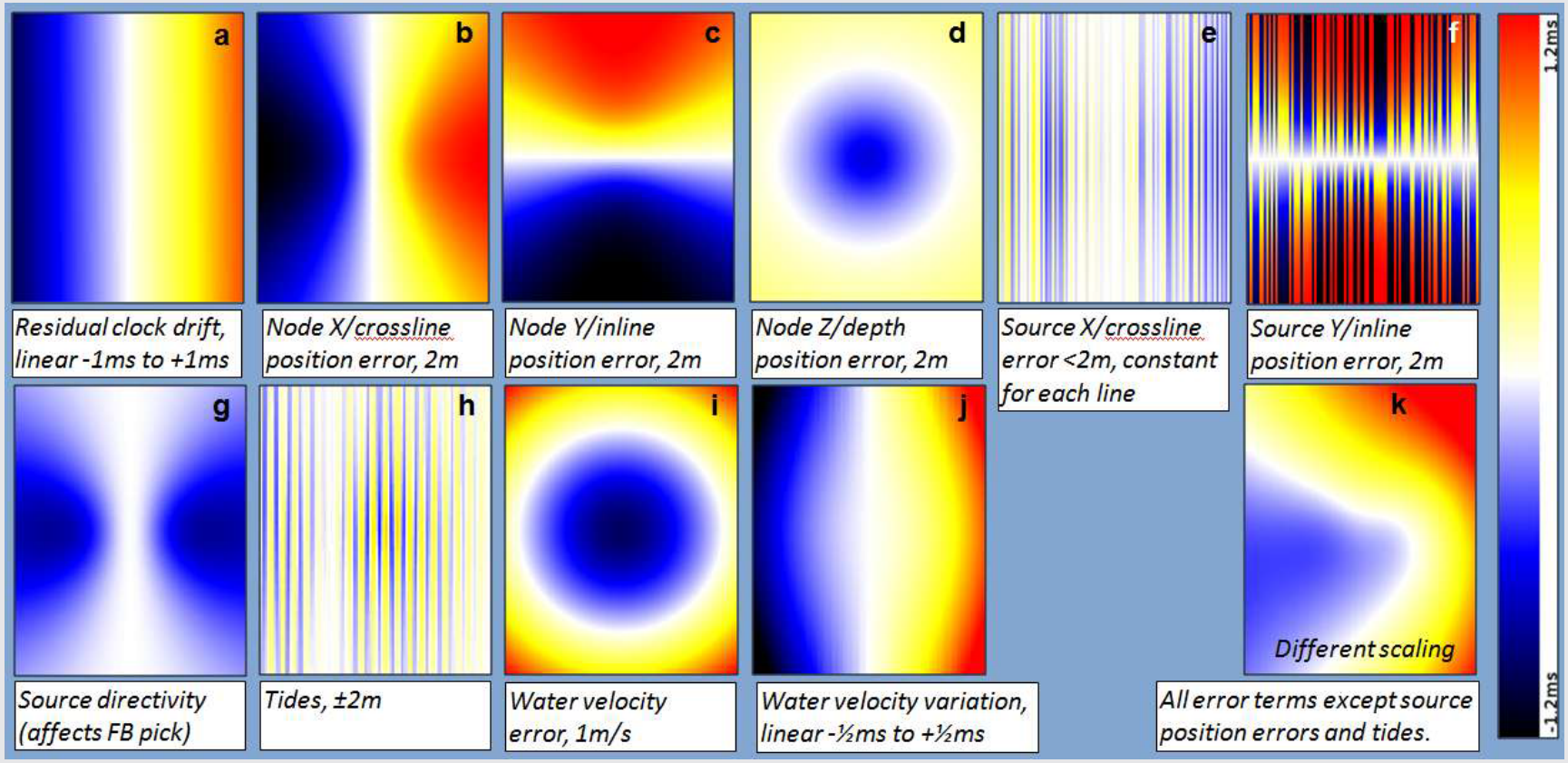
Down going after NMO



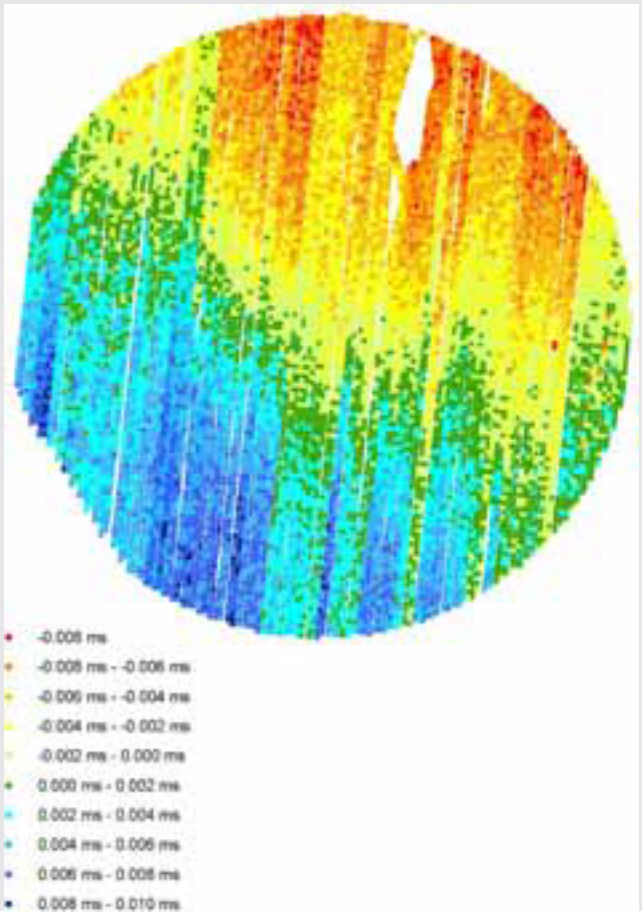
Apache Forties Mirror Image

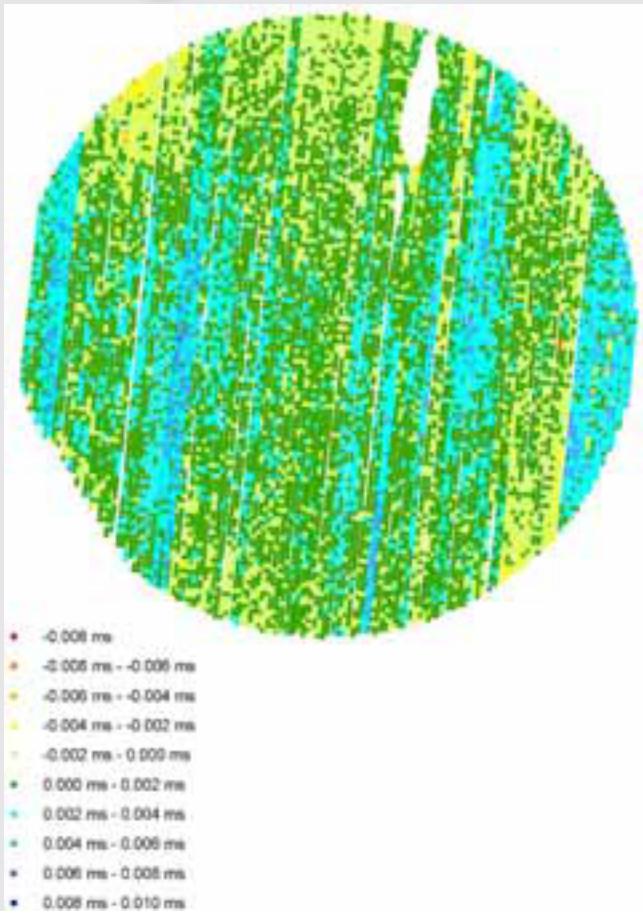


Δt maps

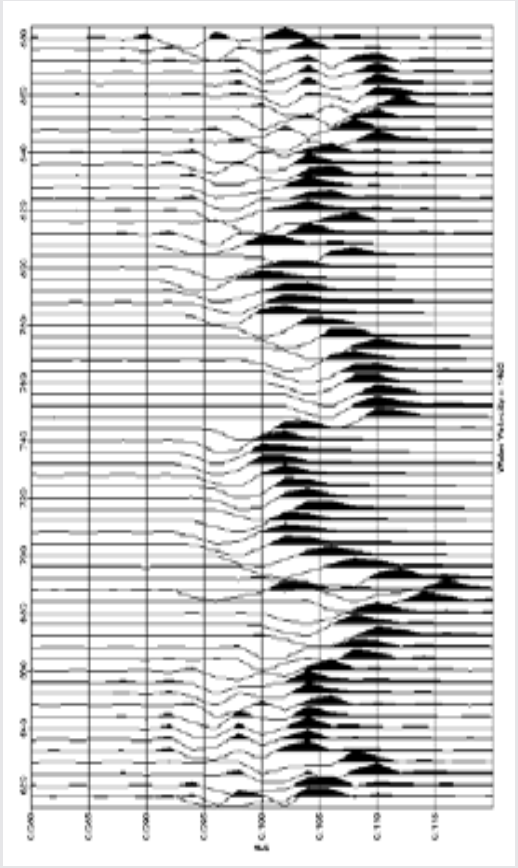

a
b
c
d
e
f
1.2ms
-1.2ms
Residual clock drift, linear -1ms to +1ms
Node X/crossline position error, 2m
Node Y/inline position error, 2m
Node Z/depth position error, 2m
Source X/crossline error <2m, constant for each line
Source Y/inline position error, 2m
g
h
i
j
k
Different scaling
Source directivity (affects FB pick)
Tides, ±2m
Water velocity error, 1m/s
Water velocity variation, linear -½ms to +½ms
All error terms except source position errors and tides.

Positioning QC





Clock drift QC



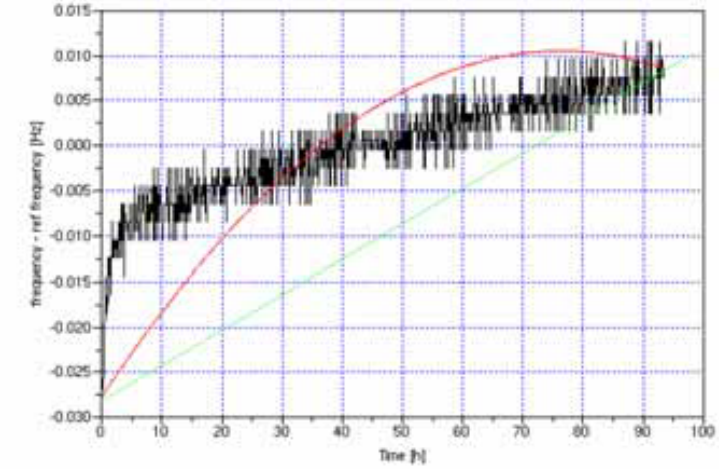
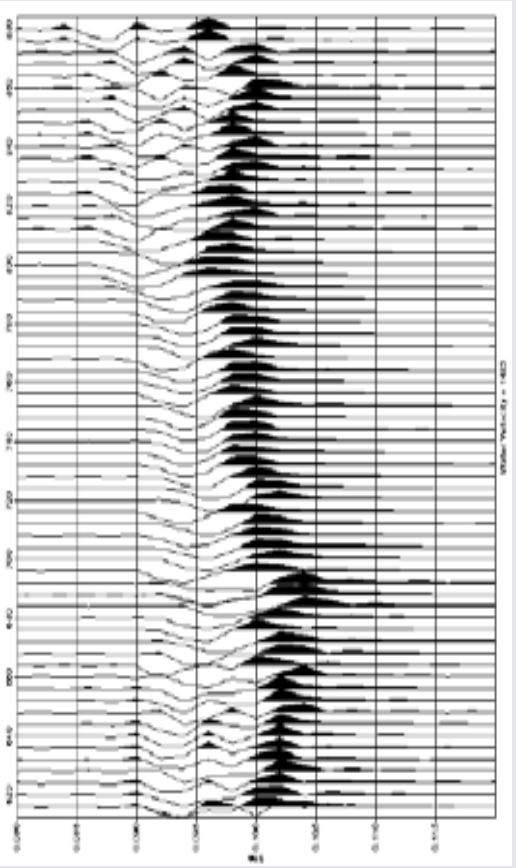


Illustration 1: Real Frequency in black, Cubic Spline calculated in red and linear predicte
green



Clock drift QC

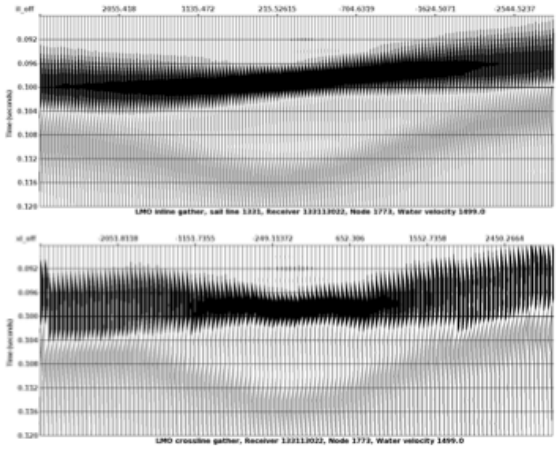
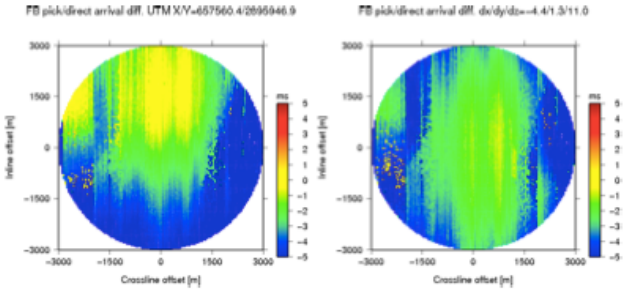


Figure 17: Inline (top) and crossline (bottom) LMO gathers of FB with bulk shift of 100 ms



(a) As-laid node position (b) Corrected node position

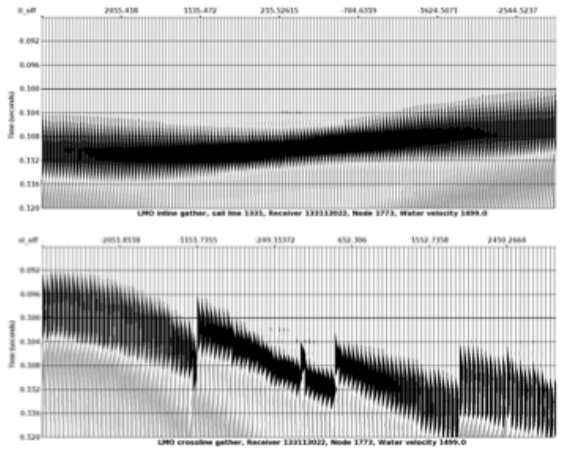
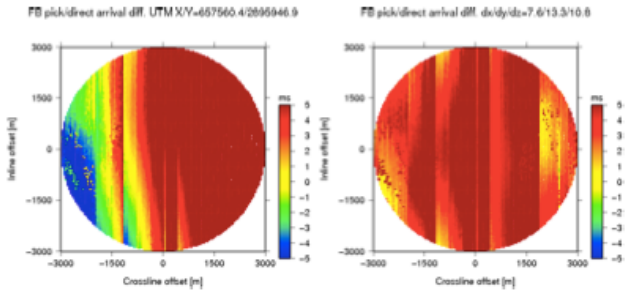


Figure 17: Inline (top) and crossline (bottom) LMO gathers of FB with bulk shift of 100 ms



(a) As-laid node position (b) Corrected node position

Clock drift QC

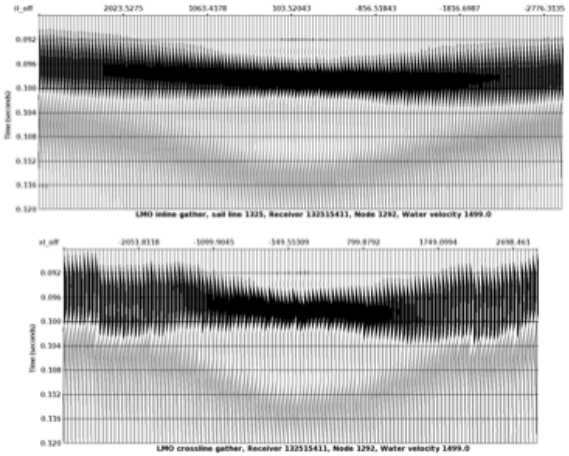
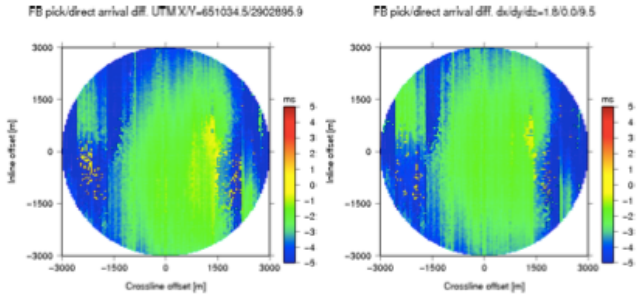


Figure 17: Inline (top) and crossline (bottom) LMO gathers of FB with bulk shift of 100 ms



(a) As-laid node position (b) Corrected node position

Figure 18: Shot maps of differences between picked FB and computed FB times

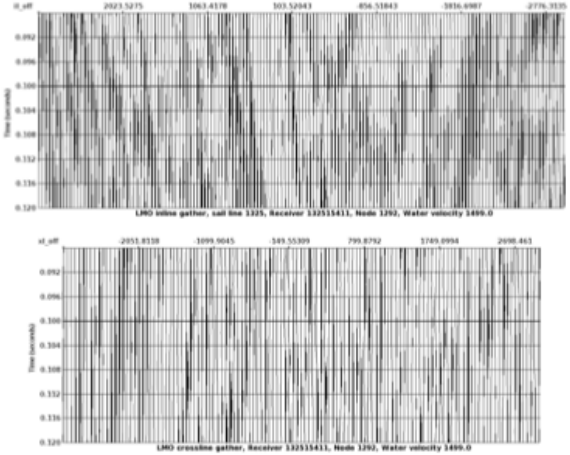
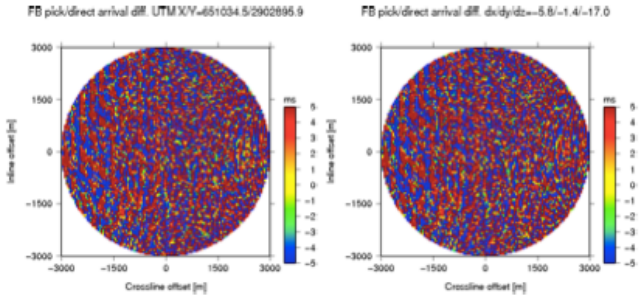


Figure 17: Inline (top) and crossline (bottom) LMO gathers of FB with bulk shift of 100 ms



(a) As-laid node position (b) Corrected node position

Figure 18: Shot maps of differences between picked FB and computed FB times

Tilt QC

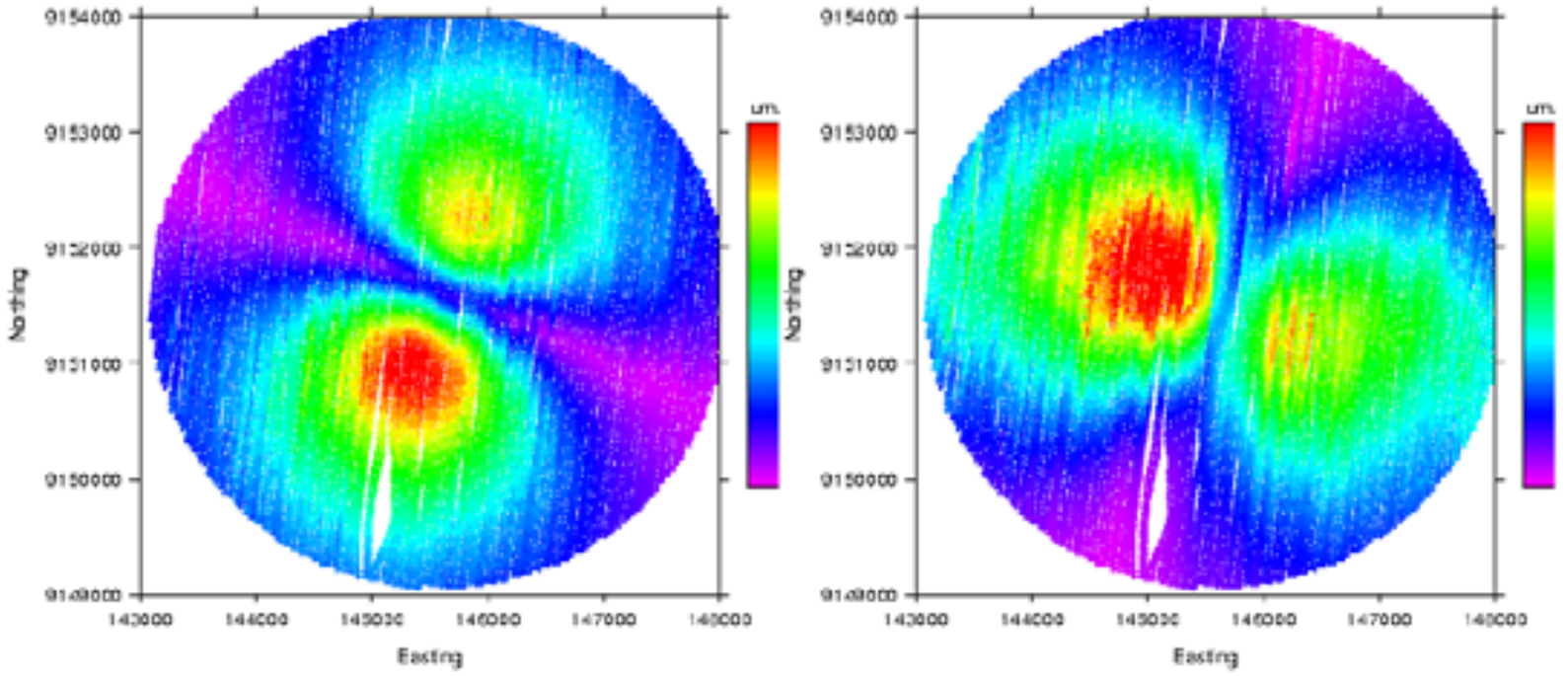
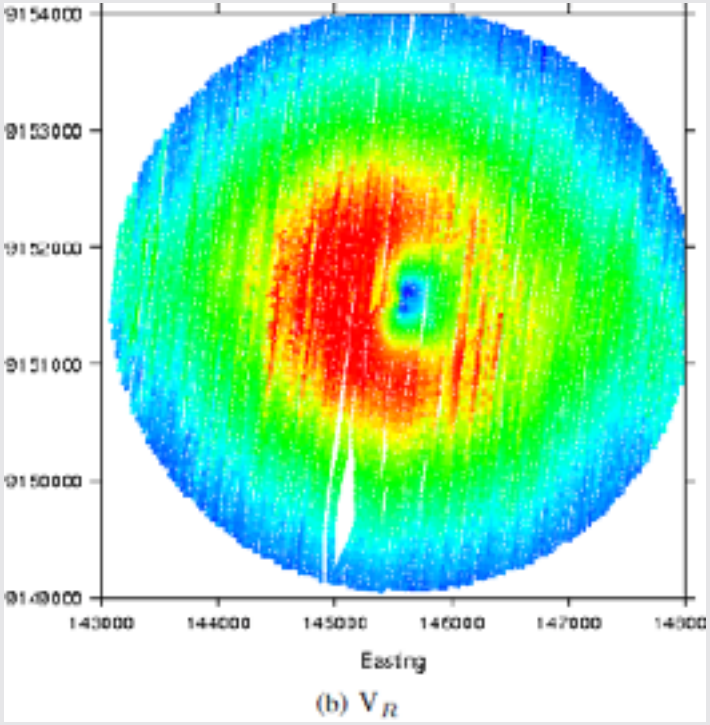
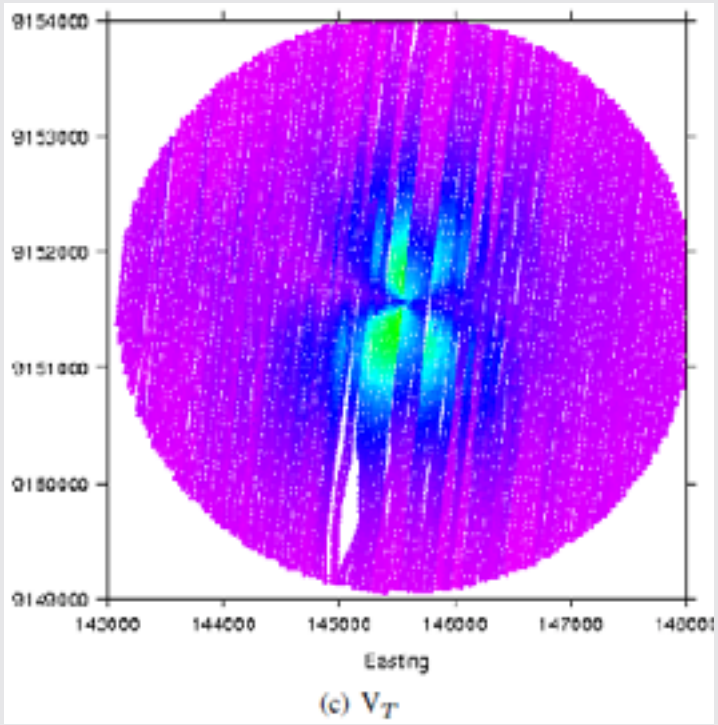


Figure 19: Maps of RMS amplitudes in a 100 ms window around the direct arrival.

Azimuth QC



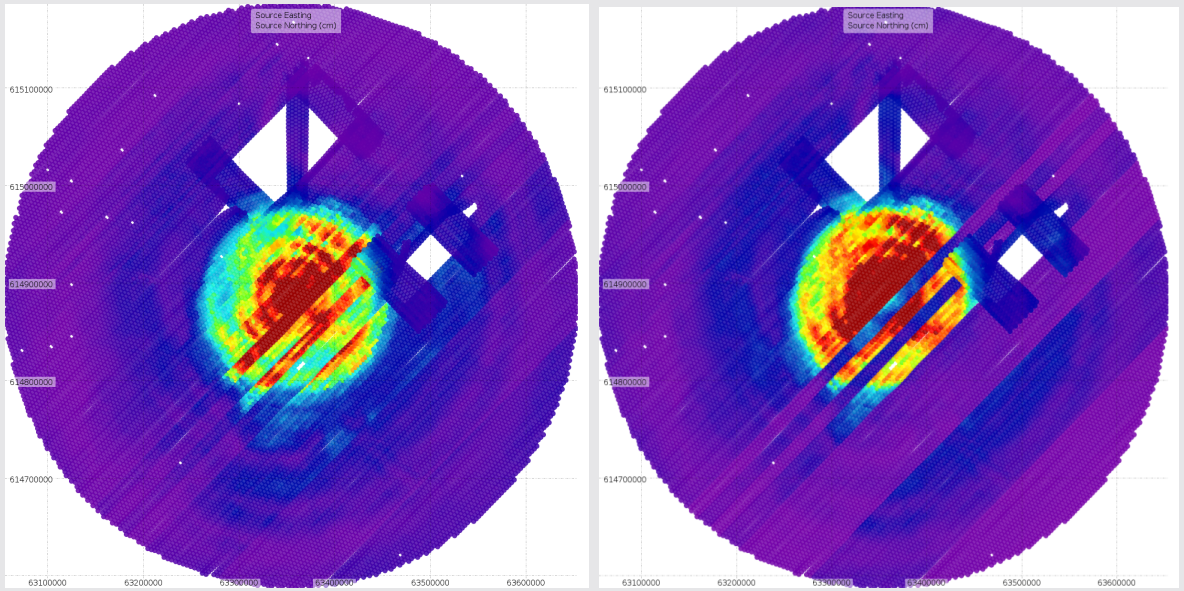
(b) V_R



(c) V_T

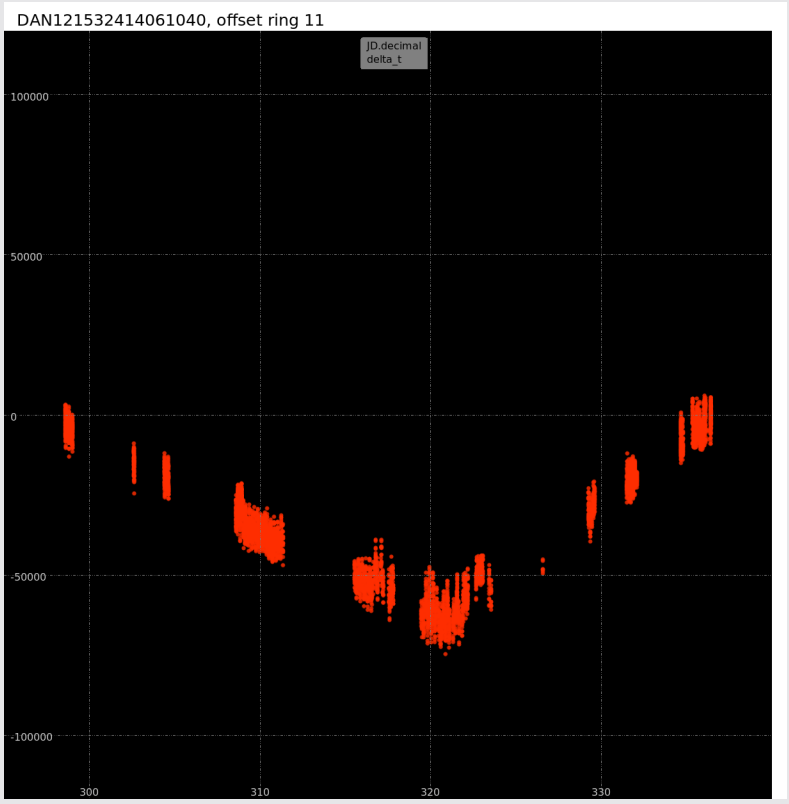


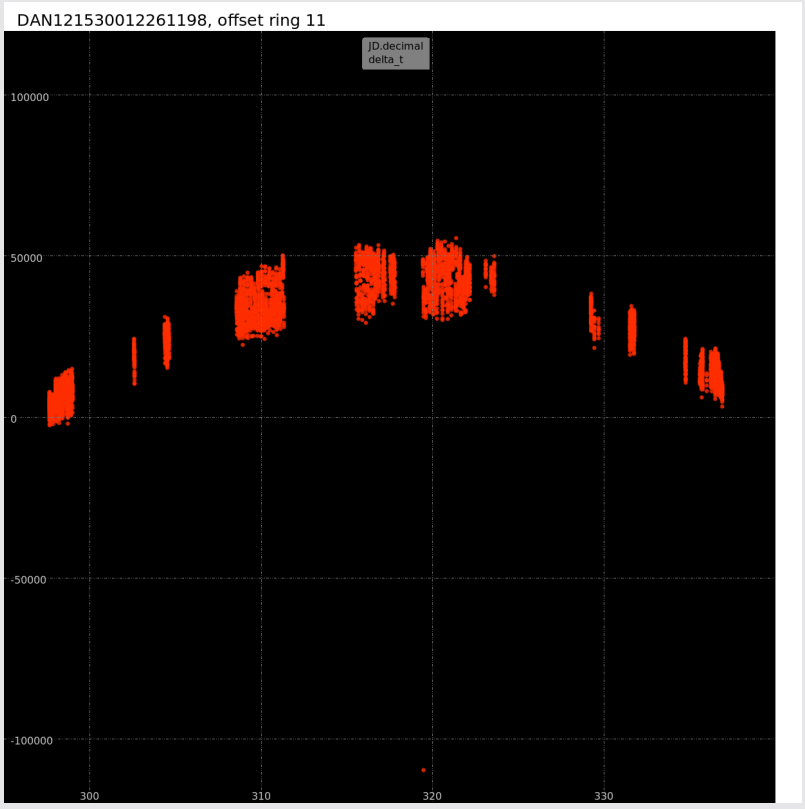
Trawled nodes



RMS maps of horizontal components around the onset of the first break for a node that has been moved and rotated by the trawler.

Clock drift QC





Continuous data

