Highest Possible Resolution (HPR) Stratigraphic Seismic Imaging Case Study – Deep Reef Platform*

Norman S. Neidell[1]

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[1]N.S. Neidell & Assoc., Houston, TX (neidell@worldnet.att.net)
[2]GGS- Spectrum, Inc., Houston, TX
[3]Tsunami Development, Houston, TX

Abstract

Huygens' or Holographic Imaging of the earth subsurface using seismic survey data produces substantially greater spatial and time resolution than may be obtained by commonly used signal processing methods. For this reason such imaging is often called "High Definition" Imaging.

Attainable resolution using Huygens' Imaging represents the highest possible values with limits imposed by the imaging approximations, estimated propagation velocities, noise, and the geologic character. Such character relates to the sediment deposition and its energy, having specific expression in terms of variations over the effective Fresnel Zone and vertical grading or transitioning of the lithologies. For such imaging, as typical of Holographic methods, illumination bandwidth is largely incidental, and frequencies in the image domain may range between 3 and 10 times the input bandwidth, and possibly greater as geology ultimately permits.

Not only should we expect much improved **attributes**, but also the possibility of newer **attributes** which relate more closely to the geology. These may include measures of depositional energy and "indices" of "correlatability" with well information. We should also derive further information about fractures, connectivity and other reservoir related properties.

In this initial study we present examples of Holographic Imaging and examine just a few of the most basic **attributes**. Moving beyond the obvious advantages in broader bandwidths for frequency and wave number, we see remarkable improvement in particular in Velocity Analyses. Coherence attributes also show much higher resolution and interpretable detail. Faults, chimneys, and other features can be seen with clarity, including in many cases with evidence of "wrench" character.

Highest Possible Resolution (HPR) Stratigraphic Seismic Imaging Case Study – Deep Reef Platform

Presented by

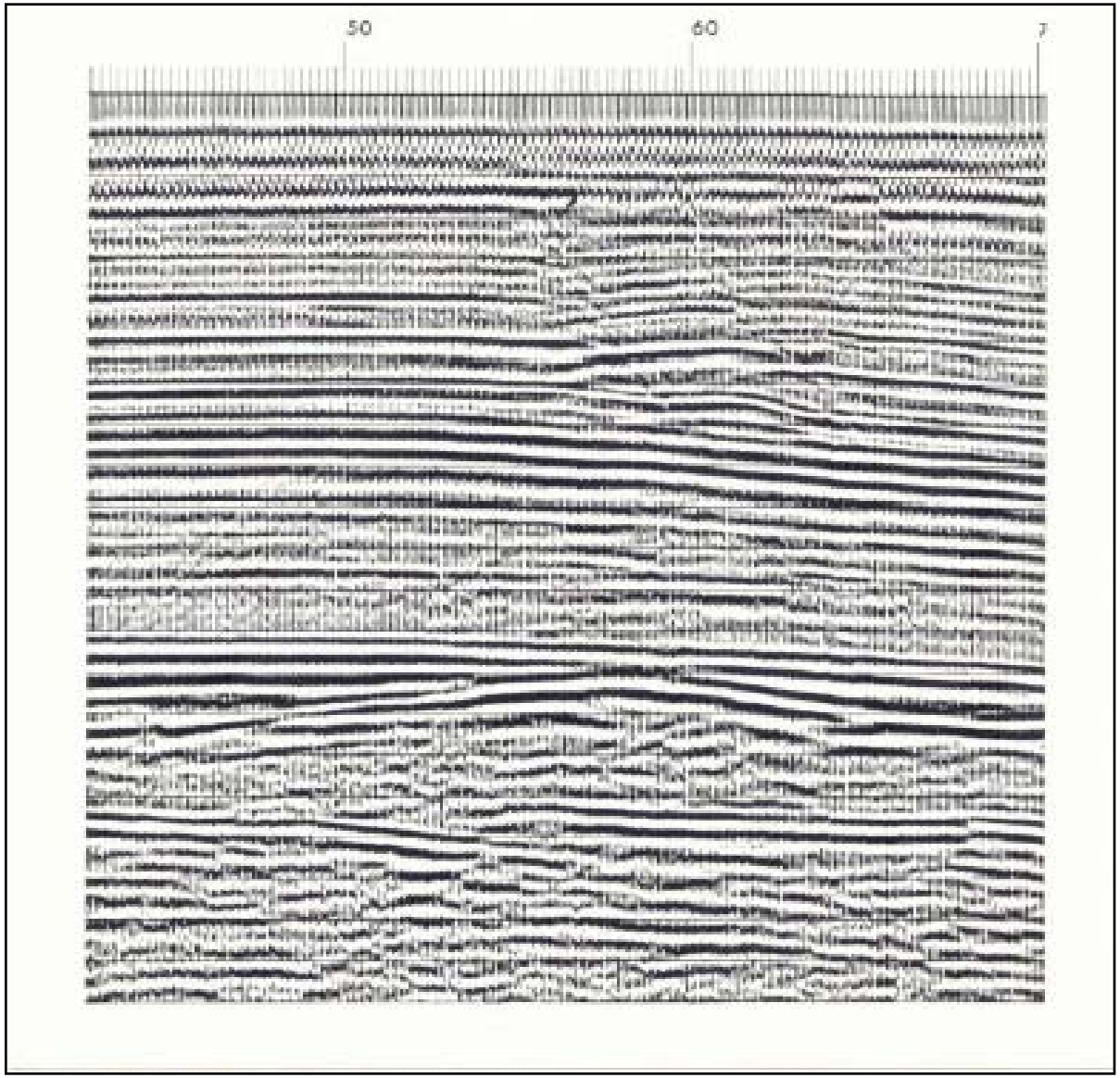
Dr. Norman S. Neidell

AAPG, San Antonio, Texas, 2008

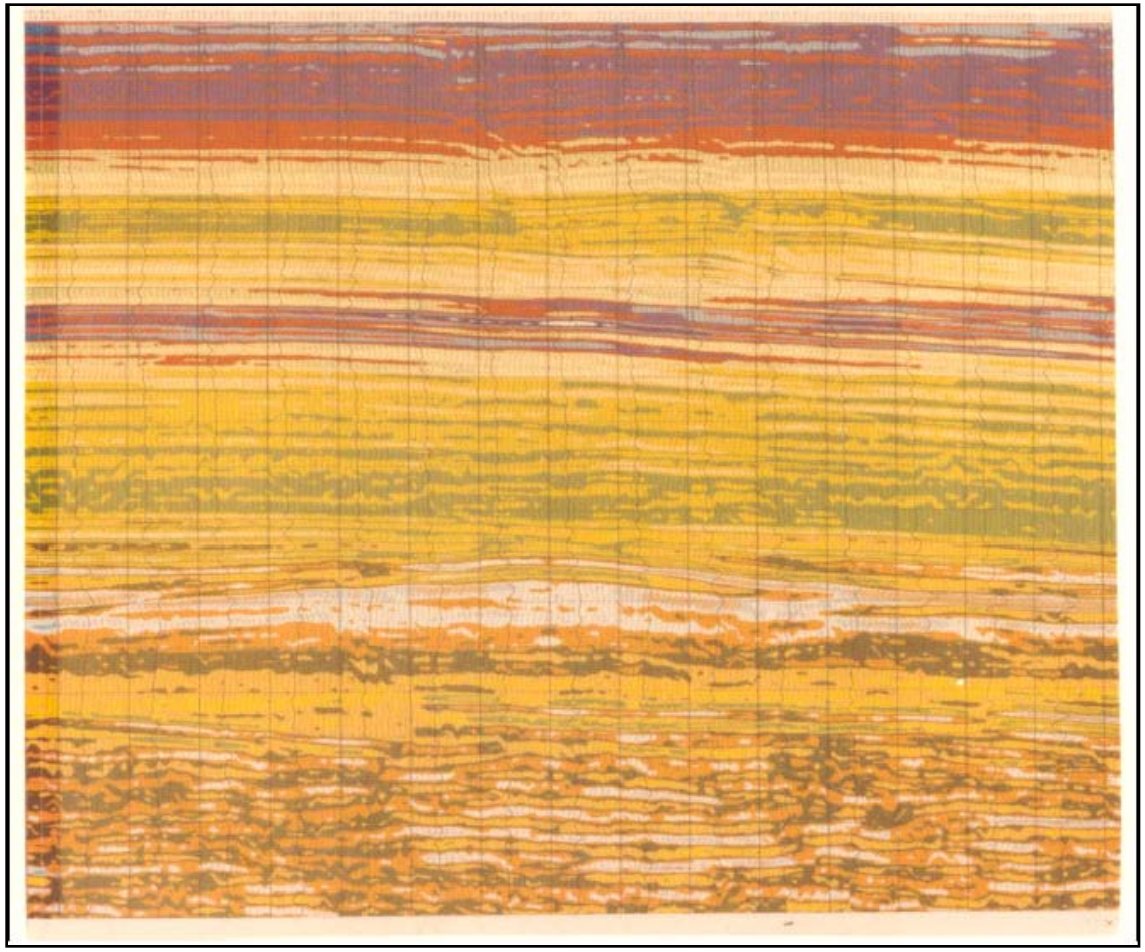
Factors affecting seismic "visibility":

- Geometry
- Reflection contrast
- Signal/noise ratio
- Depth
- Signal bandwidth
- Display dynamic range

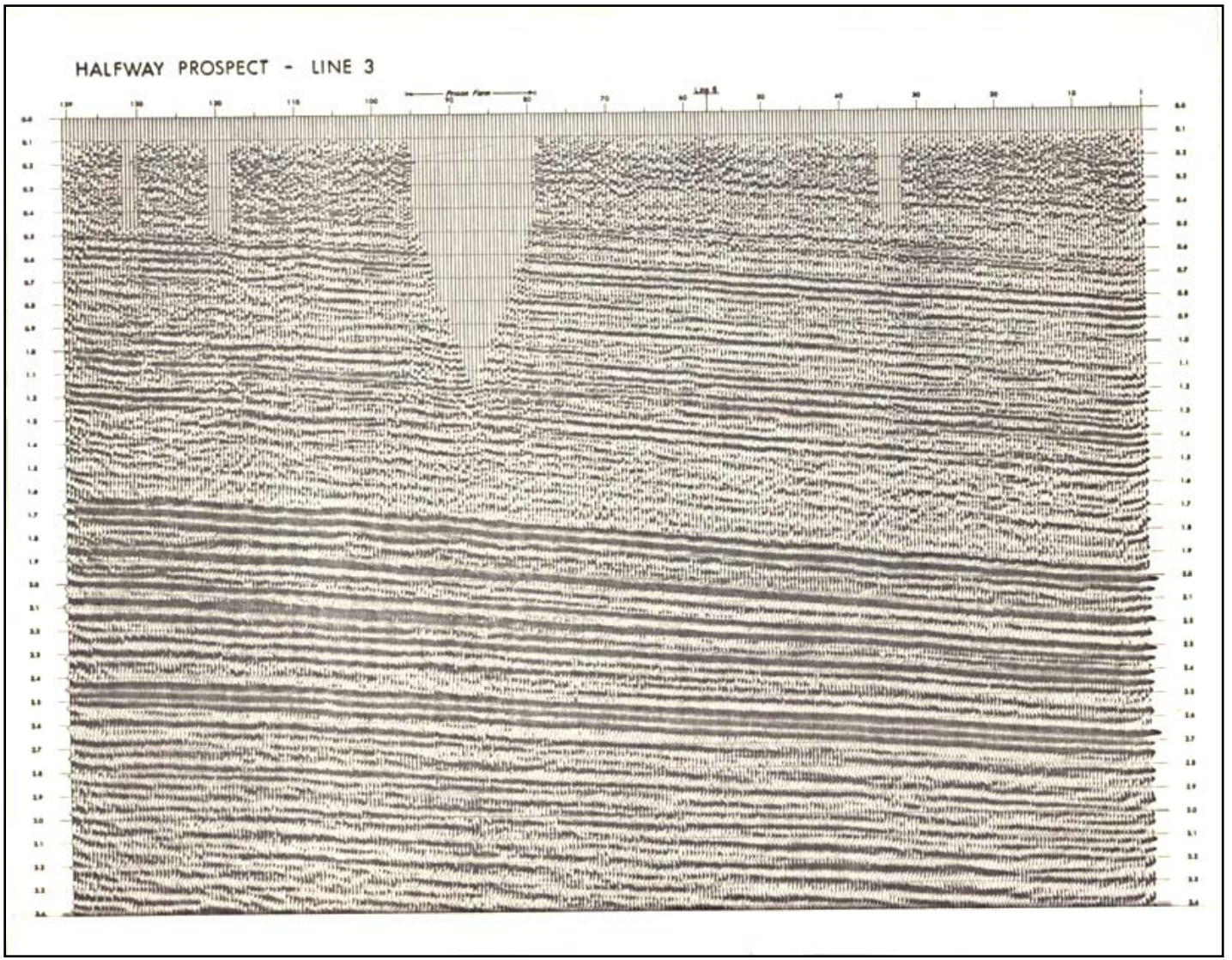
North Sea – Brittania Gas Field



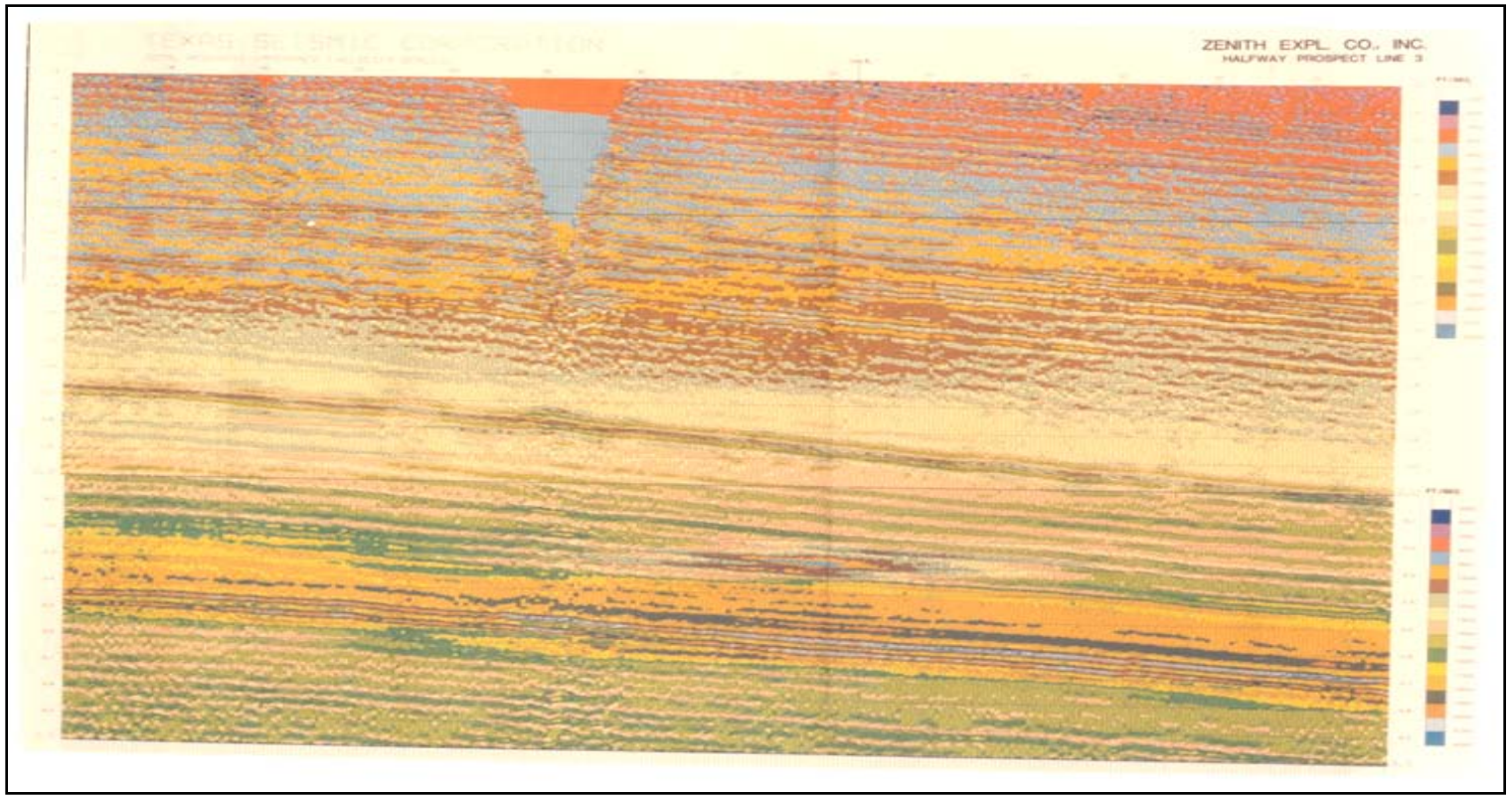
North Sea – Brittania Gas Field



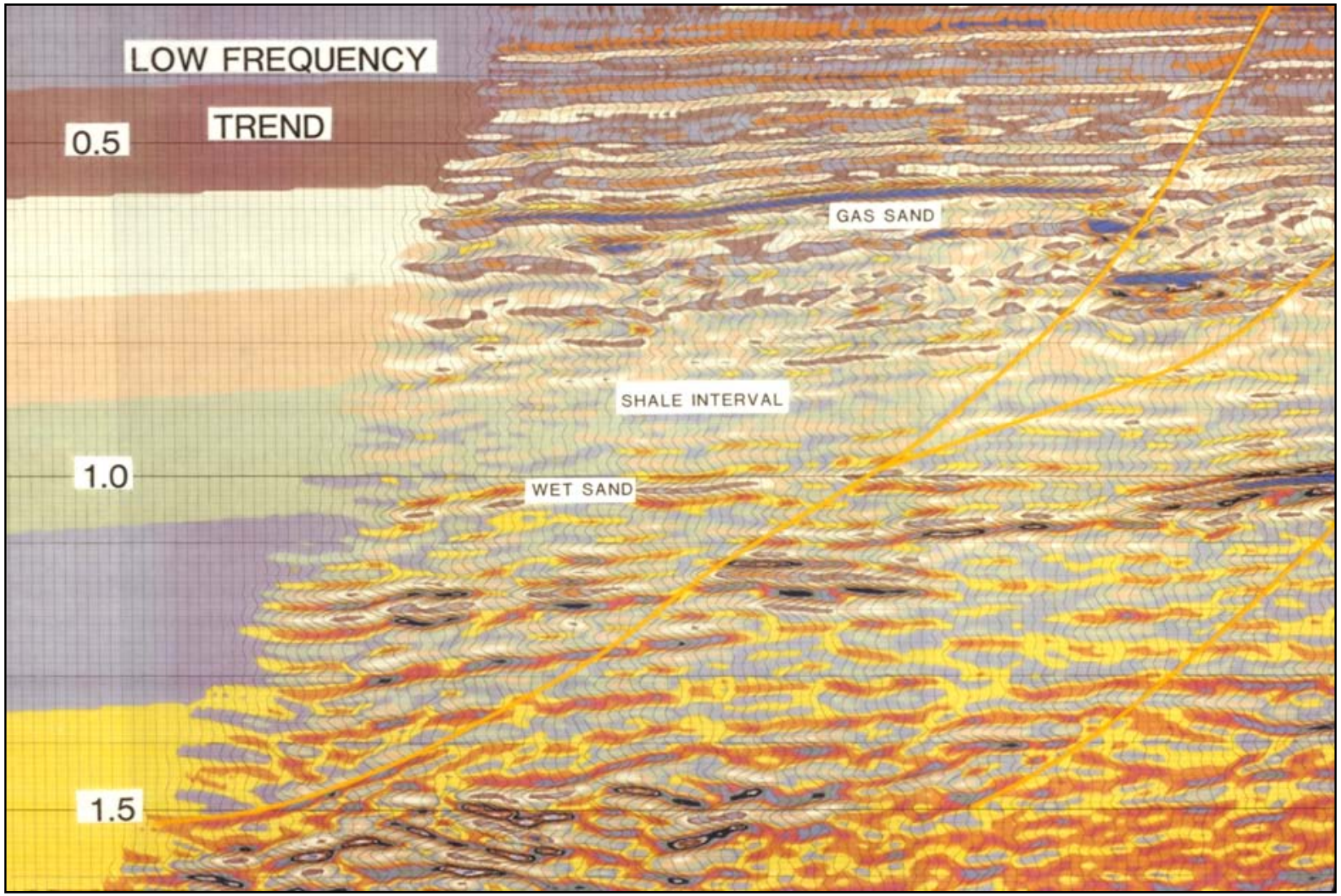
Eastham State Farm - Glenrose



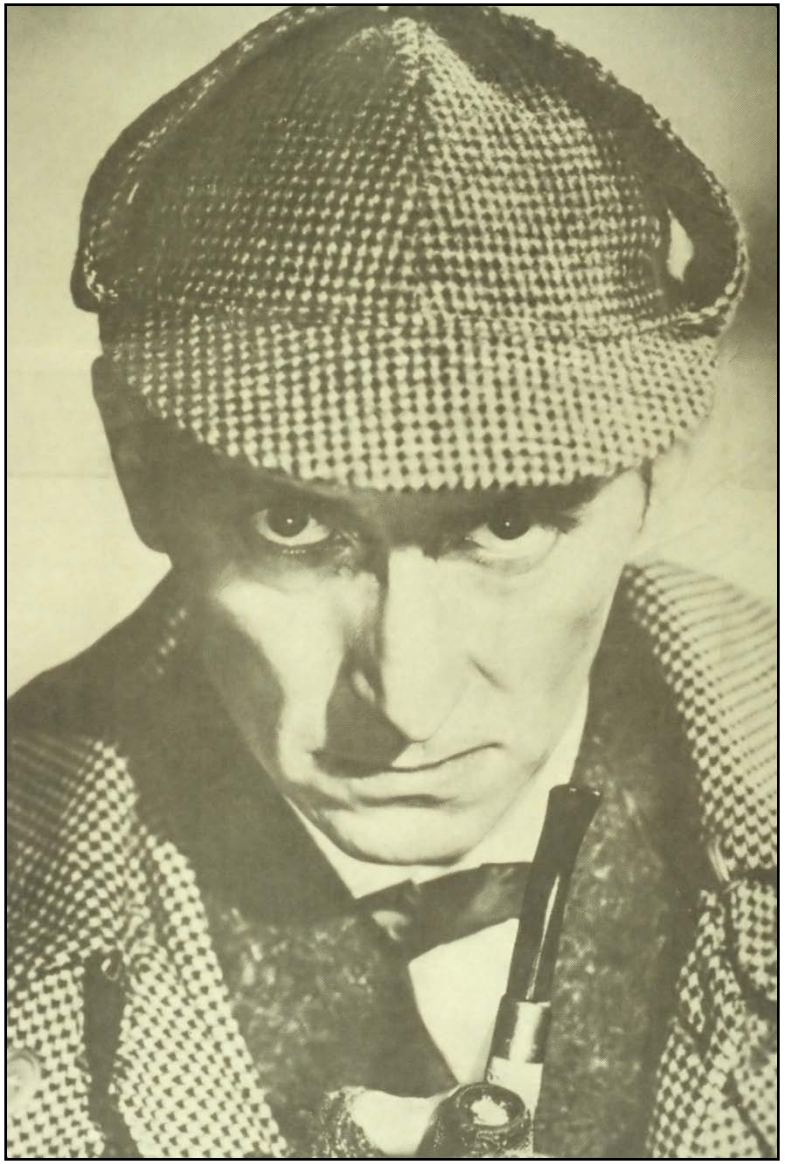
Inversion Display

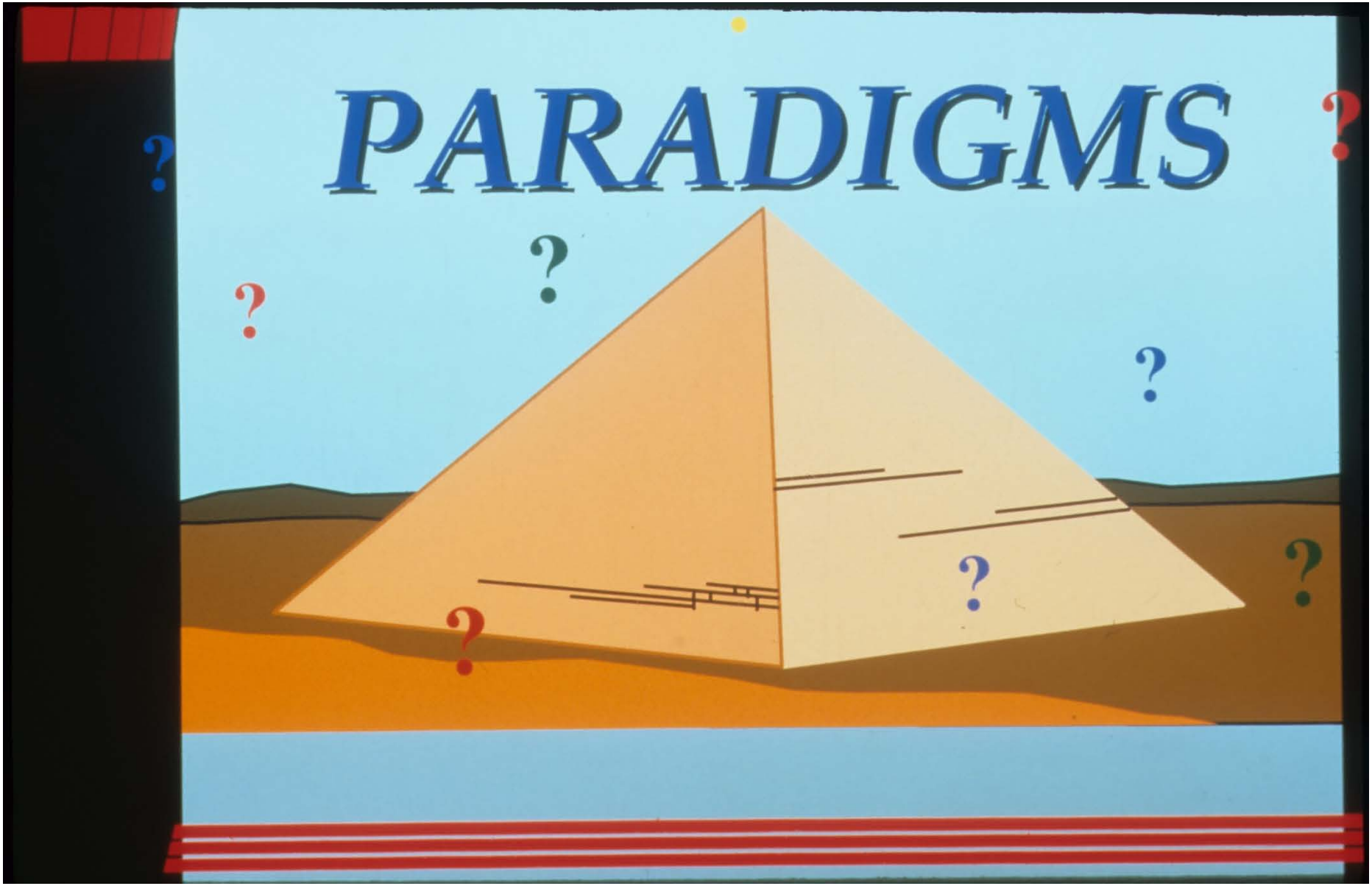


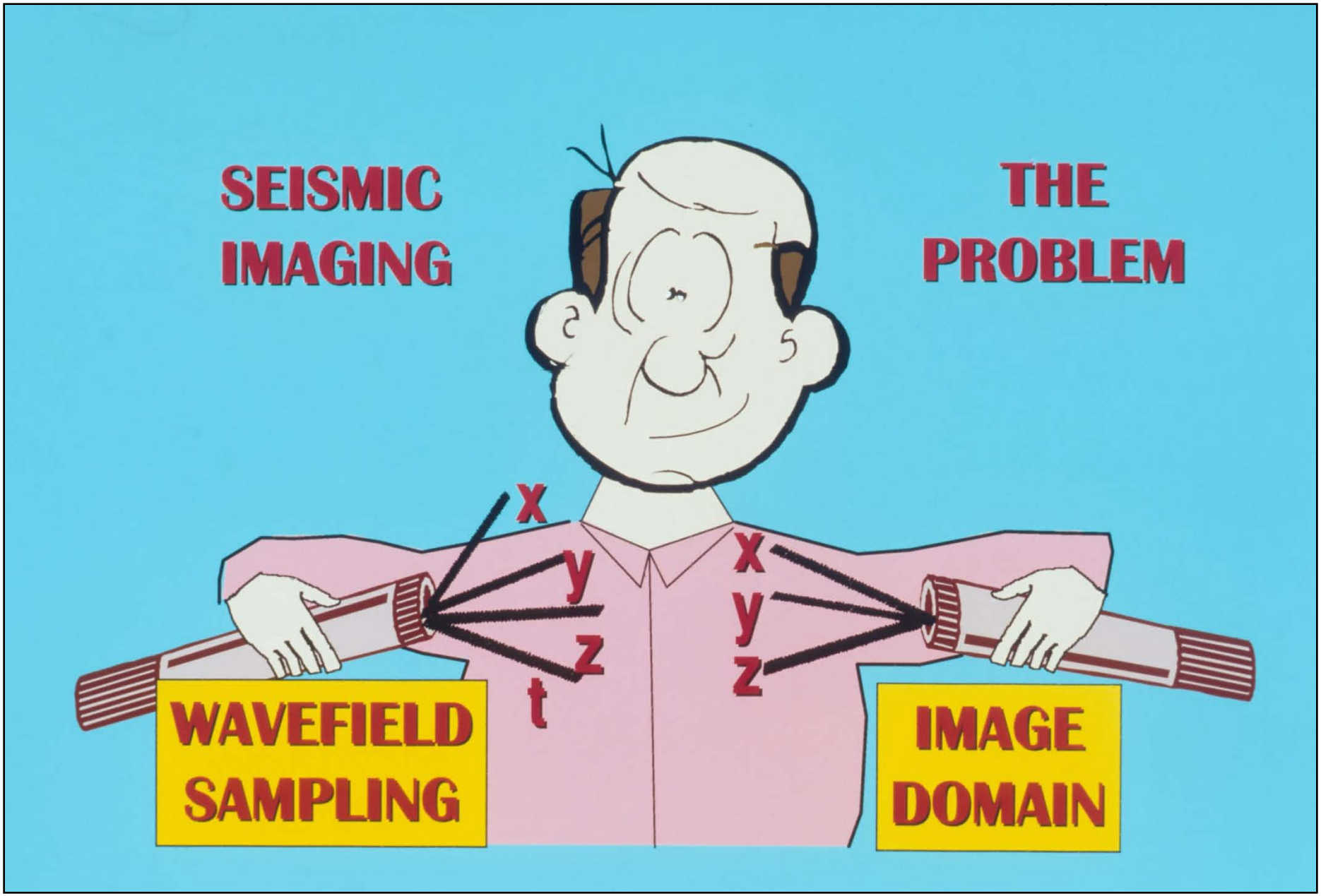
Inversion Velocity Trend and Geopressure Top

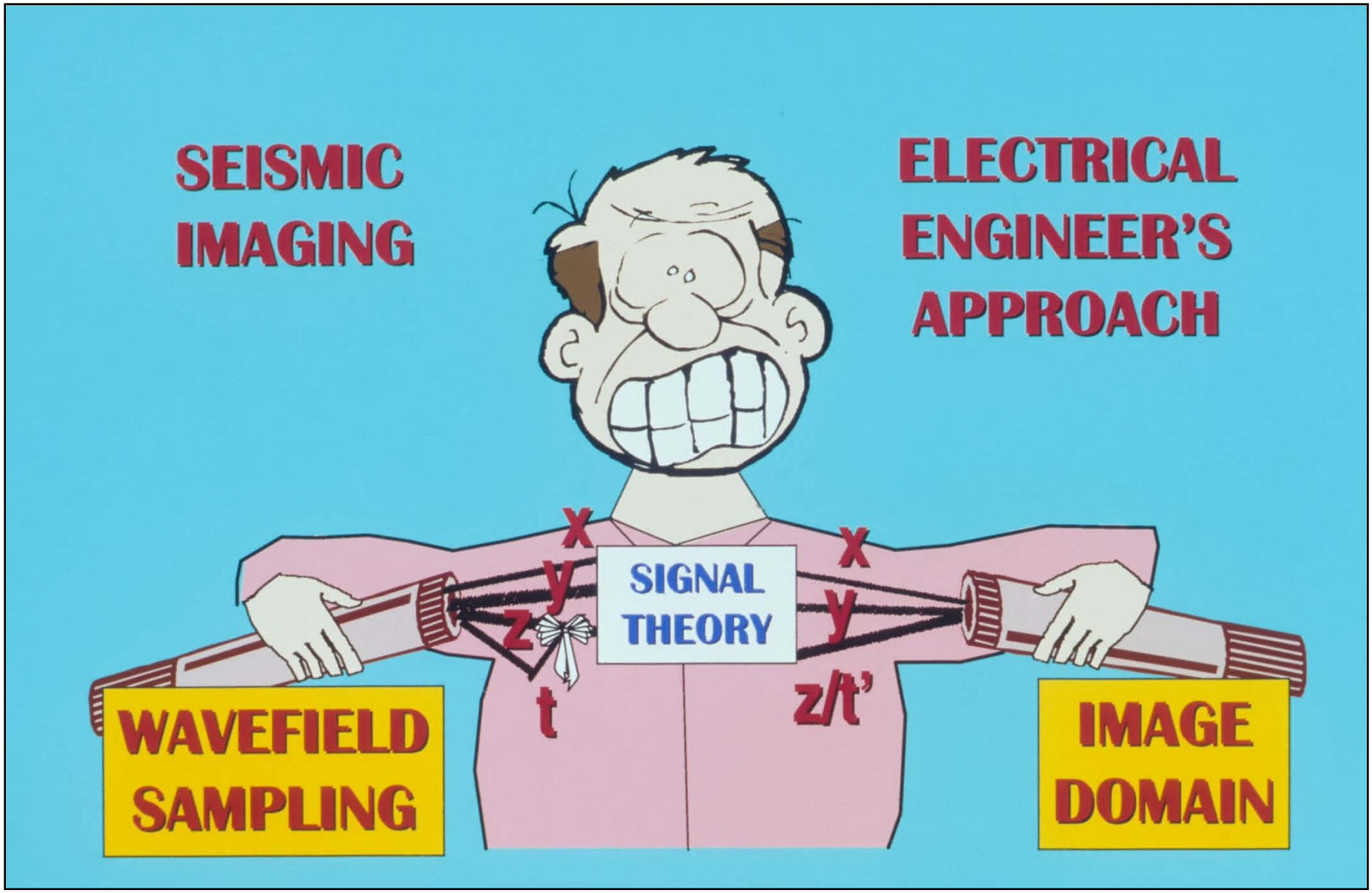


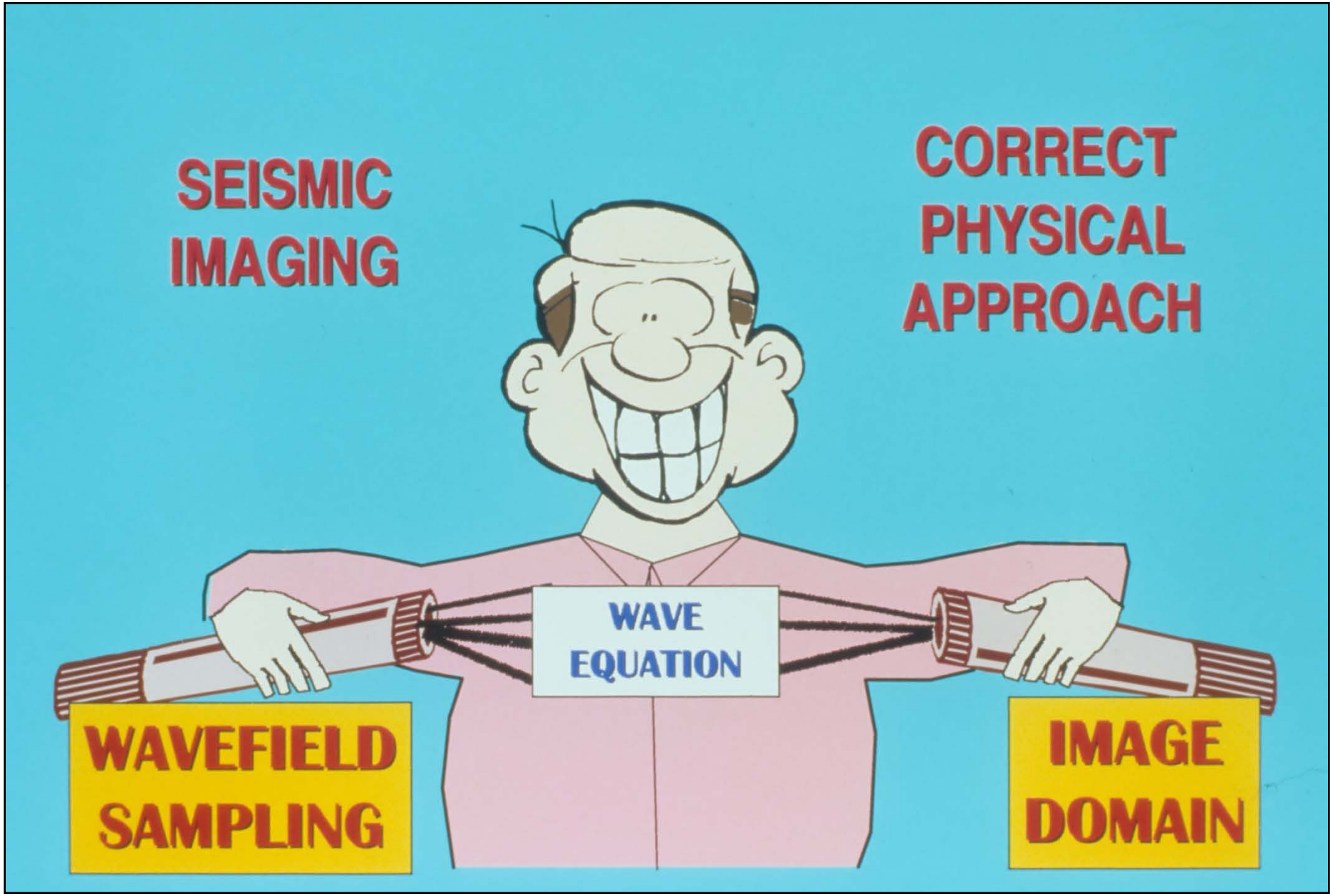
Addressing the Problem



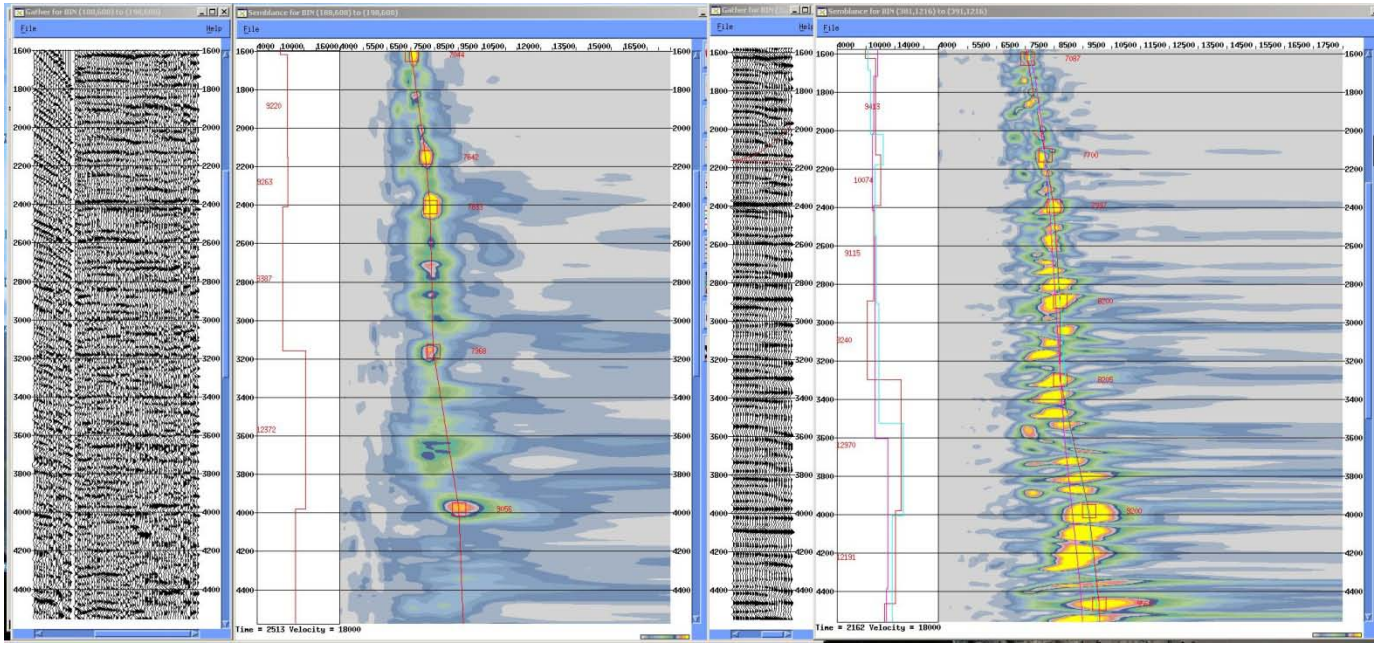

PARADIGMS

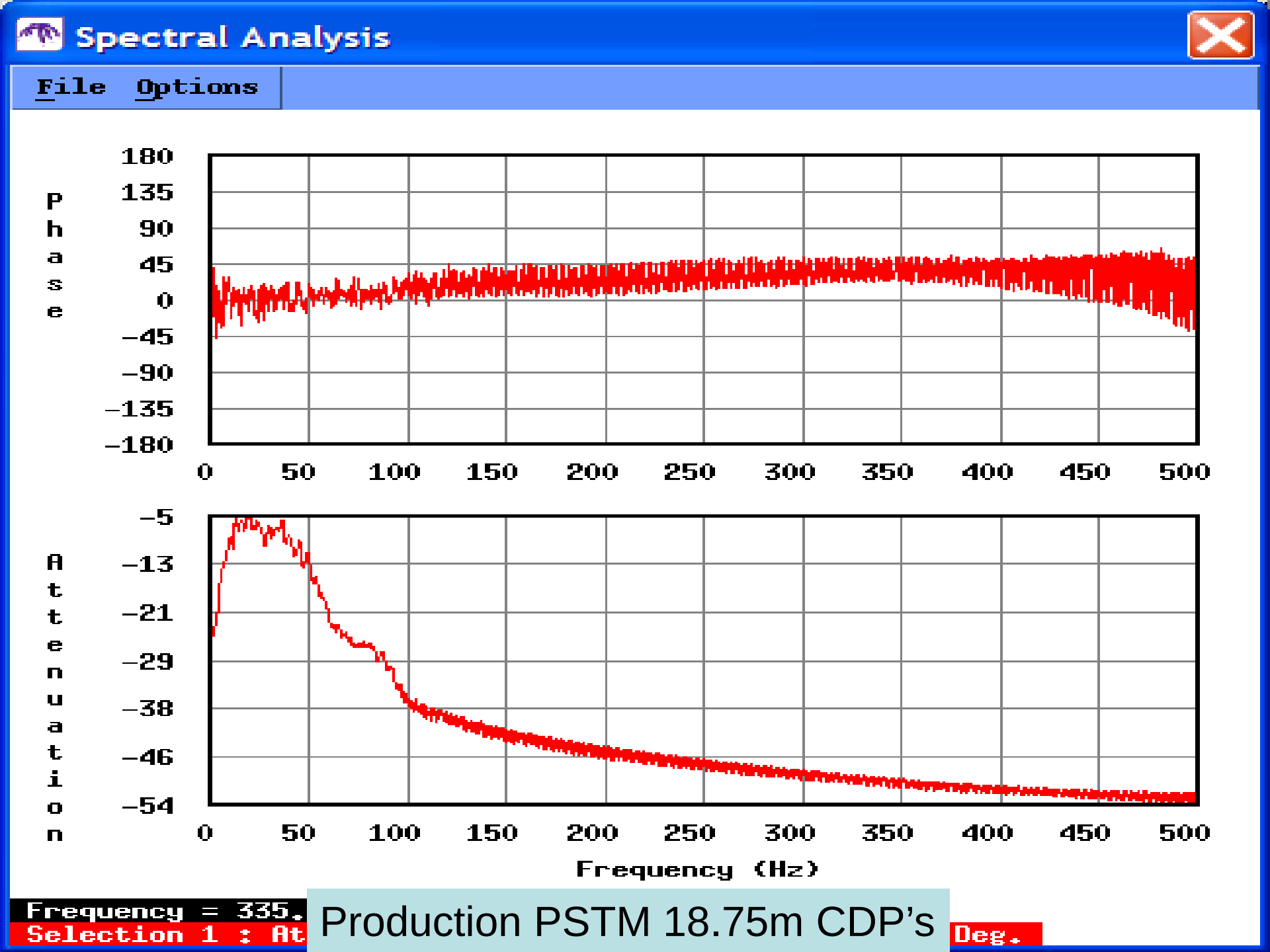

SEISMIC IMAGING
THE PROBLEM
x
y
z
t
x
y
z
WAVEFIELD SAMPLING
IMAGE DOMAIN


SEISMIC IMAGING
ELECTRICAL ENGINEER'S APPROACH
x
y
z
t
SIGNAL THEORY
x
y
z/t'
WAVEFIELD SAMPLING
IMAGE DOMAIN

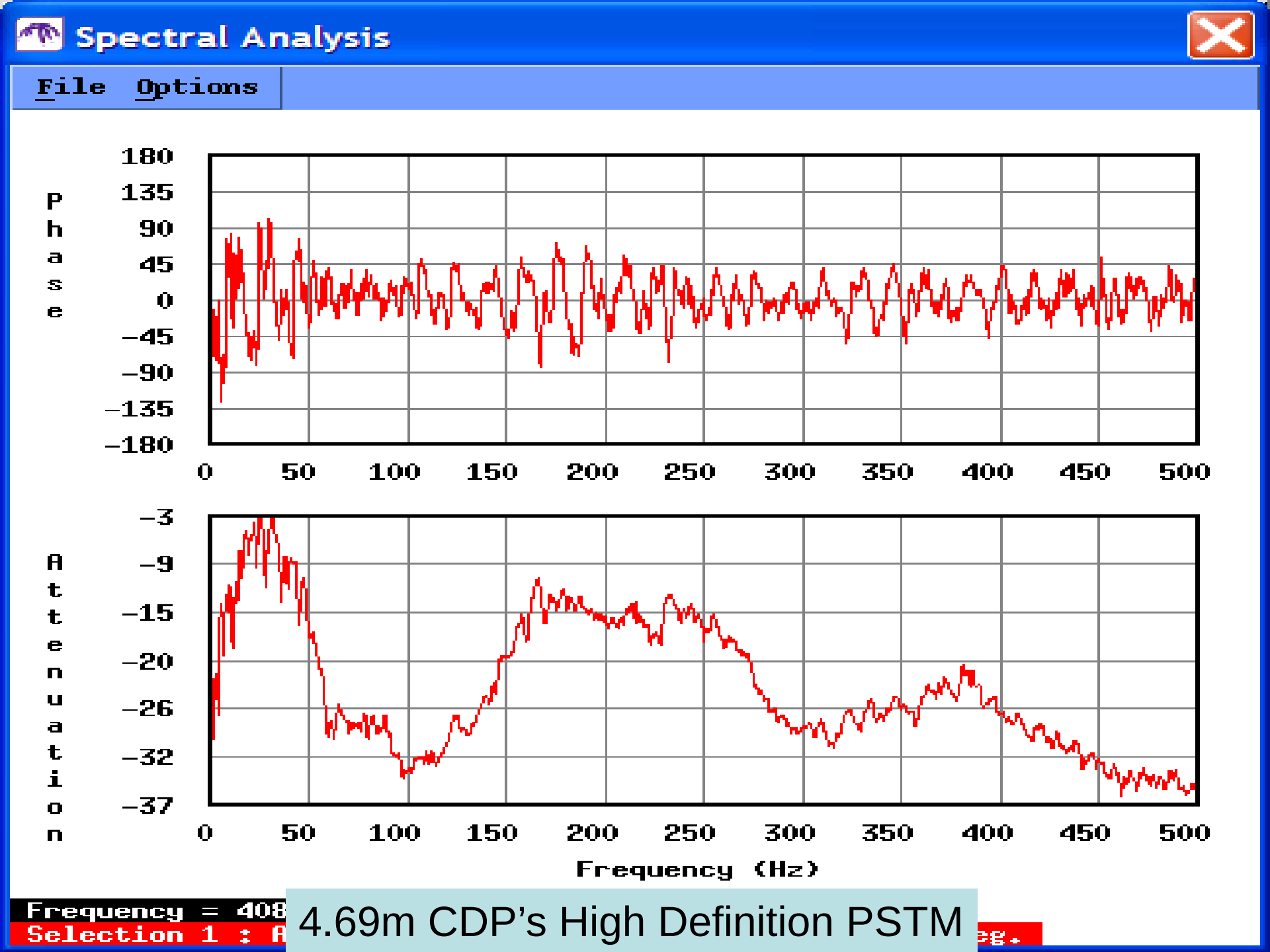

SEISMIC
IMAGING
CORRECT
PHYSICAL
APPROACH
WAVE
EQUATION
WAVEFIELD
SAMPLING
IMAGE
DOMAIN

Improved Velocity Analysis

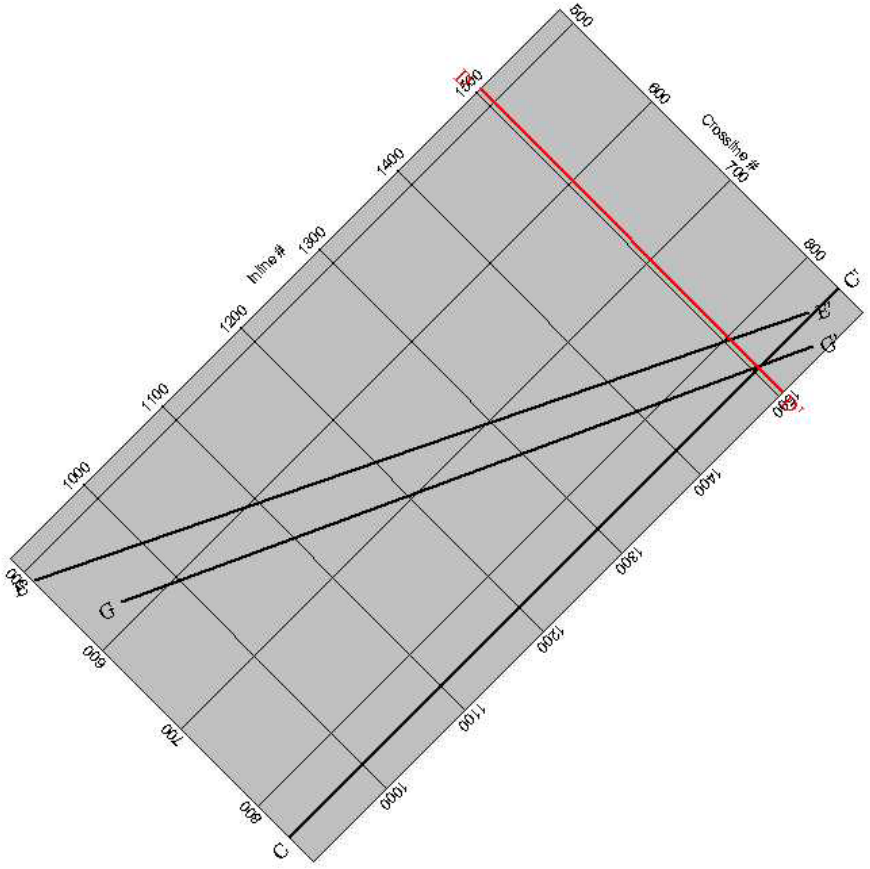




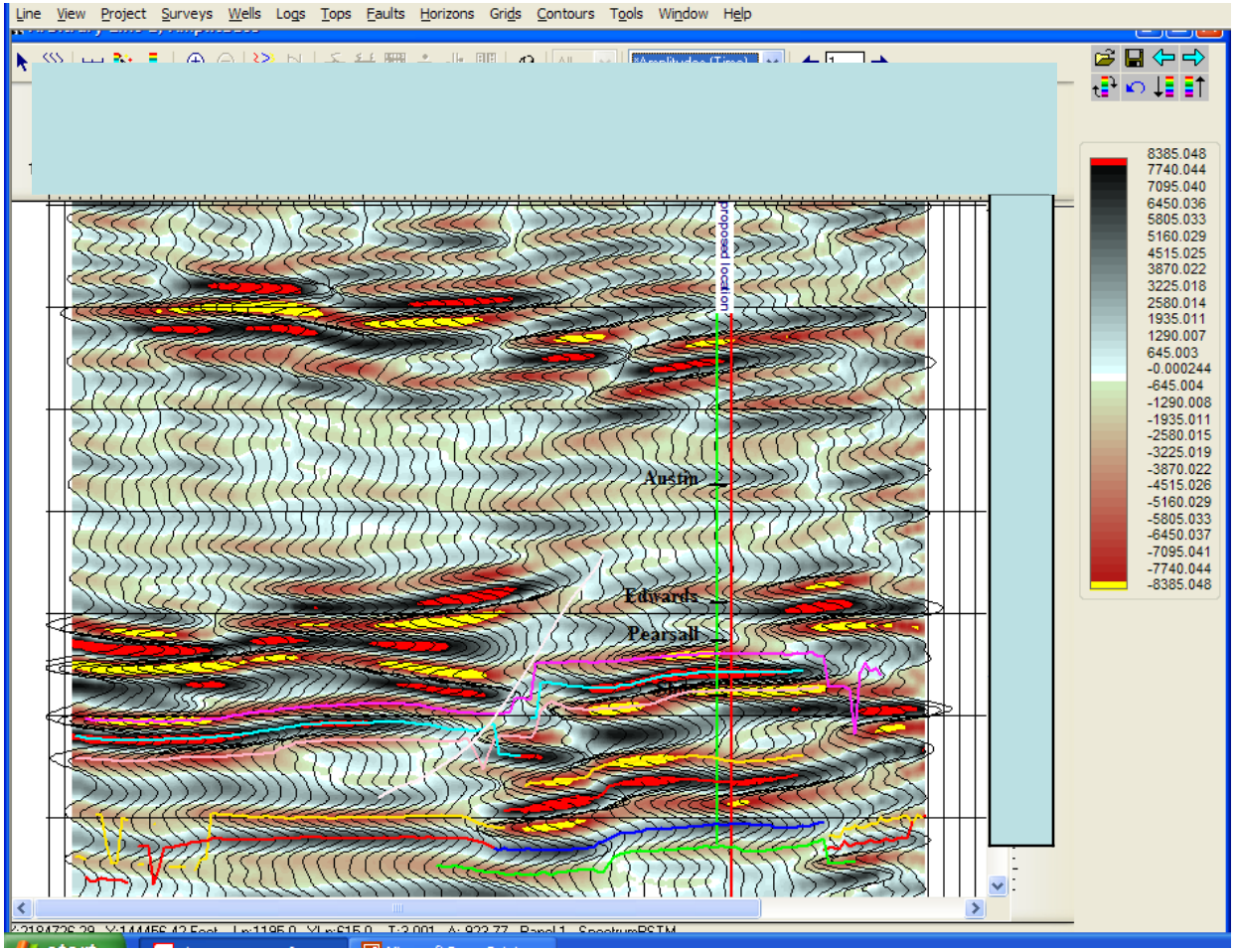
Production PSTM 18.75m CDP's


Spectral Analysis
File Options
Phase
180
135
90
45
0
-45
-90
-135
-180
0 50 100 150 200 250 300 350 400 450 500
Attenuation
-3
-9
-15
-20
-26
-32
-37
0 50 100 150 200 250 300 350 400 450 500
Frequency (Hz)
Frequency = 408
Selection 1 : A
4.69m CDP's High Definition PSTM

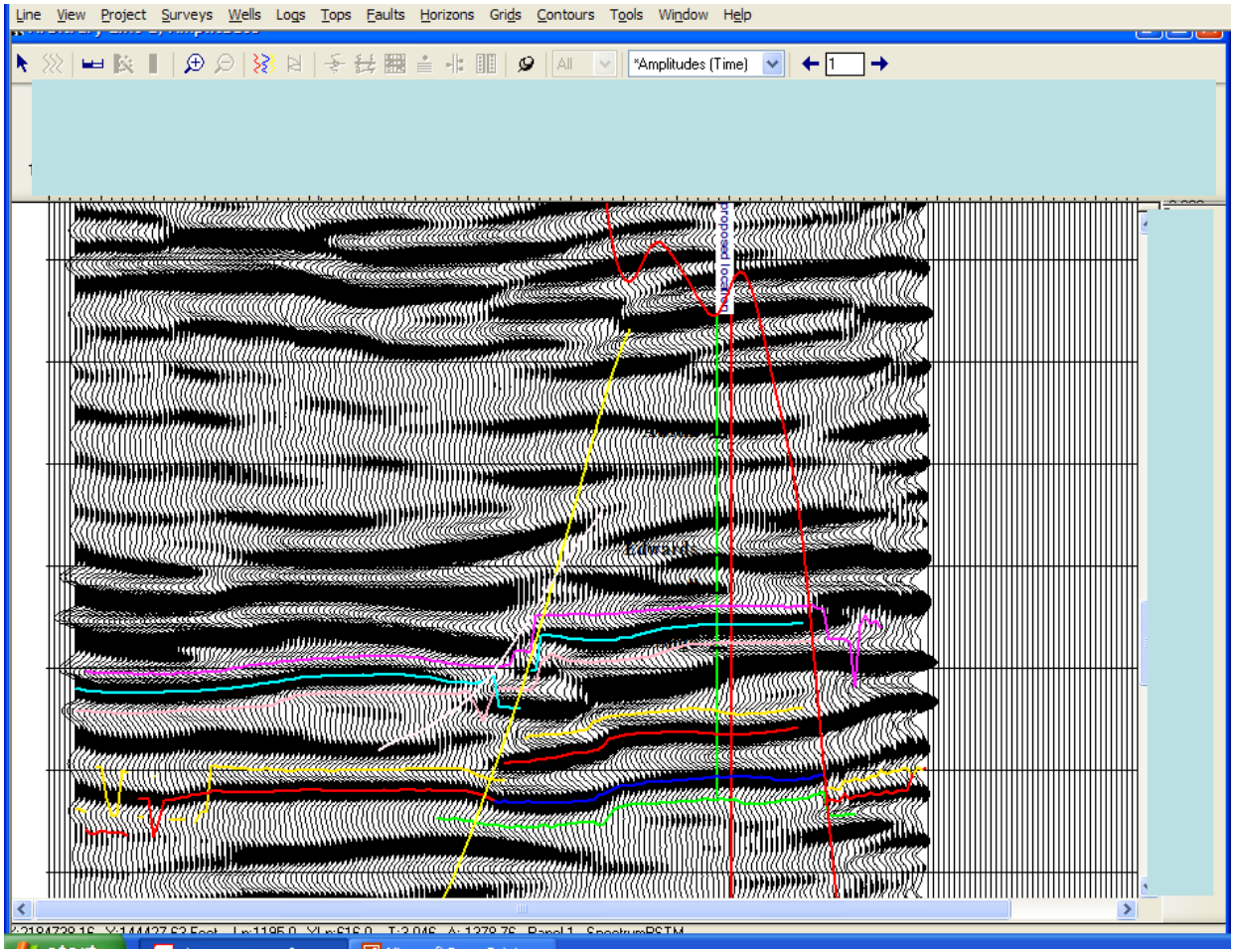
Base Map Lines GG”, 1505



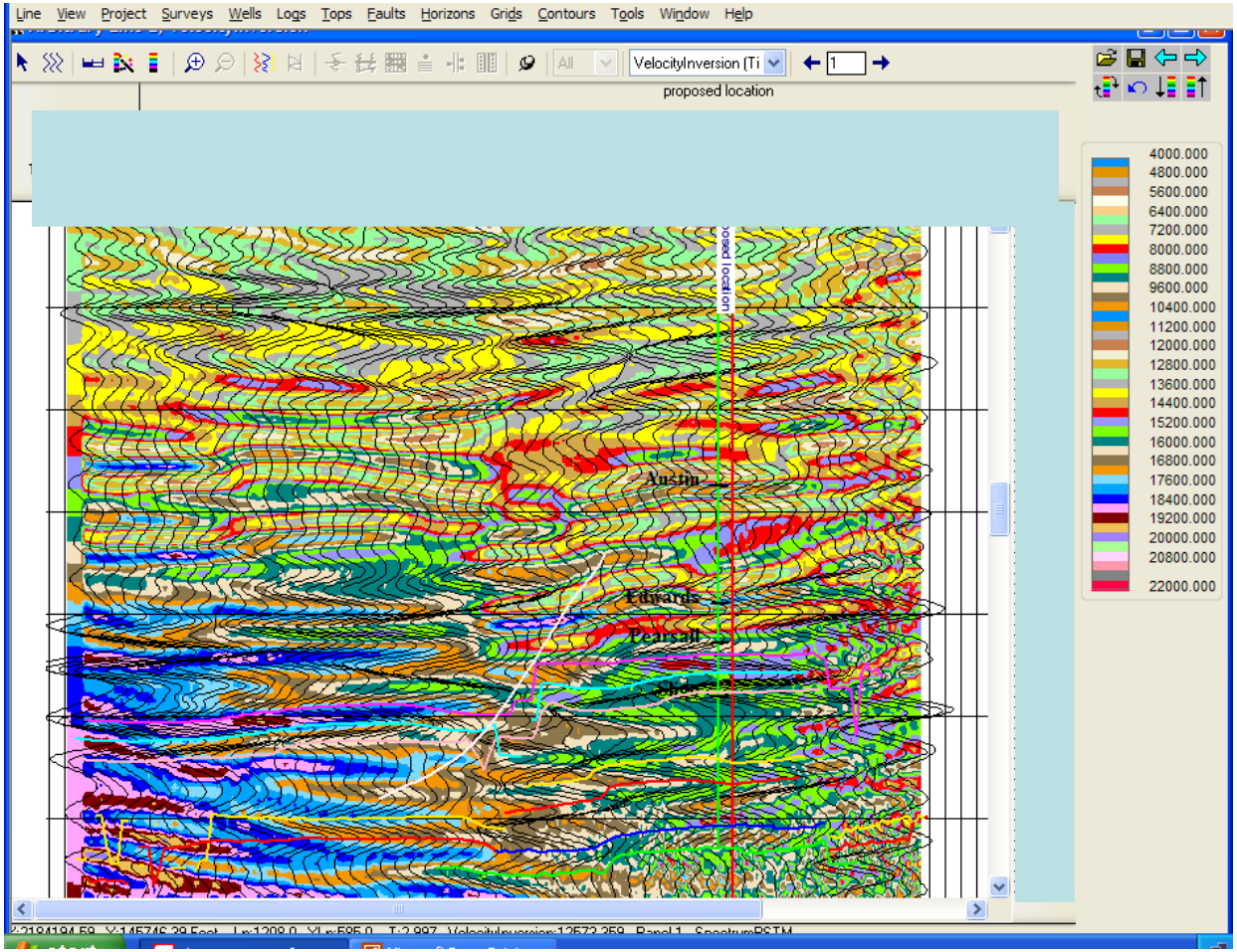
Conventional Seismic Image – Proposed Location



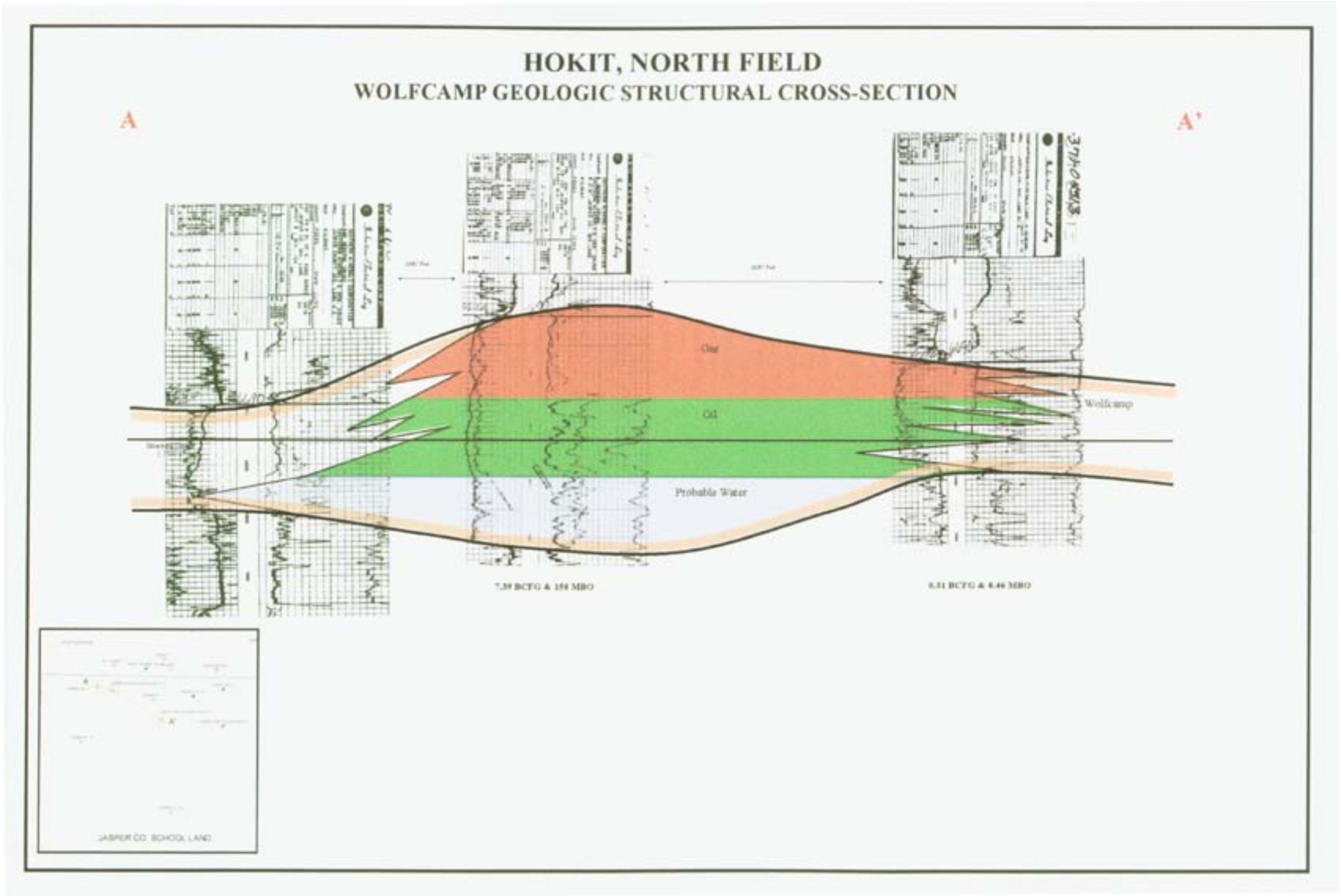
HRR Imaging- Proposed Location



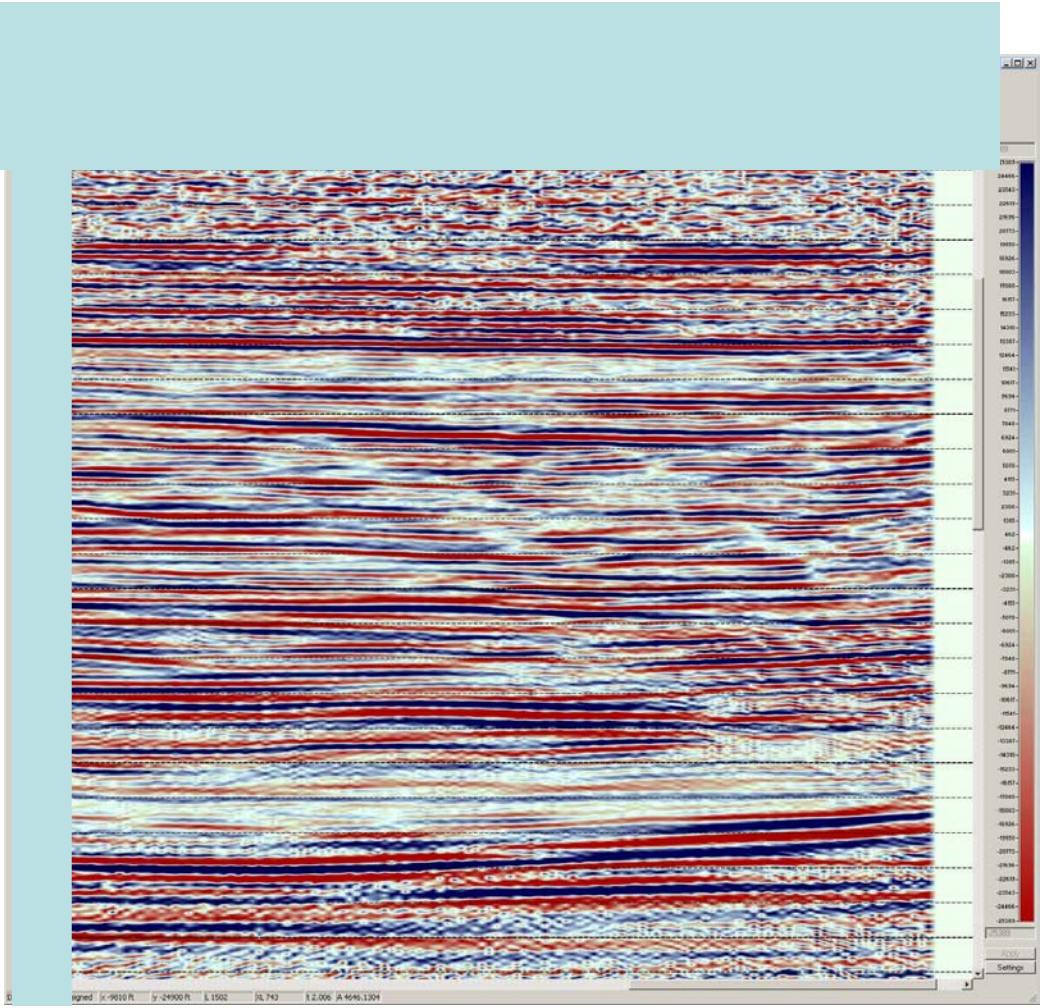
HPR Inversion – Proposed Location



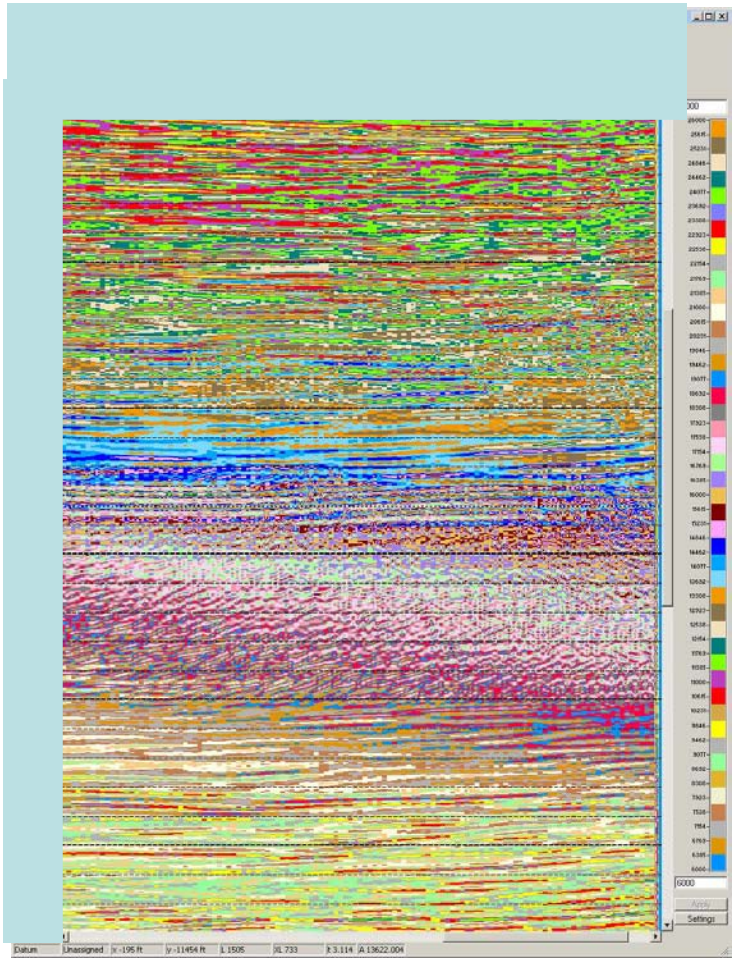
Wolfcamp Structural Cross Section after Carlisle



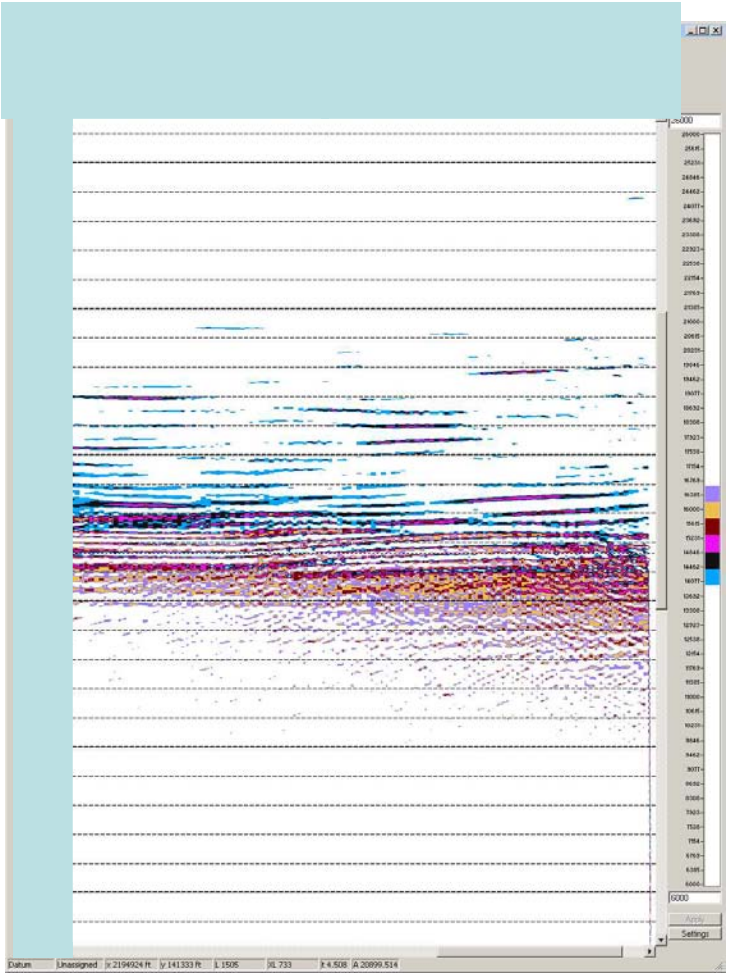
HPR Image 1505 Conventional



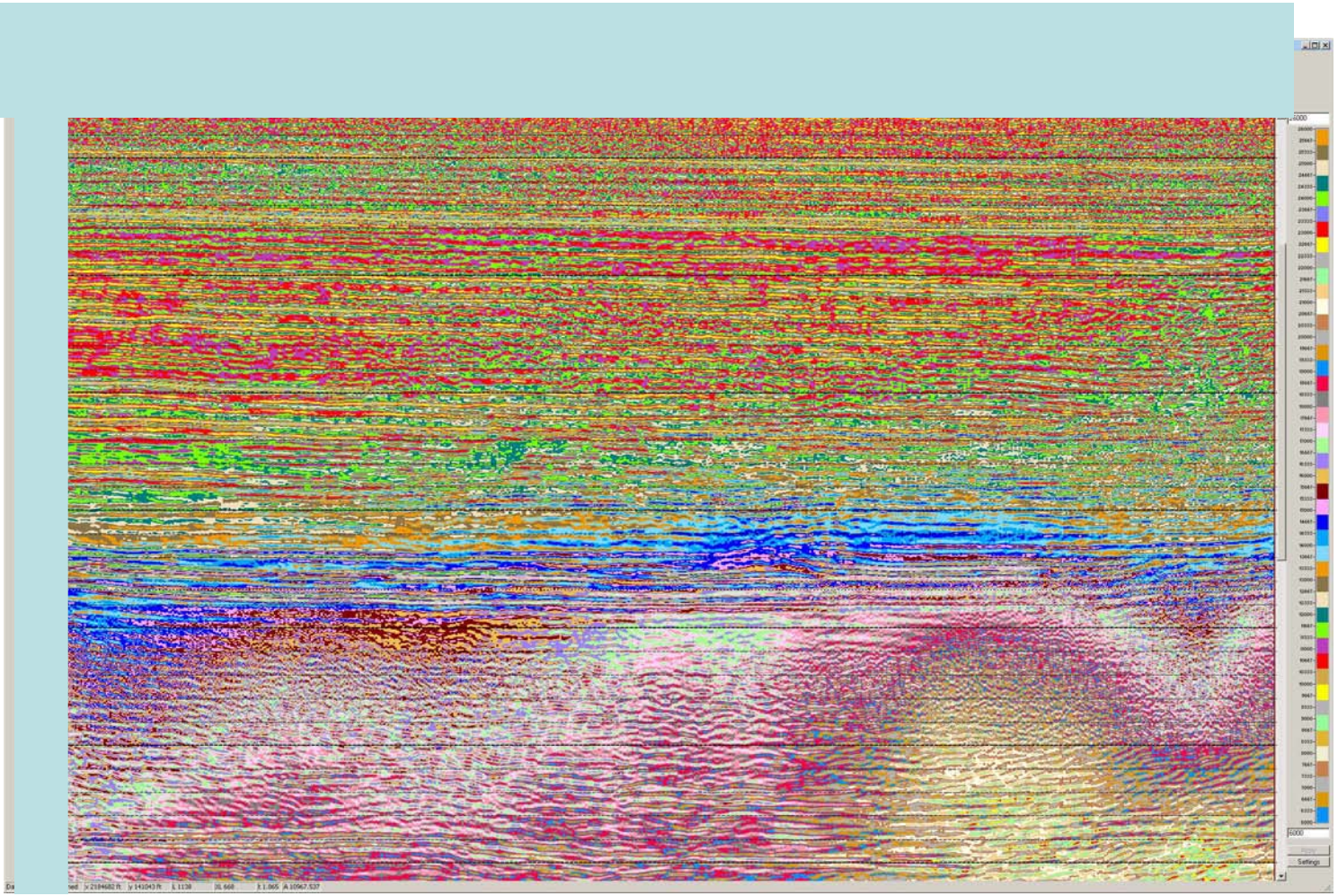
HPR Inversion 1505



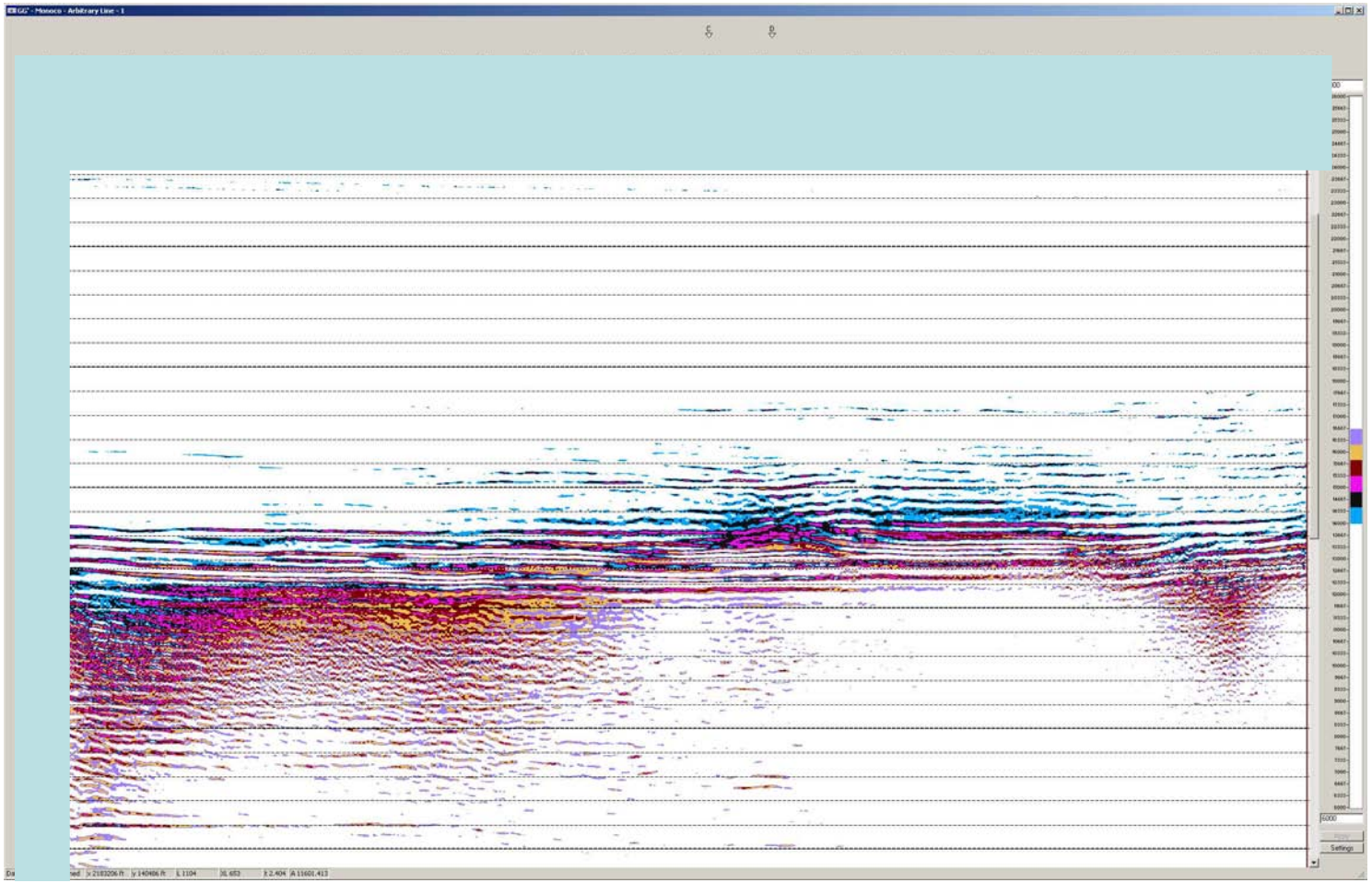
HPR Inv 1505 Carbonates



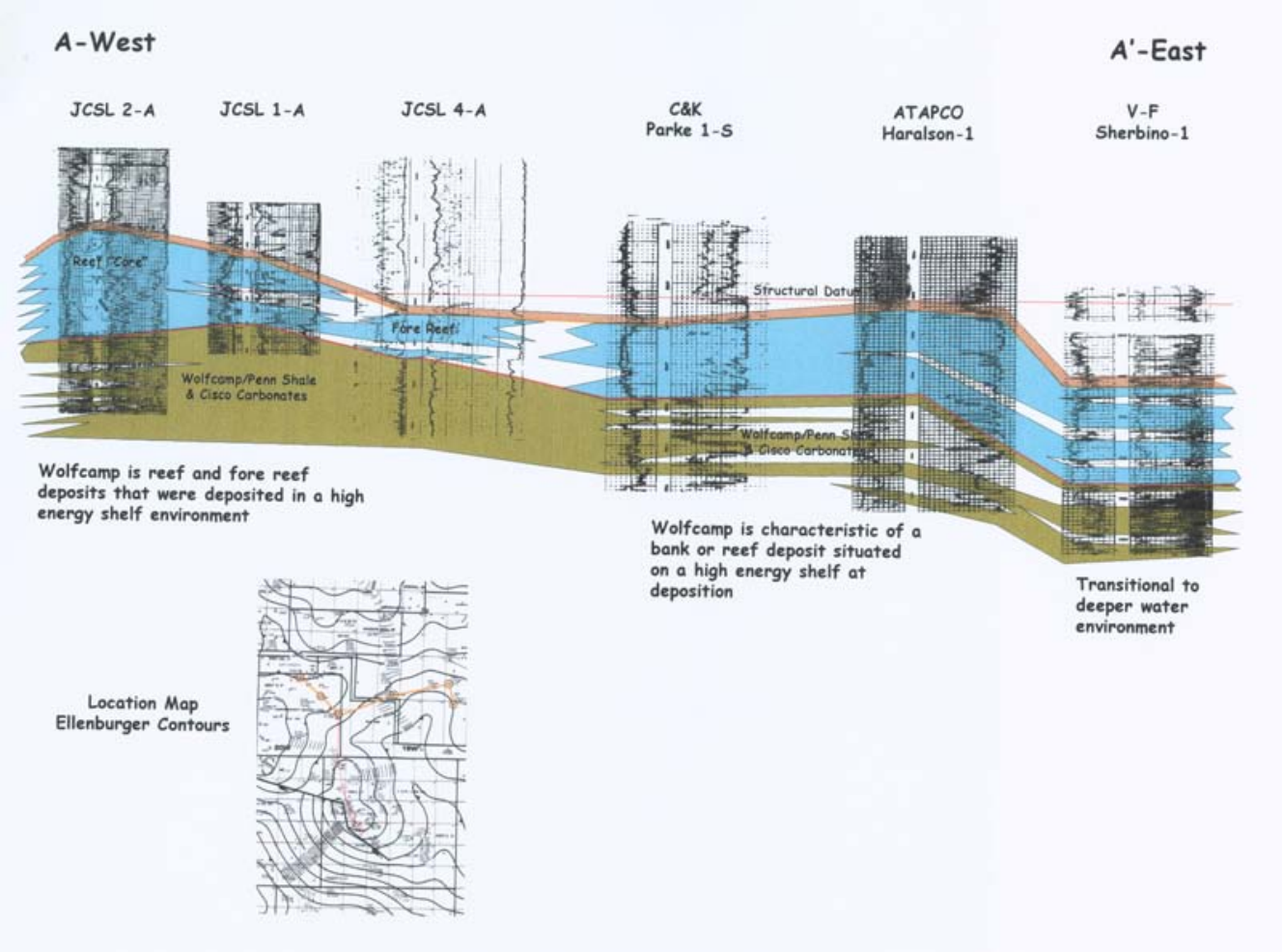
HPR Inv GG’



HPR Inv GG’ Carbonates

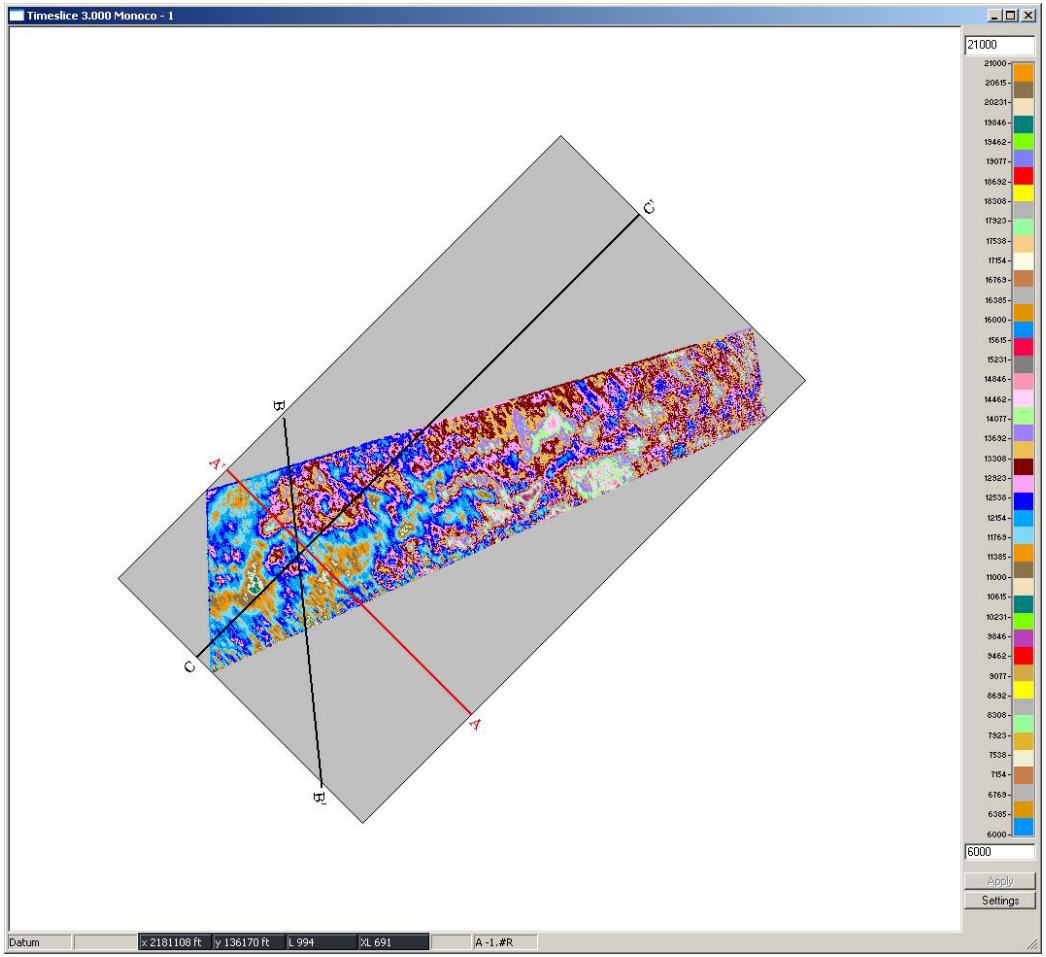


Wolfcamp Regional View after Carlisle

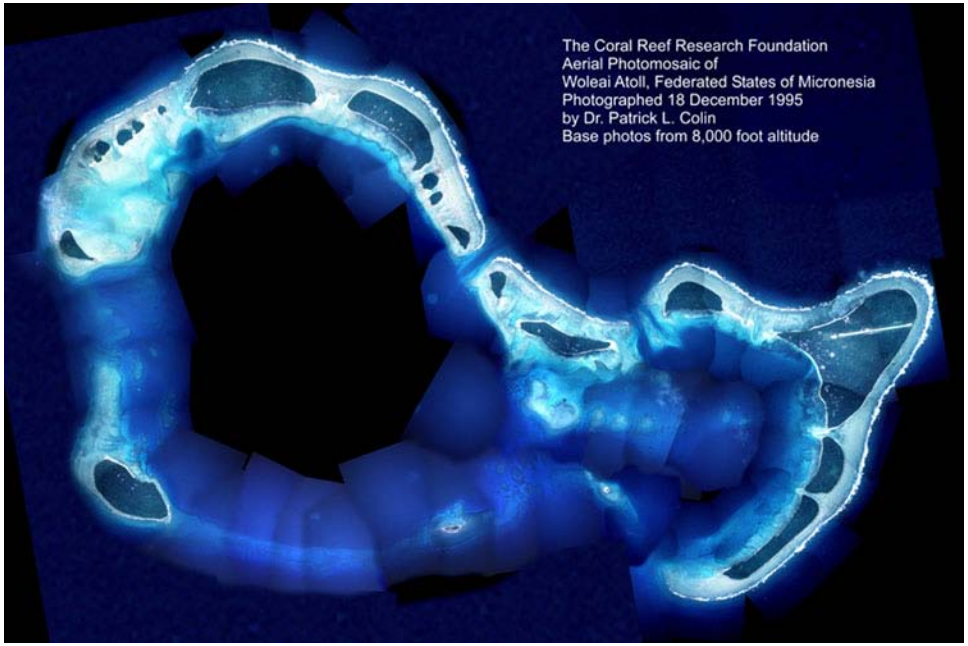


Great Barrier Reef –abc news

Inversion Time Slice



Woleai Atoll after Colin



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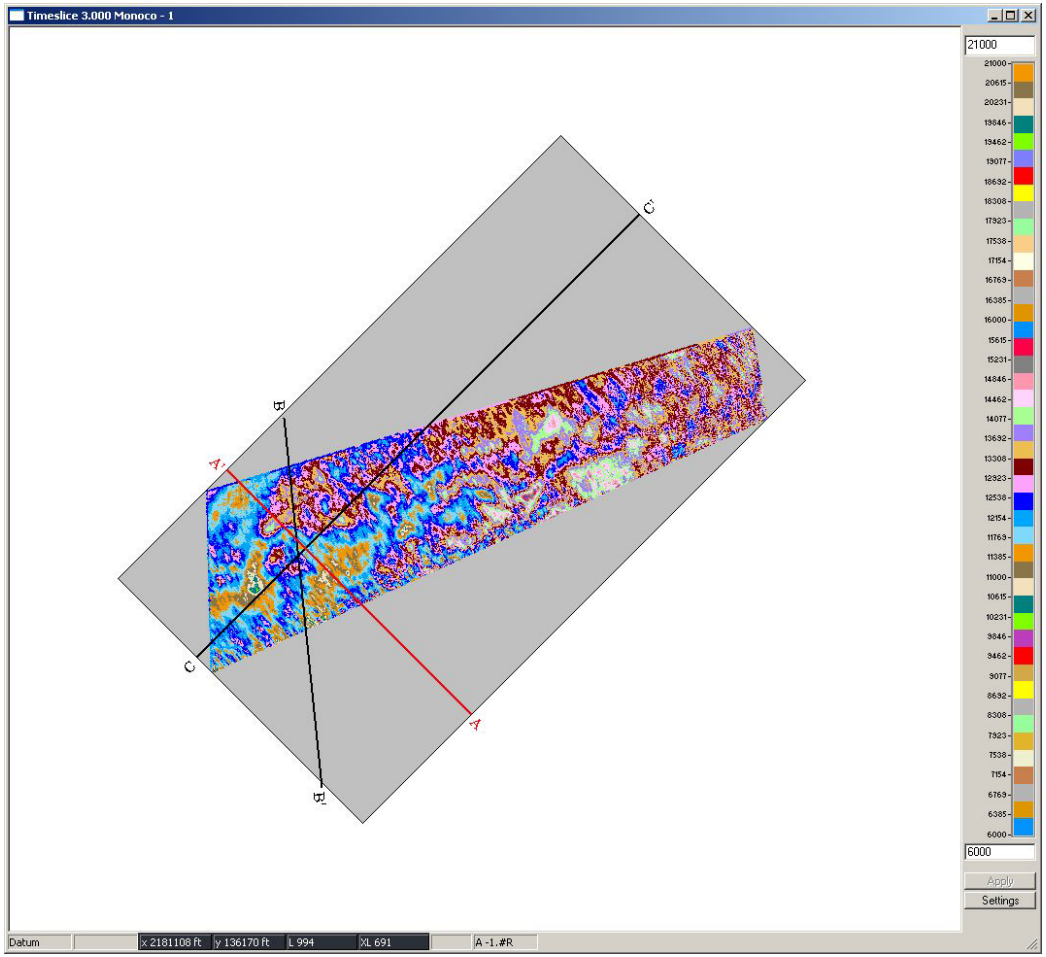
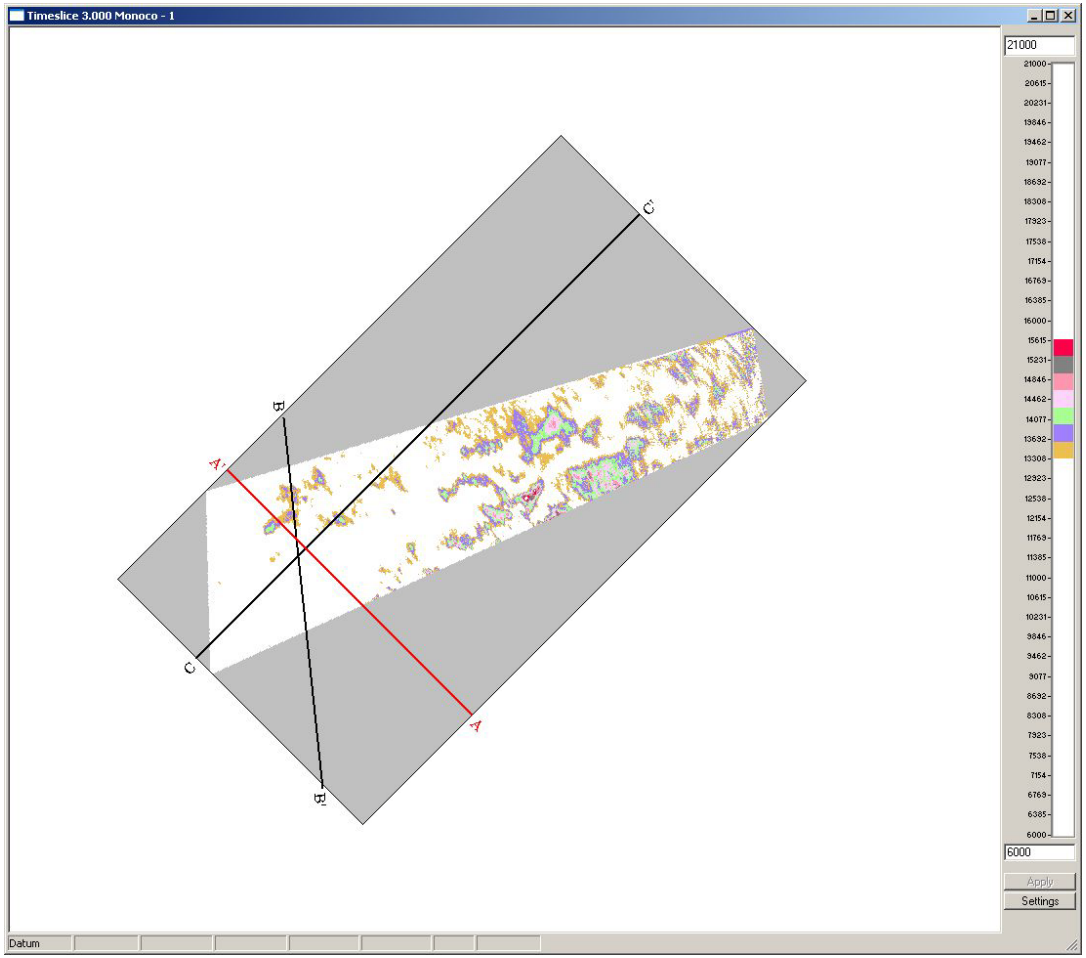
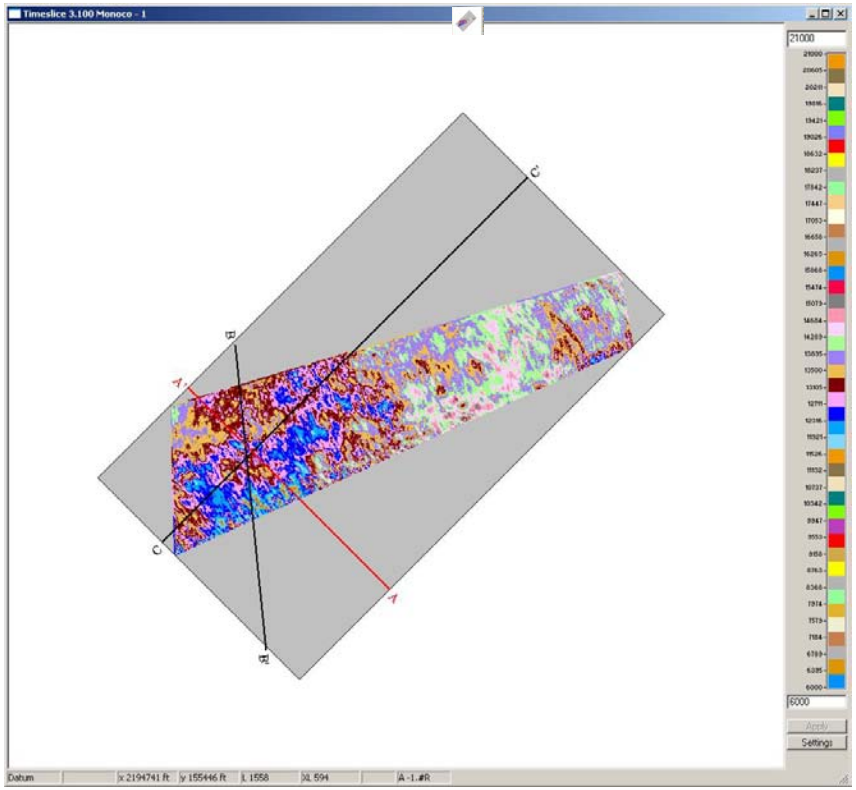


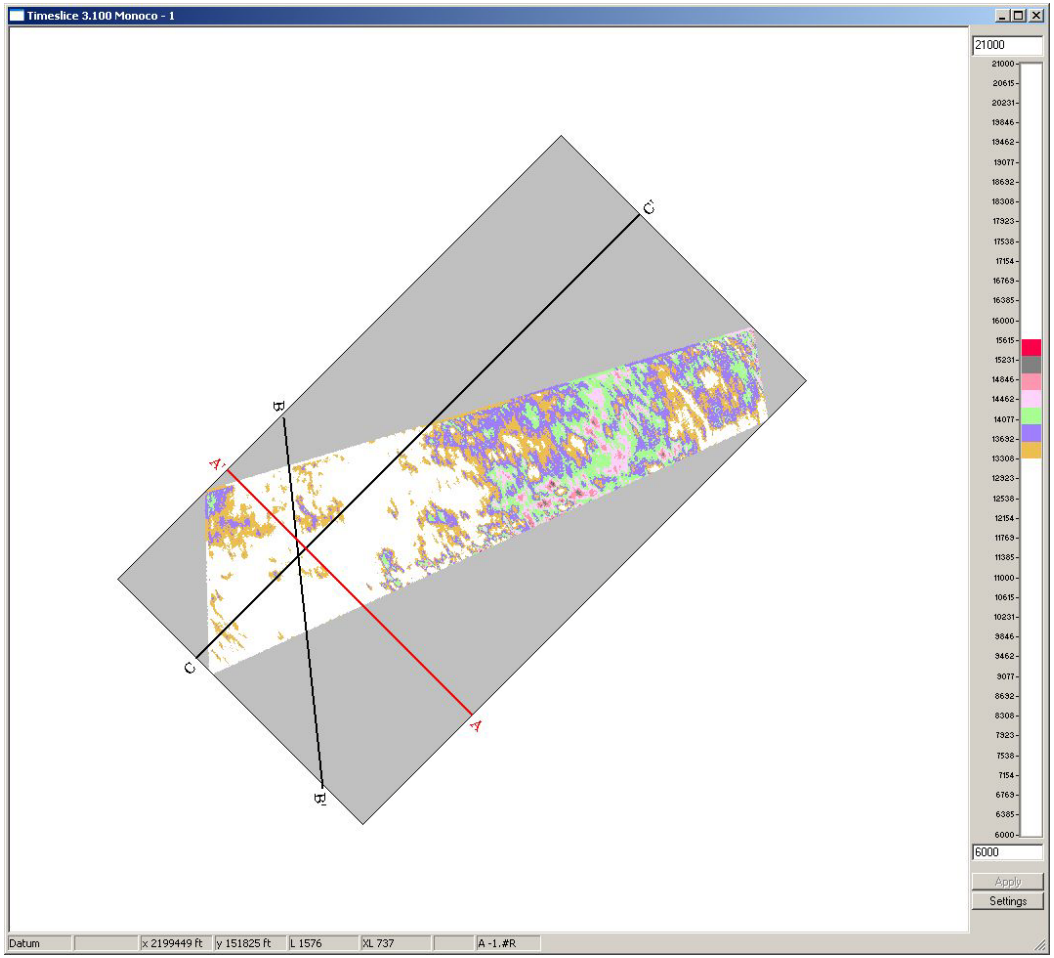
Inversion TS Carbonate Velocities



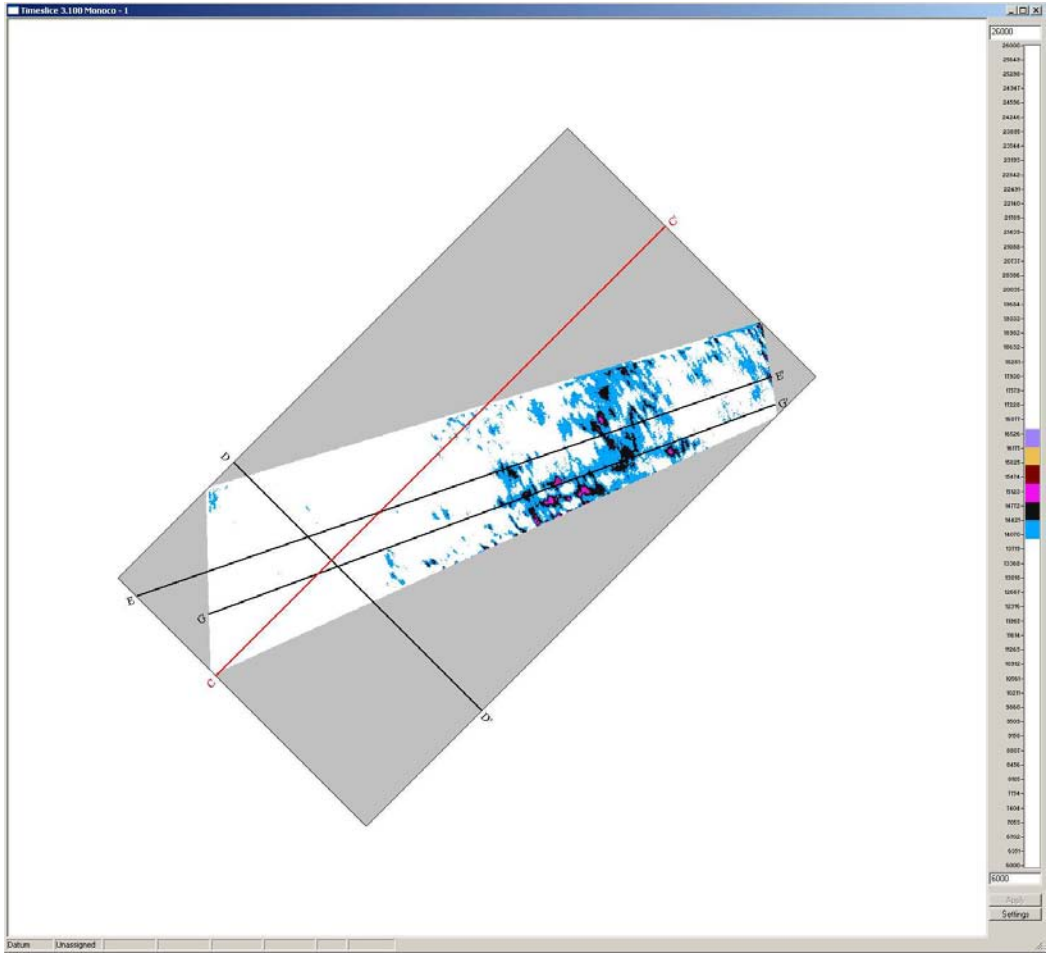
Inversion TS +100 msec



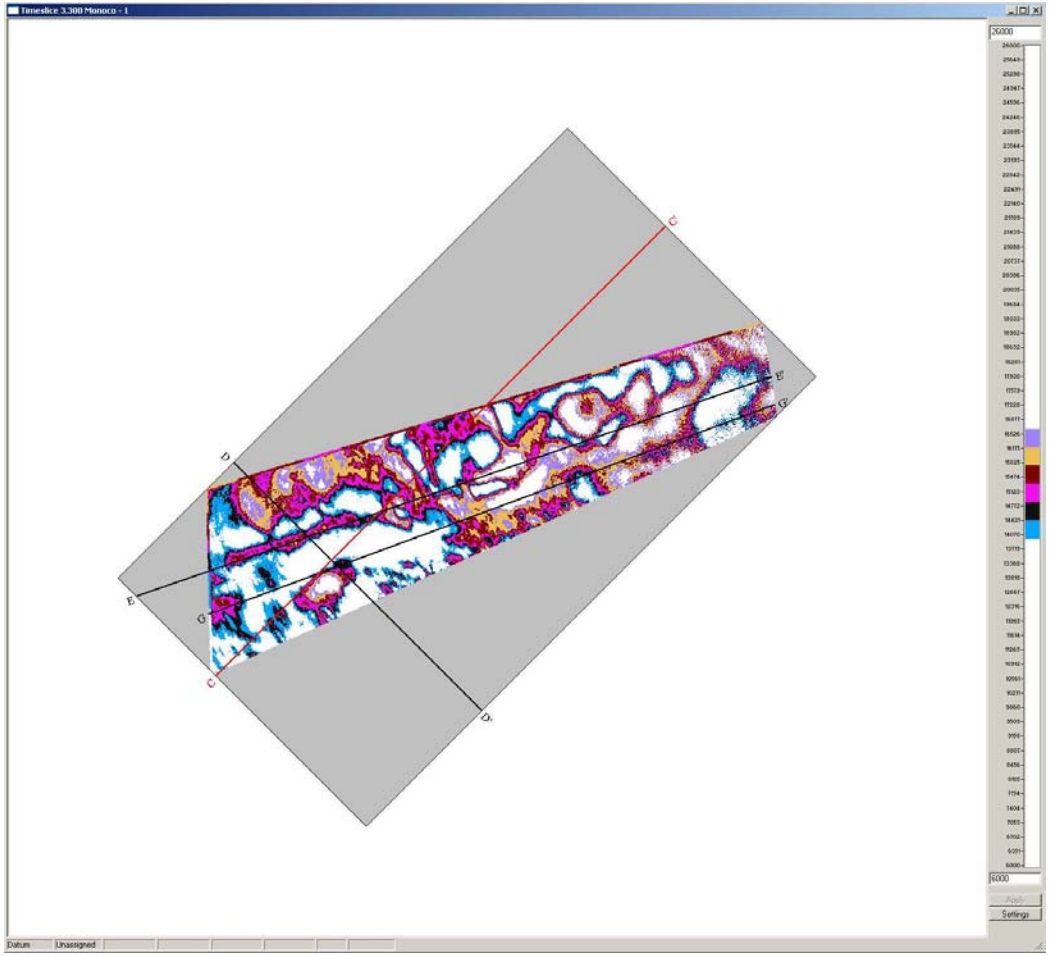
TS + 100 msec - Carbonates



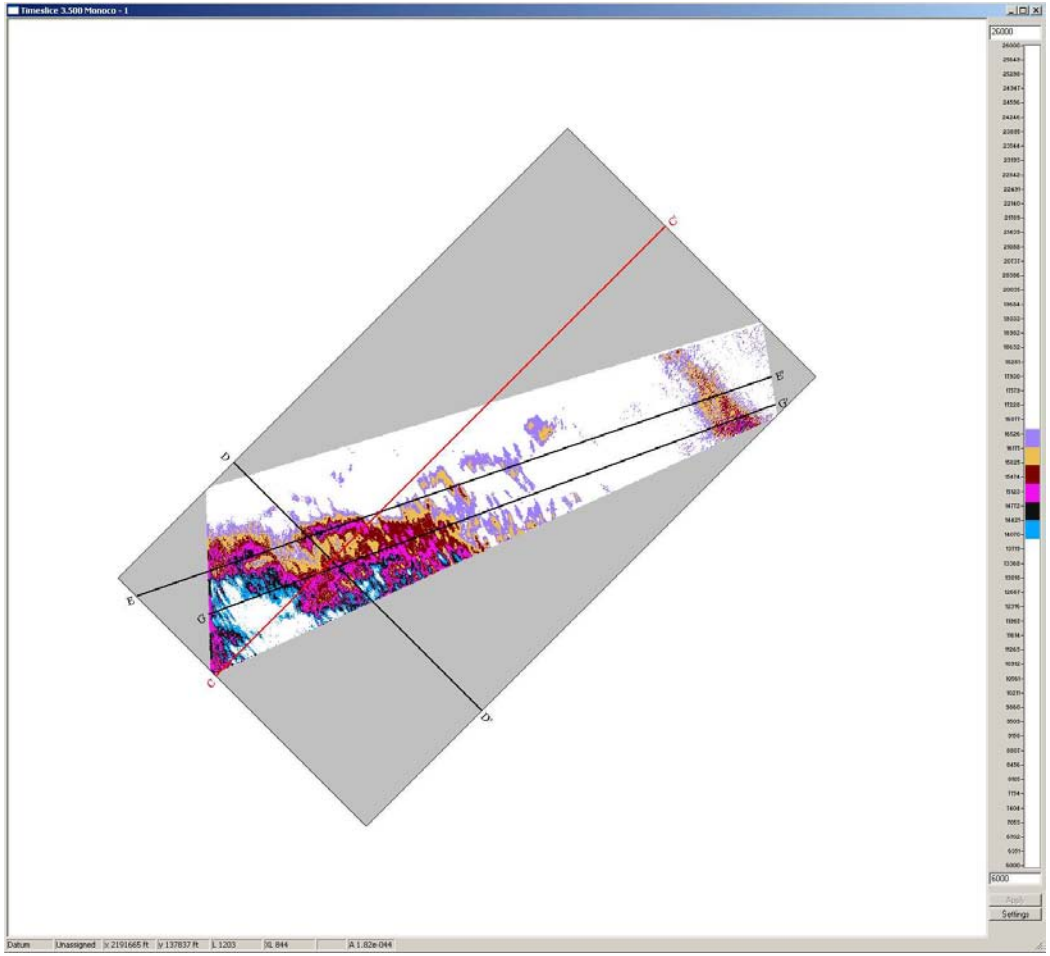
TS + 100 msec Possible Gas



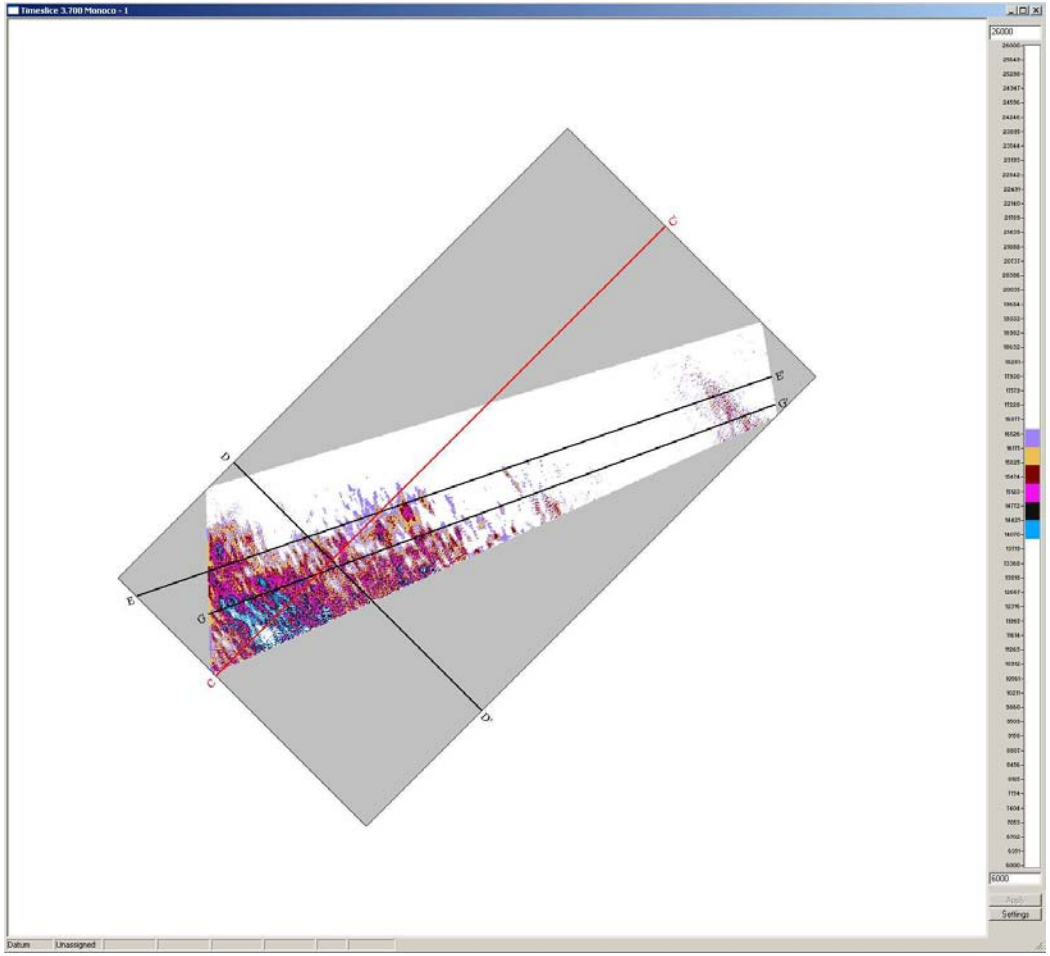
TS + 300 msec - Possible Gas



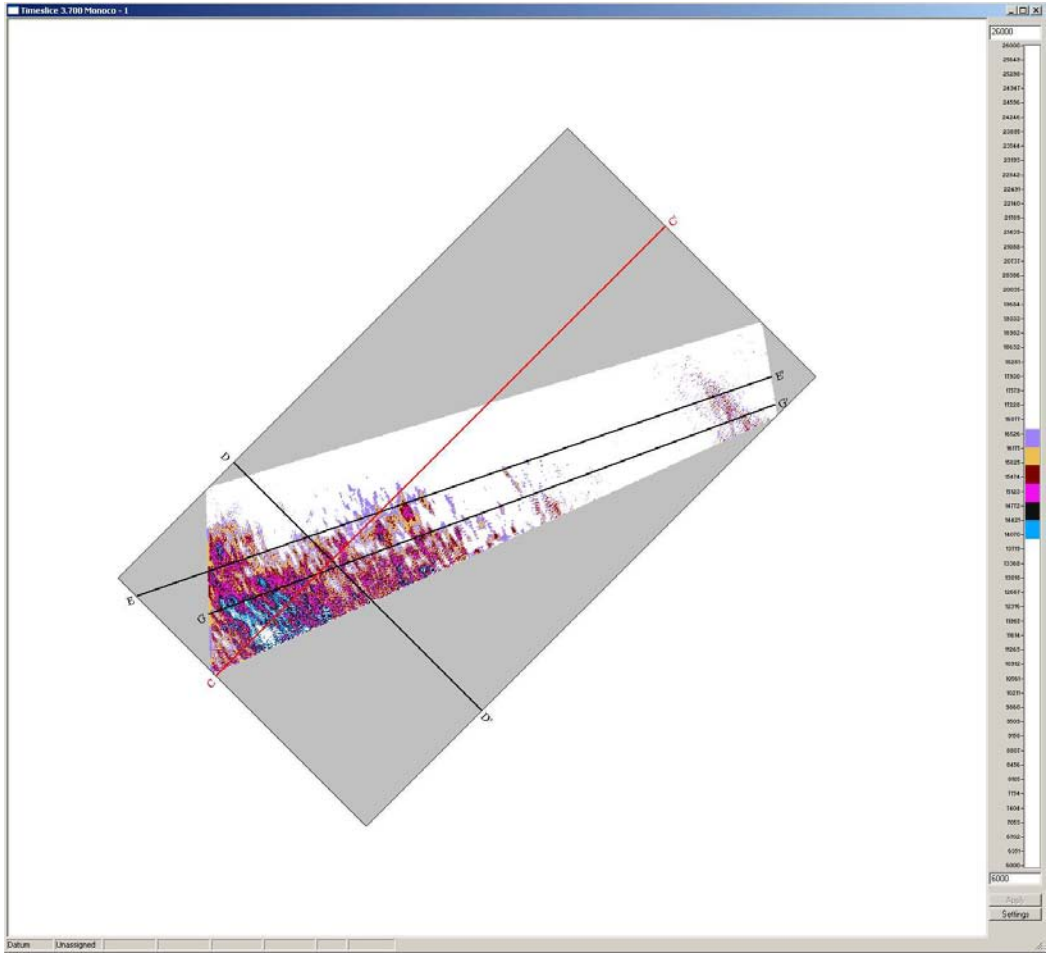
TS + 500 msec - Possible Gas



TS +700 msec - Possible Gas



TS + 900 msec - Possible Gas



References

Carlisle, Philip, H., 2003, The attributes of a Wolfcamp “Reef” play Pecos County, Texas: Search and Discovery Article #10037 (2003) (http://www.searchanddiscovery.net/documents/carlisle/index.htm).

Colin, Patrick L., Woleai Atoll (re-touched composite air photo), in Tribute Trips. Web: ://www.pacificworlds.com/yap/arrival/tribute.cfm. Accessed 10-05-2008.