Seismic Attribute Mapping for Identification of Cypress Sands, Illinois Basin, Indiana, USA*

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Abstract

Mississippian Cypress sands are the major exploration and exploitation target in the Illinois basin with the thickness of the sands varying from well to well in the same field. The present study area is from Illinois basin, Posey County, Indiana, U.S.A. The Posey County area is a mature exploration area with production established in the 1920s. More than 7,000 wells have been drilled in Posey County, with the majority being drilled before 1960. If any well log data exist, they are typically in the form of old electrical logs. The renewed interest in understanding the subsurface started in mid 1990s during which time independent operators started acquiring 3D seismic data, with the present survey covering 40 km^2. In this paper we report on the success in delineating the Mississippian Cypress sands with the aid of modern seismic attribute technology.

We use modern 3D visualization tools of opacity and Hue-Lightness-Saturation (HLS) color modulation to co-render complementary seismic attributes along stratal slices at 2 ms intervals. Such co-rendering allows us to interactively cluster mathematically independent attributes that are coupled through the same geologic features (e.g. low impedance with lower peak frequency). We present our findings through a suite of multi-attribute displays and animations loops through the data volume to highlight the subtle lenticular sand bodies associated with structural faults/ridges characteristic of braided channels.

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Selected References

Montgomery, S.L., and H.E. Leetaru, 2000, Storms Consolidated field, Illinois Basin: Identifying new reserves in a mature area: AAPG Bulletin, v. 84/2, p. 157-173.

Potter, P.E., 1962, Regional distribution patterns of Pennsylvanian sandstones in Illinois Basin: AAPG Bulletin, v. 46/10, p. 1890-1911.

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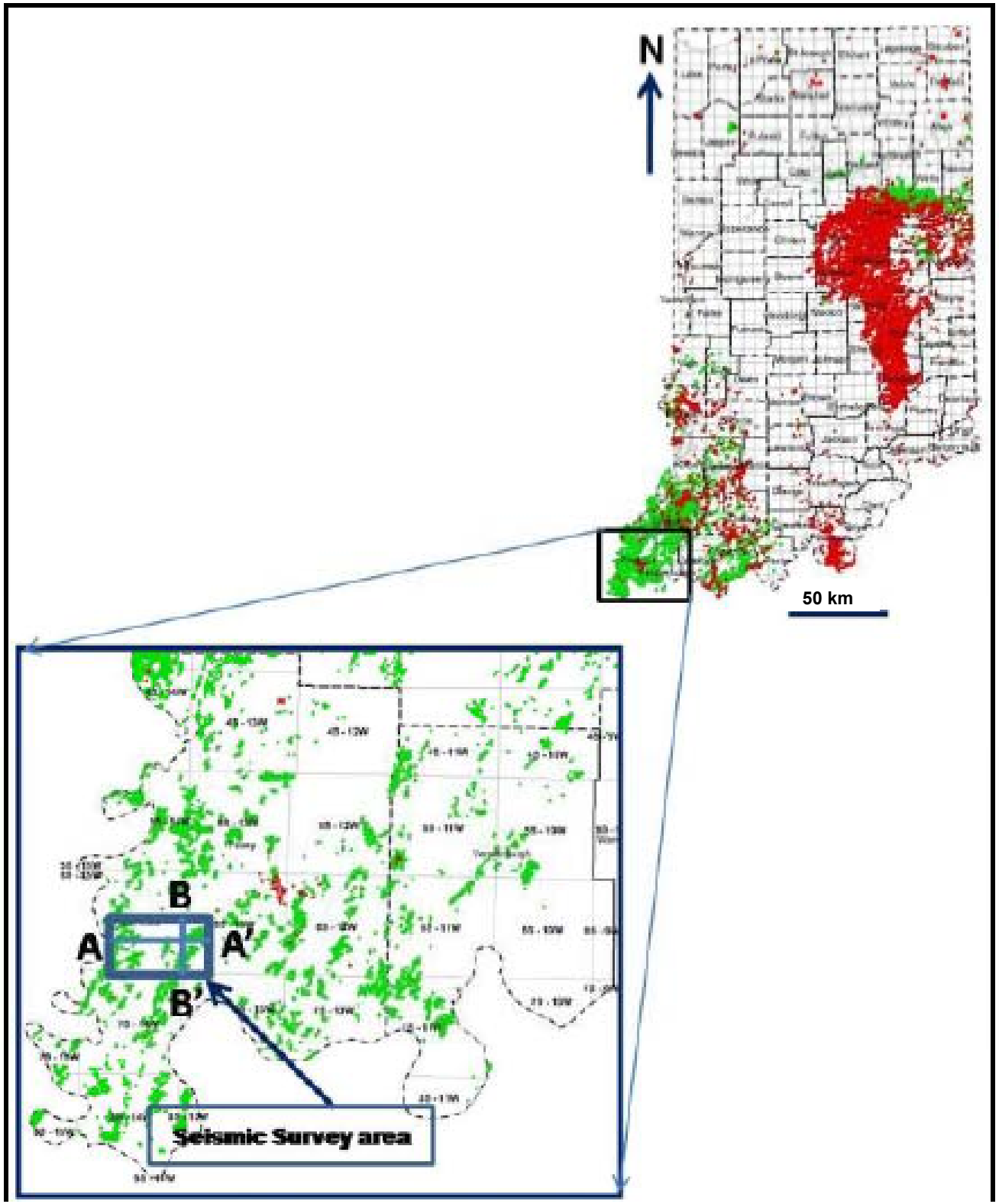
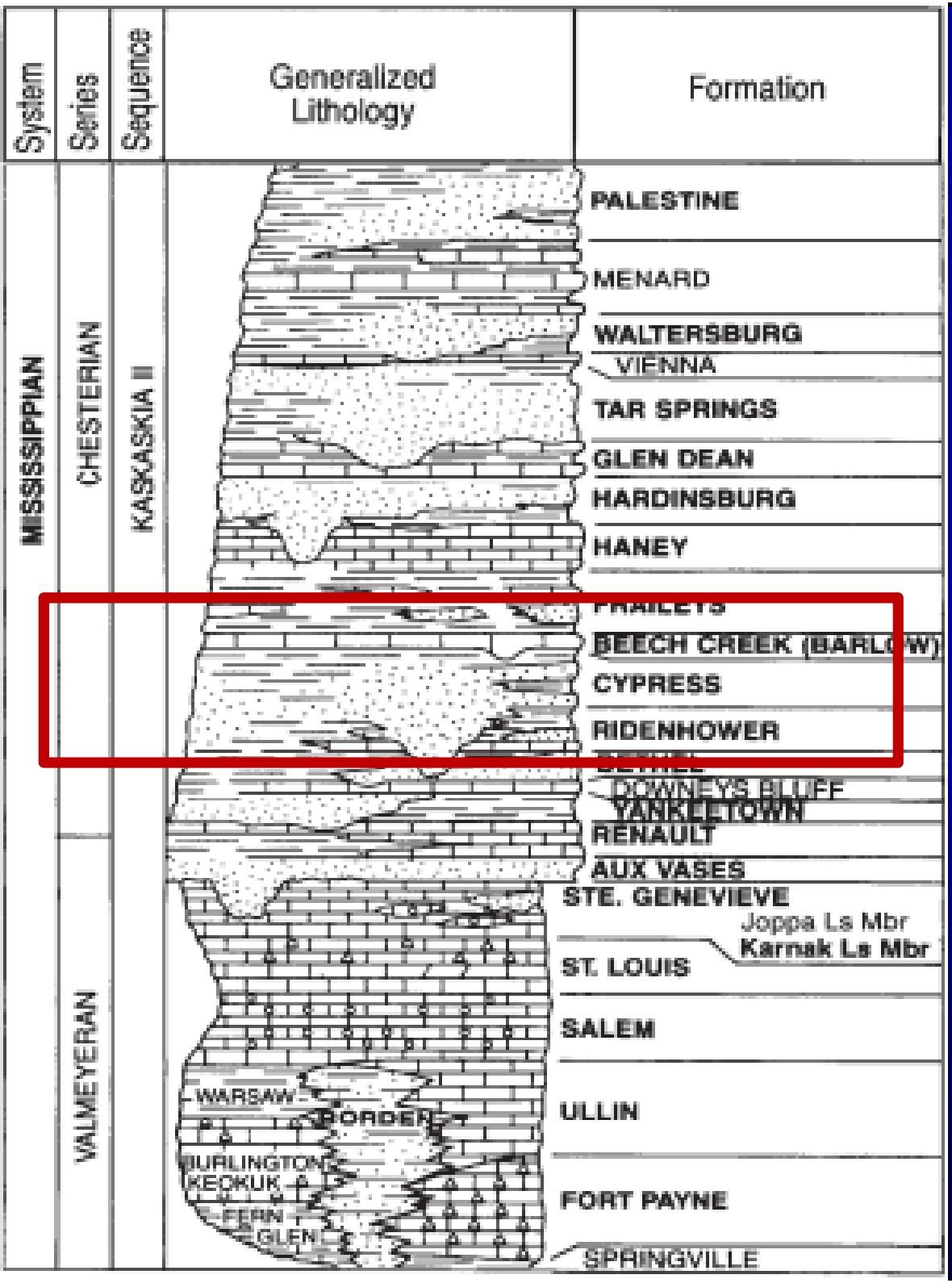
Abstract Id: 985300
Date: 13th April, 2011
Time: 8.45 to 9.05 AM
Session Title: Theme 9: Seismic Visualization & Attributes

About Cypress sands of Illinois Basin:

- Cypress sands were deposited from distal delta to pro-delta, lenticular in nature.
- Cypress sands are clean with porosity of 15-20% and permeability of 100-200 mD.
- Cypress sands are oil productive on structural closures.
- Cypress sands have produced more than 500 million barrels of oil.
- The major challenge is to map the lenticular Cypress sands seismically.

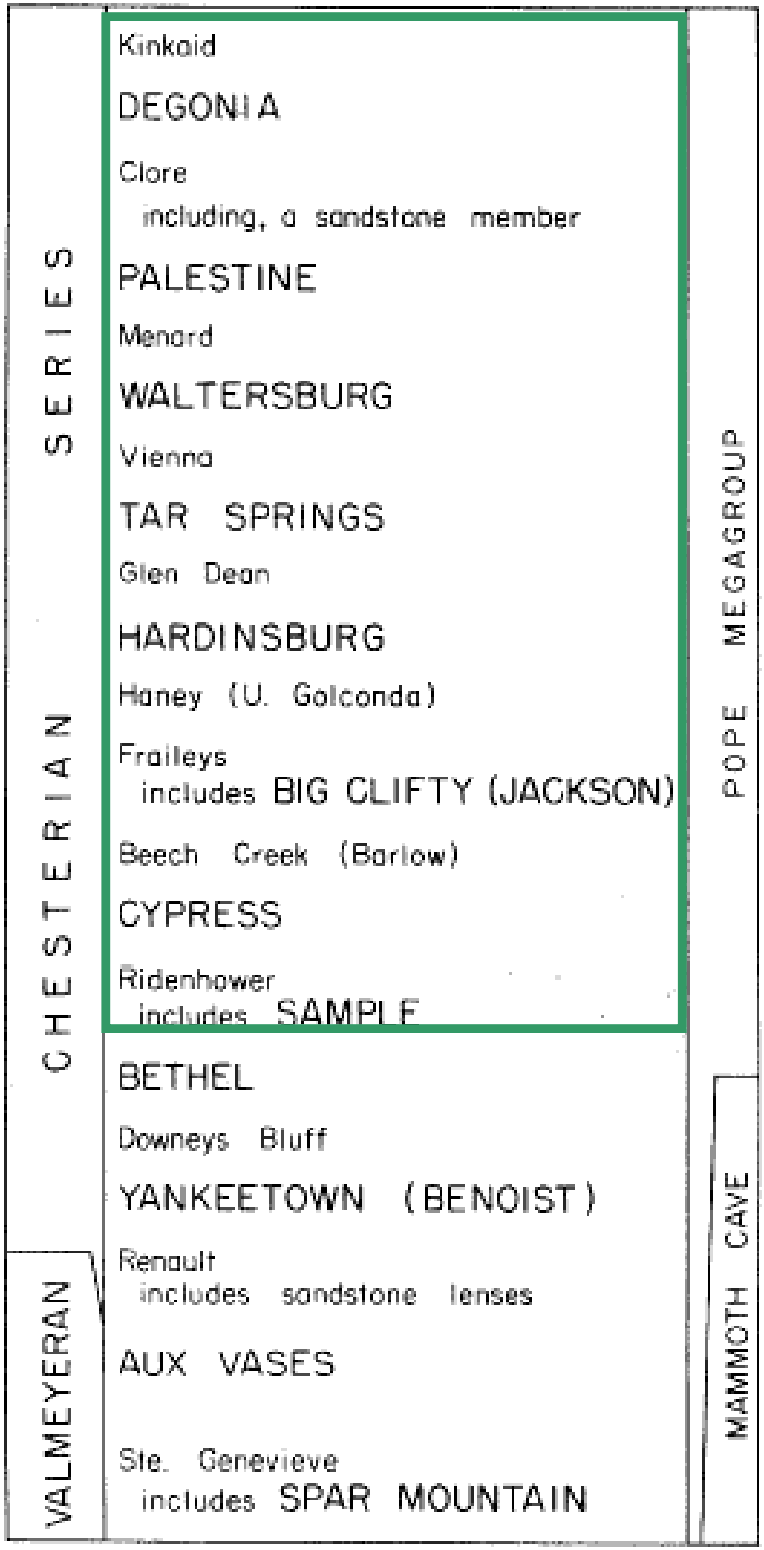


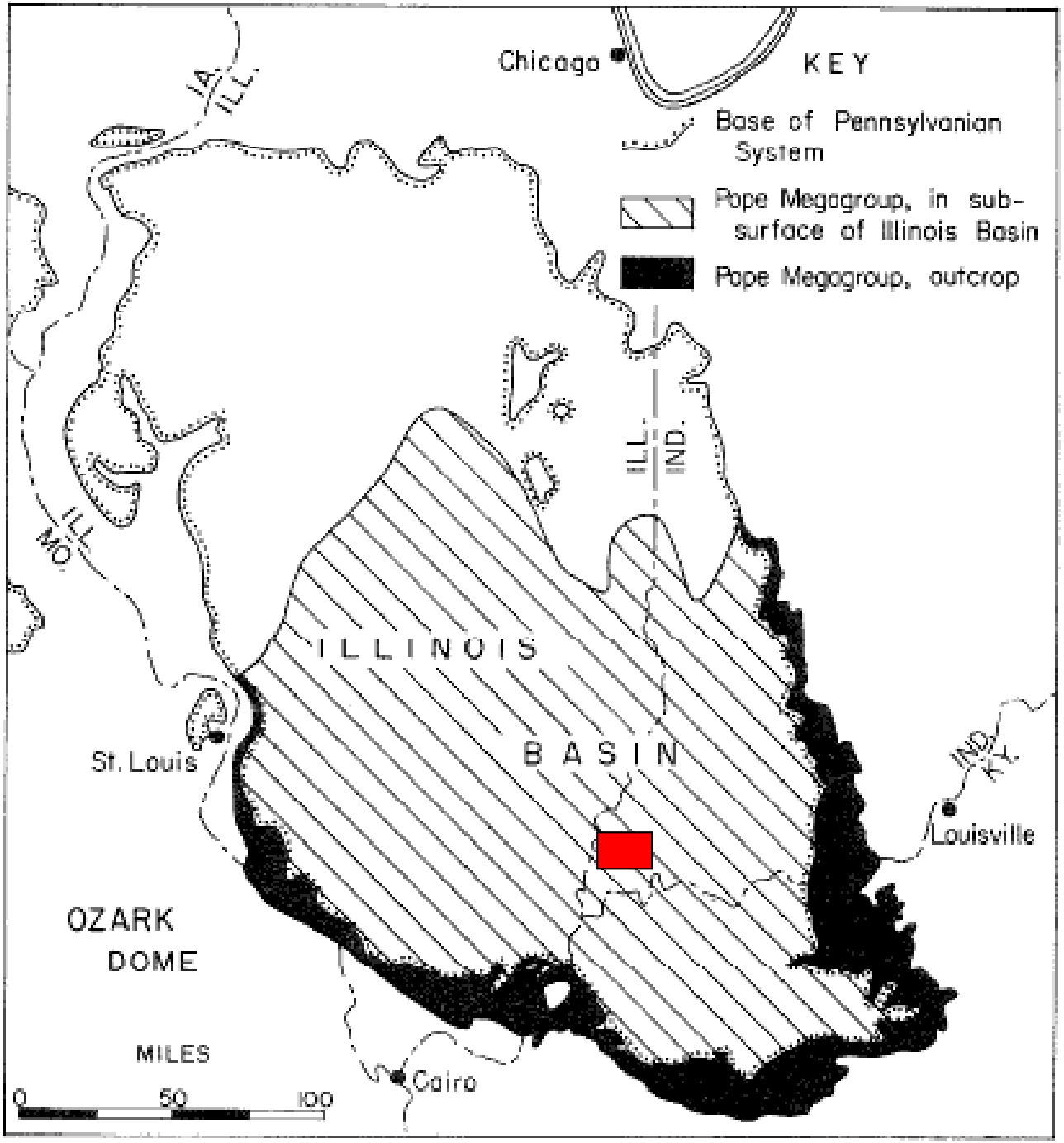
Oil and Gas production in Indiana (Courtesy of Indiana Geological Survey)



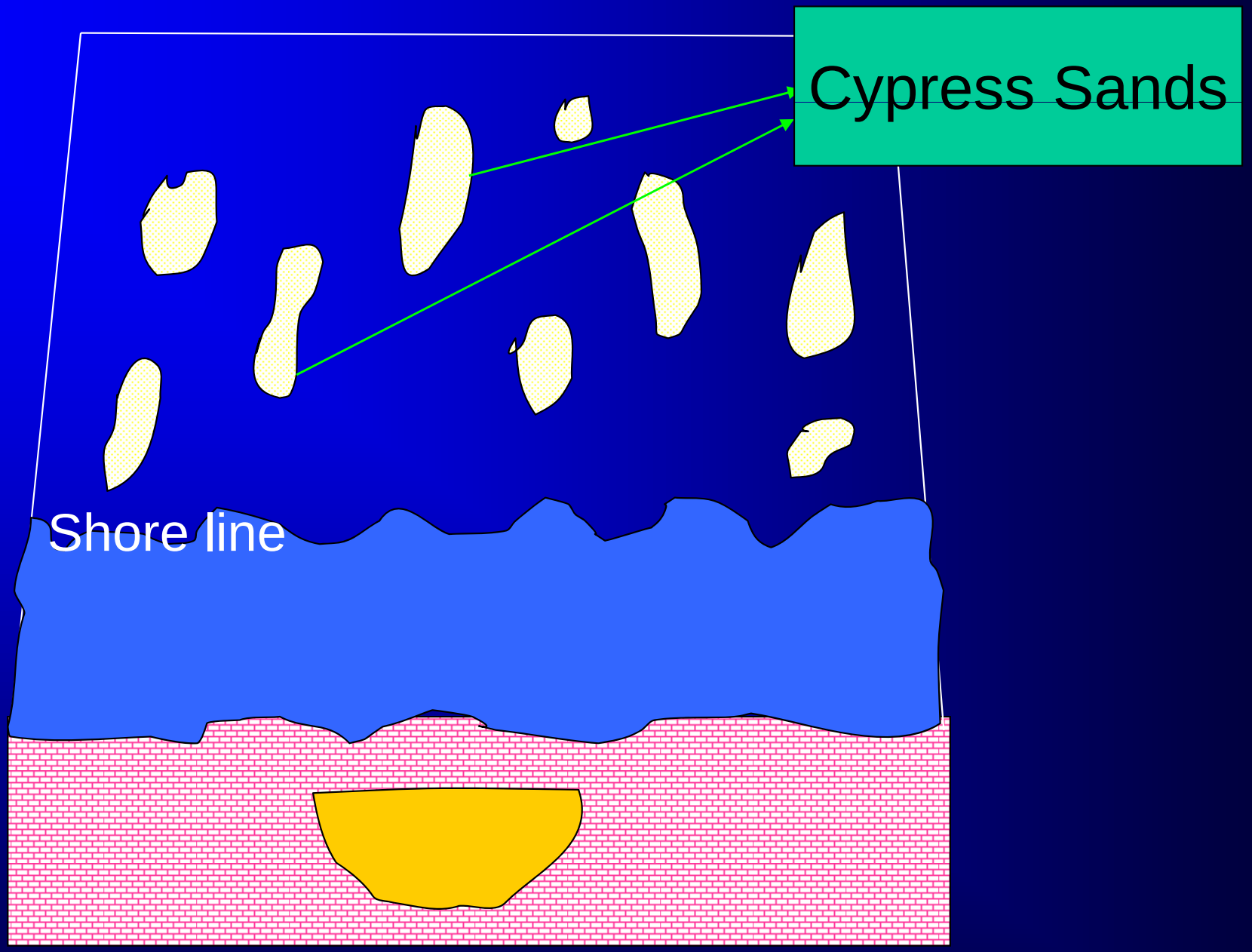
Stratigraphic column of Illinois Basin

Montgomery and Leetaru, 2000


SERIES
CHESTERIAN
VALMEYERAN
POPE MEGAGROUP
MAMMOTH CAVE
Kinkaid
DEGONIA
Clore
including, a sandstone member
PALESTINE
Menard
WALTERSBURG
Vienna
TAR SPRINGS
Glen Dean
HARDINSBURG
Haney (U. Golconda)
Fraileys
includes BIG CLIFTY (JACKSON)
Beech Creek (Barlow)
CYPRESS
Ridenhower
includes SAMPLE
BETHEL
Downeys Bluff
YANKEETOWN (BENOIST)
Renault
includes sandstone lenses
AUX VASES
Ste. Genevieve
includes SPAR MOUNTAIN


KEY
Base of Pennsylvanian System
Pope Megagroup, in subsurface of Illinois Basin
Pope Megagroup, outcrop
Chicago
IA.
ILL.
ILL.
MO.
ILL.
IND.
ILLINOIS
BASIN
St. Louis
IND.
KY.
Louisville
OZARK
DOME
MILES
0
50
100
Cairo

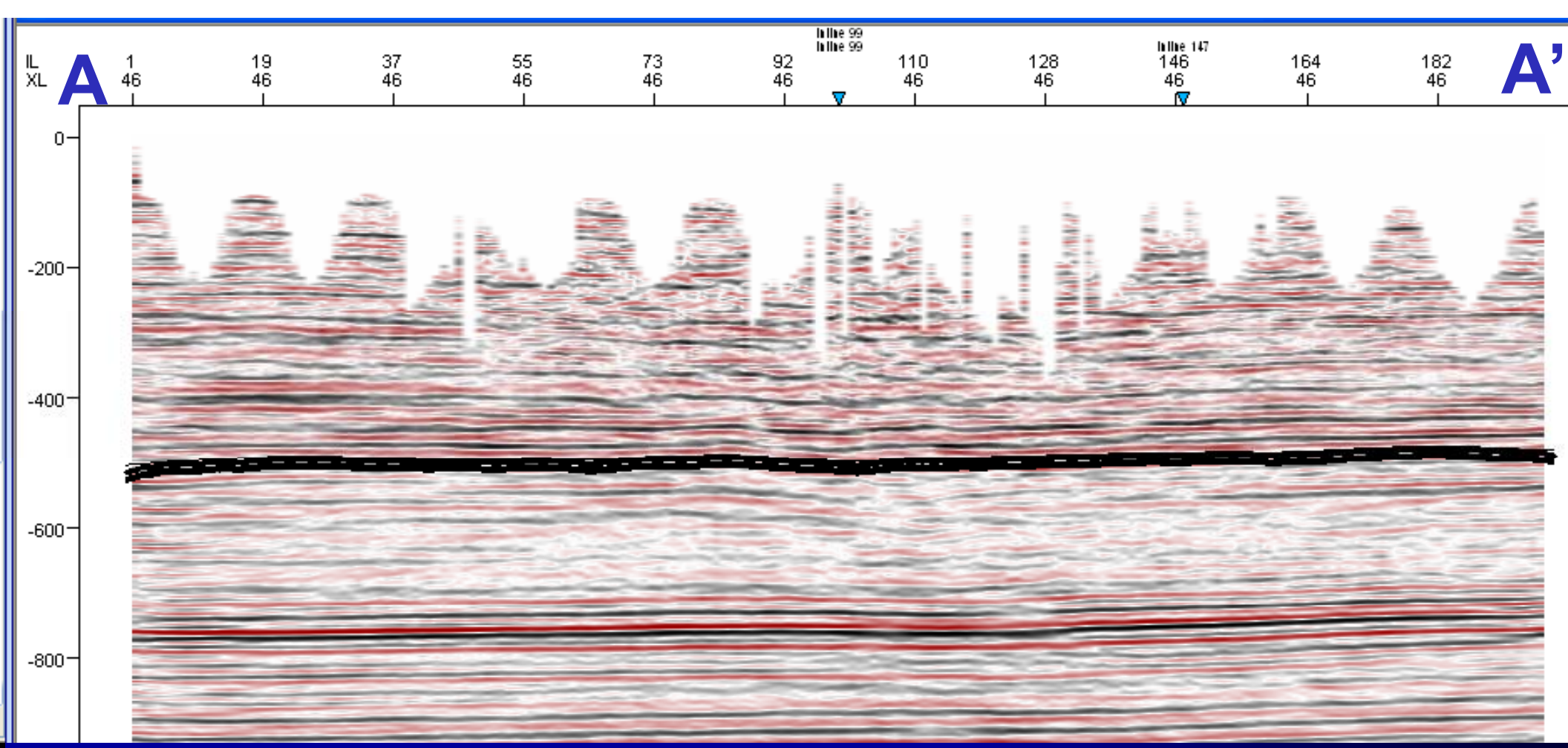
Potter, 1962



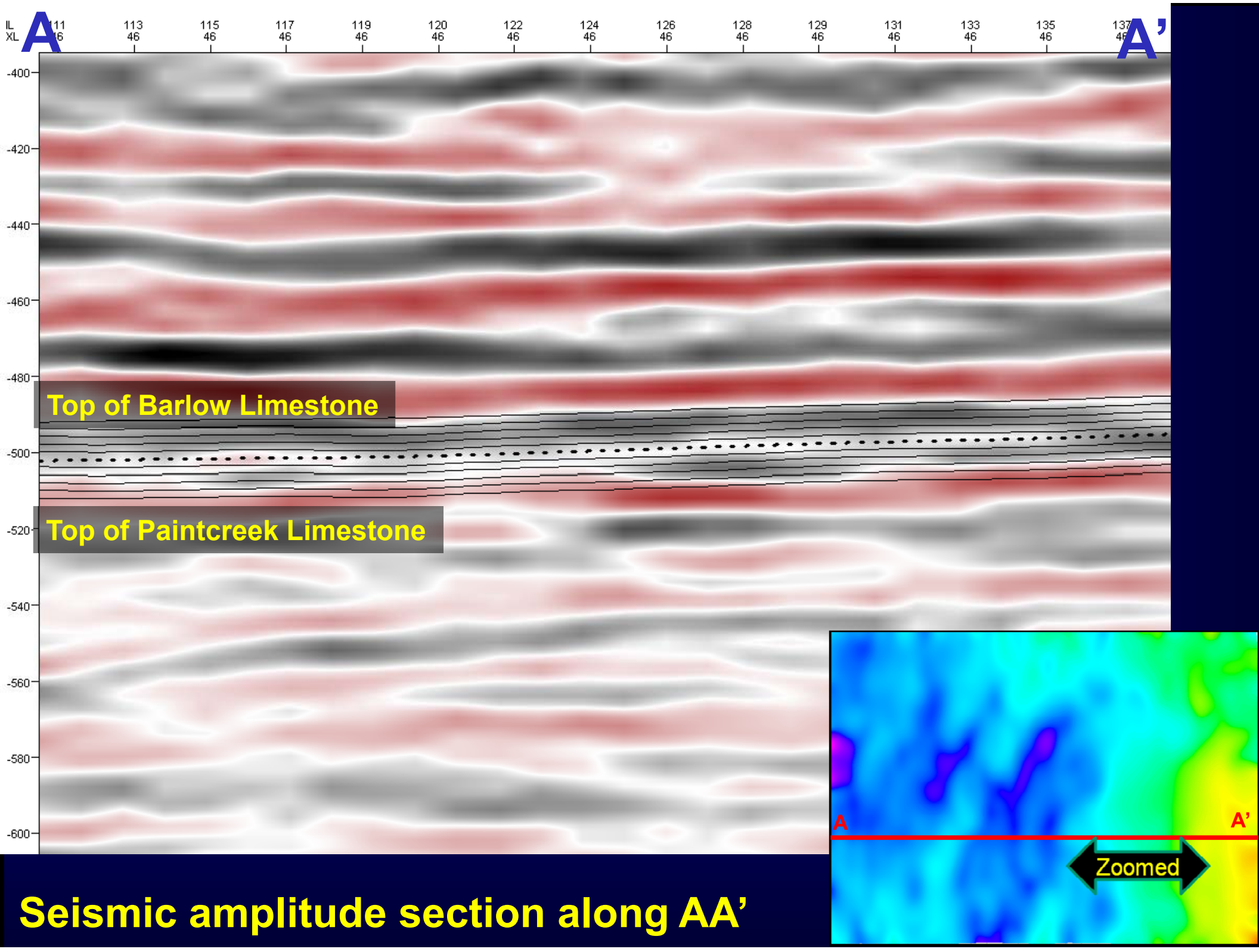
Idealized Depositional model for Cypress sands

Electric log characteristics of Cypress sands

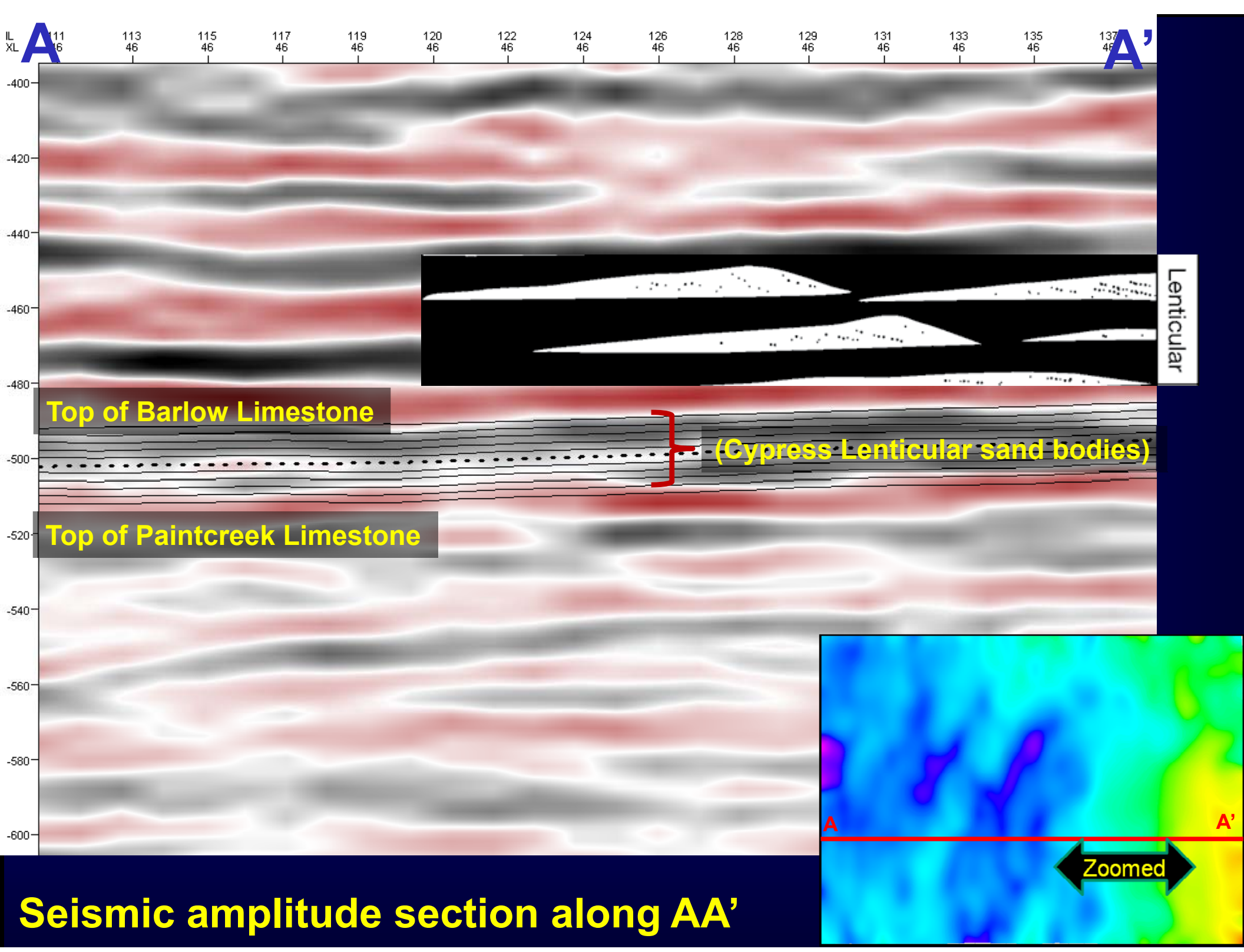
Seyler and Cluff, 1995



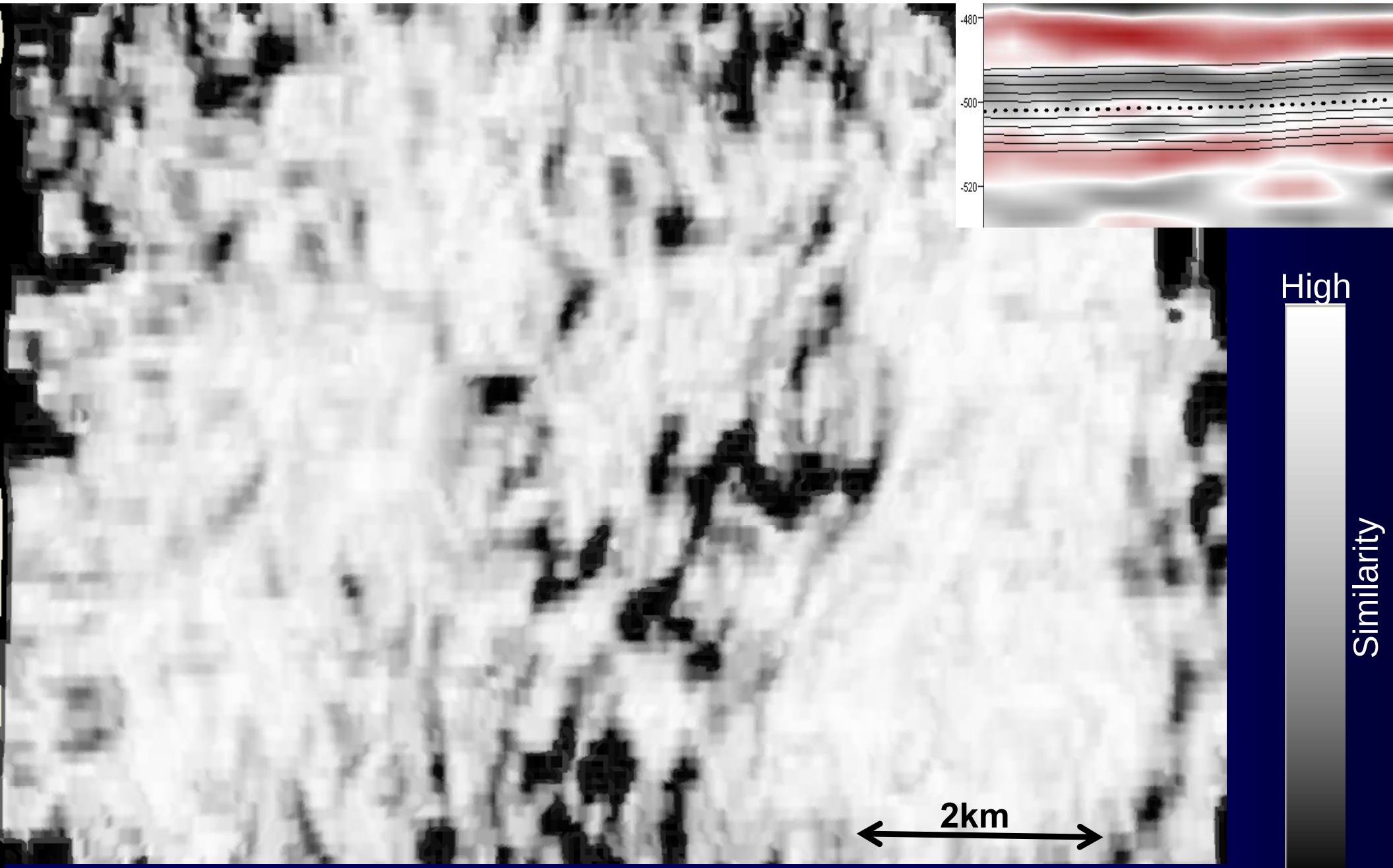
Seismic Data Quality: Seismic section along AA'



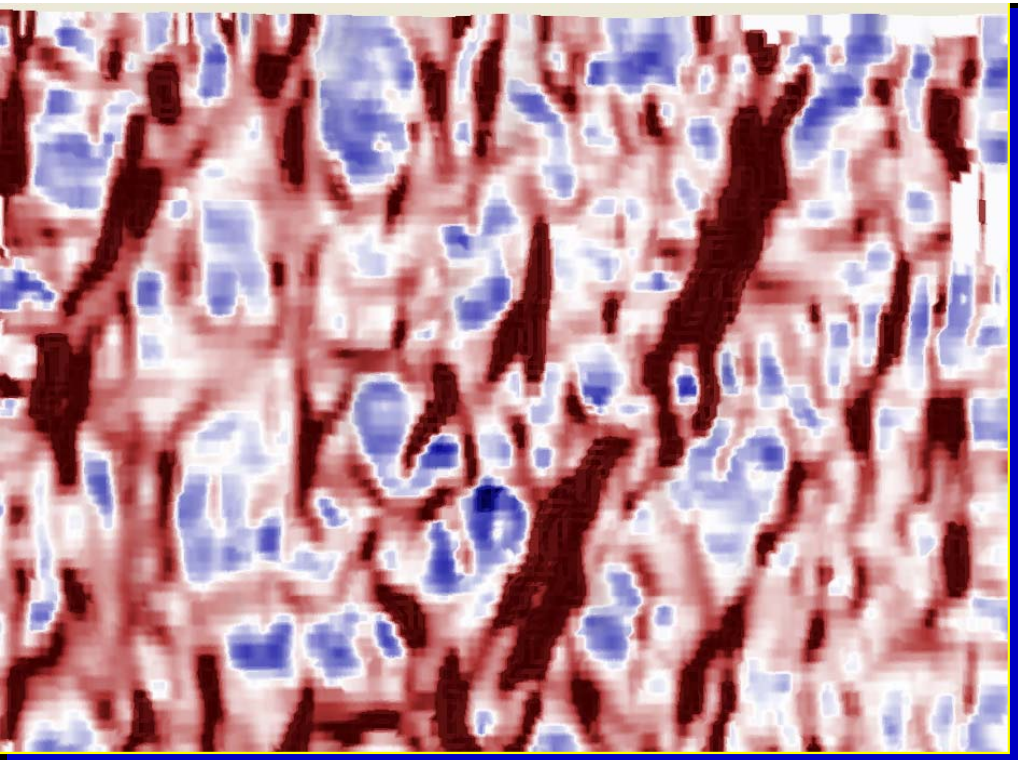
Seismic amplitude section along AA'



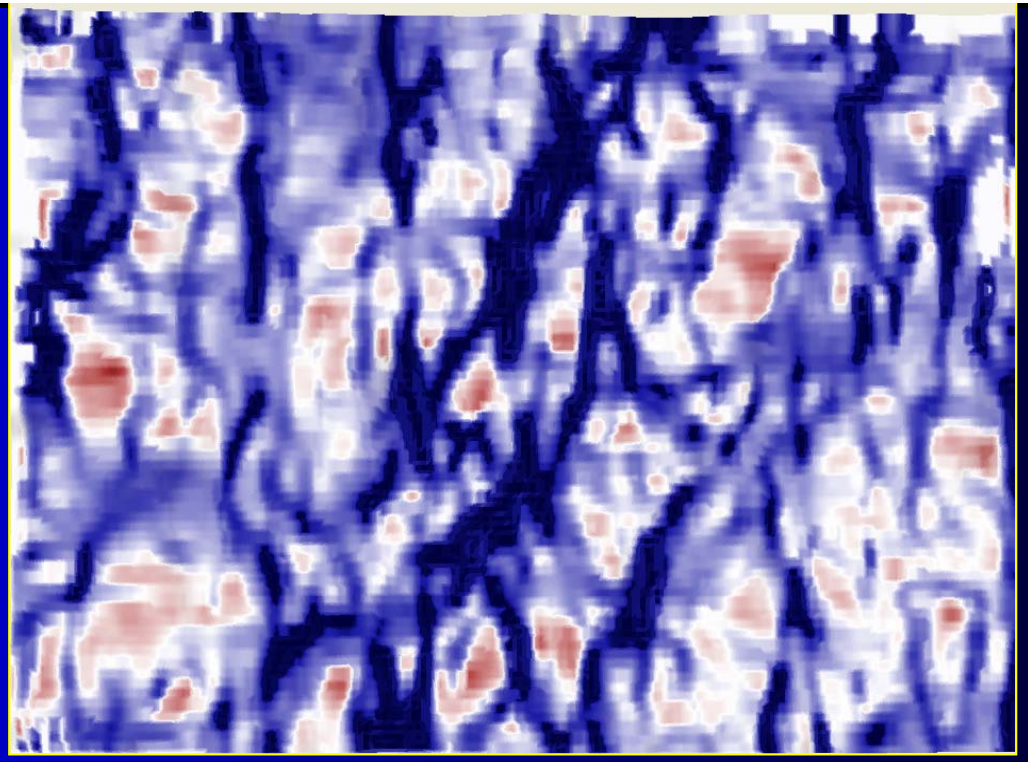
Seismic amplitude section along AA'



Sobel Filter similarity along the dashed surface (Barlow+10ms) as shown in the inset

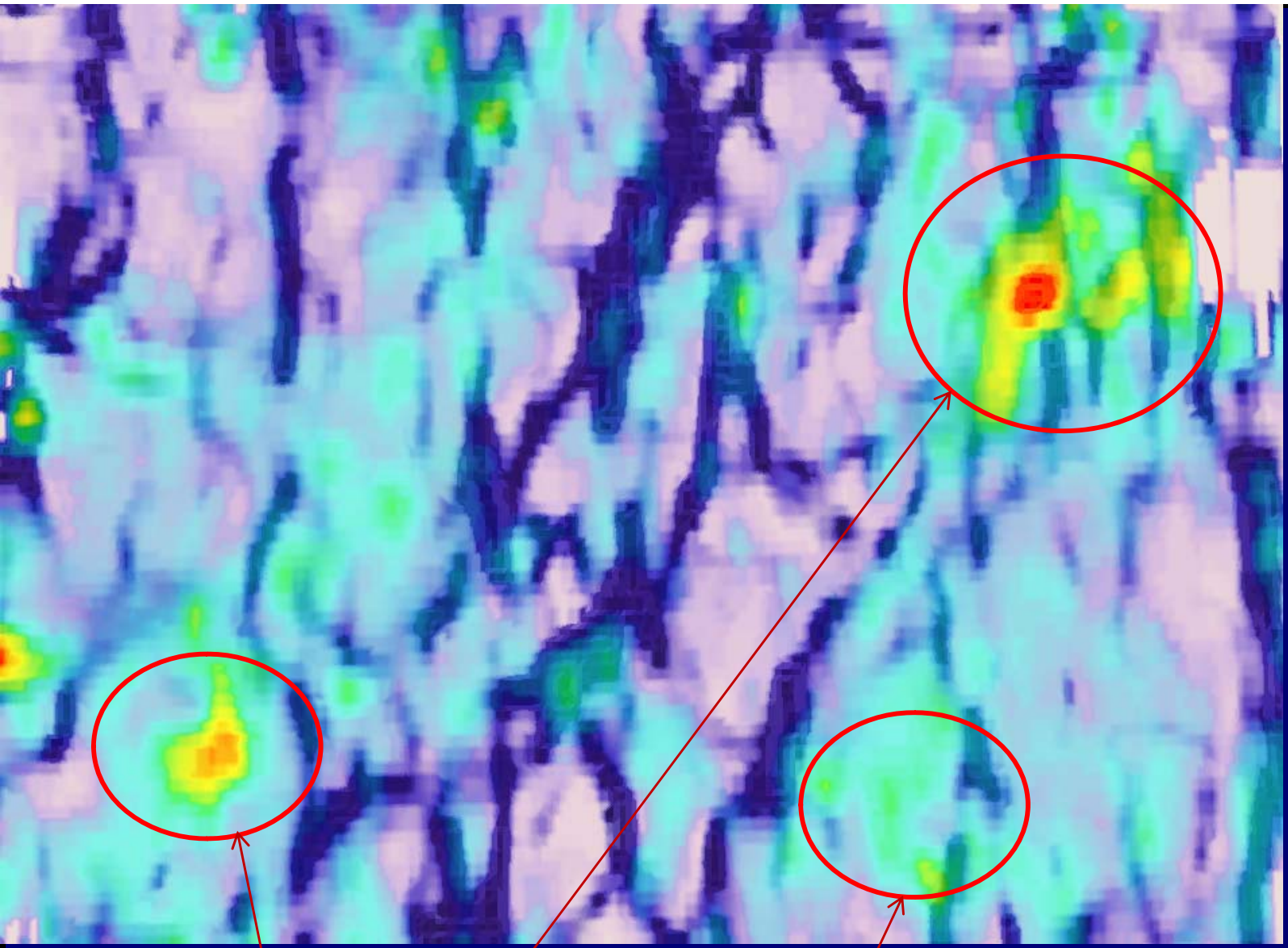


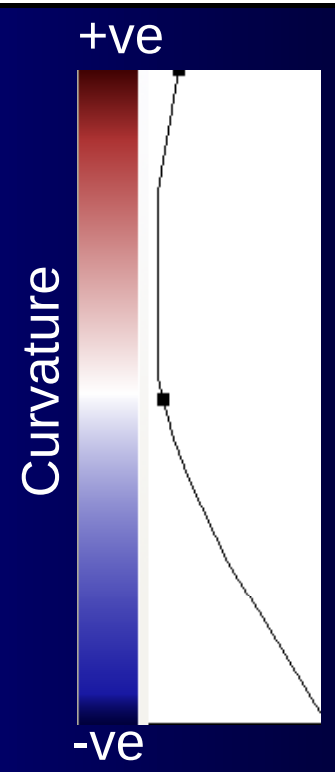
K1 along the dashed surface

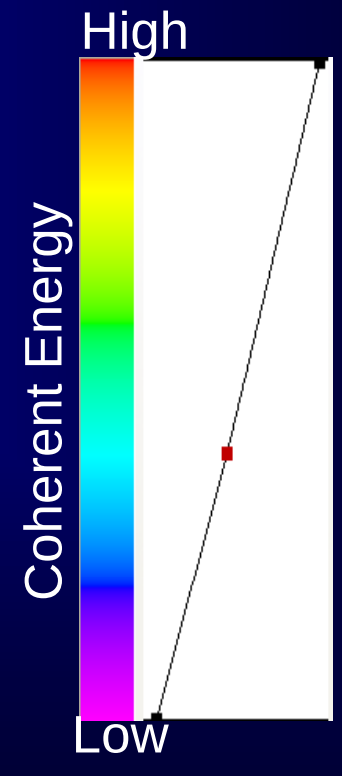


K2 along the dashed surface

Curvature Attributes: Structural deformation

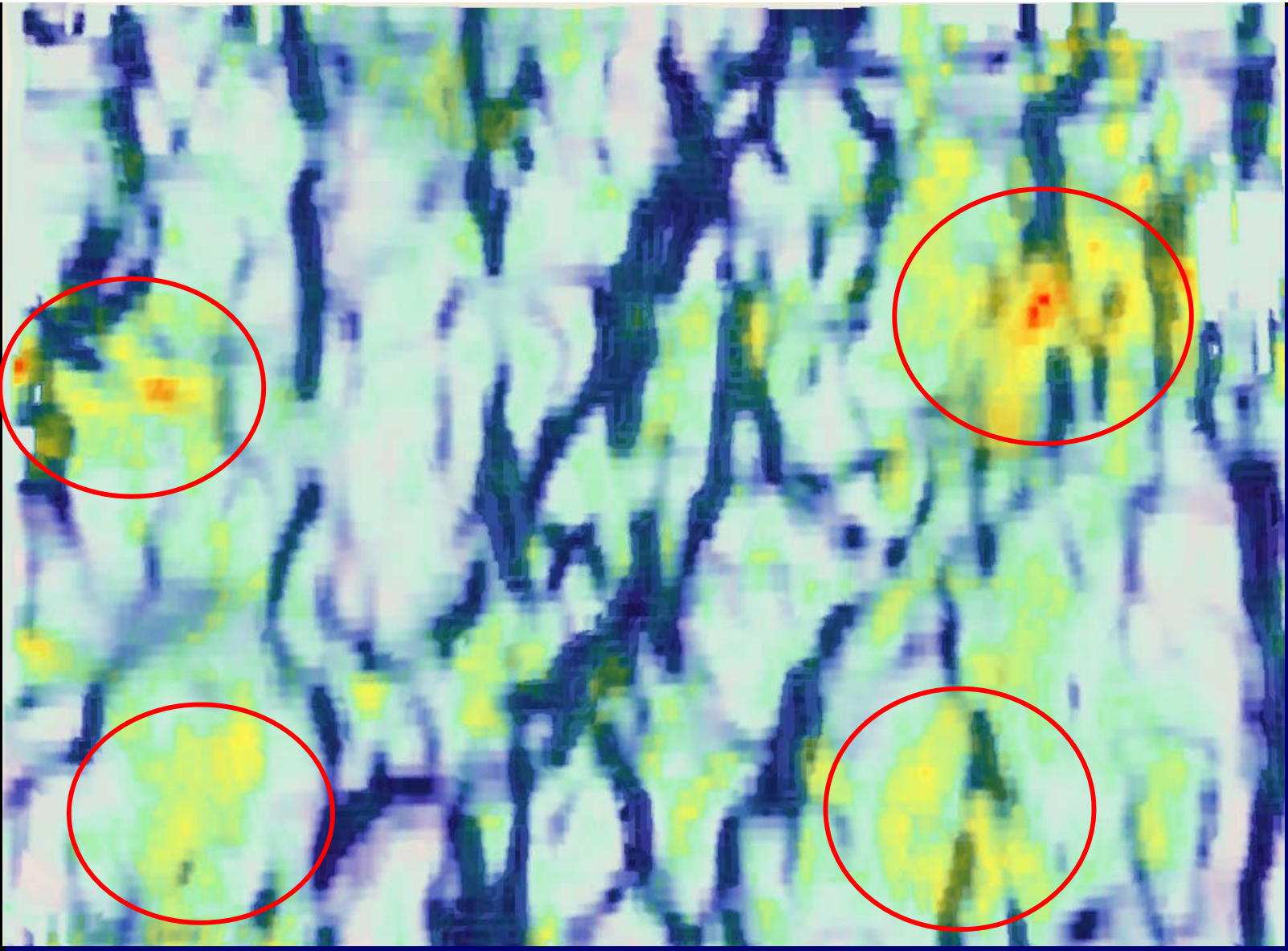


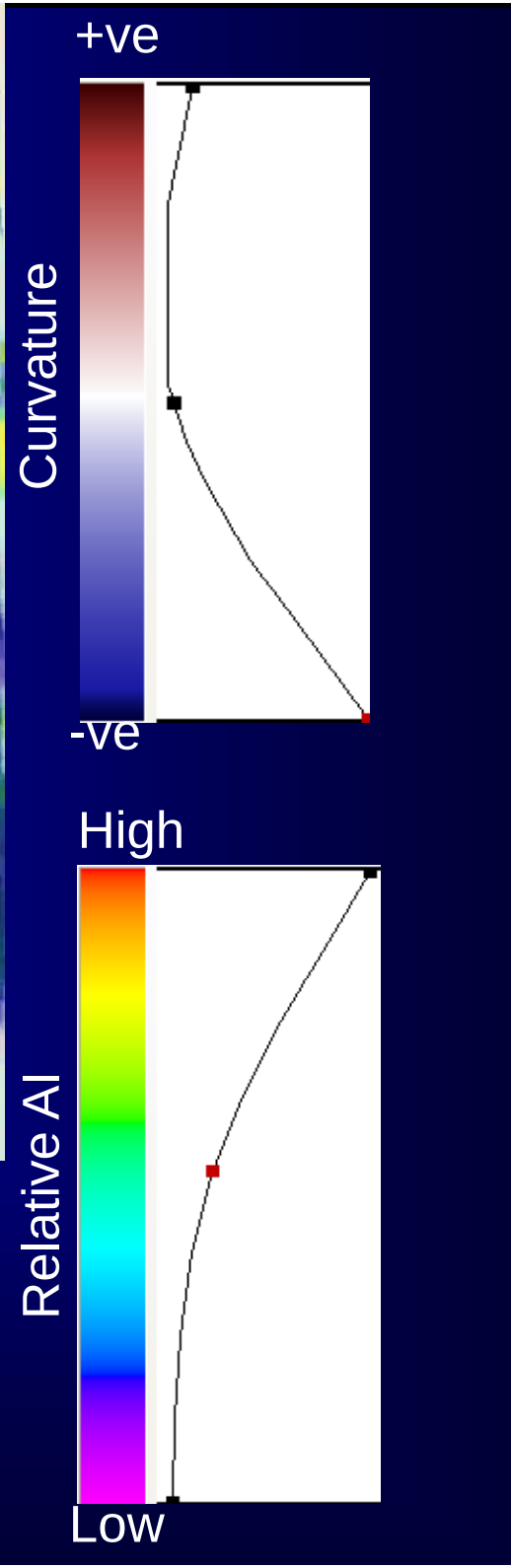




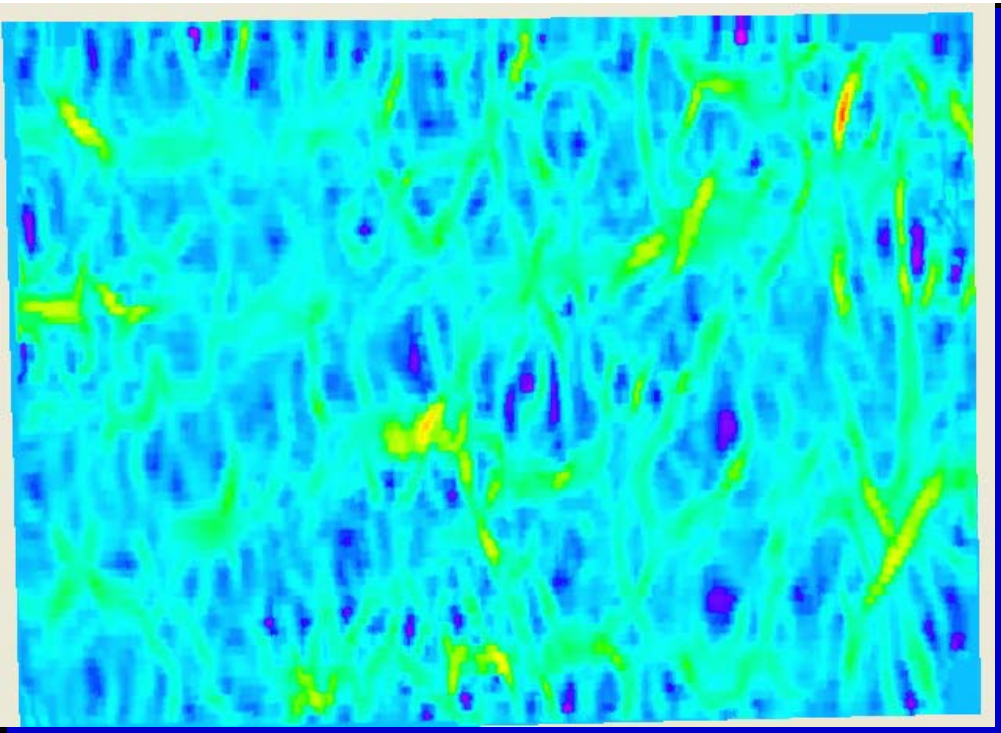
(Are these red-encircled Cypress lenticular sand bodies?)

Coherent energy co-rendered with k2 along the dashed surface

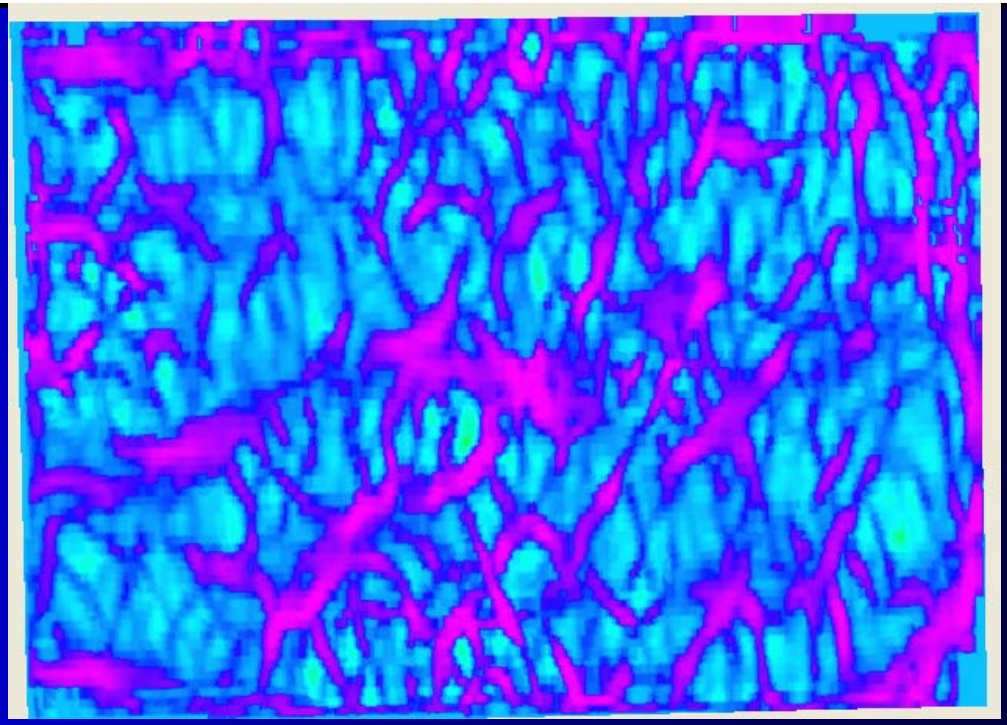




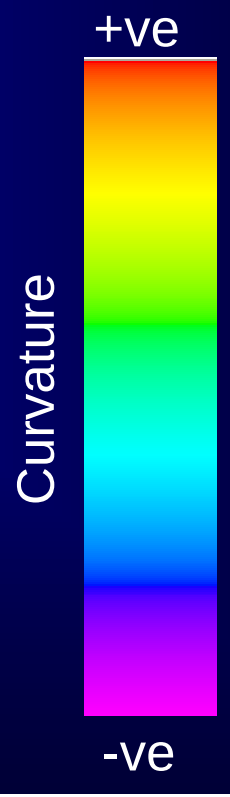
Relative Acoustic Impedance co-rendered with k2 along the dashed surface



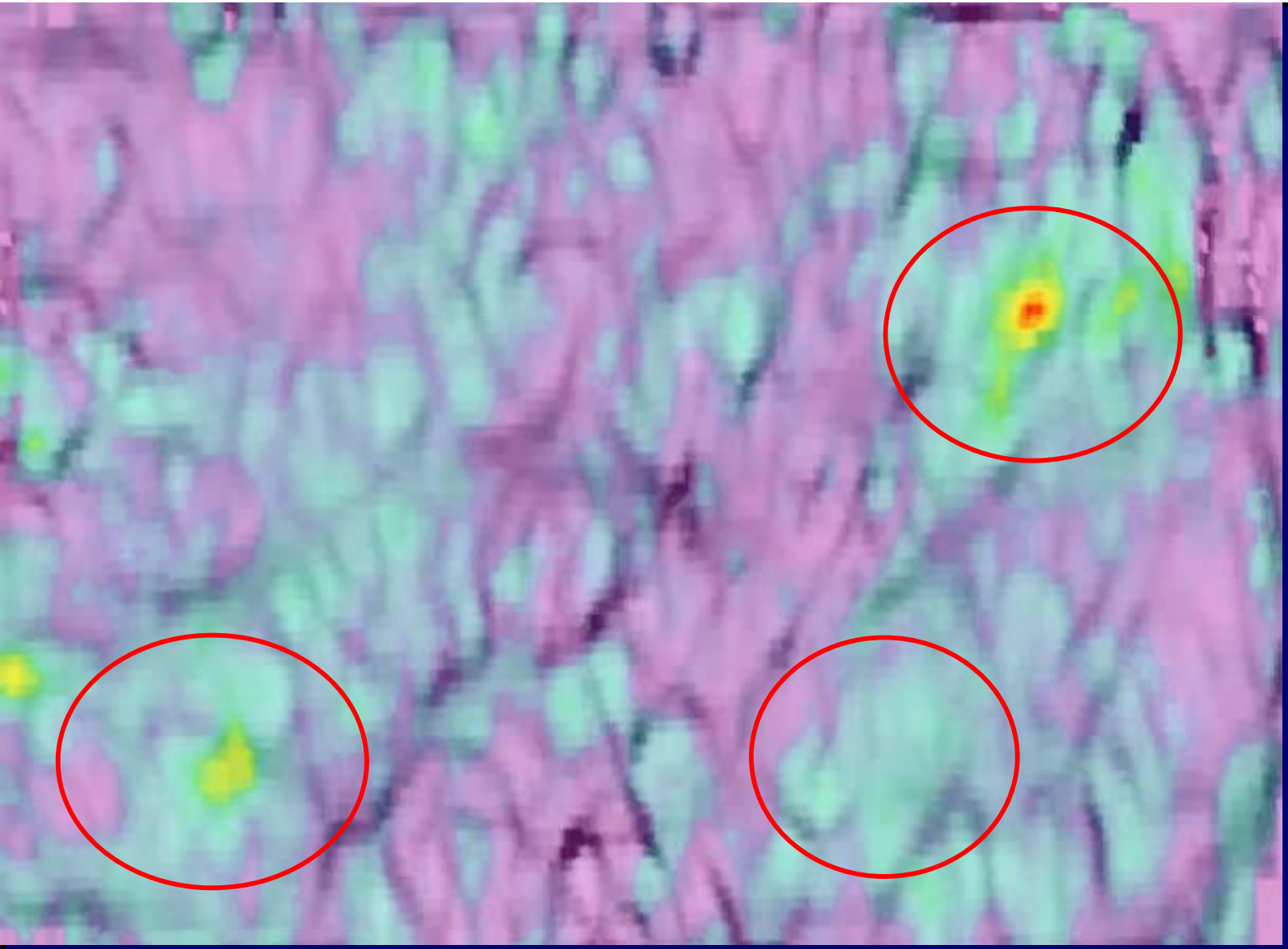
E-Pos

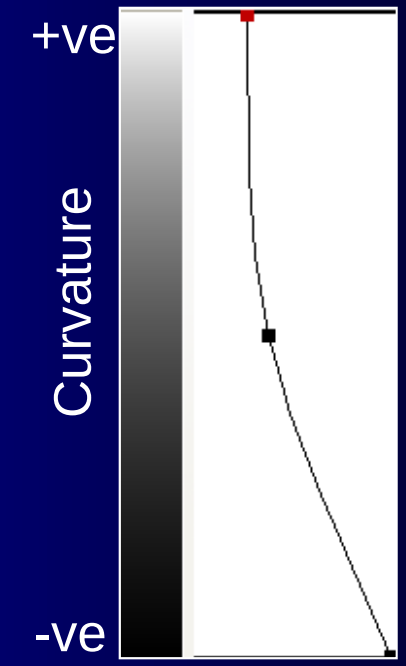


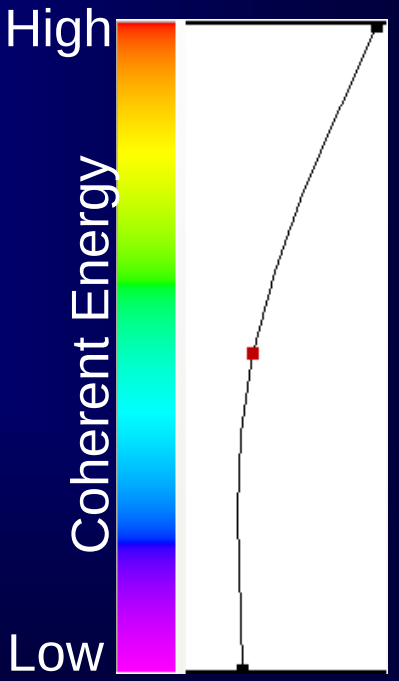
E-Neg



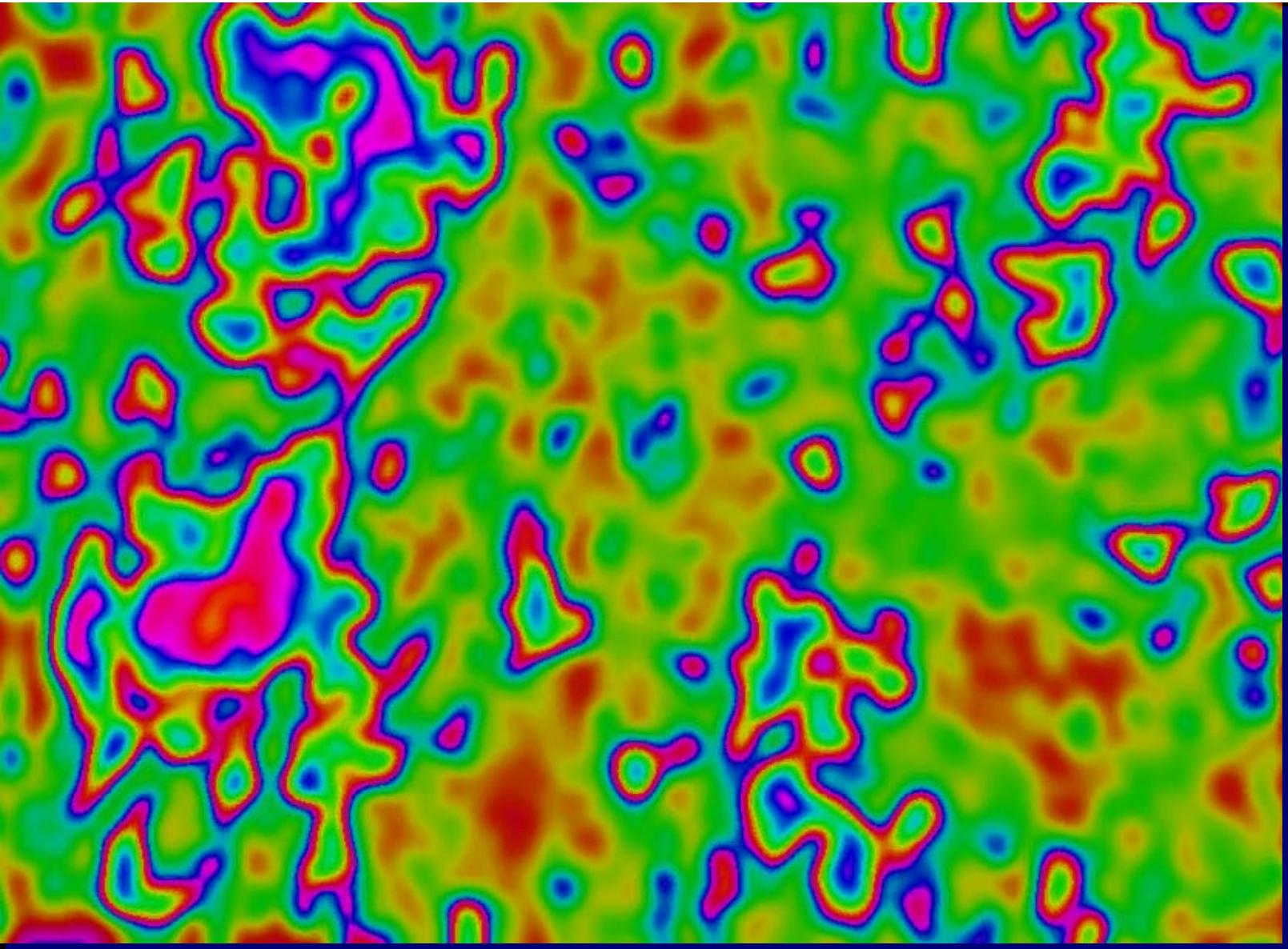
Amplitude curvatures generated from Relative Acoustic Impedance



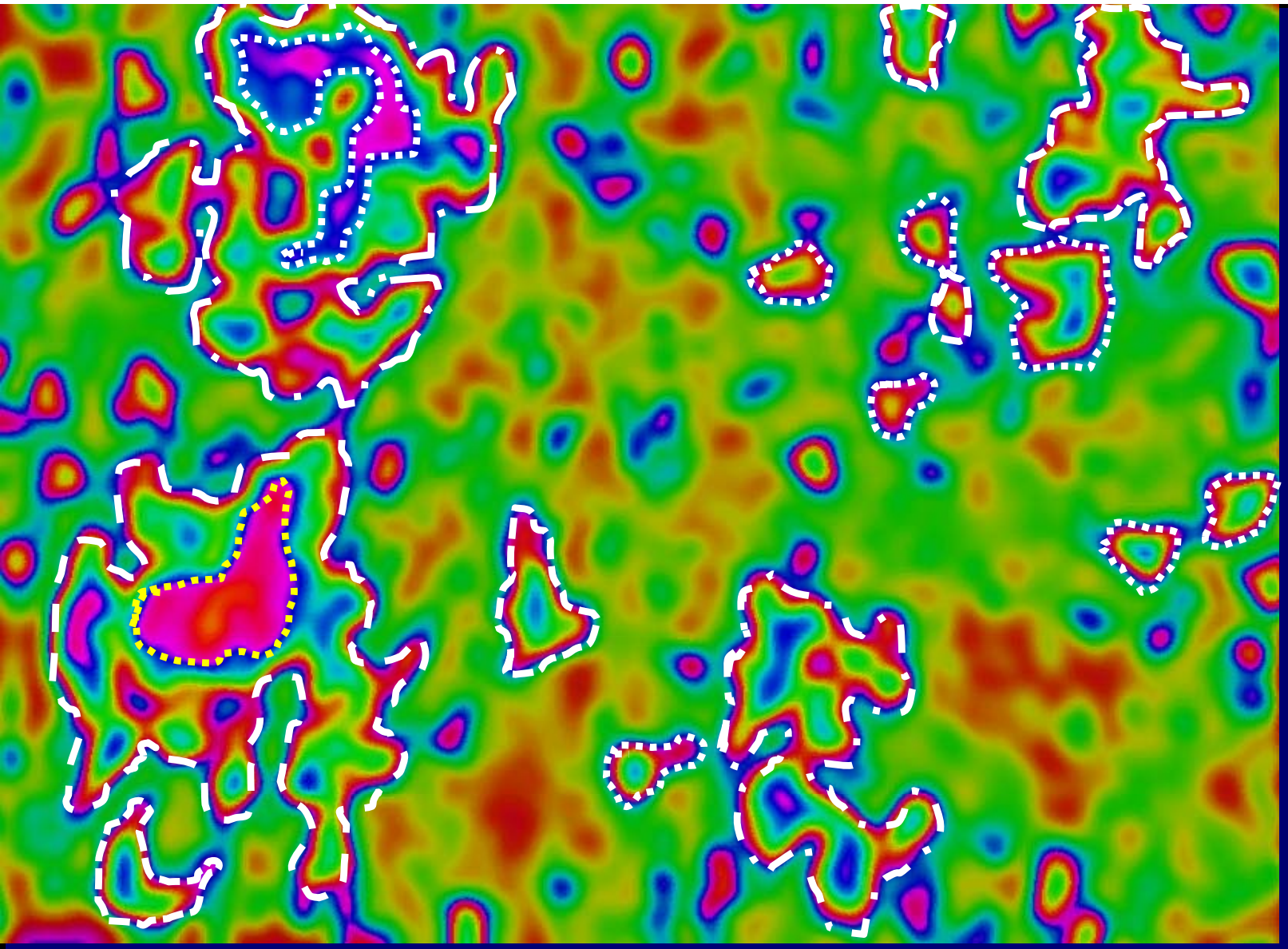


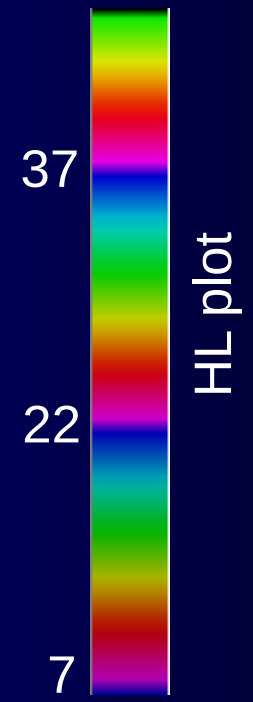


Rendered image of Coherent energy and amplitude curvature (e-neg) of Acoustic Impedance



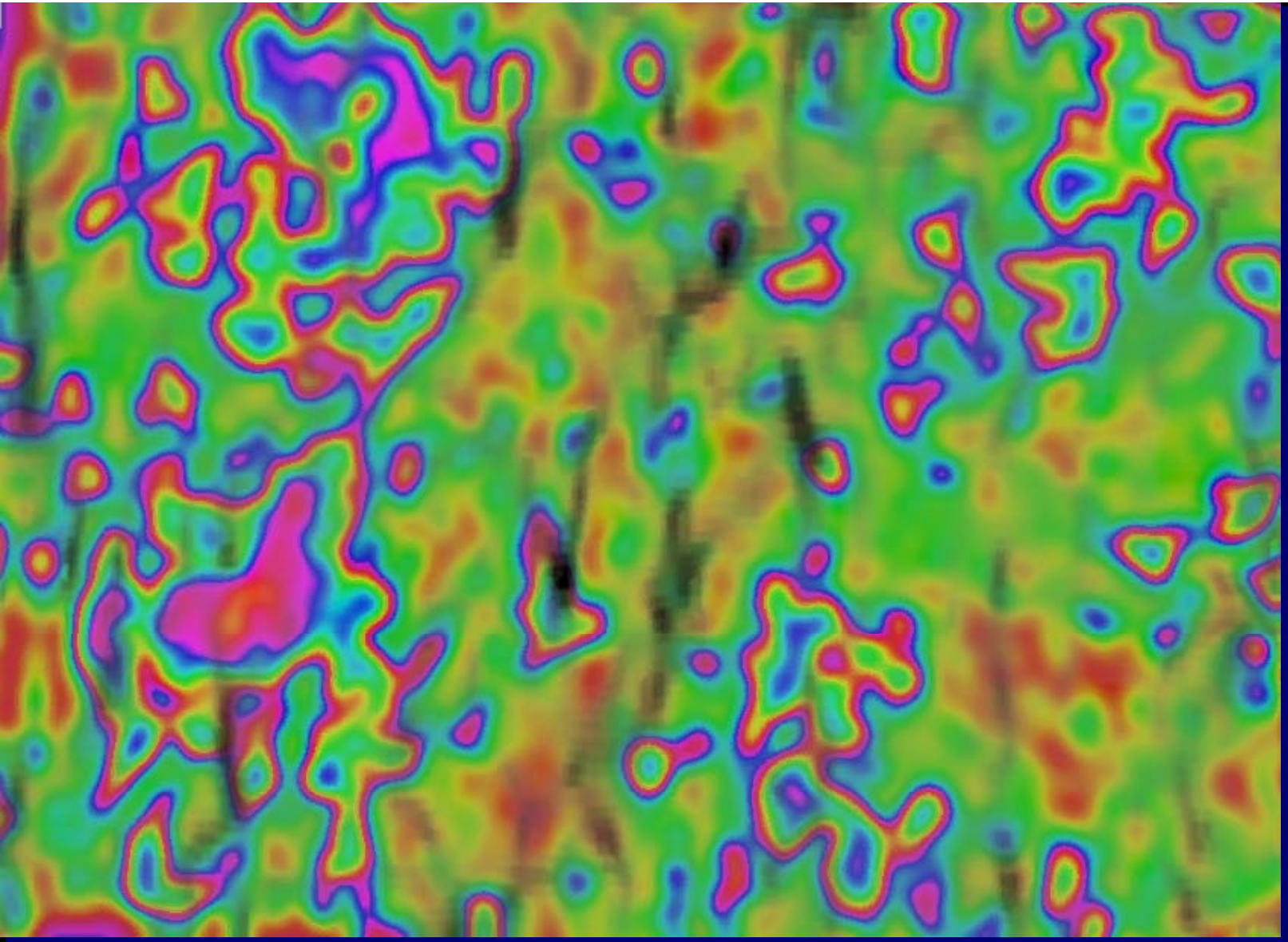
HL plot image by making Peak-Freq and Peak-Mag along the dashed surface

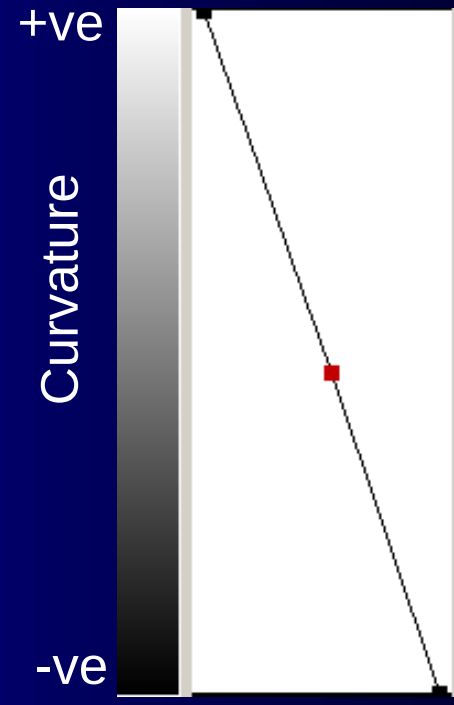




Cypress Lenticular sands

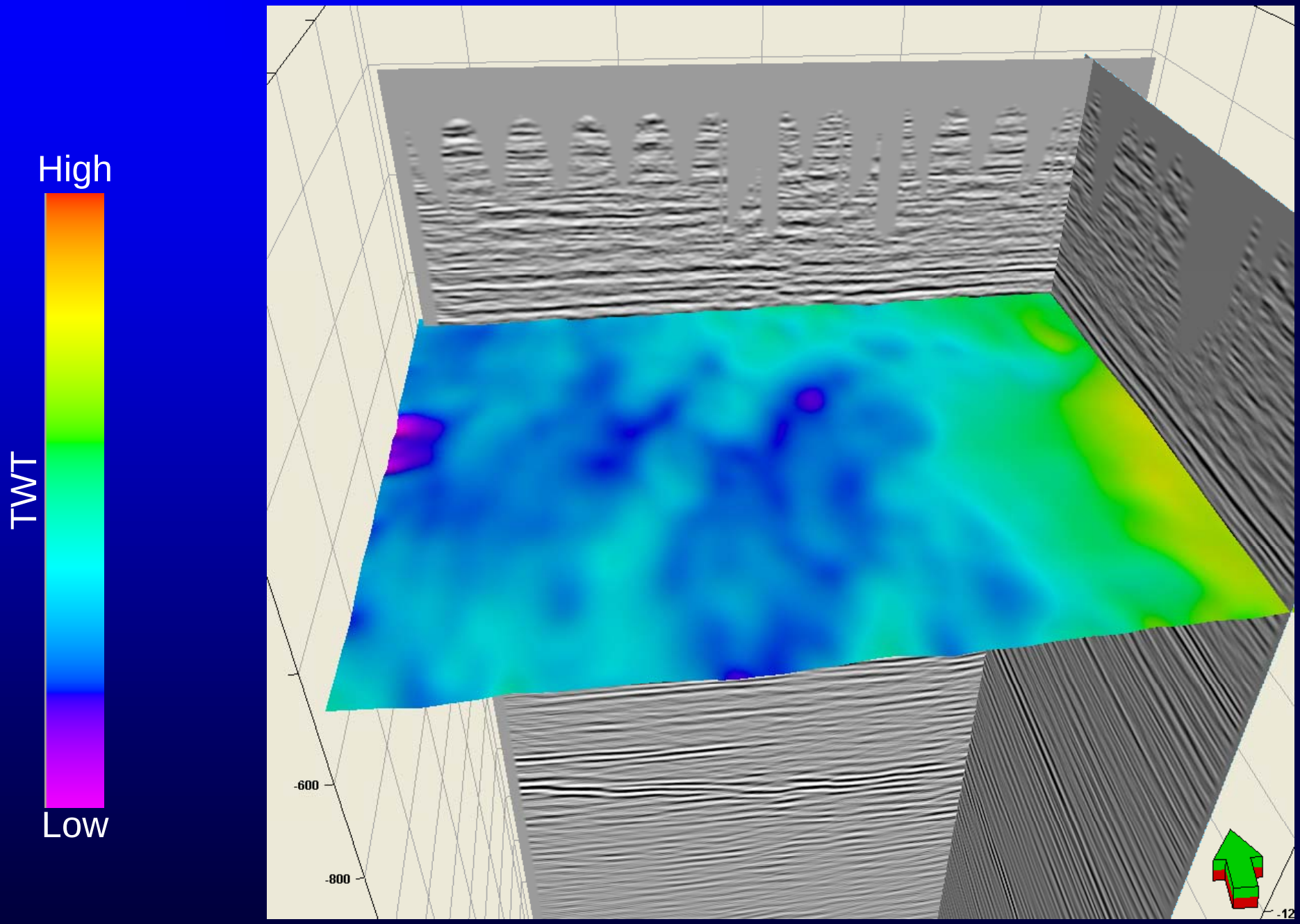
HL plot image by making Peak-Freq and Peak-Mag along the dashed surface



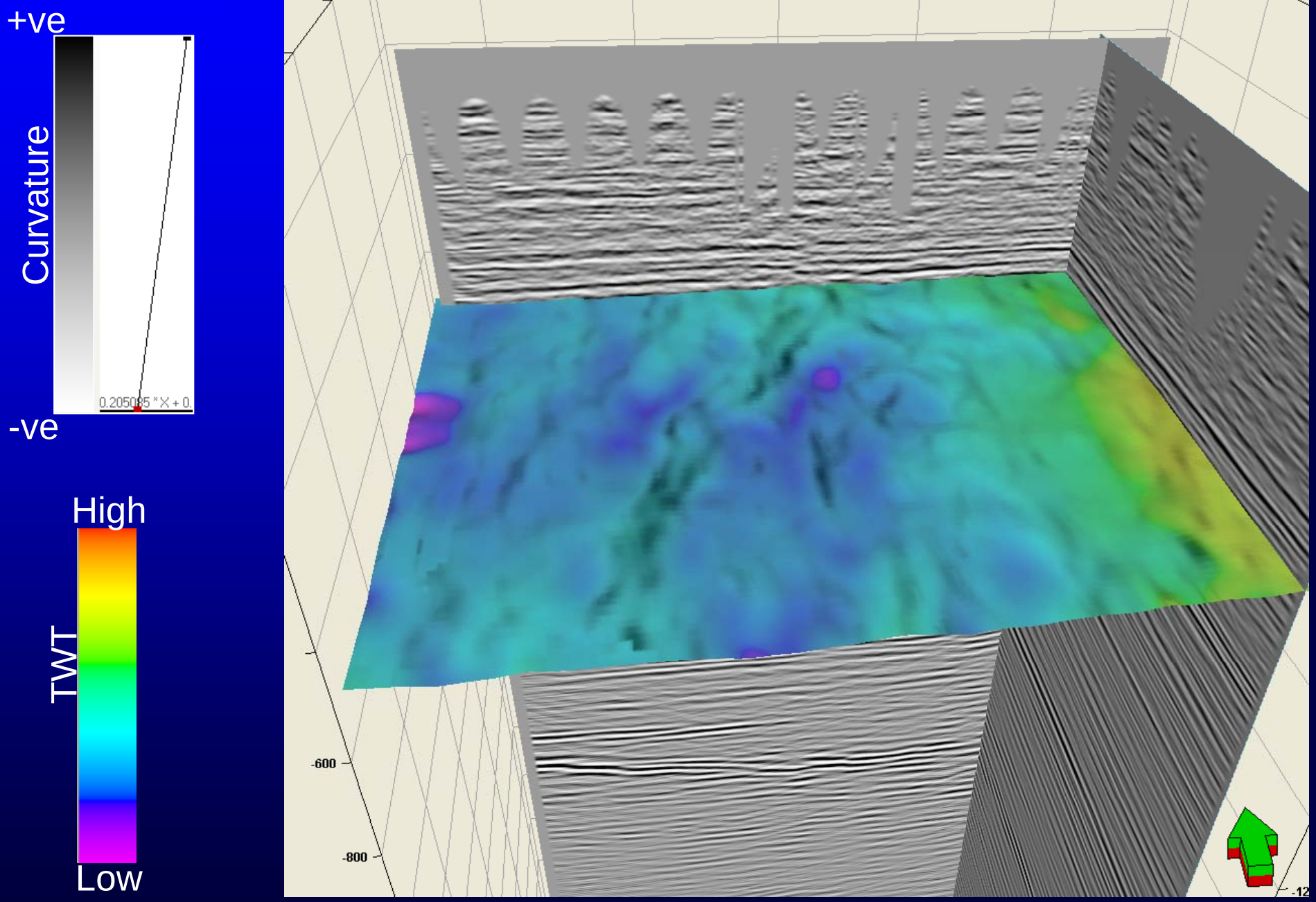


Co-rendered image of HL plot and most negative curvature

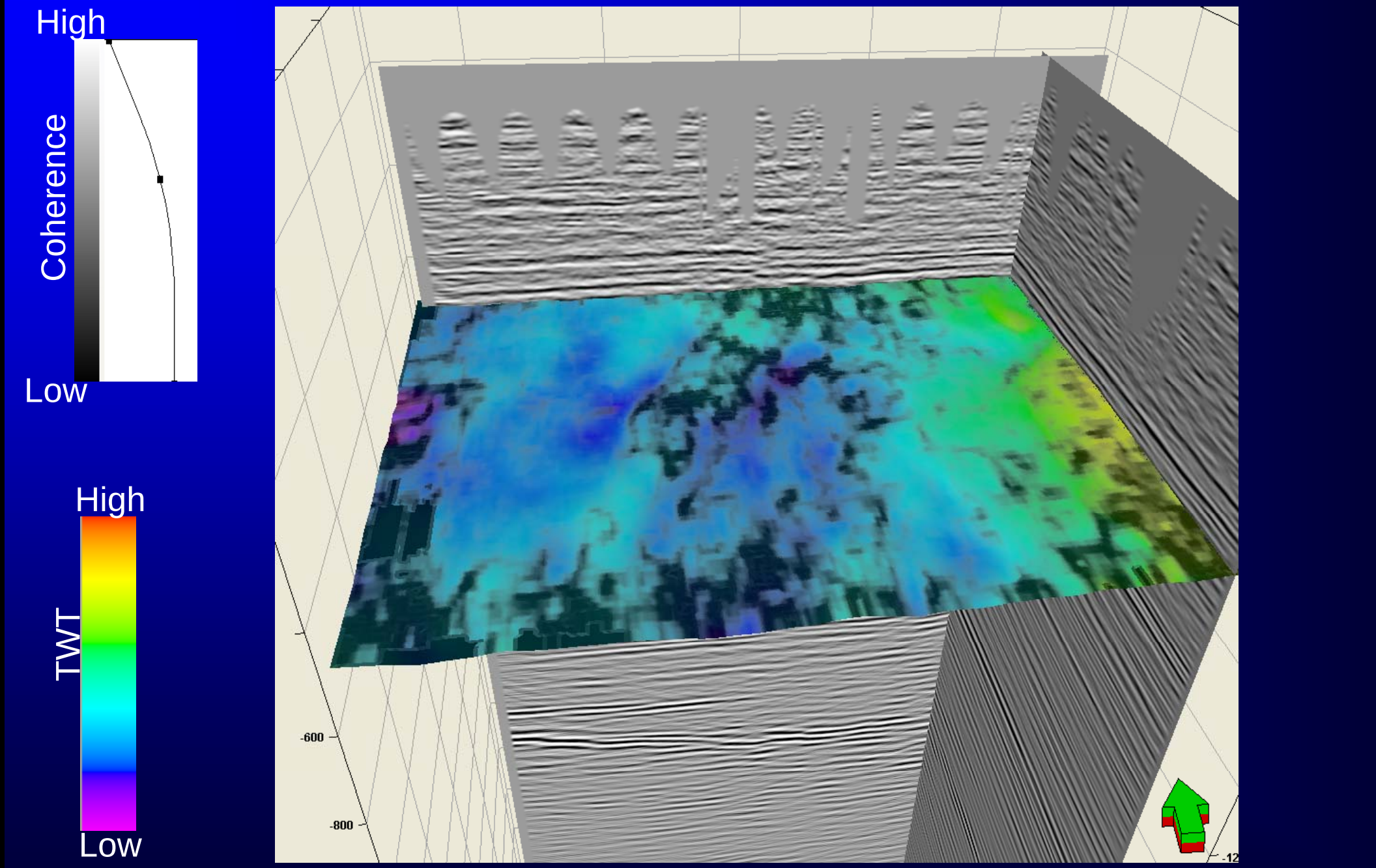
Time-structure map of Cypress horizon (dashed surface)



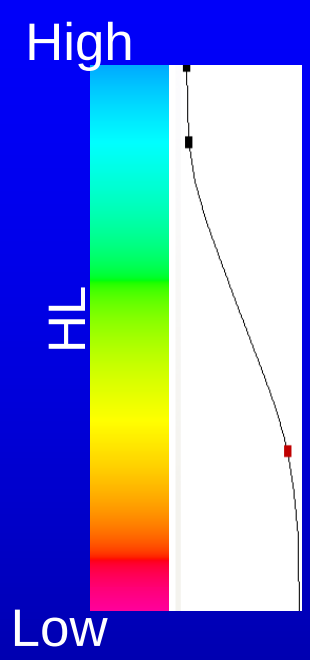
Time-structure map of Cypress horizon co-rendered with most-positive principal curvature

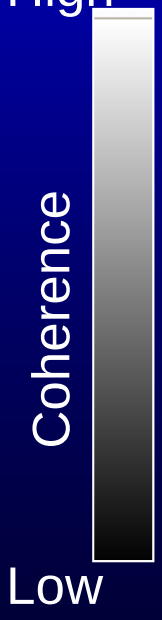


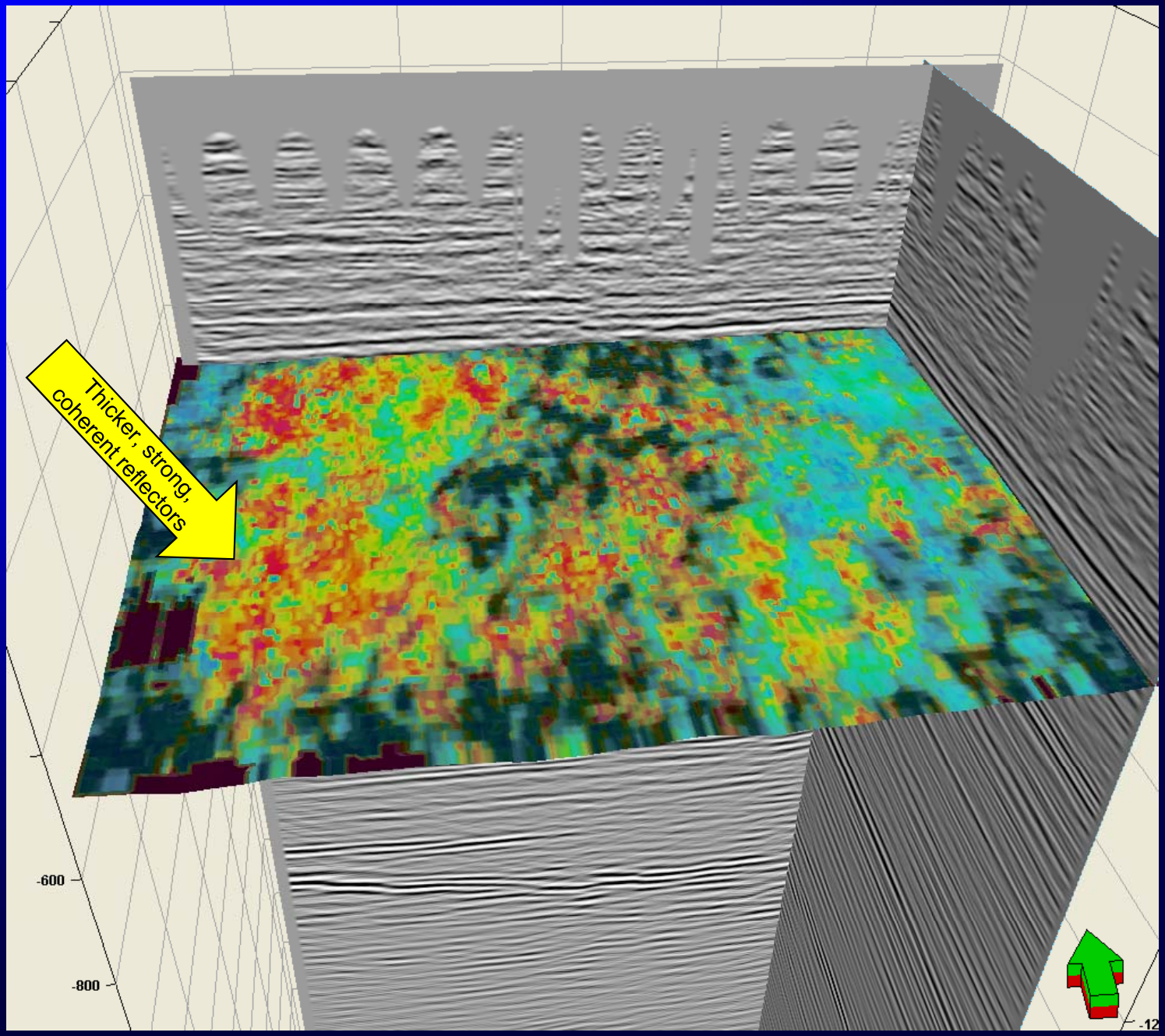
Time-structure map of Cypress horizon co-rendered with coherence



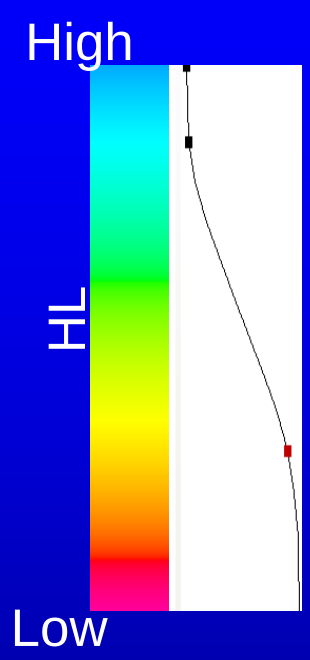
Peak frequency (against red-blue axis) vs. peak spectral magnitude (against whiteness/opacity) co-rendered with coherence.

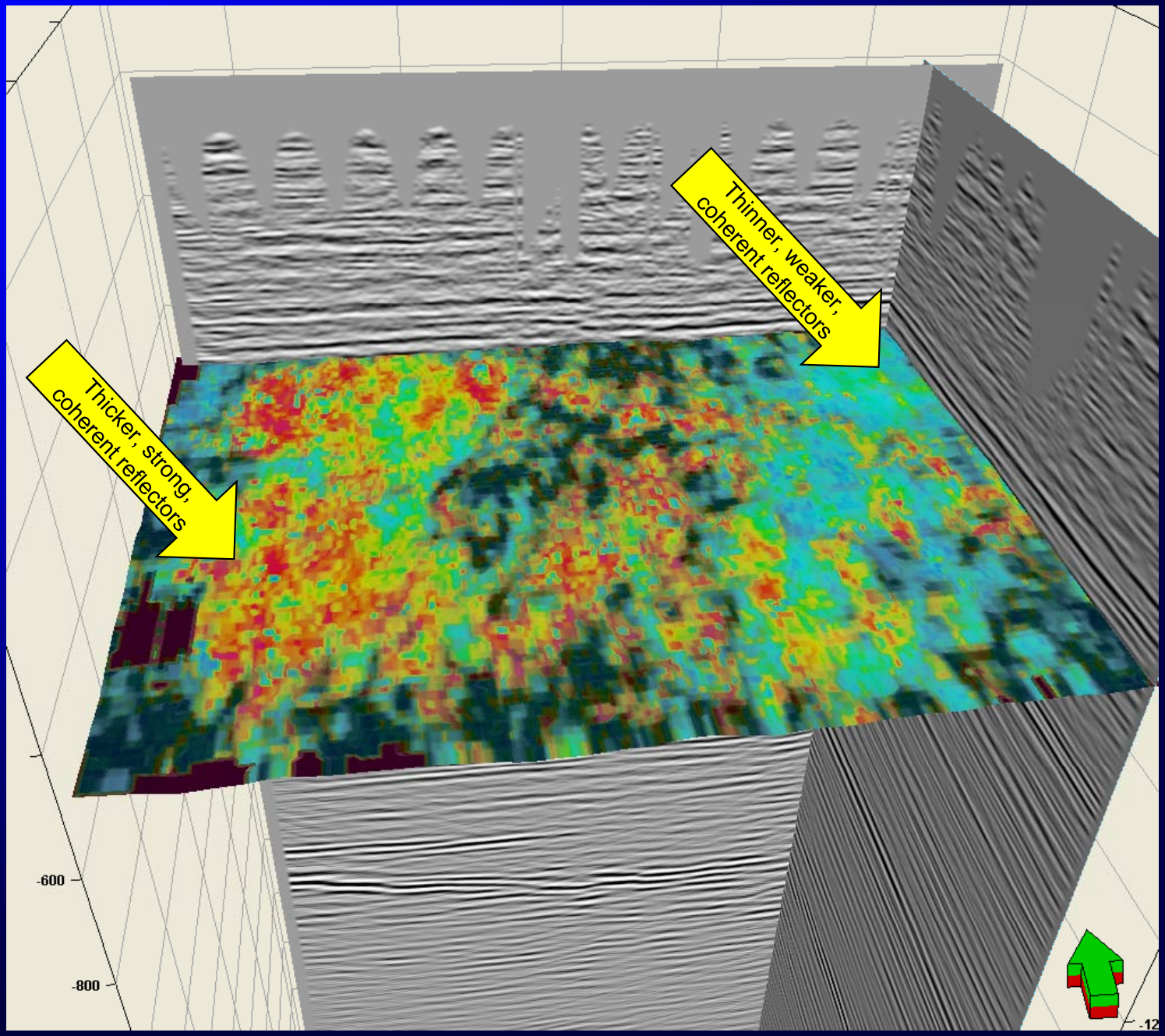




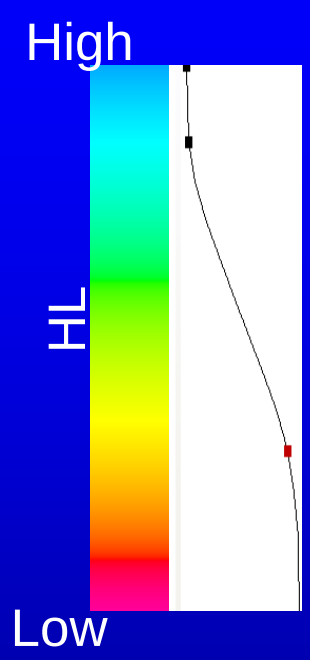


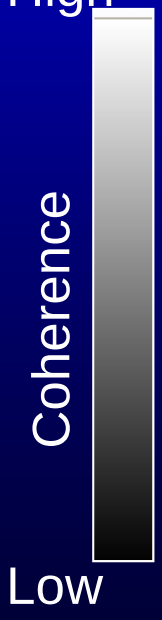
Peak frequency (against red-blue axis) vs. peak spectral magnitude (against whiteness/opacity) co-rendered with coherence.

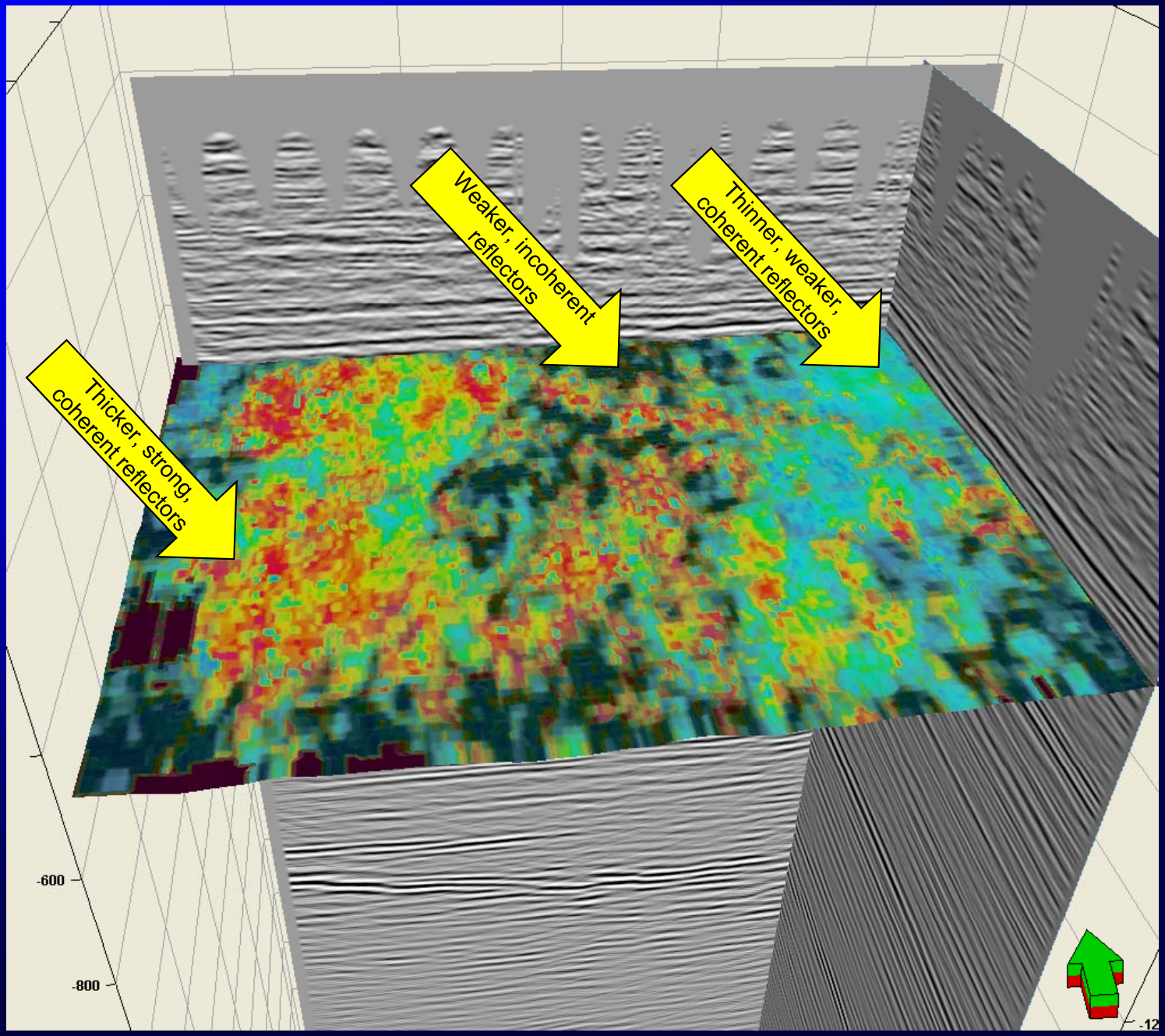




Peak frequency (against red-blue axis) vs. peak spectral magnitude (against whiteness/opacity) co-rendered with coherence.







Conclusions:

- Different seismic attributes have been generated and used to characterize the lenticular Cypress sands
- Coherence and Curvature attributes used to identify the fault/fracture lineaments (structural).
- Coherent energy, Relative AI, Peak frequency and Peak magnitude have been used to identify the depositional environment of Cypress sands (stratigraphic).
- HL plotting, co-rendering and visualization of multiple attributes helped to identify and characterize the lenticular Cypress sands qualitatively.

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Montgomery, S.L., and **H.E. Leetaru**, 2000, Storms Consolidated Field, Illinois Basin: Identifying New Reserves in a Mature Area: AAPG Bulletin, v.84, p.157-173.

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www.igs.indiana.edu, accessed in August and September of 2010.

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- Thanks to the sponsors of AASPI research consortium at OU.
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