

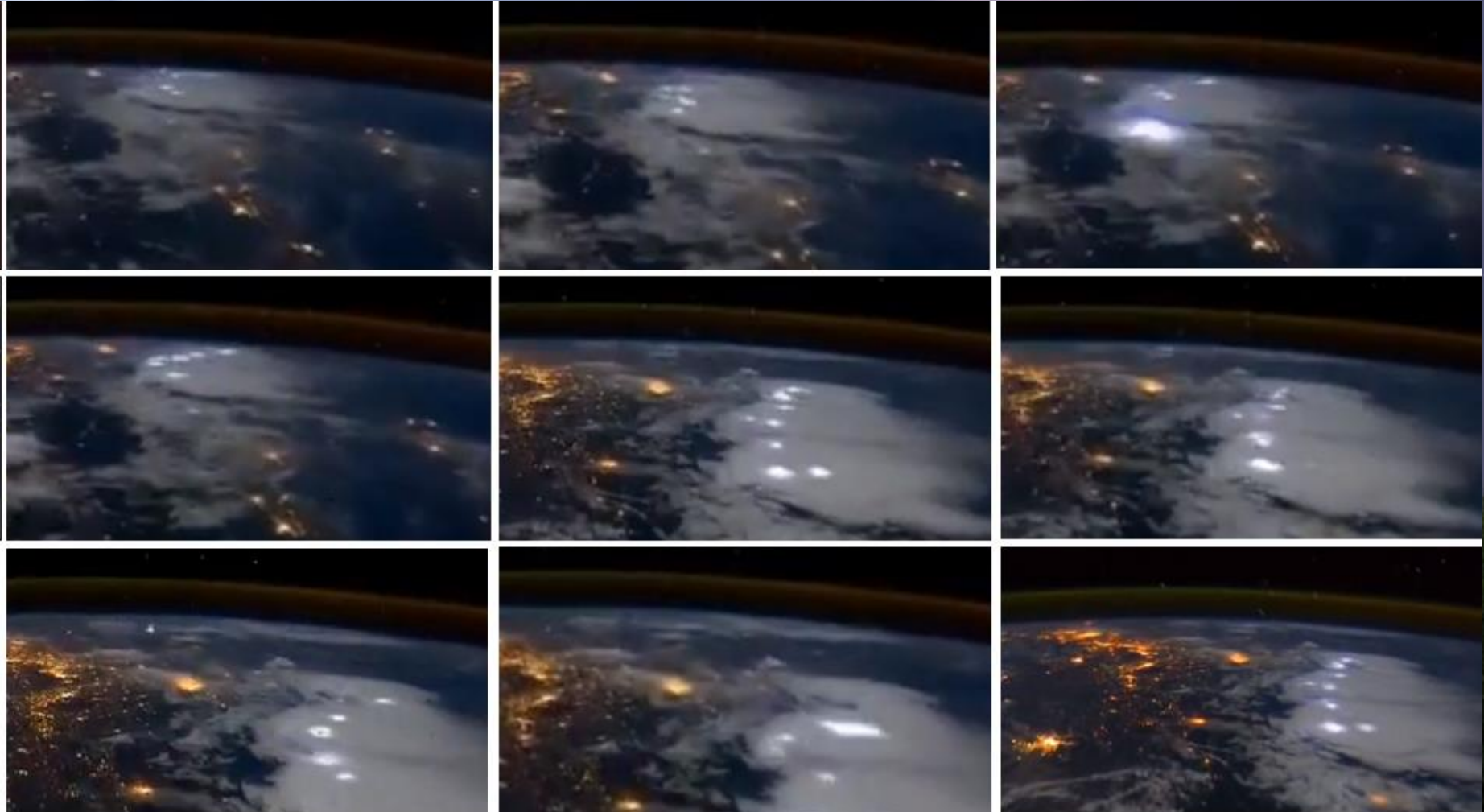
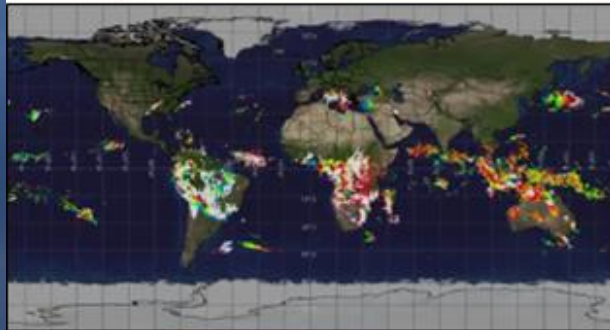
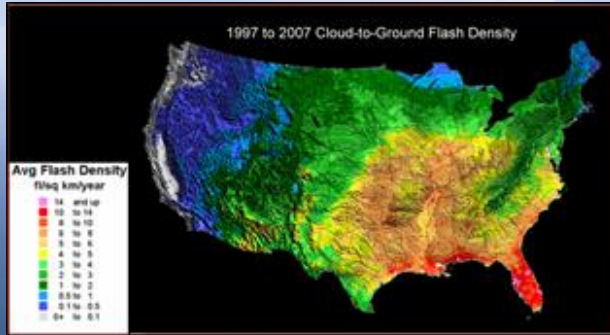


Using Resistivity from Lightning Databases in Exploration

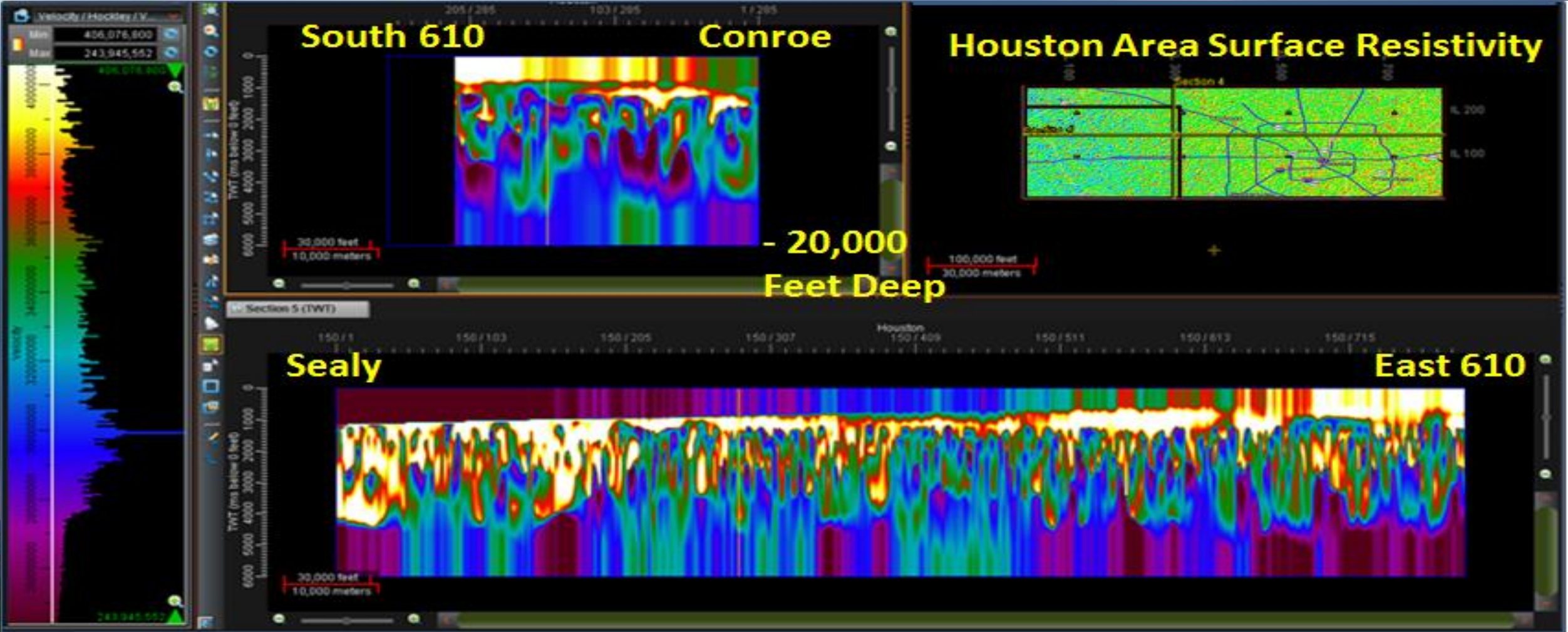
Joint LGS-SIPES Lafayette Lunch Meeting
19 November 2014

Kathleen S. Haggar, Geologist
H. Roice Nelson, Jr., Geophysicist

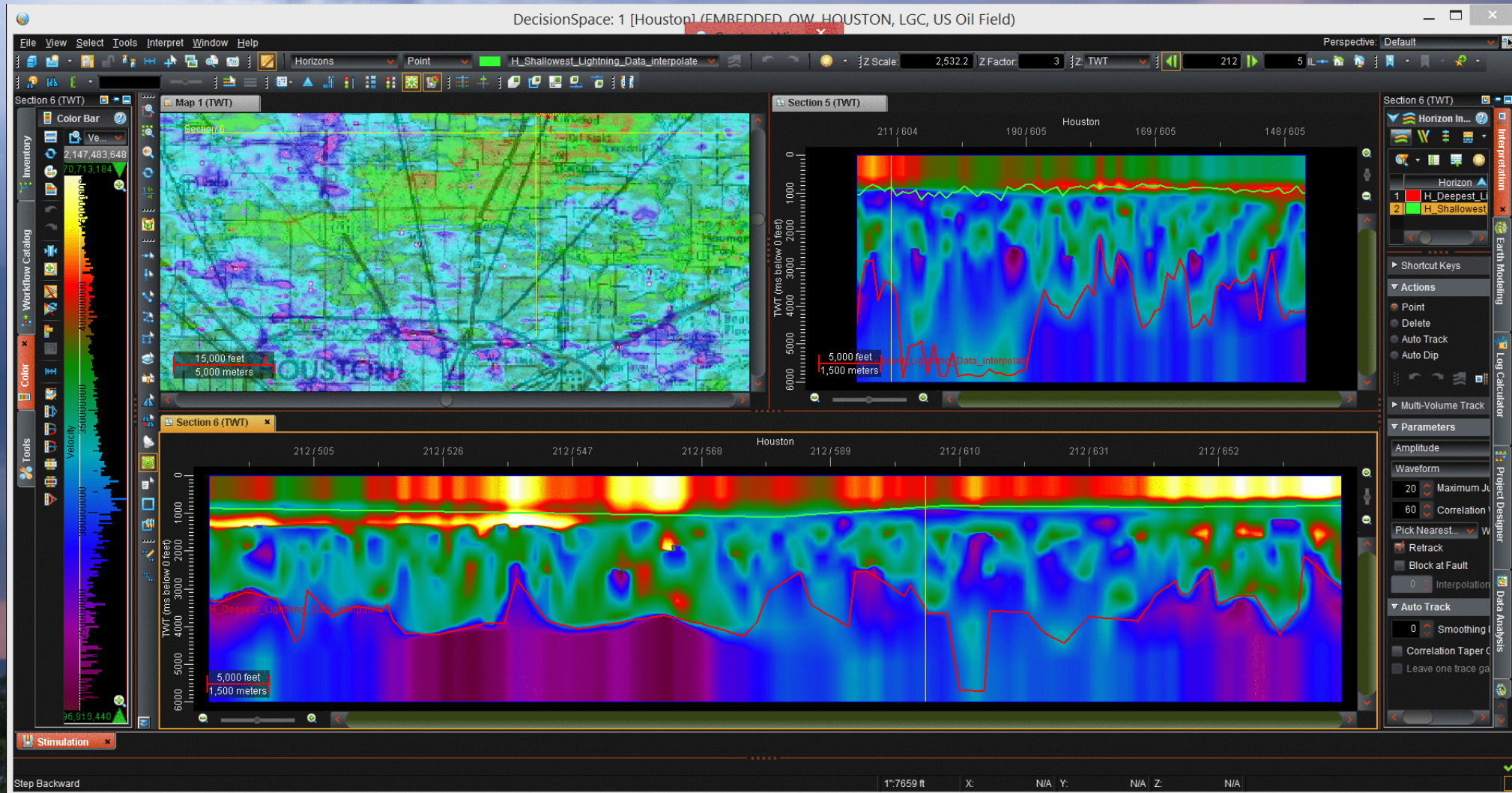
Lightning Occurs Everywhere



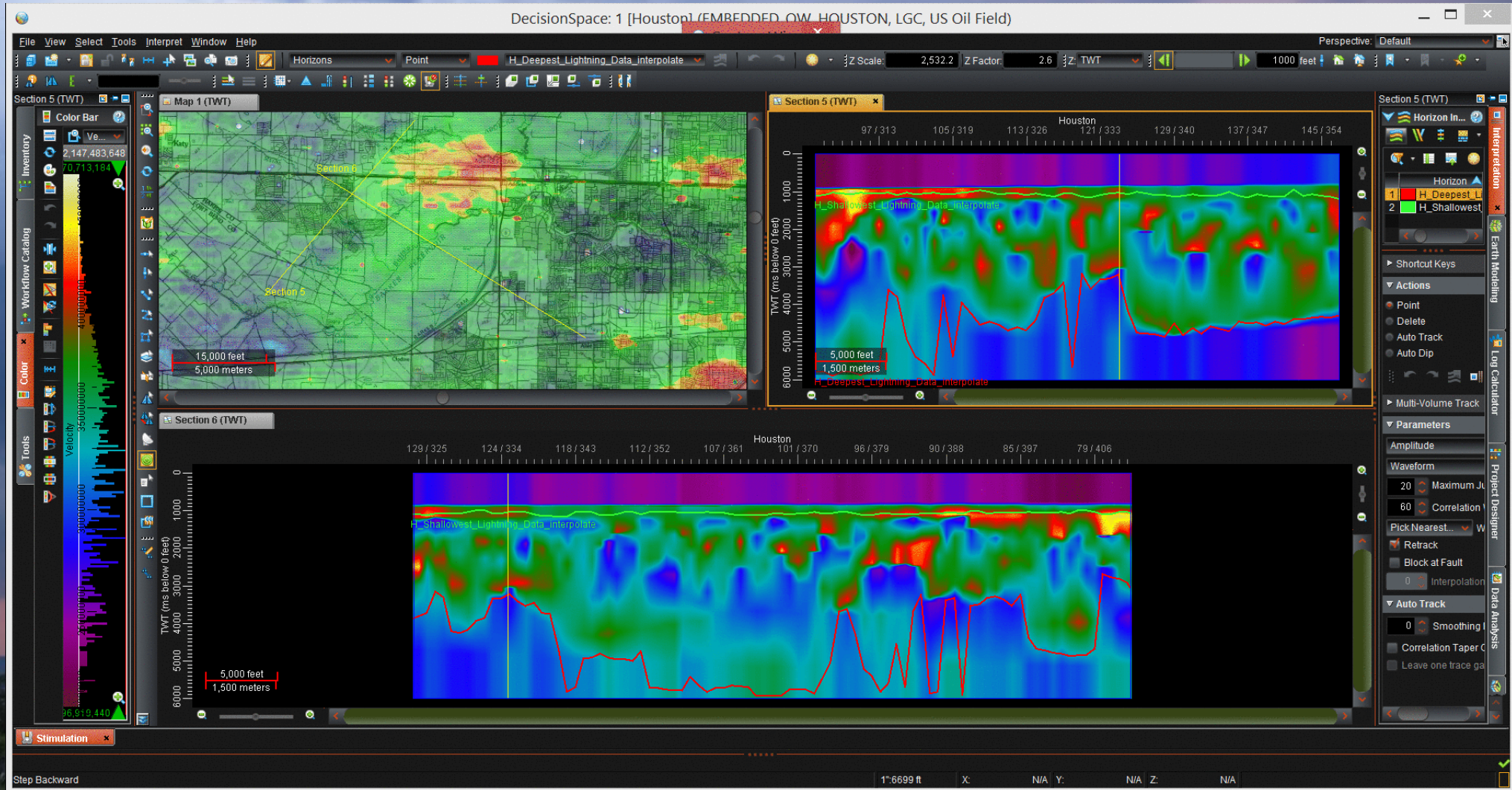
Even Downtown Houston



North of Downtown Houston

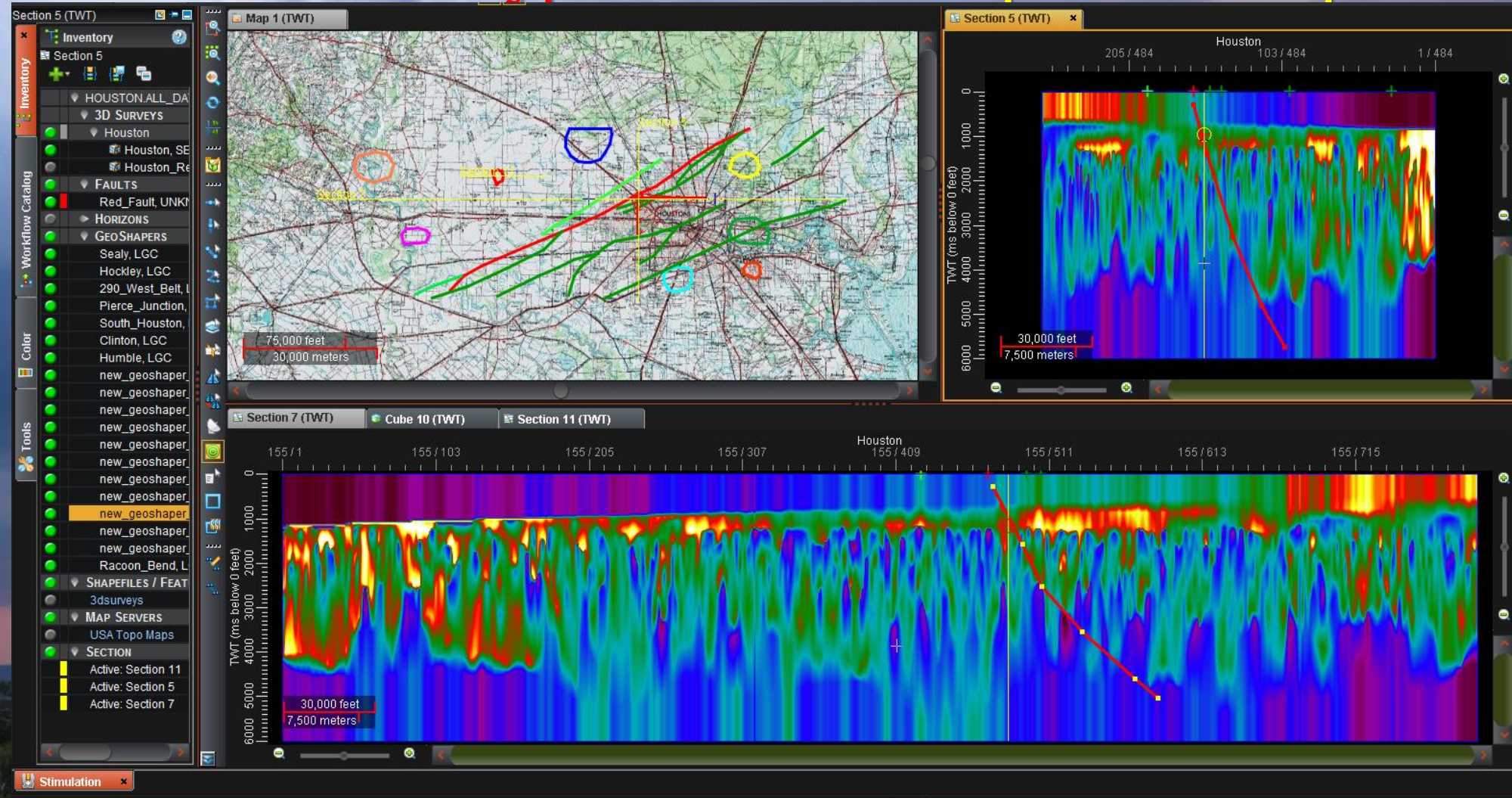


West of Downtown Houston along Pipelines

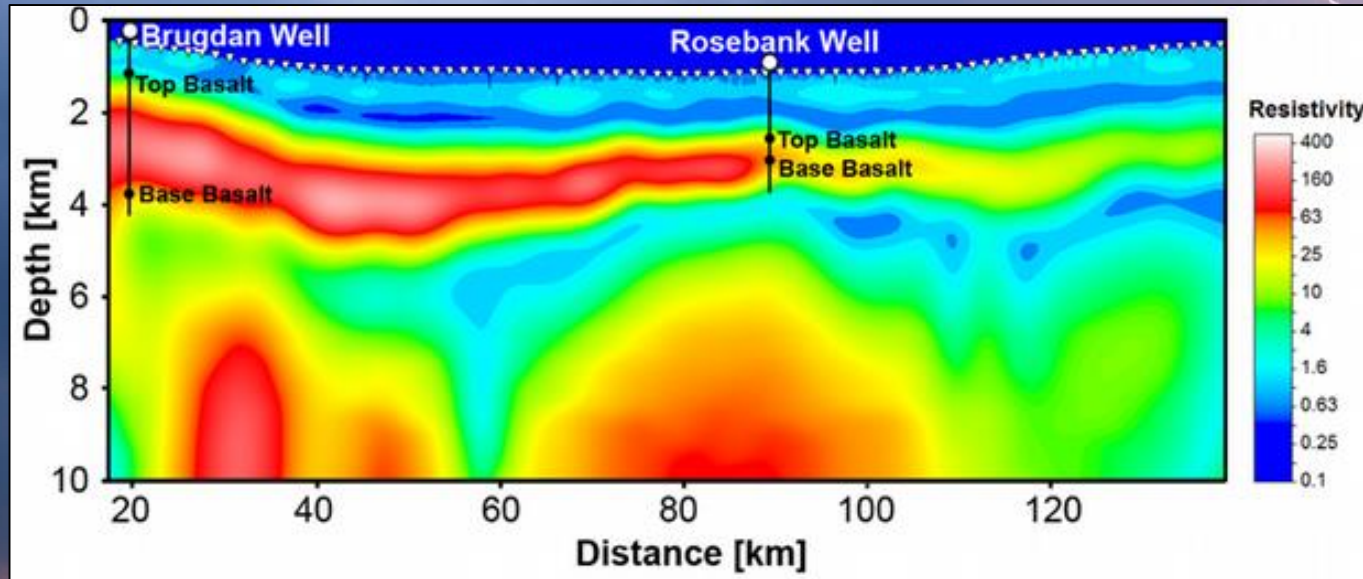


Resistivity Volumes Derived from Lightning Databases

Add a new set and type of data to Improve Interpretations



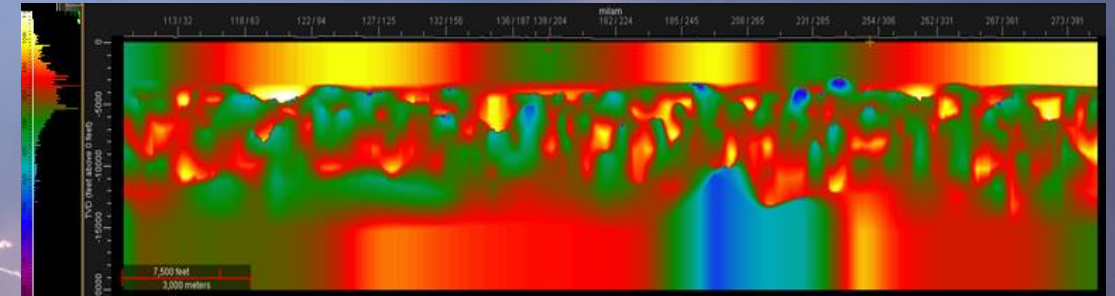
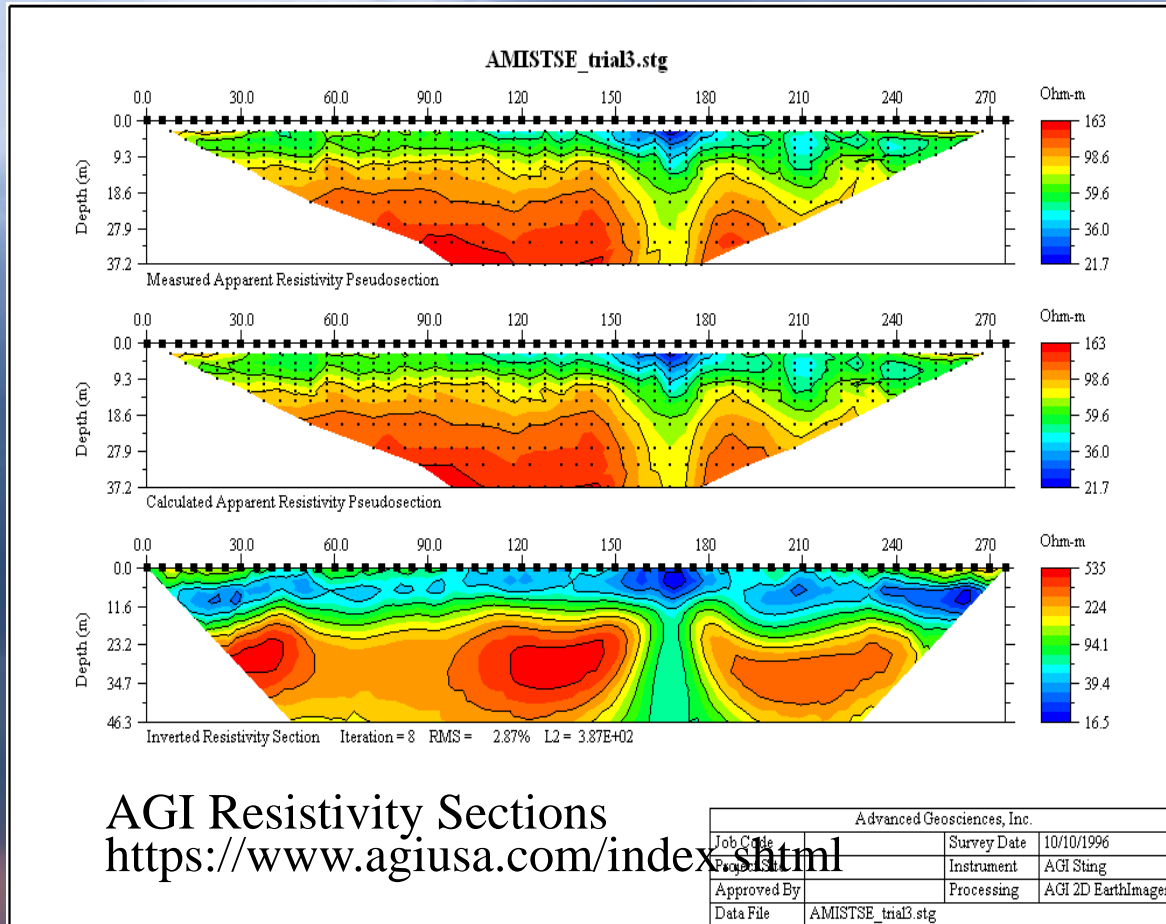
Resistivity Volumes are similar to an Onshore CSEM Survey



- CSEM Survey From: EMGS:
<http://www.emgs.com/content/870/Structural-imaging>

- Resistivity Volume from Central Texas

Resistivity Volumes similar to EM Resistivity Imaging



Technical Merit:

- Sections and Volumes
- Evergreen Data
- Volumes and Maps from 16 year ground sensor database in the US & Canada
- Maps from 4 year database worldwide
- Easy to Integrate
- Simple, Patented, & Pending Patent

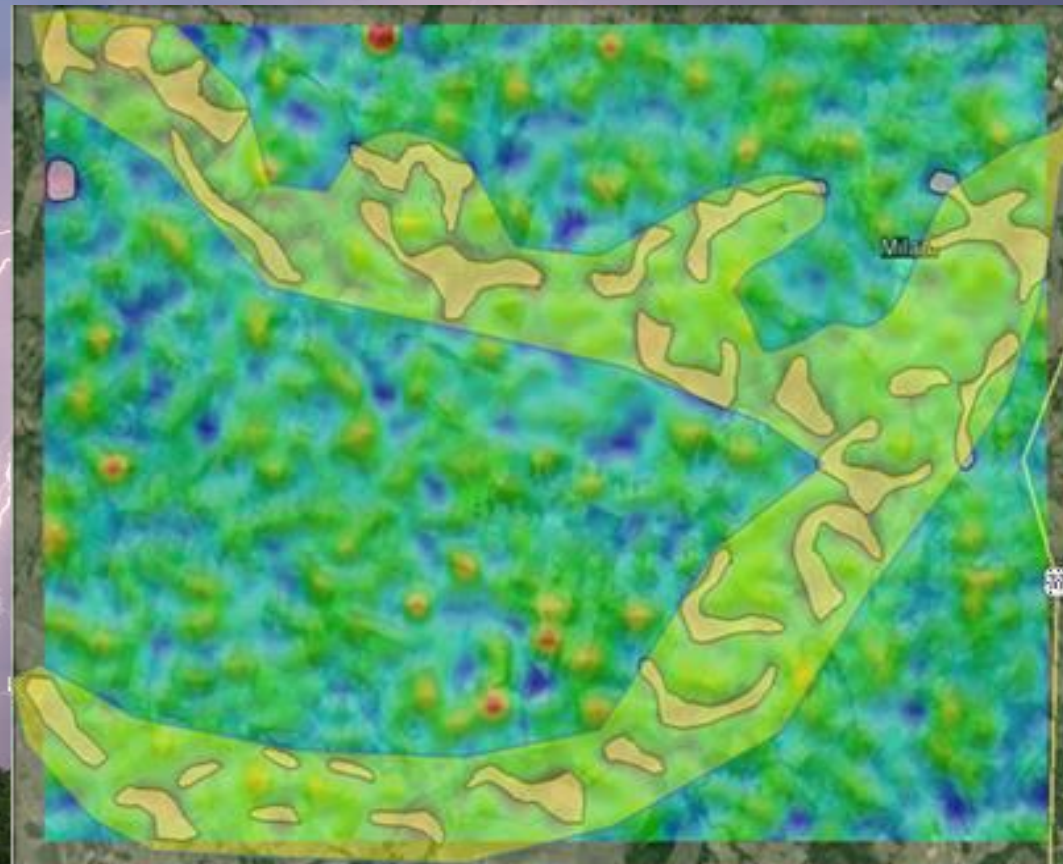
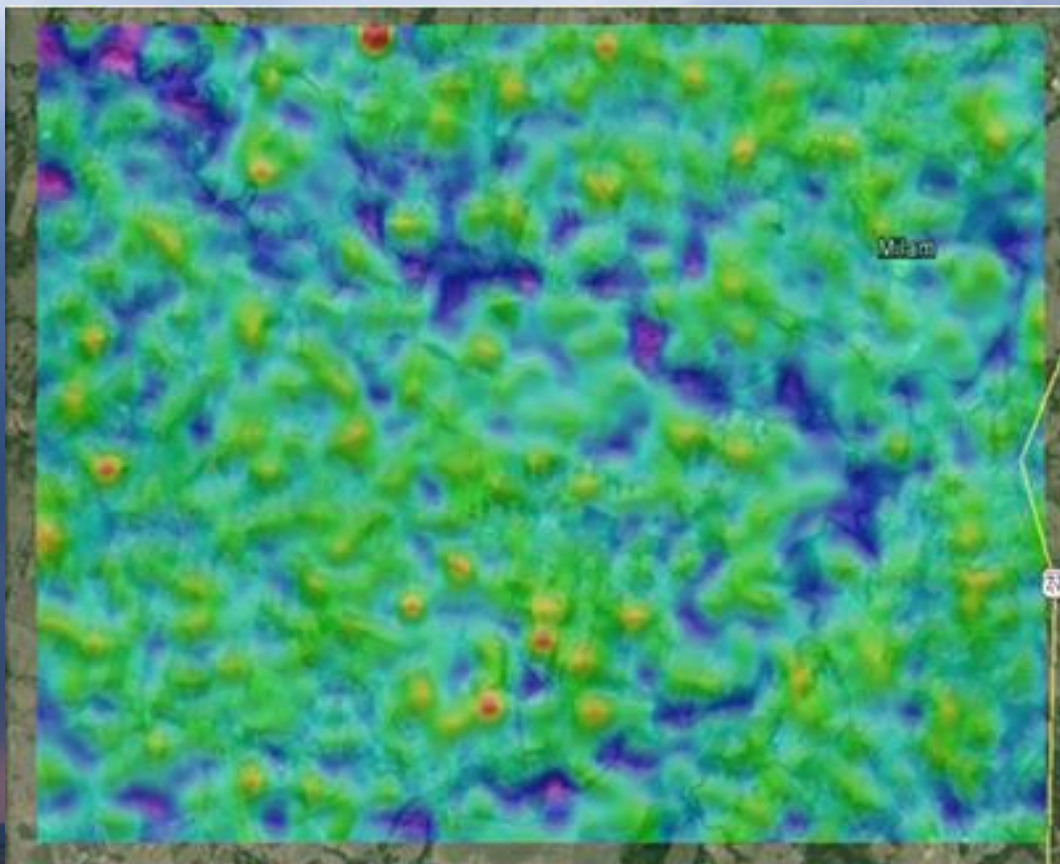
Economic Benefit:

- 2 month turnaround
- Larger Area – Less Expense

Will set up webinars to explain the technology

Exploration Examples

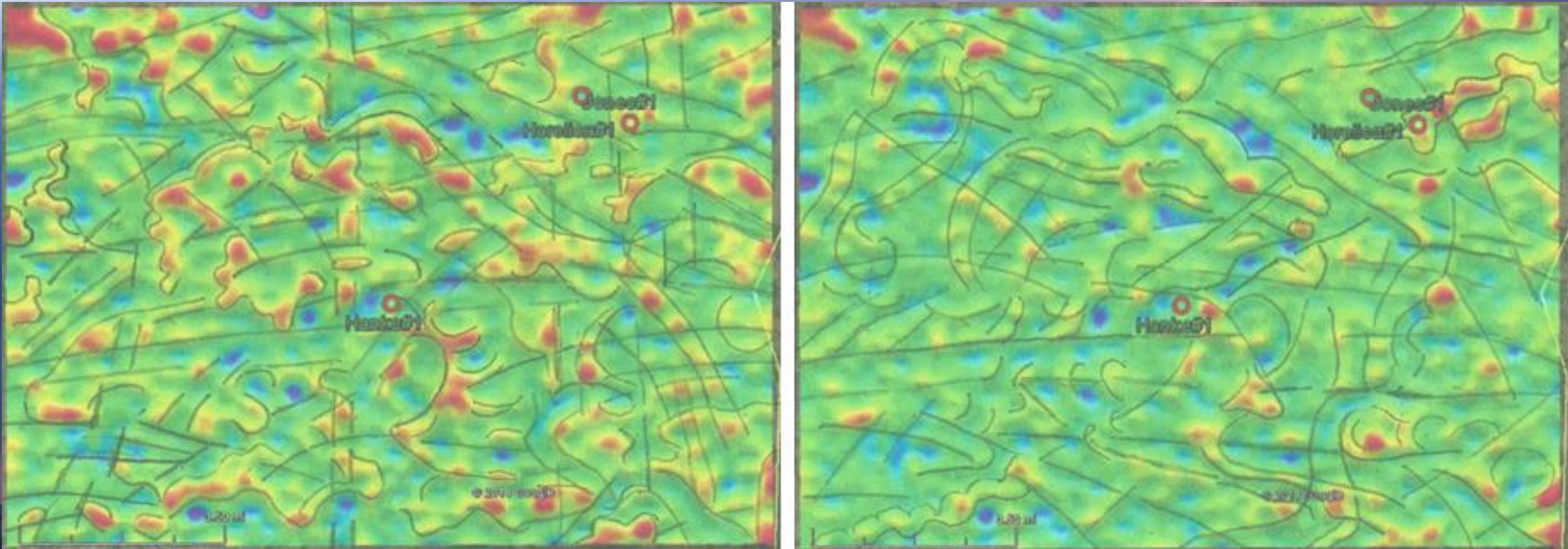
Starting in Central Texas and Working East



Lightning Attribute: Rate of Rise-Time

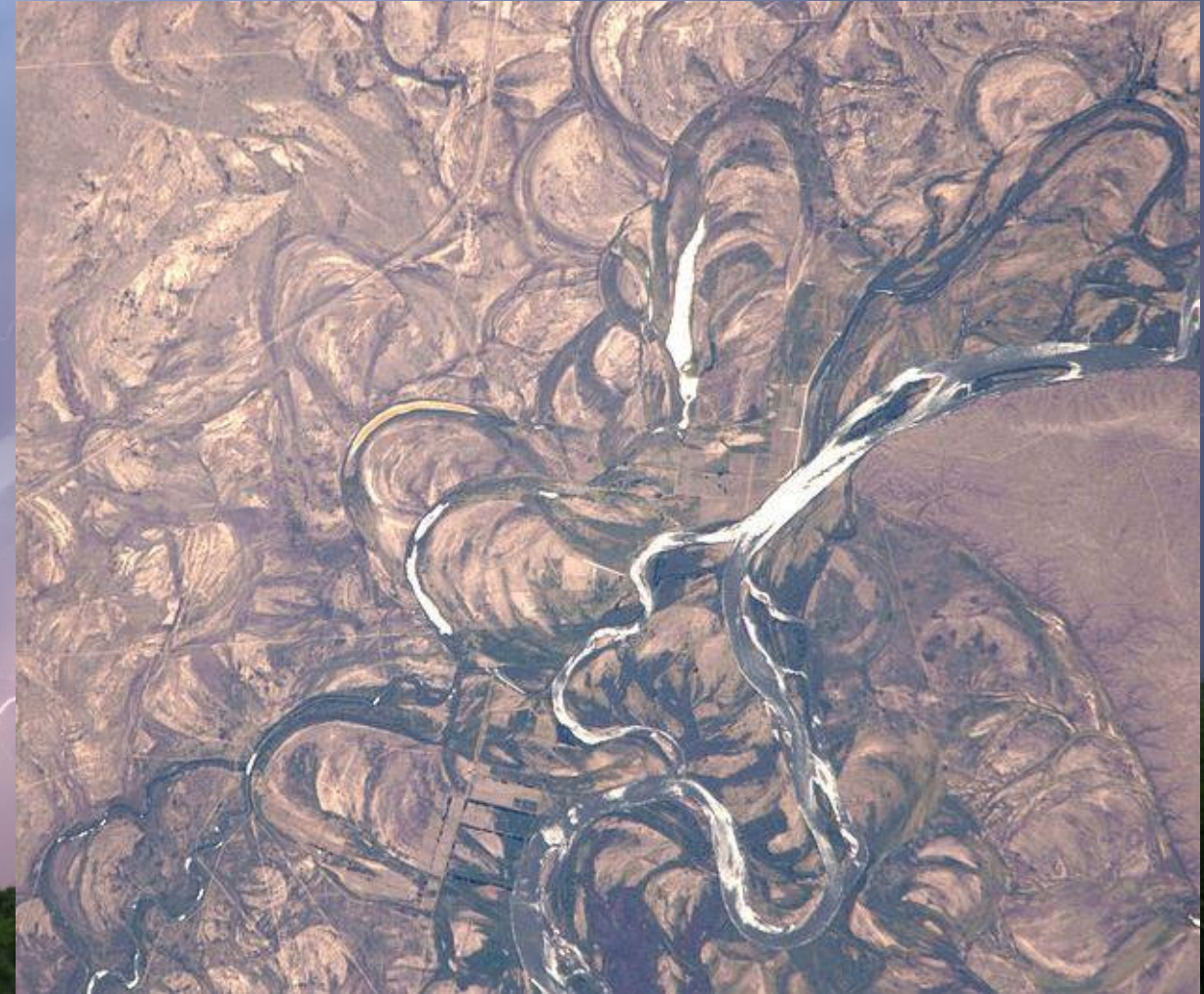
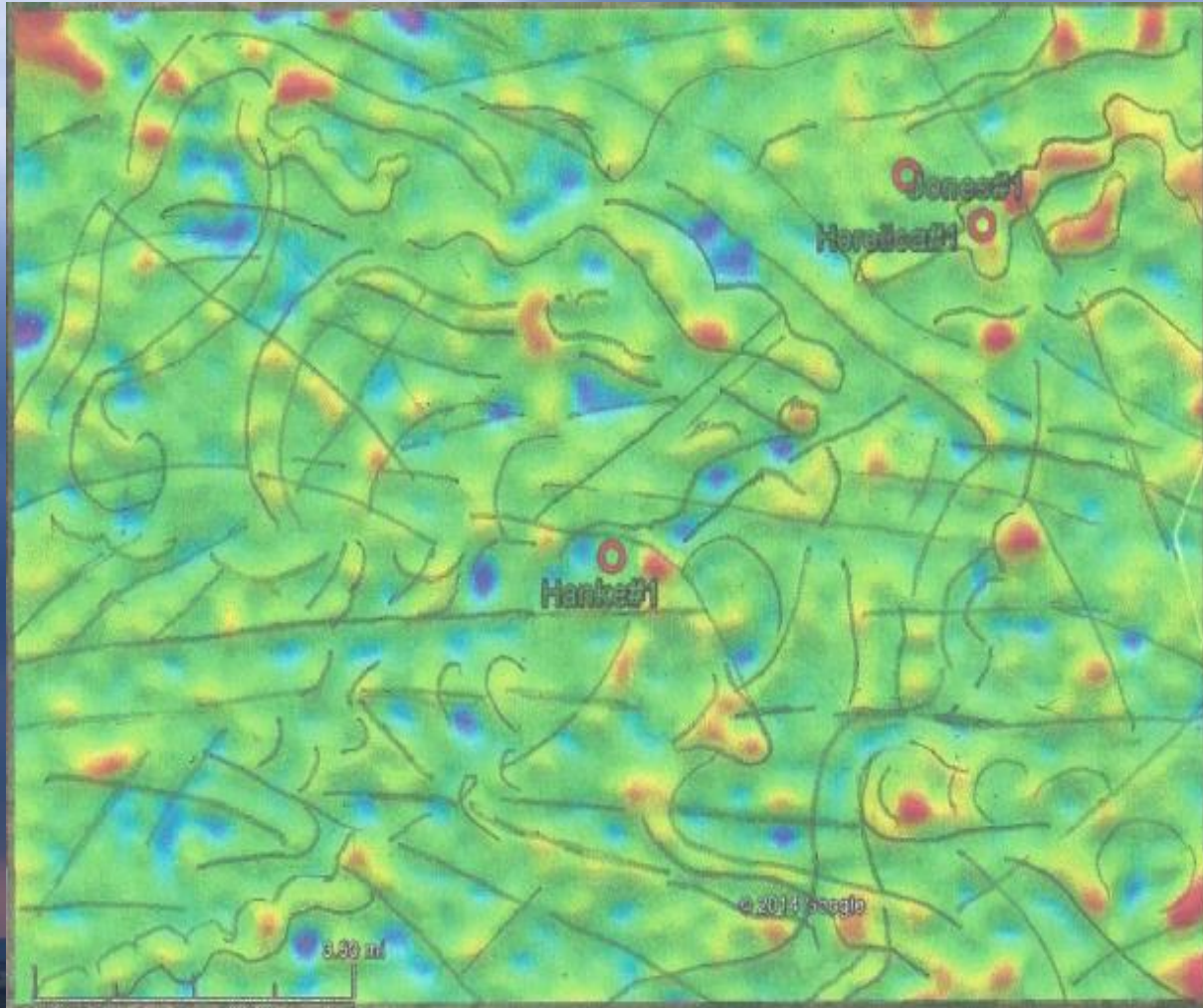
Lightning Analysis

Interprets Paleochannels and Meander Schrolls



Lightning Attributes: Surface Resistivity (left) Peak-to-Zero (right)

Looking At Meander Schrolls Like Lightning Does

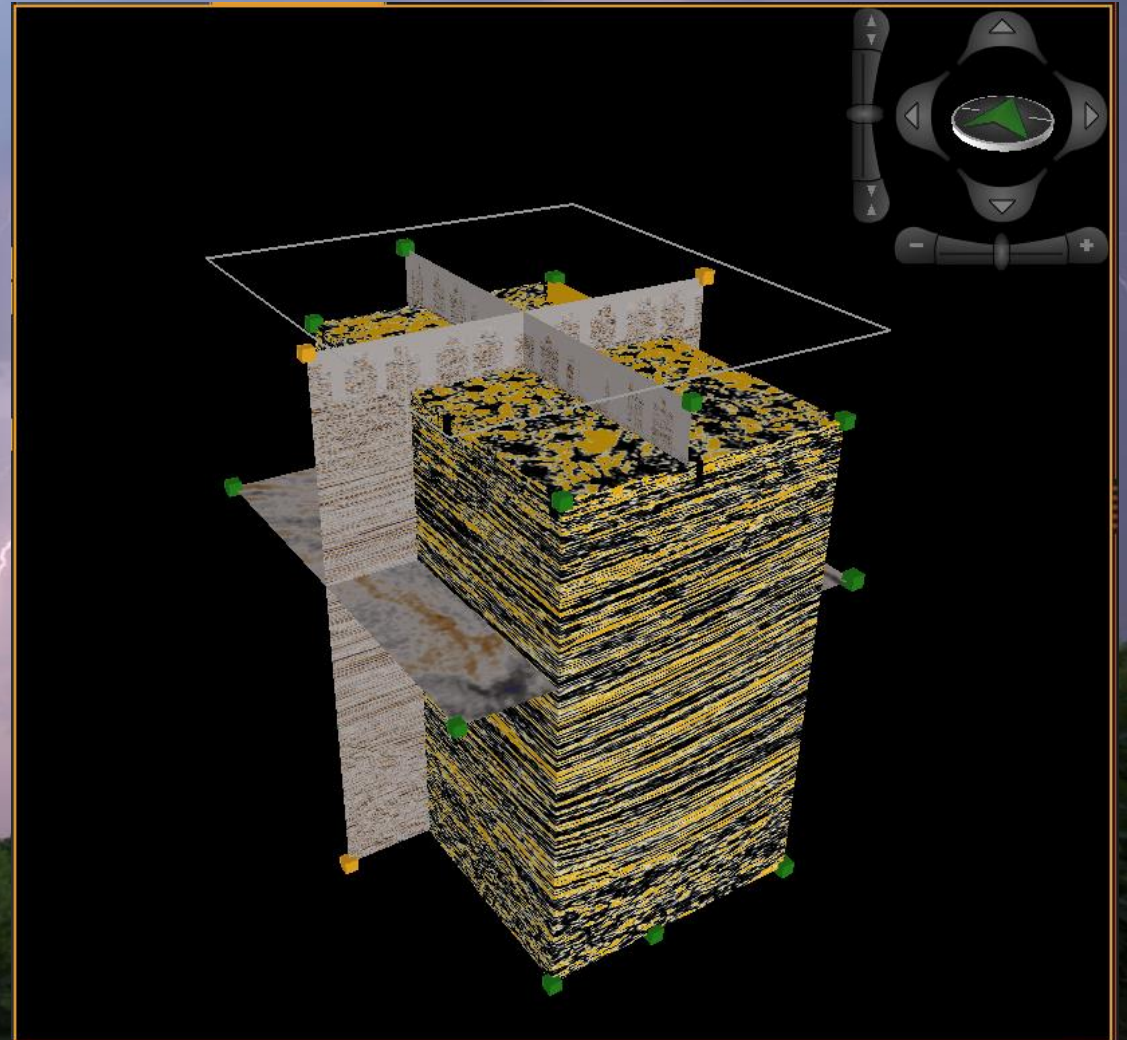
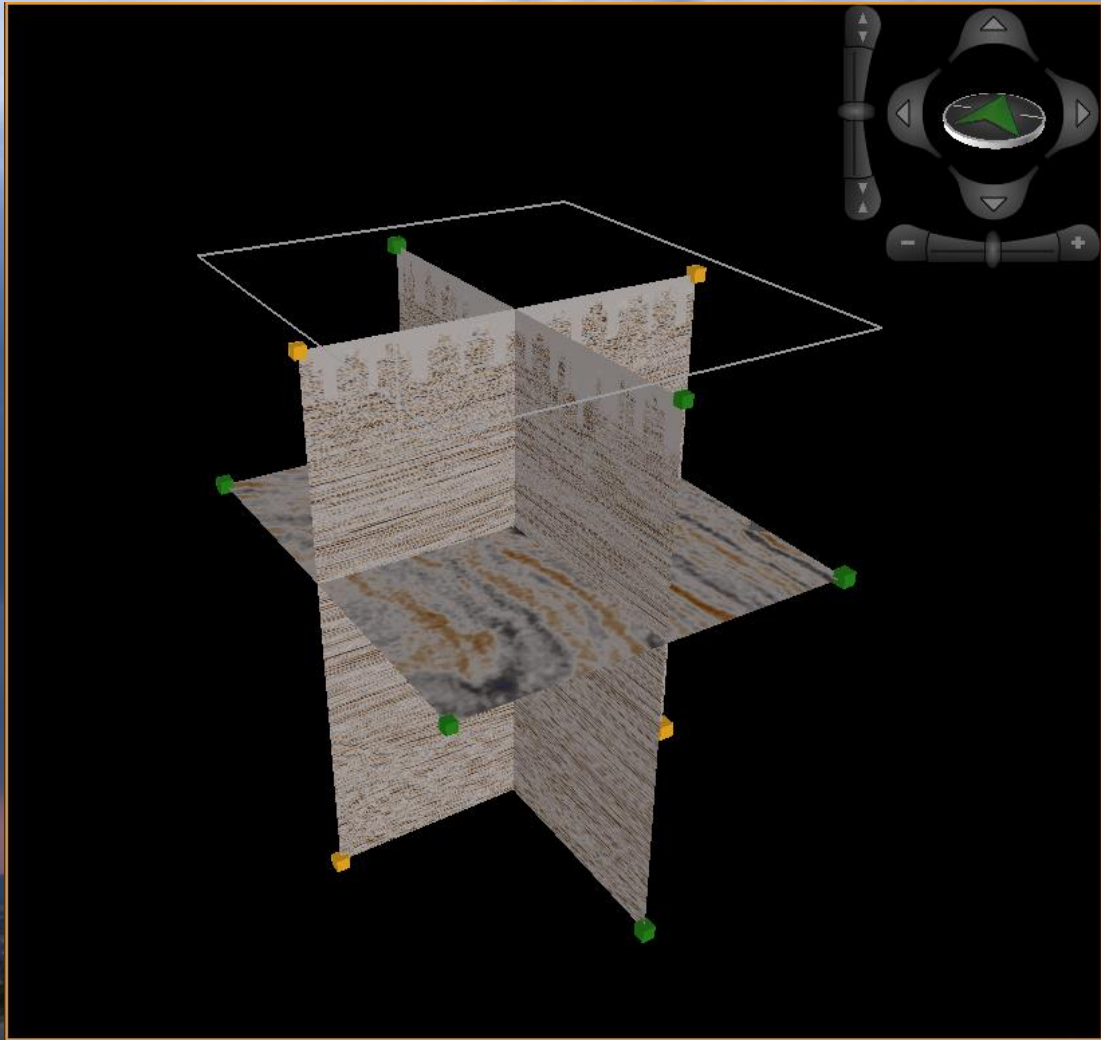


Left: Peak-to-Zero Central Texas

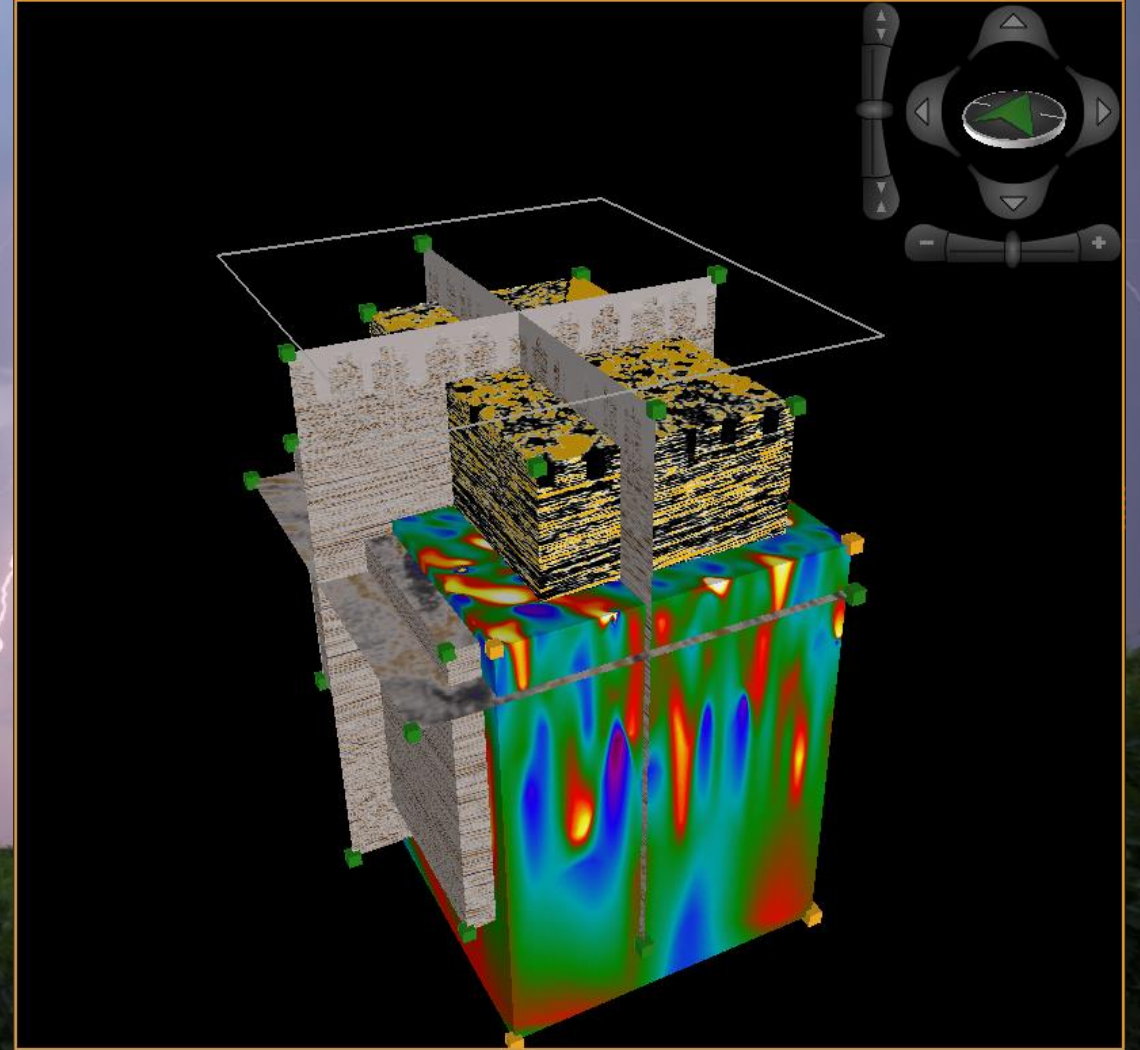
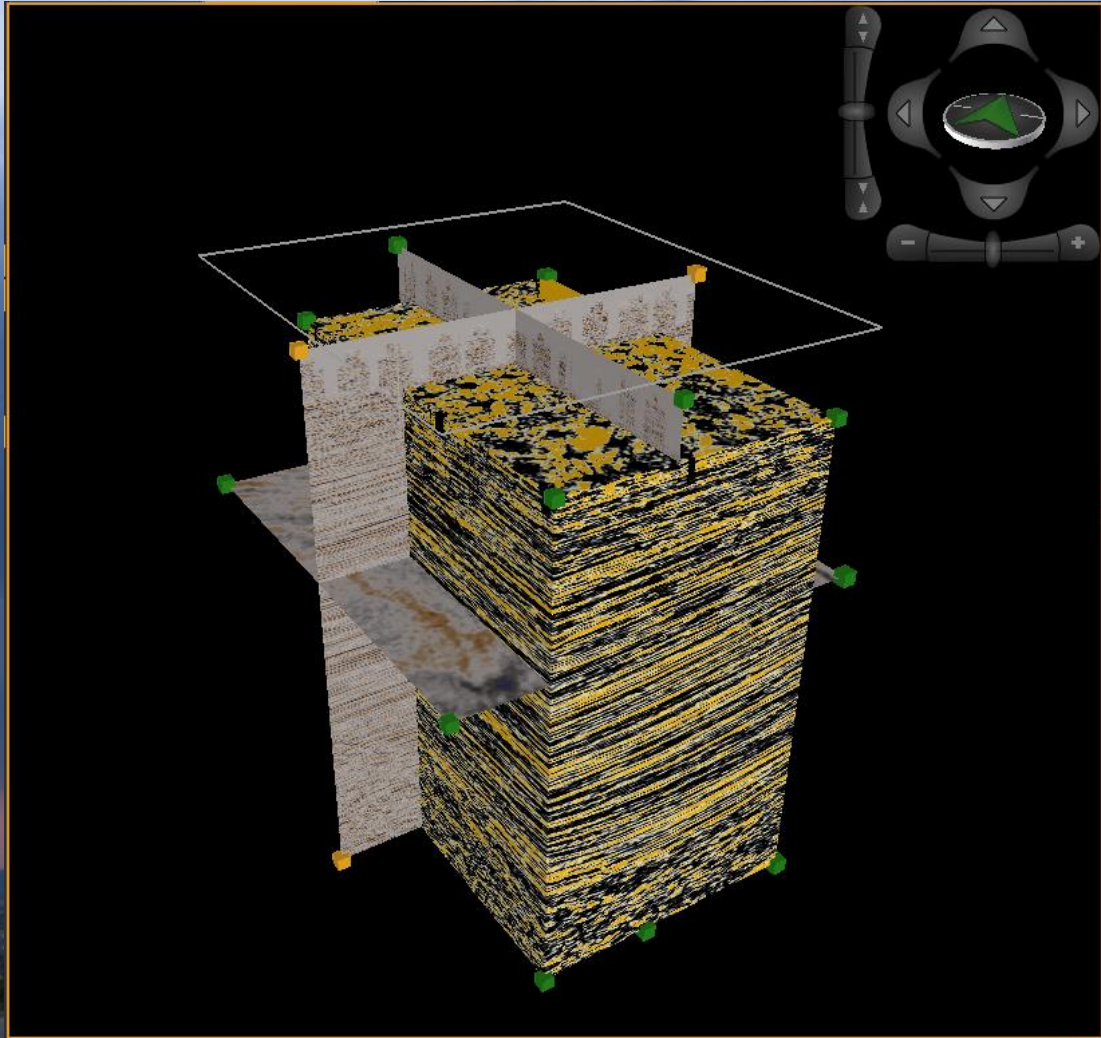
-

Right: http://en.wikipedia.org/wiki/File:Rio_Negro_meanders.JPG

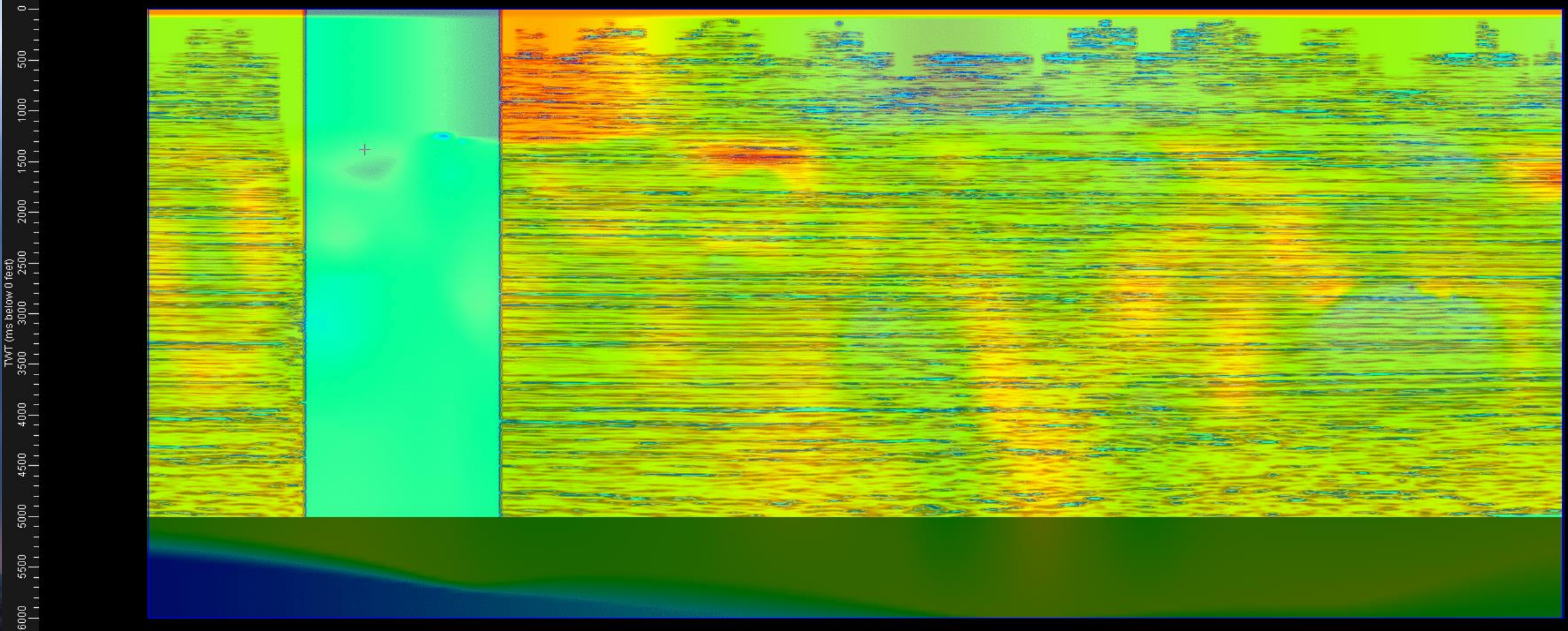
For Exploration, Maps Need to be Supplemented with Seismic



Resistivity Volumes Fill The Gaps Between Surveys & Wells



Overlaying Resistivity on Seismic Tells About Fluid Migration



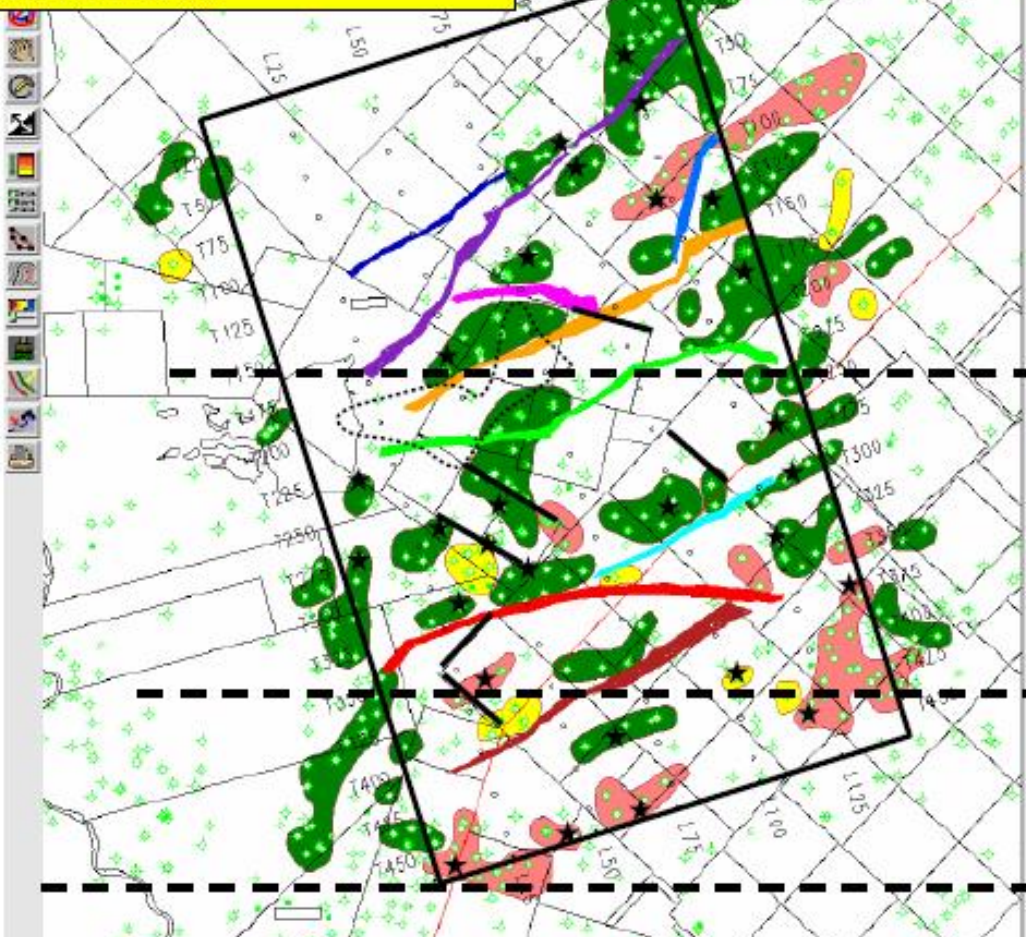
18 November 2014

1,000 feet
400 meters

Copyright © 2014
Dynamic Measurement LLC.

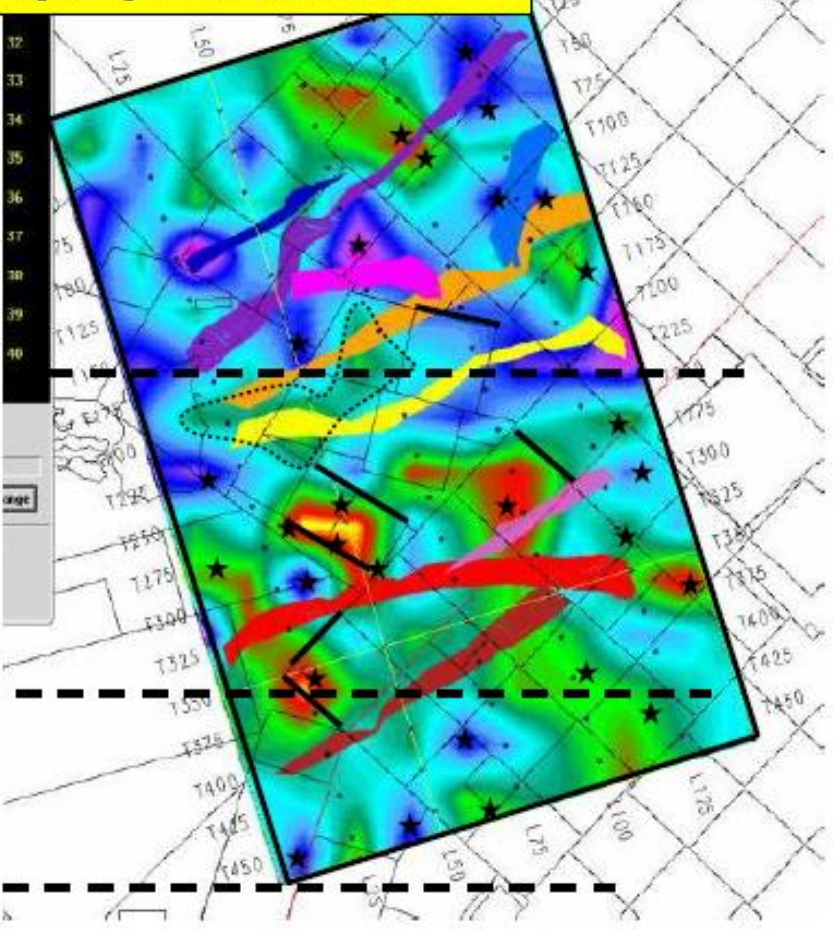
LGS-SIPES_Lafayette 14

**Fault Interpretation & Field Outlines
3D Seismic Data**



Of the 27 fields identified on the 3D seismic data above, 26 of them (96%) could have been identified on just one of the lightning attribute maps as shown on the right.

**Fault Interpretation & Field Outlines
Lightning "Rise Time" Attribute**



Based on existing discoveries only 4 out of 30 (13%) of the lightning anomalies did not correlate to production. Future drilling may reduce this percentage.



Correlation polygon



Orientation aids



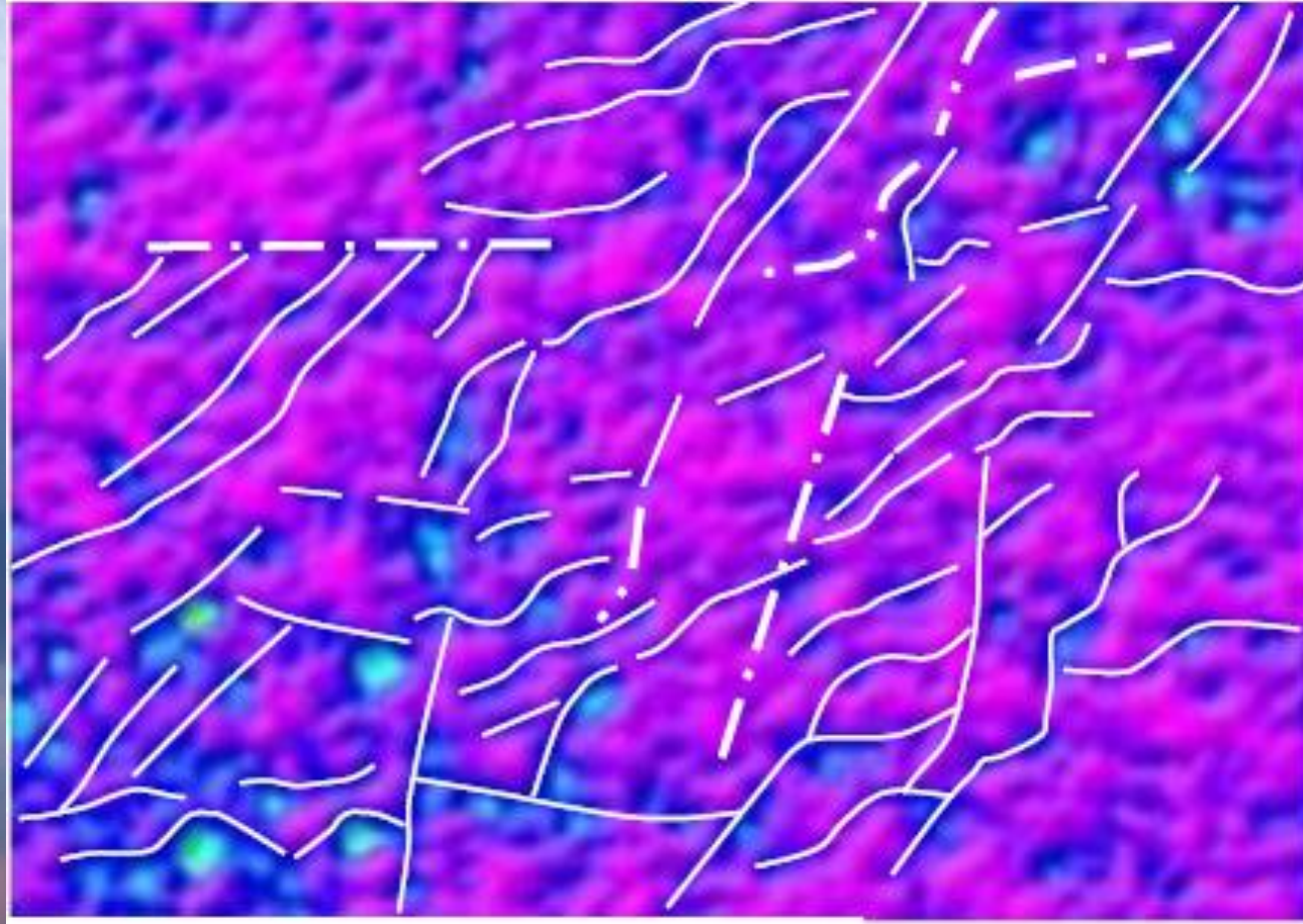
Alignment aids



Field correlations – detailed comparisons to check lightning data's ability to predict oil/gas fields.

Colorado County, Texas Prospect Scale Correlation Exercise

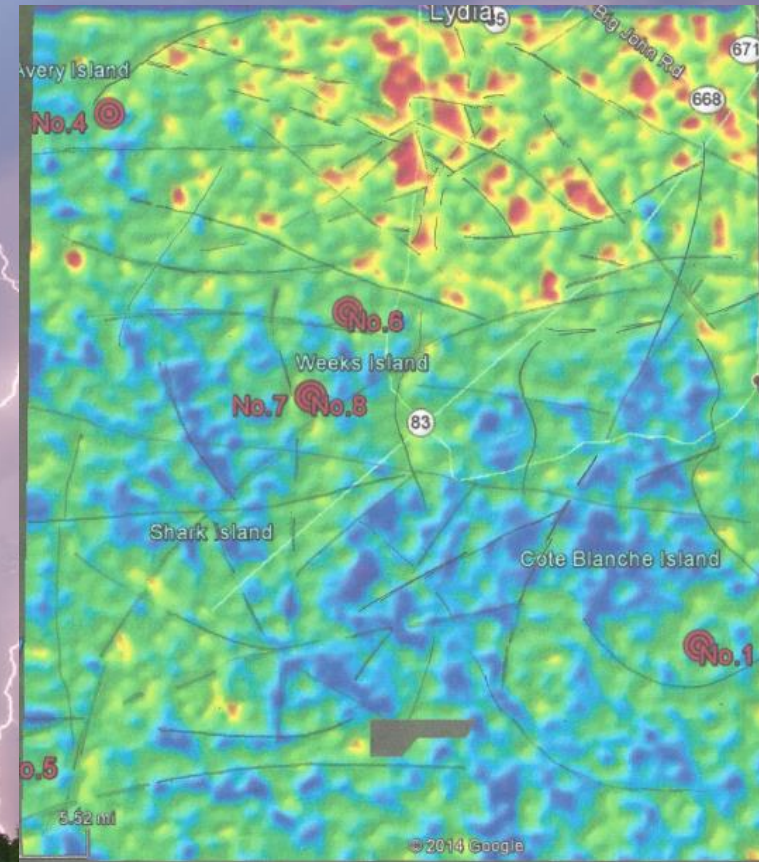
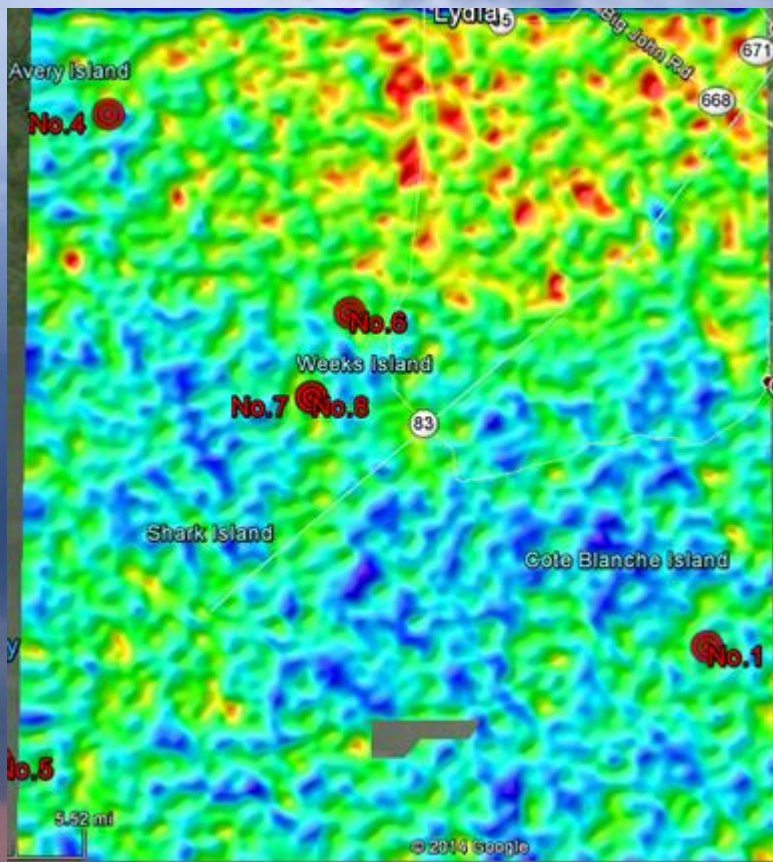
Fault Interpretation West Harris County, Texas



Lightning Attribute: Lightning Strikes when the Earth Tide is Greater than 75% of the monthly maximum rate

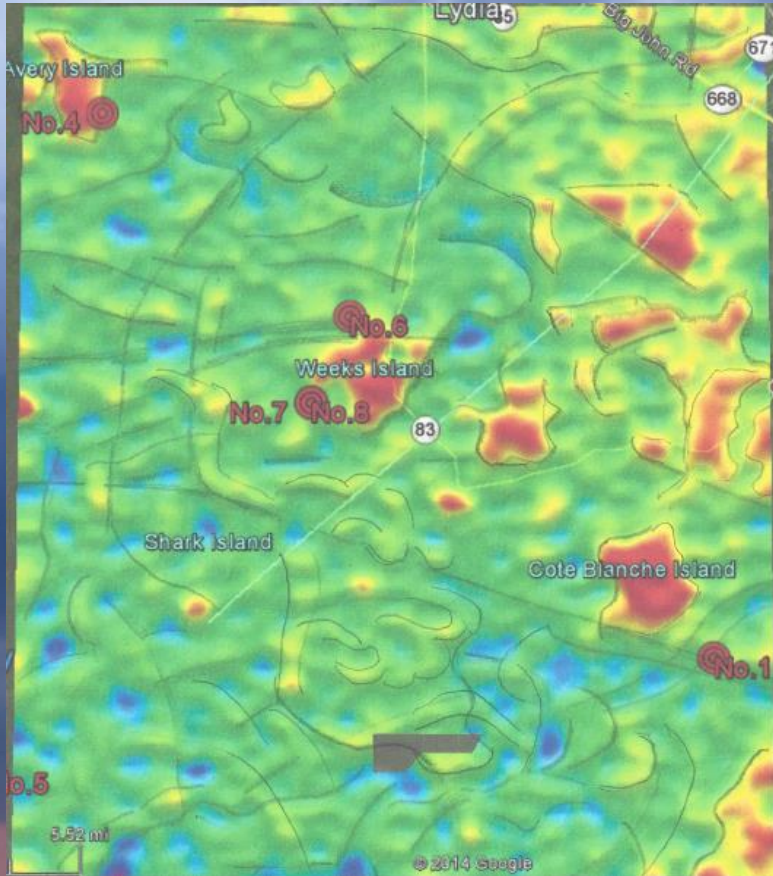
Exploration Starts with the Geologic Framework

Lightning Attribute Maps Help Define Faults,



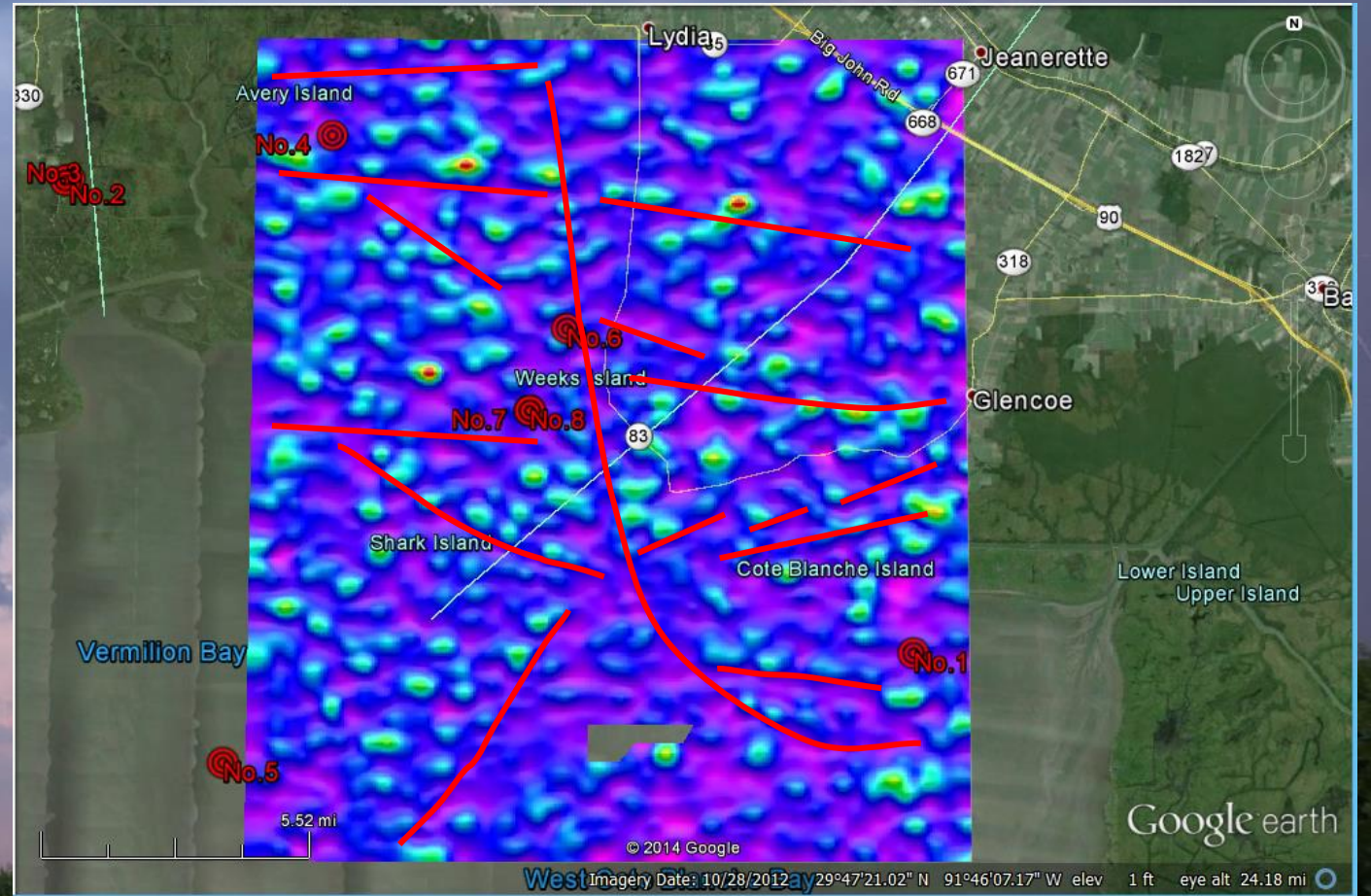
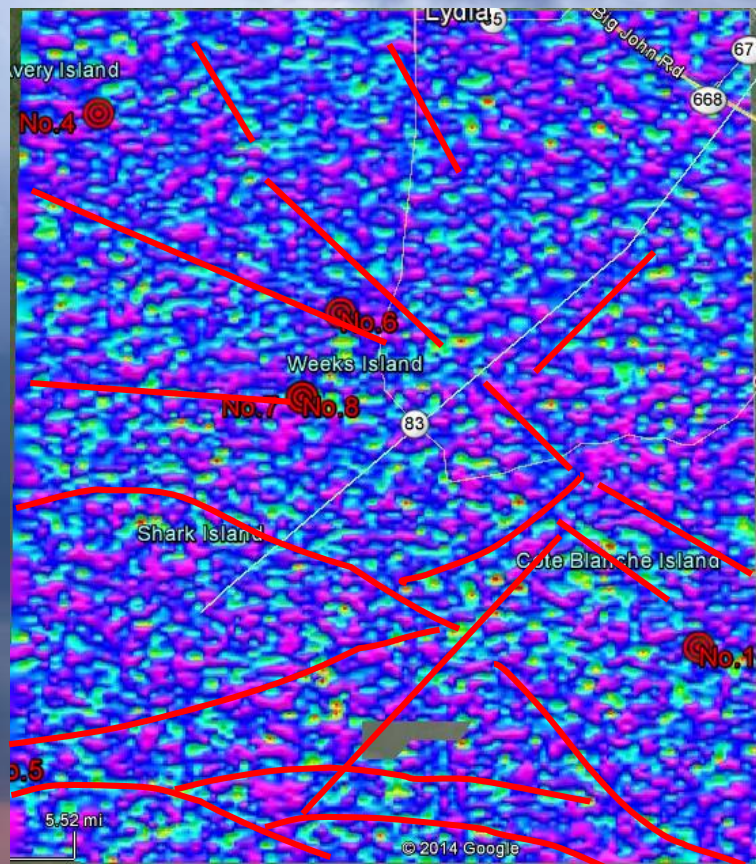
Lightning Attributes: Surface Density (left) Interpretation (right) Iberia Parish

Tie to Analogs like Goose Point,



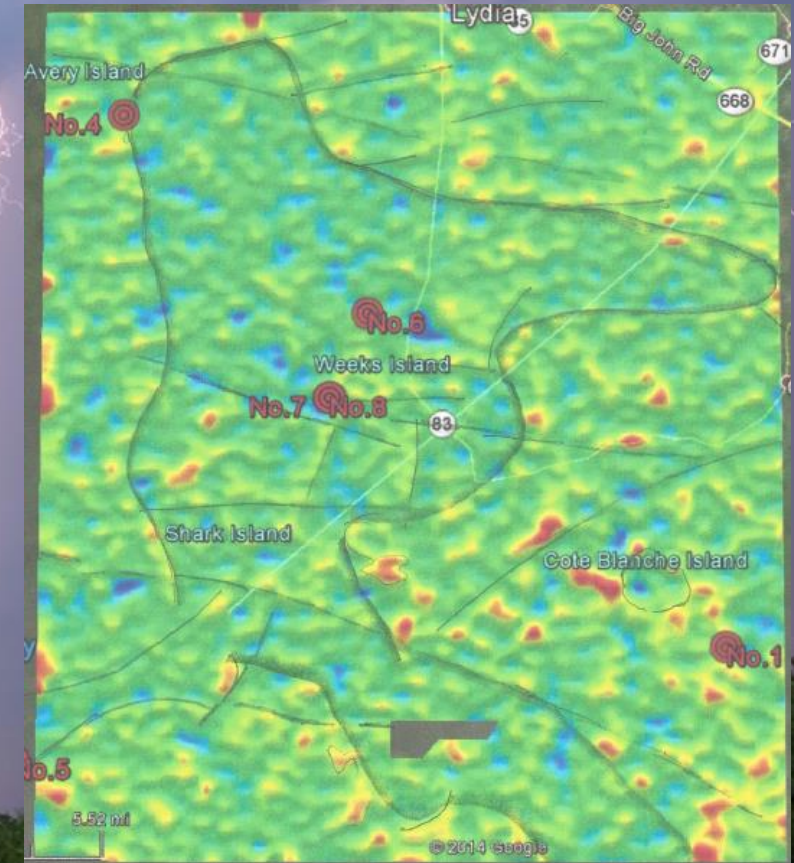
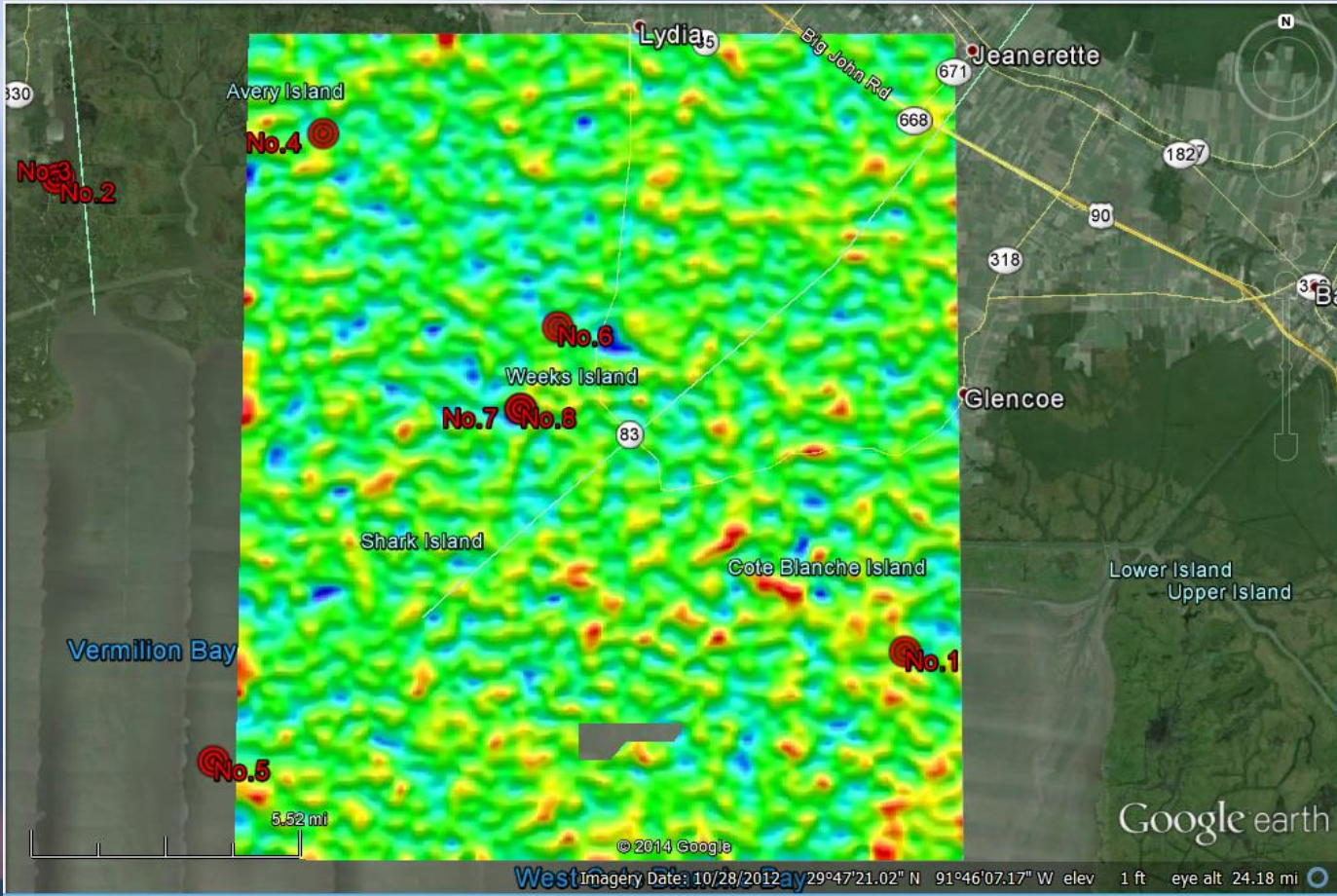
Lightning Attributes: Res Rise-Time Interpretation (left) Goose Point Analog (right)

Define Fault Framework Options,



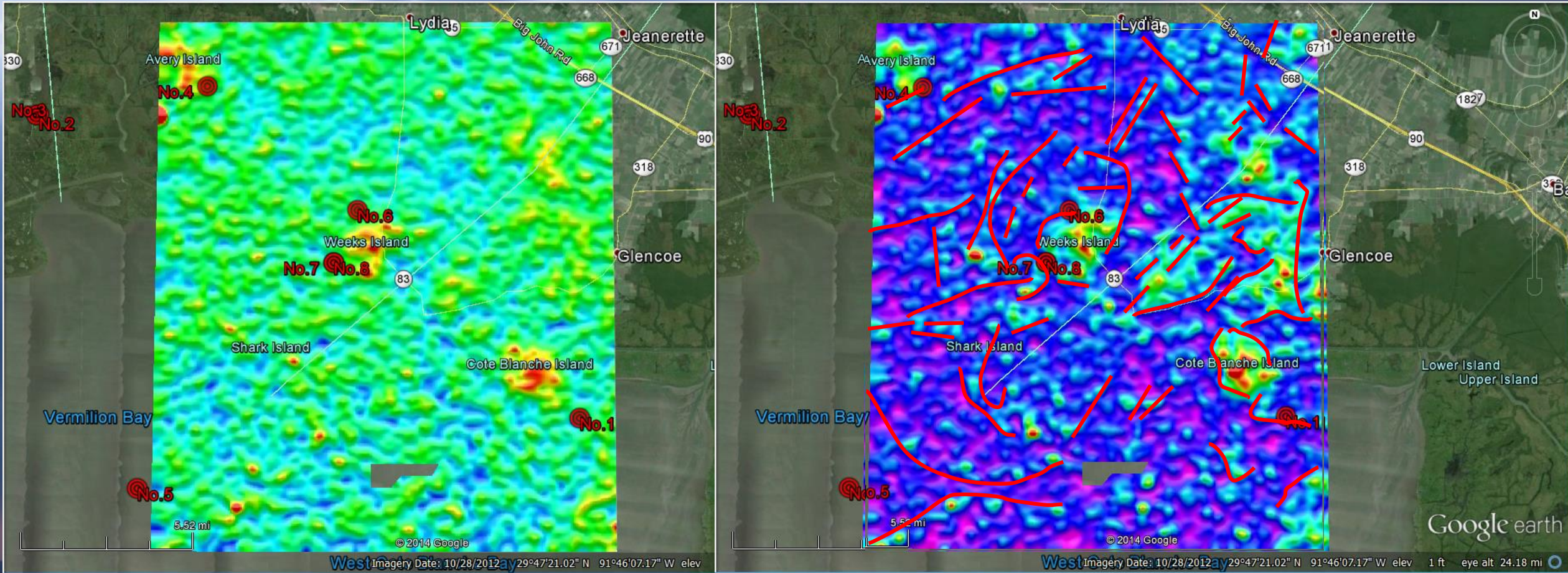
Lightning Attributes: Peak Current Negative (left) Peak Current Positive (right)

and Paleo Geology,



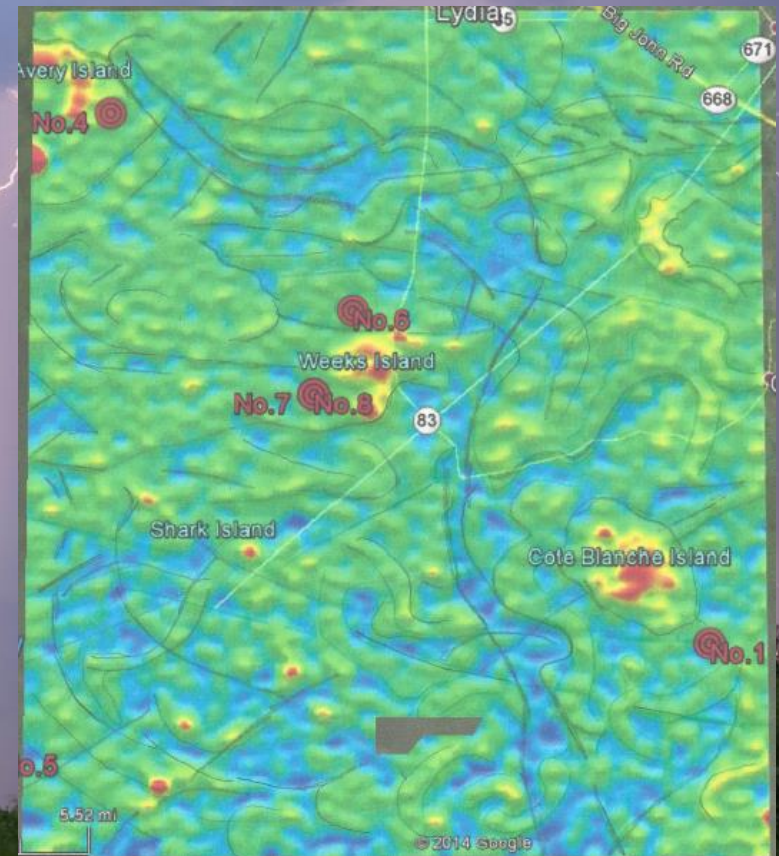
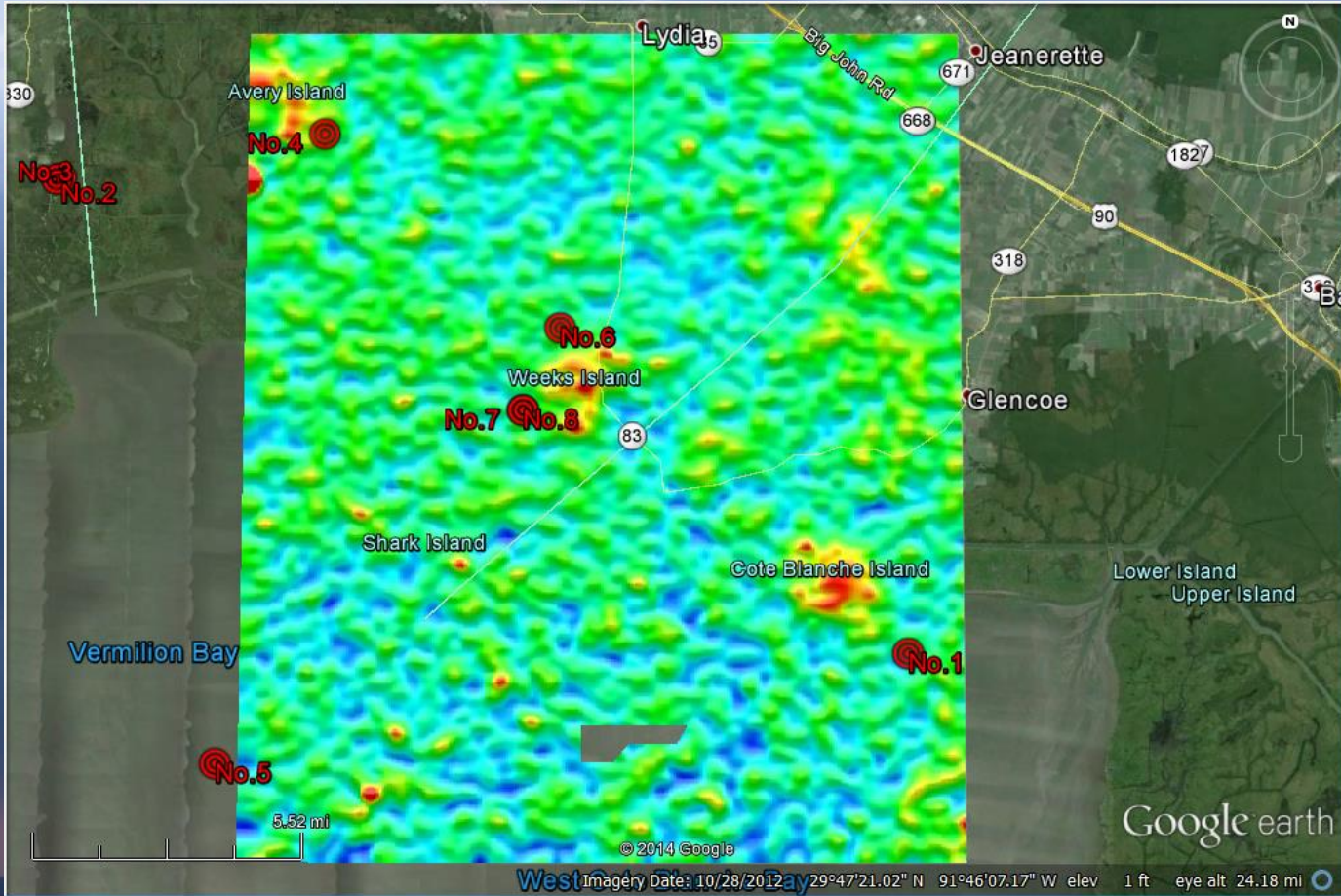
Lightning Attributes: Peak-to-Zero (left) Peak-to-Zero Interpretation (right)

and Salt,



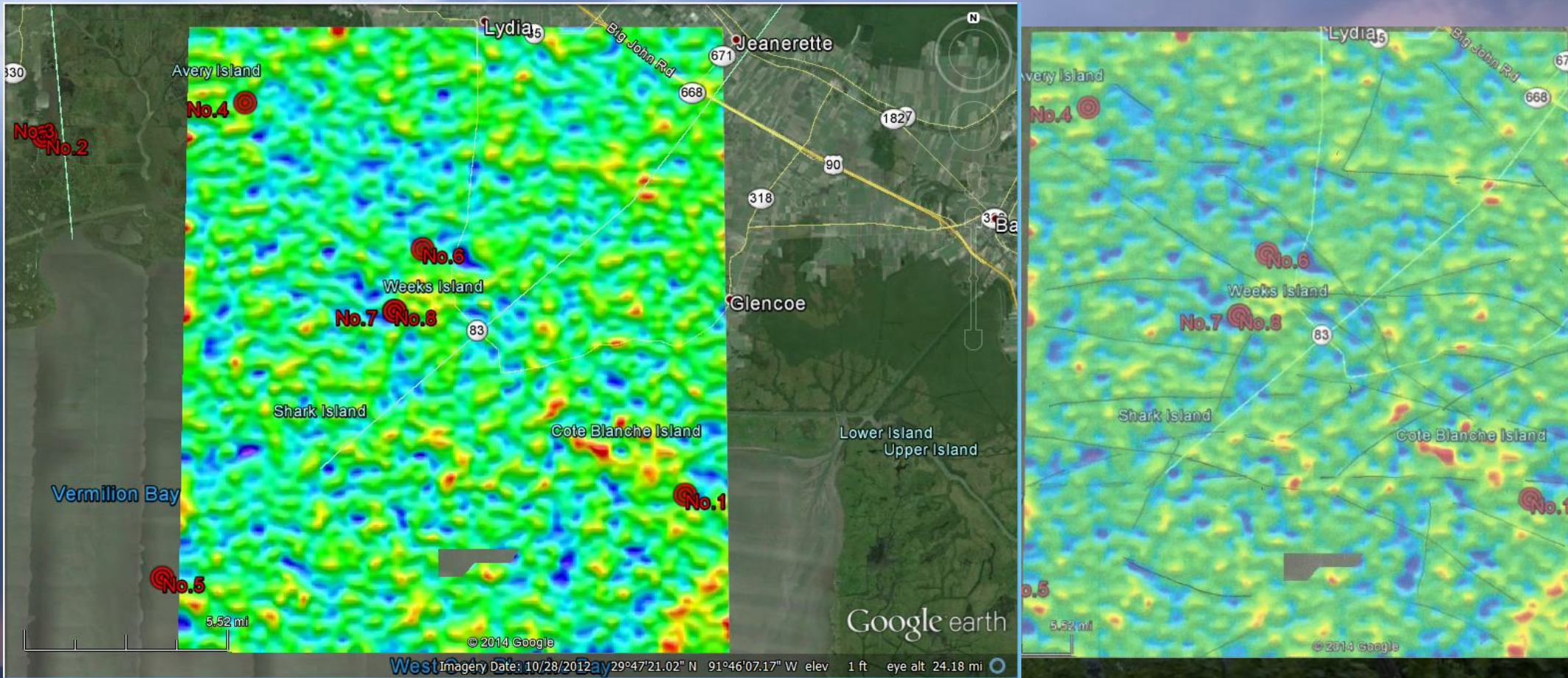
Lightning Attributes: Wavelet Symmetry (left) Rate-of-Rise-Time (right)

and Paleo Channels,



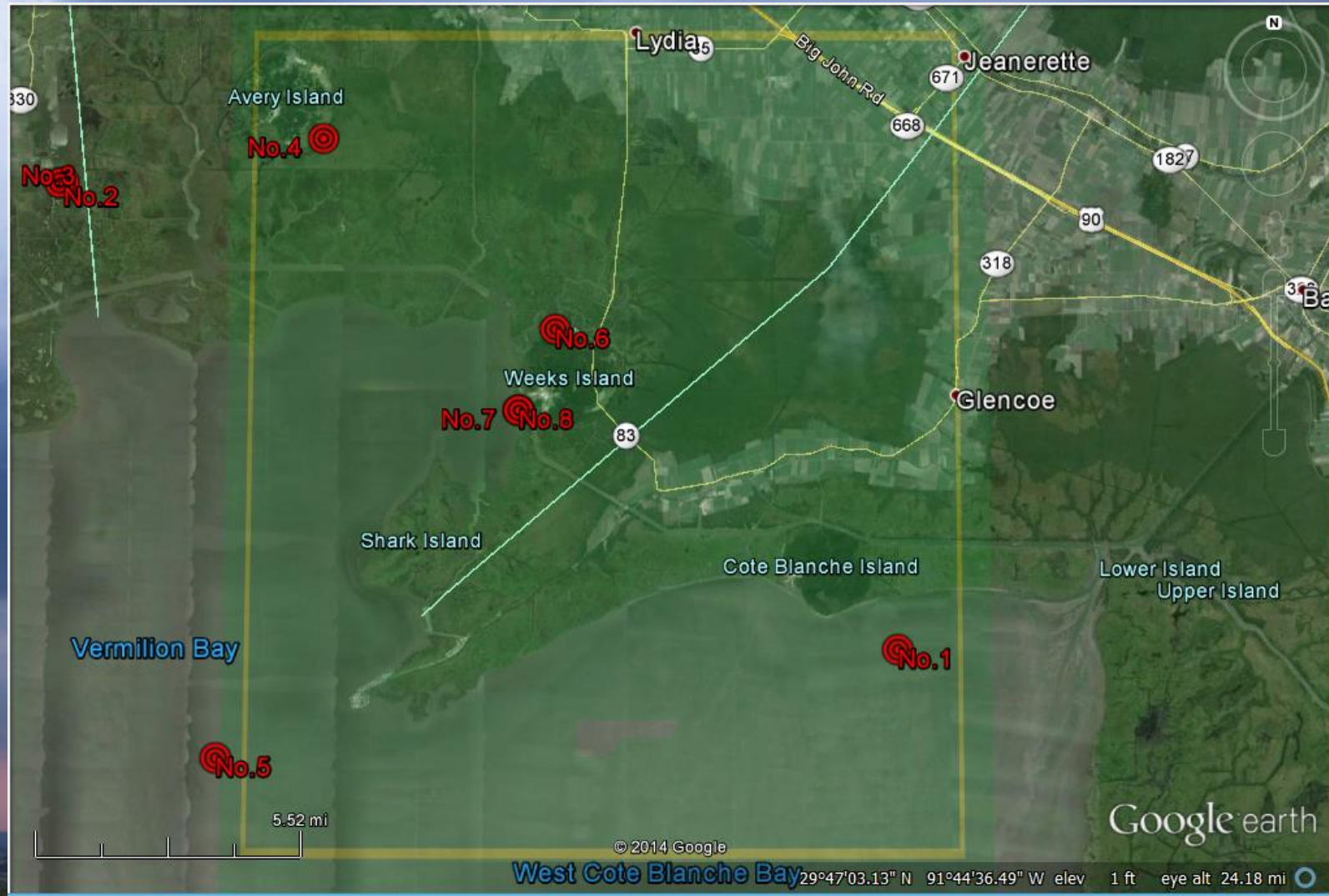
Lightning Attributes: Rise-Time (left) Rise-Time Interpretation (right)

and Integrated Structural and Stratigraphic Frameworks.



Lightning Attributes: Total Wavelet Time (left) Interpretation (right)

LGS & SIPES Members Know Exploration Starts with Logs



Iberia Parish Wells to Test Lightning Correlation

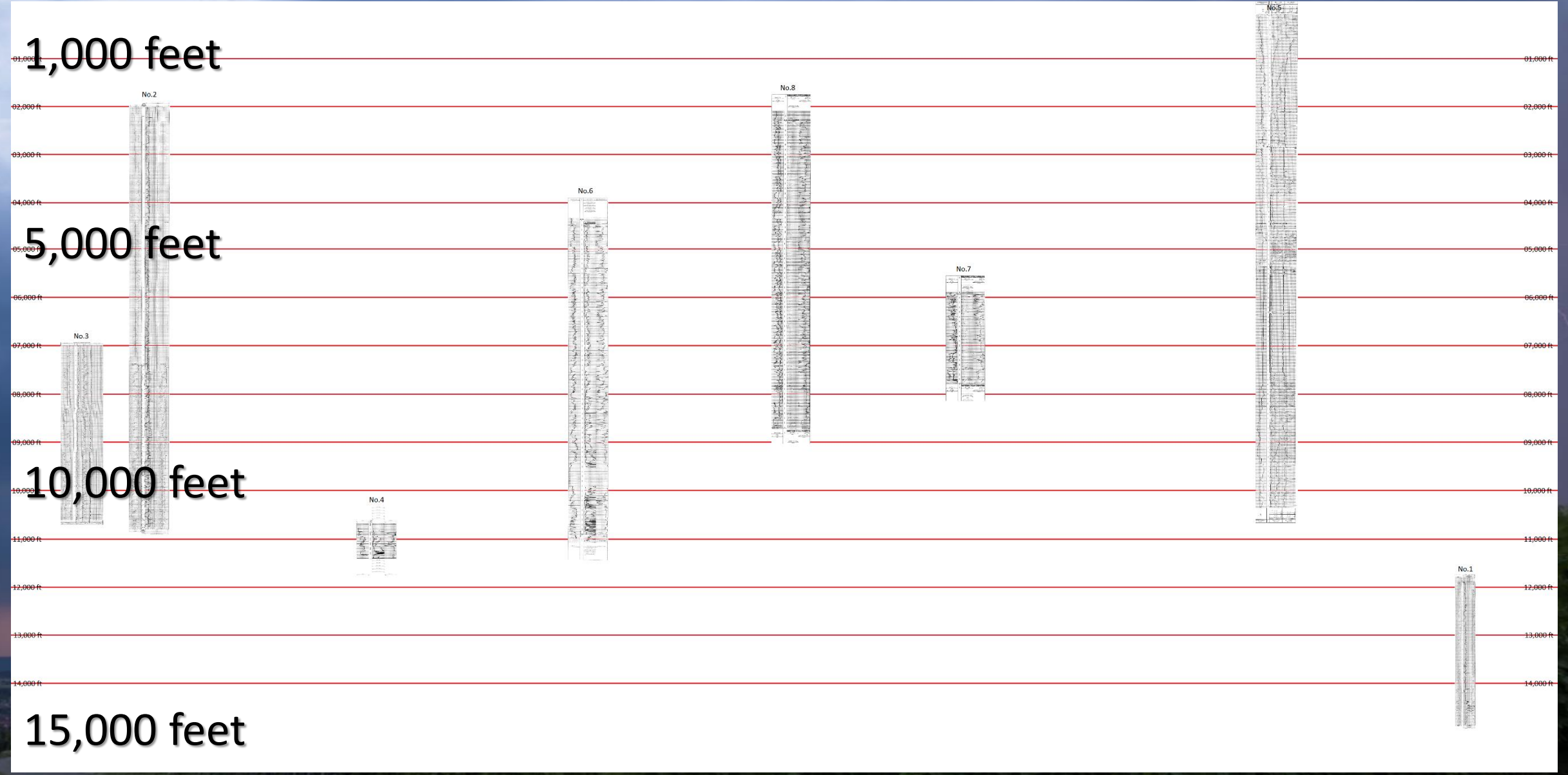
Log Cross-Section

1,000 feet

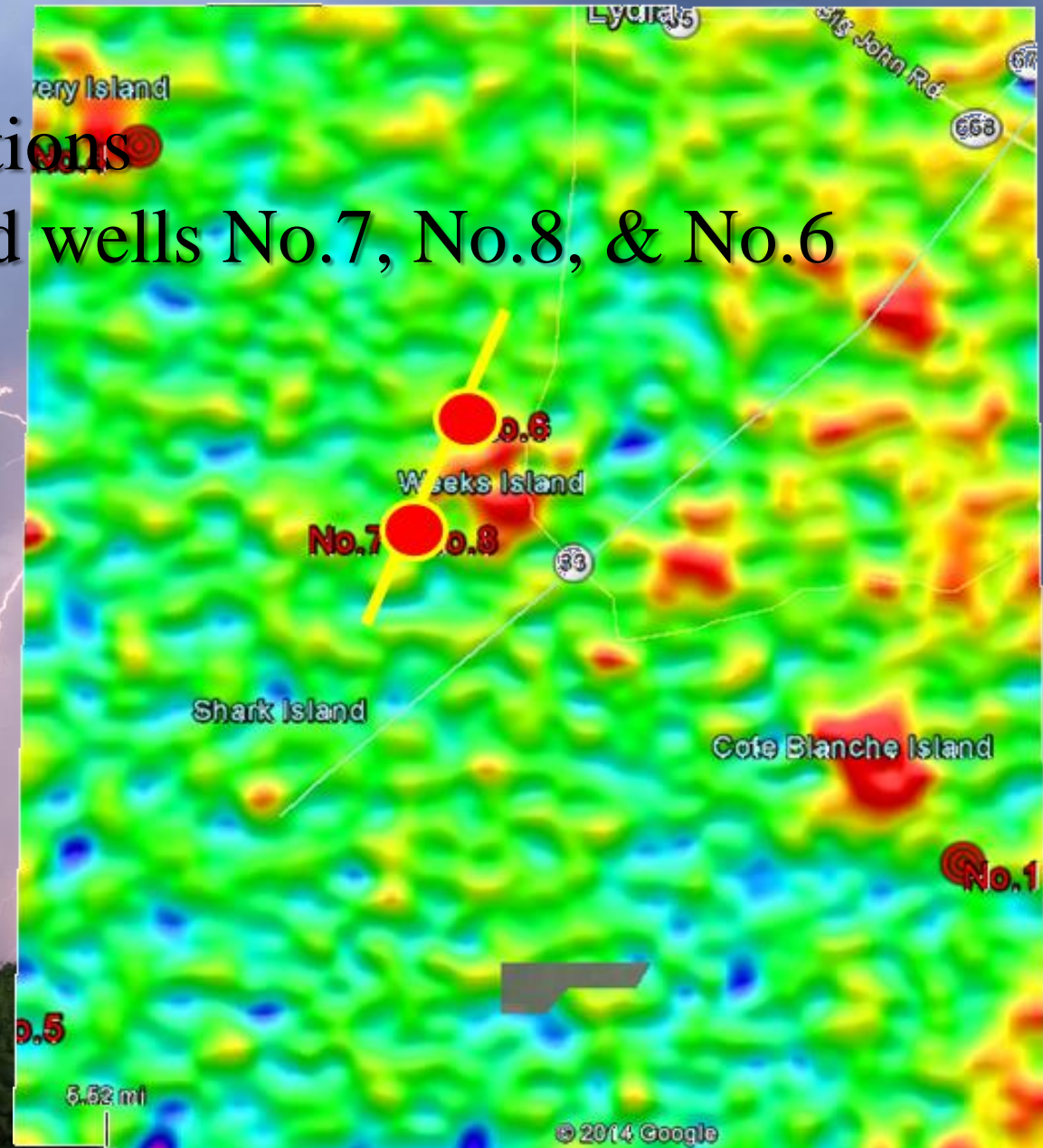
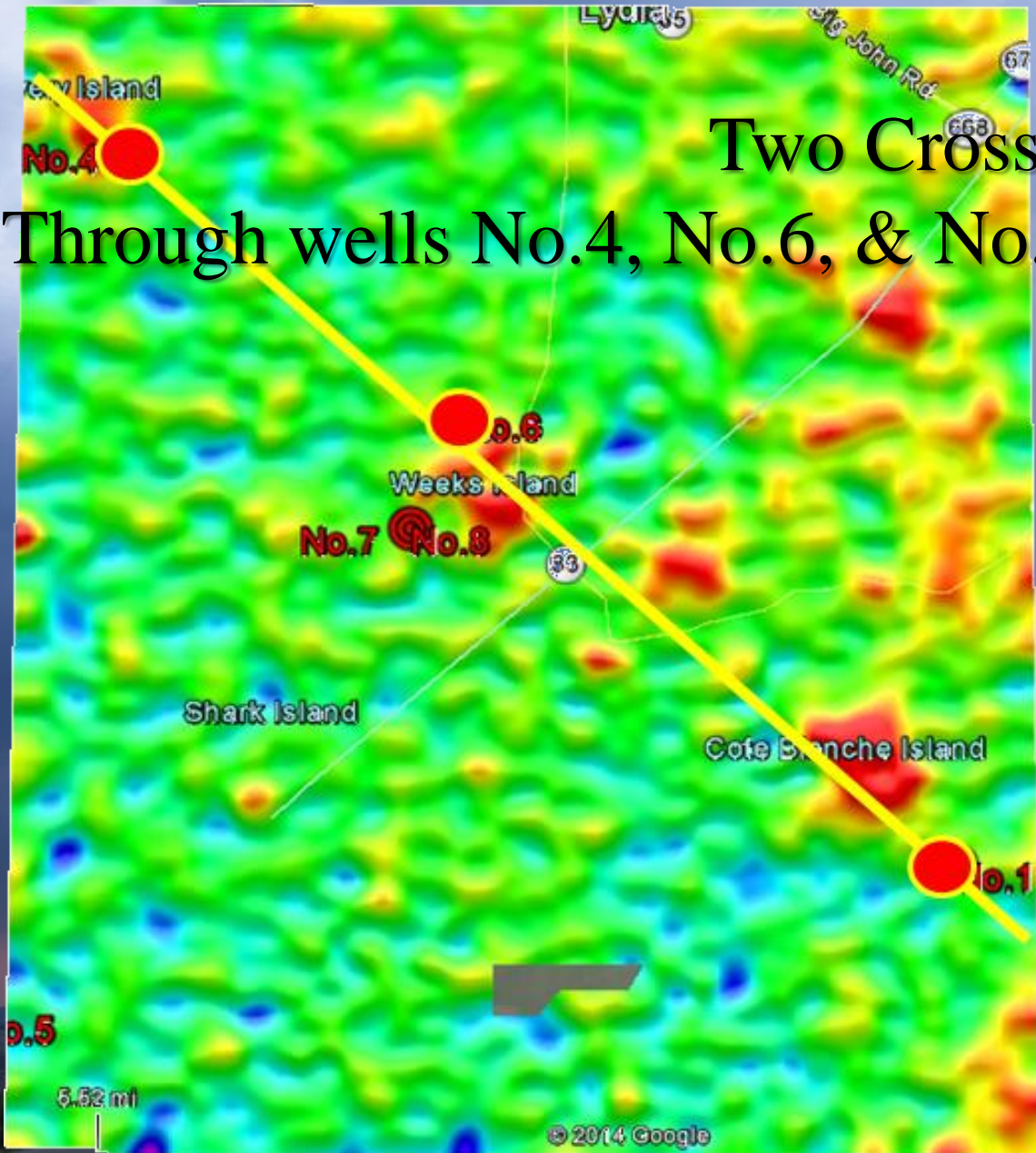
5,000 feet

10,000 feet

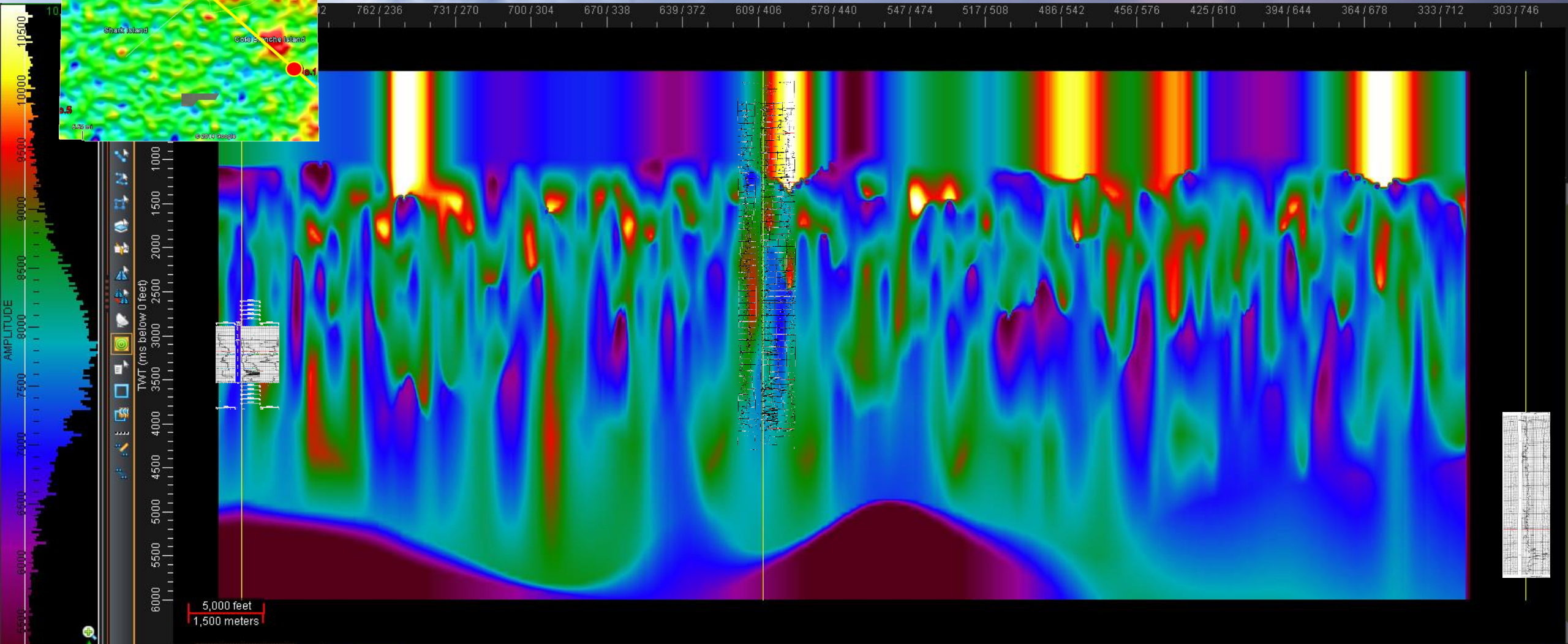
15,000 feet



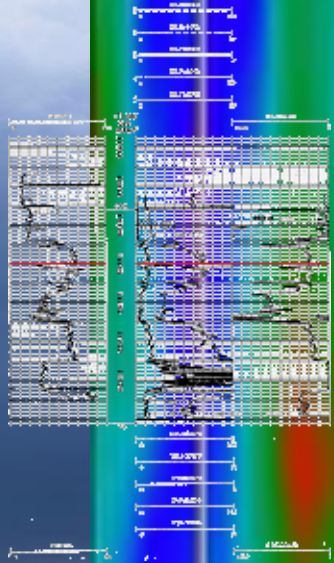
Two Cross-Sections Through wells No.4, No.6, & No.1 and wells No.7, No.8, & No.6



NW-SE Cross Section Through 3 Salt Domes and wells No.4, No. 6, and No.1

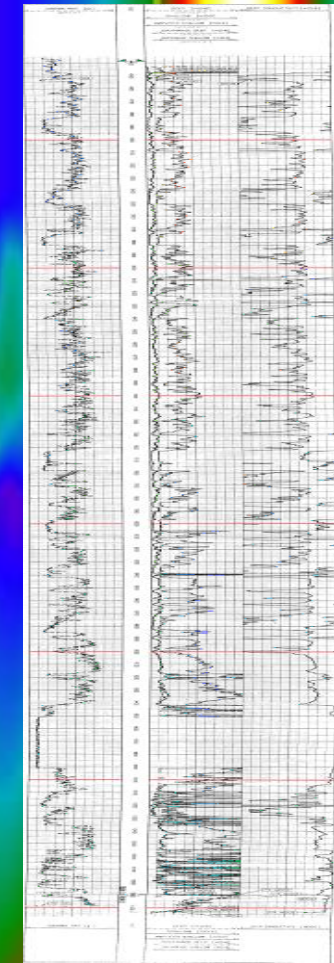
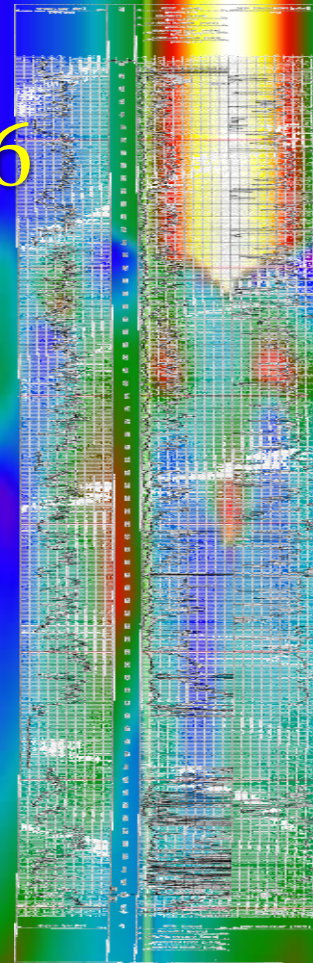


Zoom on No.4



&

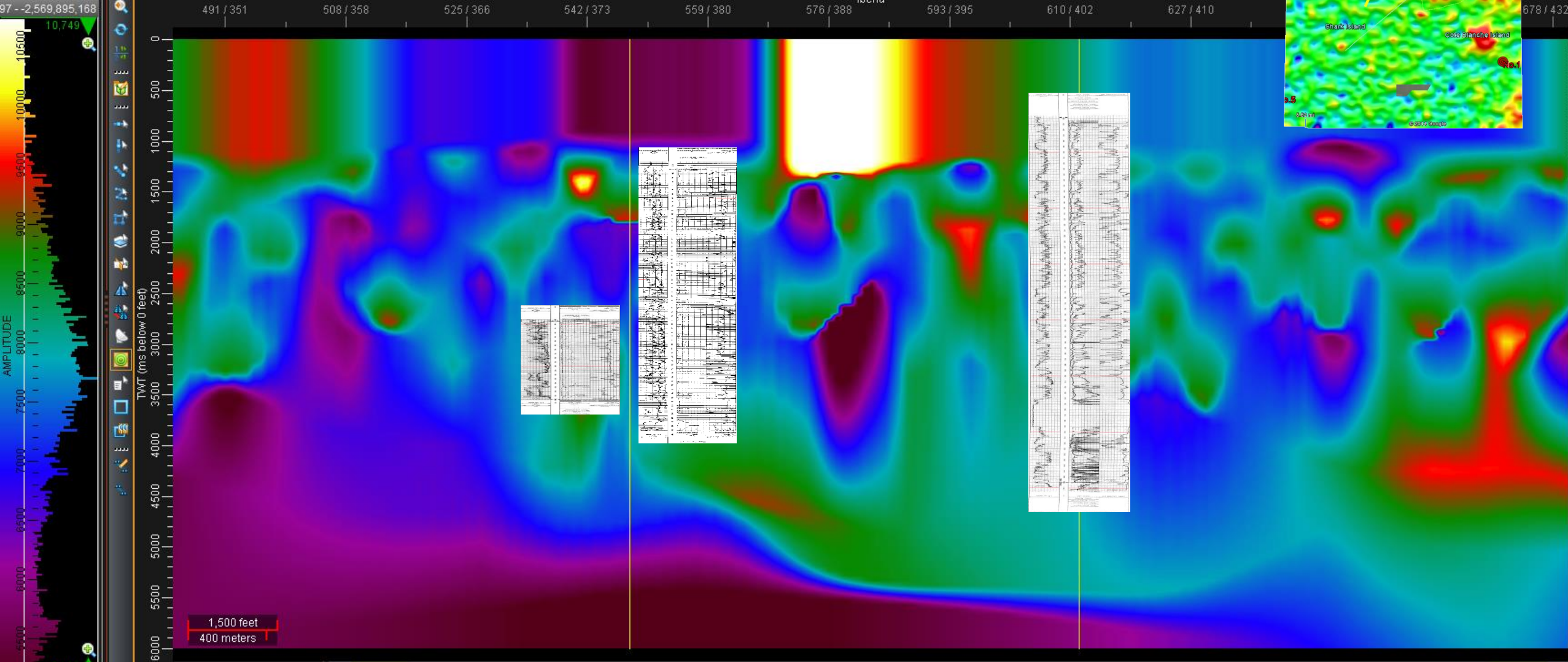
No.6



5,000 feet
1,500 meters

5,000 feet
1,500 meters

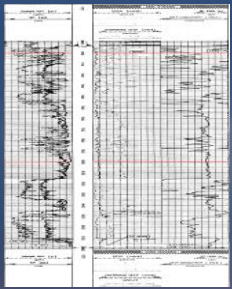
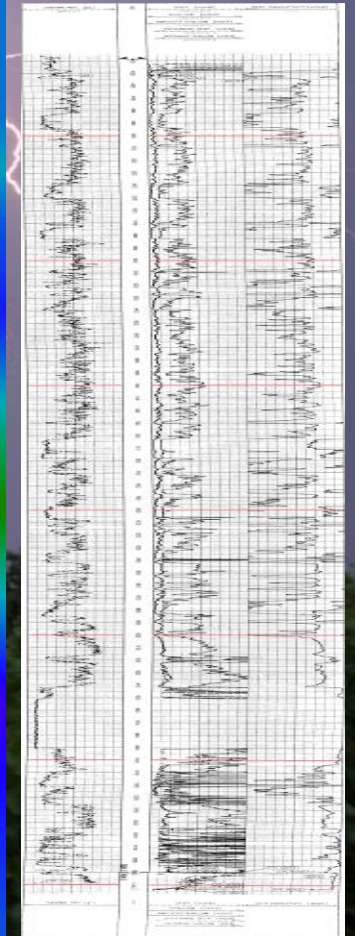
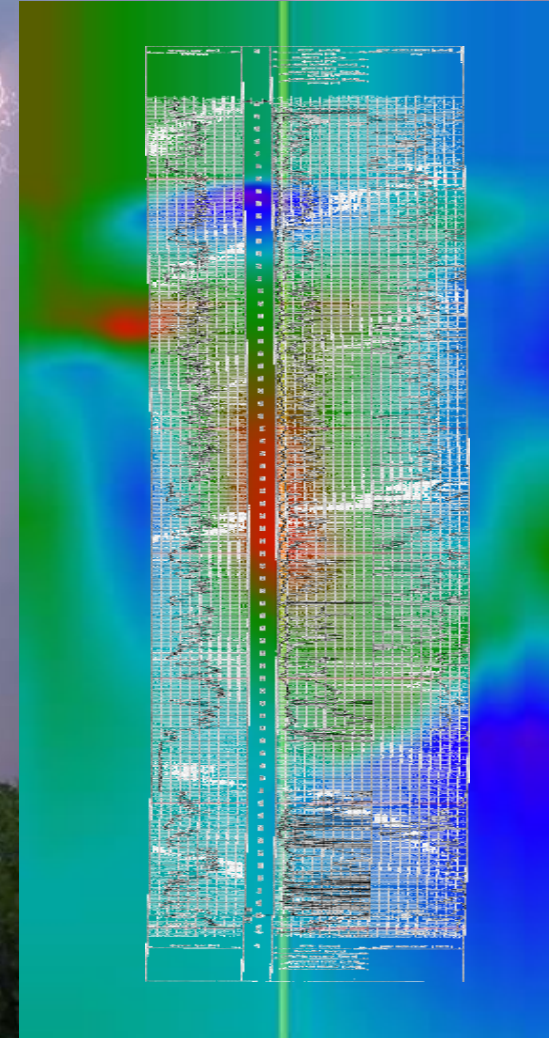
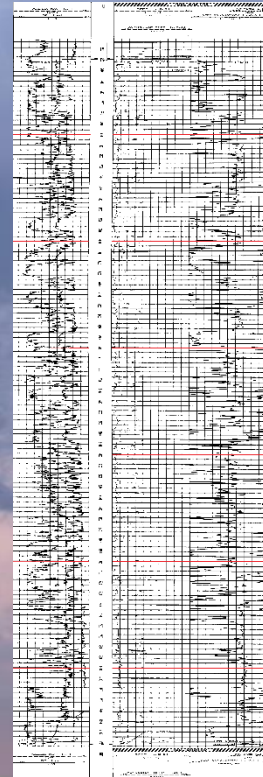
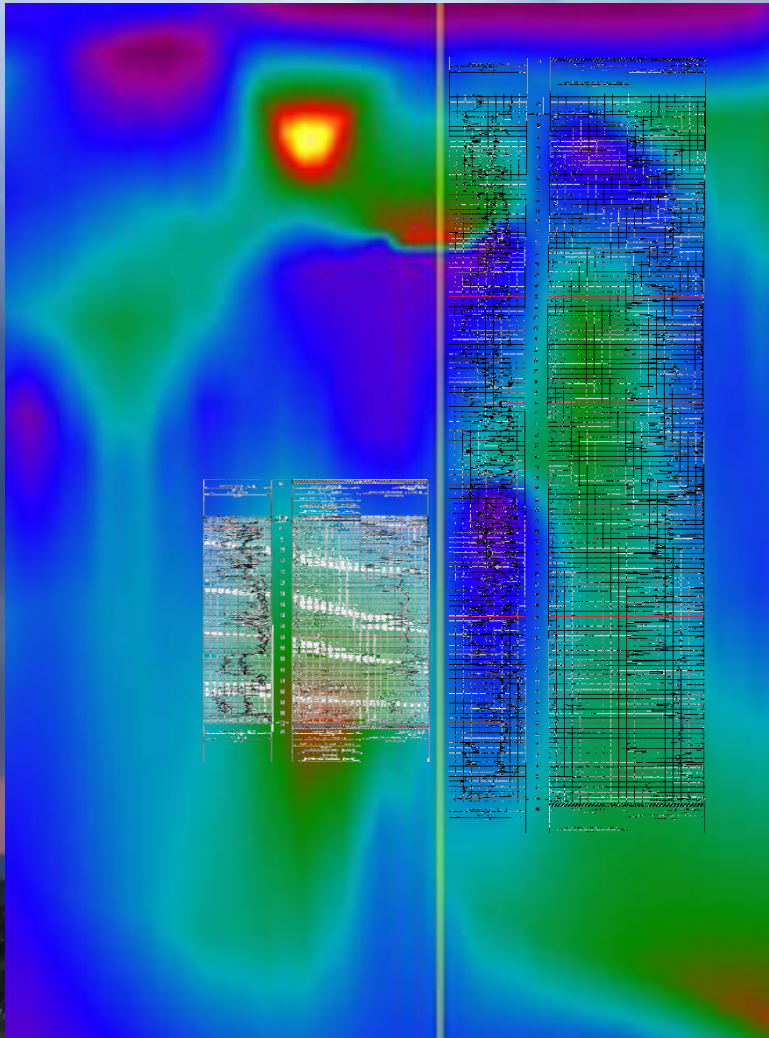
SW-NE Cross-Section Edge of Weeks Island Dome and wells No.7, No.8, and No.6



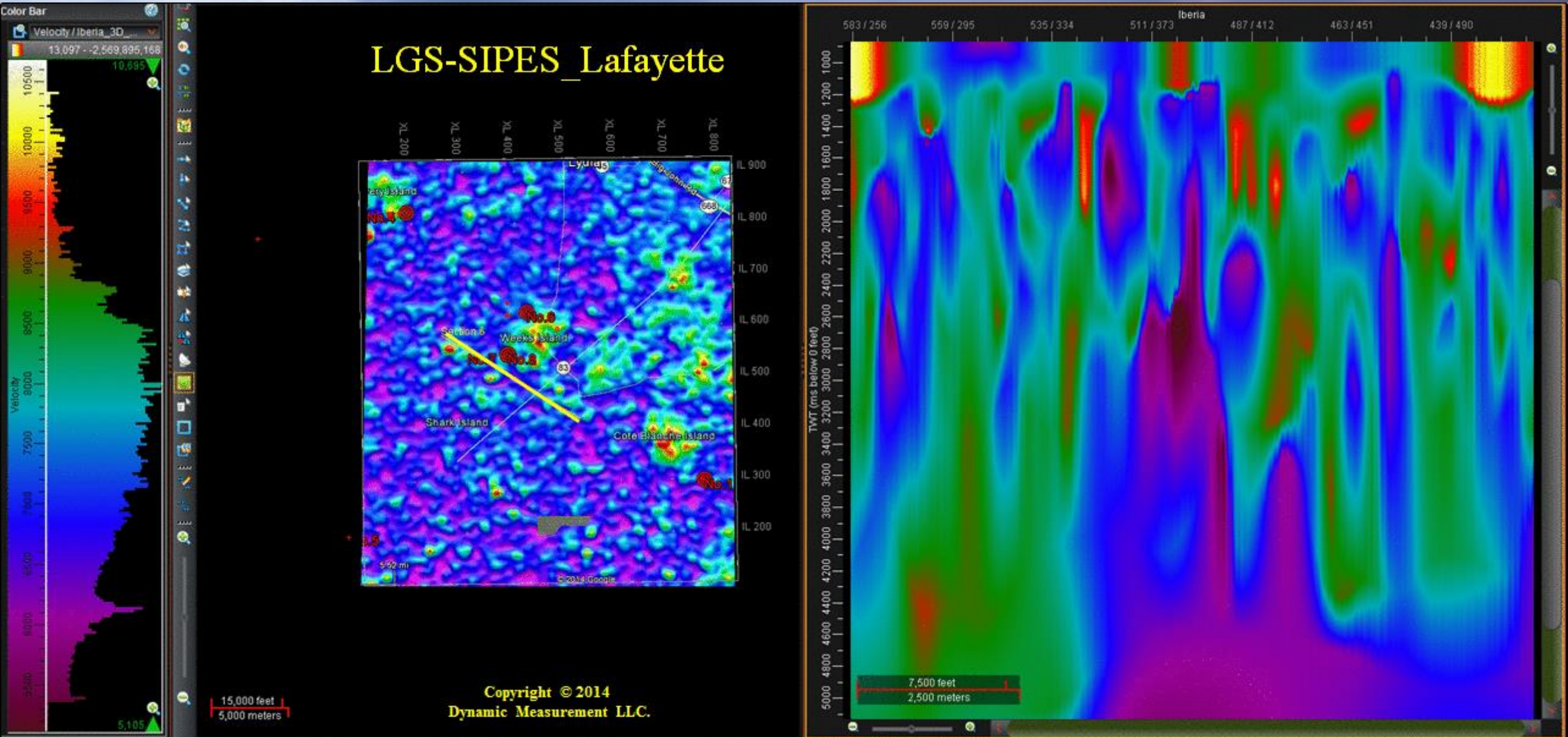
Zoom on No.7, No.8

&

No.6



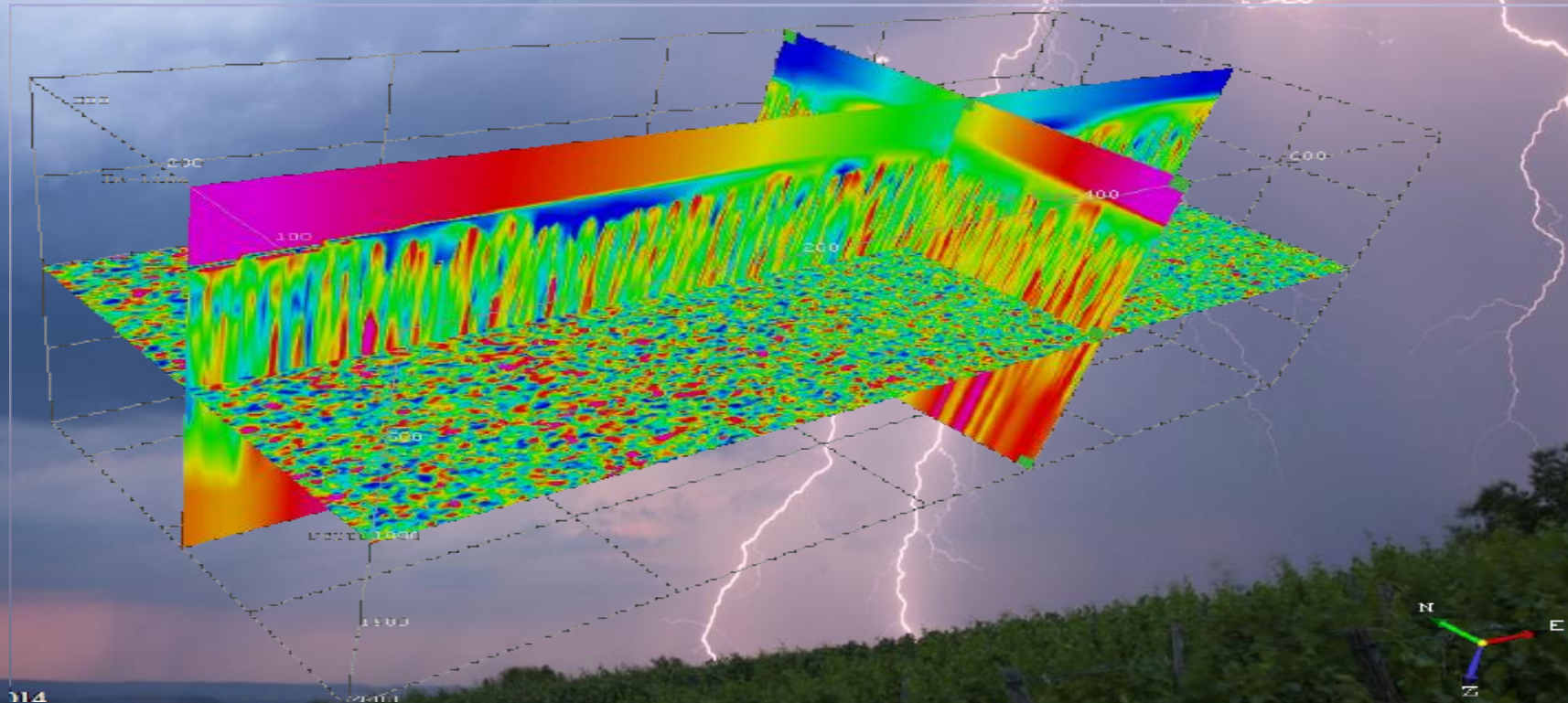
Movie of First Correlation of Logs & Resistivity Volumes



Find out more at <http://www.dynamicmeasurement.com>



Thank You!



See lightning, think DML!