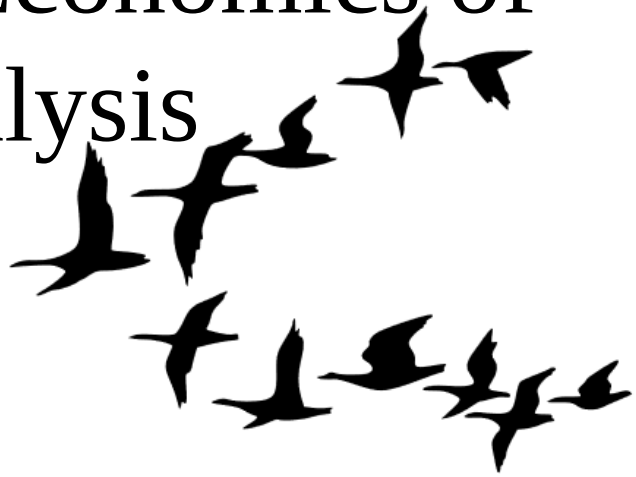
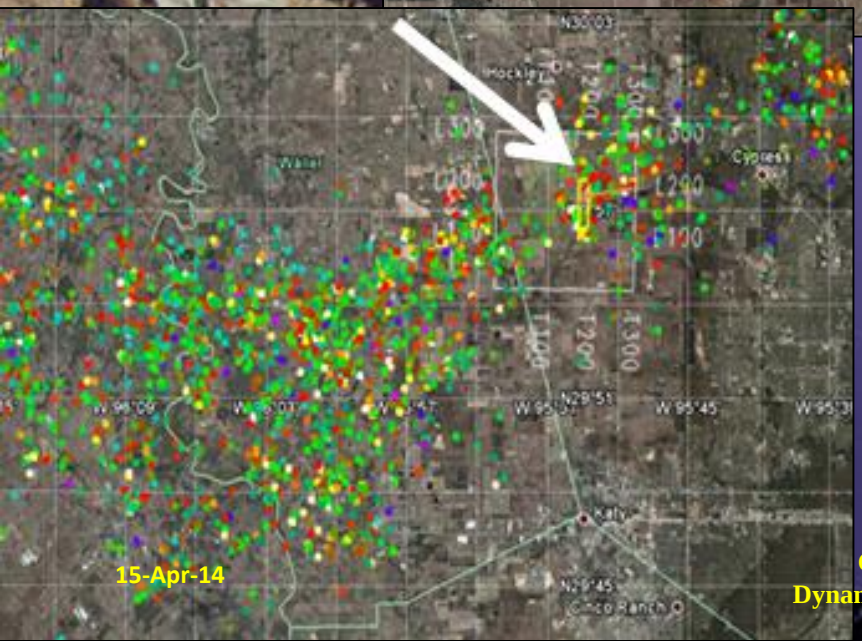
The Technology and Economics of Lightning Analysis



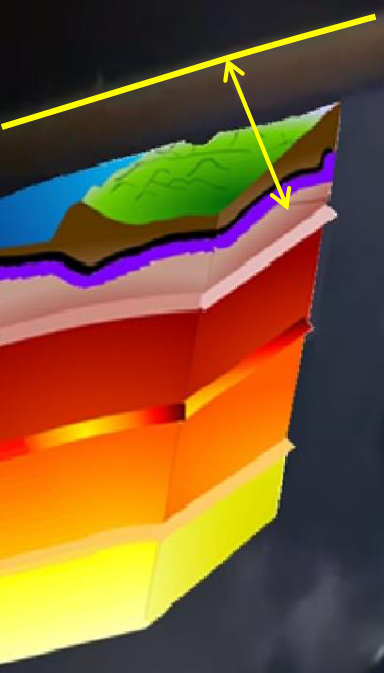
15 April 2014

H. Roice Nelson, Jr. & Kathy S. Haggar

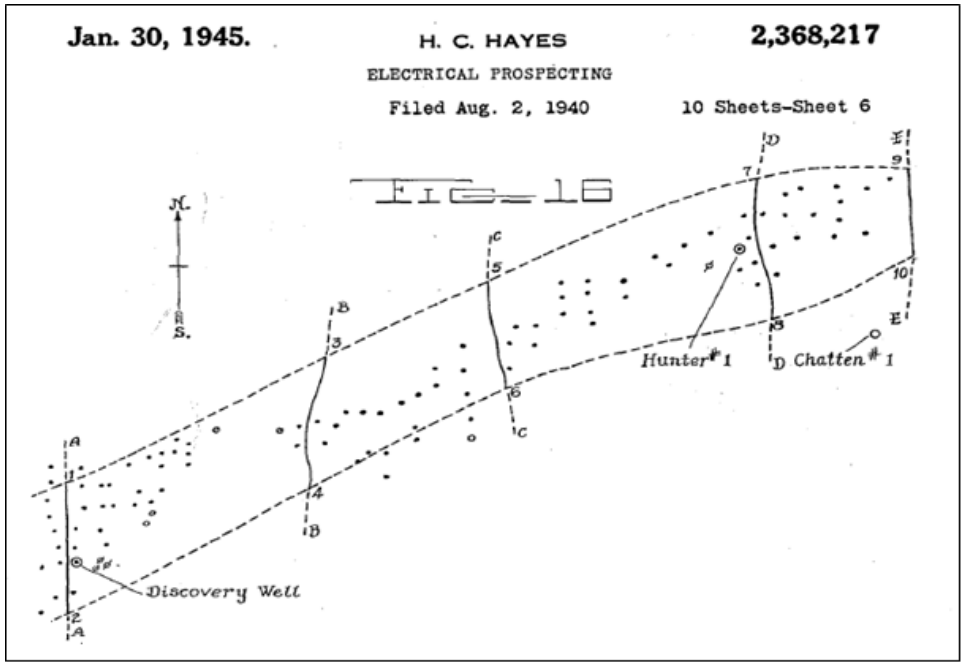
A Texas Duck Hunting Story

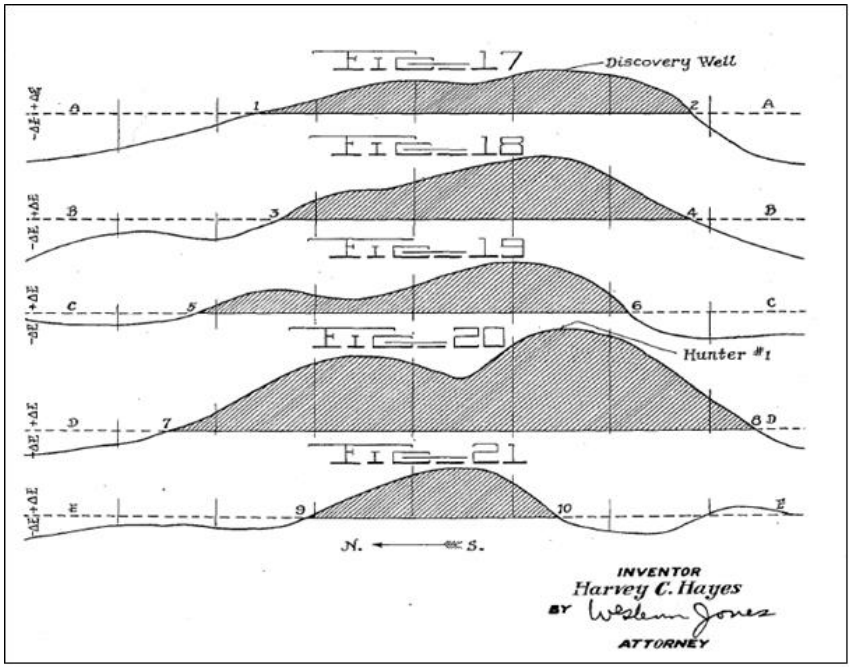


Lightning balances Earth's capacitor

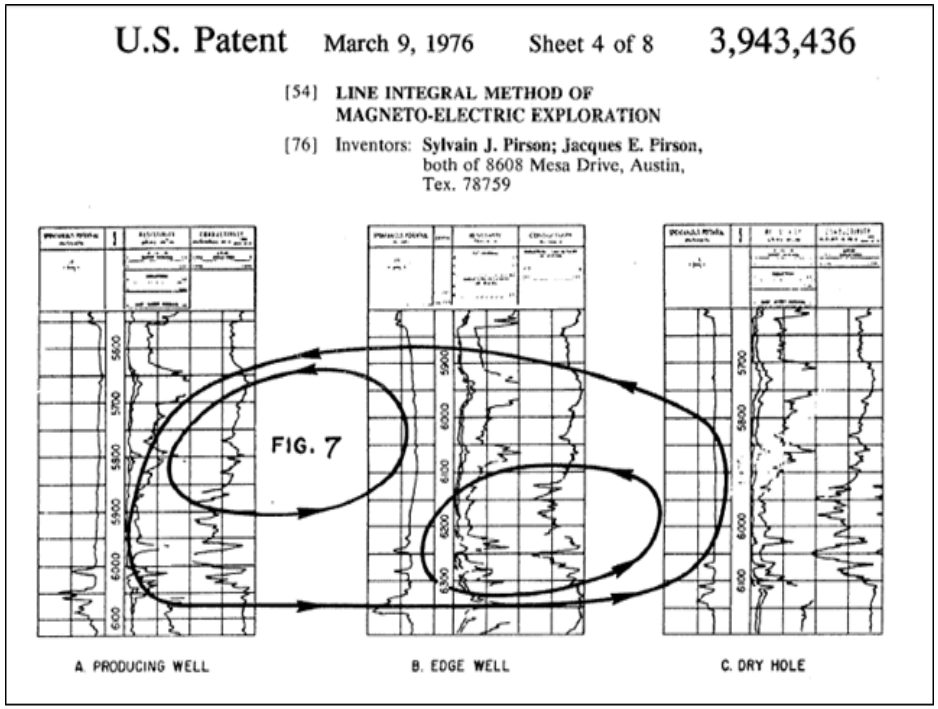


Earth Resistivity Profiles
(Hayes, 1945)





Electrotelluric Currents
(Pirson and Pirson, 1976)


U.S. Patent March 9, 1976 Sheet 4 of 8 3,943,436

[54] LINE INTEGRAL METHOD OF MAGNETO-ELECTRIC EXPLORATION

[76] Inventors: Sylvain J. Pirson; Jacques E. Pirson, both of 8608 Mesa Drive, Austin, Tex. 78759

FIG. 7

A. PRODUCING WELL B. EDGE WELL C. DRY HOLE

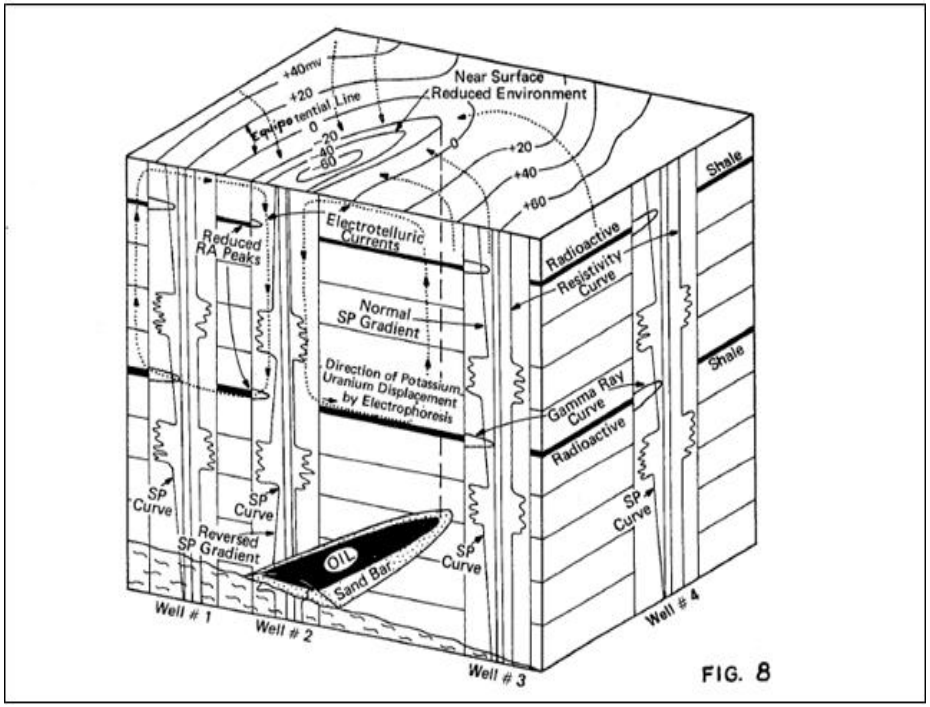
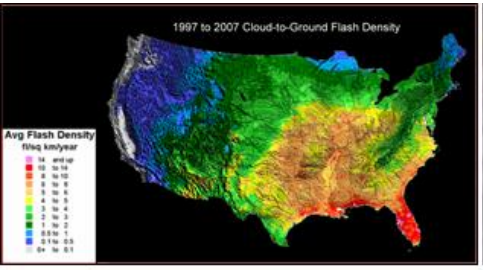
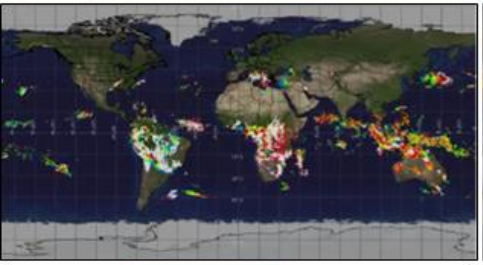


FIG. 8

Terralevis (shallow earth) Currents

Lightning occurs everywhere and is available in private and public databases





Collecting Lightning Data

WHY?

- Early storm warning
- Safety
- Meteorology
- Insurance
- Energy & Natural Resources

Collecting Lightning Data

WHY?

- Early storm warning
- Safety
- Meteorology
- Insurance
- Energy & Natural Resources

WHAT?

- Location
- Time and Duration
- Rise Time
- Peak Current
- Peak-to-Zero
- Total Wavelet Time
- Wavelet Symmetry
- Polarity
- Chi Squared
- Number of Sensors

Collecting Lightning Data

WHY?

- Early storm warning
- Safety
- Meteorology
- Insurance
- Energy & Natural Resources

WHAT?

- Location
- Time and Duration
- Rise Time
- Peak Current
- Peak-to-Zero
- Total Wavelet Time
- Wavelet Symmetry
- Polarity
- Chi Squared
- Number of Sensors

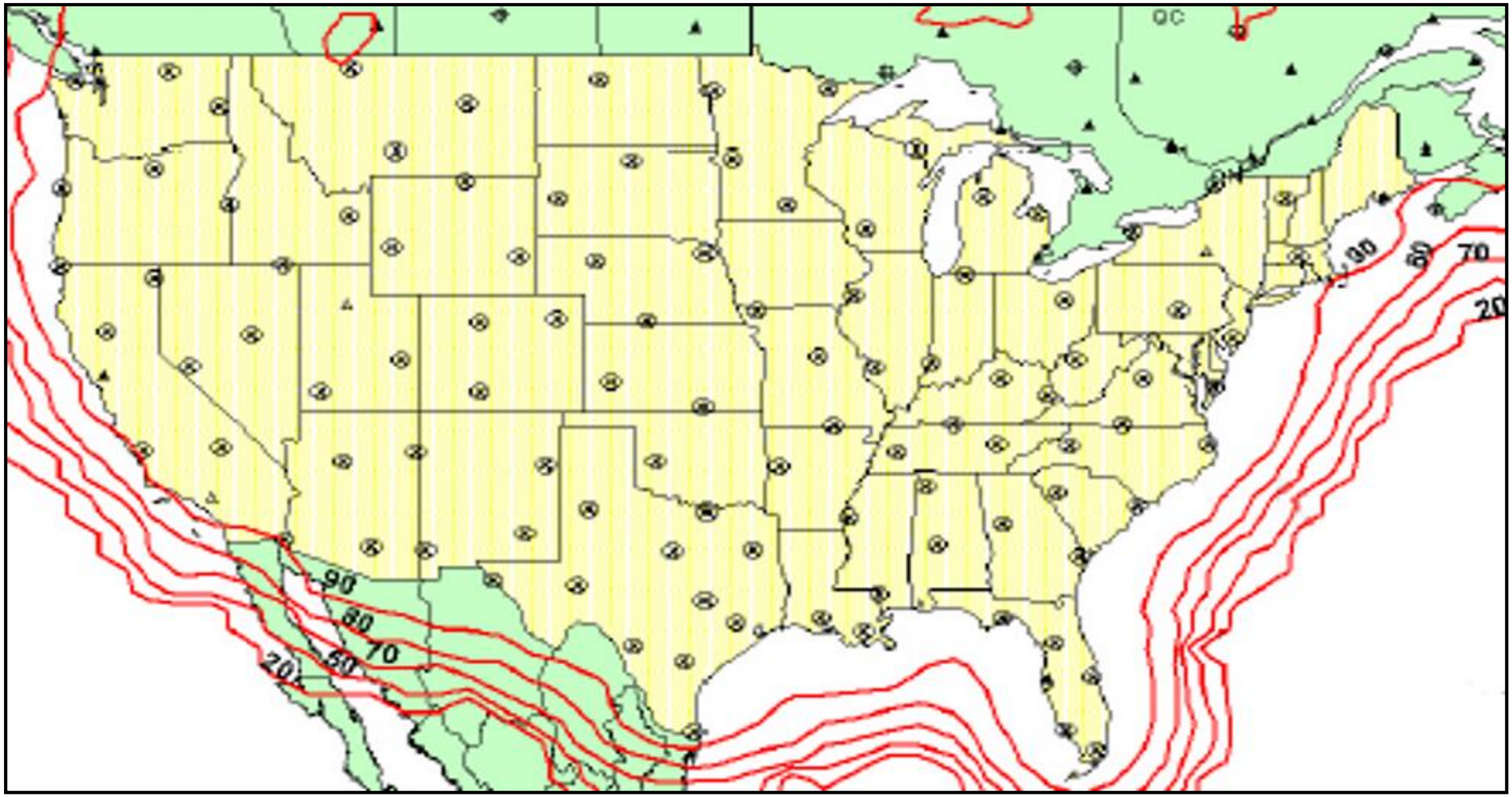
HOW?

~330 Sensors in U.S.

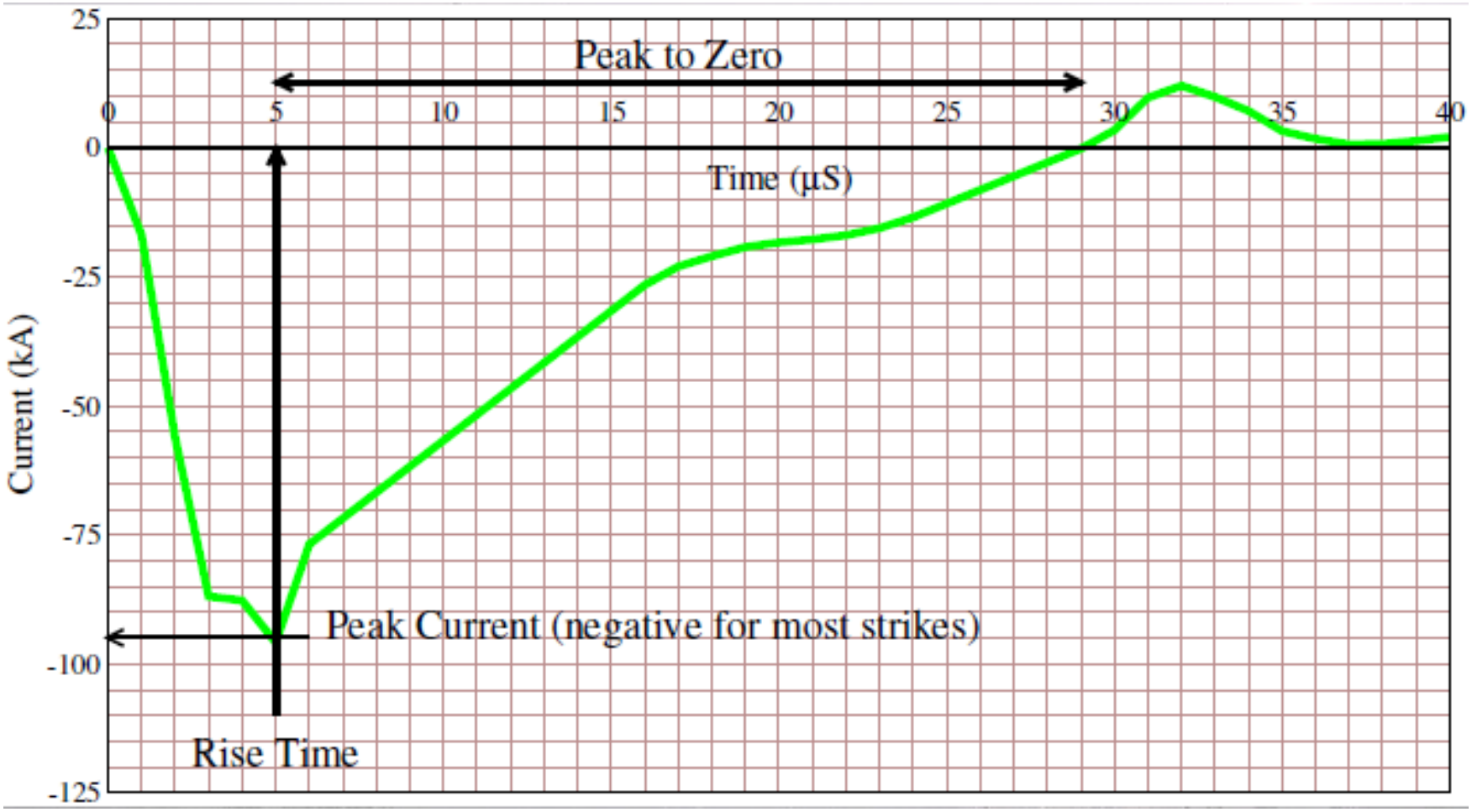
+/- 100-500 foot location resolution

NLDN

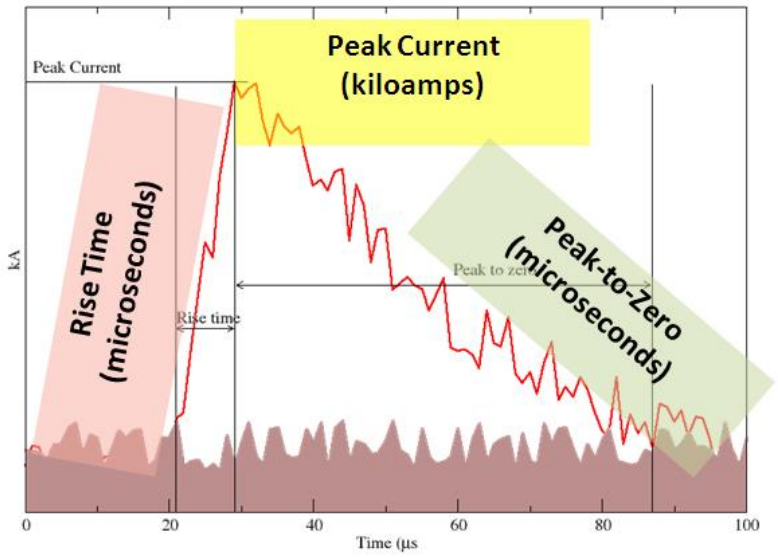
(National Lightning Detection Network)

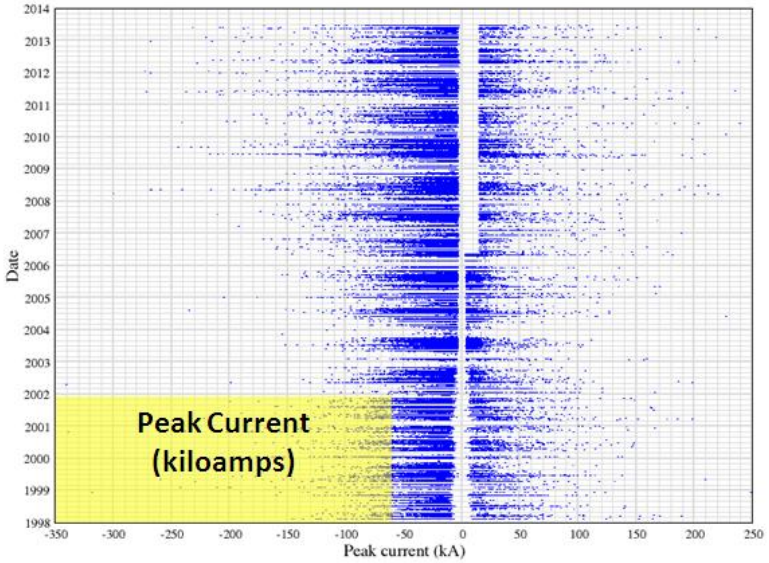


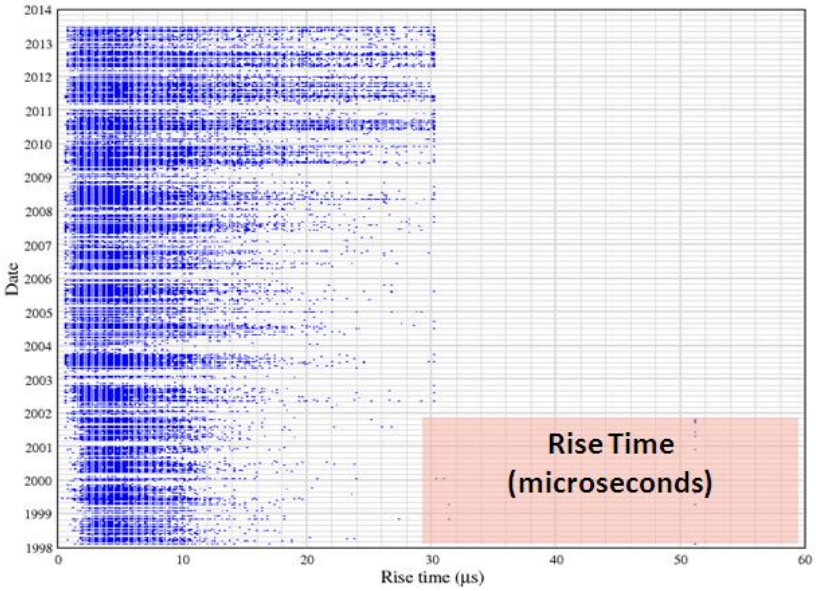
Recorded Lightning Data

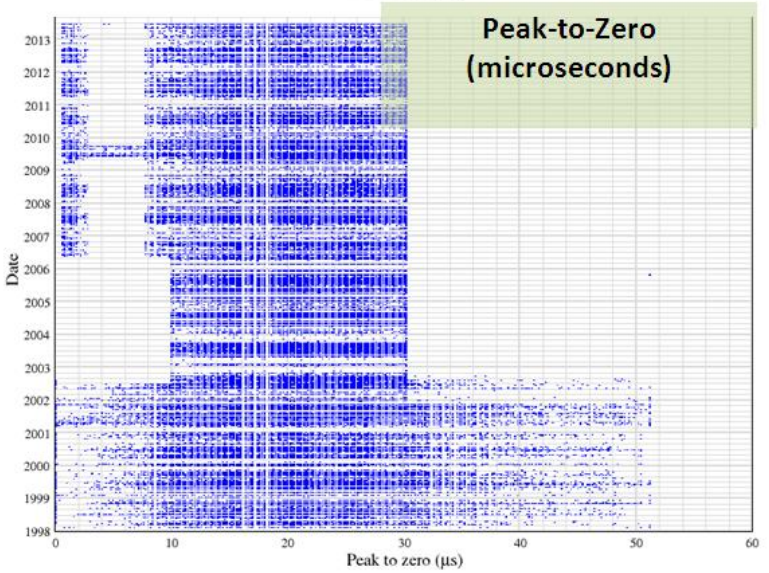


Recorded Lightning Data

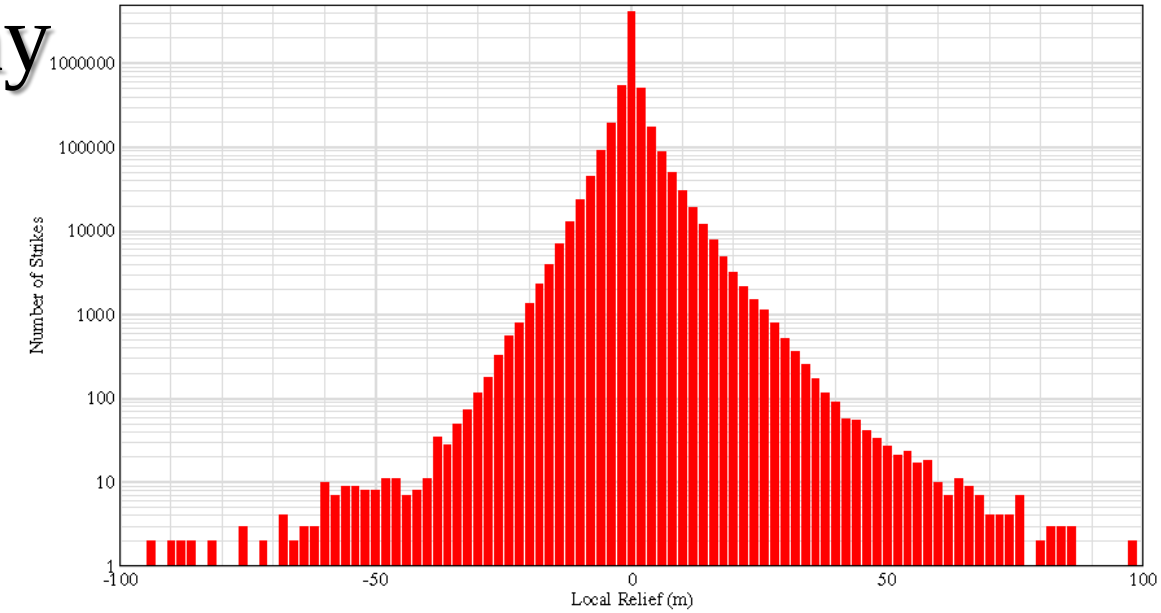


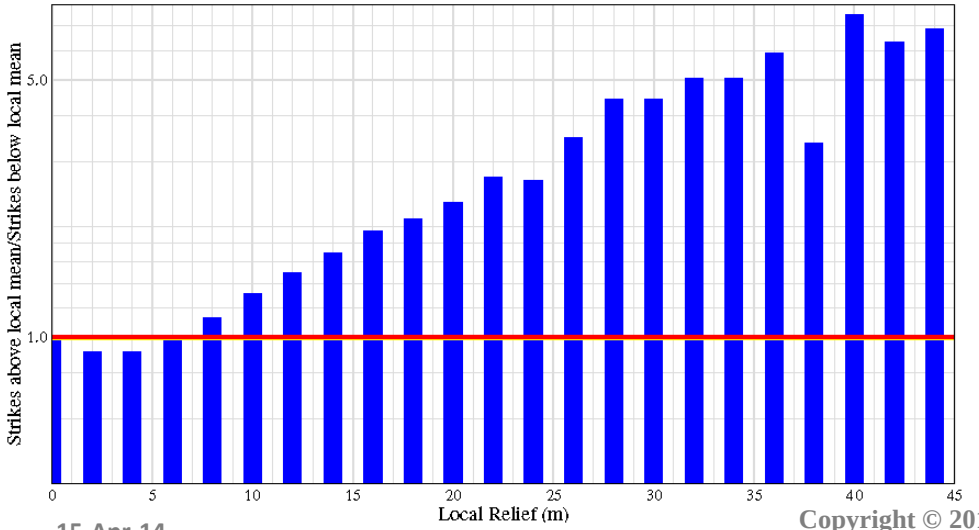






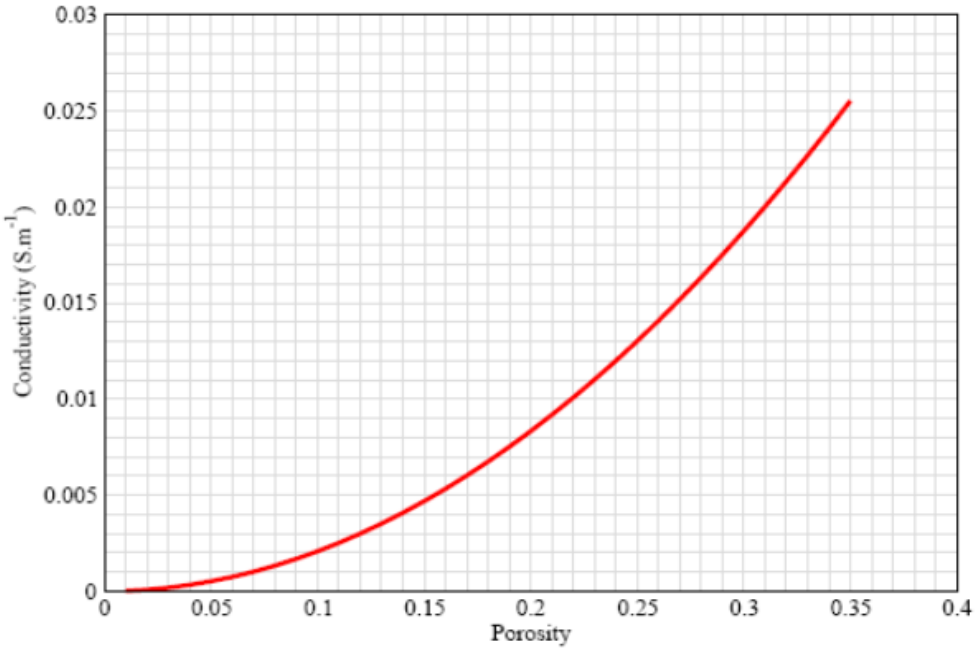
Lightning Strikes and Topography





Lightning travels up to 250 km Cloud-to-Cloud, then goes to ground

Air Conductivity & Rock Conductivity Graph



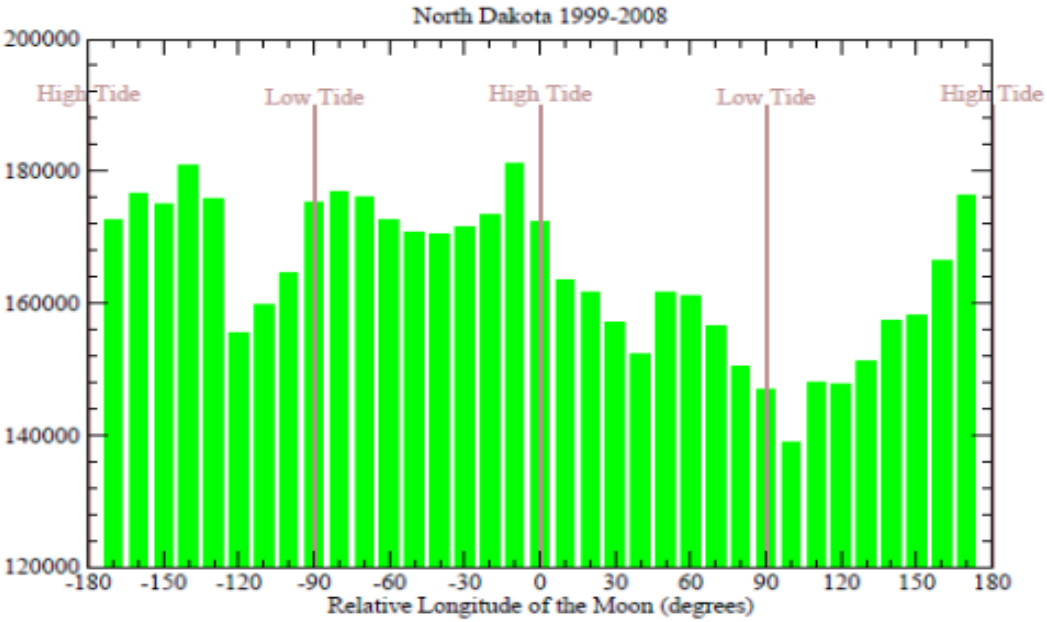
Electrical conductivity of air:
0.3-0.8 * 10^{-14} Siemens per Meter

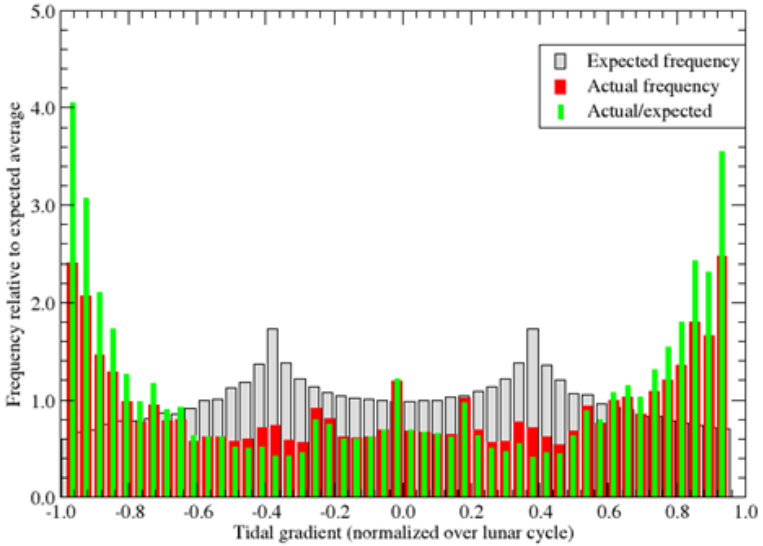
Lightning & Electrical Lines

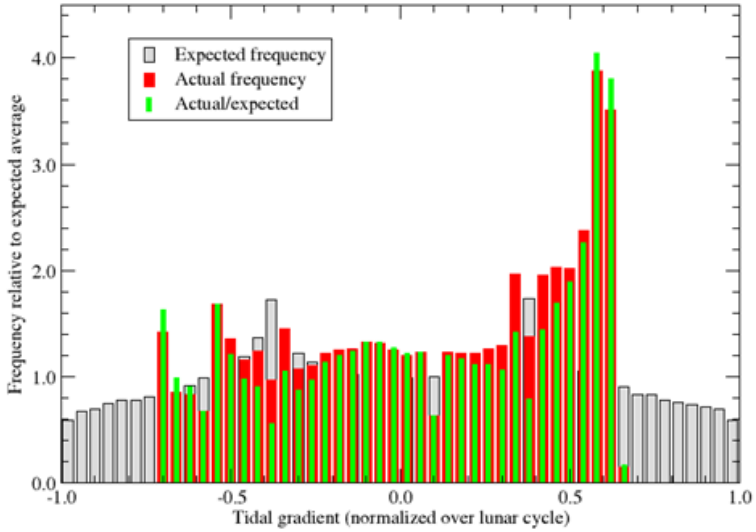
Is it the line or the geology?

Proactive protecting of pipelines from corrosion

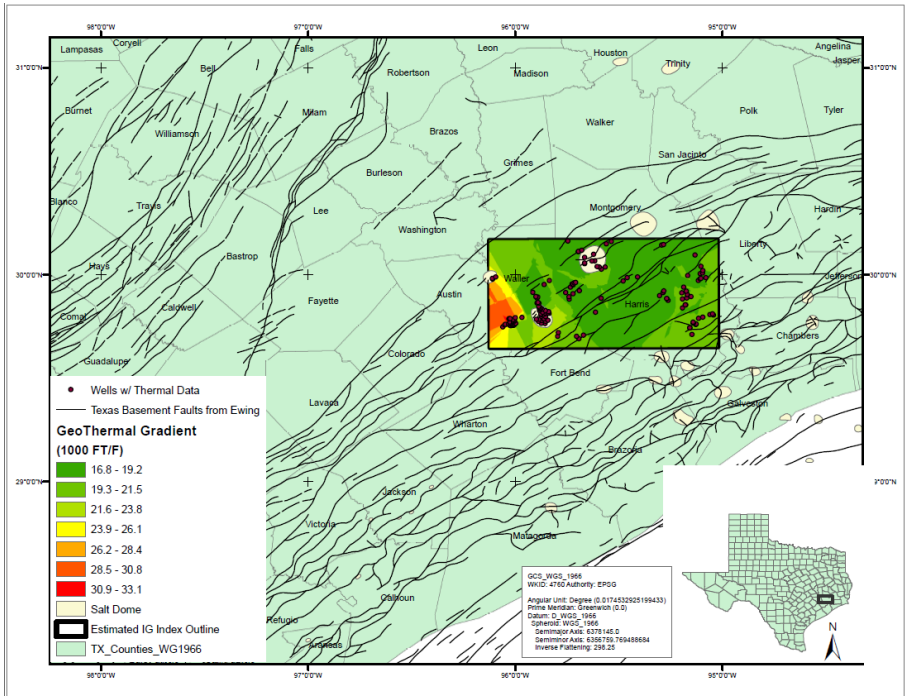
Lightning Strikes and Earth Tides

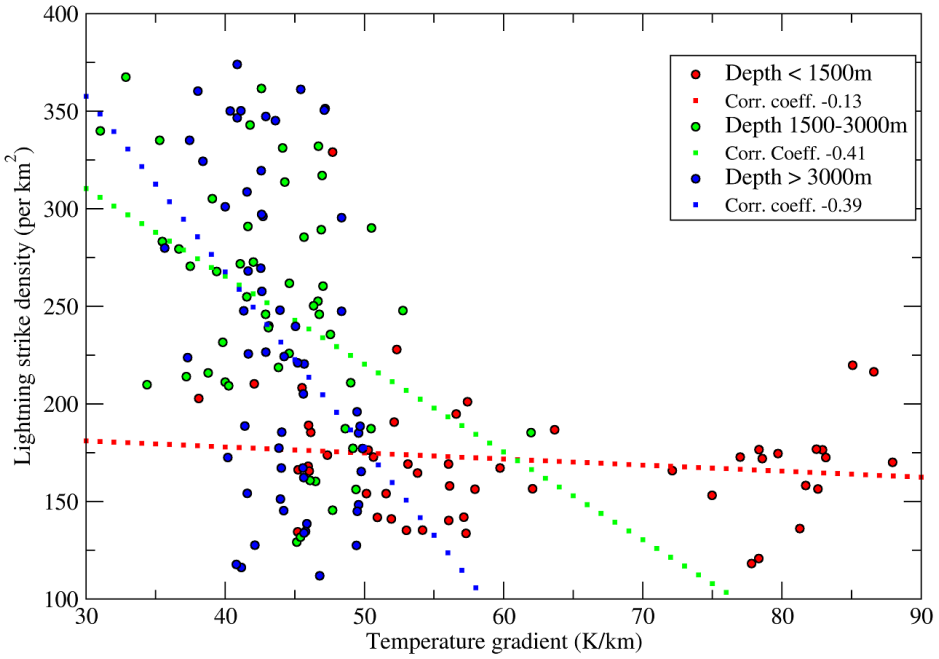




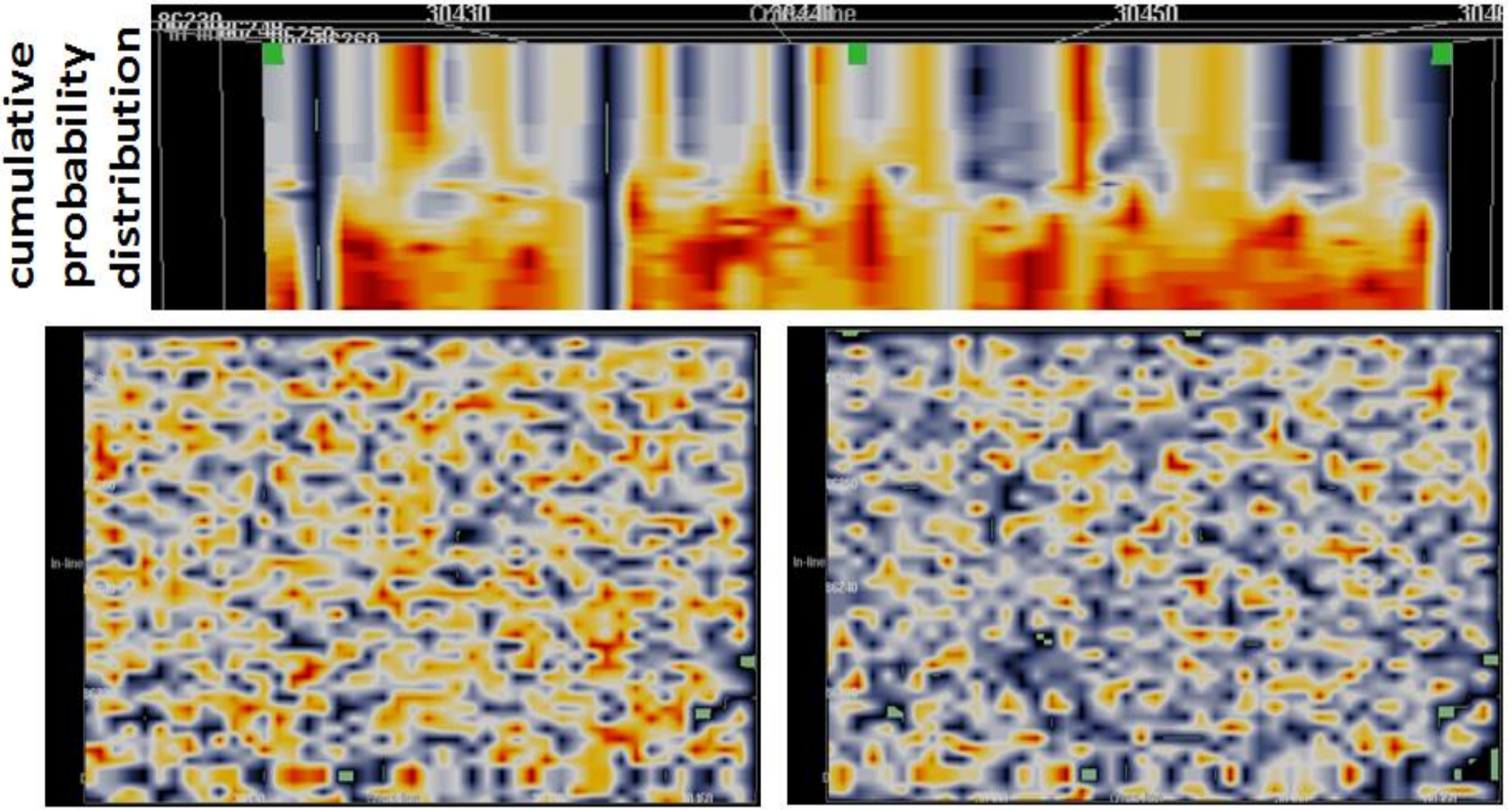


Integration of Lightning Data with Geothermal Gradient





Surface Resistivity and Resistivity Volumes



Lightning Clusters and clusters are somewhat consistent over time

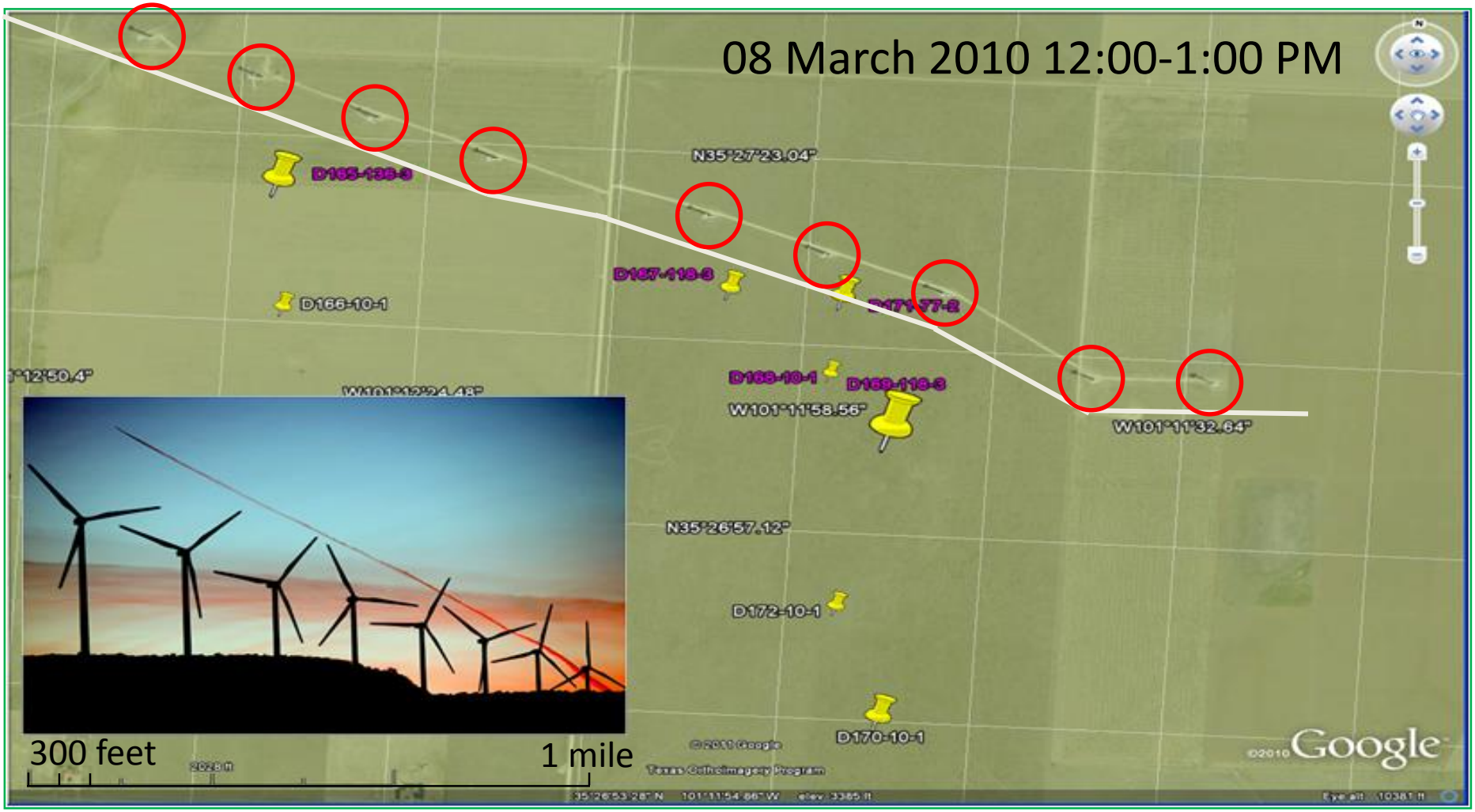
- DML has a worldwide exclusive license to use lightning data for natural resource exploration

  (15 years U.S., 3 years worldwide).

- DML has a methodology patent for using lightning data to explore for natural resources, issued 01 January 2013.

- DML has experience and a history of creativity and innovation which can be leveraged by early customers.

Budah Limestone Analysis
2.5 x 1.25 miles = 3.125 sq. mi.



Lightning Analysis US$14,500.

E17 | 3.125

DML Decimal Longitude & Latitude Calculator

Enter Minutes:		Enter Seconds:		Decimal Calculation:	0

DML Area Calculator from Longitude & Latitude Input

Data Entry Red Cells (decimal longitude & latitude), Calculations/Parameters Yellow Cells, Results Green Cells

NW Corner Longitude:		W (km)	0.000000	Radius:	6367444.5
NW Corner Latitude:		E (km)	0.000000	M2F:	0.30480061
NE Corner Longitude:	0	N (km)	0.000000	F2Mi:	5280
NE Corner Latitude:	0	S (km)	0.000000	Area (sq km)	0
SW Corner Longitude:	0	W (mi)	0.000000		
SW Corner Latitude:	0	E (mi)	0.000000		
SE Corner Longitude:		N (mi)	0.000000		
SE Corner Latitude:		S (mi)	0.000000	Area (sq mi)	0

DML Lightning Analysis Project Price Calculator

Enter Area (sq. km.):		Enter Area (sq. mi.):	3	Enter Area (acres):	
Area (sq. km)	8			Price ($US):	$14,446.81

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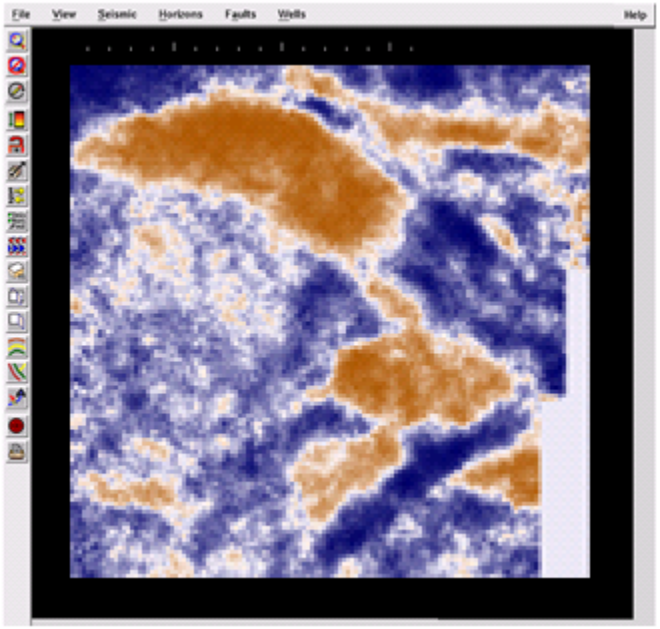
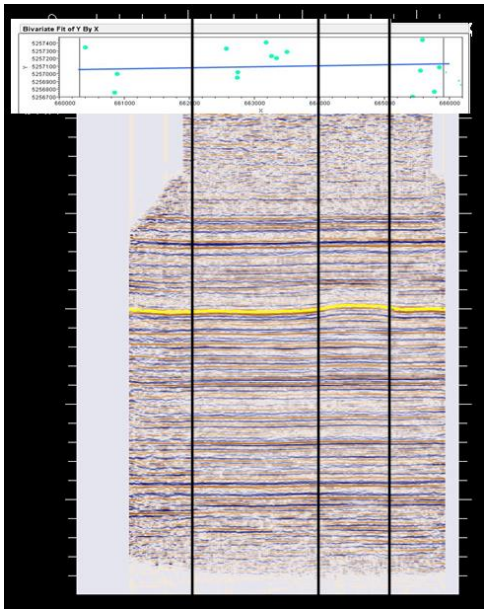
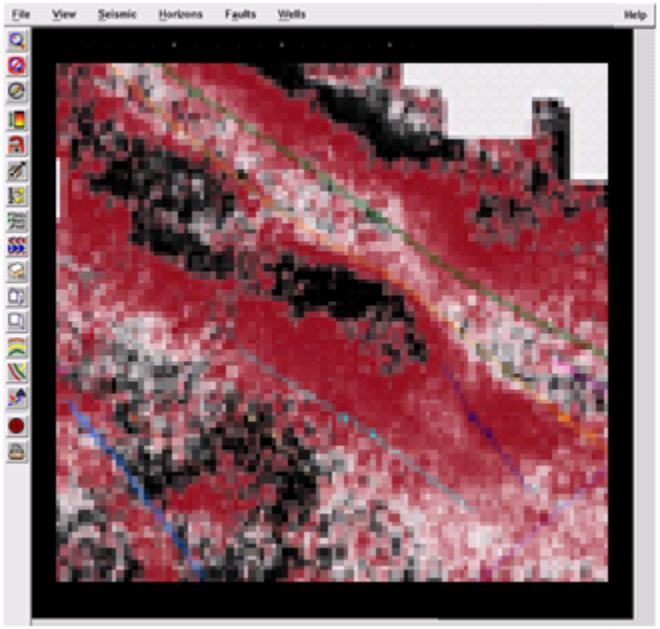
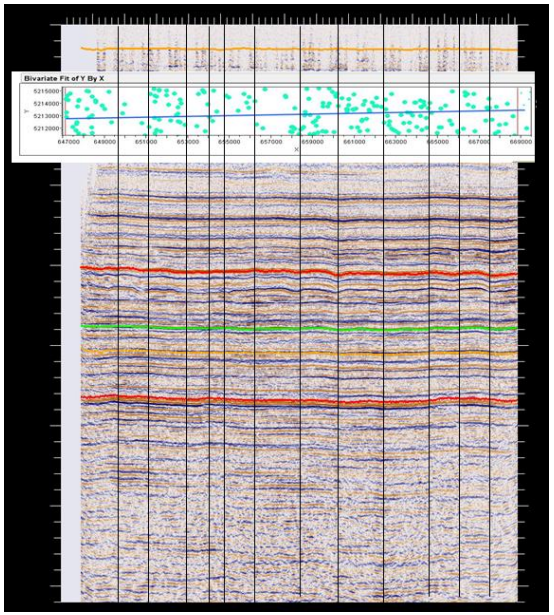






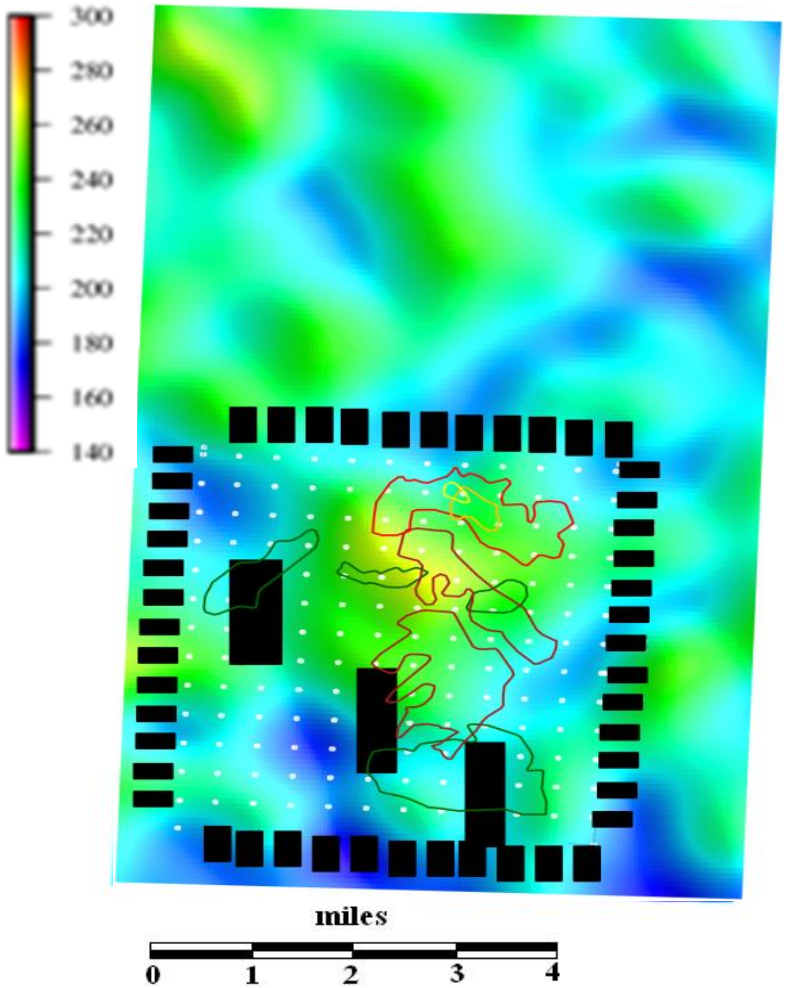


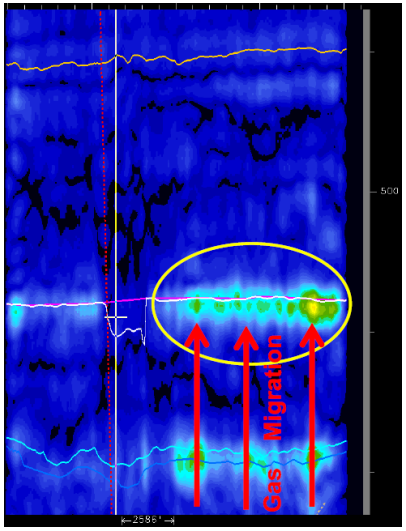
Few Faults
(20 sq. km.)
vs.
Many Faults
(575 sq. km.)

US$19,765 for 20 sq. km.
vs.
US$63,288 for 575 sq. km.

DML Lightning Analysis Project Price Calculator					
Enter Area (sq. km.):	20	Enter Area (sq. mi.):		Enter Area (acres):	
Area (sq. km)	20			Price ($US):	$19,765.37

DML Lightning Analysis Project Price Calculator					
Enter Area (sq. km.):	575	Enter Area (sq. mi.):		Enter Area (acres):	
Area (sq. km)	575			Price ($US):	$63,288.23





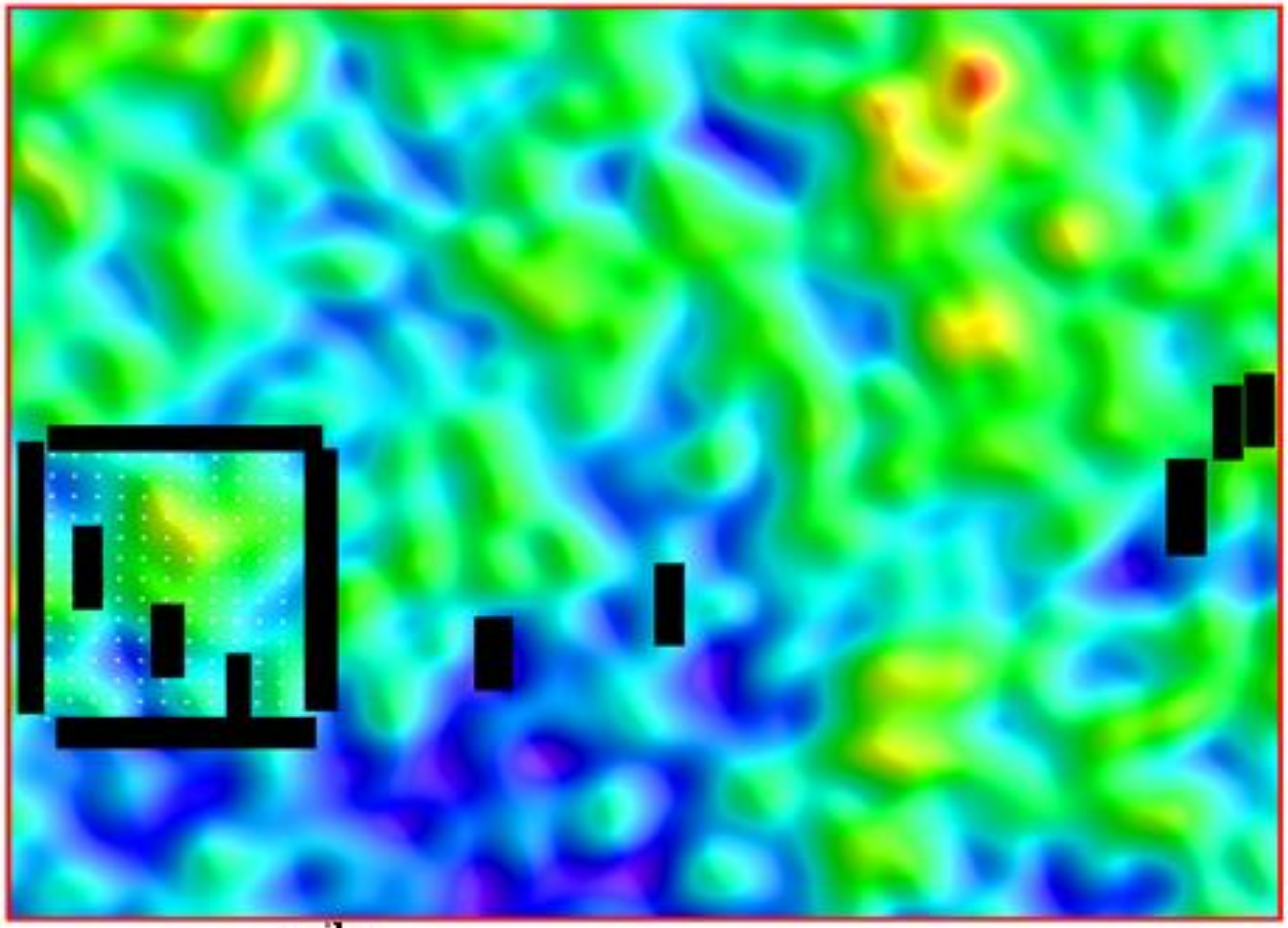
Prospect Scale Analysis

6.2 mi. x 9.3 mi.
or 57.66 sq. mi.

US$39,669 + integration

E17 | 57.66

16	DML Lightning Analysis Project Price Calculator				
17	Enter Area (sq. km.):		Enter Area (sq. mi.):	58	Enter Area (acres):	
18	Area (sq. km)	149			Price ($US):	$39,668.85



Play Fairway Lightning Analysis

19.5 x 12 mi.
or
234 sq. mi.

$64,453 + integration

DML Lightning Analysis Project Price Calculator					
Enter Area (sq. km.):		Enter Area (sq. mi.):	234	Enter Area (acres):	
Area (sq. km)	606			Price ($US):	$64,452.51

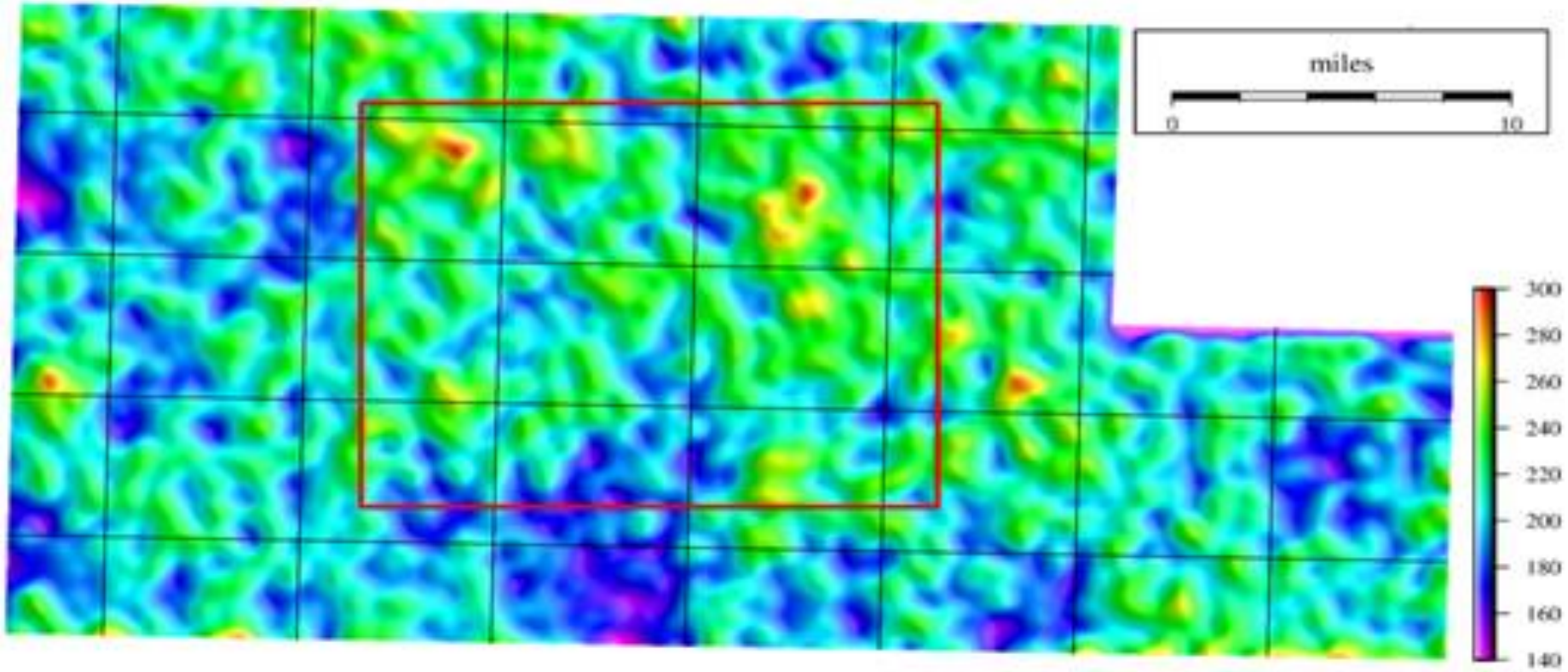
County or Parish Scale

44.4 x 18.6 mi. = 826 sq. mi.

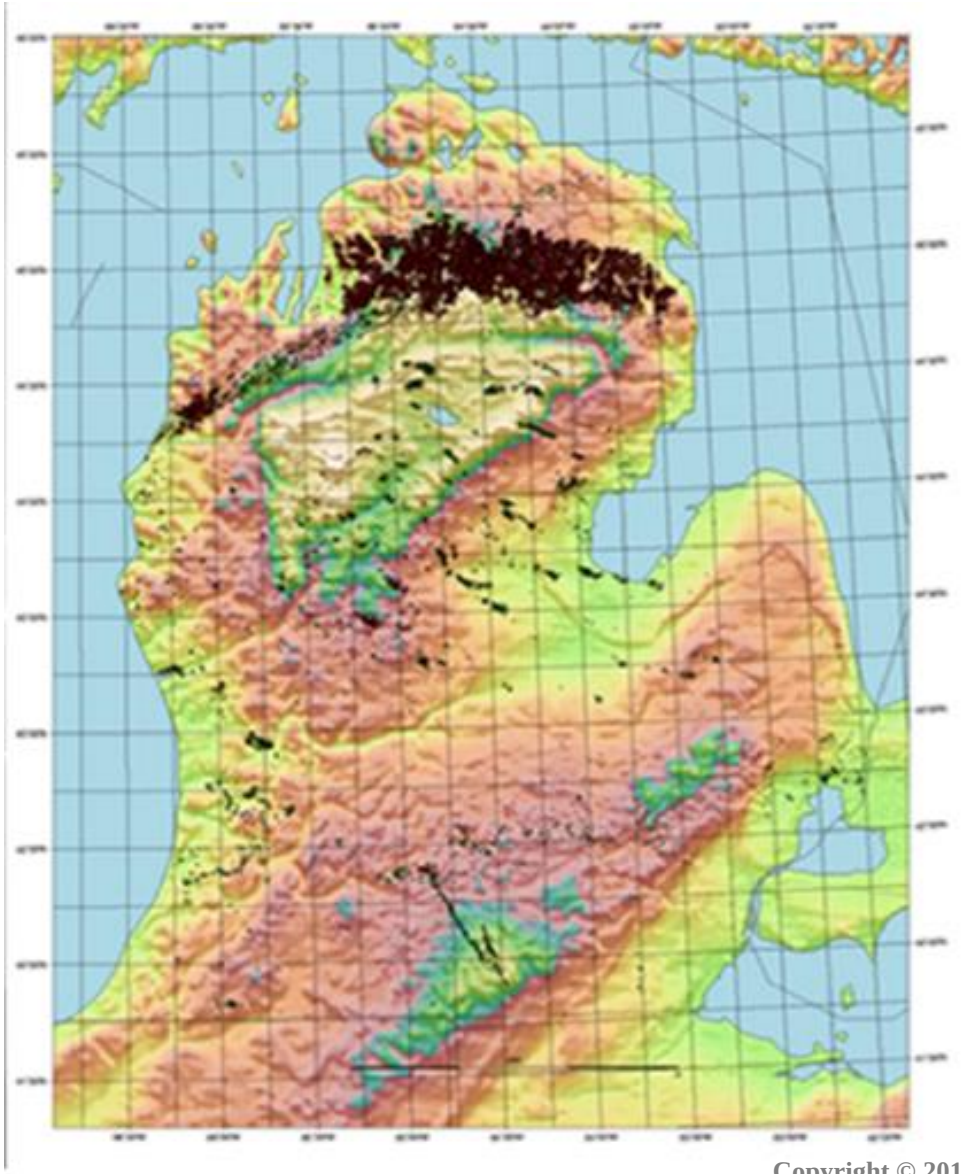
US$99,771.

E17 | 825.8

16	**DML Lightning Analysis Project Price Calculator**					
17	Enter Area (sq. km.):		Enter Area (sq. mi.):	826	Enter Area (acres):	
18	**Area (sq. km)**	2,139			**Price ($US):**	$99,770.86



Michigan: topography

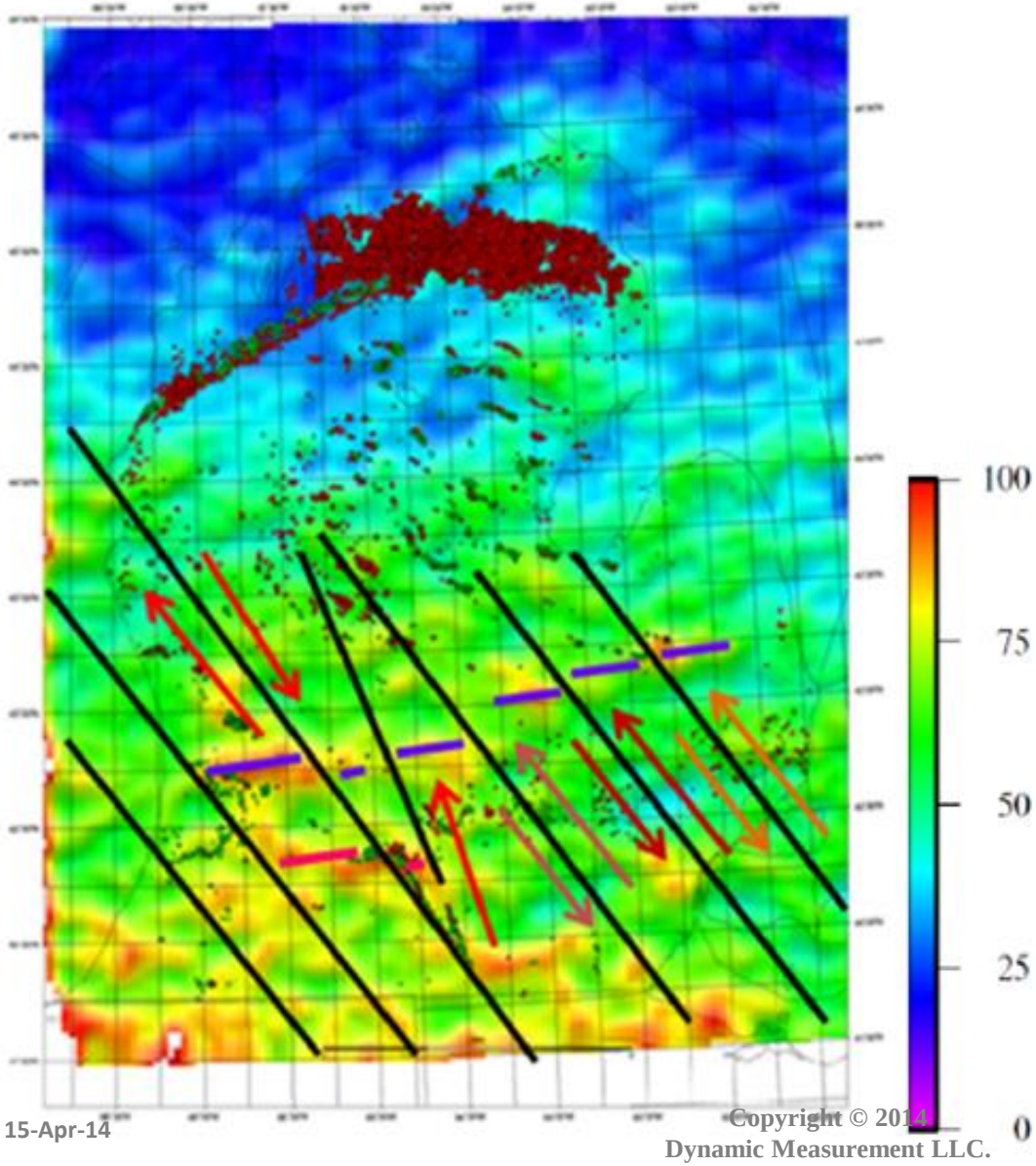


Basin Scale Analysis

- 87º to -82º Longitude
- 41º30’ to 46º Latitude

- Red dots gas fields
- Green dots oil fields
- Note Great Lakes
- Note Detroit

Michigan: strike density



Basin Scale Analysis

- Fewer strikes in north
- Strikes offshore
- No Detroit anomalies
- Fault interpretation is based only on lightning data and extrapolating from Albion Scipio and Stoney Point Fields

Lightning Analysis US$481,217.

E17 | 77444.25373

DML Decimal Longitude & Latitude Calculator

Enter Minutes:	30	Enter Seconds:		Decimal Calculation:	0.5

DML Area Calculator from Longitude & Latitude Input

Data Entry Red Cells (decimal longitude & latitude), Calculations/Parameters Yellow Cells, Results Green Cells

NW Corner Longitude:	-87	W (km)	500.097922	Radius:	6367444.5
NW Corner Latitude:	46	E (km)	500.097922	M2F:	0.30480061
NE Corner Longitude:	-82	N (km)	385.996897	F2Mi:	5280
NE Corner Latitude:	46	S (km)	416.167999	Area (sq km)	200580.4987
SW Corner Longitude:	-87	W (mi)	310.745820		
SW Corner Latitude:	41.5	E (mi)	310.745820		
SE Corner Longitude:	-82	N (mi)	239.846872		
SE Corner Latitude:	41.5	S (mi)	258.594289	Area (sq mi)	77444.25373

DML Lightning Analysis Project Price Calculator

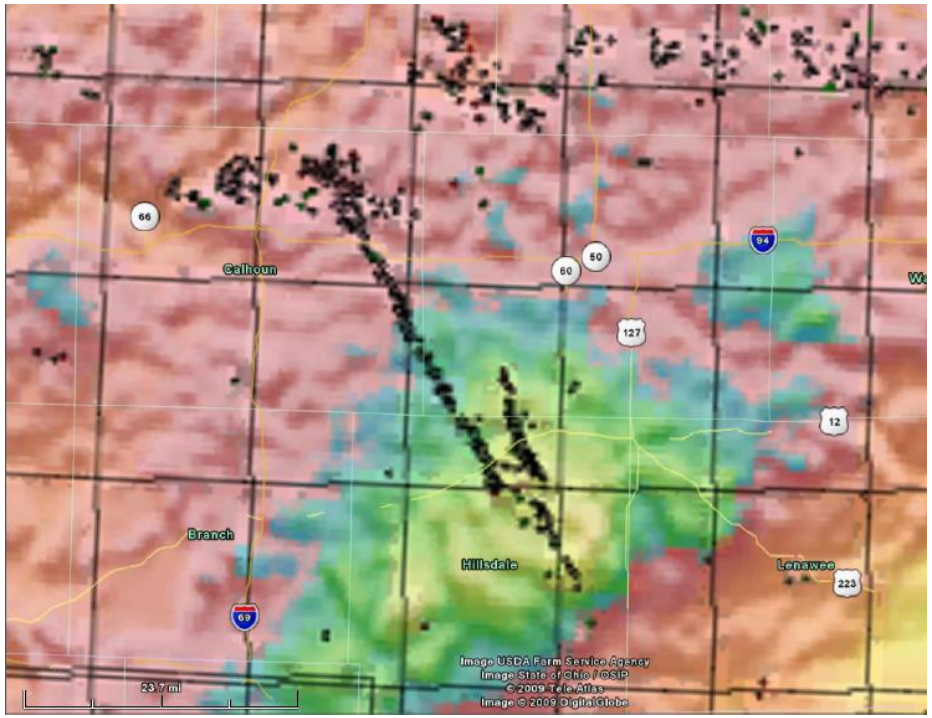
Enter Area (sq. km.):		Enter Area (sq. mi.):	77,444	Enter Area (acres):	
Area (sq. km)	200,581			Price ($US):	$481,217.39

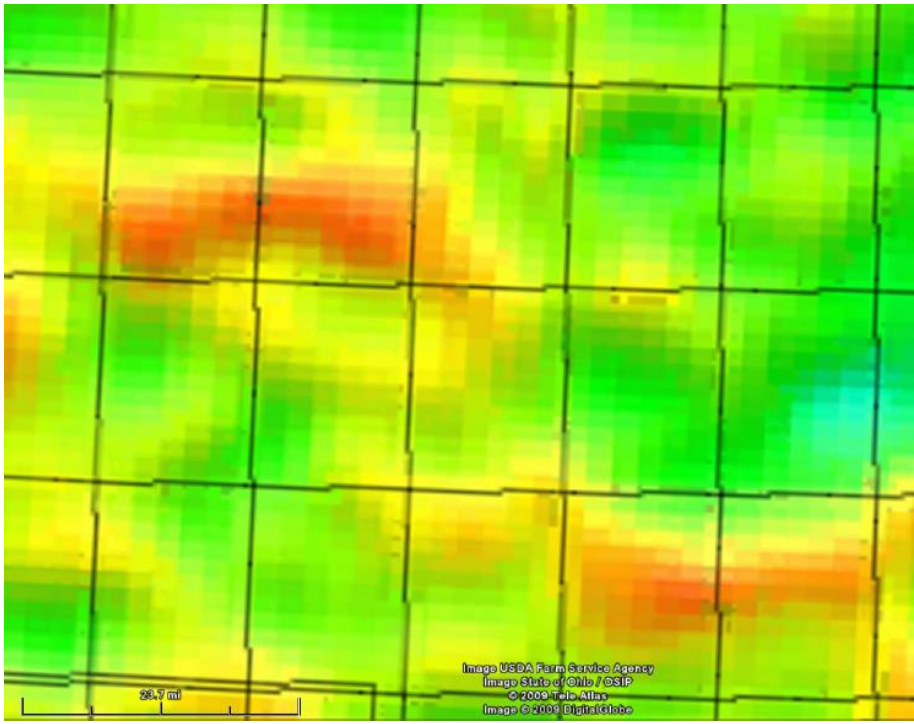
Confidential to Dynamic Measurement LLC

Michigan: strike density across the Albion Scipio Field

Topography

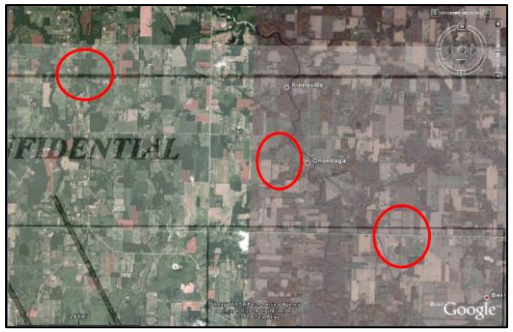
Lightning Density
1 Mile Grid Cells

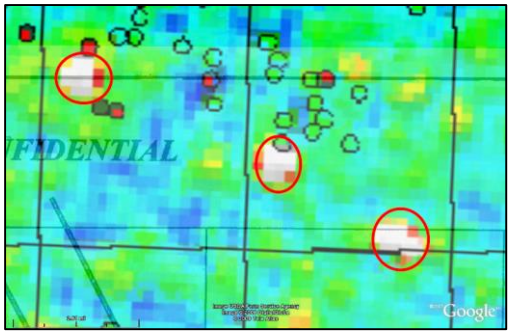


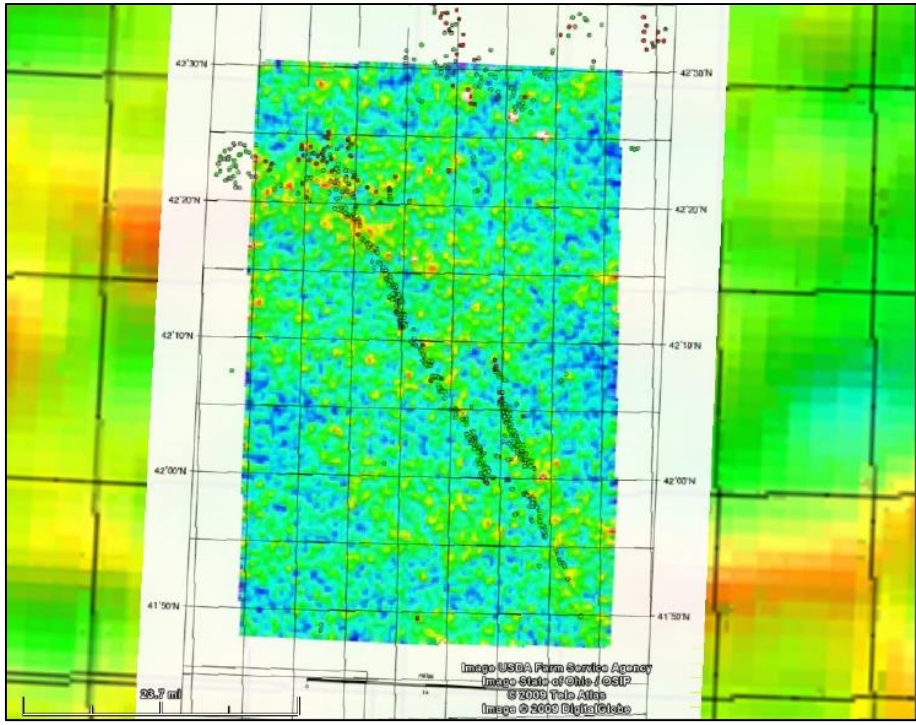


Michigan: strike density

Anomalies with 1,000 foot grid cells







Lafayette 2008 Prediction

"Oil and gas, in the earth, is far more abundant and widely distributed than is generally realized. . . . This concept will one day be proven when a direct method for locating hydrocarbons is discovered by scientists. This, in my opinion, is certain to happen in the future. When this occurs, oil and gas will be found in huge quantities, contained mostly in large stratigraphic traps that are not detectable by present-day technologies."

Ode of an Oilman, Dan Frantzen, page 93

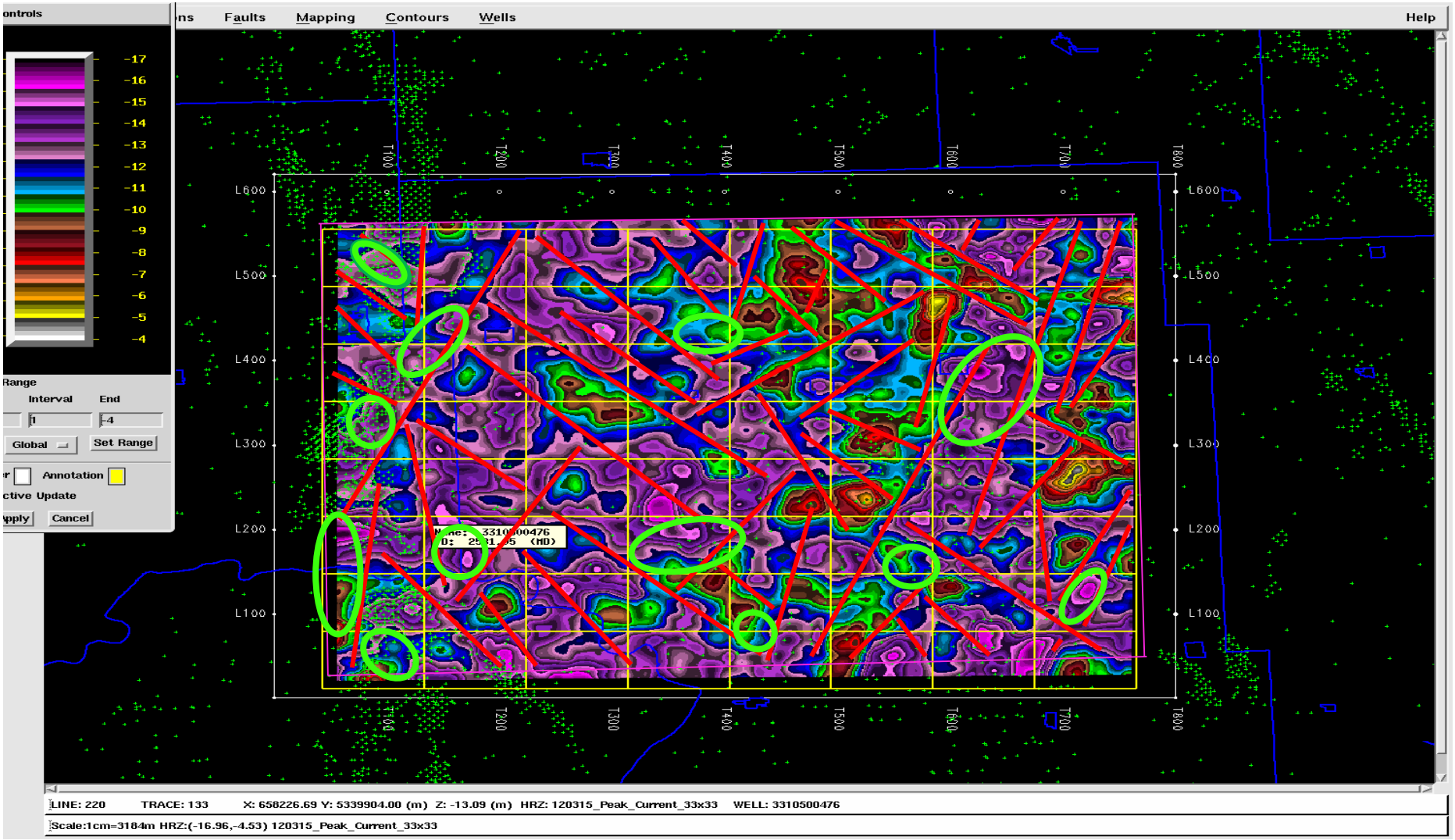
Lightning Analysis
Exploration and Development Economics

- Lightning databases exist and are evergreen.
- A lightning analysis can be done at a Basin, Parish, Play Fairway, or Prospect Scale in less than 2 months.
- Lightning analysis is a cost effective supplement to gravity, magnetics, log, and seismic analysis.
- Lightning clusters define fault frameworks and seeps.
- Fault density and orientation defines anisotropy.
- Fault frameworks optimize seismic survey design.
- Calibrated lightning anomalies define new opportunities along a trend or in a Play Fairway.

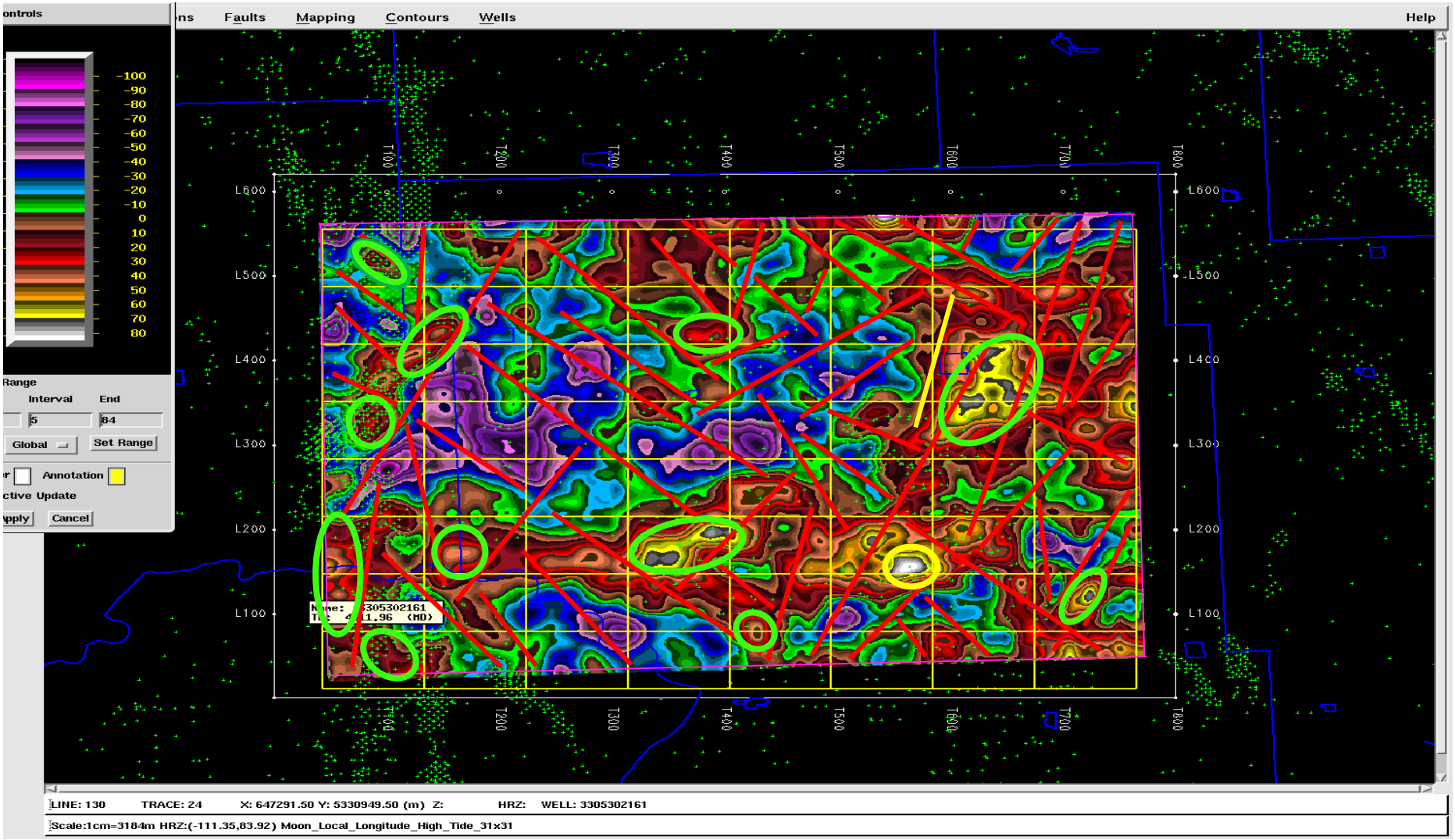
Lightning Analysis
Environmental, Permitting, and Aquifer Economics

- Resistivity volumes help rank sweet spots, which can determine which leases to keep and which to release.
- Lightning data provides a baseline snap shot of project areas.
- Analysis guides aquifer studies - pre and post production.
- Lightning analysis opens way to study methane tides.
- Fifteen years of data helps legal defense in legacy lawsuits.
- Lightning analysis defines high current zones for pipeline design.

Example 1: Peak Current
Mountrail County, North Dakota

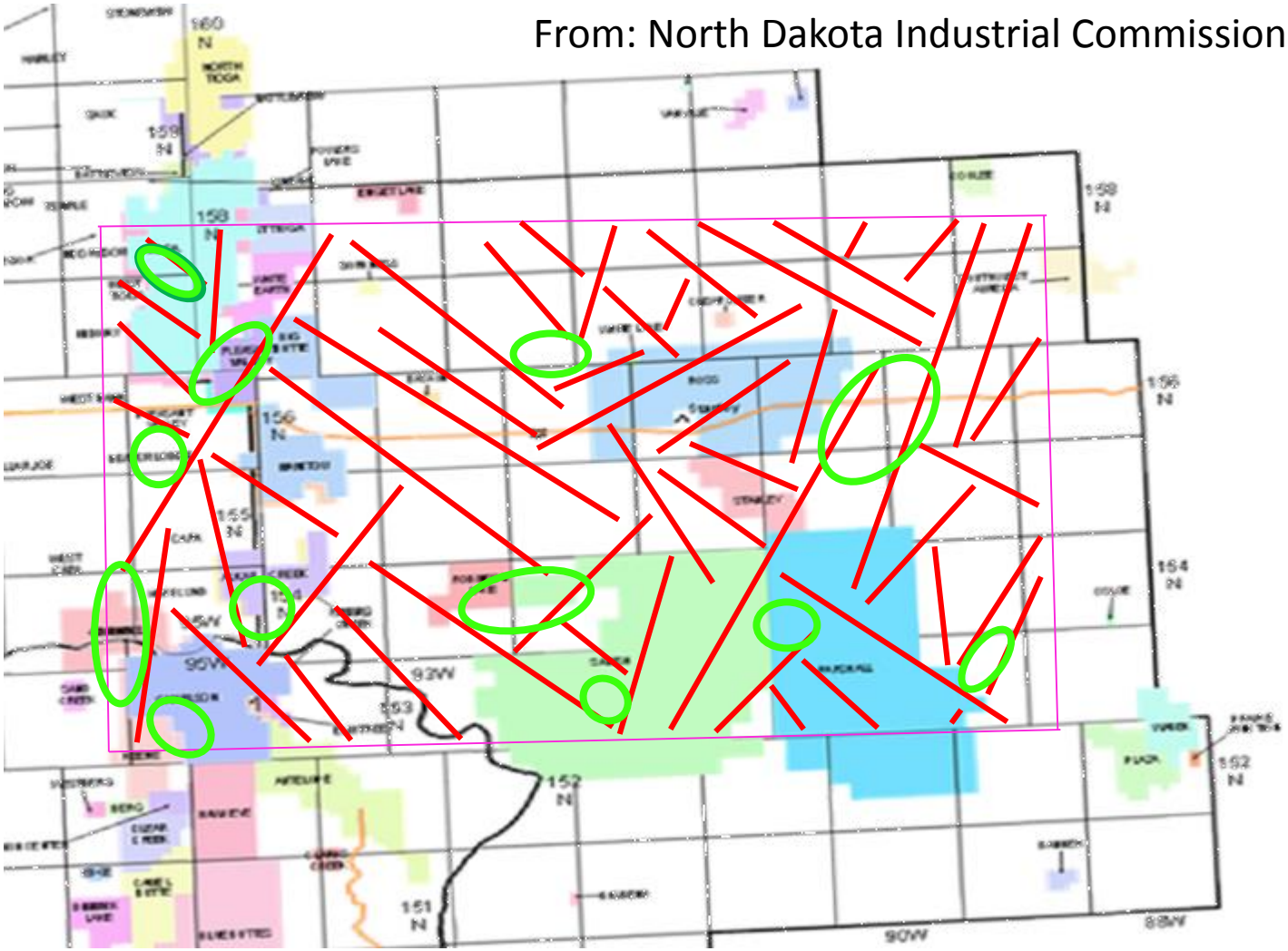


Example 1: PC high lunar tide
Mountrail County, North Dakota



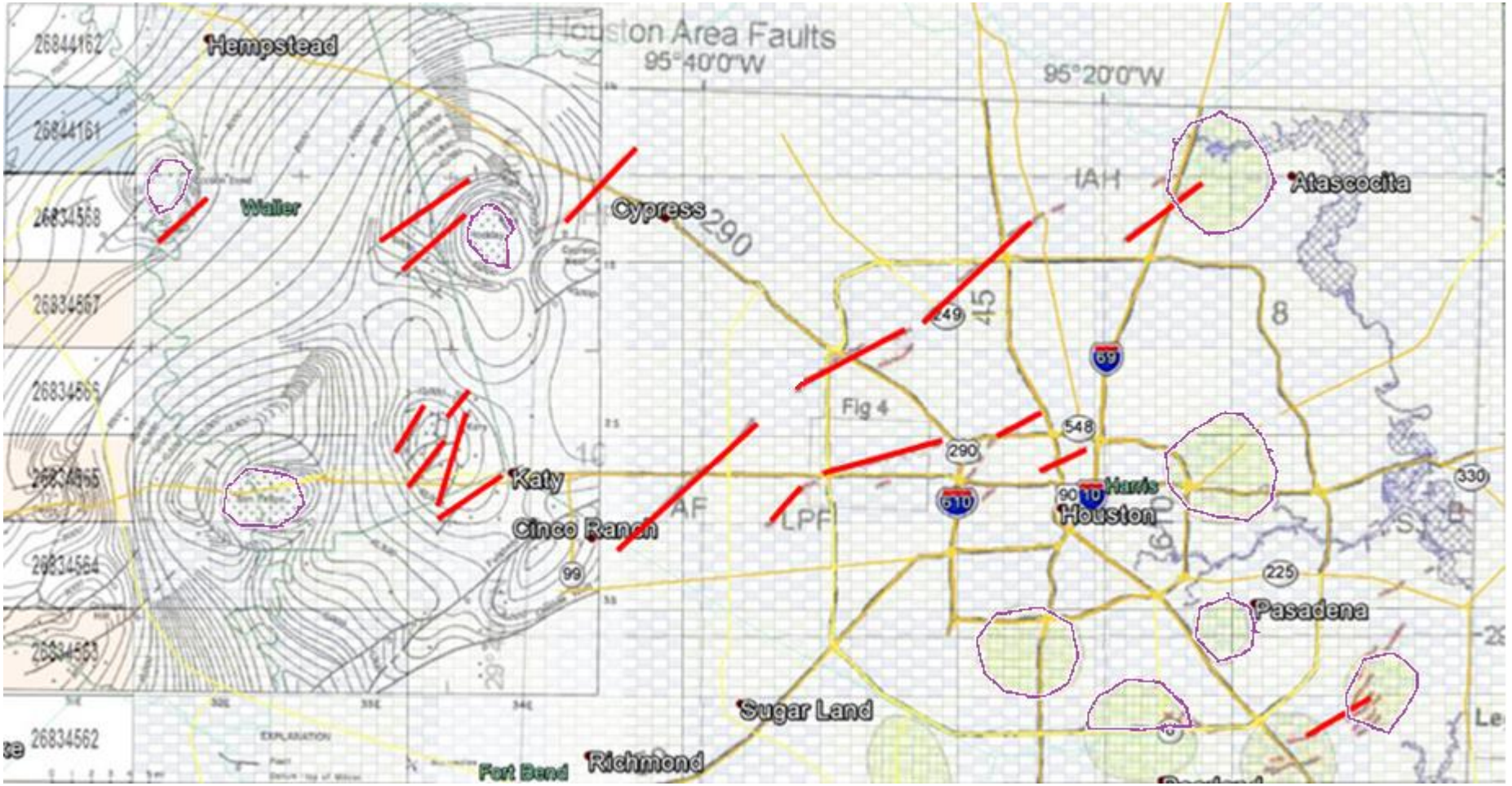
Example 1: Lineaments and Anomalies over Field Boundaries

From: North Dakota Industrial Commission 1988



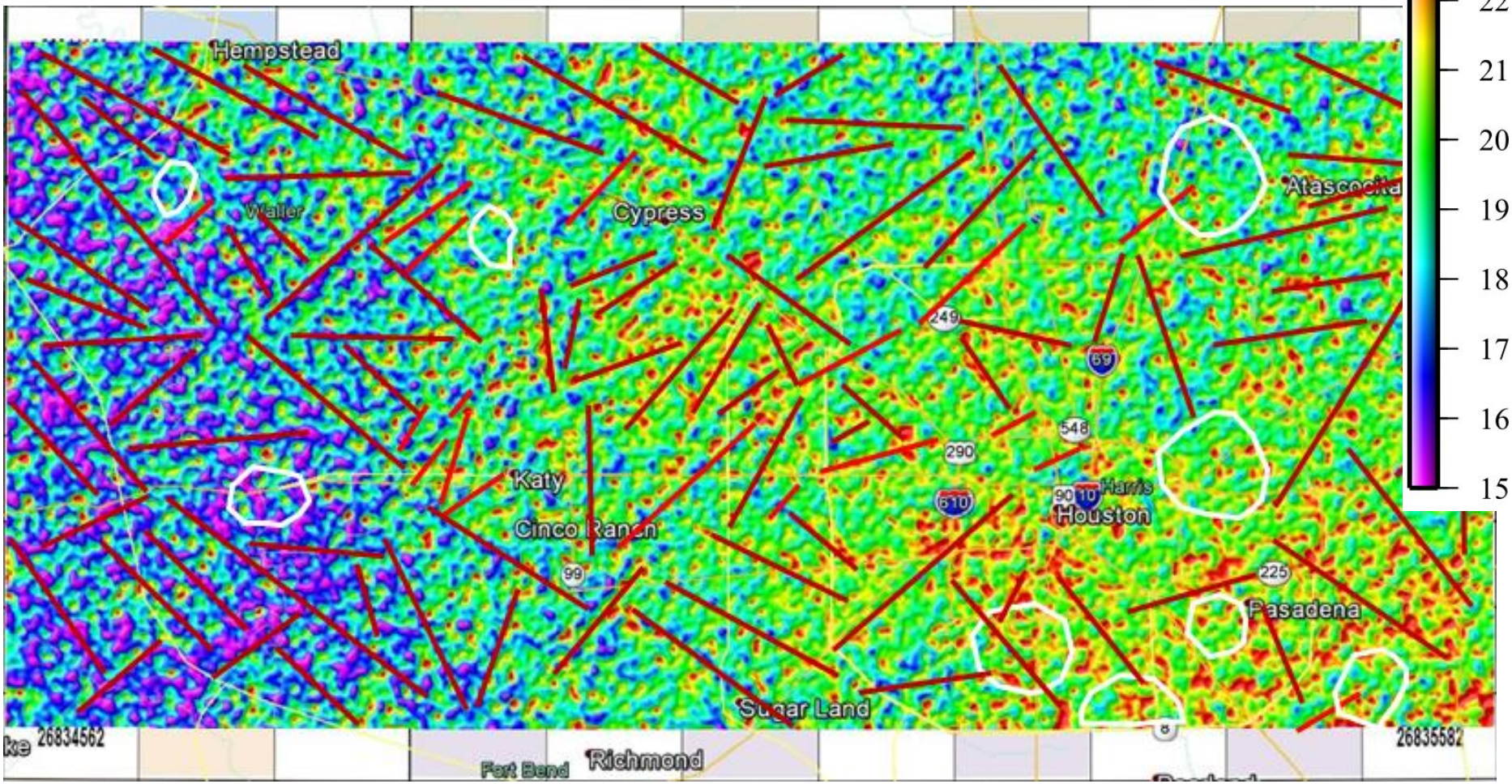
Salt Domes and Surface Faults

Example 2: Harris County, Texas

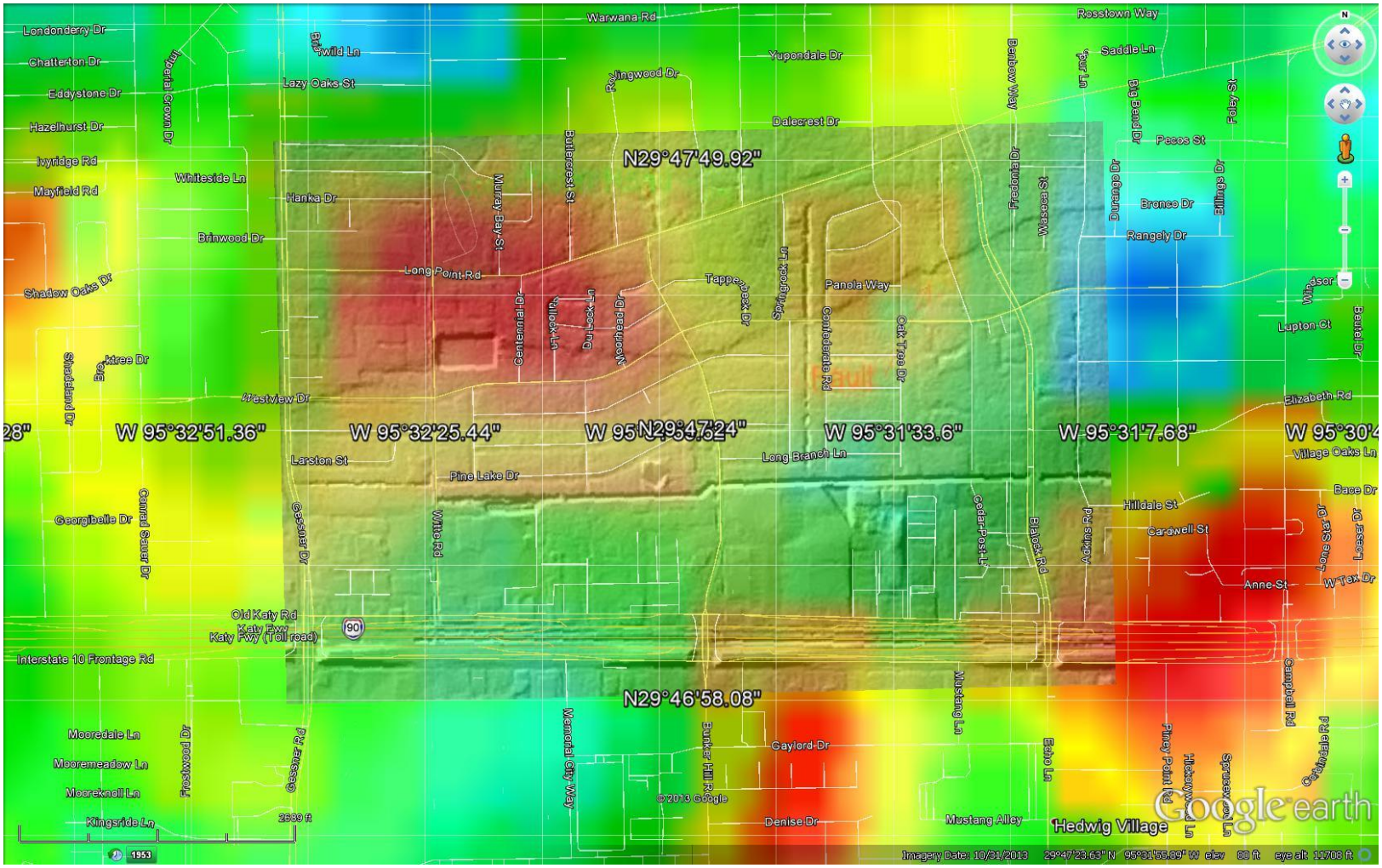


Example 2: Harris County Area

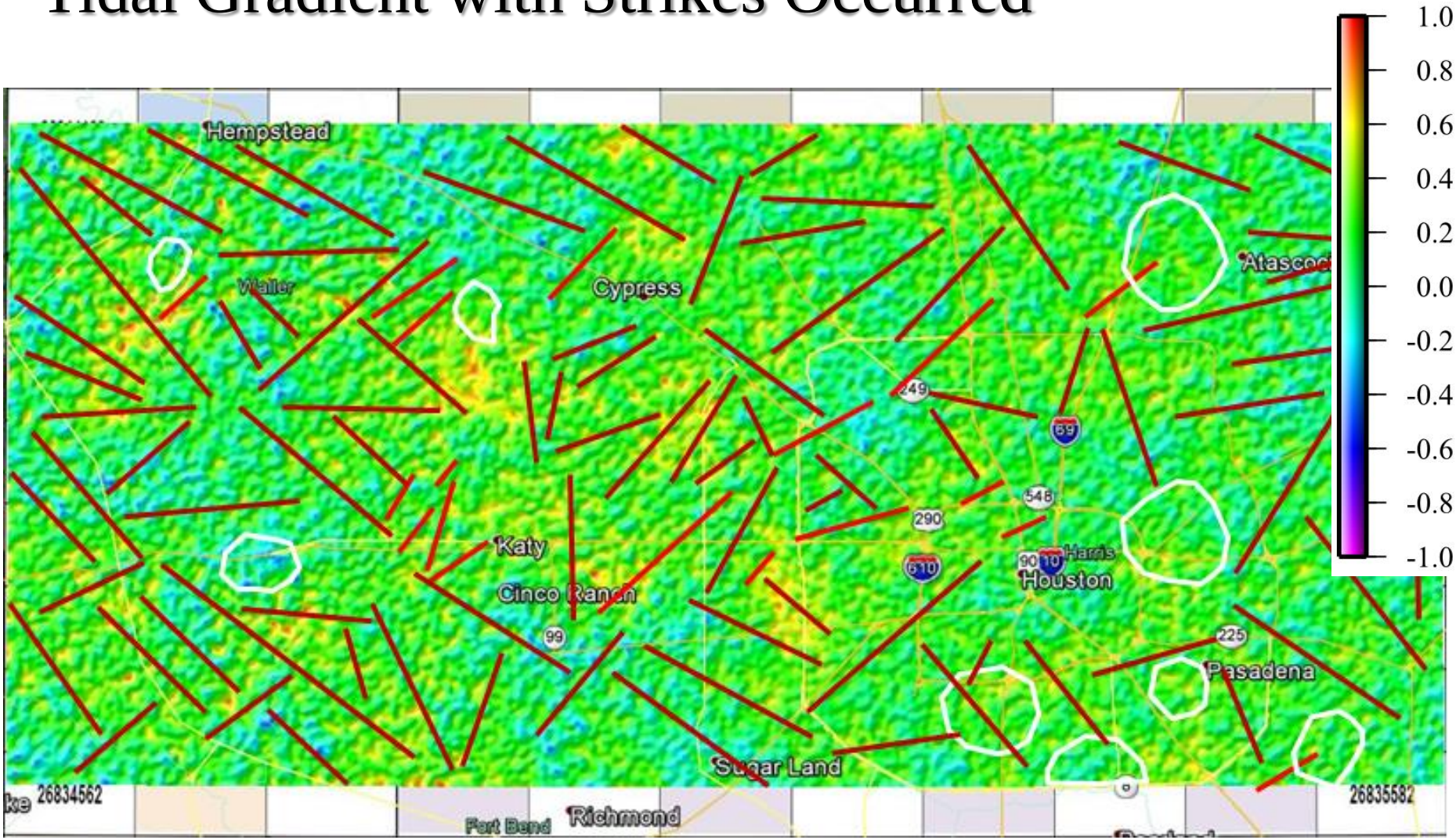
Peak Current



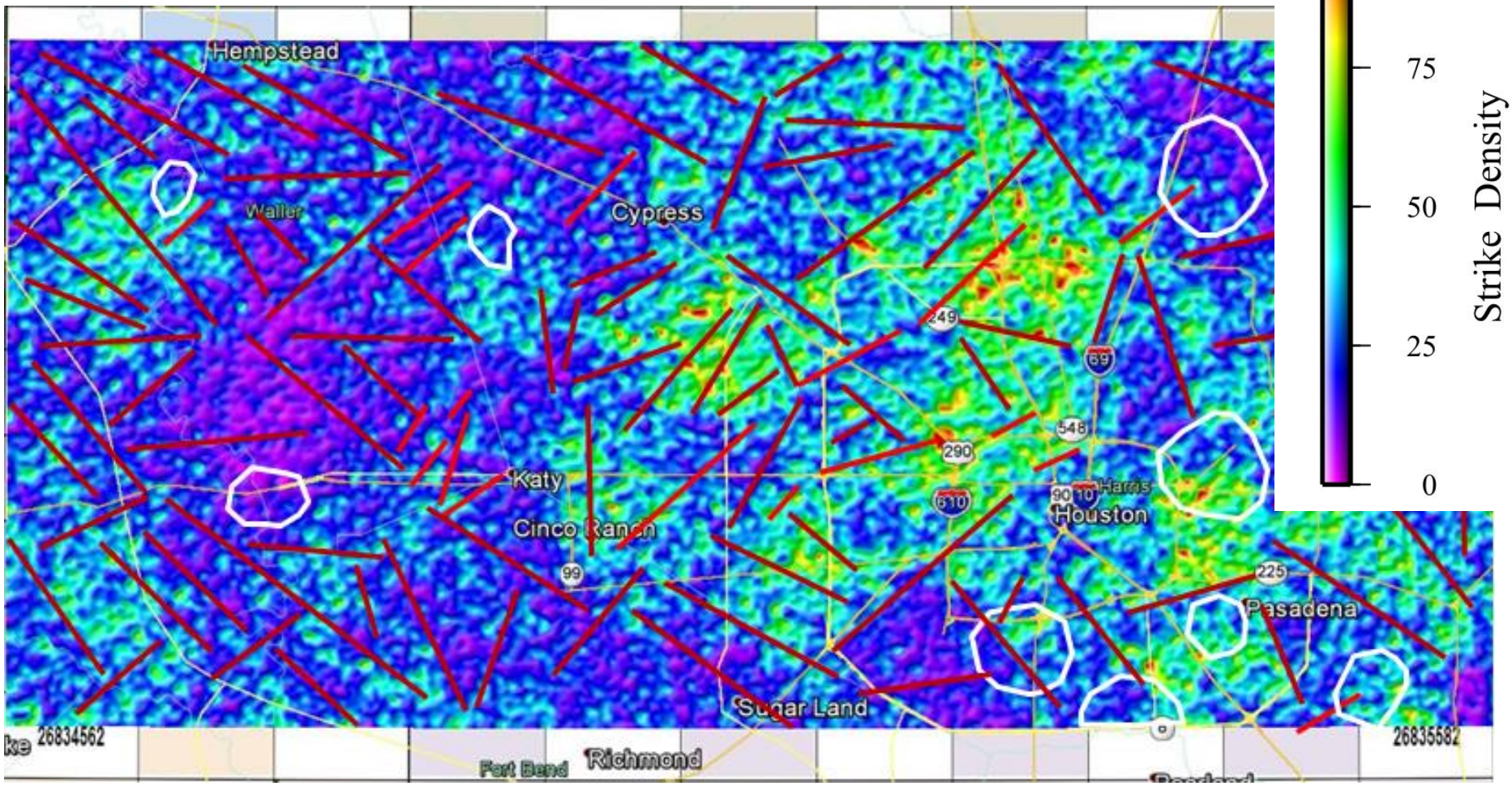
Example 2: Harris County Area
Long Point Fault & LIDAR Peak Current



Example 2: Harris County Area
Tidal Gradient with Strikes Occurred



Example 2: Harris County Area
Strikes Density 75-100% Tidal Flood



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