Lightning Data:
the new EM "seismic" data

H. Roice Nelson, Jr.
D. James Siebert
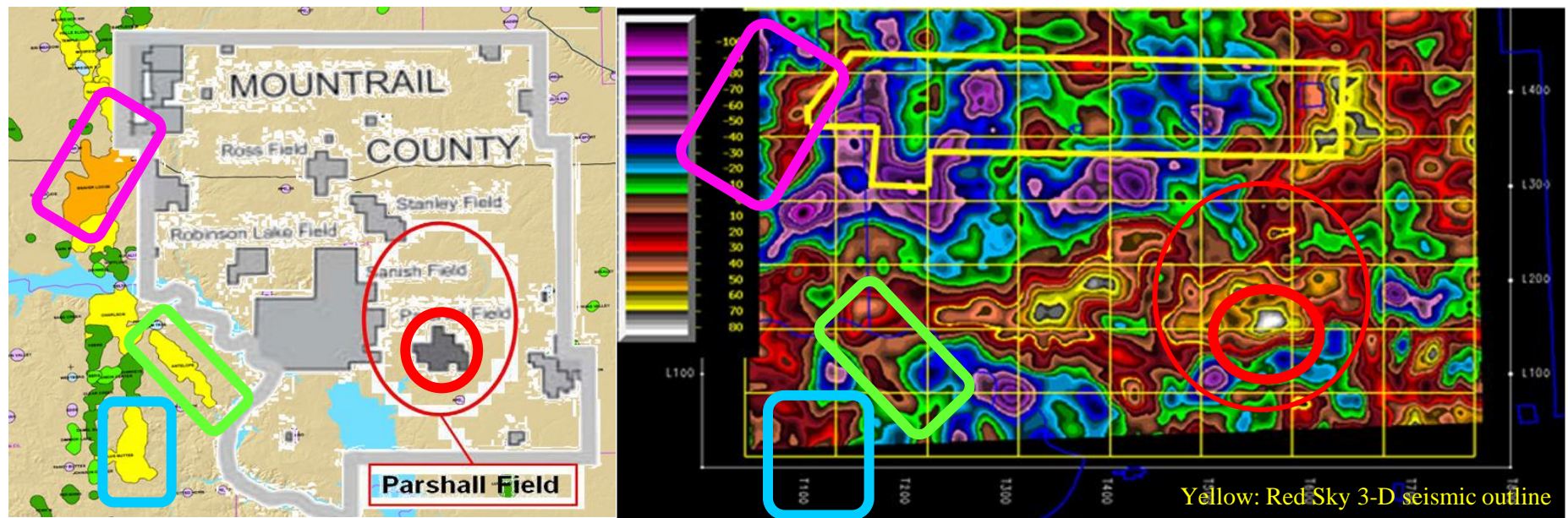*L. R. Denham*

Dynamic Measurement LLC
08 November 2012

Electromagnetic Data
maps the extent of natural resources

Yellow: Red Sky 3-D seismic outline
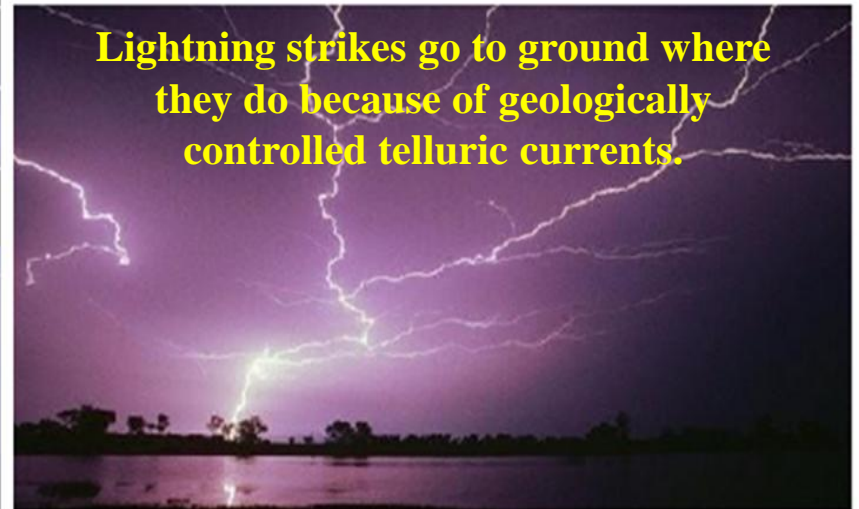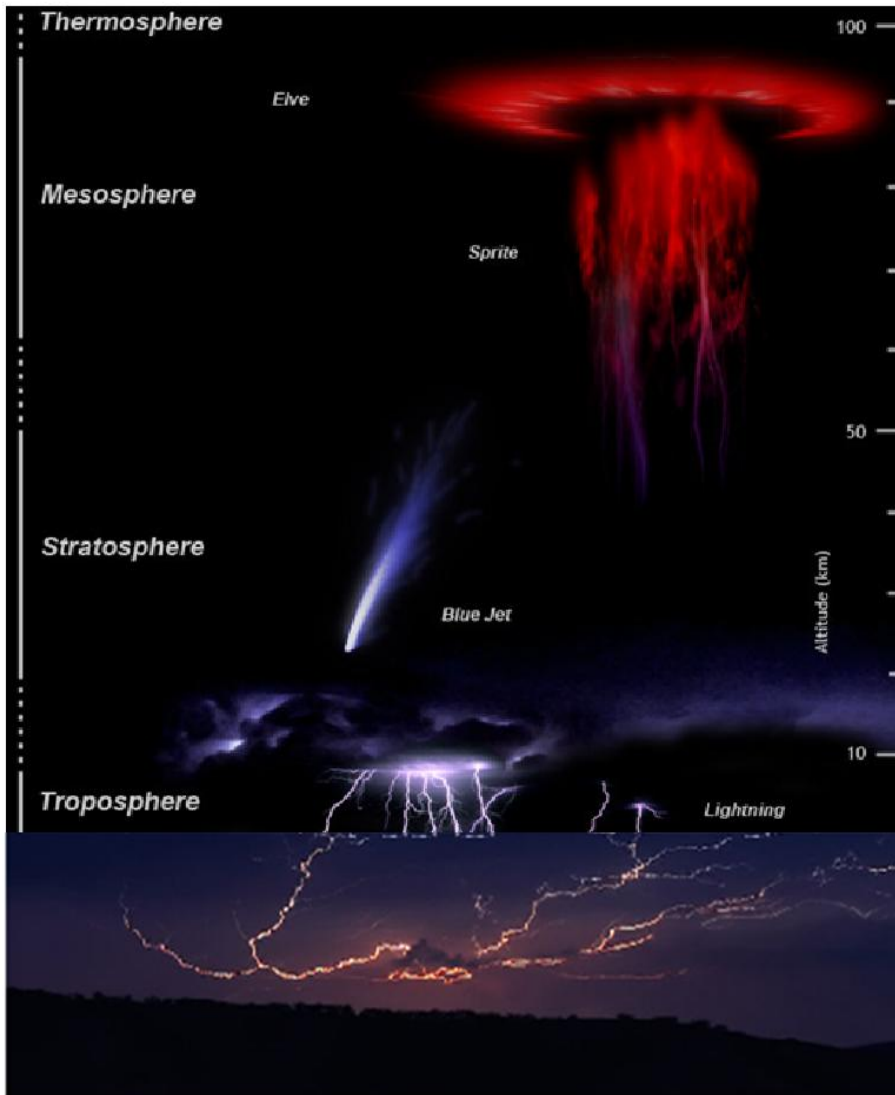
Pershall, **Beaver Lodge**, **Antelope**, and
Blue Butte fields, Montrail County, ND

**Peak Current of Lightning
Strikes at high lunar tide**

350 million annual cloud-to-ground strikes provide both **a rich and inexpensive database to mine**

Cloud-to-Cloud lightning travels 250+ km or 2 ½ times more distance than Sprite & Elves.

Lightning strikes go to ground where they do because of geologically controlled telluric currents.

LIGHTNING DATA:
a new "**Geophysical Data Type**"

- Lightning occurs everywhere

- Lightning databases are available to data mine

- Lightning density varies spatially

- Lightning density is somewhat consistent over time

- Data mining lightning data bases help exploration for natural resources
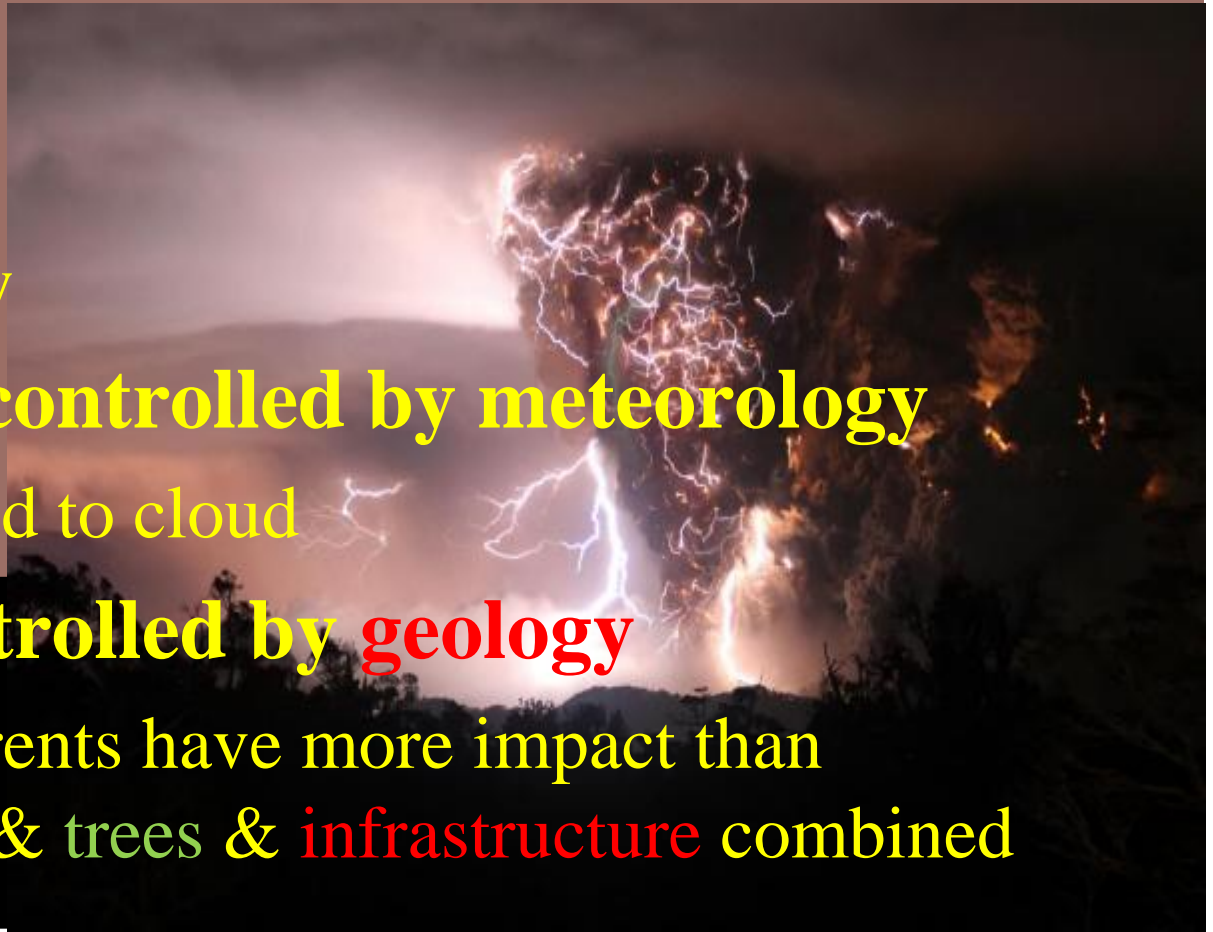
LIGHTNING DATA:

- **Present uses:**
  - Insurance
  - Safety
  - Meteorology
- **Regionally controlled by meteorology**
  - 250 km cloud to cloud
- **Locally controlled by geology**
  - Telluric currents have more impact than topography & trees & infrastructure combined

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Acquisition: U.S. lightning strike locations & attributes

~330 Sensors owned and managed by Vaisala, Inc.
as the NLDN (National Lightning Detection Network)

with +/- 100-500 foot location resolution

Sensor Electronics

LS7000/8000

LDAR

Thunderstorm

Cloud-to-Ground Lightning

Central Analyzer

Remote Sensor Communication Link

Lightning Detection Remote Sensor
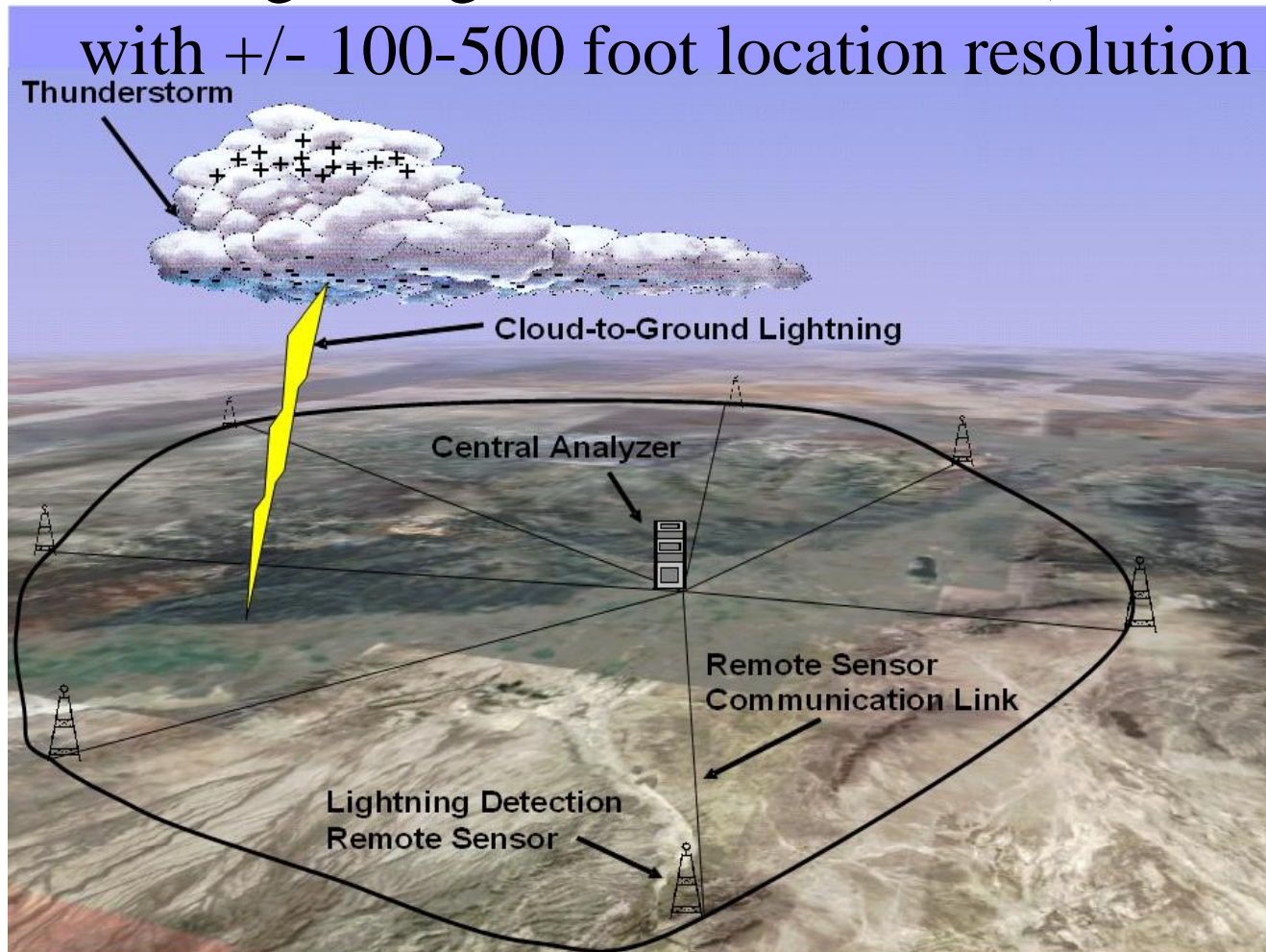
Noise Removal: bias in North Dakota lightning data

Peak-to-Zero
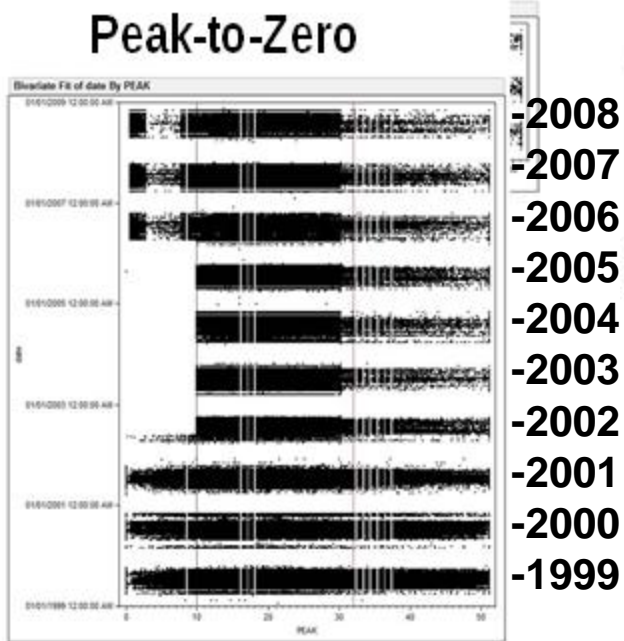
-2008
-2007
-2006
-2005
-2004
-2003
-2002
-2001
-2000
-1999

Peak Current
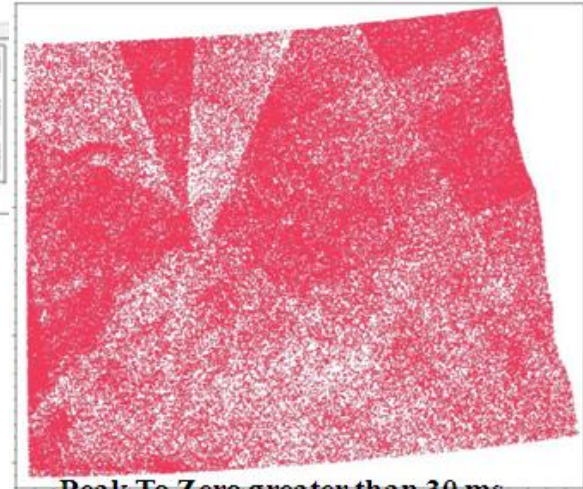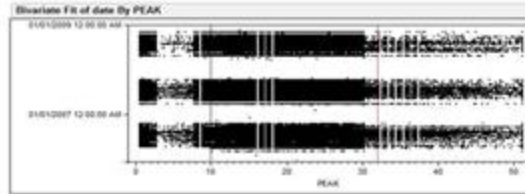
Peak To Zero greater than 30 ms. (all years) The patterns are artifacts.

Bivariate Fit of date By RISE
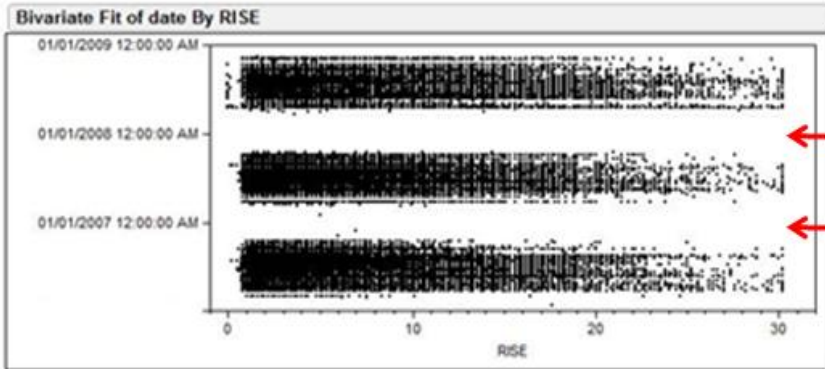
2009
Winter
2008
Snow
2007

Rise Time (microseconds)
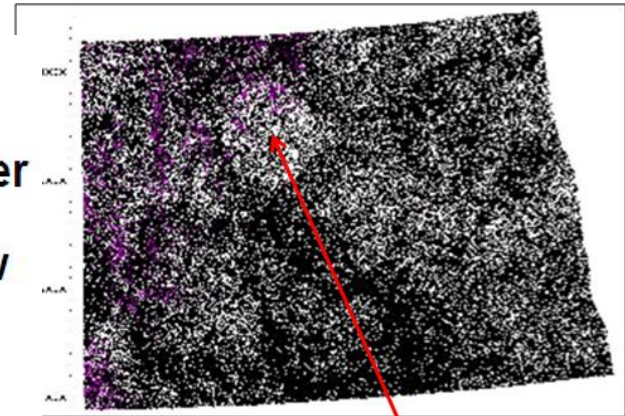
Top 10% of Rise Time (>7 microseconds) Note "crop circle" around sensor location.

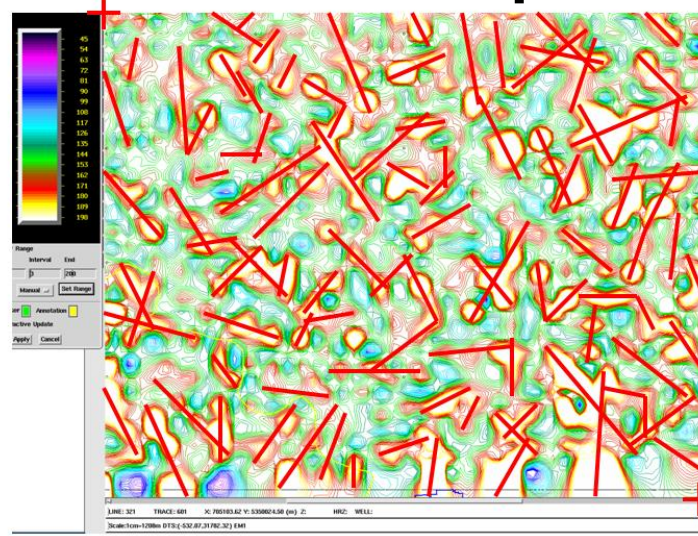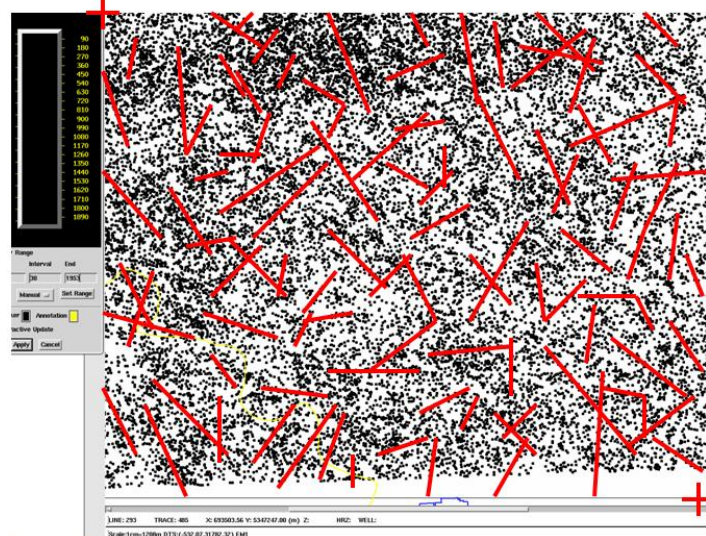# **Processing:** Michigan topography & lightning attribute map

1 mile grid

8
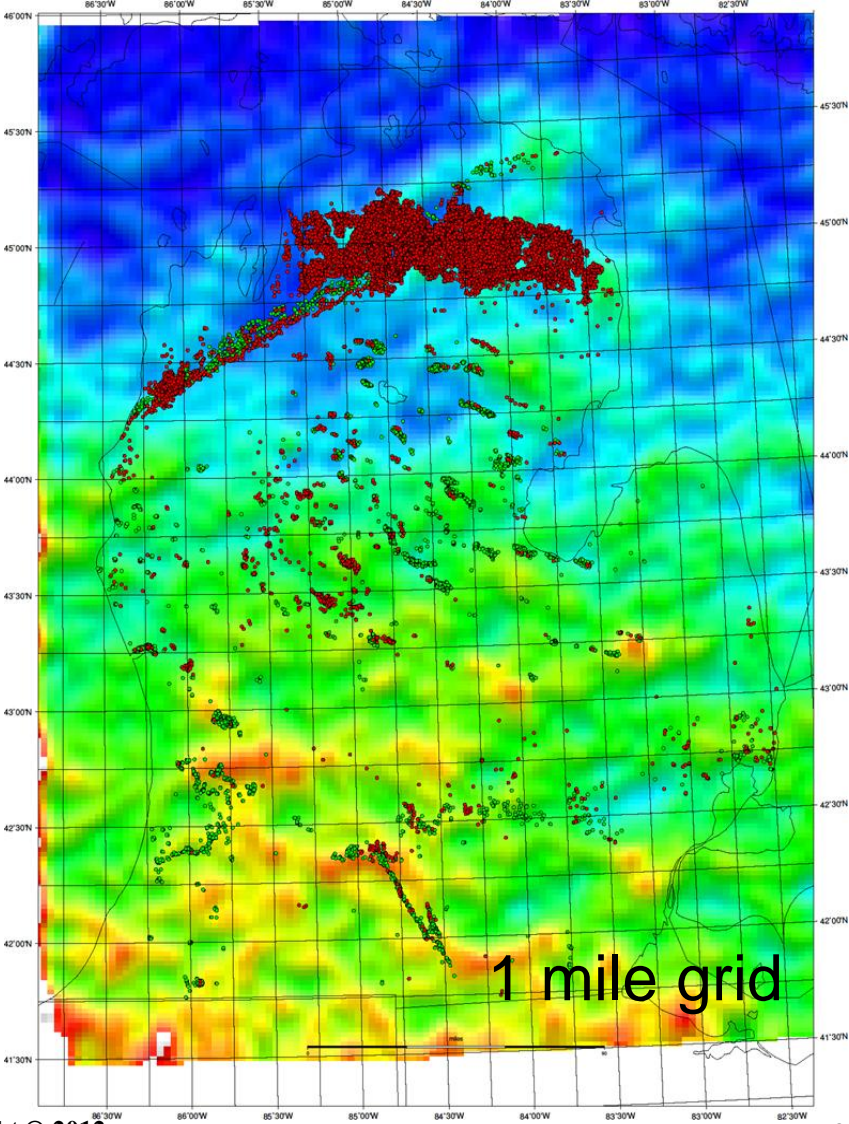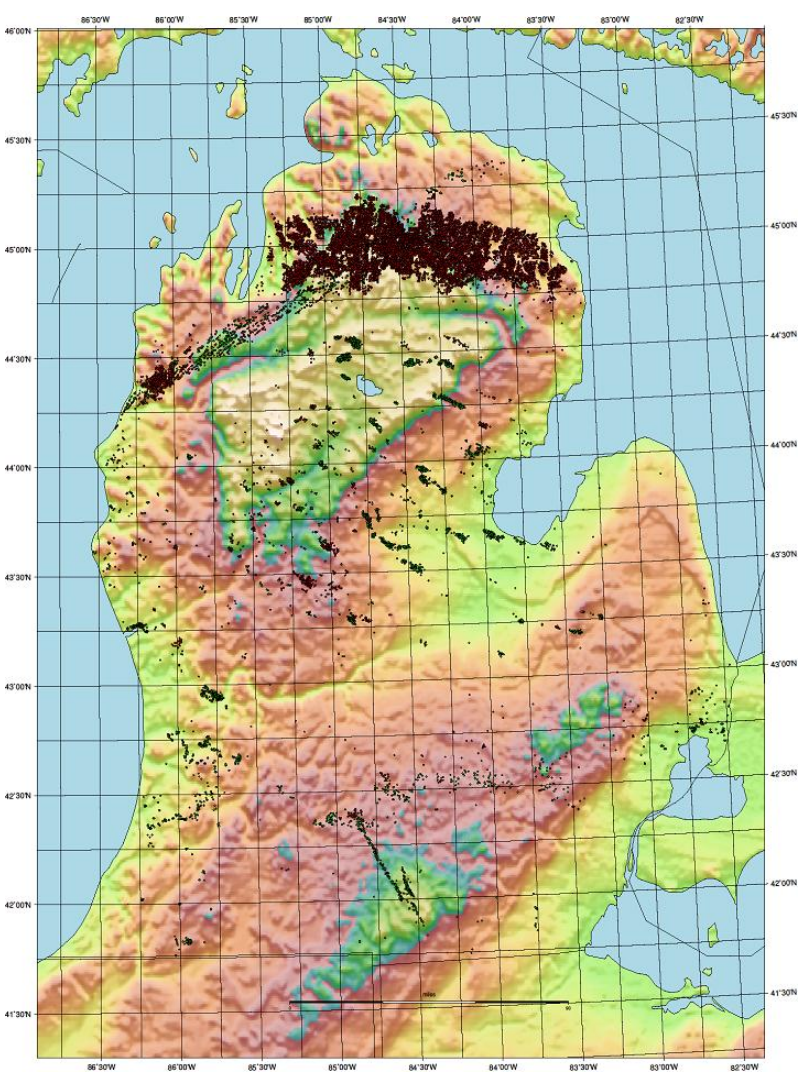
Interpretation: Montrail County, ND example
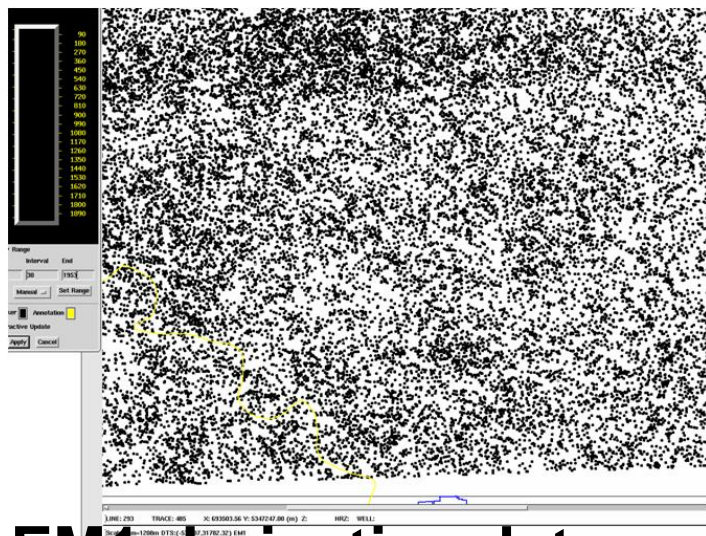
EM1 derivative data
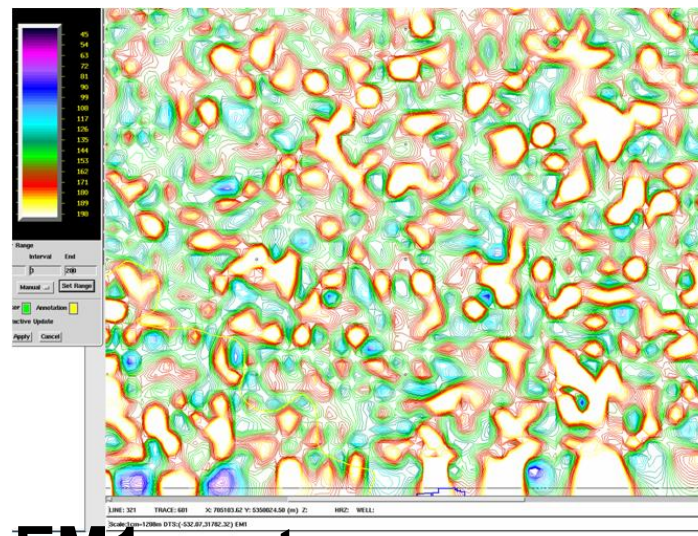
EM1 contour map

Integration: Relating Fields and Strikes Texas Coast first pass with the new exploration data type
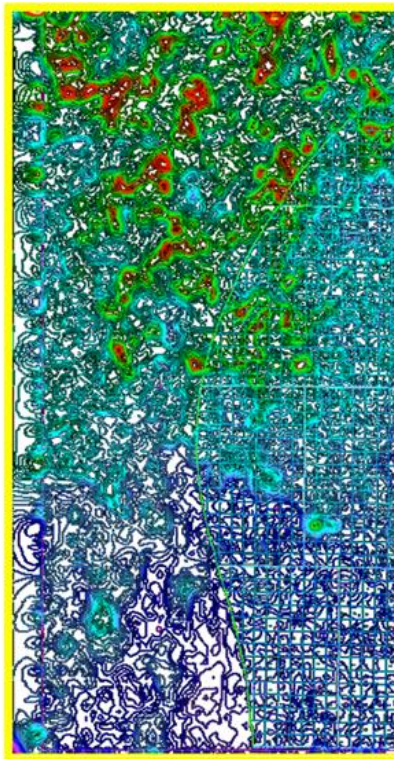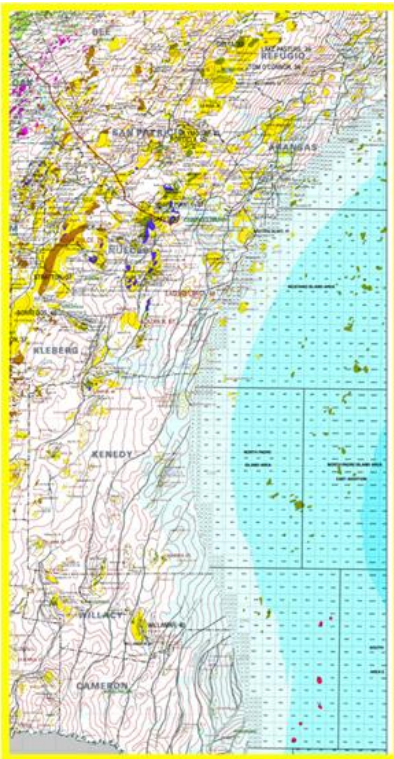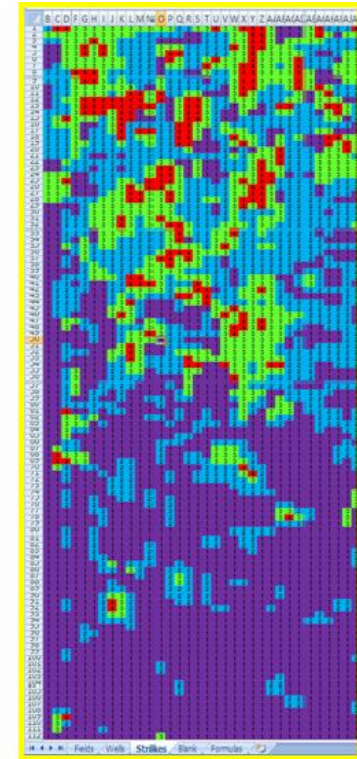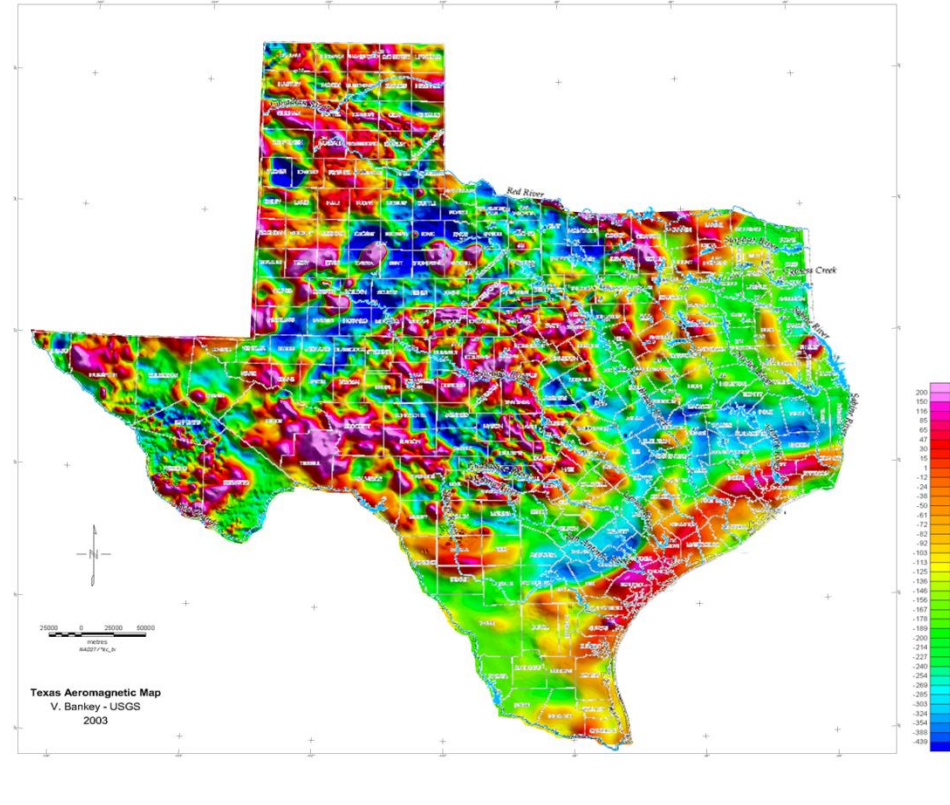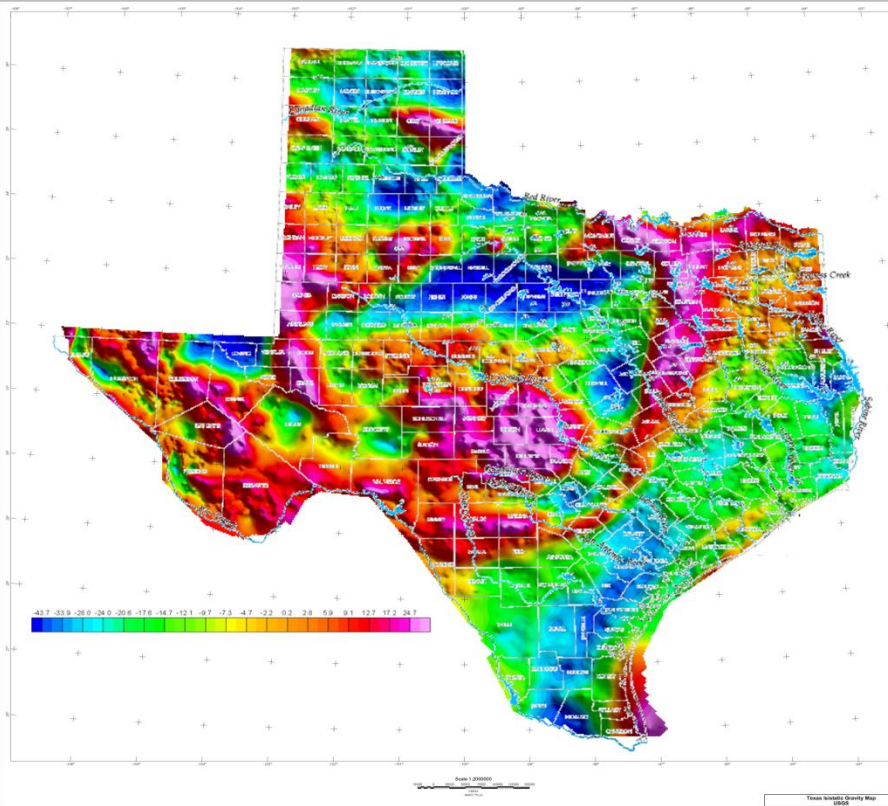

Hydrocarbon fields **Lightning Density** **Hydrocarbon fields** **Lightning Density**

Potential Field Data provides regional context
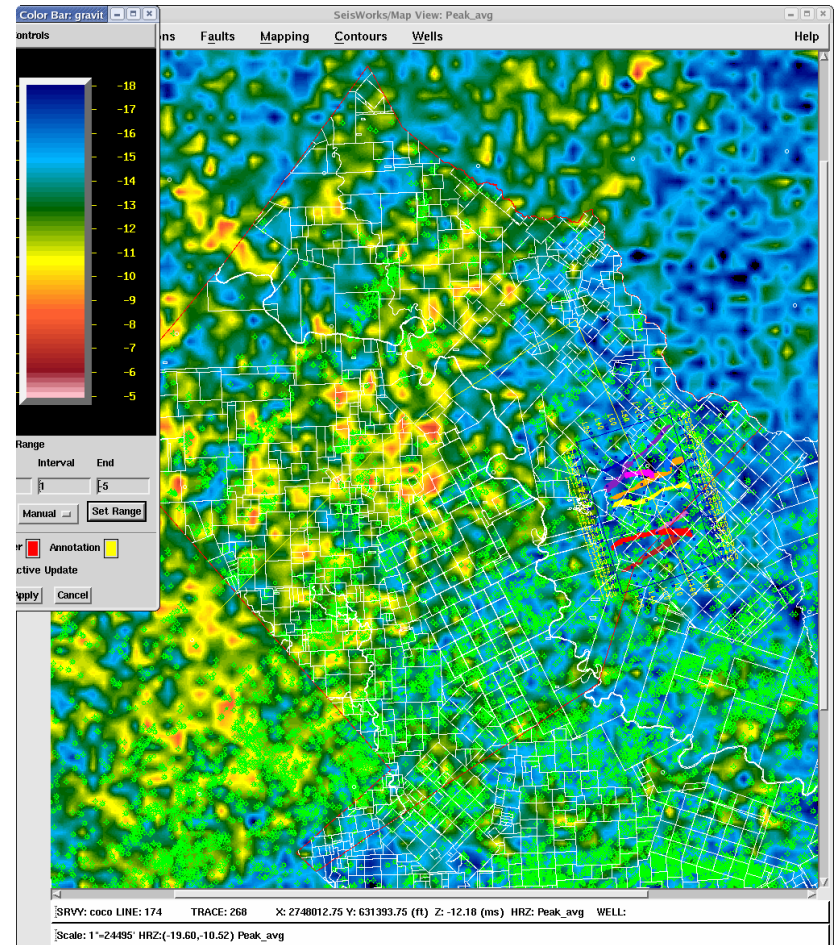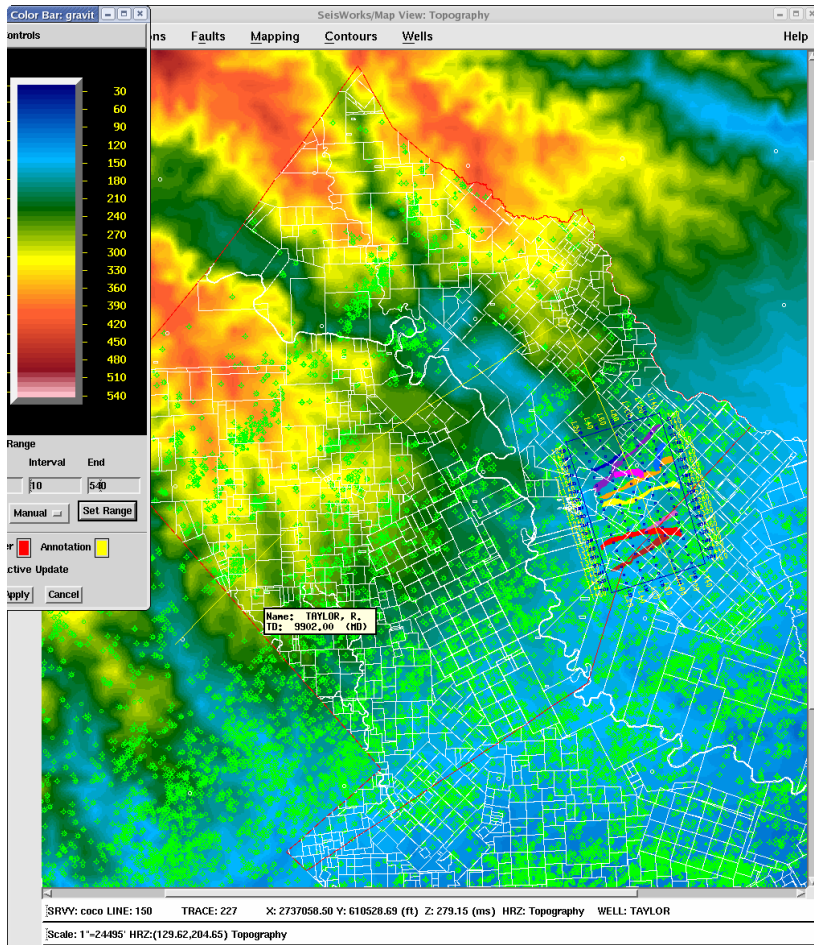

Isogravity and Aeromagnetic Maps of Texas

Lightning Data is a new EM data type

Avg Flash Density
fl/sq km/year

14	and up
10	to 14
8	to 10
6	to 8
5	to 6
4	to 5
3	to 4
2	to 3
1	to 2
0.5 to	1
0.1 to	0.5
0+ to	0.1
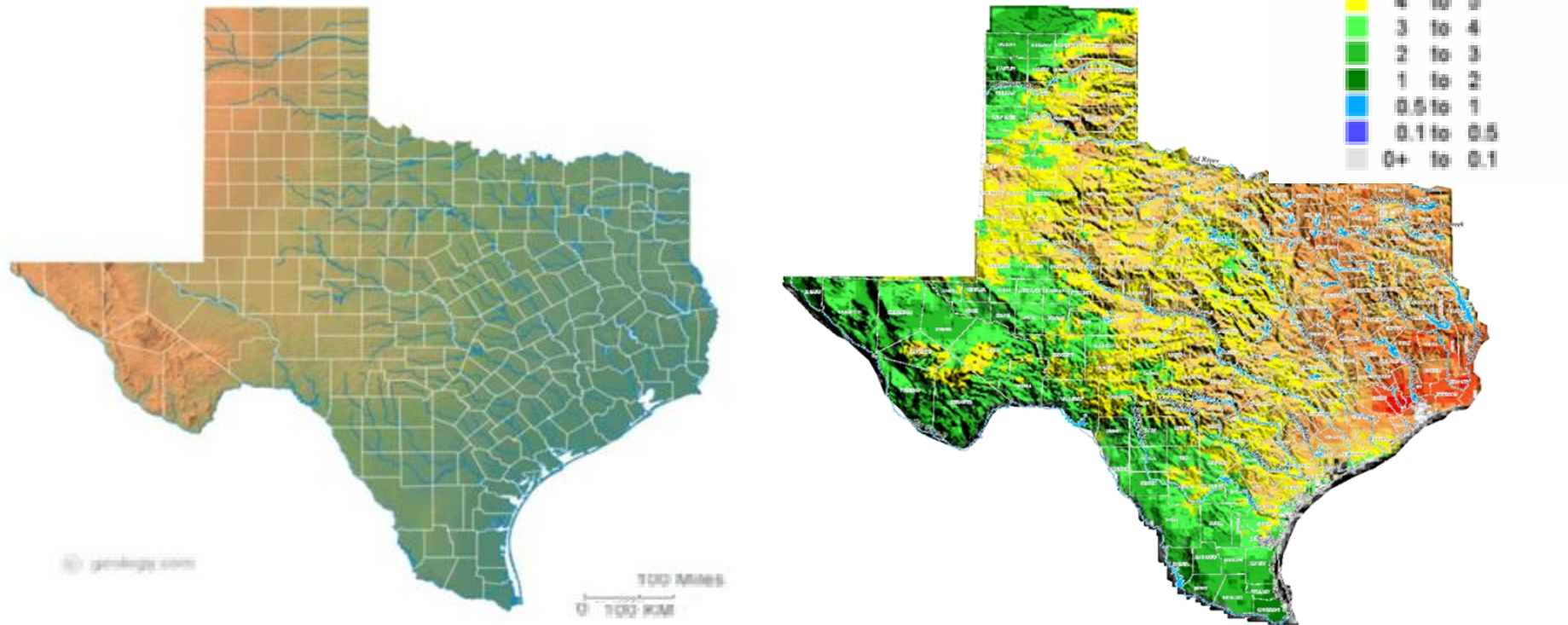
Texas Topography and Lightning Density Maps

Lightning patterns are not tied only to topography

Colorado County Topography and Lightning Peak Current

Colorado County, TX
Area of Lightning Data coverage
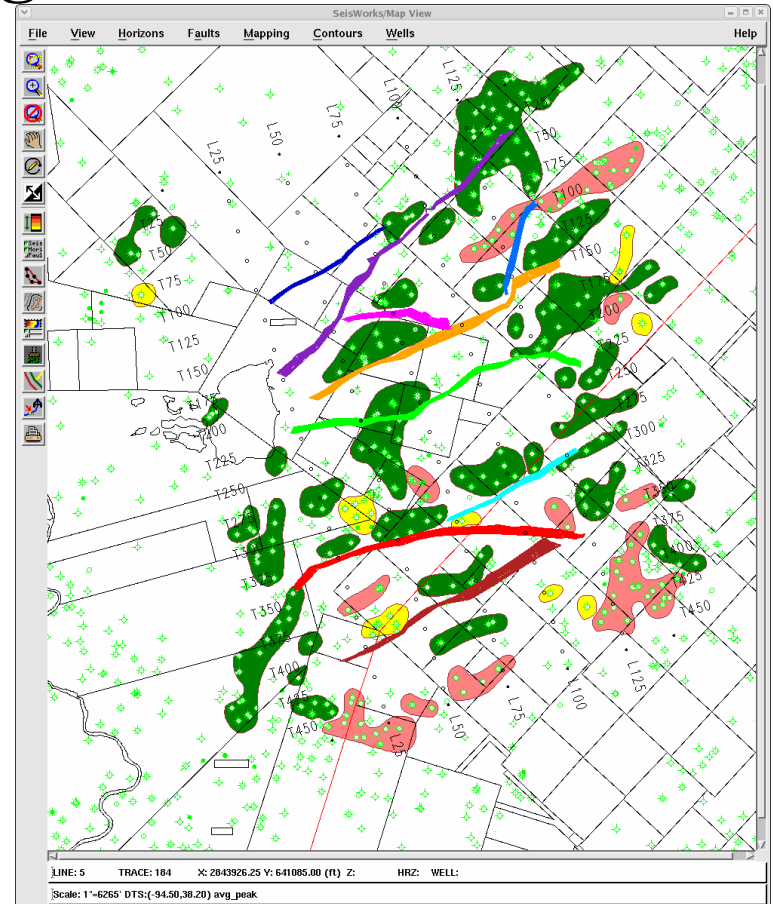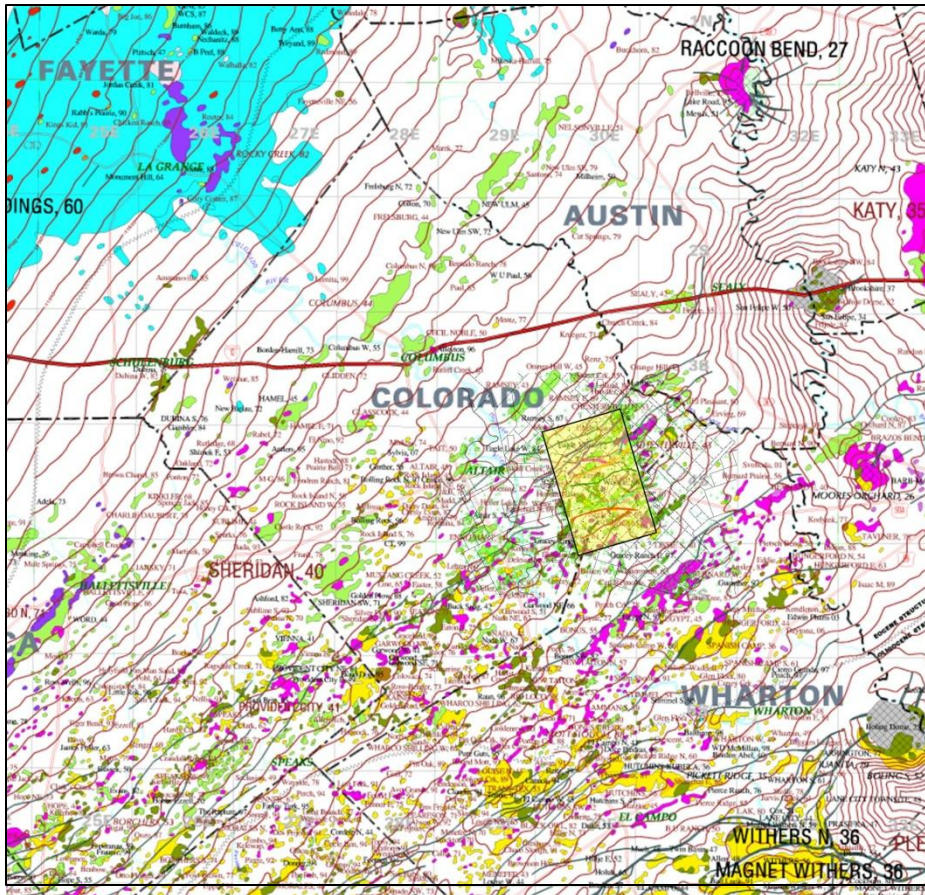
GeoMap oil and gas production: Colorado County, Texas
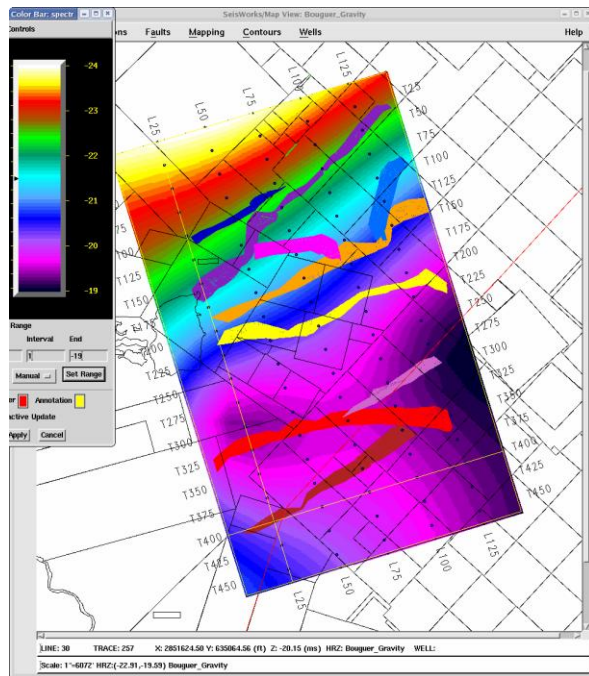
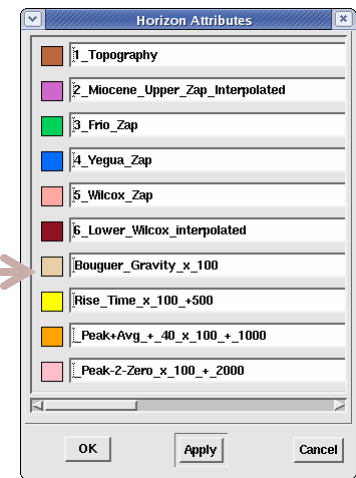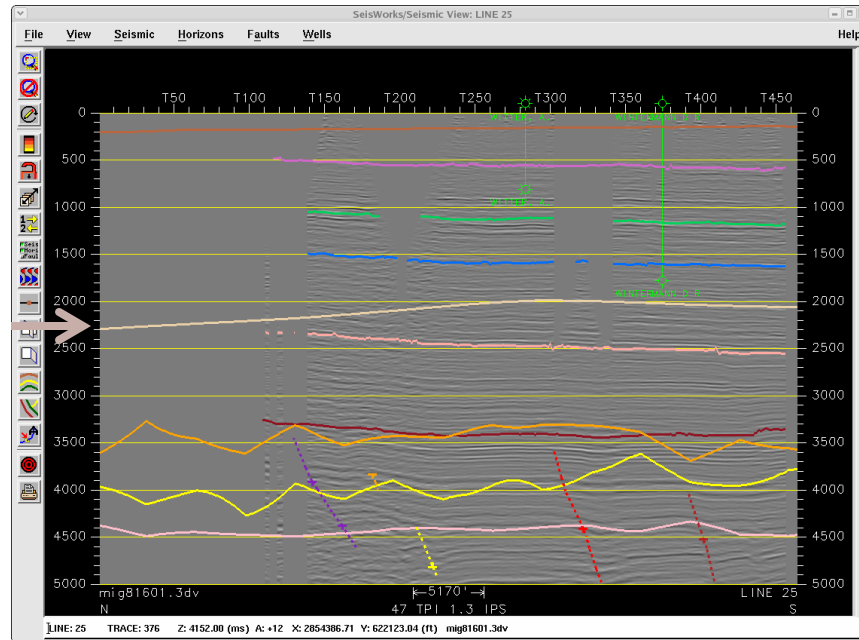# Lightning patterns are not all understood yet
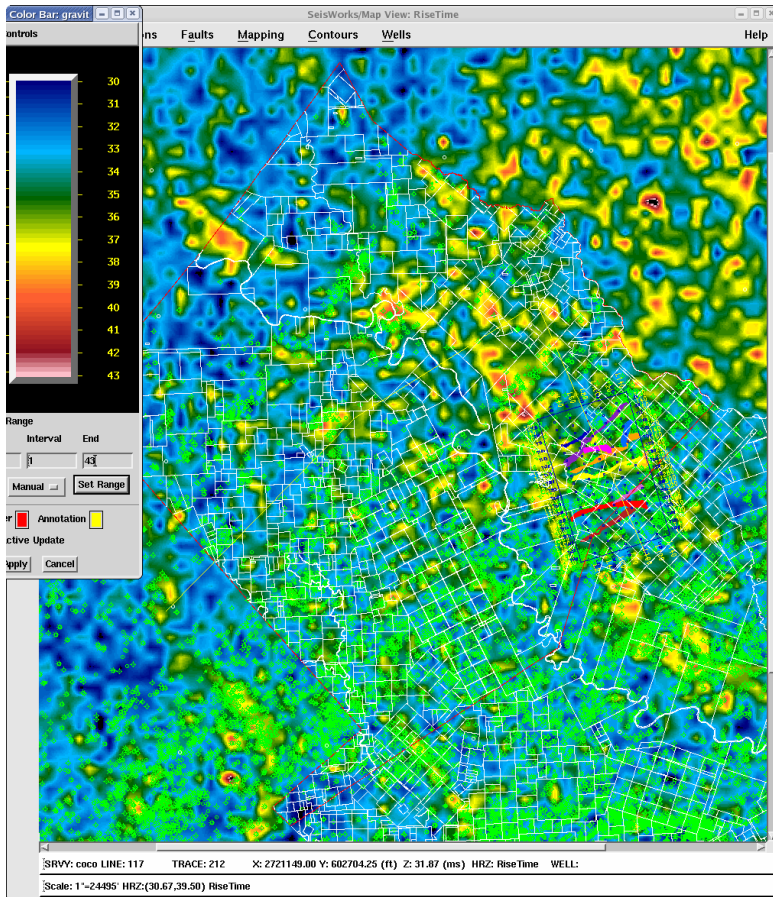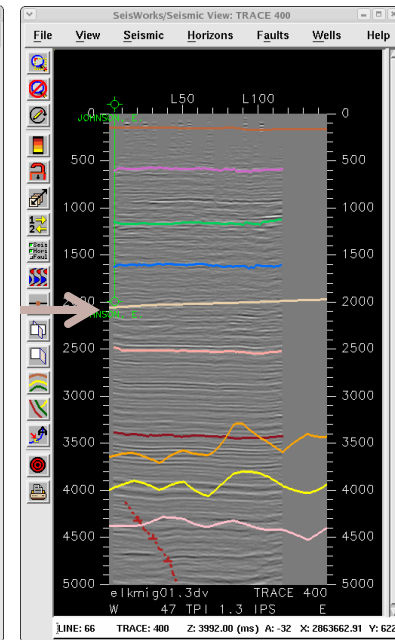

Rise Time
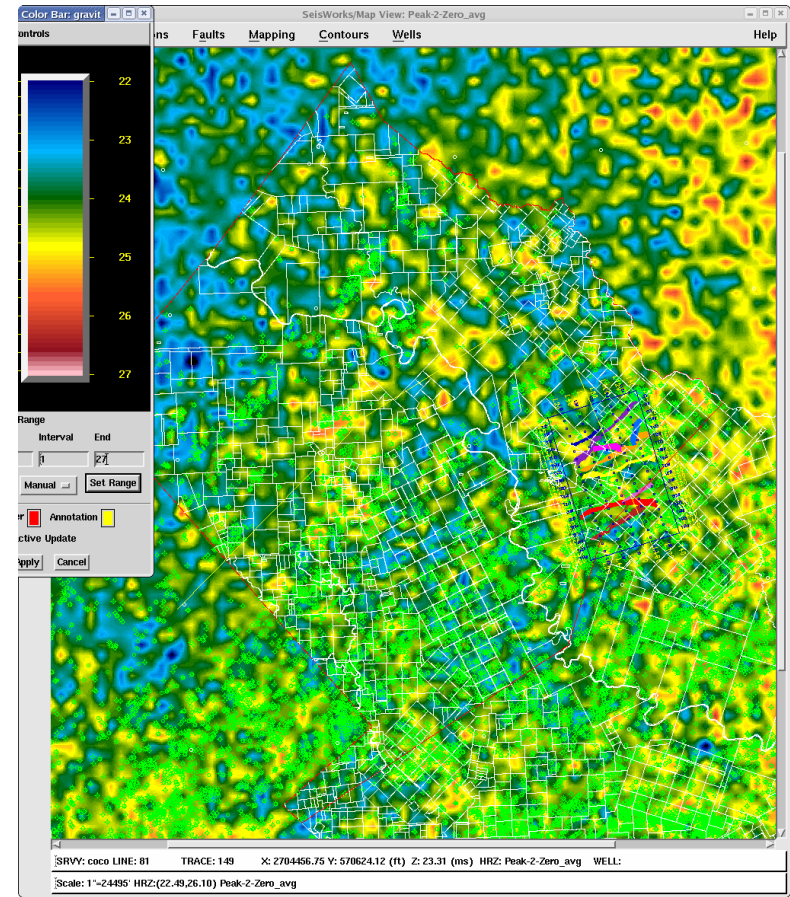
Peak-to-Zero

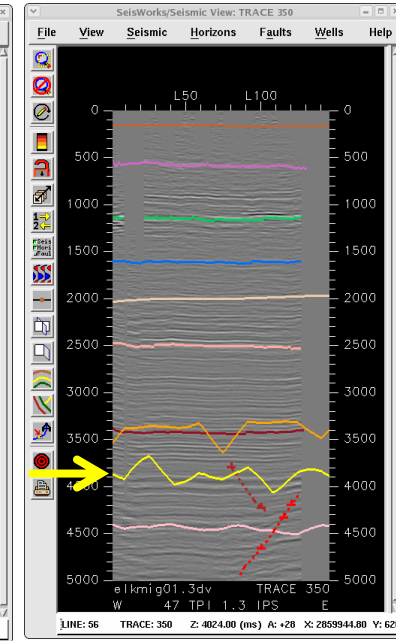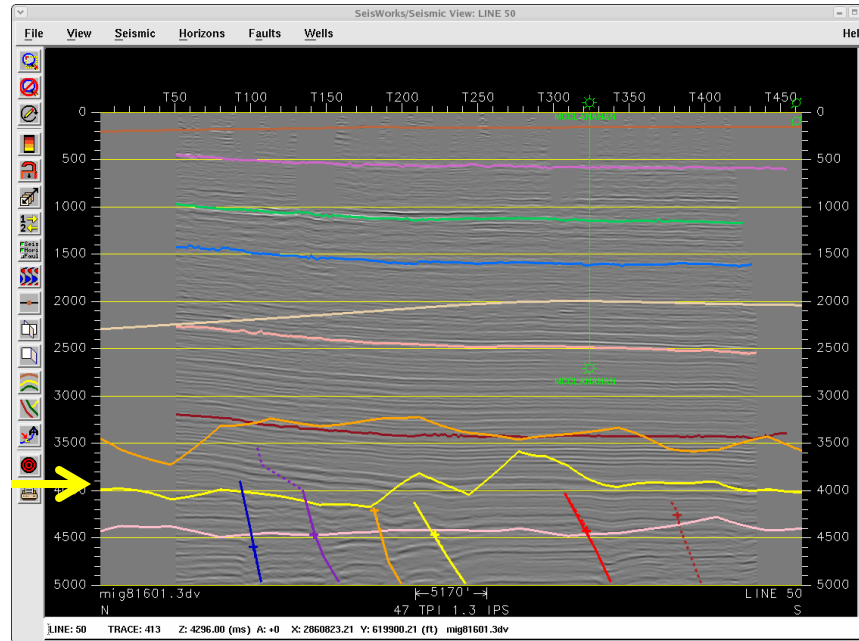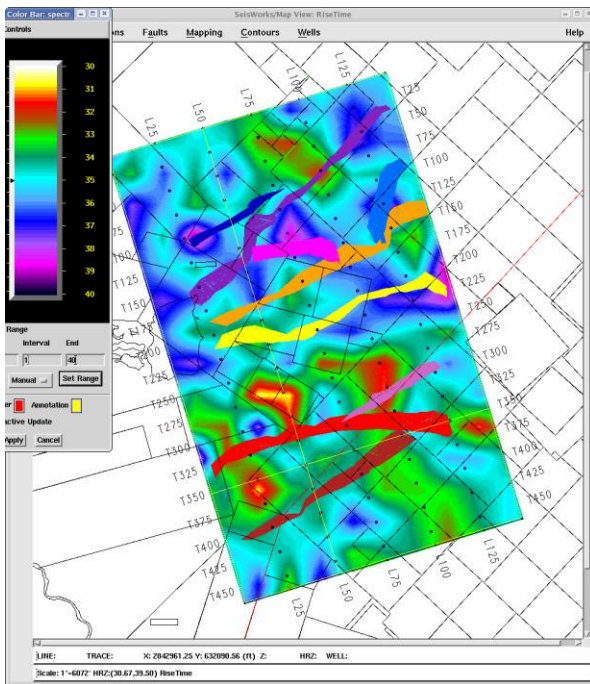# Integrating Lighting data with seismic
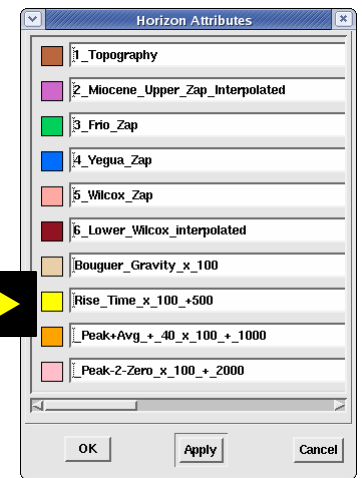

Bouguer Gravity   Line 25   Trace 400

16

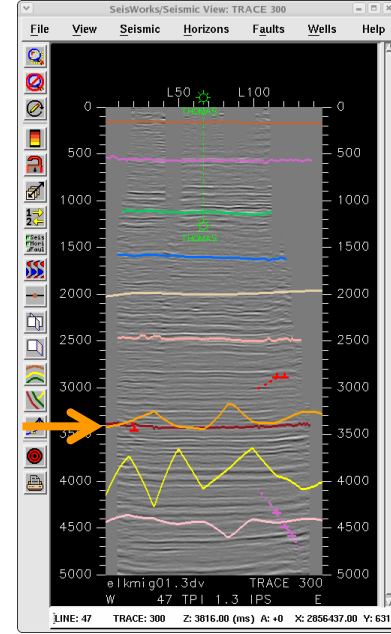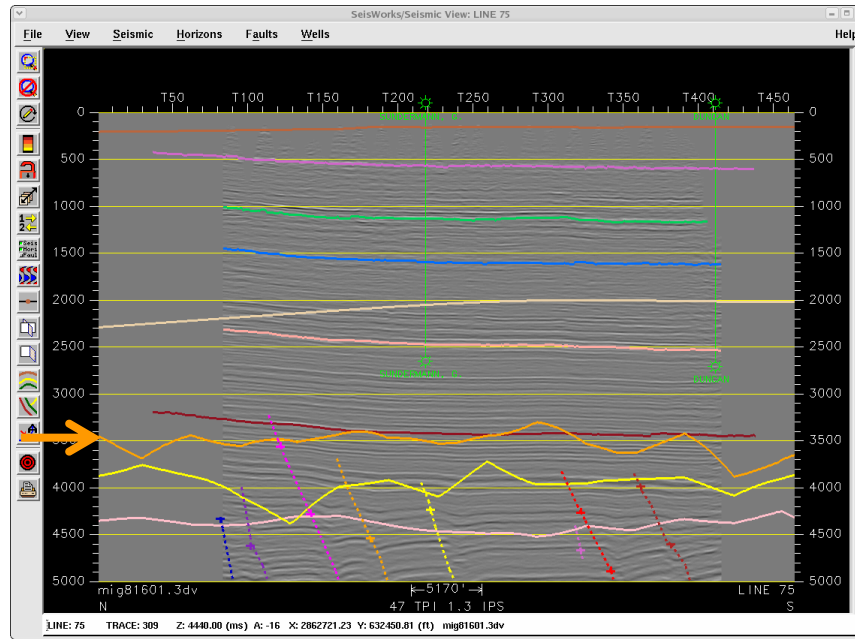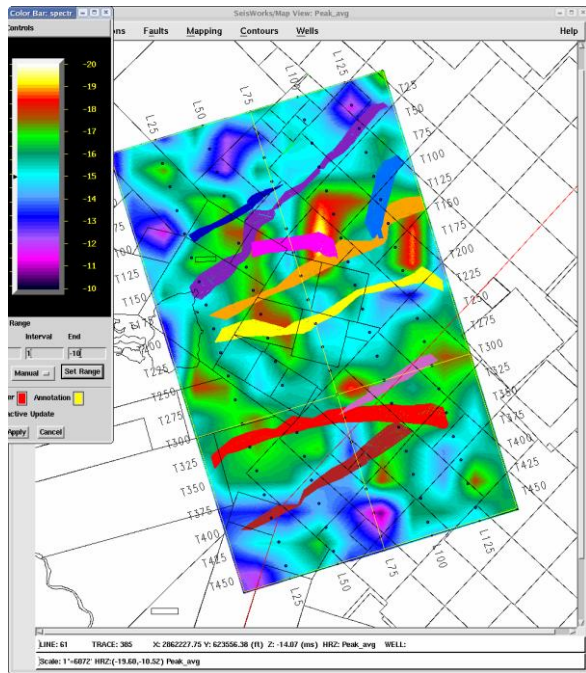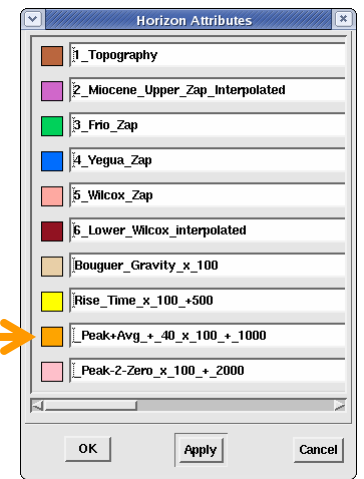# Integrating Lighting data with seismic

Rise Time   Line 50   Trace 350
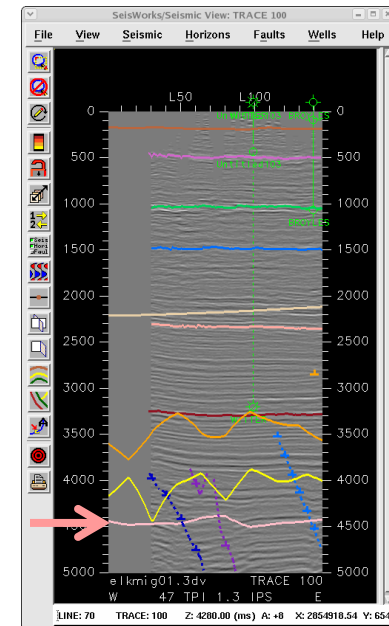
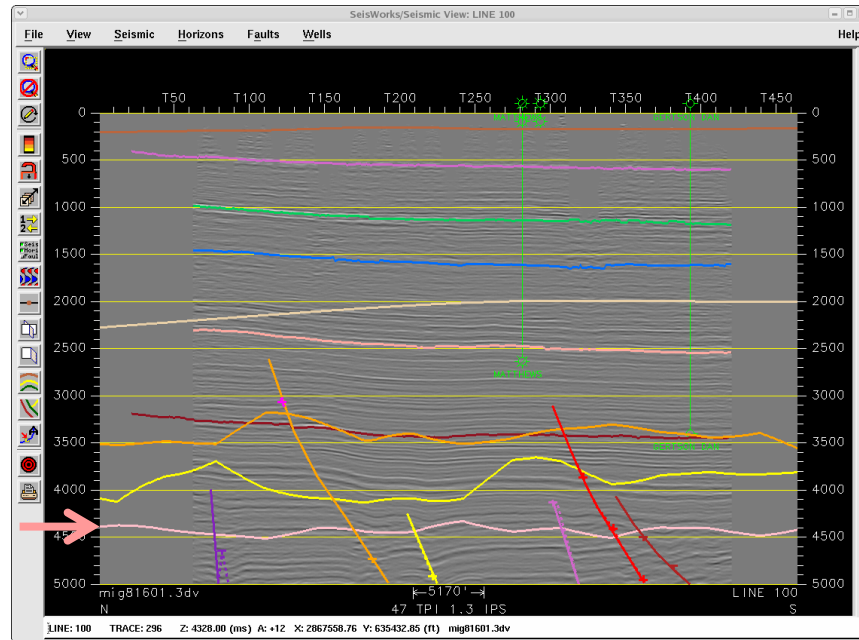# Integrating Lighting data with seismic
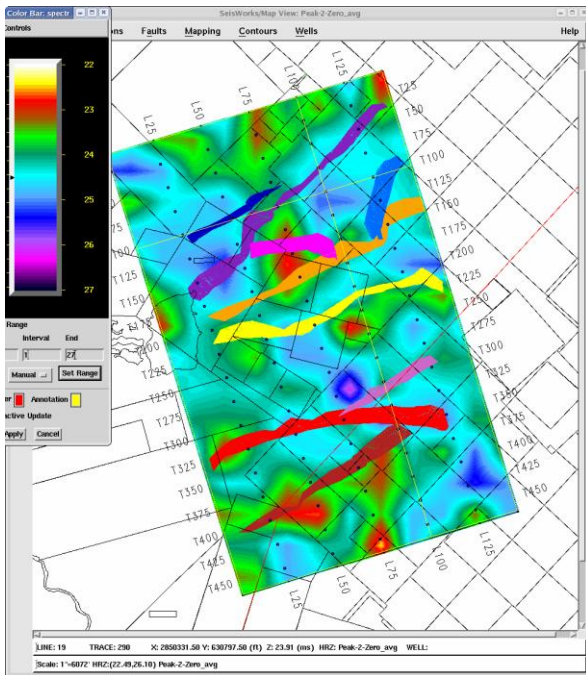

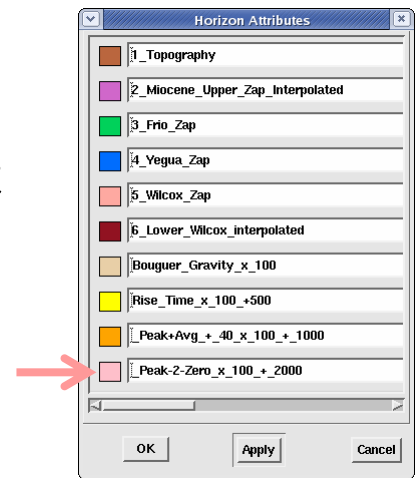
Peak Current   Line 75   Trace 300

Integrating Lighting data with seismic
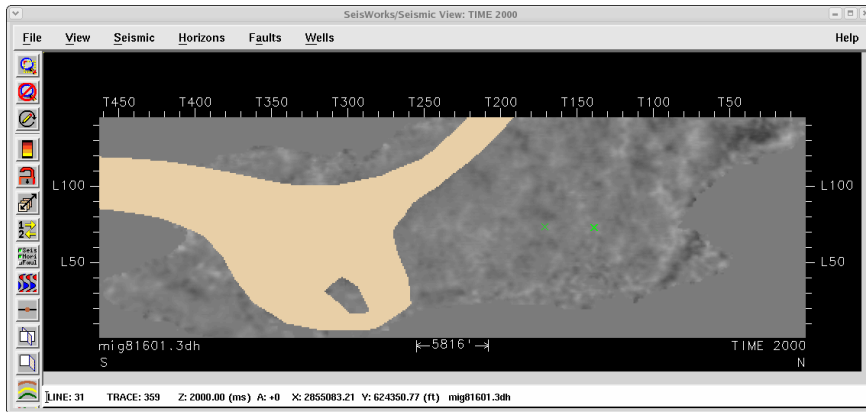

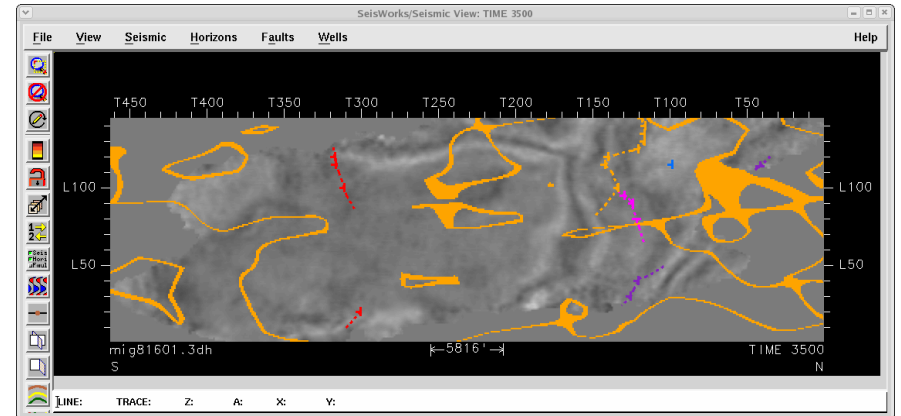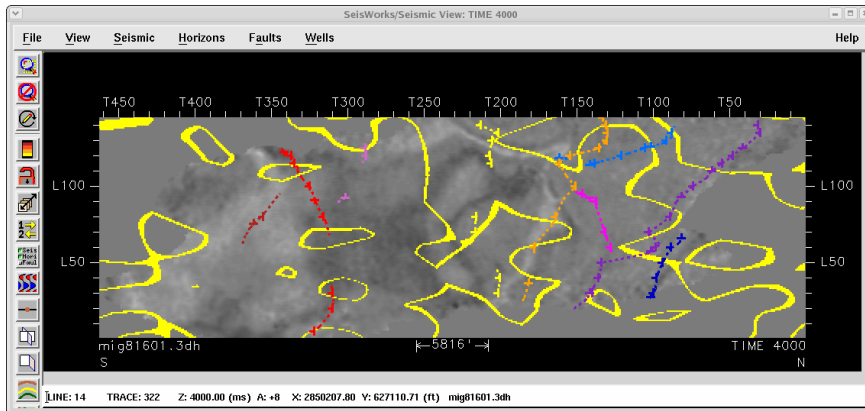Peak-to-Zero   Line 100   Trace 100

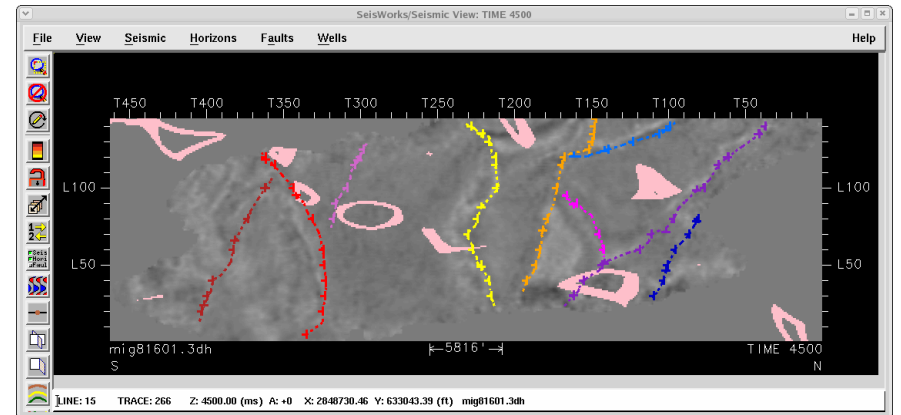# Integrating Lighting data with seismic time-slices

Bouguer Gravity 2000 ms

Peak Current 3500 ms

Rise Time 4000 ms

Peak-to-Zero 4500 ms

Lightning Data is
the new electromagnetic "seismic" data

- Acquisition, Noise Removal, Processing, Interpretation, and Integration are similar to seismic data exploration processes

- Lightning Data is a new geophysical data type

- There will be much more discovered as additional projects are undertaken

Yellow: Red Sky 3-D seismic outline
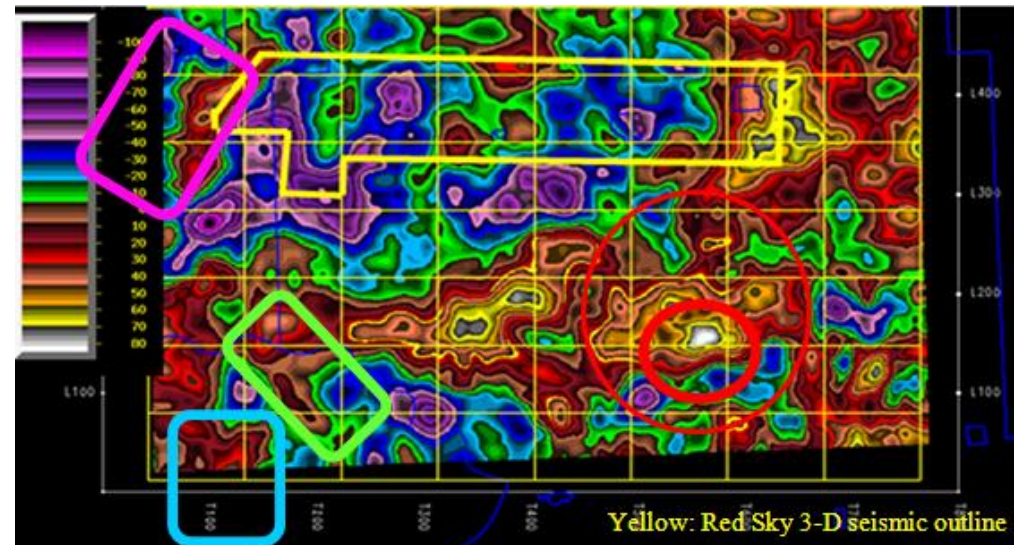
This is just the beginning . . .

Missouri Skies: http://www.athousandandone.com/27/