



Advances in Lightning Technology; Creating New Protections for the Pipeline Industry

A New Geophysical Data Type

A fast, cost-effective complement to existing data

Jim Siebert, Ph.D.

FOX 26 News Houston

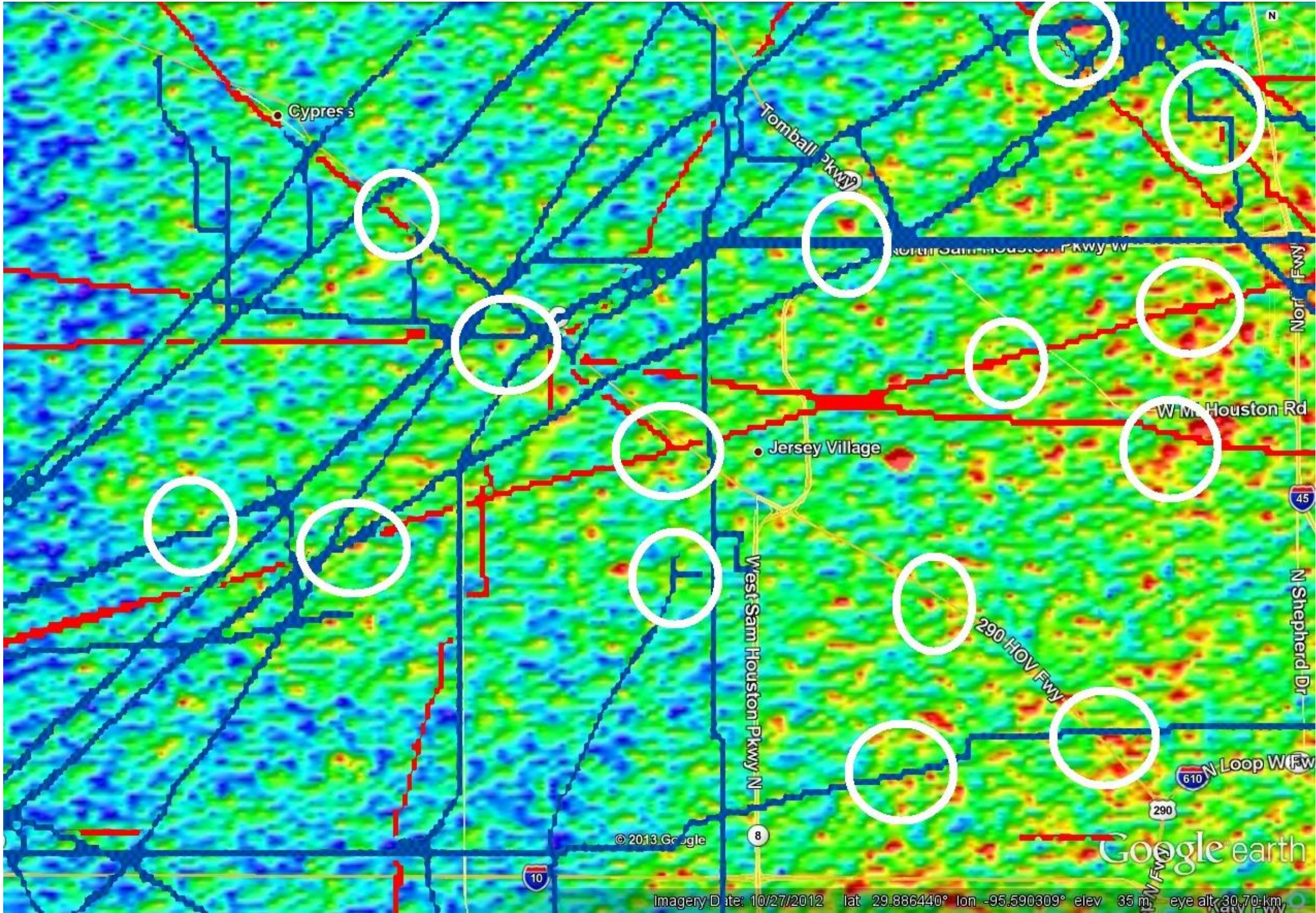
Dynamic Measurement LLC

“Studies of space weather effects on the Finnish natural gas pipeline and on the Finnish high-voltage power system.”



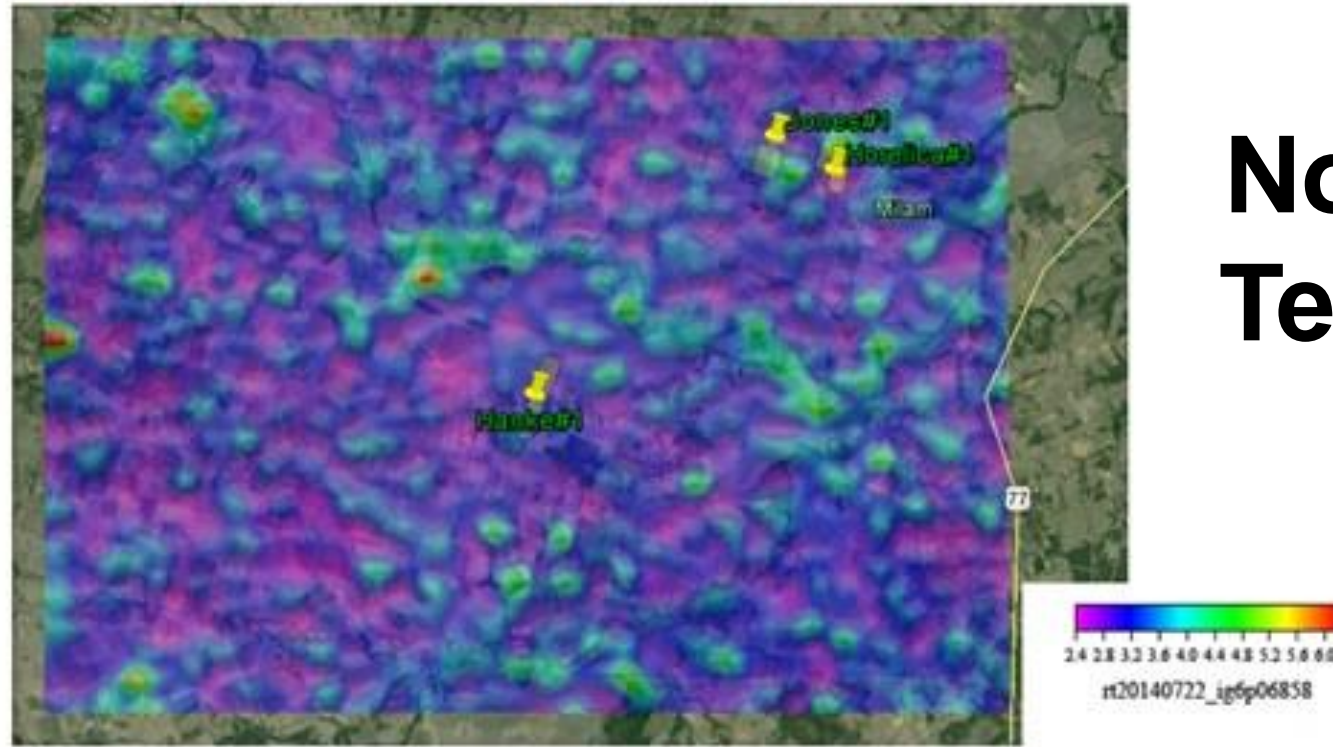
Geomagnetically Induced Currents (GIC) in technological systems are the ground end of the complicated space weather chain. Values greatly depend on the network (pipeline) configuration. The electric field at the Earth's surface is the key parameter when calculating GIC in a network.

Pipeline Protection from Lightning & Geomagnetic Hot Zones

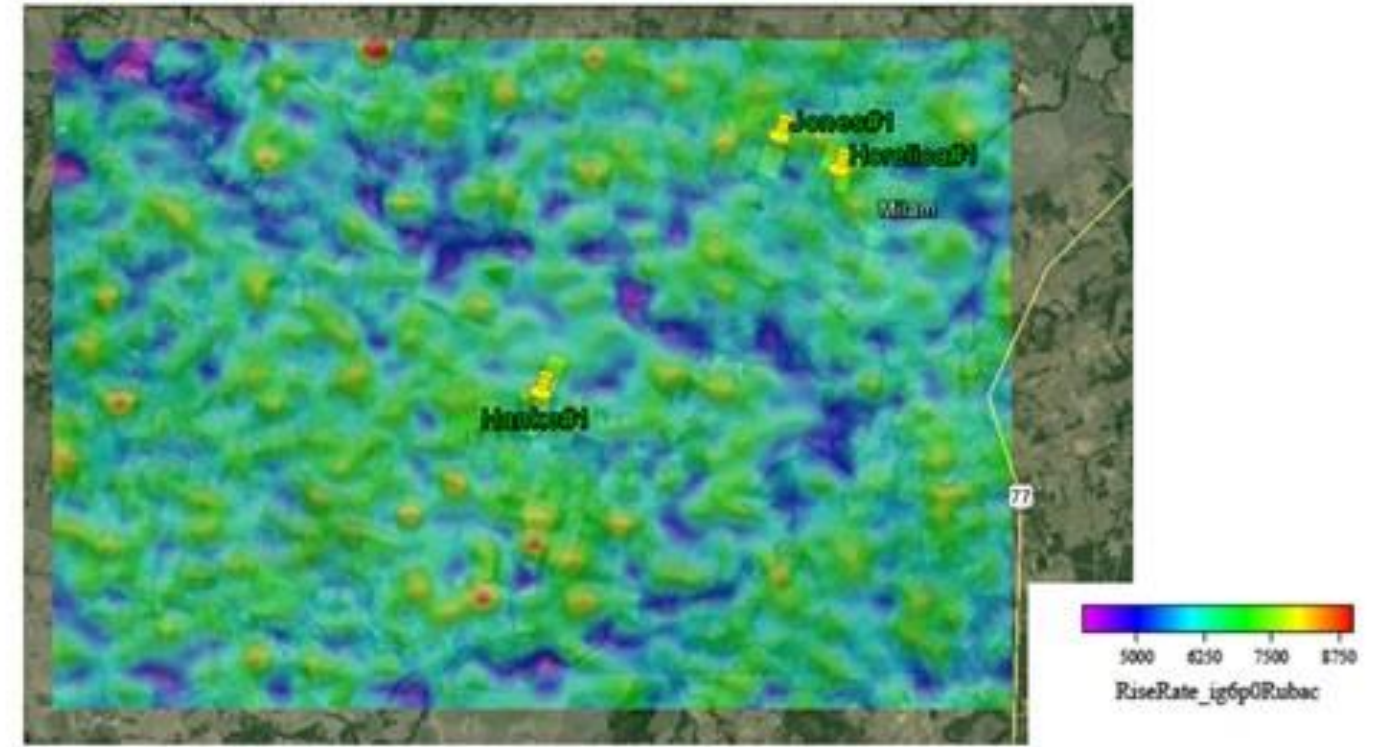


Shallow Stratigraphy Interpretation from Lightning Data

Rise-Time

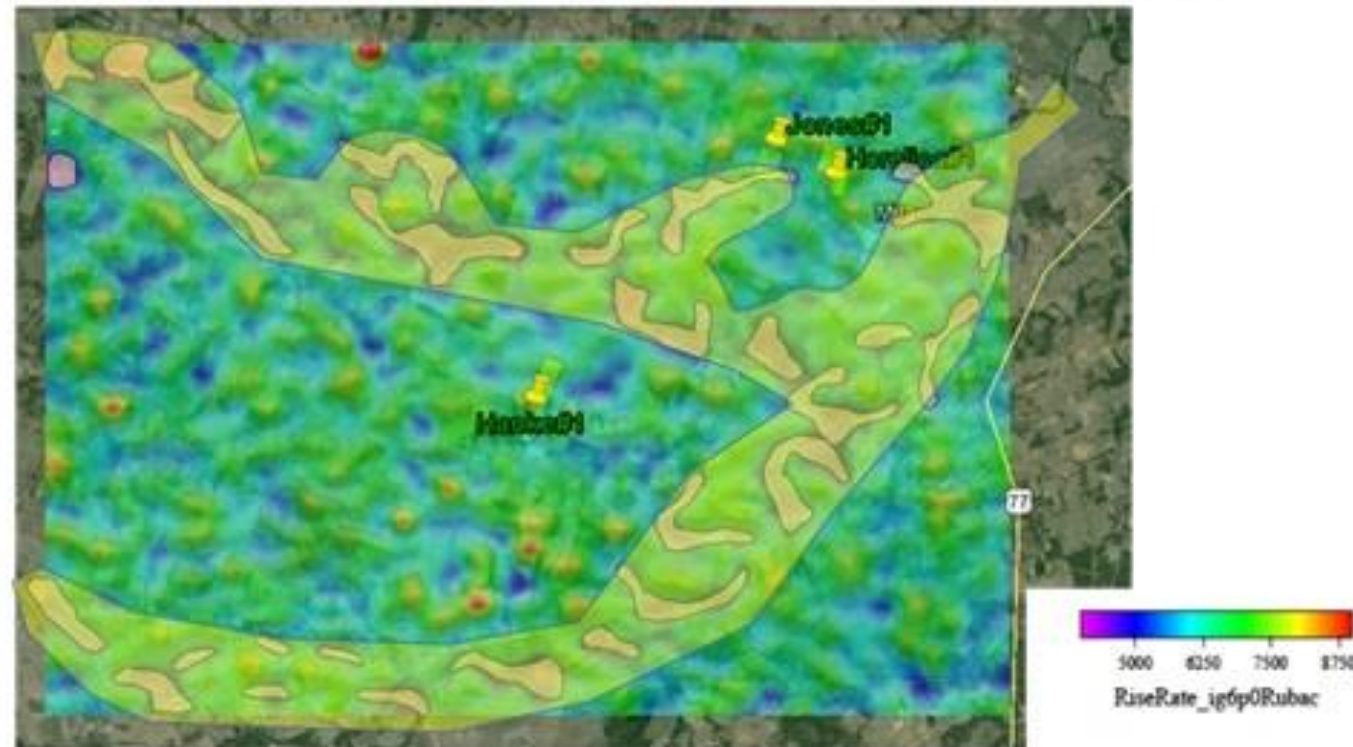


Rise-Time-Rate



North Texas

Interpretation: modern point bars and areas anticipated washed of hydrocarbons.



Interpretation overlaid on Google map of area



Storm Time Lapse





Meteorologists study clouds



Geophysicists study rocks



Lightning Data is both an Old & a New Geophysical Data Type

1752 Benjamin Franklin measured electricity attaching a metal key to the bottom of a dampened kite, in what we now know as the Marcellus Shale Resource Play.

1833 First measurements of earth's magnetic field

1920's Seismic refraction & reflection techniques pioneered in Germany & U.S.

1927 Schlumberger's first electrical resistivity well log recorded in France.

1936 First modern Gravimeter Howard N. Potts Medal to Vening Meinesz.

1950's Magnetotellurics invented, measuring lightning charged earth currents.

1960's & '70's The first image processing of satellite imagery.

1974 First 3-D seismic survey collected for Gulf Oil.

1997 CSEM (Controlled Source Electromagnetics).

2008 Data mining lightning data as a new Geophysical Data Type.

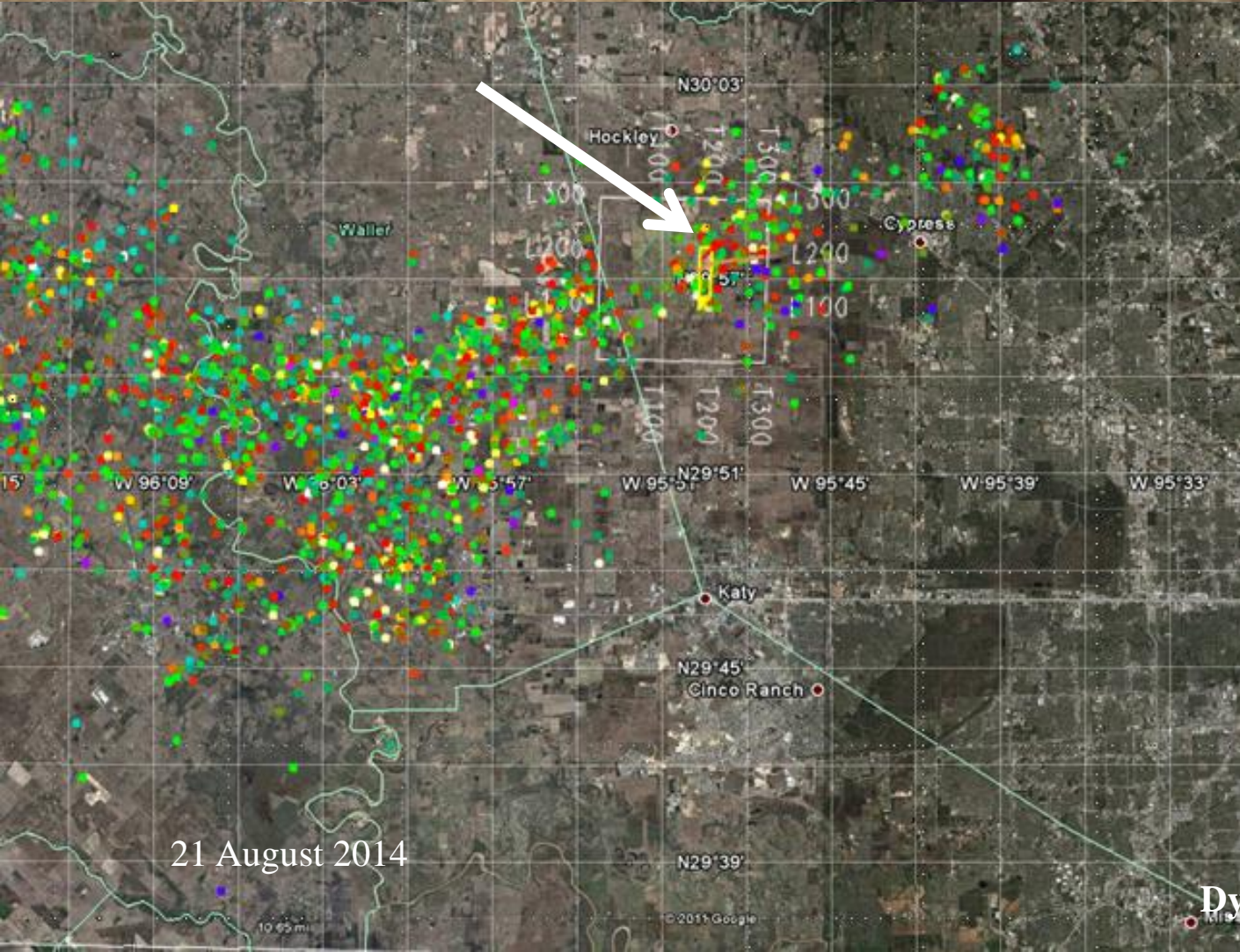
Each new data type sparked millions of dollars in sales of data & services.

How It Started



Something between:

- Inspiration
- Perspiration
- Curiosity





Co-Founders:

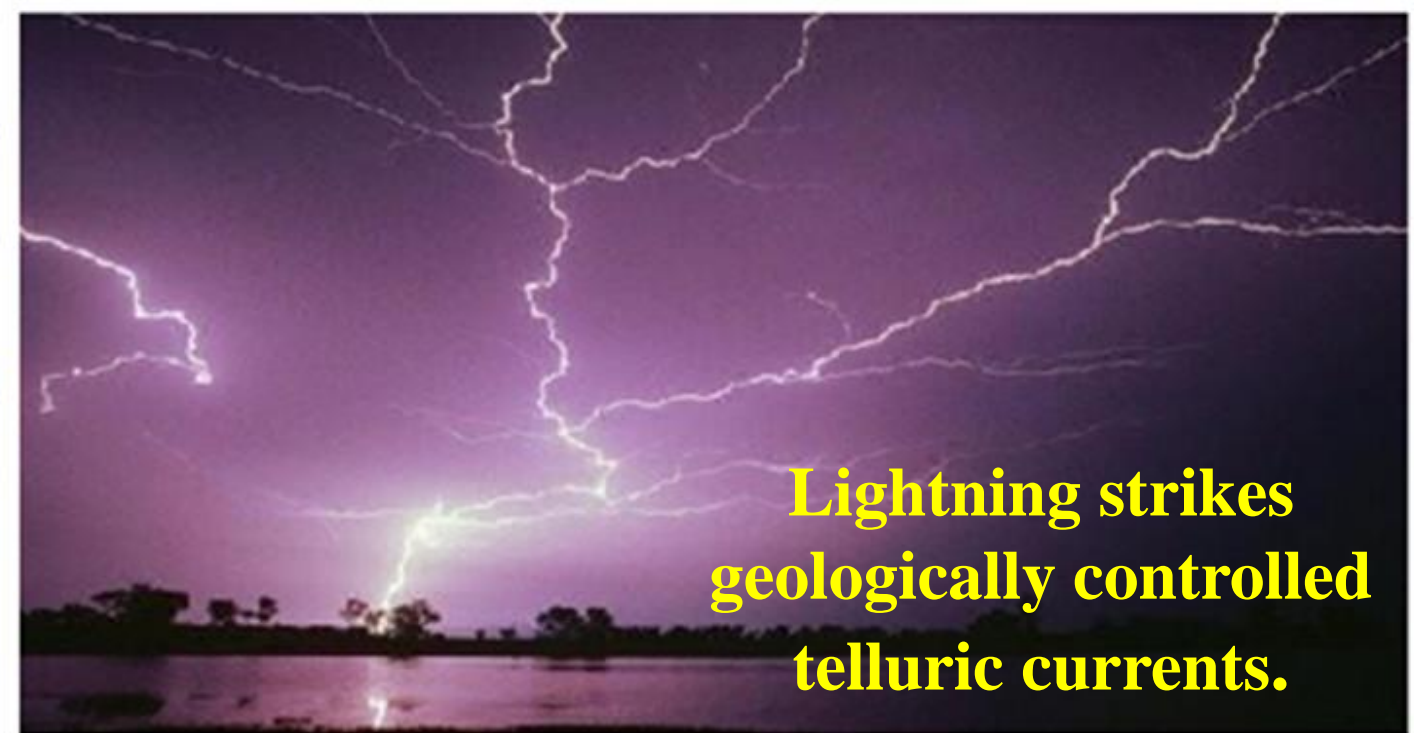
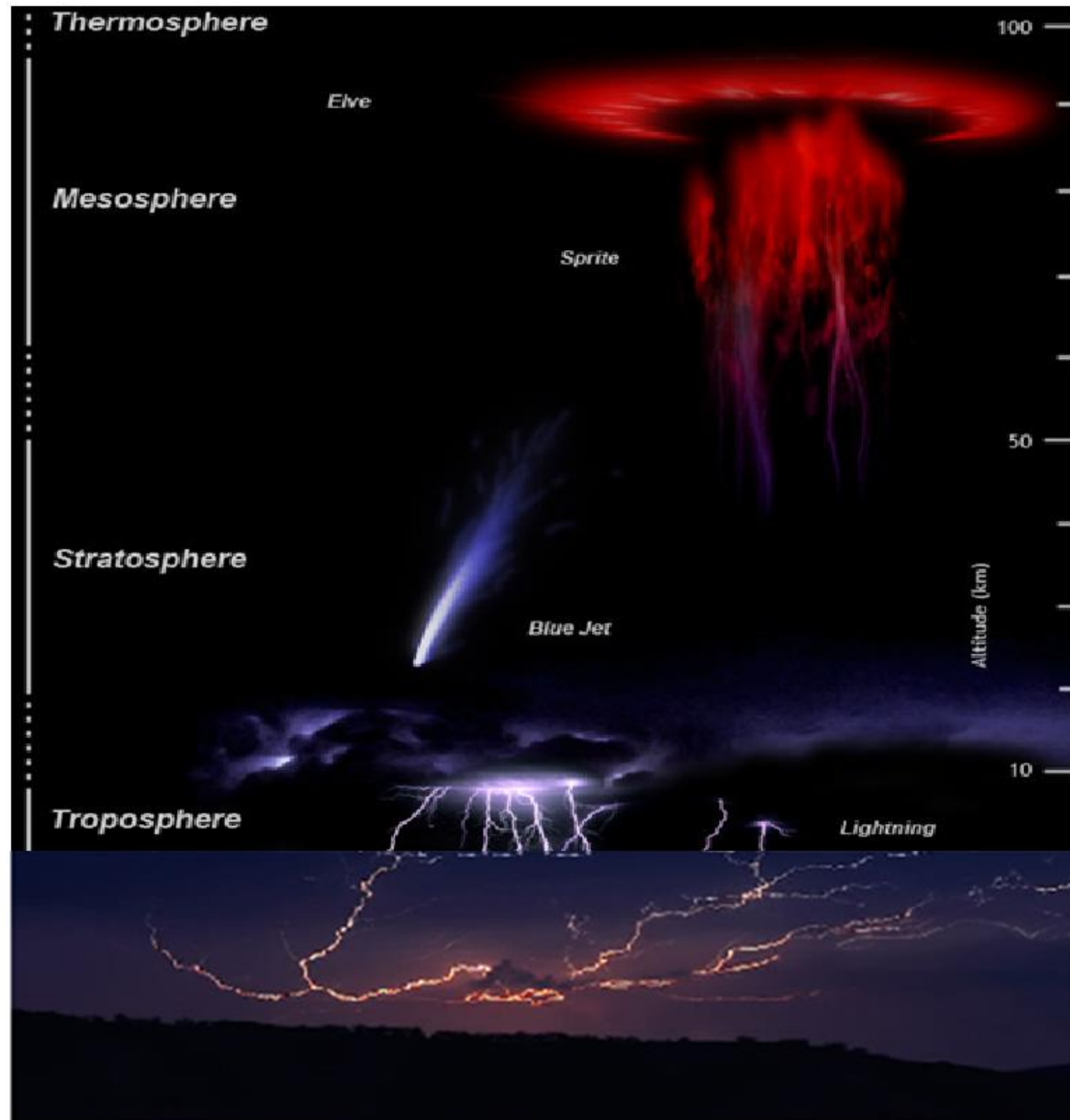
H. Roice Nelson, Jr. (geophysicist - entrepreneur)

Dr. D. James Siebert (meteorologist – earth sciences)

Les R. Denham (geophysicist – integration)



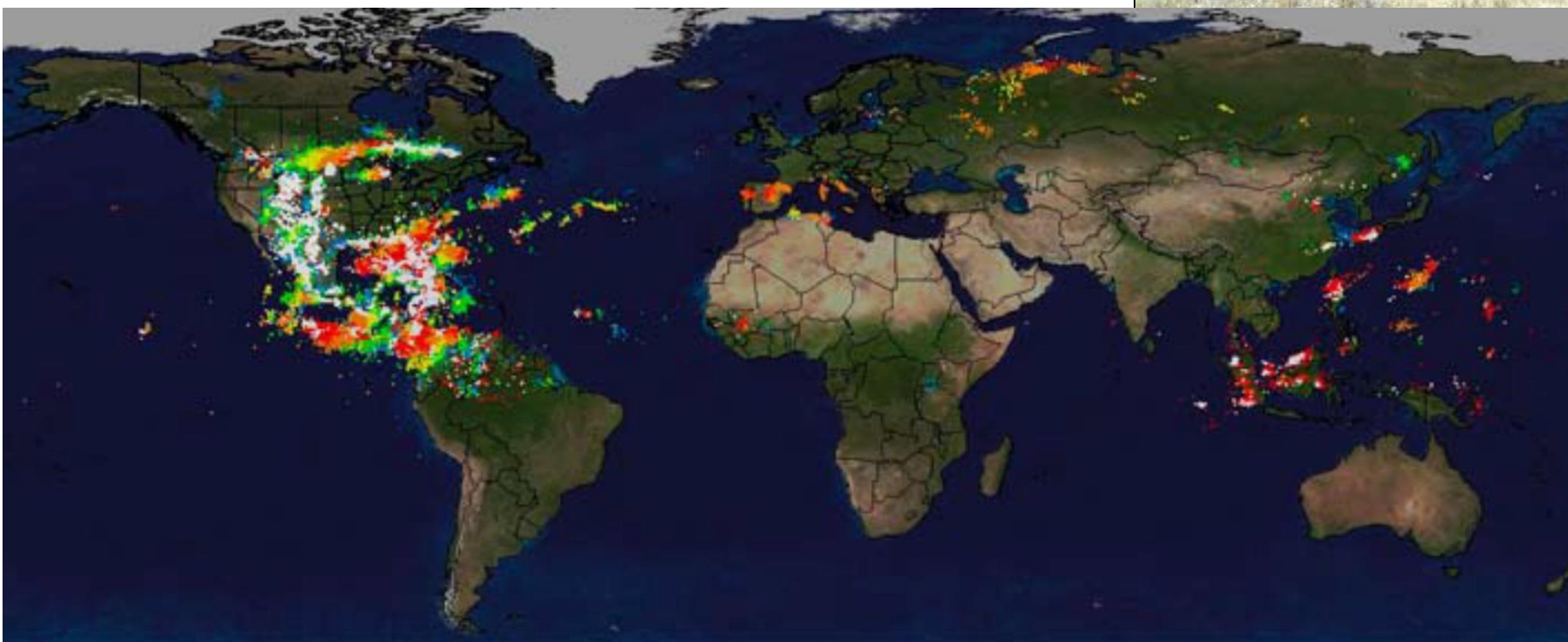
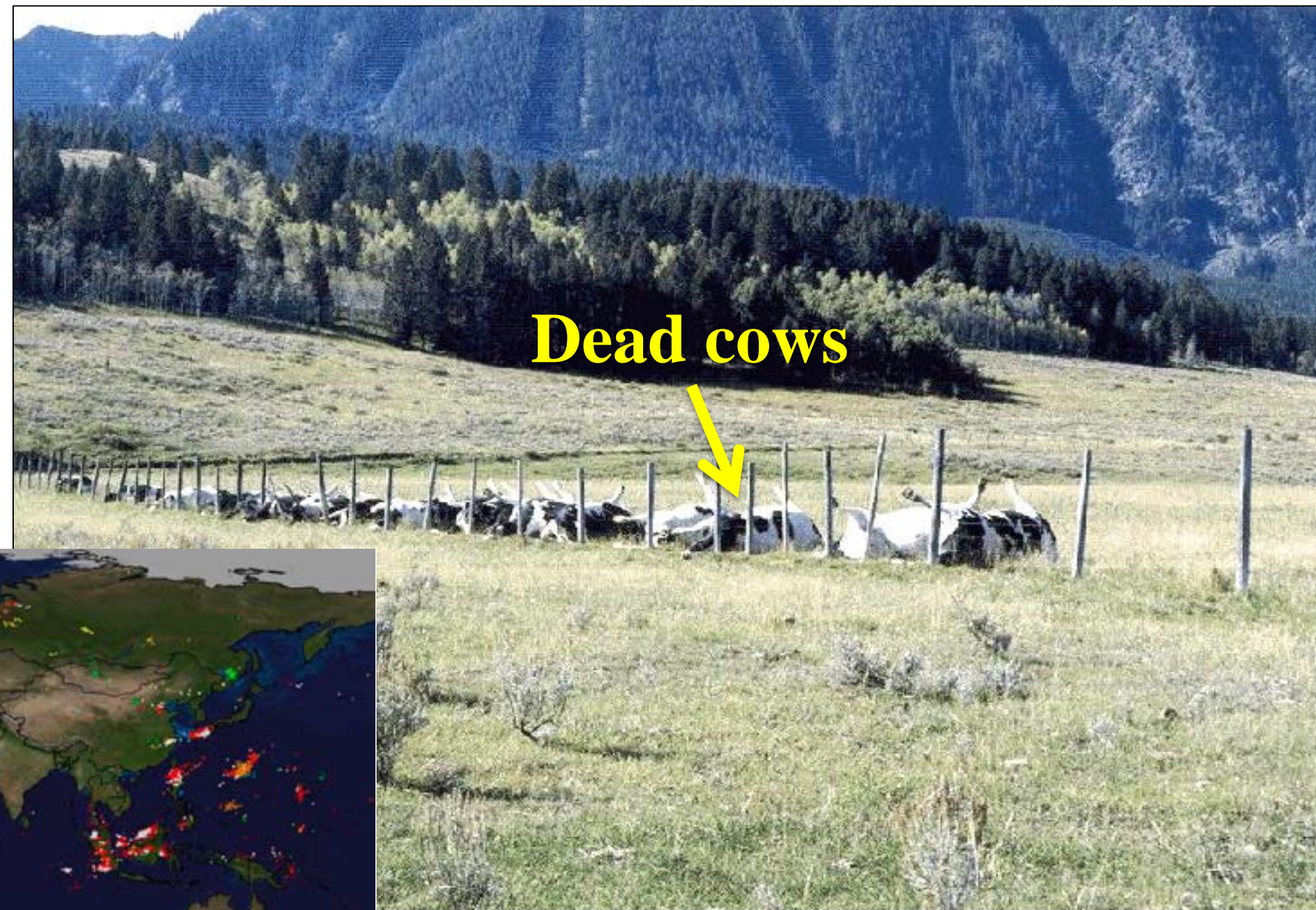
350 million annual cloud-to-ground strikes provide a rich database to mine



Lightning recorded for early storm warning, safety, **insurance**, & meteorology purposes



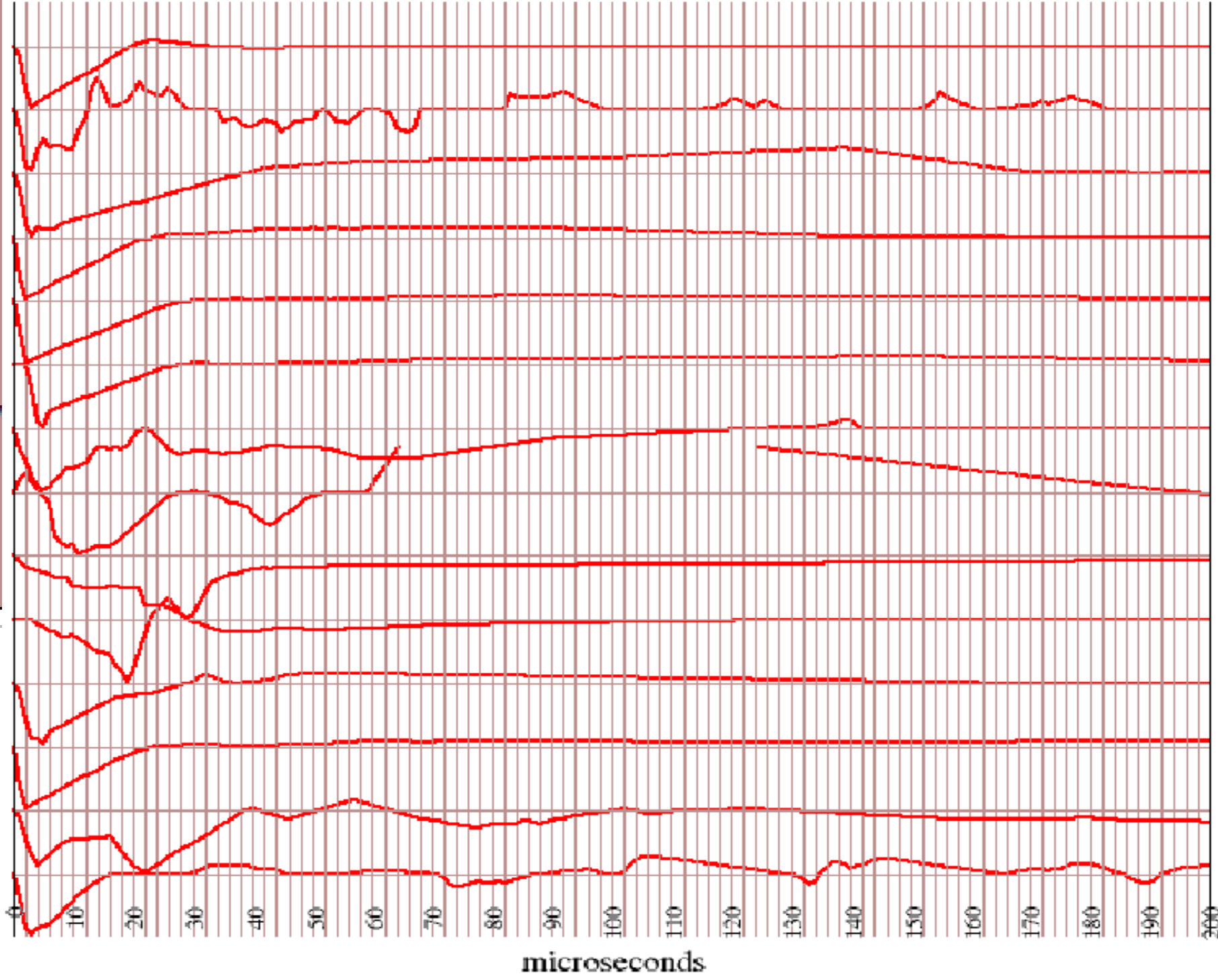
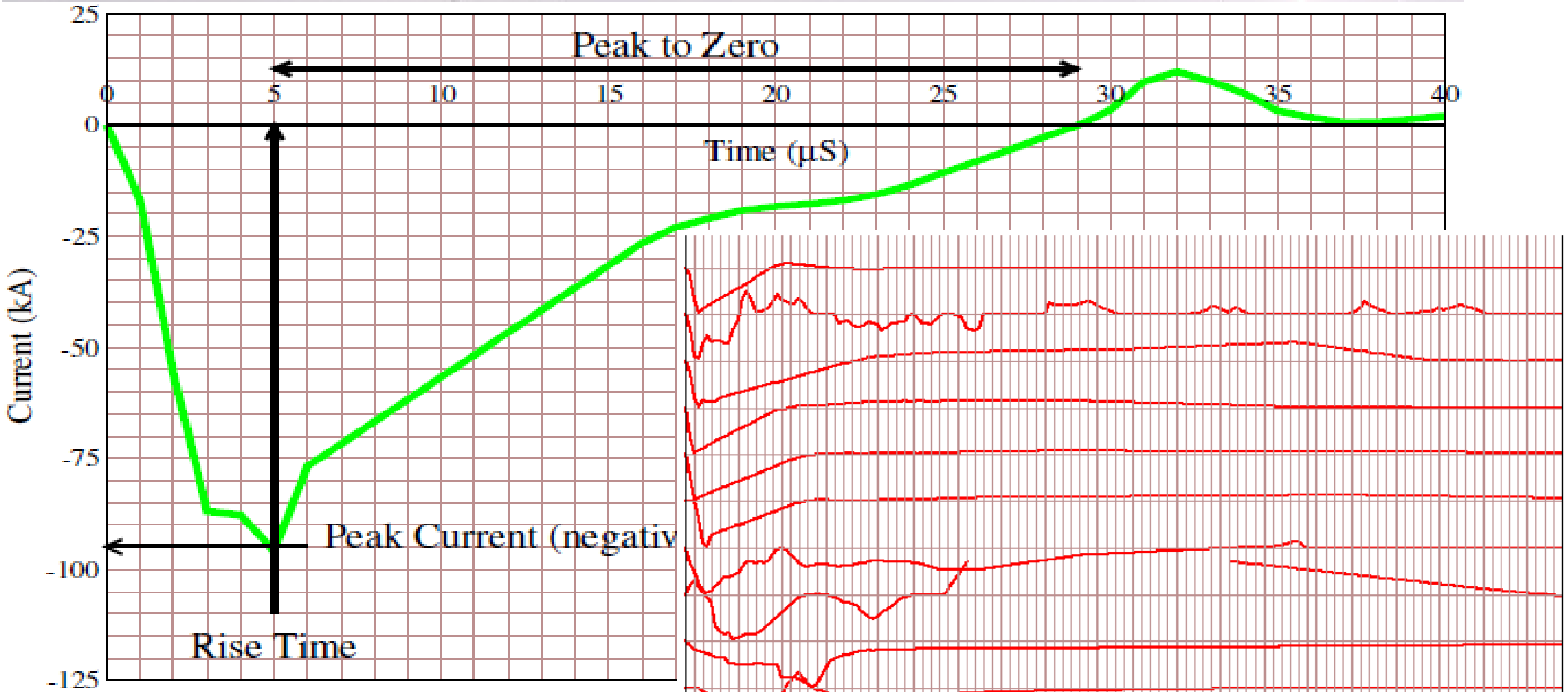
**The U.S. NLDN
(National Lightning
Detection Network &
Global 360) owned by
Vaisala**



Lightning Measurements

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

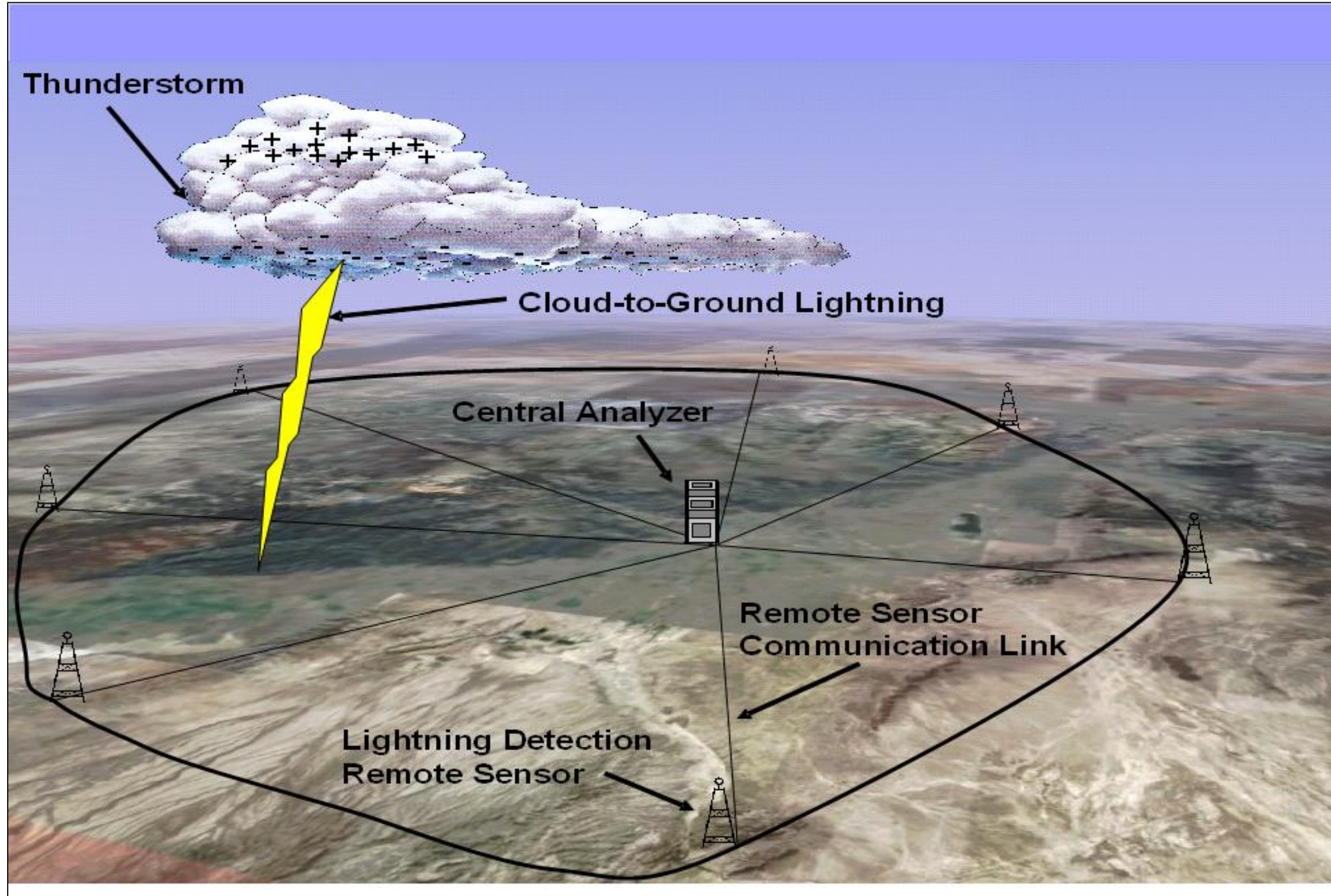




**Each Strike
is Unique**



~330 Sensors record U.S. lightning strikes with +/- 100-500 foot location resolution



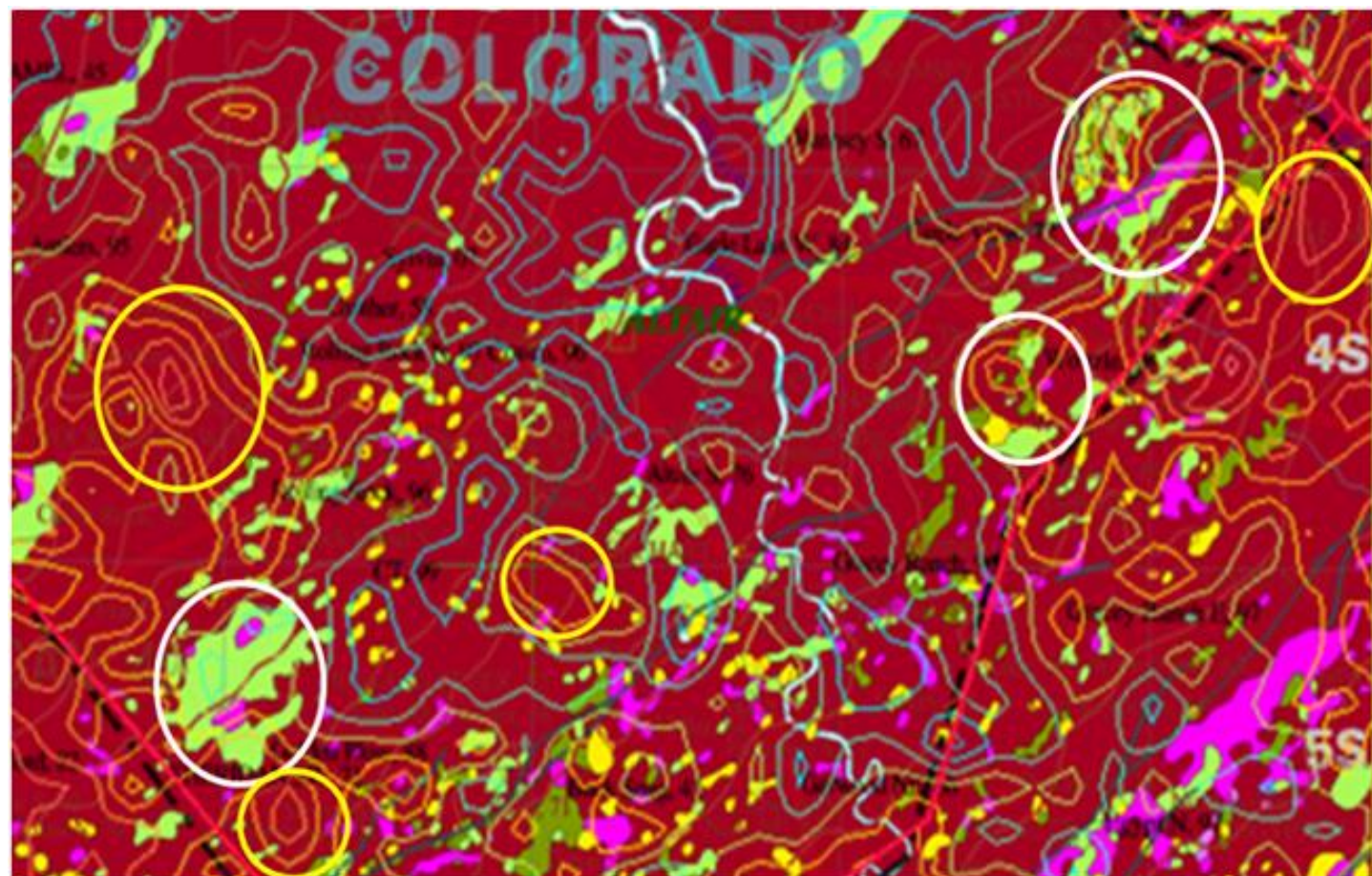


Lightning is more inclined to bypass tall objects in favor of geology.

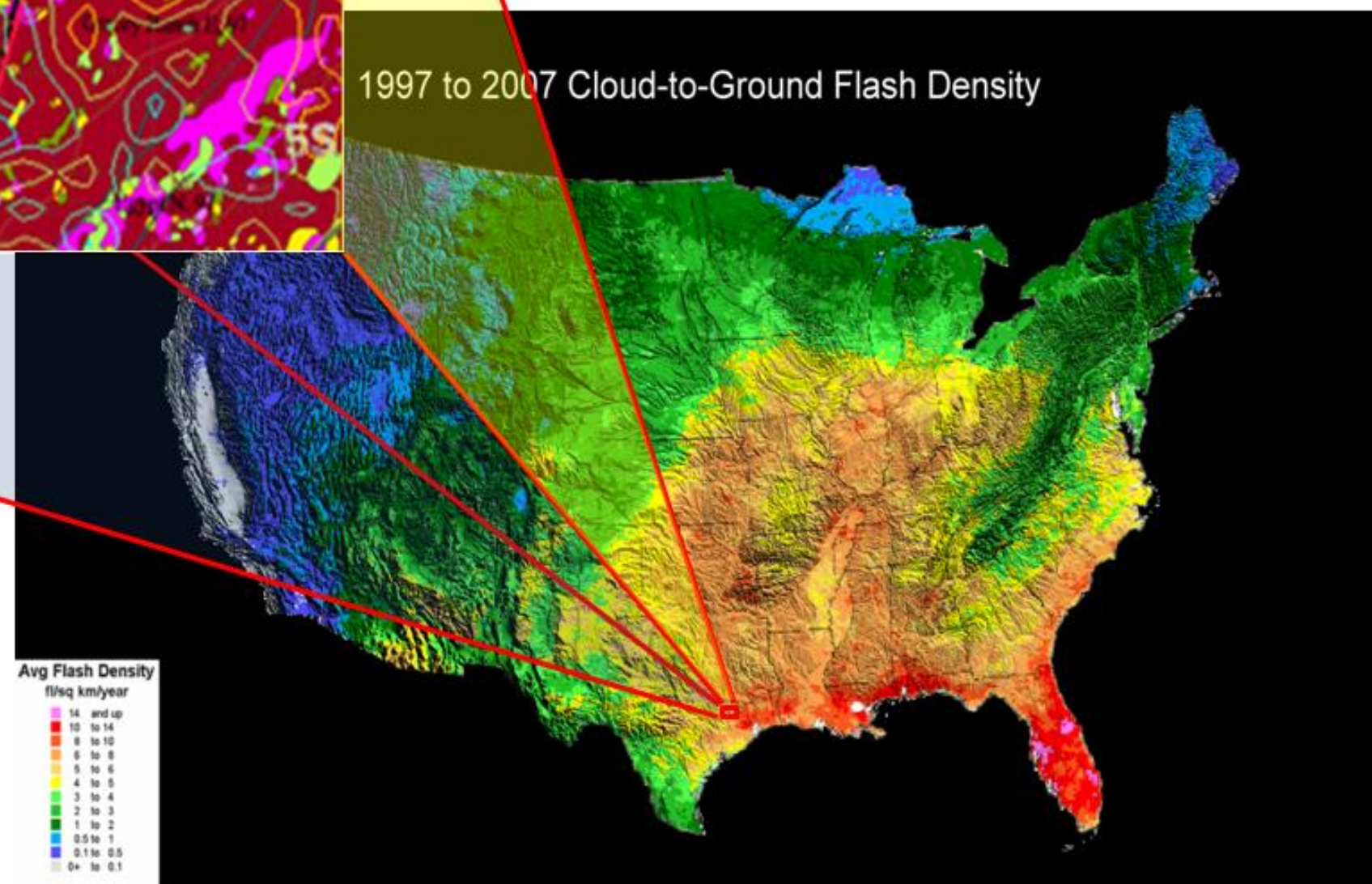
Lightning maps & natural resources



Lightning strike density variations are regionally controlled by Meteorology & locally controlled by Earth/Telluric currents.



Colorado County, TX. The green anomalies are known oil & gas fields. The yellow circles are new leads.



Proven and Patented Technology

(12) **United States Patent**
Nelson, Jr. et al.

(10) Patent No.: **US 8,344,721 B2**
(45) Date of Patent: **Jan. 1, 2013**

(54) **METHOD FOR LOCATING SUB-SURFACE NATURAL RESOURCES**

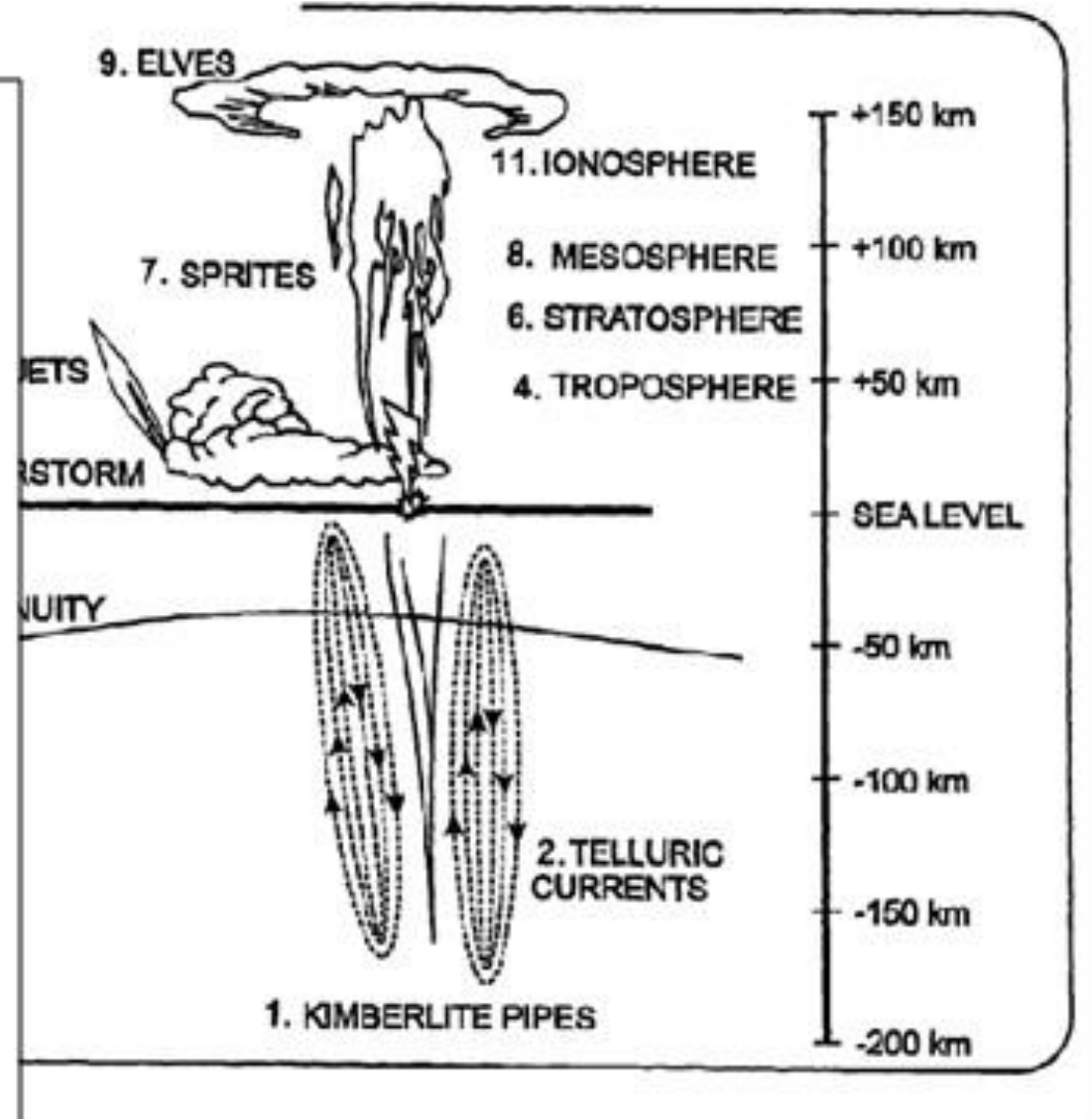
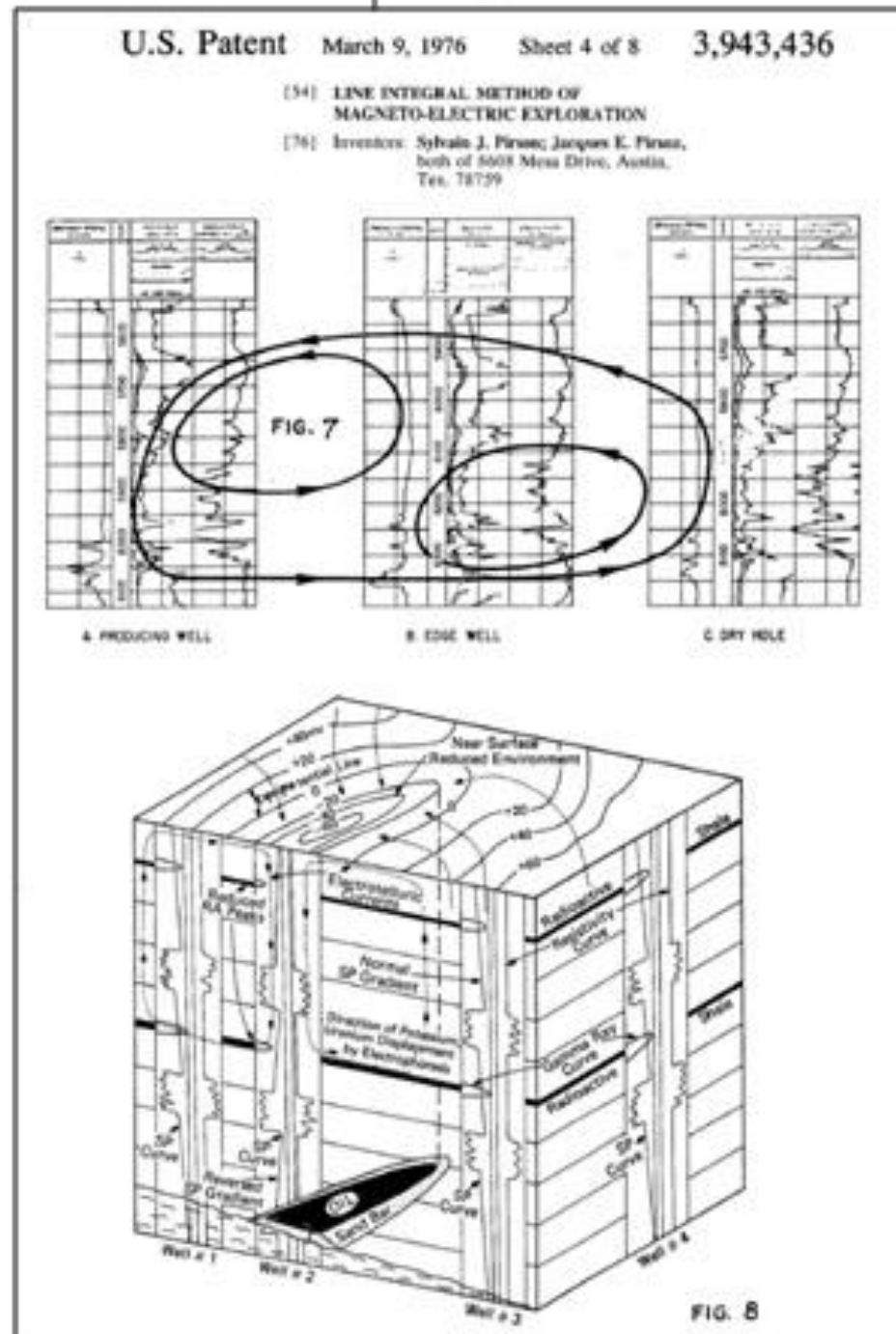
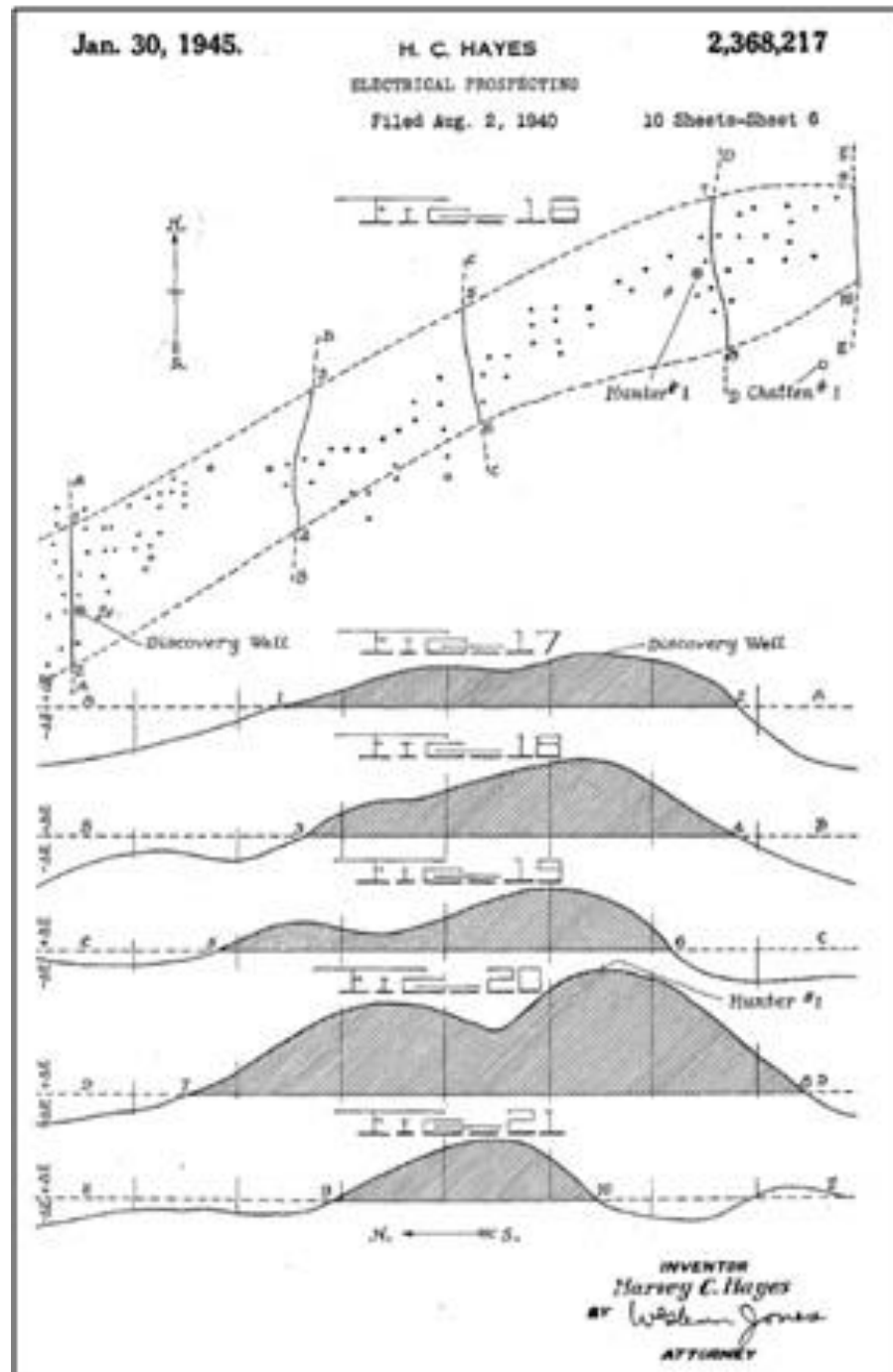
(51) Int. Cl.
G01R 31/02 (2006.01)
G01N 27/00 (2006.01)
G01W 1/00 (2006.01)

(75) Inventors: **H. Roice Nelson, Jr.**, Houston, TX (US); **Joseph H. Roberts**, Houston, TX (US); **D. James Siebert**, Katy, TX (US); **Wulf F. Massell**, Conroe, TX (US); **Samuel D. LeRoy**, Houston, TX (US); **Leslie R. Denham**, Houston, TX (US); **Robert Ehrlich**, Salt Lake City, UT (US); **Richard L. Coons**, Katy, TX (US)

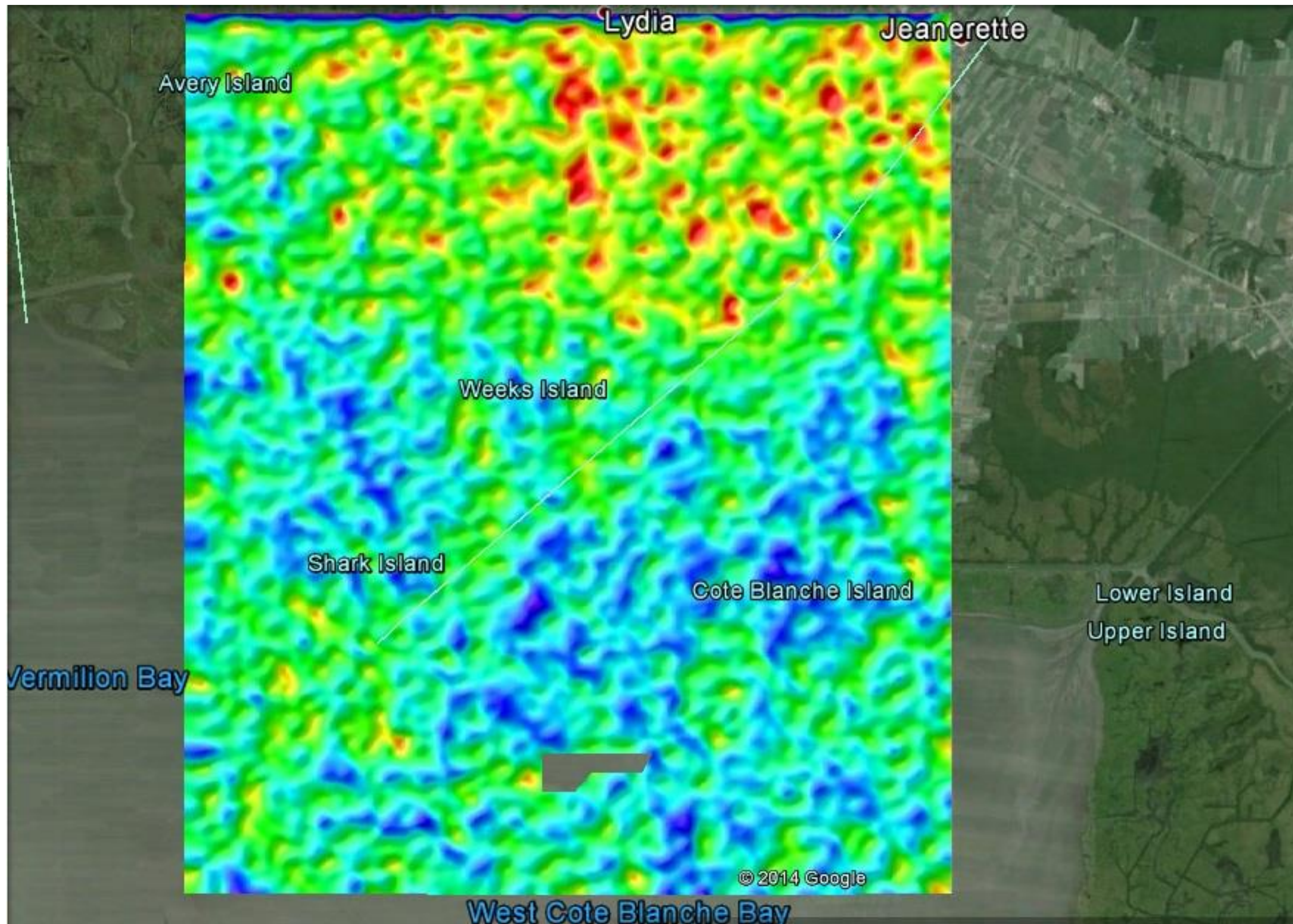
(52) U.S. CL 324/72; 324/71.1; 702/4
(58) Field of Classification Search 324/72, 324/71.1; 702/4
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

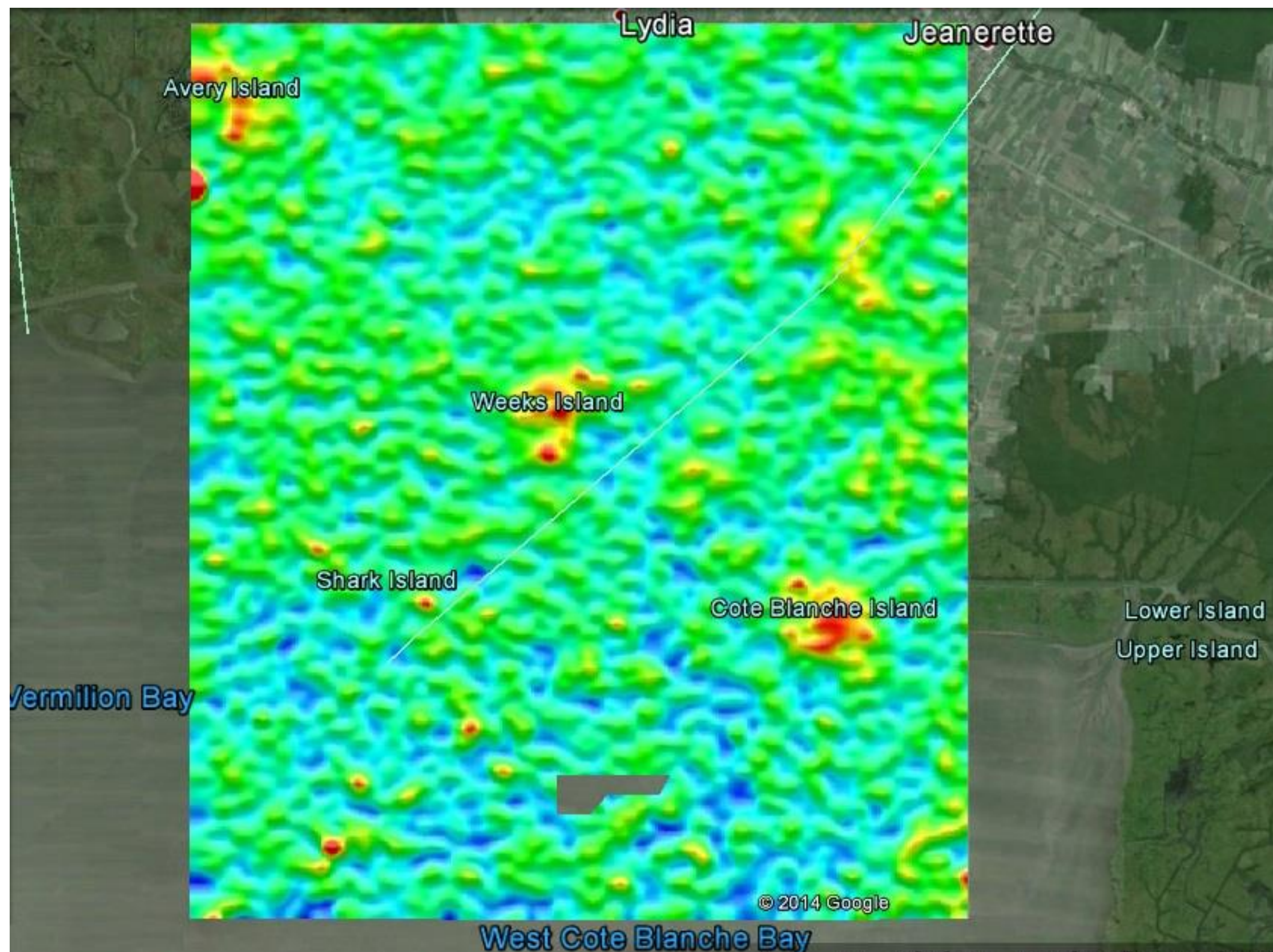
Fig. 1



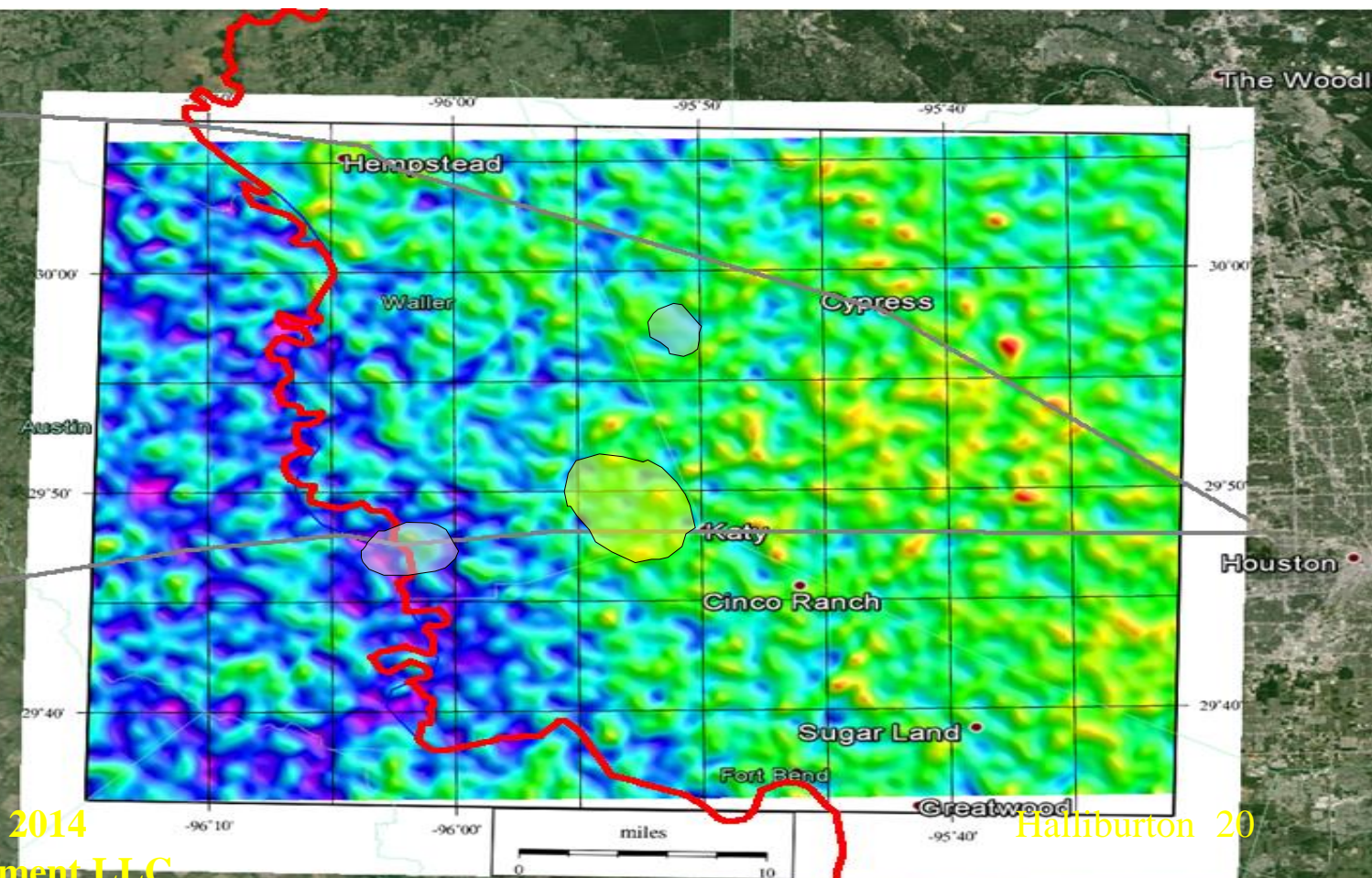
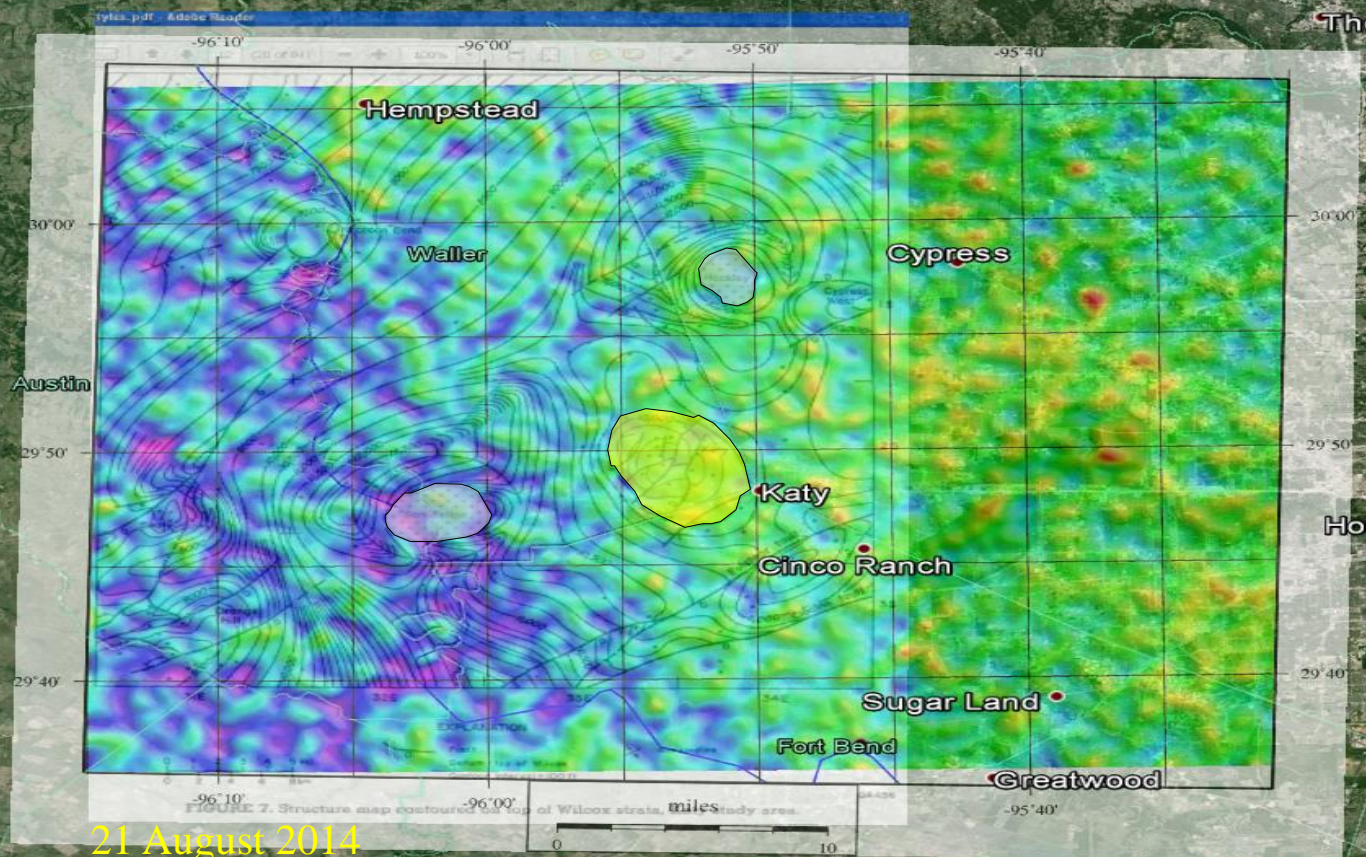
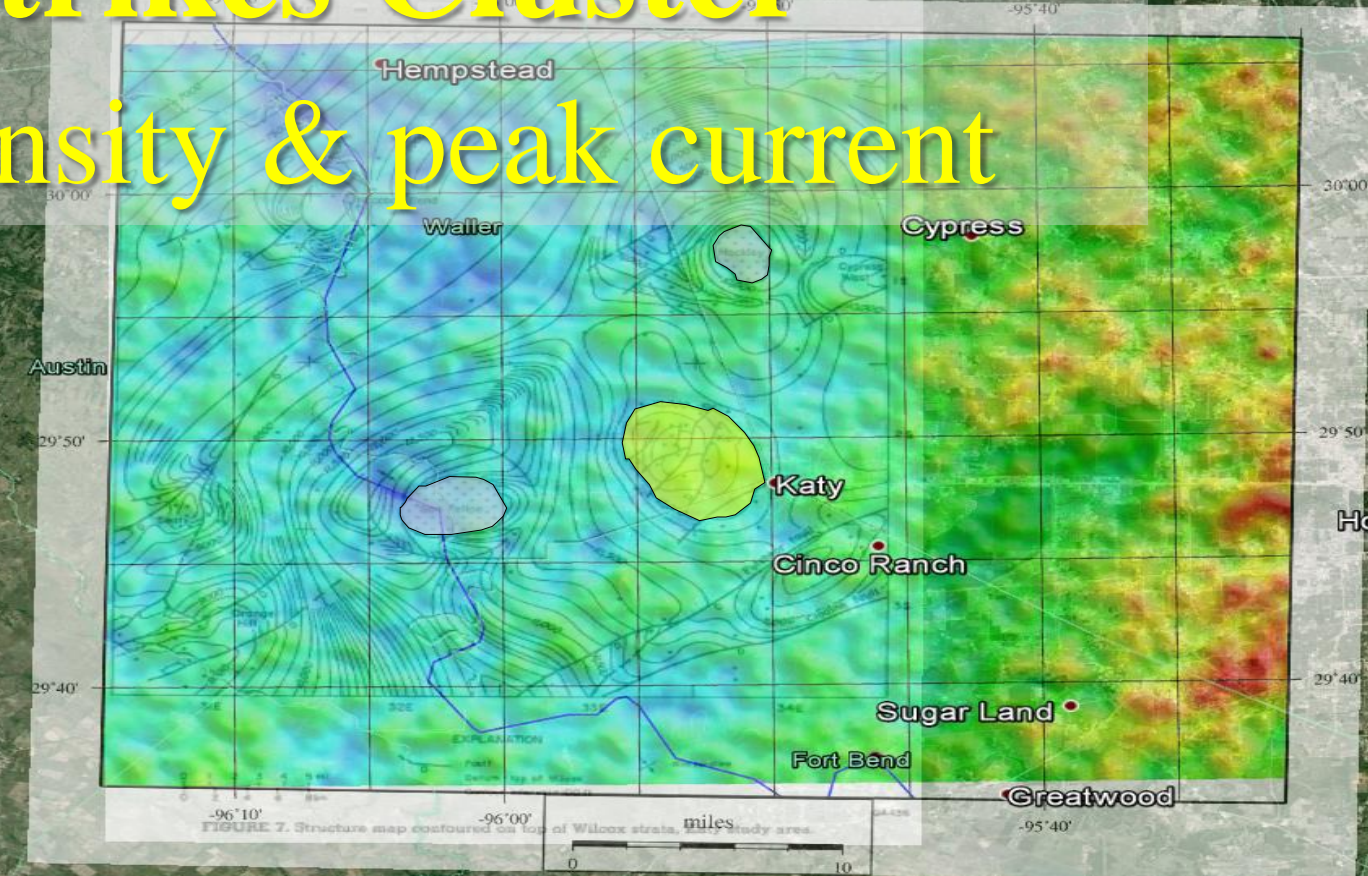
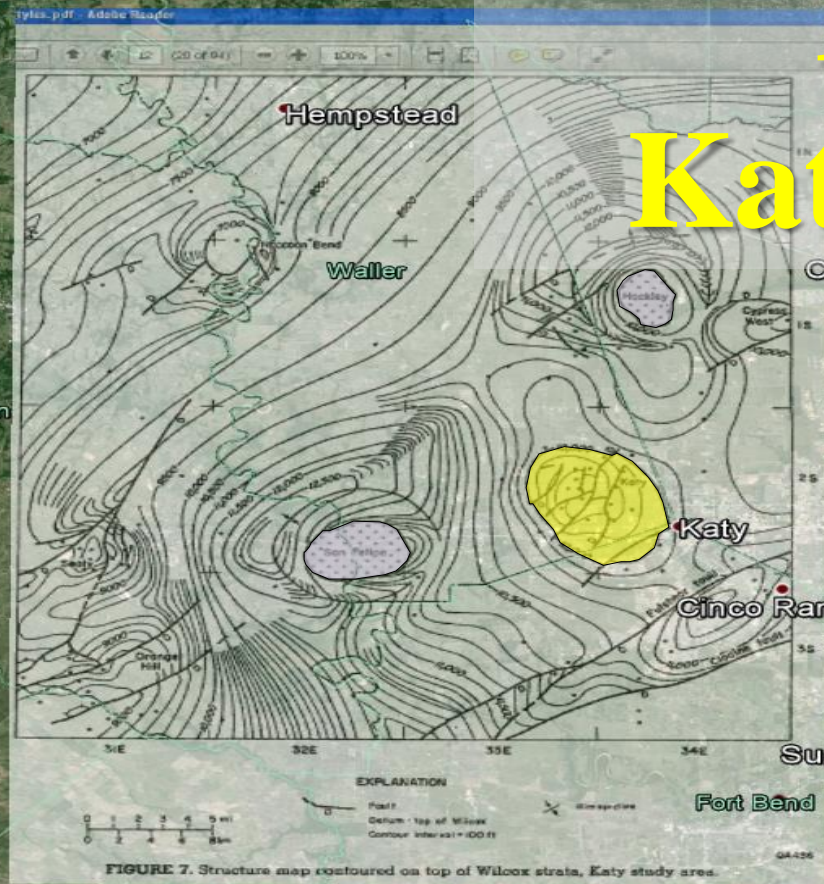
Louisiana Lightning Density



**Louisiana
Lightning
Rise
Time
Identifies
Salt Domes**



Lightning Strikes Cluster Katy, Texas: density & peak current

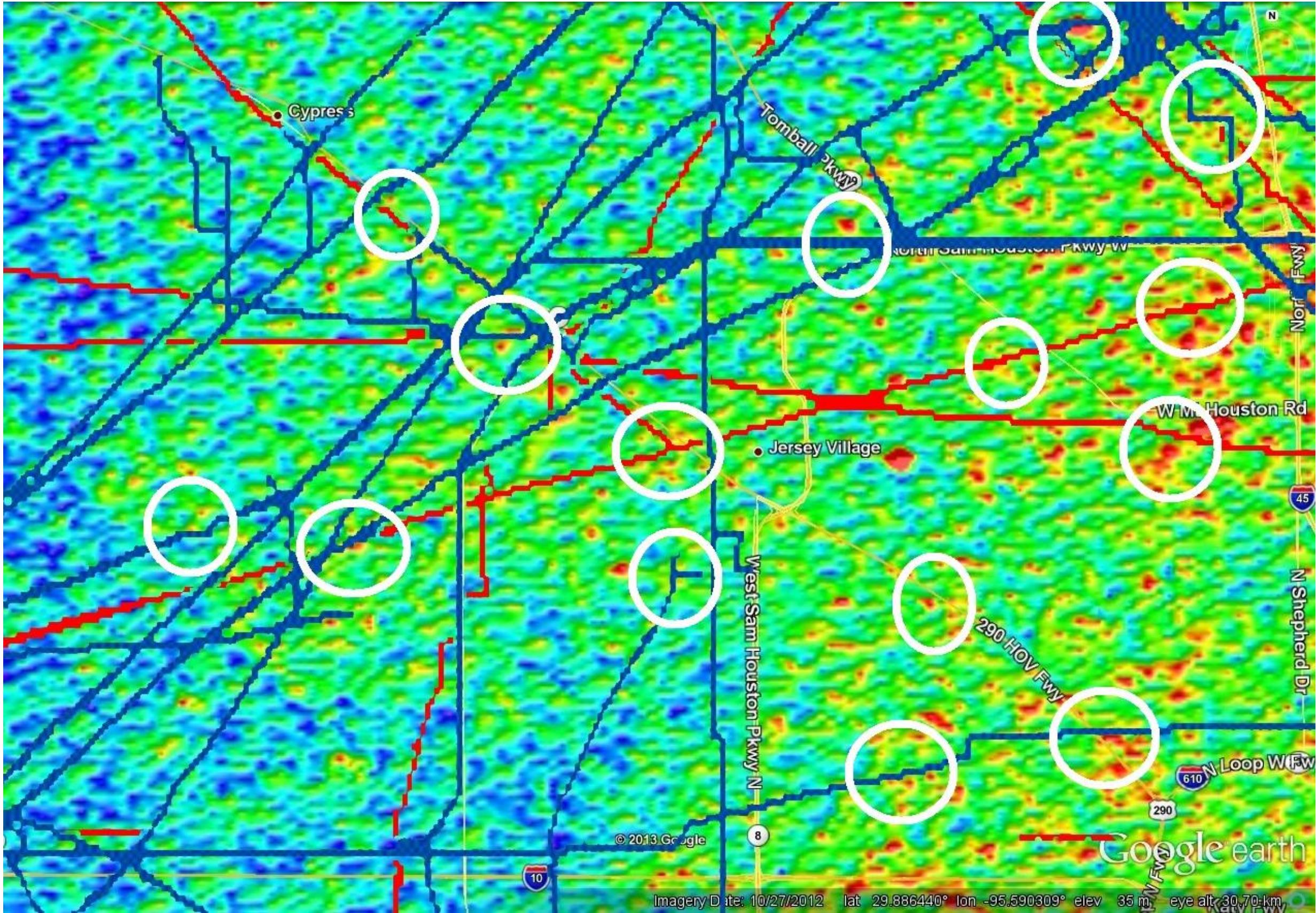


21 August 2014

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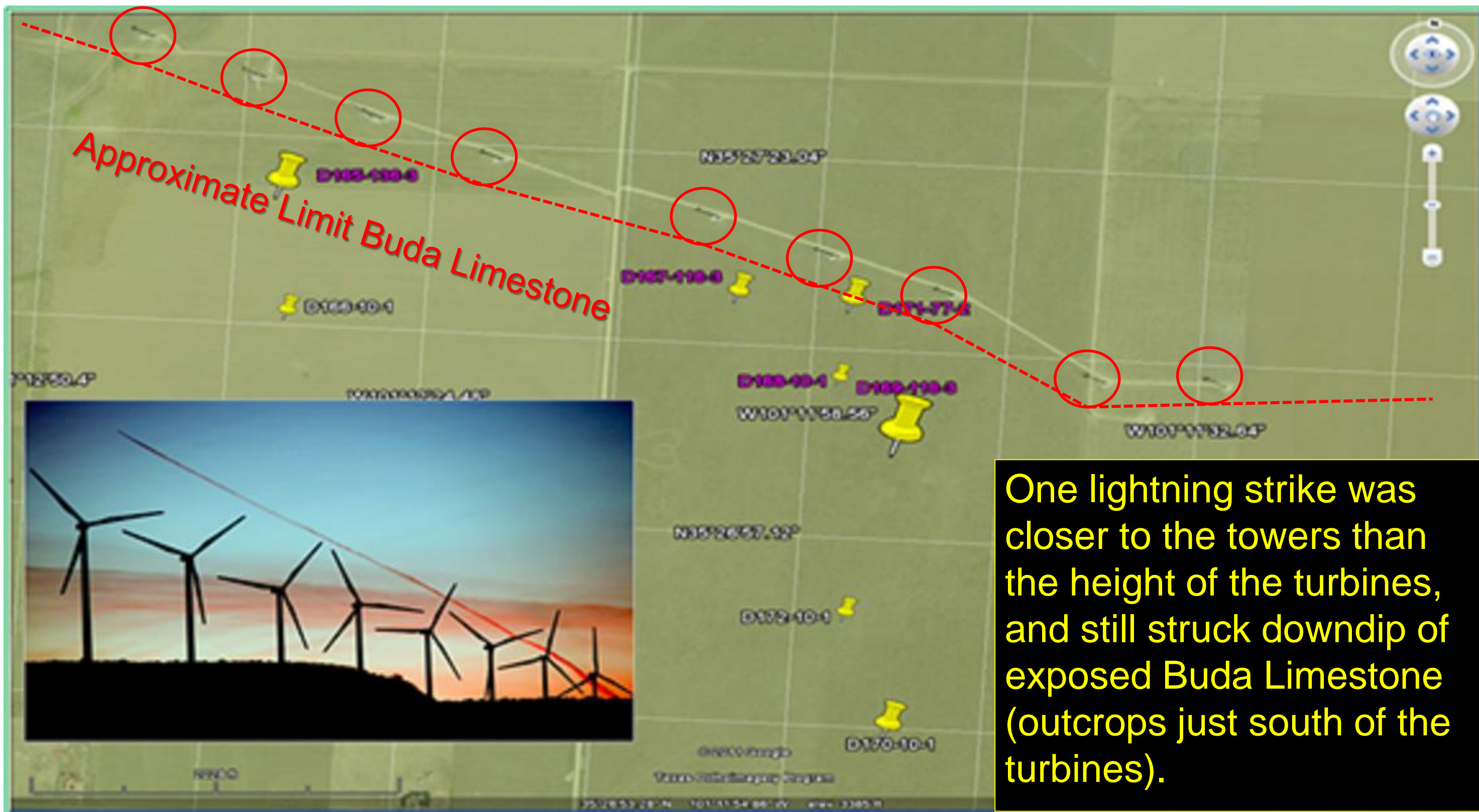
Halliburton 20

Pipeline Protection from Lightning & Geomagnetic Hot Zones





Texas Lunch Hour Storms: 08 March 2010



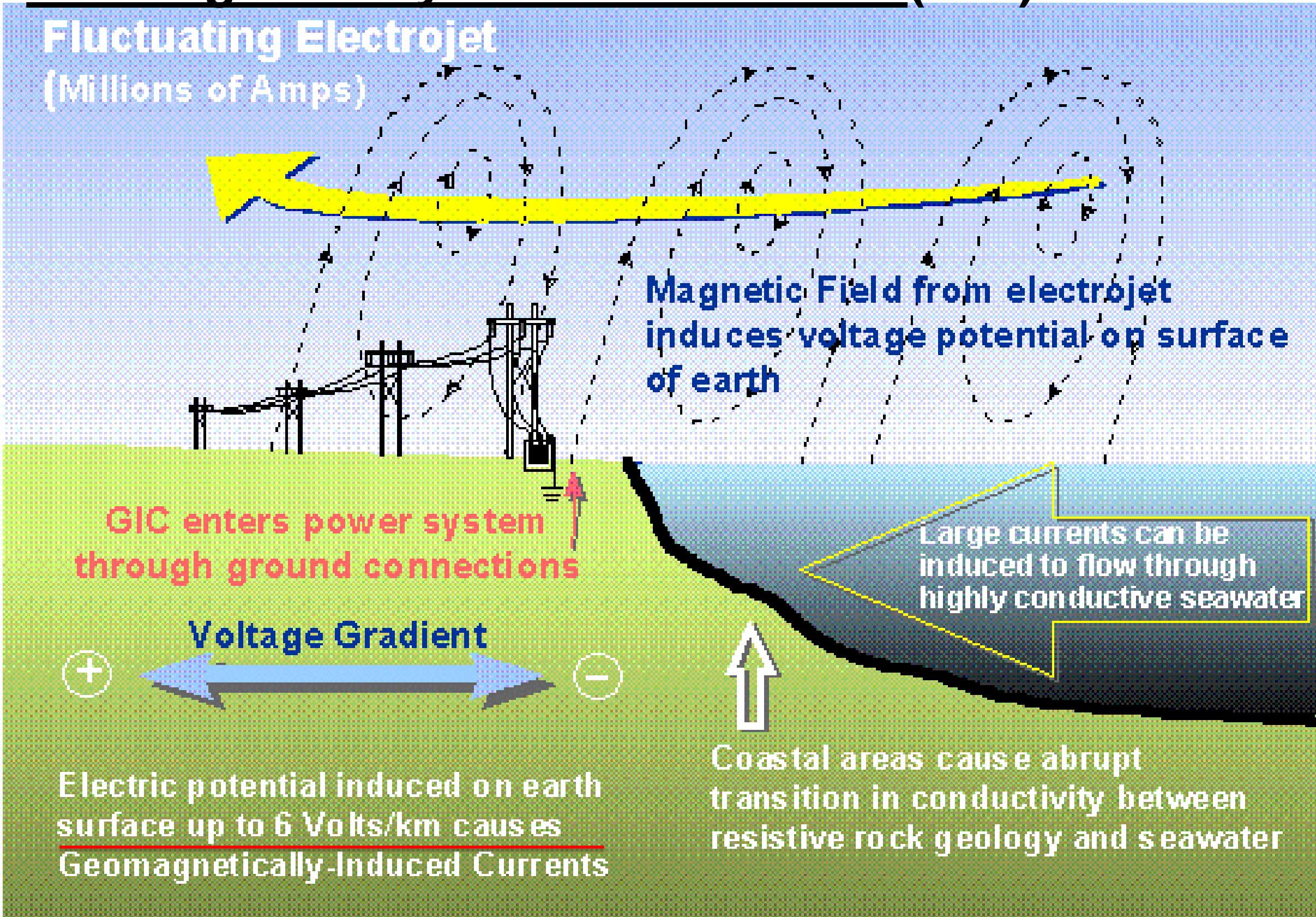
Main Bolts More Inclined to Hit the Ground



Geomagnetically Induced Currents (GIC)



Fluctuating Electrojet
(Millions of Amps)



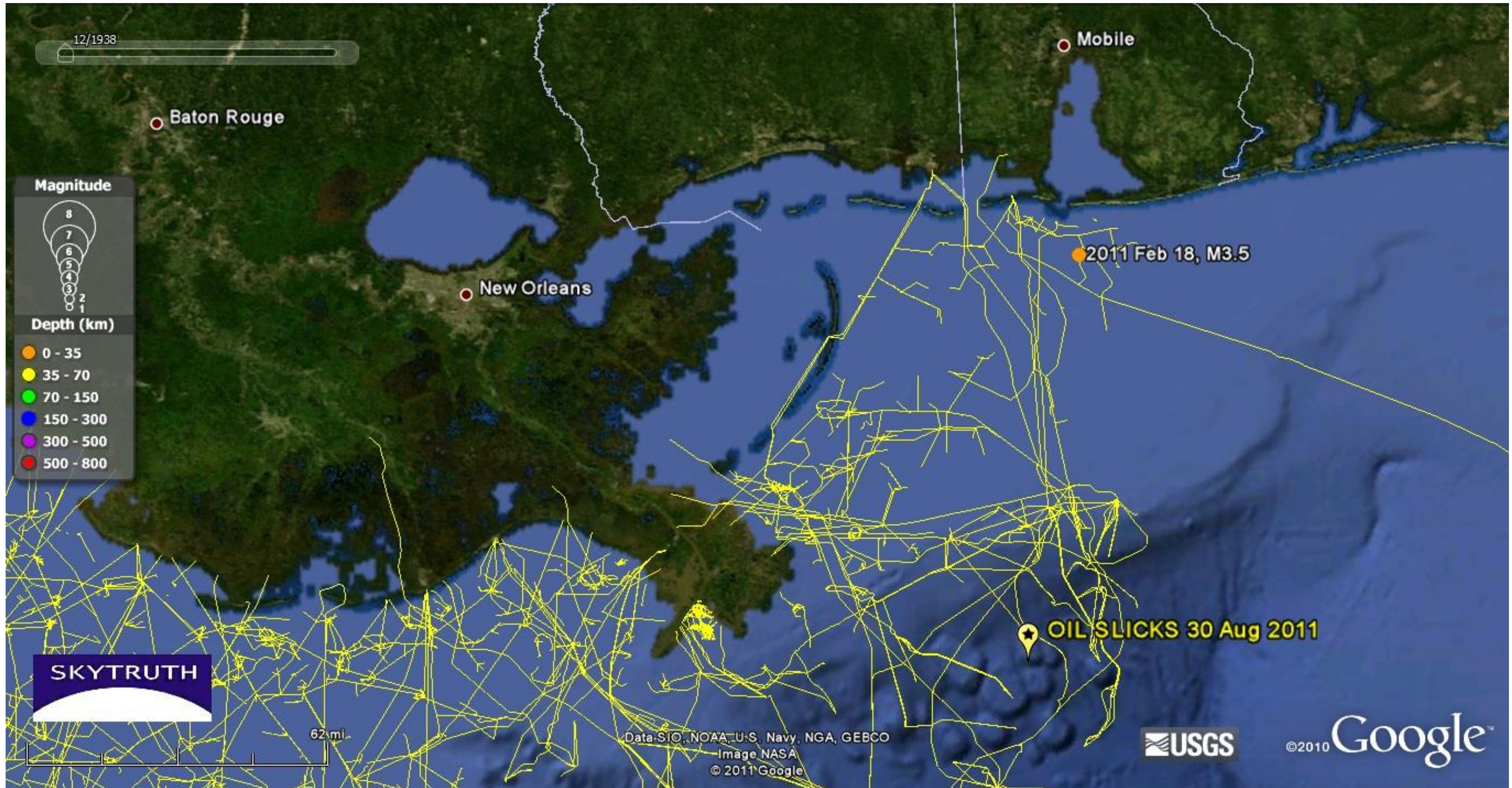
Space weather storms can alter the flow of electricity in our power system so much that they cause blackouts.

Image courtesy John G. Kappenman, Minnesota Power, Duluth, Minnesota

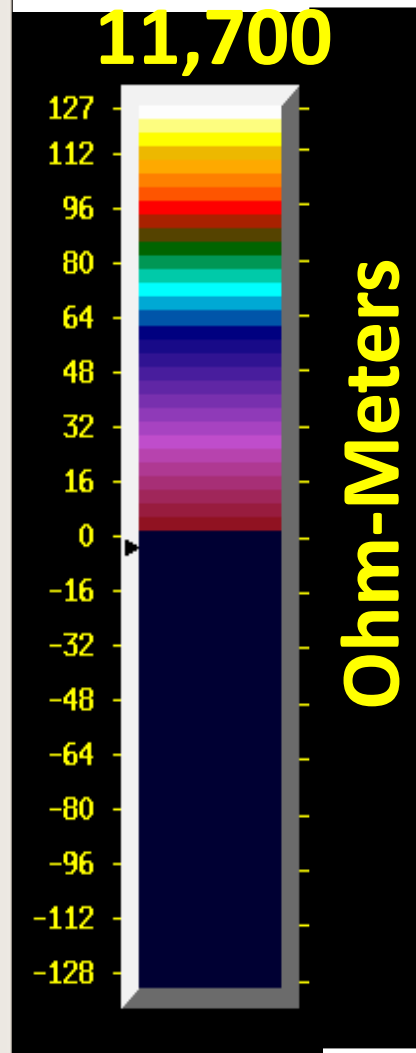
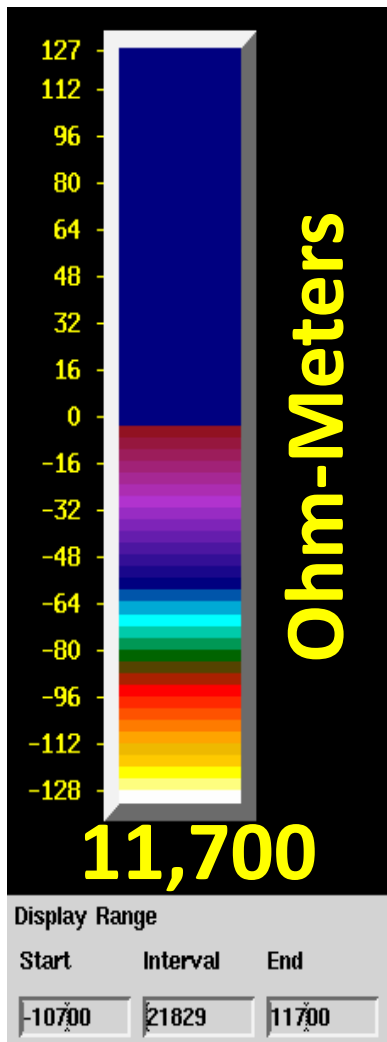
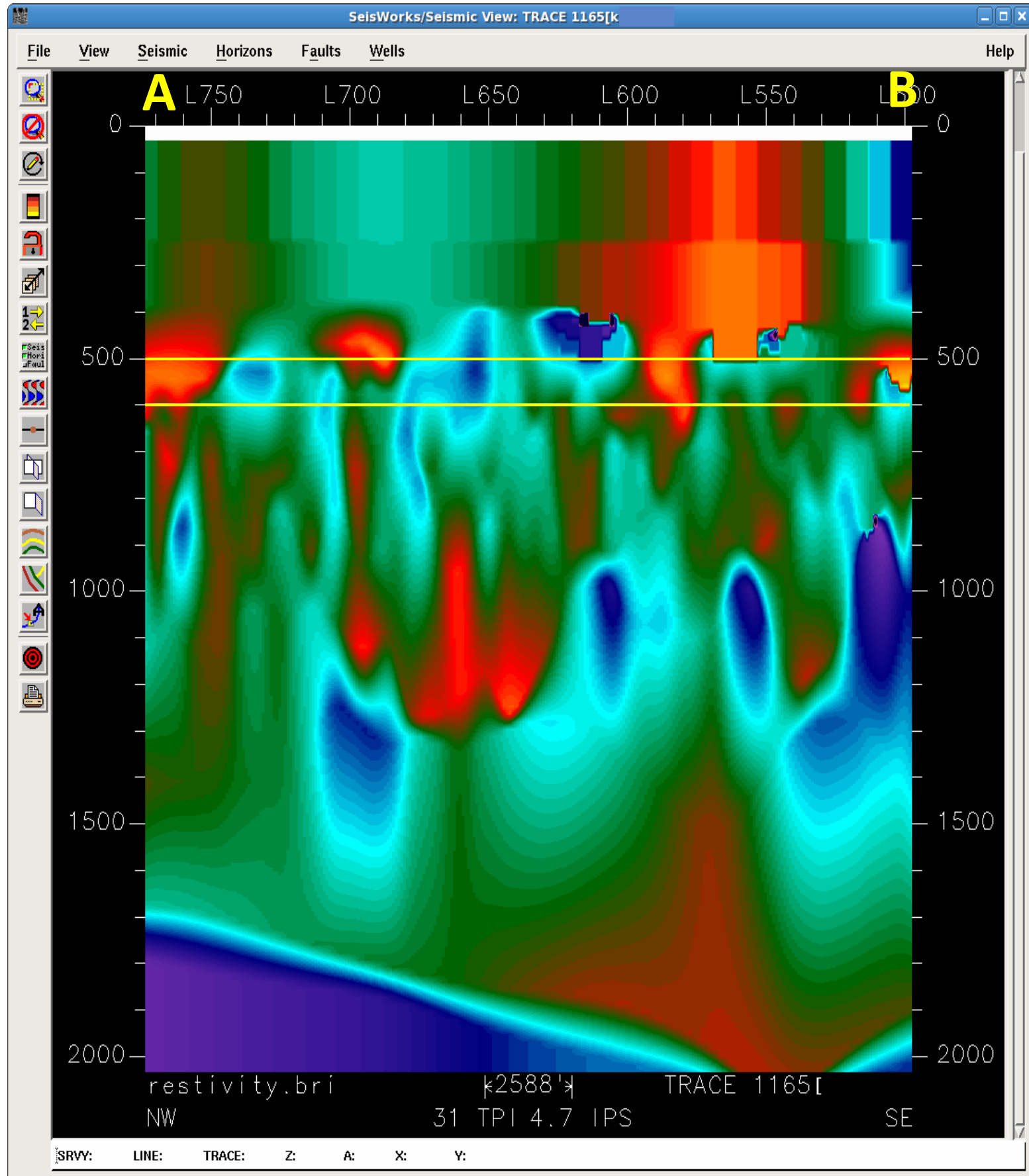
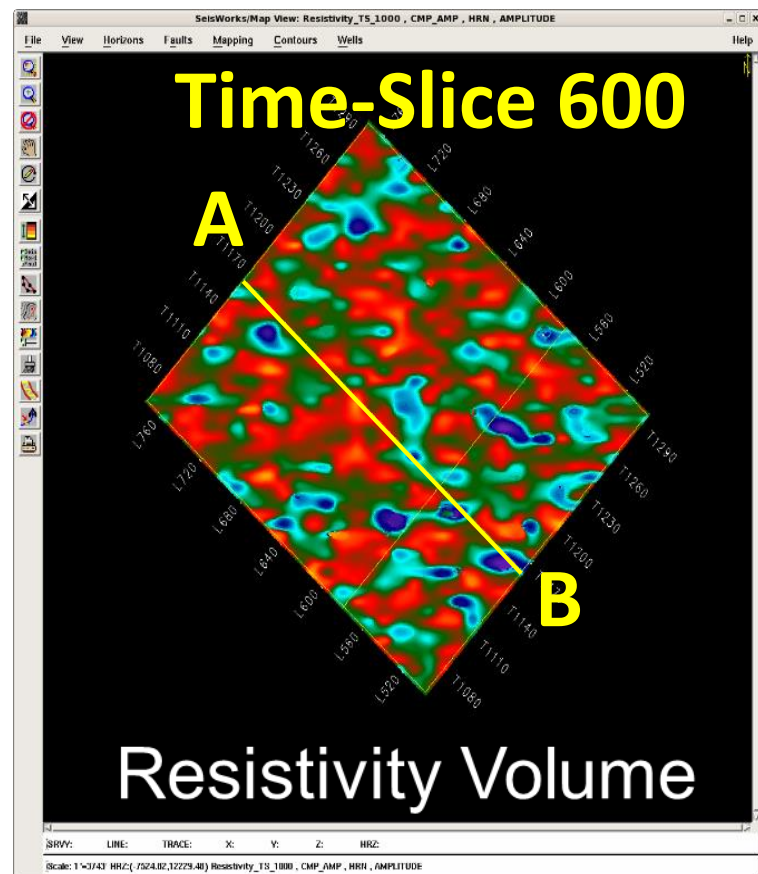
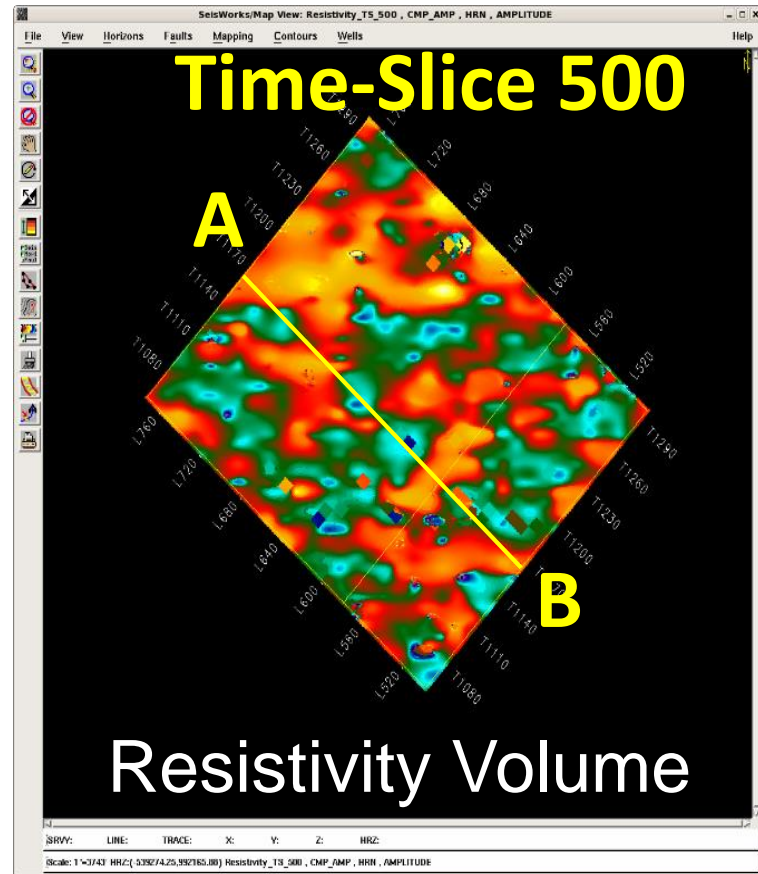
It is imperative to take a proactive approach to protecting the pipeline from external forces of corrosion that can comprise the integrity.



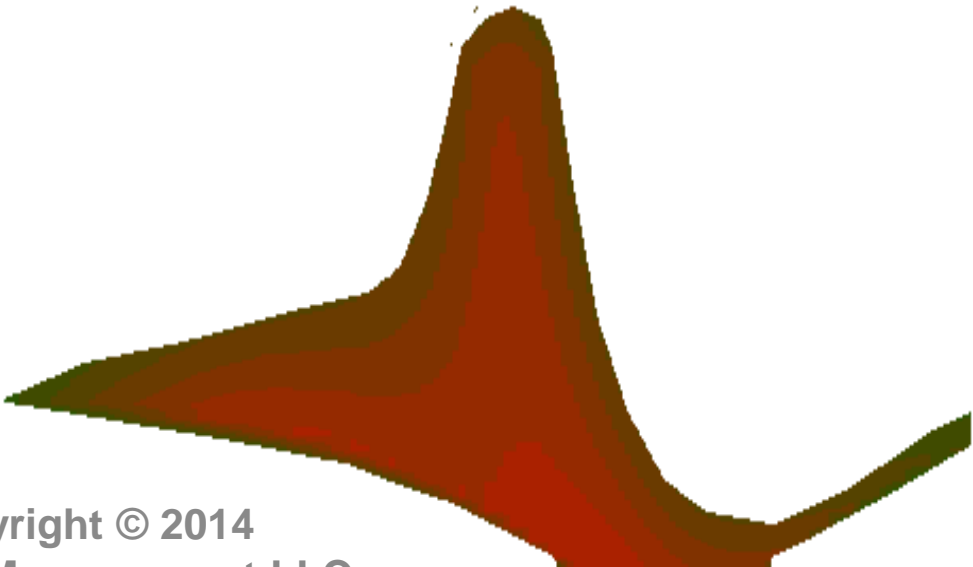
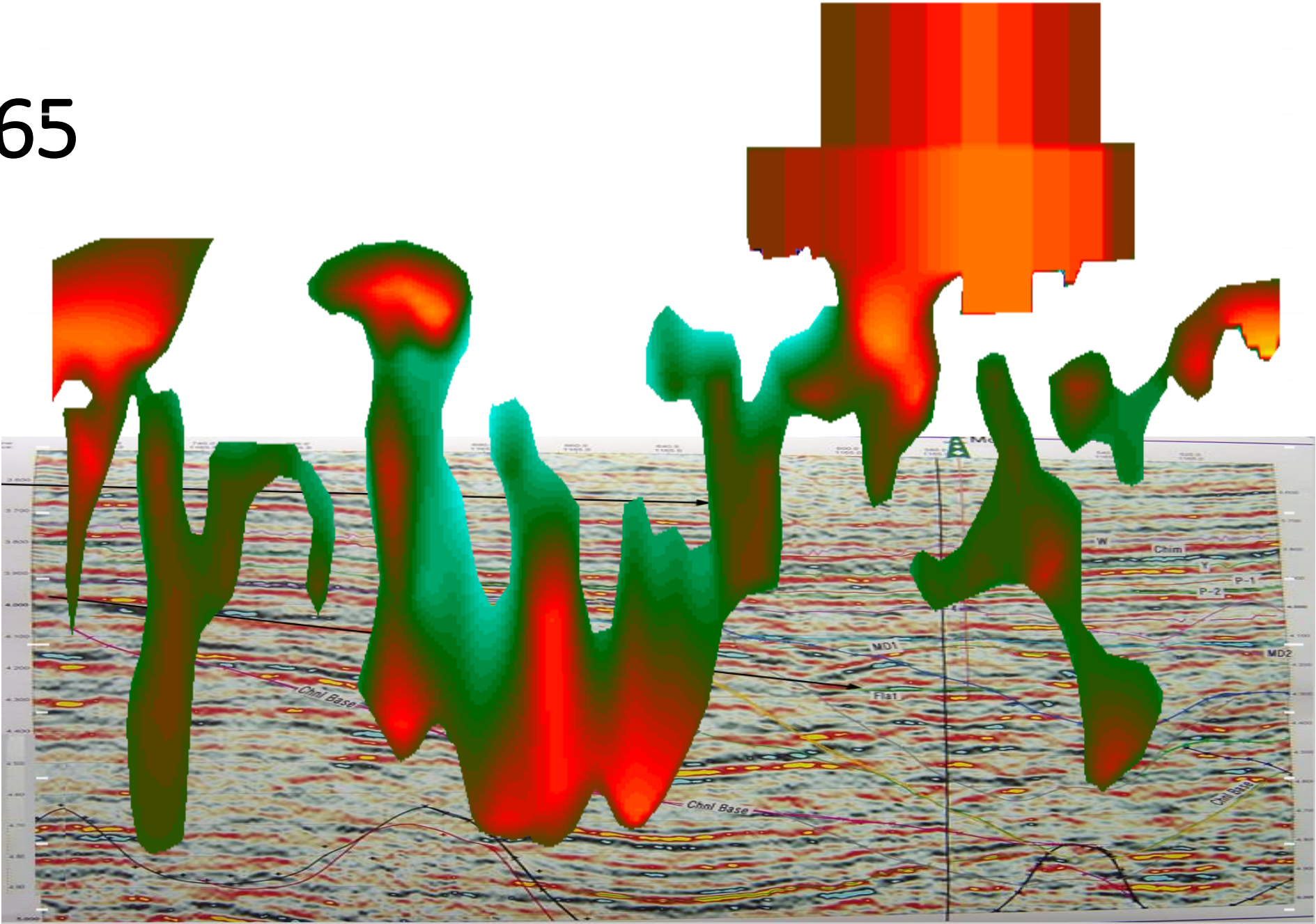
Our technology works out to 200-300 feet of water.



Trace 1165 Time Slices



Trace 1165





This is just the beginning!

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