Essential Fault Mapping
for “New Levee Assessment Techniques”
from Non-Invasive Lightning Technology
using Naturally Sourced Electromagnetic Analysis (NSEM)

by Kathy Haggar, Dynamic Measurement LLC

Mississippi River Commission - Low Water Inspection Trip
Public Presentation

21 August 2015
Regional Geology – MS Delta and Faults
Mississippi Delta Cycle by Penland

Mississippi Deltas by Frasier

Figure 2. Three stage evolution of a deltaic barrier island. (Barrier Islands Educators Guide: model from Penland and Boyd, 1981.)


Recent Deltatic Deposits of the Mississippi River: Their development and chronology, by David E. Frazier, Gulf Coast Association of Geological Societies, Transactions, 1967
Slumps in a drained lake in SELA act on same principle as Mega Slumps.

Mega Slumps in the Northern Gulf of Mexico

Many known surface and subsurface faults

after Peel et al. 1995; base map with permission of Port Publishing Co., Houston, TX; fault zones reported. Color patterns correspond to those in Figure 6. Note apparent massive slumping of continental slope in the Central Province.
Lightning Data Facts
17 years of digital lightning strike data available!

Cloud-to-Ground Flash Density Efficiency

Network Median Location Efficiency
Two conducting plates, the storm cloud and the earth, are separated by an insulating dielectric, the atmosphere. Voltage is created by collision of ice within the cloud and lightning bolts rebalance the charge between the plates.

Lightning Physics is analogous to Relaxation Oscillator Physics

The atmospheric capacitor is nearly the same physics
Just an additional resistance ($R_2$) limiting the current
$R_2$ is the resistance between the lightning strike point and the bottom plate of the capacitor
Lightning Measurements/Attributes, & Wave Form

- Location / Time and Duration / # of Sensors
- Rise Time
- Peak Current
- Peak to Zero
- Polarity
- Chi Squared
- Number of Sensors
There are more lightning attributes than seismic.
Lightning Interpretation
# Rock Property Specifics

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<th>Method</th>
<th>Type of measurement</th>
<th>Physical property detected</th>
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<td>Gravity</td>
<td>Spatial variations in the strength of the Earth's gravitational field</td>
<td>Density</td>
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<tr>
<td>Magnetic</td>
<td>Spatial variations in the strength of the Earth's magnetic field</td>
<td>Magnetic susceptibility</td>
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<tr>
<td>Seismic</td>
<td>Travel times of seismic waves</td>
<td>Density and elastic moduli</td>
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<td>Electrical Resistivity</td>
<td>Electrical resistance</td>
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<td>Electromagnetic</td>
<td>Response to electromagnetic radiation</td>
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<td>Ground Penetrating Radar (GPR)</td>
<td>Travel time of radar pulses</td>
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<tr>
<td>Lightning</td>
<td>Location, Time, Rise-Time, Peak Current, Peak-to-Zero</td>
<td>Resistivity and Permittivity</td>
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</table>
The Dutch, Germans, and Belgians have published extensively on new shallow levee assessment techniques – EM, GPR, Sparker, LIDAR, SAR, and Gravity.
Lightning Data provides the framework for integrating sparse and diverse data sets creating a more coherent subsurface interpretation on a regional scale.
Integrating sparker with resistivity volumes and fault picks at Goose Point, LA for interpretation.
Regional interpretation integrates:
- sparker seismic
- core data
- well data
- surface fault offsets
- LIDAR
into a lightning data framework
This red box is about 860 sq. miles.

Can’t shoot seismic over a major metro area … Marsh 3-D seismic average cost to shoot is $120,000+/- per sq. mi.!
Our Coast Line Is Rapidly Changing

Lightning data - Already collected & increasing daily
Processed and delivered in about 2 months
Costs less than 2 squares of seismic data.
Conclusion
Lightning data – NSEM – geophysical evaluation technology cost effective, non-invasive, evergreen, for integrating diverse data sets from urban, marsh or shelf areas to craft robust subsurface evaluation interpretations imaging faults as potential geohazards to civil works across the US and wherever lightning networks exist or can be created.
Thank you for the opportunity to present our new geophysical lightning data - NSEM - to the Mississippi River Commission

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