ABSTRACT

TITLE: Mapping Subsurface Faults with Lightning and Resistivity.

AUTHORS: Louis J. Berent[1], H. Roice Nelson[2]
INSTITUTIONS: 1. Dynamic Measurement, LLC, Houston, TX, United States, 2. Dynamic Measurement, LLC, Cedar Rapids, UT, United States.

The ability to identify & map subsurface faults is often of vital interest to the petroleum, environmental, mining & geotechnical industries. In the search for traps, contaminant & mineralization conduits or potential foundation failure sites, geophysics offers an array of tools to map faults.

In this presentation, a newly-developed electromagnetic data type, derived from lightning, has been integrated with 2-D Resistivity Imaging to map & validate active radial faults associated with the Hockley Salt Dome in Harris Co., TX.

Natural Sourced Electromagnetics (NSEM) is a patented emerging technology offering the above mentioned industries a relatively quick, scalable & inexpensive mapping tool. Although lightning is guided by meteorological conditions, the precise location of strikes & their individual attributes appear to be influenced by lateral inhomogeneity caused by faults, fractures, mineralization, pore-fluids & salinity variations.

The field & laboratory work published by Dr. Friedemann Freund of the NASA AMES Research Center, & his “Rock Stress Electromagnetic Signal Theory,” provides independent support for Dynamic Measurement’s empirical field results & theoretical argument linking geology to lightning strike patterns & lightning attributes. The combined theories, empirical results & laboratory findings suggest faults may facilitate the upward flow of positive & negative currents that can in turn influence lightning, in much the same way faults are believed to facilitate micro-seepage of hydrocarbons to the surface.

3-D apparent resistivity volumes can be generated from lightning data & displayed in the same fashion as 3-D seismic data, with all wells, curves & synthetic seismograms posted & correlated in the usual manner. Lines, traces, arbitrary lines & apparent resistivity slices can then be extracted from lightning attribute volumes to match the location & orientation of any available seismic, subsurface, potential field, electrical or other electromagnetic data. A regional NSEM survey can thus be integrated & calibrated to various existing regional or prospect-scale data sets, allowing the interpreter to expand the interpretation both beyond & within the bounds of existing conventional geophysical data.

In summary, this presentation will reveal how lightning attribute lineations, data clusters & apparent resistivity offsets appear to correlate to geologic features, electrical rock properties & hydrocarbon accumulations.