Deriving Exploration Maps and Rock Property Volumes from Lightning Databases

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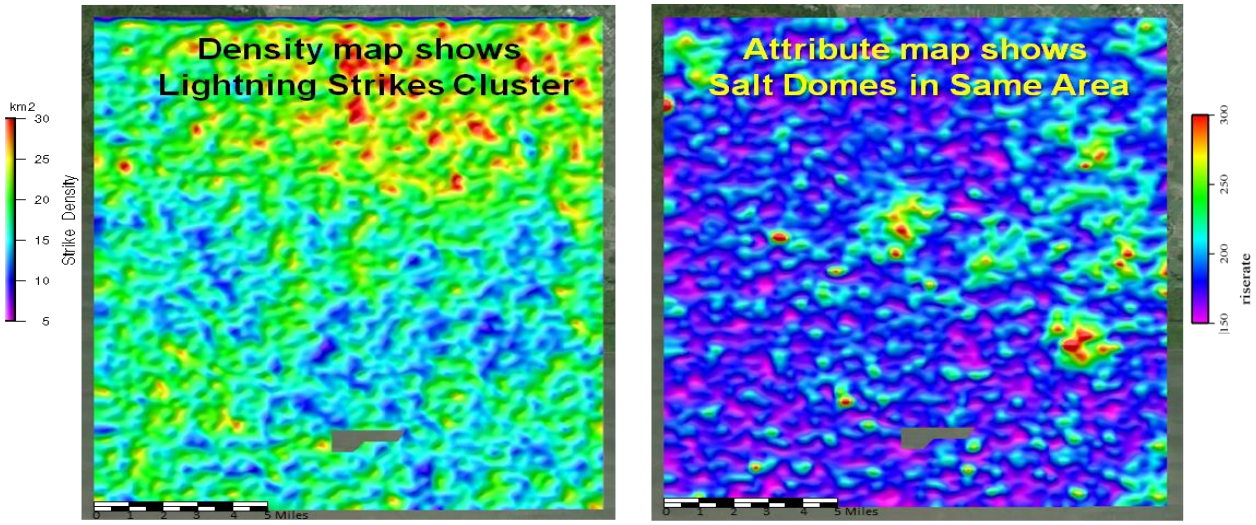
Lightning occurs everywhere. Where lightning strikes and the attributes of lightning strikes are related to terralevis (shallow earth) currents. Both lightning strikes and lightning strike attributes cluster, based on geologic features in the first 20,000 feet of the earth. The skin depth of lightning strikes is measured in centimeters. However, terralevis and telluric currents vary at the depths which are of interest to hydrocarbon and mineral exploration. Since subsurface geology does not change that rapidly, the primary geologic causes driving where different types of lightning hits the earth is fairly consistent across human time frames. Therefore lightning density and lightning attributes derived from the 16 years of available data can be stacked, somewhat like seismic data, in order to improve signal and decrease noise.

Clusters on the resulting lightning density and attribute maps create patterns and lineaments which are somewhat consistent across different attribute maps (see Iberia Parish maps below). These maps define surface projections of fault and stratigraphic impact on terralevis currents. Lightning density and attribute maps can be created anyplace on the planet, using exclusively licensed lightning databases. In addition, data in U.S. and Canadian lightning databases enables calculation of resistivity and permittivity volumes, via patent pending algorithms (see Gulf Coast volumes below). Animations through a resistivity volume created over the Houston Metropolitan Area will be shown to demonstrate the resolution and value of resistivity volumes (see below).

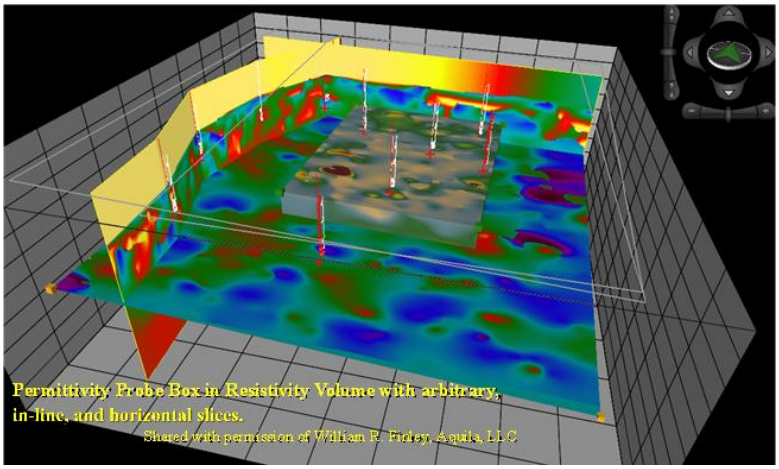
These resistivity volumes can be created anyplace onshore in the continental United States and Canada out to the shelf break, or about 300 foot water depths. The lightning database derived resistivity and permittivity volumes can be interpolated to be at the same line and trace spacing as any 3-D seismic survey within this area. These resistivity and permittivity volumes can be overlaid on the seismic volumes in workstations, in the same way velocity volumes are overlaid on seismic data. However, instead of showing velocity based characteristics related to lithology and fluids, they show the rock property resistivity.

Because lightning occurs everywhere, these volumes allow a first pass “filling-in of the gaps” between 2-D seismic lines, between well control, and between 3-D seismic surveys. The lateral resolution of lightning derived traces is has been demonstrated to be 173 meters (568 feet) with rocket trigged lightning. The ohm-meter (resistivity) and nano-farads per meter (permittivity) calculations show a data concentration window. We have data suggesting this window starts at about -1,500 feet and possibly goes as deep as 20,000 feet, and are currently working to better calibrate the vertical extent of the data. Resistivity concentrations show faulting, hydrocarbon migration pathways, and traps. The vertical resolution of lightning derived resistivity trace data is far less than the vertical resolution on a resistivity log. This presentation will share a status report of DML’s most recent work. Combining the interpretations of resistivity and permittivity volumes with surface projection from various lightning attributes derives a geologic framework for aquifer, hydrocarbon, and mineral exploration, as well as for geo-hazard analysis.

Maps from Iberia Parish, Louisiana:



Volumes from the Gulf Coast:



Resistivity Volumes across area around Houston, Texas: