Lightning Analysis for Mapping Faults and Identifying Exploration Sweetspots

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No

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Abstract:
Lightning strikes occur worldwide. The National Lightning Detection Network (NLDN) database has collected 18+ years of the timing (microseconds), location (150-600 foot horizontal resolution), rise-time (microseconds), peak current (kilo-amperes), polarity (80% of strikes negative), peak-to-zero (microseconds), number of sensors recording the strike, the major and minor axis of triangulated location calculations, and chi-squared (quality measurement) for each lightning strike in the continental U. S. Historically these data were collected for insurance, meteorology, and safety markets. These data are now also used to support the oil & gas, mineral, and aquifer exploration.

Lightning strike density, total wavelet time, wavelet symmetry, rate-of-rise-time, and other attributes are calculated from this database. Because the time of the lightning strike is recorded, it can be correlated with solar and lunar tides to relate lightning strikes to moon local longitude, moon phase, sun local longitude, tidal gravity, tide, and tide gradient. Lightning strikes and associated attributes also correlate with micro-seismic and earthquake timings and locations. In addition, using the simple electrical current model of lightning as a relaxation oscillator (a giant neon tube), resistivity and permittivity rock property values can be calculated for each lightning strike. Each of these attributes are calculated for lightning strike locations on the surface of the earth, then contoured or gridded, and overlaid on topographic maps. Lineaments, like fault scarps, have been mapped with 30 foot horizontal location accuracy.

Subsurface values for each of these attributes are also calculated. Assuming the height of the cloud (distance the lightning travels through the atmospheric dielectric) is proportional to the Peak Current (charge buildup required to bridge the cloud to earth capacitor) and using mirror image theory (earth's surface acts like a mirror for

electromagnetic pulses), values for each of these attributes can be calculated for a subsurface location at a depth beneath the strike location tied to the calculated cloud height. Lightning does not occur for clouds less than about 1,500 feet in height, nor for clouds higher than about 30,000 feet, and so the depth interval where lightning volumes are useful is typically from 1,500-30,000 feet. Lightning strikes are passive energy pulses, and contain all frequencies. Therefore the skin effect of the high frequency information recorded in the ~50 microsecond total wavelet time is not the controlling factor on the depth the electrical energy interacts with telluric currents. Since there are millions of lightning strikes in the 18+ year NLDN database, there are millions of subsurface (x, y, attribute) values calculated for each project area. These values can be interpolated to create volumes, and the volumes can be converted to SEG-Y files to load in standard exploration workstations. These volumes can be interpolated to have samples at the same line and trace and sample rate as any planned or existing aeromagnetic or 3-D seismic survey, and the resulting rock property or lightning attribute volumes overlaid on the seismic as if it were a velocity volume.

Maps and volumes created from these lightning database attributes tie to geology and can be used to map faults and identify exploration sweetspots. Maps, volumes, and interpretations will be shown from Arizona, Louisiana, Michigan, and Texas.

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If necessary, are you willing to SWITCH your presentation format (e.g., oral rather than poster or vice versa)?

Yes

Dear Roice,

Thank you for submitting an abstract submission profile for the Pacific + Rocky Mountain Sections' Joint Meeting in Las Vegas.

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