Detecting metal concentrations in Great Basin shales with surface gamma ray logs

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Radioactivity of shales with higher organic carbon typically produces higher gamma ray readings than shales with lower organic content. X-ray fluorescence (XRF) analyses, confirmed by certified analyses, of samples indicate that shales with the highest organic content also have the highest concentrations of vanadium, silver, gold, rare earths, and other metals.

Scree from the overlying Mississippian Joana Limestone mostly conceals the underlying Mississippian/Devonian Pilot Shale in the Great Basin of eastern Nevada and western Utah. Continuous exposures of the Pilot Shale from the underlying Devonian Guilmette Formation to the overlying Joana Limestone are practically non-existent. The Pilot shales with the highest organic content tend to be less resistant that adjacent shales containing more carbonates or sandstone and silt. However, digital surface gamma ray logs of measured sections can help “see” through the scree and identify where the shale has the highest organic content and associated highest metal content.

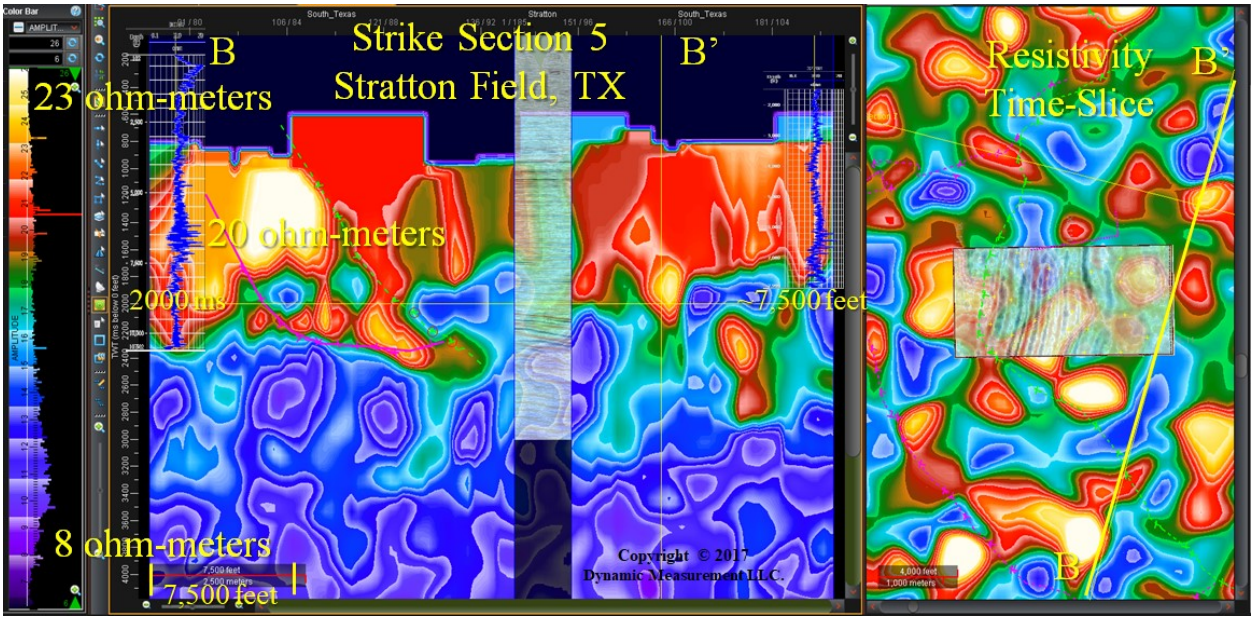
Great Basin Shales Corporation (GBSC) geologists efficiently determine concentrations of metals in well cuttings with XRF analyzers without causing damage or destruction of the cuttings. Once they determine the concentrations of metals in the cuttings, they compare the cuttings interval with the subsurface gamma ray log. Then they correlate the subsurface gamma ray logs of wells with surface gamma ray logs of measured sections to identify where to trench and collects surface samples.

Therefore, higher concentrations of organic carbon and metals in well cuttings with higher gamma radiation can be correlated to intervals of higher gamma radiation in measured sections that also likely contain higher concentrations of metals. The intervals of higher gamma radiation in surface gamma ray logs can be a guide to where to uncover the hidden Pilot shale and collect samples for chemical analyses. Once GBSC geologists calibrate the surface gamma ray log is with analyses of the samples the gamma ray log can be used to calculate the thickness of strata with concentrations of metals.

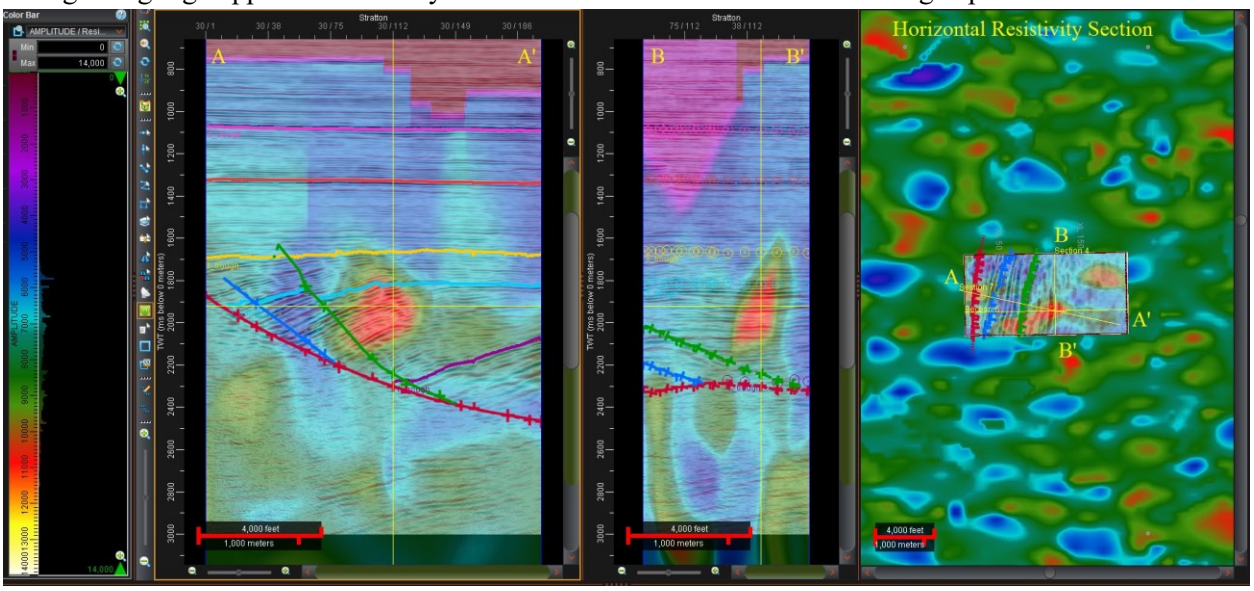
It is likely that GBSC geologists will find the highest concentrations of metals and rare earth elements at the transgressive sequence boundaries at the top of the organic-rich shales. However, scree from the overlying rocks obscure the sequence boundaries.

Just as you can use surface gamma ray logs to directly detect metal concentrations, you can you a new branch in the geophysical services industry, lightning analysis, to understand the subsurface. These three examples are from South Texas in the Corpus Christi area.

The first slide shows a cross-section through the southwestern edge of a small 3-D seismic survey released by the BEG (Bureau of Economic Geology at the University of Texas at Austin). This apparent resistivity cross-section, where apparent resistivity is calculated from lightning data, goes through 2 deep wells. The resistivity logs are overlaid, and show a good tie with lightning derived resistivity values.

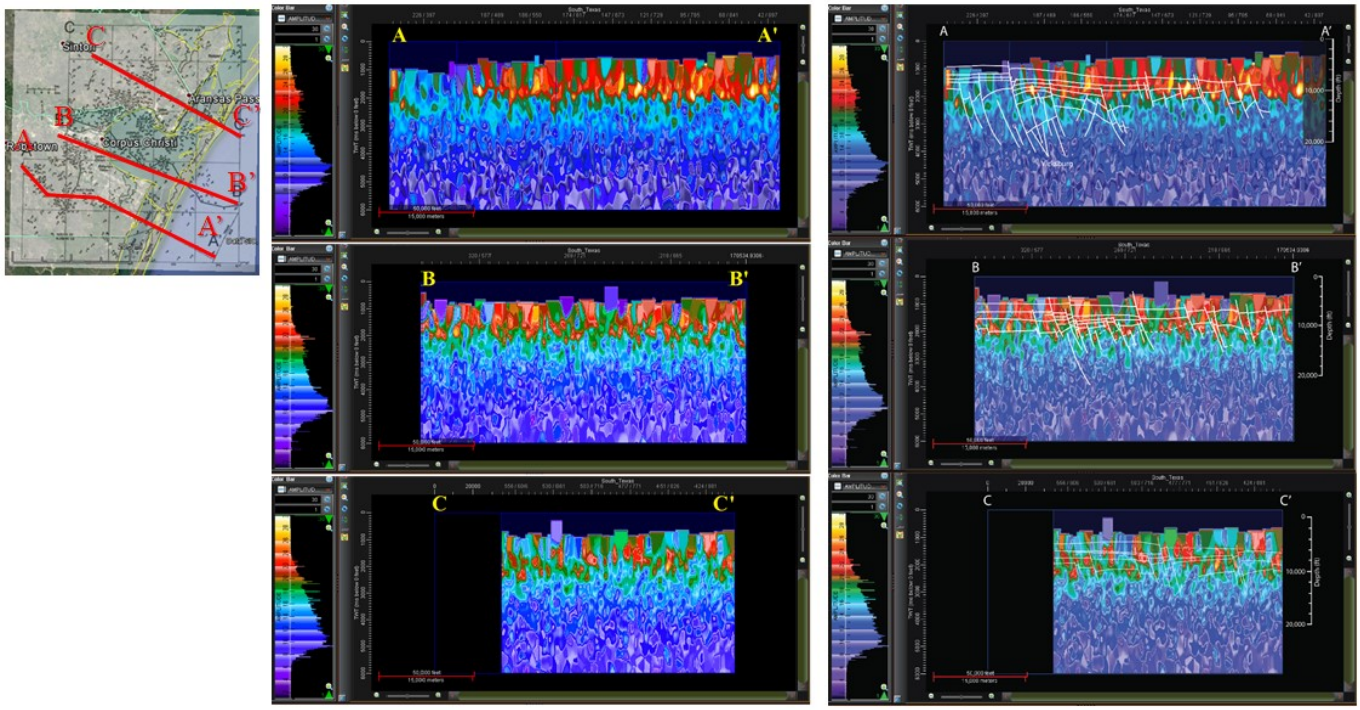


The seismic cross-sections below are overlaid with lightning derived apparent resistivity. Note how well the lightning high apparent resistivity fits within the seismic defined Vicksburg expansion fault.



Stratton_Animation.png

This lightning analysis was part of a regional project, comparing 2016 lightning derived apparent resistivity cross-sections with 1986 fault and horizon interpretation by Tom Ewing at the BEG. The fault interpretation is overlain in white on the right three cross-sections. The point of these examples is lightning data (from the strongest electromagnetic source on earth) allows users to see through shallow geology and map faults and rock properties like apparent resistivity and apparent permittivity in volumes at an exploration prospect, along a geologic trend, or over small or large lease holdings in order to high-grade exploration opportunities.



South_Texas_Examples.png