

Abstract

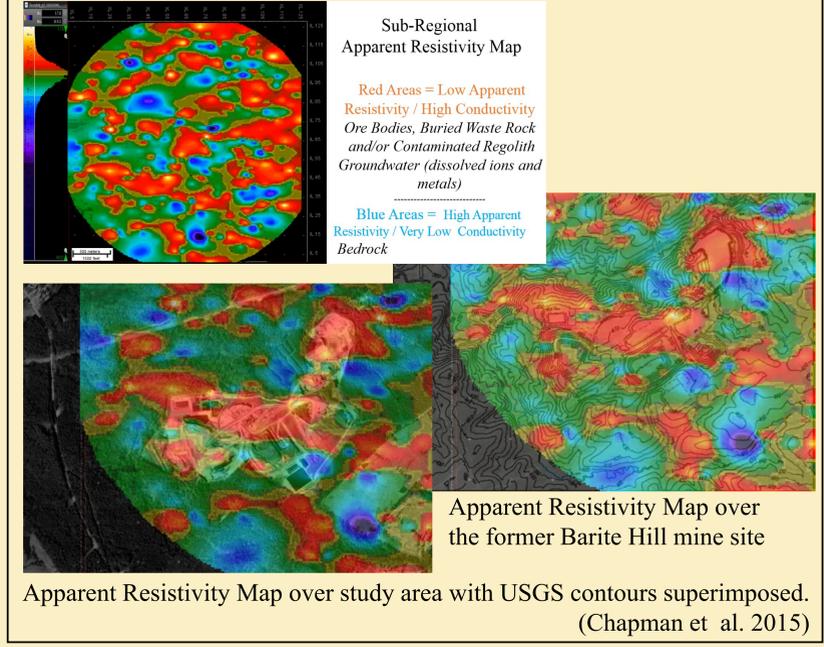
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A case study from this EPA (Environmental Protection Agency) Superfund site and cleanup areas in South Carolina illustrates how remotely sensed lightning strike generated maps and volumes correlate with geology and ground-based EM (Electro-Magnetic) technologies. Lineaments appear related to basement faulting. USGS (United States Geological Survey) electrical conductivity surveys along 3 lines match resistivity cross-sections across these same locations, where the resistivity cross-sections are arbitrary lines matching the location of the USGS surveys from an apparent resistivity volume. This correlation is similar to work done calibrating apparent resistivity traces, lines, and volumes in Southern Louisiana.

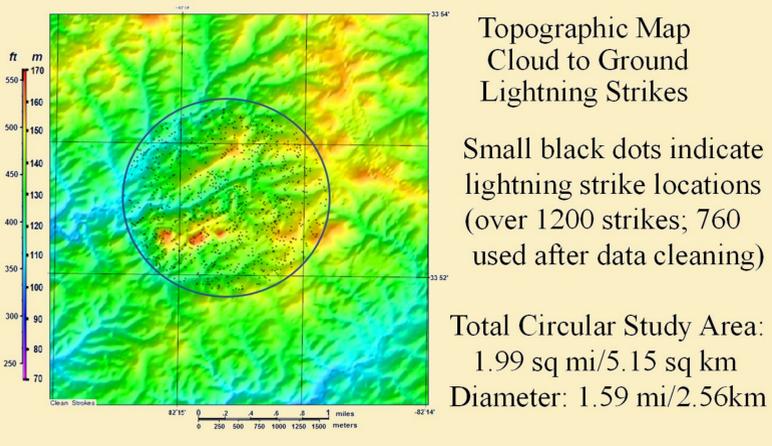
Overview

The Nevada Gold Fields, Inc. - now closed **Barite Hill Gold Mine Project** site - was one of four major mines in the South Carolina Slate Belt. It produced gold, silver and other minerals from 1991 to 1999. Ore was extracted from an open pit, crushed, treated, spread on leach pads, then sprayed with a cyanide solution to dissolve the gold. Waste water was recycled in the process, however, by 1994, the adjacent stream was devoid of fish and macroinvertebrates. Reclamation was attempted from 1995 until 1999, when Nevada Gold Fields declared bankruptcy and turned over the property to the South Carolina Department of Health and Environmental Control. By 2006, the pH of the water in the main pit had fallen to 2, the approximate acidity of lemon juice. Contamination had spread into the Savannah River and sites down river. Sporadic testing and site studies accompanied remediation efforts. In 2008, EPA added 1300 tons of hydrated lime to neutralize the acidic water in the Pit Lake. However, contamination persisted in the ground water. EPA placed the former Barite Hill mine site on the National Priorities List (Superfund) in 2009. Chapman *et. al.* wrote a USGS geologic report (2015) on various studies of the site, including conductivity surveys. Willowstick, LLC conducted an EM Flow Path Study in 2016. Dynamic Measurement, LLC (DML) chose this old mine in 2017 as a comparative study site for lightning attribute correlation studies. This poster reviews some of the results of the recent DML study.

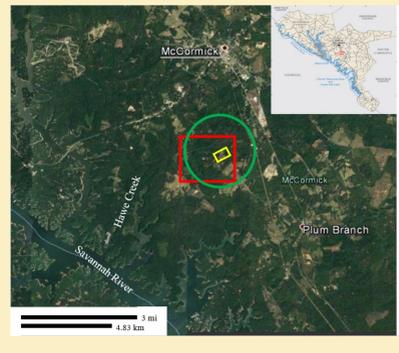
Barite Hill Lightning Attribute Map Study



Lightning Attribute Study over the former Barite Hill Gold Mine

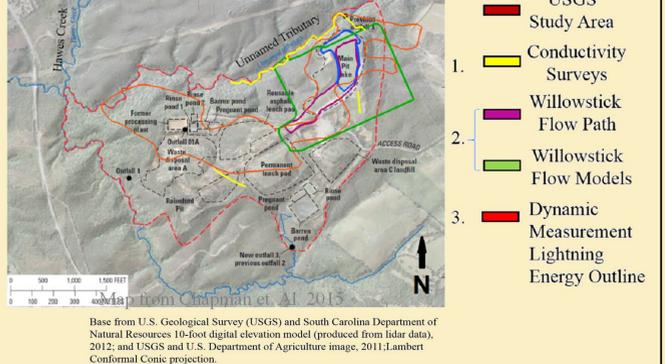


Index Maps



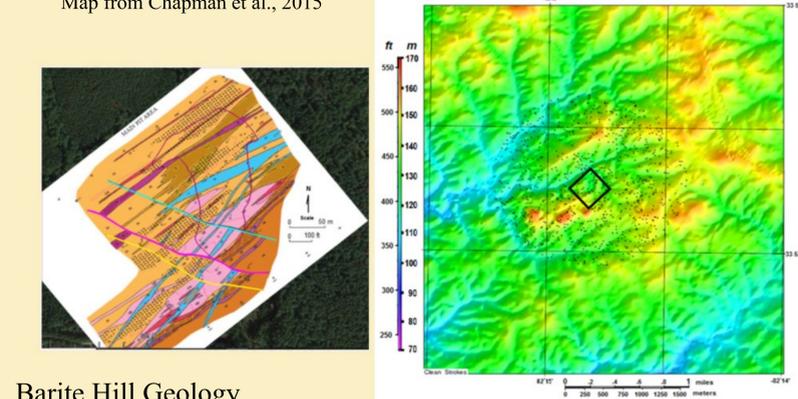
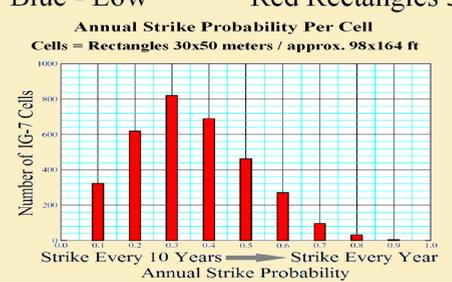
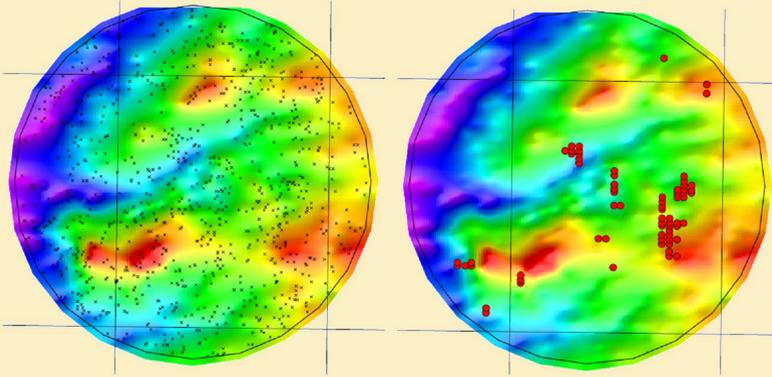
- #### 3 EM Technologies
1. Red Box - USGS 2015 EPA Superfund Site Study Area
 2. Yellow Box - Willowstick Flow Path Mapping and Modeling Patented Process by Willowstick LLC
 3. Green Circle - Dynamic Measurement's Lightning Attribute Analysis Remotely Sensed - Processed Archived Lightning Strike Data Patented Process by Dynamic Measurement LLC

Three Stacked EM Studies



20 Years of Data - Cloud to Ground (CG) Strike Point Risk Probability Demonstrates Strikes Are Not Random

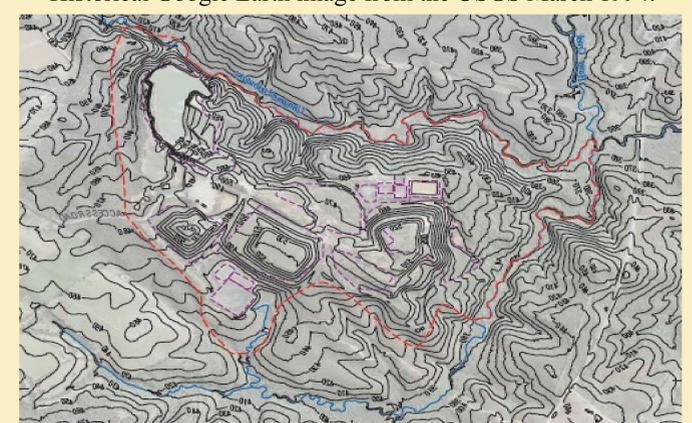
Distribution of CG Strikes over Barite Hill Study Area Distribution of Risk Points Over Barite Hill Study Area

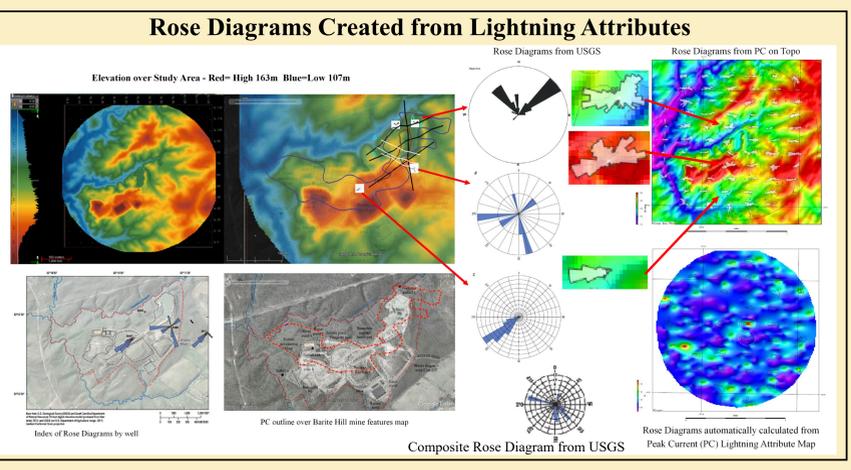
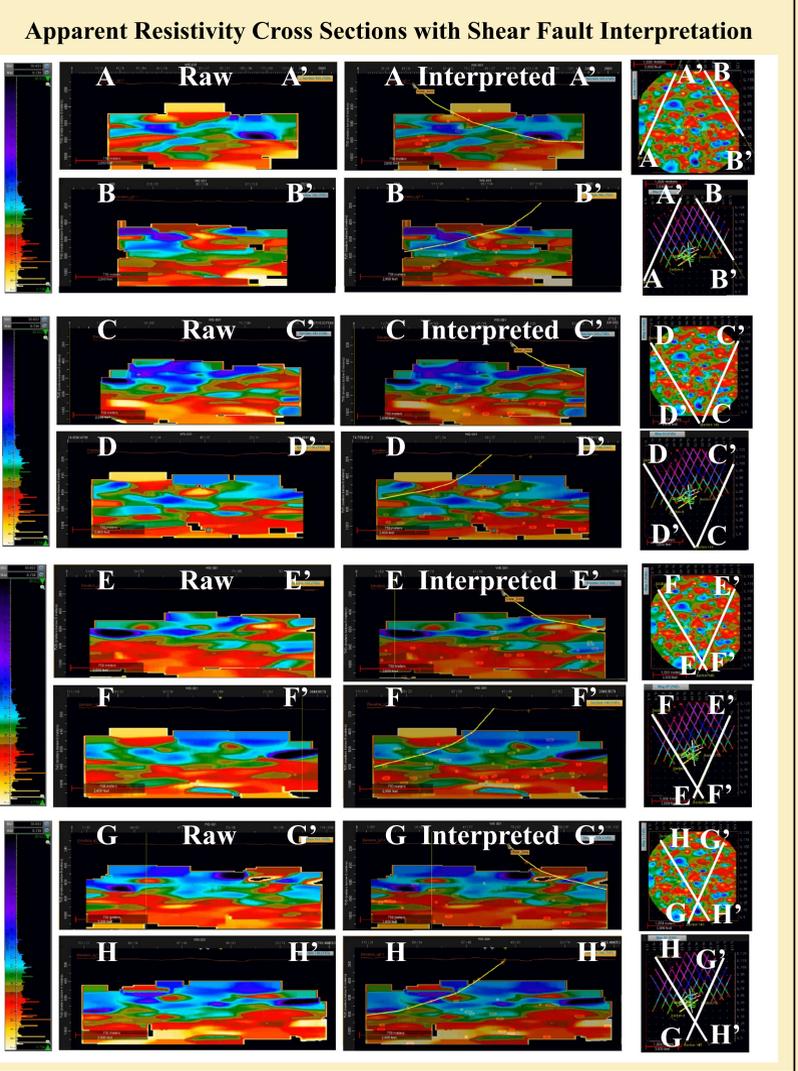
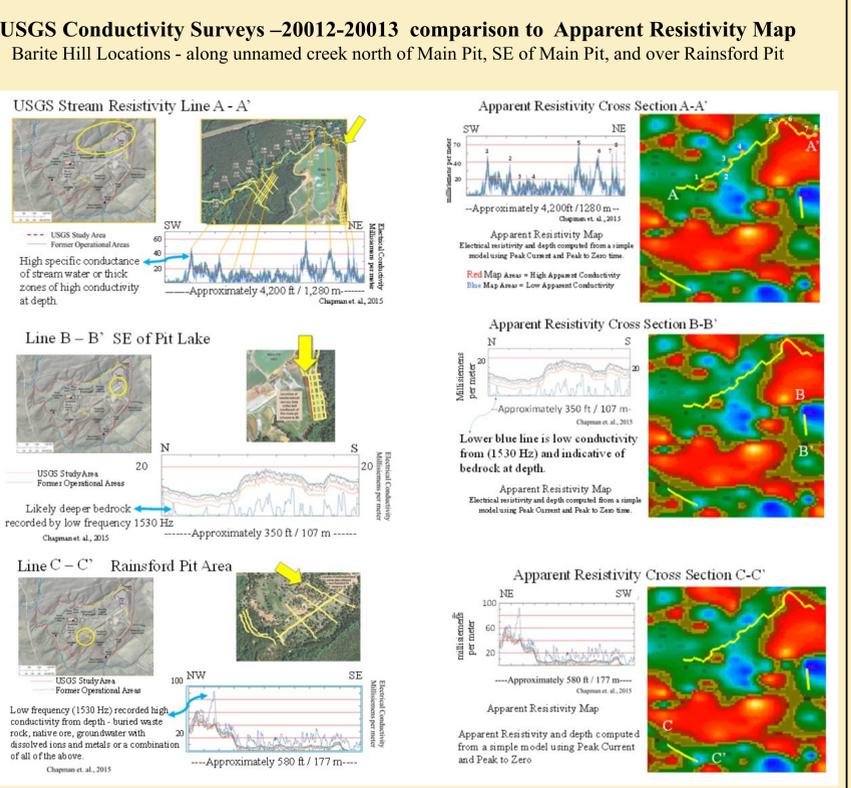
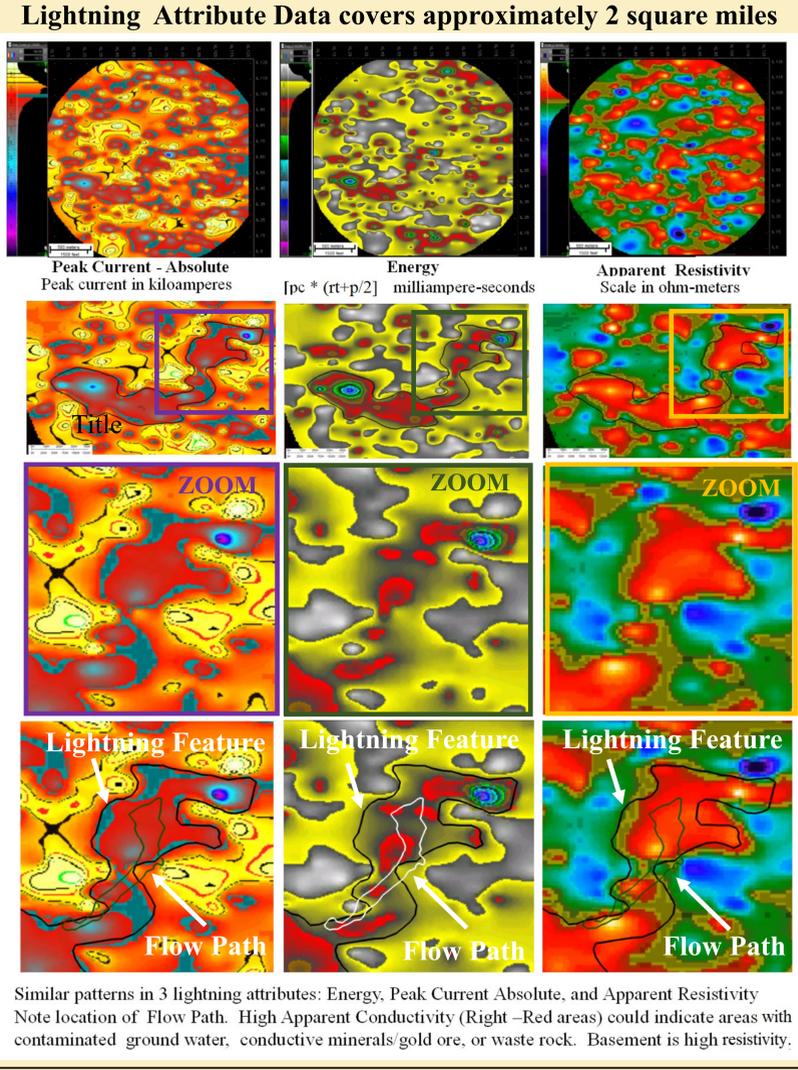
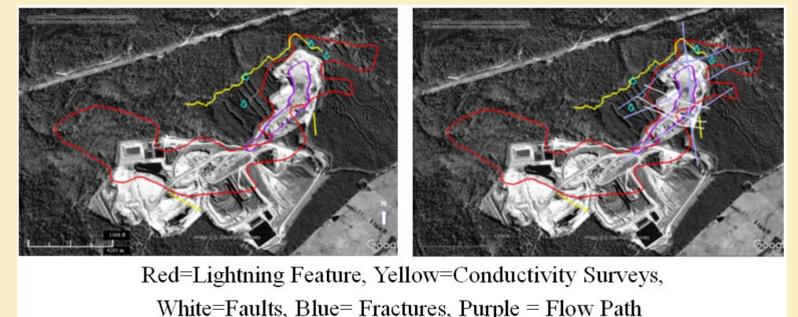
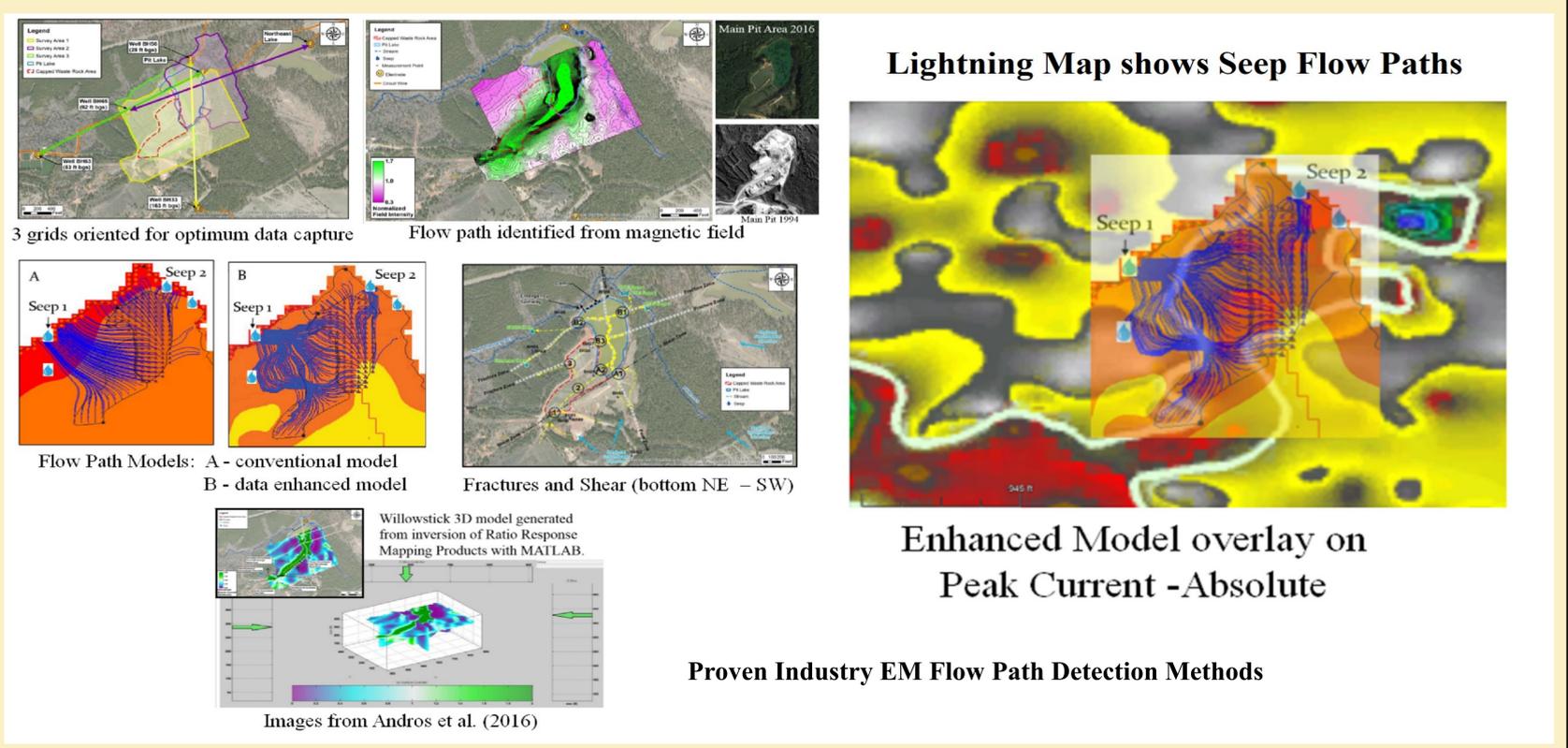


Barite Hill Geology

“Metavolcanics – rock-hosted, stratiform gold-silver Deposit.” Barite Hill gold and silver mineralized zone consists of 4 layers in the Main Pit area between the Upper and Lower Units of the Persimmon Formation, Late Proterozoic Pyroclastic. (from Clark, 1999, Clark et al. 1999)

- m - mafic to intermediate dike or sill
 - Persimmon Fork Fm. - Late Proterozoic Pyroclastics**
 - Upper Pyroclastic Unit**
 - ud - metadacite porphyry
 - us - metavolcanic and metasedimentary rocks
 - gold and silver -----
 - Lower Pyroclastic Unit**
 - lms - sub massive sulfides
 - lqb - quartz - barite rich rock
 - ls - metasedimentary rock - volcanoclastics/ felsic tuffs
 - lk - metakarapophyre – similar to metadacite porphyry
 - ifv - felsic - metavolcanic
- (from Clark, 1999, Clark et al. 1999)





Barite Hill Gold Mine Study Conclusions

Geologists and geophysicists benefit from stacking data from diverse technologies contributing to a coherent interpretation of the surface and subsurface. The varied data sets at Barite Hill build confidence in the validity of the geological interpretation at the surface and in the shallow subsurface. Here you see the blending of several electromagnetic technologies to locate surface and subsurface contamination from the former Barite Hill Gold Mine - spanning nearly two decades. For many years, simple surface water analysis led the regulators to believe that the contamination was confined to the mining operation's footprint and to the drainage outfall areas. Later seeps were identified along an unnamed tributary to Hawes Creek, west of Pit Lake, and along the hill west of Pit Lake. Over time, the surface contamination spread, with Pit Lake's contamination slowly making its way through the mining fracture and fault networks into ground water. The subsurface extent of the contamination was unknown; there were no subsurface maps. A different approach was required. The very complex surface geology mapping study was conducted by the USGS; faults were identified. Electromagnetic geophysical tools such as surface resistivity survey measurements provided additional definition of high contamination sites. The use of explosives in surface mining primarily at the main pit, now Pit Lake, created a chaotic assemblage of fractures which likely also served as conduits of extremely low Ph contaminated water. An electromagnetic survey was conducted over Pit Lake by Willowstick, LLC. Their data revealed a preferred pathway of water through the lake, curving along previously unknown faults and a shear zone which bounded the water flow on the south. These fault interpretations tied to some of the seeps. Models used to image the ground water produced patterns. Also observed in the remotely sourced and recorded data generated from lightning strikes. Barite Hill was Dynamic Measurement, LLC's initial study projecting lightning strike data to the surface. The much earlier apparent resistivity surveys closely matched the apparent resistivity patterns from lightning data. The overlays of modeled flow path patterns closely resembled the attributes of lightning - Energy, Peak Current Absolute, and Apparent Resistivity - in the study area. Lightning data is usually displayed on workstations along with seismic, well logs, and other forms of data. Faults were also interpreted from lightning data. When combined, these diverse geological and electromagnetic data sets bring additional confidence to interpretations useful in tracking and remediating subsurface contamination plumes.

Quicker, safer, & less expensive than other geophysical data types.
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