Number: NS23A-1645

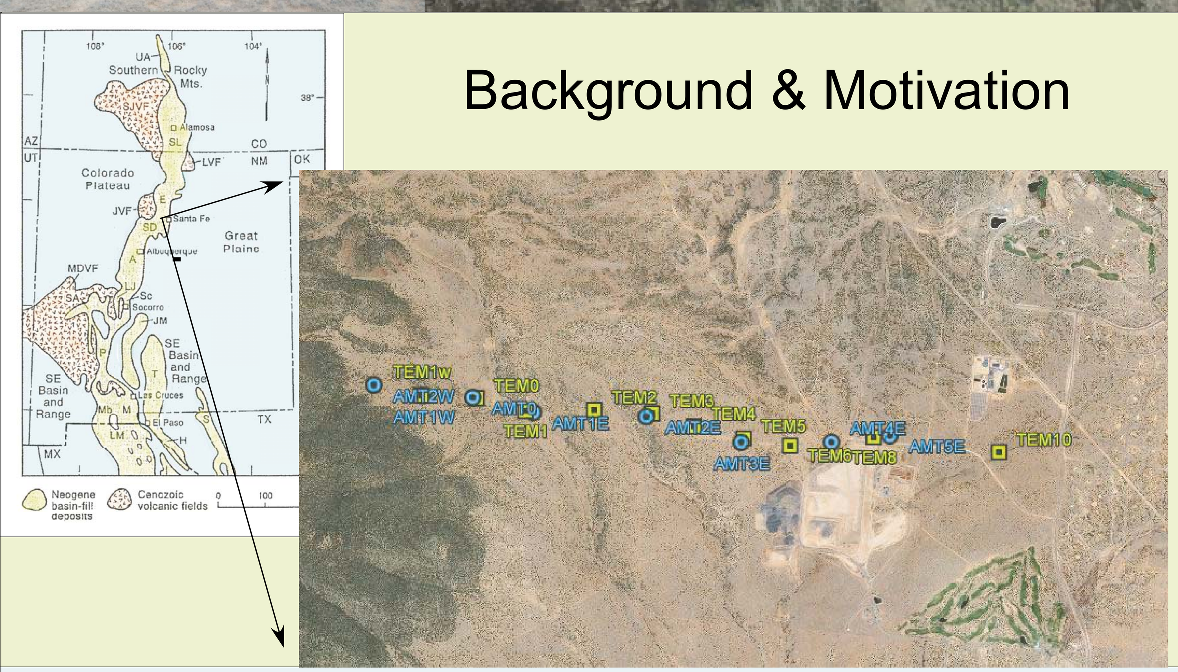
Mapping the edge of the Cerros del Rio volcanic field, New Mexico: a piece of the puzzle to understanding a potential geothermal resource

Louise Pellerin, Green Engineering, Berkeley, CA, pellerin@ak.net; Madison Gallegos, DePauw University, IN, madisongallegos_2013@depauw.edu; Meredith Goebel, University of California, Berkeley, CA, mkgoebel@berkeley.edu; Ben Murphy, Pomona College, CA, bsm02009@mymail.pomona.edu; John Smith, Brigham Young University, UT, smithjohnh@gmail.com; Daniela Soto, University of Santiago, Chile, dsoto@wellfield.cldanisotom@gmail.com; Jerlyn Swiatlowski, California State University, East Bay, CA, jerlyn.swiatlowski@gmail.com; Christopher Volk, University of Utah, UT, christopher.volk@utah.edu; Mark Welch, Cornell University, NY, mwelch12@gmail.com;Danny Feucht, University of Colorado, Boulder, CO, dwfeucht@gmail.com; Becky Hollingshaus, Colorado School of Mines, CO, bholling@mines.edu; Paul A. Bedrosian, U.S. Geological Survey, Denver, CO, pbedrosian@usgs.gov and Darcy K. McPhee, U.S. Geological Survey, Menlo Park, CA, dmcphee@usgs.gov

Summer of Applied Geophysical Experience - SAGE
http://www.sage.lanl.gov/

A four-week-long, field-based program in exploration geophysics where 25-30 students study field problems that include mapping archaeological sites, and studying subsurface structure, water and geothermal resources of the Rio Grande Rift near Santa Fe, New Mexico

Background & Motivation

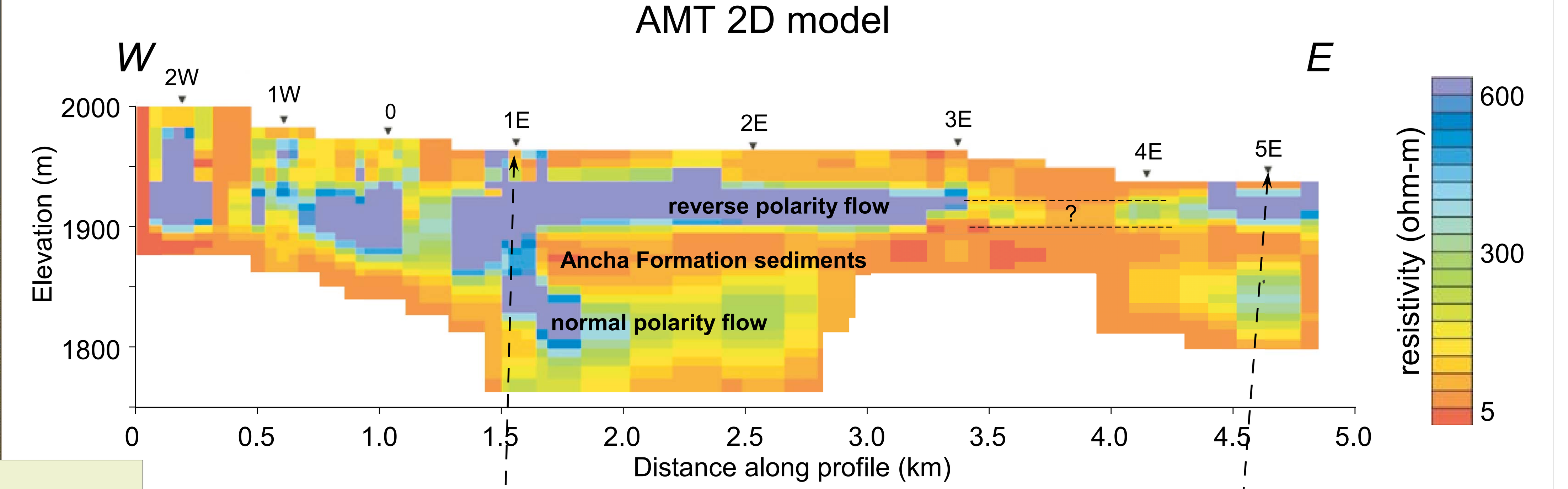


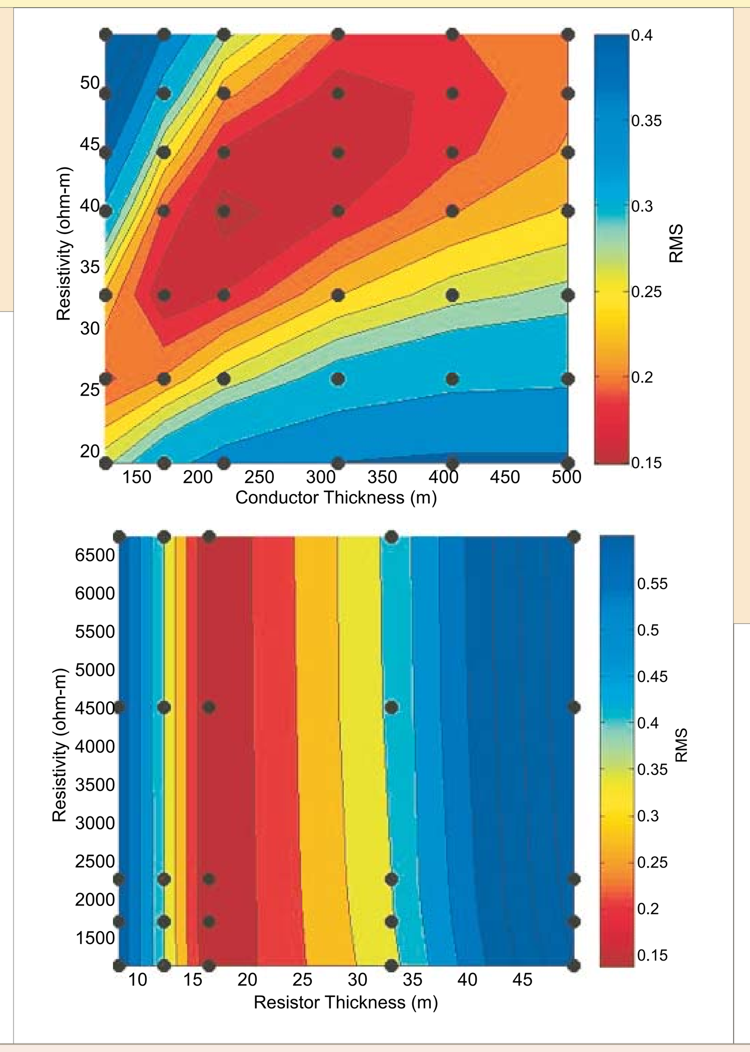
The Cerros del Rio volcanic field located west of Santa Fe, New Mexico, spans the southwestern part of the Espanola Basin with the Rio Grande to the west. Underlying the volcanics are the Santa Fe Group sediments that contain the Ancha Formation, an important aquifer in the region. High temperature gradients in water wells reveal a potential geothermal prospect.

In 2012 SAGE acquired transient electromagnetic (TEM), audiomagnetotelluric (AMT), gravity and ground magnetic data to determine the buried eastern margin of the volcanic field and the connectivity related to the underlying sediments. The roughly EW 5-km long transect was sited from USGS aeromagnetic data to cross the boundary of the Cerros del Rio volcanic field.

Audiomagnetotelluric - AMT

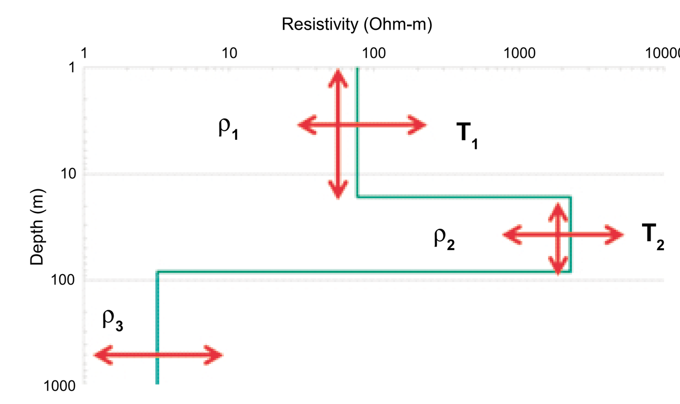
AMT data were acquired at eight stations, at 400-500 m spacing, using the Geometric Stratagem system recording from 92 kHz to 10 Hz. Data were sorted with 0.9, 0.7 and 0.5 coherencies; 0.5 was found to produce the highest quality apparent resistivity and phase curves, which were used in the inversion.



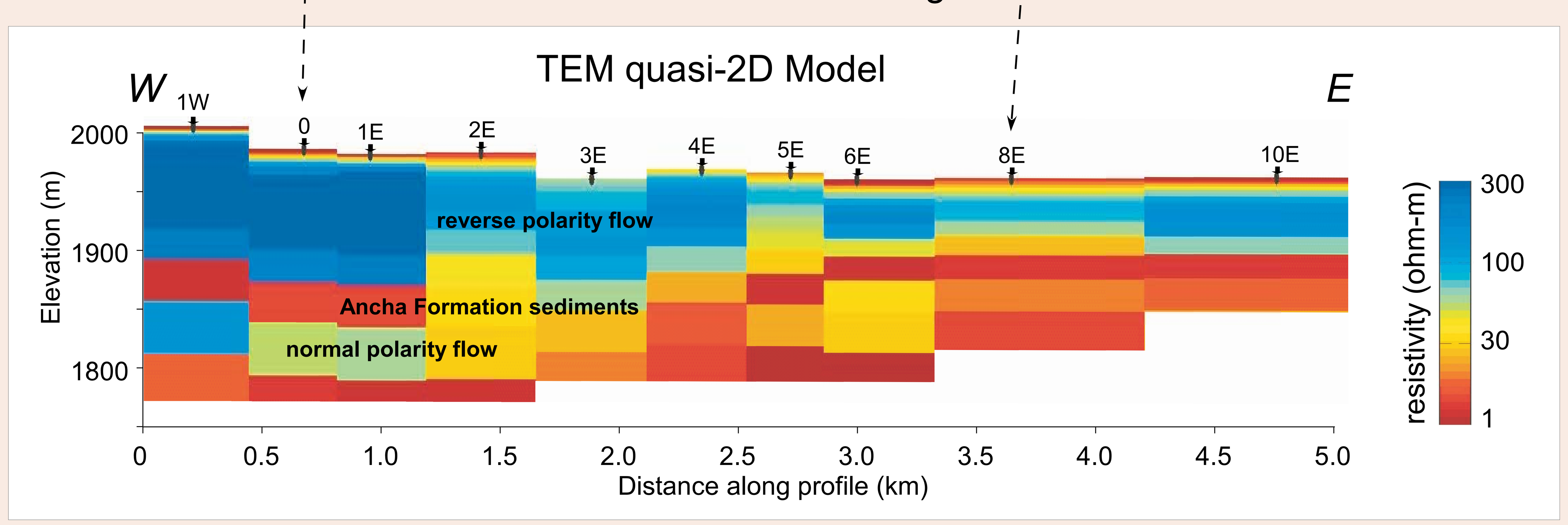


1D Sensitivity Analysis

1D sensitivity analysis allows constraints to be put on the depths and resistivities of layers. The depths to the top and bottom of the resistive layers are accurate to within about 10 meters. The resistivities in the SAGE data for the top and bottom layers are reasonably well constrained to within about 20 and 2 ohm-m, respectively.



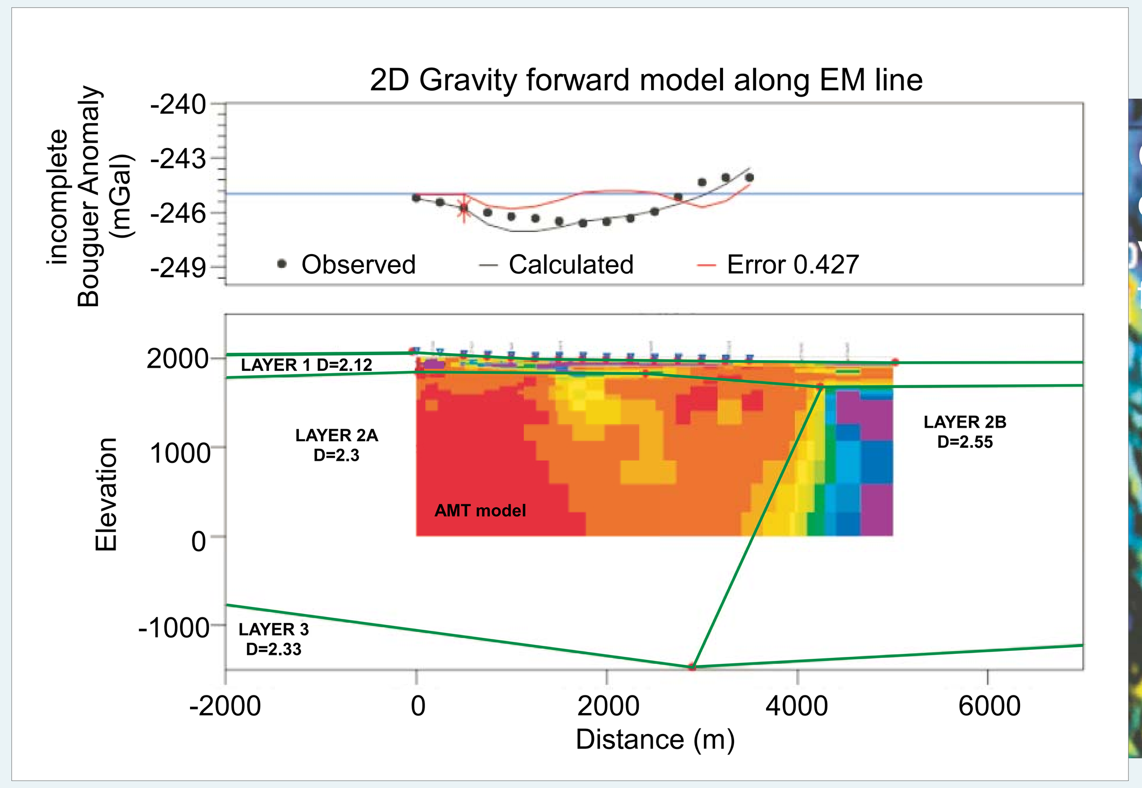
Transient Electromagnetics - TEM

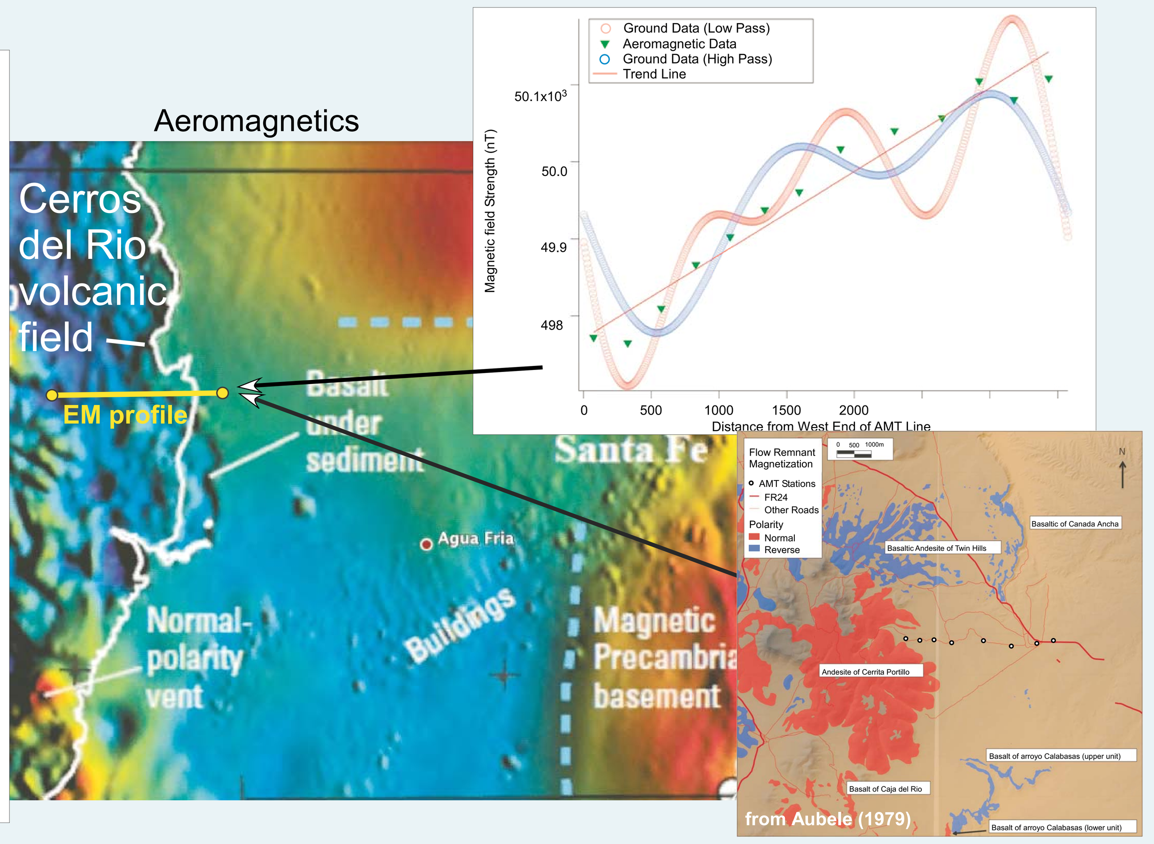


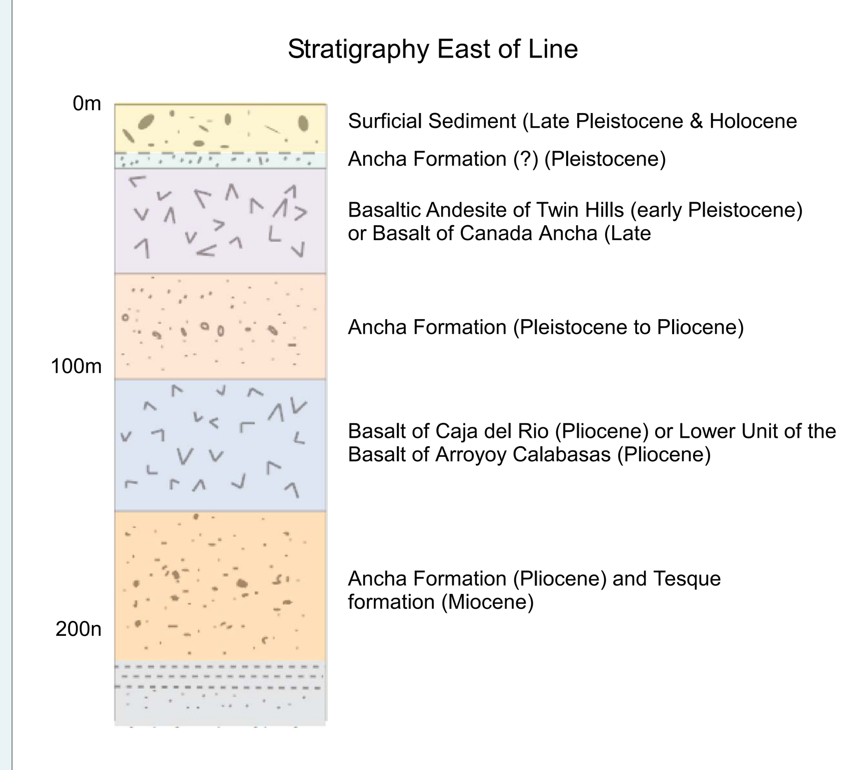
TEM data acquired at ten stations with 200-400 m spacing along a ~5 km transect. We employed an in-loop configuration with a square 100 m x 100 m transmitter loop and both a Zonge receiver coil and a 5-m square receiver loop. The 5-m loop allowed for the recovery of early-time data that was saturated when using the coil, while the coil permitted greater depth of penetration. Twenty layer-earth (or 1D) models were fit to the data at each station and stitched together along the profile to create a pseudo 2D cross-section. The model indicates the resistive volcanics are thickest in the west and thin towards the east, with an upper and lower resistive unit in the West separated by a thin conductor. Possible explanations for the observed structure include multiple volcanic flows, fault control, and the presence of water.

Gravity & Magnetics

The 2D gravity forward model is based on the AMT model. Aeromagnetic data (Grauch et al., 2009) were used to site the EM profile. About 3500 m of ground magnetic data were acquired with a Geometrics Cs vapor G-858 magnetometer along the EM profile at a 0.5 second sample rate during SAGE 2012.Note the center region of the magnetic field strength plot is generally higher than the overall trend of the data; this region corresponds to the lower volcanic flow in the AMT data. The magnetic data suggest that the flow is normally magnetized.







Conclusions

Two volcanic flows interbedded with Ancha Formation and overlying Santa Fe Group sediments were identified in both the TEM and AMT modeling. High surface resistivity zones (>300 ohm-m) with depths ranging from ~100 to 300 m define the volcanic flows and correspond to high densities (2.3 to 2.55 g/cm3), while low resistivity zones (<30 ohm-m) correspond to lower densities (~2.1 g/cm3). High spatial-frequency magnetic variations are a possible indication of different volcanic flows that are characterized by normal or reverse remnant magnetization. The upper flow (normally polarized) is inferred to extend beyond the study area and, therefore, past the end of the Cerros del Rio volcanic field boundary defined by USGS aeromagnetic data.

References

Grauch, V.J.S., Phillips, J.D., Koning, D.J., Johnson, P.S., Bankey, V., 2009, Geophysical Interpretations of the Southern Espanola Basin, New Mexico, That Contribute to Understanding Its Hydrogeologic Framework , U.S Geological Survey Professional Paper 1761, p. 13-23.

Acknowledgments

Special thanks to the students and faculty of SAGE 2012, Zonge International, GM-SYS, Geometrics and Aarhus Geophysics for their work and support.