Magnetotelluric Data In the Española Basin, West of Santa Fe, New Mexico

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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
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Introduction

The Santa Fe region is rapidly growing. The Santa Fe Group aquifer in the Españolola Basin is the main source of municipal water for the region (fig. 1), and water shortfalls could have serious consequences. Future growth and land management in the region depend on accurate assessment and protection of the region's ground-water resources. An important issue in managing the ground-water resources is a better understanding of the hydrogeology of the Santa Fe Group, the sedimentary deposits that fill the Rio Grande rift and contain the principal ground-water aquifers.

The U.S. Geological Survey (USGS) is doing a series of studies of the Españolola Basin in northern New Mexico. One objective of these studies is to understand the hydrogeologic framework of the Españolola Basin to help land managers plan and develop water supplies. These studies involve a multidisciplinary approach to better understand the critical aquifers in the intracontinental rift environment. Detailed geologic mapping, high-resolution airborne magnetic surveys, electromagnetic surveys, and hydrologic, lithologic, and hydrogeochemical data are being used to better understand the aquifer systems in the Españolola Basin. A magnetotelluric (MT) survey was done as part of these studies. The primary purpose of the MT survey was to map changes in electrical resistivity with depth that are related to lithologic variations important to the critical aquifers. The purpose of this report is to release the MT sounding data; no interpretation of the data is included.

Magnetotelluric Method

The MT method is a passive surface geophysical technique that uses the Earth's natural electromagnetic fields to investigate the electrical resistivity structure of the subsurface. The resistivity of geologic units is largely dependent upon their fluid content, porosity, degree of fracturing, temperature, and conductive mineral content (Keller, 1989). Saline fluids within the pore spaces and fracture openings can reduce resistivities in a resistive rock matrix. Resistivity also can be lowered by the presence of conductive clay minerals, carbon, and metallic mineralization. It is common for altered volcanic rocks to contain authigenic minerals that have resistivities 10 times less than those of the surrounding rocks (Nelson and Anderson, 1992). Increased temperatures cause higher ionic mobility and mineral activation energy, reducing rock resistivities significantly. Unaltered, unfractured igneous rocks are moderately to highly resistive (hundreds to thousands of ohm-m), whereas fault zones will show low resistivity (less than 100 ohm-m) when they are composed of rocks that are fractured enough to have hosted fluid transport and consequent mineralogical alteration (Eberhart-Phillips and others, 1995). Carbonate rocks are moderately to highly resistive (hundreds to
thousands of ohm-m) depending upon their fluid content, porosity, fracturing, and impurities. Marine shales, mudstones, and clay-rich alluvium are normally conductive (a few ohm-m to tens of ohm-m). Unaltered metamorphic rocks (non-graphitic) are moderately to highly resistive (hundreds to thousands of ohm-meters[ohm-m]). Tables of electrical resistivity for a variety of rocks, minerals, and geological environments are included in Keller (1987) and Palacky (1987).

The MT method can be used to probe the crust from depths of tens of meters to depths of tens of kilometers (Vozoff, 1991). Natural variations of the Earth's magnetic and electric field are measured and recorded at each MT station. The primary frequency bands used by the MT method are 10,000 to 1 hertz (Hz) from worldwide lightning activity and 1 to 0.001 Hz from geomagnetic micro-pulsations. The natural electric and magnetic fields propagate vertically in the Earth because the large resistivity contrast between the air and the Earth causes a vertical refraction of both fields transmitted into the Earth (Vozoff, 1972).

The natural electric and magnetic fields are recorded in two orthogonal, horizontal directions. The vertical magnetic field ("tipper") also is recorded. The resulting time-series signals are used to derive the tensor apparent resistivities and phases. First, the signals are converted to complex cross-spectra using Fast-Fourier-transform (FFT) techniques. Then, least-squares, cross-spectral analysis (Bendat and Piersol, 1971) is used to solve for a transfer function that relates the observed electric fields to the magnetic fields with the assumption that the Earth consists of a two-input, two-output linear system, with the magnetic fields as input and the electric fields as output. Prior to conversion to apparent resistivity and phase, the tensor is normally rotated into principal directions that correspond to the direction of maximum and minimum apparent resistivity. For a two-dimensional (2-D) Earth, the MT fields can be de-coupled into transverse electric (TE) and transverse magnetic (TM) modes; 2-D modeling generally is done to fit both modes. When the geology satisfies the 2-D assumption, the MT data for the TE mode are for the electric field parallel to geologic strike, and the data for the TM mode are for the electric field across strike. The MT method is well suited for studying complicated geological environments because the electric and magnetic relations are sensitive to vertical and horizontal variations in resistivity. The MT method is capable of establishing whether the electromagnetic fields are responding to subsurface terranes of effectively one, two, or three dimensions. An introduction to the MT method and references for a more advanced understanding are in Dobrin and Savit (1988) and Vozoff (1991).
Magnetotelluric Survey

Data were collected at 18 stations in 2002 and 2003 to represent the area of this study. The station locations were chosen for constraining gravity modeling across the fault, and for proximity to roads, and for avoidance of electrical noise such as power lines. All data at the stations were collected with a portable EMI MT-1 system (EMI, 1996). Horizontal electric fields were sensed using copper sulfate porous pots placed in an L-shaped, three-electrode array with dipole lengths of 30 meters (m). The orthogonal, horizontal magnetic fields in the direction of the electric-field measurement array were sensed using permalloy-cored induction coils. Frequencies sampled ranged from 4 to 23,000 Hz (4.3945, 7.3242, 12.2070, 19.0430, 28.3203, 41.5039, 60.0586, 79.0000, 85.9375, 100.0000, 122.0703, 150.0000, 172.3633, 210.0000, 270.0000, 340.0000, 460.0000, 580.0000, 720.0000, 885.0000, 1170.0000, 1500.0000, 1870.0000, 2200.0000, 2730.0000, 3550.0000, 4900.0000, 6500.0000, 9000.0000, 11590.0000, 15290.0000, 19500.0000, 23370.0000) and 0.009 to 70Hz (0.0088, 0.0146, 0.0244, 0.0381, 0.0566, 0.0830, 0.0879, 0.1201, 0.1465, 0.1719, 0.2441, 0.3447, 0.3809, 0.5664, 0.8301, 1.2012, 1.7578, 2.4414, 2.9297, 3.4473, 4.8828, 7.6172, 11.3281, 16.6016, 24.0234, 34.3750, 48.8281, 68.9453) using single-station recordings of the orthogonal, horizontal components of the electric and magnetic fields and the vertical magnetic field.

The following table lists the 18 MT station locations as recorded using a global positioning system during field acquisition. Coordinates are referenced to the 1866 Clarke spheroid and North American 1927 Western United States datum. Longitude and latitude format is degrees:minutes:seconds. Universal Transverse Mercator (UTM) units are in meters. Station elevation is given in meters. The accuracy of the x, y, z component is ±5 m.

<table>
<thead>
<tr>
<th>Station</th>
<th>Longitude</th>
<th>Latitude</th>
<th>UTM North(m)</th>
<th>UTM East(m)</th>
<th>Elevation(m)</th>
</tr>
</thead>
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<tr>
<td>10</td>
<td>-106:10:05</td>
<td>35:41:53</td>
<td>3,950,901</td>
<td>13,394,319</td>
<td>2170</td>
</tr>
<tr>
<td>11</td>
<td>-106:11:19</td>
<td>35:38:47</td>
<td>3,945,184</td>
<td>13,392,391</td>
<td>2025</td>
</tr>
<tr>
<td>17</td>
<td>-106:21:42</td>
<td>35:41:09</td>
<td>3,949,770</td>
<td>13,376,785</td>
<td>1760</td>
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<tr>
<td>18m</td>
<td>-106:16:37</td>
<td>35:23:32</td>
<td>3,917,087</td>
<td>13,384,020</td>
<td>1845</td>
</tr>
<tr>
<td>19m</td>
<td>-106:10:09</td>
<td>35:34:20</td>
<td>3,936,915</td>
<td>13,394,057</td>
<td>1886</td>
</tr>
<tr>
<td>20m</td>
<td>-106:11:36</td>
<td>35:36:16</td>
<td>3,940,539</td>
<td>13,391,897</td>
<td>1986</td>
</tr>
<tr>
<td>22m</td>
<td>-106:09:31</td>
<td>35:43:35</td>
<td>3,954,039</td>
<td>13,395,225</td>
<td>2042</td>
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<tr>
<td>23m</td>
<td>-106:09:58</td>
<td>35:42:48</td>
<td>3,952,588</td>
<td>13,394,527</td>
<td>2100</td>
</tr>
<tr>
<td>24m</td>
<td>-105:56:01</td>
<td>35:24:25</td>
<td>3,918,370</td>
<td>13,415,194</td>
<td>1860</td>
</tr>
<tr>
<td>25m</td>
<td>-106:10:09</td>
<td>35:40:42</td>
<td>3,948,914</td>
<td>13,394,185</td>
<td>2100</td>
</tr>
<tr>
<td>26m</td>
<td>-106:07:07</td>
<td>35:40:08</td>
<td>3,948,043</td>
<td>13,398,749</td>
<td>1973</td>
</tr>
<tr>
<td>27m</td>
<td>-106:09:22</td>
<td>35:47:06</td>
<td>3,960,730</td>
<td>13,395,460</td>
<td>2010</td>
</tr>
</tbody>
</table>
Magnetotelluric Data

The recorded time-series data were transformed to the frequency domain and processed to determine a 2-D apparent resistivity and phase tensor at each site. Rotation of the impedance tensor to maximum and minimum directions allows for decoupling into the TE and TM modes.

Although true remote reference techniques were not used in the survey, cross-power files were sorted to select optimal signal-to-noise time-series data sets (see Appendix at the back of the report).

The effects of near-surface resistivity anomalies caused “static shifts” in the data (Sternberg and others, 1988). Static shifts were significant at stations 9, 13, 16, 20, 22, 24, and 27. Cultural features can affect the response of the MT system. Fences, pipelines, communication lines, railways, and other manmade conductors can contaminate the responses.

The figures in the Appendix represent the field-processed MT data for each station after the time-series data were converted to the frequency domain, and the tensor-transfer function was rotated into principal directions as described in the “Magnetotelluric Method” section.

For each station, nine separate plots are given:

1. Apparent Resistivity (x and y symbols are xy and yx components)
2. Impedance Phase (x and y symbols are xy and yx components)
3. Rotation Angle
4. Impedance Skew
5. Multiple Coherency (x and y symbols are xy and yx components)
6. Impedance Polar Plots
7. Tipper Magnitude
8. Tipper Strike
9. HzHx (x symbol) and HzHy (o symbol) Coherency

Error bars (],[,) on the Apparent Resistivity, Impedance Phase, Skew, Tipper Magnitude, and Tipper Strike plots represent probable errors within one standard deviation of the sample variance (Gamble and others, 1979).

Apparent resistivity is the ratio of the electric field strength magnitude over the magnetic-field strength magnitude for a given frequency. The impedance phase is proportional to the slope of the apparent resistivity curve on a log-log plot, but from a baseline at -45 degrees (Vozoff, 1991). A measure of the dimensionality for MT data is provided by the impedance skew of the impedance tensor (Vozoff, 1972). If the effective, measured resistivity response to the geology beneath a MT station is truly one or two dimensional, then the skew will be zero. Both instrument and environmental sources of noise contribute to non-
zero skew values but are typically small (about 0.1) for relatively low-noise-level recordings. Higher skew values (above 0.2) are an indication of either the resistivity response to 3-D geology or higher levels of noise. Manmade electrical noise, such as power lines, power generators, and moving vehicles and trains, can have a negative effect on MT data quality. All of these local disturbances produce an incoherent noise mainly affecting frequencies above 1 Hz. Other manmade electrical noise, such as direct current electric trains and active cathodic protection of pipelines, produce coherent electromagnetic signals mainly affecting frequencies below 1 Hz.

In the survey area, noise from a number of small power lines and small moving vehicles was negligible at distances of 0.4 km and greater from the noise source. Power-line signal levels were measured at each site and were typically less than 20 percent of the maximum recordable signals. Noise from larger power lines, power generators, pipelines, and trains was negligible at distances greater than 5 km. Local lightning, wind, and rainstorms also can degrade data quality, but these were avoided by not recording during active thunderstorm periods. Burying the magnetic induction coils and keeping the electric dipole wires flat on the ground surface minimized wind noise.

Predicted values of the electric field can be computed from the measured values of the magnetic field (Vozoff, 1991). The coherence of the predicted electric field with the measured electric field is a measure of the signal-to-noise ratio provided in the multiple coherency plots. Values are normalized between 0 and 1, where values at 0.5 signify signal levels equal to noise levels. For this data set, coherencies were generally at an acceptable level, except at times in the frequency range “dead band” (0.01 to 5 Hz).

The figures in the Appendix represent the field-processed MT data at each station, which includes some data scatter and poor signal-to-noise ratios. The only effort at removing noisy data points was to visually inspect and select the best signal-to-noise field data to combine into the final data plots.

The impedance polar plots provide a measure of the MT data dimensionality (Reddy and others, 1977). For 1-D resistivity structures, the principal impedance polar diagram (dashed line) is a circle. For 2-D or 3-D resistivity structures, the principal impedance polar diagram (dashed line) elongates either parallel or perpendicular to strike direction. Over resistors, the principal impedance polar diagram elongates perpendicular to strike direction, and over conductors, the principal impedance polar diagram elongates parallel to strike direction. For 2-D resistivity structures, the additional impedance polar diagram (solid line) attains the shape of a symmetric clover leaf. For 3-D resistivity structures, the additional impedance polar diagram (solid line) elongates in one direction, and its amplitude is comparable to that of the principal impedance polar
diagram (dashed line). Station 27 indicates a 3-D response over all frequencies measured.

The tipper can be calculated when the vertical component of the magnetic field is measured. The tipper magnitude is a measure of the tipping of the magnetic field out of the horizontal plane (Vozoff, 1991). The magnitude is zero for the 1-D case and typically increases between 0.1 to 0.5, and rarely as great as 1, as it responds to vertical and subvertical structures. The tipper strike typically is used to help resolve the 90-degree ambiguity in the impedance rotation angle. The tipper magnitude of these stations typically was 0.1 to 0.6 over the lower frequencies, indicating some vertical structure at depth. The HxHz and HxHy coherency is a measure of the signal-to-noise ratio of the vertical magnetic field with respect to each of the orthogonal, horizontal magnetic-field directions. Values are normalized between 0 and 1, where values at 0.5 signify signal levels equal to noise levels. These three-component magnetic-field coherencies provide a check on the signal-to-noise ratio of the measured values in the tipper magnitude and tipper strike plots.

References Cited


Appendix
Magnetotelluric Data Plots

There are nine separate plots for each station:

1. Apparent Resistivity for the rotated maximum (x symbol) and minimum (o symbol) modes
2. Impedance Phase for the rotated maximum (x symbol) and minimum (o symbol) modes
3. Rotation Angle for the impedance tensor (corresponds to the direction of maximum apparent resistivity)
4. Impedance Skew for the impedance tensor
5. Multiple Coherency for the rotated maximum (x symbol) and minimum (o symbol) modes of the electric field
6. Impedance Polar Plots (at 12 selected frequencies)
7. Tipper Magnitude for the vertical magnetic field
8. Tipper Strike for the vertical magnetic field
9. HxHx (x symbol) and HzHy (o symbol) Coherency

Refer to the "Magnetotelluric Data" section in this report for an explanation of these plots.
Figure 1. Index map of magnetotelluric (MT) survey area, west of Santa Fe, in Española basin, northern New Mexico. Numbered labels are MT stations acquired in 2002 and 2003. Base map modified from USGS, Albuquerque, New Mexico 250,000 scale topographic map.
Client: e-fld 95 m east
Remote: e-fld 95 m east
Acquired: 12:3 Jul 24, 2002
Survey Co: USGS

Rotation:
Filename: cp08.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:32 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Client: 
Remote: e-fld 95 m east
Acquired: 12:3 Jul 24, 2002
Survey Co.: USGS

Rotation:
Filename: cp06.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:32 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE

North of Tetilla Peak

Station 8

MAGNITUDE

10

20

30

40

50

60

70

80

FREQUENCY (Hz)

0

1

10

100

1000

10000

100000

Rotation:
Filename: cp08.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:33 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Client:
Remote: e-fld 95 m north
Survey Co: USGS

Rotation:
Filename: cp09.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:14 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
E MULT Coh. South of Ortiz Mtn, NM Station 9

Client:
Remote: e-fld 95 m north
Survey Co: USGS

Rotation:
Filename: cp09.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:15 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
HzHx.x Coh HzHy.o

South of Ortiz Mtn, NM

Station 9

FREQUENCY (Hz)

COHERENCY

Client:
Remote: e-fld 95 m north
Survey Co:USGS

Rotation:
Filename: cp09.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:15 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Client: e-fld 95 m west
Remote: e-fld 95 m west
Acquired: 14:3 Jul 26, 2002
Survey Co: USGS

Rotation:
Filename: cp10.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:46 Jul 07, 2004

EMI - Electromagnetic Instruments
HzHx.x Coh HzHy.o

South of Twin Hills, NM

Client:
Remote: e-fld 95 m west
Acquired: 14:3 Jul 26, 2002
Survey Co: USGS

Rotation:
Filename: cp10.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:18 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
IMPEDEANCE SKEW

SE of Colorado Peak, NM

FREQUENCY (Hz)

SKEW

Client:
Remote: e-fld 95 m north
Acquired: 13:2 Jul 27, 2002
Survey Co: USGS

Rotation:
Filename: cp11.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:30 Jul 06, 2004
< EMI - Electromagnetic Instruments >
Client:
Remote: e-fld 95 m north
Acquired: 13:2 Jul 27, 2002
Survey Co: USGS

Rotation:
Filename: cp11.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:30 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
ROTATION ANGLE

West of St. Peters Dome

DEGREES

FREQUENCY (Hz)

Client:
Remote: e-fld 95 m west
Acquired: 15:1 Jul 29, 2002
Survey Co: USGS

Rotation:
Filename: cp12a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:48 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Impedance Skew

West of St. Peters Dome

Frequency (Hz)

Skew

Client: e-fld 95 m west
Acquired: 15:1 Jul 29, 2002
Survey Co: USGS

Rotation:
Filename: cp12a. avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:31 Jul 06, 2004

< EMI - ElectroMagnetic Instruments >
EMULT Coh. West of St. Peters Dome

![Graph showing frequency response with coherency values]

Client:
Remote: e-fld 95 m west
Acquired: 15:1 Jul 29, 2002
Survey Co:USGS

Rotation:
Filename: cp12a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:31 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

West of St. Peters Dome

4.394 Hz 150 Hz 1870 Hz
12.207 Hz 210 Hz 2730 Hz
41.504 Hz 460 Hz 6500 Hz
85.938 Hz 885 Hz 15290 Hz

Client:
Remote: e-fld 95 m west
Acquired: 15:1 Jul 29, 2002
Survey Co: USGS

Rotation:
Filename: cp12a.av
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:31 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
IMPEDEANCE SKEW

East of Cerrito Pelado

FREQUENCY (Hz)

SKEW

Client:
Remote: e-fld 90m west
Acquired: 13:0 Jul 30, 2002
Survey Co: USGS

Rotation:
Filename: cp13a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:33 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Polar Plots

East of Cerrito Pelado

---

79.000 Hz
580 Hz
3550 Hz

885 Hz

210 Hz
1500 Hz
11590 Hz

340 Hz
2200 Hz
19500 Hz

---

Client:
Remote: e-fld 90m west
Acquired: 13:0 Jul 30, 2002
Survey Co: USGS

Rotation:
Filename: cp13a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:34 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Station 16

APPARENT RESISTIVITY
East of Twin Hills, NM

Client:
Remote: e-fld 95m west
Acquired: 11:5 Aug 01, 2002
Survey Co: USGS

Rotation:
Filename: cp16a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:36 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
E MULT Coh.  East of Twin Hills, NM

Client:
Remote: e-fld 95m west
Acquired: 11:5 Aug 01, 2002
Survey Co: USGS

Rotation:
Filename: cp16a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:36 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

East of Twin Hills, NM

4.394 Hz
150 Hz
1870 Hz

12.207 Hz
210 Hz
2730 Hz

41.504 Hz
460 Hz
6500 Hz

85.938 Hz
885 Hz
15290 Hz

Client:
Remote: e-fld 95m west
Acquired: 11:5 Aug 01, 2002
Survey Co: USGS

Rotation:
Filename: cp16a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:36 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE

East of Twin Hills, NM

MAGNITUDE

FREQUENCY (Hz)

Client:
Remote: e-fld 95m west
Acquired: 11:5 Aug 01, 2002
Survey Co: USGS

Rotation:
Filename: cp16a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:36 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Station 16

TIPPER STRIKE

East of Twin Hills, NM

FREQUENCY (Hz)

DEGREES

Client: Remote: e-fld 95m west
Acquired: 11:5 Aug 01, 2002
Survey Co: USGS
Rotation:
Filename: cp16a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:36 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Station 17

APPARENT RESISTIVITY

Canada de Cochiti, NM

Client: Remote: e-fld 90m west
Acquired: 12:4 Aug 02, 2002
Survey Co: USGS

Rotation: Filename: cp17a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:38 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Station 17

IMPEDEANCE PHASE

Canada de Cochiti, NM

Client:
Remote: e-fld 90m west
Acquired: 12:4 Aug 02, 2002
Survey Co: USGS

Rotation:
Filename: cp17a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:38 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Canada de Cochiti, NM

4.394 Hz
150 Hz
1870 Hz

12.207 Hz
210 Hz
2730 Hz

41.504 Hz
460 Hz
6500 Hz

85.938 Hz
885 Hz
15290 Hz

Client:
Remote: e-fld 90m west
Acquired: 12:4 Aug 02, 2002
Survey Co: USGS

Rotation:
Filename: cp17a avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:38 Jul 06, 2004

< EMI - ElectroMagnetic Instruments >
Station 17

HzHx.x Coh HzHy.o

Canada de Cochiti, NM

FREQUENCY (Hz)

COHERENCY

Client:
Remote: e-fld 90m west
Acquired: 12:4 Aug 02, 2002
Survey Co:USGS

Rotation:
Filename: cp17a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:38 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
ROTATION ANGLE

Santa Fe, NM

DEGREES

FREQUENCY (Hz)

Client:
Remote: e-fld 95 m south
Acquired: 14:4 Jun 17, 2003
Survey Co:

Rotation:
Filename: cp180aall.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:52 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
E MULT Coh.
Santa Fe, NM
Station 18

Coherence vs Frequency (Hz)

Client:
Remote: e-fld 95 m south
Acquired: 14:4 Jun 17, 2003

Rotation:
Filename: cp18aall.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:39 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Client:
Remote: e-flb 95 m south
Acquired: 14:4 Jun 17, 2003
Survey Co:

Rotation:
Filename: cp18aall.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:39 Jul 06, 2004

< EMI - ElectroMagnetic Instruments >
Client: 
Remote: e-fld 95 m east 
Acquired: 14:2 Jun 18, 2003 
Survey Co: 

Rotation: 
Filename: cp19.avg 
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7 
Plotted: 09:48 Jul 06, 2004 
< EMI – ElectroMagnetic Instruments >
Client:
Remote: e-fld 95 m north
Acquired: 14:06 Jun 19, 2003
Survey Co: USGS

Rotation:
Filename: cp20.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:50 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Station 21

APPARENT RESISTIVITY
Santa Fe, NM

FREQUENCY (Hz)

OHM METERS

Client:
Remote: e-fld 95 m north
Acquired: 14:5 Jun 20, 2003
Survey Co:USGS

Rotation:
Filename: cp21.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:52 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
E MULT Coh.

Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

0

0.2

0.4

0.6

0.8

Client:
Remote: e-fld 95 m north
Acquired: 14:5 Jun 20, 2003
Survey Co: USGS

Rotation:
Filename: cp21.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:52 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Polar Plots

Santa Fe, NM

4.394 Hz
150 Hz
1870 Hz

12.207 Hz
210 Hz
2730 Hz

41.504 Hz
460 Hz
6500 Hz

85.938 Hz
885 Hz
15290 Hz

Client:
Remote: e-flld 95 m north
Acquired: 14:5 Jun 20, 2003
Survey Co: USGS

Rotation:
Filename: cp21.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:52 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Rotation Angle
Santa Fe, NM

DEGREES

FREQUENCY (Hz)

-180
-120
-60
0
60
120
1
10
100
1000
10000
100000

Client:
Remote: e-fld 95 m north
Acquired: 10:5 Jan 08, 2004
Survey Co: USGS

Rotation:
Filename: cp22 avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:55 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Rotation:
Filename: cp22.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 15:34 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
Client:          Rotation:
Remote: e-fld 95 m north          Filename: cp22.avg
Acquired: 10:5 Jan 08, 2004        Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Survey Co:USGS                  Plotted: 15:34 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
APPARENT RESISTIVITY
Santa Fe, NM

FREQUENCY (Hz)

OHM METERS

Client:
Remote: e-fld 70m north
Acquired: 14:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:55 Jul 06, 2004
< EMI - Electromagnetic Instruments >
Client: e-fld 70m north
Remote: e-fld 70m north
Acquired: 14:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 13:18 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
E MUlt Coh.  
Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client:
Remote: e-fld 70m north
Acquired: 14:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:56 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

<table>
<thead>
<tr>
<th></th>
<th>4.394 Hz</th>
<th>12.207 Hz</th>
<th>41.504 Hz</th>
<th>85.938 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 Hz</td>
<td>210 Hz</td>
<td>460 Hz</td>
<td>885 Hz</td>
<td></td>
</tr>
<tr>
<td>1870 Hz</td>
<td>2730 Hz</td>
<td>6500 Hz</td>
<td>15290 Hz</td>
<td></td>
</tr>
</tbody>
</table>

Rotation:
Filename: cp24a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:41 Jul 06, 2004

Client: Remote: e-fld 80m east
Acquired: 12:5 Jun 23, 2003
Survey Co: USGS

< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE

Santa Fe, NM

FREQUENCY (Hz)

MAGNITUDE

Client: Remote: e-fld 80m east
Acquired: 12:5 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:41 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
ROTATION ANGLE

Santa Fe, NM

FREQUENCY (Hz)

DEGREES

1 10 100 1000 10000 100000

Client:
Remote: e-fld 90m east
Acquired: 13:3 Jun 24, 2003
Survey Co: USGS

Rotation:
Filename: cp25.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:56 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Station 25

E MULT Coh. Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client:
Remote: e-fld 90m east
Acquired: 13:3 Jun 24, 2003
Survey Co:USGS

Rotation:
Filename: cp25.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:57 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

4.394 Hz
150 Hz
1870 Hz

12.207 Hz
210 Hz
2730 Hz

41.504 Hz
460 Hz
6500 Hz

85.938 Hz
885 Hz
15290 Hz

Client:
Remote: e-fld 90m east
Acquired: 13:3 Jun 24, 2003
Survey Co: USGS

Rotation:
Filename: cp25_avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:57 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE
Santa Fe, NM

Client:
Remote: e-fld 90m east
Acquired: 13:3 Jun 24, 2003
Survey Co:USGS

Rotation:
Filename: cp25.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 09:57 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
HzHx.x Coh HzHy.o  
Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client:  
Remote: e-fld 90m east  
Acquired: 13:3 Jun 24, 2003  
Survey Co: USGS

Rotation:  
Filename: cp25.avg  
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7  
Plotted: 09:57 Jul 06, 2004

< EMI - ElectroMagnetic Instruments >
Client: e-fld 64m east
Survey Co: USGS

Rotation:
Filename: cp26a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 12:57 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Impedance Skew
Santa Fe, NM

Rotation:
Filename: cp26a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:42 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >

Client:
Remote: e-fld .64m east
Survey Co:USGS
POLAR PLOTS

Santa Fe, NM

4.394 Hz  12.207 Hz  41.504 Hz  85.938 Hz
150 Hz    210 Hz    460 Hz    885 Hz
1870 Hz   2730 Hz   6500 Hz   15290 Hz

Client:
Remote: e-fld 64m east
Survey Co: USGS

Rotation:
Filename: cp26a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:42 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
ROTATION ANGLE
Santa Fe, NM

DEGREES

FREQUENCY (Hz)

Client: none
Remote: none
Acquired: 13:2 Jun 26, 2003
Survey Co: USGS

Rotation:
Filename: cp27a.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2
Plotted: 12:58 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
E MULT Coh.  
Santa Fe, NM

Client: 
Remote: none
Acquired: 13:2 Jun 26, 2003
Survey Co: USGS

Rotation:
Filename: cp27.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2
Plotted: 10:20 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS
Santa Fe, NM

4.394 Hz  79.000 Hz
79.000 Hz  270 Hz

7.324 Hz  85.936 Hz
270 Hz  340 Hz

19.043 Hz  122 Hz
122 Hz  580 Hz

41.504 Hz  172 Hz
172 Hz  885 Hz

Rotation:
Filename: cp27.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2
Plotted: 10:20 Jul 06, 2004
< EMI - ElectroMagnetic Instruments >

Client:
Remote: none
Acquired: 13:2 Jun 26, 2003
Survey Co: USGS
Impedance Skew
Santa Fe, NM

Frequency (Hz)

Skew

Client: e-fld 95 m south
Acquired: 12:3 Jun 17, 2003
Survey Co: USGS

Rotation:
Filename: cp16m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:41 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
Station 18

TIPPER STRIKE Santa Fe, NM

FREQUENCY (Hz)

DEGREES

Client:
Remote: e-fld 95 m south
Acquired: 12:3 Jun 17, 2003
Survey Co:USGS

Rotation:
Filename: cp18m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 06:41 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
IMPEDANCE PHASE
Santa Fe, NM

DEGREES

FREQUENCY (Hz)

Client: e-fld 95 m east
Acquired: 11:5 Jun 16, 2003
Survey Co: USGS

Rotation: cp19m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:45 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Client: 
Remote: e-fld 95 m east
Acquired: 11:5 Jun 18, 2003
Survey Co:USGS

Filename: cp19m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:46 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE
Santa Fe, NM

FREQUENCY (Hz)

MAGNITUDE

Client: e-fld 95 m east
Acquired: 11:5 Jun 18, 2003
Survey Co: USGS

Rotation: cp19m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:46 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
Impedance Phase
Santa Fe, NM

Frequency (Hz)

Degrees

Client: e-fld 95 m north
Acquired: 11:2 Jun 19, 2003
Survey Co: USGS

Rotation:
Filename: cp20mall.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:47 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
ROTATION ANGLE

Santa Fe, NM

FREQUENCY (Hz)

DEGREES

Client:
Remote: e-fld 95 m north
Acquired: 11:2 Jun 19, 2003
Survey Co: USGS

Rotation:
Filename: cp20mall.agg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 10:46 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

.0088 Hz  .0244 Hz  .0566 Hz  .120 Hz
.172 Hz   .361 Hz   .830 Hz   1.719 Hz
2.930 Hz  4.883 Hz  16.602 Hz  34.375 Hz

Client:
Remote: e-fld 95 m north
Acquired: 11:2 Jun 19, 2003
Survey Co: USGS

Rotation:
Filename: cp20mall.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:47 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Station 21

Rotation Angle

Santa Fe, NM

Client: e-fld 95 m north
Survey Co:USGS

Filename: cp21m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 10:45 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
E MULT Coh.  
Santa Fe, NM

Client: 
Remote: e-fld 95 m north 
Acquired: 11:4 Jun 20, 2003 
Survey Co: USGS

Rotation: 
Filename: cp21m.avg 
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7 
Plotted: 08:49 Jul 07, 2004 
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

.0086 Hz
.172 Hz
2.930 Hz

.0244 Hz
.345 Hz
7.617 Hz

.0566 Hz
.566 Hz
16.602 Hz

.120 Hz
1.758 Hz
34.375 Hz

Rotation:
Filename: cp21m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:49 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >

Client:
Remote: e-fld 95 m north
Acquired: 11:4 Jun 20, 2003
Survey Co: USGS
Station 22

POLAR PLOTS

Santa Fe, NM

<table>
<thead>
<tr>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0086 Hz</td>
</tr>
<tr>
<td>0.0244 Hz</td>
</tr>
<tr>
<td>0.0566 Hz</td>
</tr>
<tr>
<td>0.120 Hz</td>
</tr>
<tr>
<td>0.172 Hz</td>
</tr>
<tr>
<td>0.345 Hz</td>
</tr>
<tr>
<td>0.566 Hz</td>
</tr>
<tr>
<td>1.758 Hz</td>
</tr>
<tr>
<td>2.930 Hz</td>
</tr>
<tr>
<td>7.617 Hz</td>
</tr>
<tr>
<td>16.602 Hz</td>
</tr>
<tr>
<td>34.375 Hz</td>
</tr>
</tbody>
</table>

Rotation:

Client:
Remote: e-flx 95 m north
Acquired: 11:4 Jun 21, 2003
Survey Co: USGS

Filename: cp22m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:50 Jul 07, 2004

< EMI - ElectroMagnetic Instruments  >
Station 22

HzHx.x Coh HzHy.o Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client: 
Remote: e-fld 95 m north
Acquired: 11:4 Jun 21, 2003
Survey Co:USGS

Rotation: 
Filename: cp22m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:50 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Station 23

Rotation Angle
Santa Fe, NM

DEGREES

-180
-120
-60
0
60
120

FREQUENCY (Hz)

0.01
1
10
100
1000

Client:
Remote: e-fld 70 m east
Acquired: 11:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 10:27 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
**IMPEDEANCE SKEW**

Santa Fe, NM

---

**FREQUENCY (Hz)**

**SKREW**

---

Client: e-fld 70 m east
Remote: e-fld 70 m east
Acquired: 11:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 06:51 Jul 07, 2004

EMI = ElectroMagnetic Instruments
POLAR PLOTS

Santa Fe, NM

.0086 Hz  .0244 Hz  .0566 Hz  .120 Hz
.172 Hz   .345 Hz   .566 Hz   1.756 Hz
2.930 Hz  7.617 Hz  16.602 Hz  34.375 Hz

Rotation:
Filename: cp23m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:51 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >

Client:
Remote: e-fld 70 m east
Acquired: 11:2 Jun 22, 2003
Survey Co: USGS
HzHx.x Coh HzHy.o
Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client:
Remote: e-fld 70 m east
Acquired: 11:2 Jun 22, 2003
Survey Co: USGS

Rotation:
Filename: cp23m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:51 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Client:
Remote: e-fld 80m east
Acquired: 10:3 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 15:42 Jul 28, 2004
< EMI - ElectroMagnetic Instruments >
IMPEDEANCE SKEW

Santa Fe, NM

FREQUENCY (Hz)

SKEW

Client:
Remote: e-fld 80m east
Acquired: 10:3 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:53 Jul 27, 2004
< EMI - ElectroMagnetic Instruments >
Client:
Remote: e-fld 80m east
Acquired: 10:3 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:53 Jul 27, 2004
< EMI – ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

0.0068 Hz 0.0244 Hz 0.0566 Hz 0.120 Hz
0.172 Hz 0.361 Hz 0.830 Hz 1.719 Hz
4.394 Hz 12.207 Hz 41.504 Hz 85.938 Hz

Client: 
Remote: e-fld 80m east
Acquired: 10:3 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:53 Jul 27, 2004
< EMI - ElectroMagnetic Instruments >
Station 24

HzHxx Coh HzHy.o

Santa Fe, NM

---

FREQUENCY (Hz)

COHERENCY

---

Client:
Remote: e-fld 80m east
Acquired: 10:3 Jun 23, 2003
Survey Co: USGS

Rotation:
Filename: cp24m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 14:54 Jul 27, 2004
< EMI - ElectroMagnetic Instruments >
APPARENT RESISTIVITY
Santa Fe, NM

FREQUENCY (Hz)

OHM METERS

Client: e-fld 90m east
Acquired: 11:2 Jun 24, 2003
Survey Co: USGS

Rotation: cp25m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:55 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
E M U L T Coh.  Santa Fe, NM

COHERENCY

FREQUENCY (Hz)

Client:
Remote: e-fld 90m east
Acquired: 11:2 Jun 24, 2003
Survey Co: USGS

Filename: cp25m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:55 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Polar Plots
Santa Fe, NM

0.0088 Hz 0.0244 Hz 0.0566 Hz 0.120 Hz

0.172 Hz 0.345 Hz 0.566 Hz 1.758 Hz

2.930 Hz 7.617 Hz 16.602 Hz 34.375 Hz

Client:
Remote: e-flld 90m east
Acquired: 11:2 Jun 24, 2003
Survey Co: USGS

Rotation:
Filename: cp25m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:55 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
Client: e-fld 90m east
Remote: e-fld 90m east
Acquired: 11:2 Jun 24, 2003
Survey Co: USGS

Filename: cp25m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:55 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
HzHx.x Coh HzHy.o
Santa Fe, NM

Client: e-fld 90m east
Acquired: 11:2 Jun 24, 2003
Survey Co:USGS

Rotation:
Filename: cp25m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:55 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
APPARENT RESISTIVITY
Santa Fe, NM

Client:
Remote: e-fld 64m east
Acquired: 12:2 Jun 25, 2003
Survey Co: USGS

Filename: cp26m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:56 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
POLAR PLOTS

Santa Fe, NM

.0086 Hz  .0244 Hz  .0566 Hz  .120 Hz
.172 Hz  .345 Hz  .566 Hz  1.758 Hz
2.930 Hz  7.617 Hz  16.602 Hz  34.375 Hz

Client:
Remote: e-fld 64m east
Acquired: 12:2 Jun 25, 2003
Survey Co:USGS

Rotation:
Filename: cp26m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:56 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
TIPPER MAGNITUDE
Santa Fe, NM

Station 26

FREQUENCY (Hz)

MAGNITUDE

Client: e-fld 64m east
Acquired: 12:2 Jun 25, 2003
Survey Co: USGS

Rotation:
Filename: cp26m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:56 Jul 07, 2004

< EMI - ElectroMagnetic Instruments >
Client: Remote: e-fld 64m east
Acquired: 12:2 Jun 25, 2003
Survey Co: USGS

Filename: cp26m. avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:56 Jul 07, 2004
< EMI – ElectroMagnetic Instruments >
Station 26

HzHx.x Coh HzHy.o

Santa Fe, NM

FREQUENCY (Hz)

COHERENCY

Client: Remote: e-fld 64m east
Acquired: 12:2 Jun 25, 2003
Survey Co: USGS

Rotation:
Filename: cp26m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7
Plotted: 08:56 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >
APPARENT RESISTIVITY
Santa Fe, NM

Rotation:
Filename: cp27m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2
Plotted: 09:00 Jul 07, 2004
< EMI - ElectroMagnetic Instruments >

Client:
Remote: none
Acquired: 12:0 Jun 26, 2003
Survey Co: USGS
E MULT Coh.  
Santa Fe, NM

COHERENCY

FREQUENCY (Hz)

Client:  
Remote: none  
Acquired: 12:0 Jun 26, 2003  
Survey Co: USGS

Rotation:  
Filename: cp27m.avg  
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2  
Plotted: 09:00 Jul 07, 2004  
< EMI - ElectroMagnetic Instruments >
Station 27

Polar Plots

Santa Fe, NM

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>0.0088 Hz</th>
<th>0.0244 Hz</th>
<th>0.0566 Hz</th>
<th>0.120 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0088 Hz</td>
<td>.172 Hz</td>
<td>.345 Hz</td>
<td>.586 Hz</td>
<td>1.758 Hz</td>
</tr>
<tr>
<td>2.930 Hz</td>
<td>7.617 Hz</td>
<td>16.602 Hz</td>
<td>34.375 Hz</td>
<td></td>
</tr>
</tbody>
</table>

Rotation:

Filename: cp27m.avg
Channels: Ch1 Ch2 Ch3 Ch4 Ch5 Ch1 Ch2
Plotted: 09:00 Jul 07, 2004

Client: none
Remote: none
Acquired: 12:00 Jun 26, 2003
Survey Co: USGS

< EMI - ElectroMagnetic Instruments >