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Geophysical Survey Plan
for
Surface DC Resistivity Data Collection
in
Pajarito, Sandia, DP, Los Alamos, and Pueblo Canyons

Los Alamos National Laboratory
Los Alamos, New Mexico

by
Geophex, Ltd.

Prepared For:
Kleinfelder, Inc.
Albuquerque, New Mexico
&
Department of Energy
Office of Los Alamos Site Operations
Los Alamos, New Mexico

October 2005

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GEOPHYSICAL SURVEY PLAN

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Geophex has prepared this survey plan for the field activities of our geophysical crews working at Los Alamos National Laboratory during the upcoming field season during the winter of 2005/2006.

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As project manager Dr. Carr will be responsible for the oversight of all onsite activities. He will also serve at the site safety and health officer (SSHO).

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As crew chief, Mr. Mellor will be responsible for logistics and equipment.

Peter Hubbard Crew Chief #2 Cellular Ph: (508) 400-2427
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Karlin Yudichak Crew Member

Robert Davis Crew Member Cellular Ph: (919) 971-2276

1.3 Survey Objectives

The survey objectives are to acquire, process, and interpret two-dimensional direct current (DC) ground surface resistivity data to delineate lithologic, hydrogeologic, and other changes that may potentially impact groundwater infiltration, transmissivity, fate and transport of contaminants, and identify the potential existence of groundwater to a depth of 50 meters. The survey results will be used, in part, to identify shallow water bearing units in which to complete monitoring wells.

1.4 Locations for 2005/2006 DC Resistivity Surveys in LANL Canyons

The locations for 2005/2006 DC resistivity surveys are described in Table 1 and shown in Figure 1. More detailed views of the planned profile lines in each canyon are in Appendix A.

Table 1. Survey Locations for 2005/2006 LANL DC Resistivity

Canyon	Distance (ft)	Special Requirements	Description
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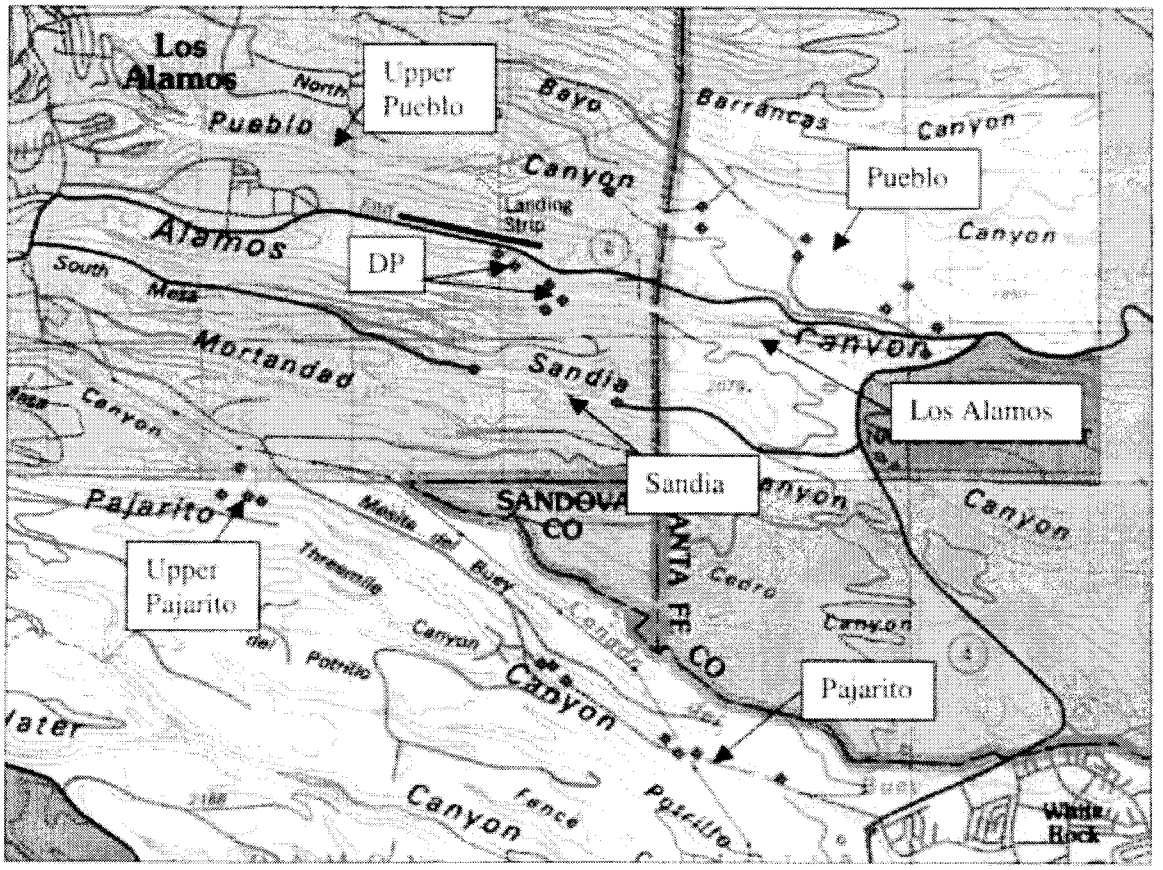
Pajarito Canyon	14602	Will need security escort. DX Training.	Axis of Pajarito Canyon from PM-2 to eastern LANL boundary. 6 m electrode spacing.
DP Canyon #1	902	none	Above DP Spring. 2.5 to 5 m electrode spacing.
DP Canyon #2	1082	none	Lower DP Canyon to Los Alamos Canyon. 6 m electrode spacing.
Los Alamos Canyon	14189	none	From DP Confluence to eastern LANL. 6 m electrode spacing.
Sandia Canyon	5215	none	Along Sandia Canyon axis where canyon widens south of LANSCE, eastward to R-11. 6 m electrode spacing.
Pueblo Canyon	24441	none	Along canyon axis from Acid Canyon to Otowi-1. 6 m electrode spacing.
Pueblo Canyon Cross Lines	2614	none	Three N-S cross lines arrayed along Pueblo Canyon. 4 to 6 m electrode spacing.
Total	**65563**		



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1.5 Work and Deliverable Schedules for 2005/2006 DC Resistivity collection at LANL

Table 2. Work Schedules

Geophex Personnel	PLAN	NOTES
Nov. 4 - Nov. 6	Truck/Equipment MOB to NM	On-site Geophex Crew: B. Carr, C. Mellor, K. Yudichak, P. Hubbard
		Standby Geophex Crew: K. Davis
Nov. 7	BC/CM/KY arrive in Los Alamos	
Nov. 7 – Nov. 9	Badge CM/KY; GET training	Nov. 8 or Nov. 9 GET training for CM & KY
Nov. 10 – Nov. 17	BC/CM/KY fieldwork	
Nov. 18 - Nov. 27	Thanksgiving Break	
Nov. 28	BC, CM, PH, KD and KY return to NM	
Nov. 29 – Dec. 1	Badge PH/KD; BC/CM/KY fieldwork	Nov. 29 or Dec. 1 GET training for PH & KD
Dec. 4	KD returns to NC	
Dec. 2 – Dec. 17	BC/PH/CM/KY field work	
Dec. 18 – Jan. 2	Holiday Break	
Jan. 3	BC/KY/CM/PH return to NM	
Jan. 4 – Jan. 28	BC/PH/CM/KY field work	
Fieldwork		
Nov. 10 - Nov. 12	Work 3 days -- off Sunday, Nov. 13	Data Acquisition in DP (2 days; Th-F), Sandia (1 day; Sat)
Nov. 14 – Nov. 17	Work 4 days	Data Acquisition in Sandia (2 days; M-T), Pueblo (2 days; W-Th)
Nov. 18 – Nov. 28	Thanksgiving Break	
Nov. 29 – Dec. 3	Work 5 days -- off Sunday, Dec. 4	Data Acquisition in Pueblo (5 days; T-Sat)
Dec. 5 - Dec. 10	Work 6 days -- off Sunday, Dec. 11	Data Acquisition in Pajarito (5 days; M-F), Pueblo (1 day; Sat)
Dec. 12 - Dec. 17	Work 6 days	Data Acquisition in Pajarito (3 days; M-W), Pueblo (3 days; Th-Sat)
Dec. 18 - Jan. 3	Holiday Break	
Jan. 4 - Jan. 7	Work 4 days -- off Sunday, Jan. 8	Data Acquisition in Los Alamos (4 days; W-Sat)
Jan. 9 - Jan. 14	Work 6 days -- off Sunday Jan. 15	Data Acquisition in Los Alamos (3 days; M-W), Pueblo(3 days; Th-Sat)
Jan. 16 - Jan. 21	Work 6 days -- Begin Standby Days (if needed)	Standby Data Acquisition (6 days; M-Sat)

Table 3. Projected Schedule of Deliverables

Data Processing Schedule (based on current field schedule)	Canyon	NOTES
Nov. 22	DP	Data Processing deliverable will include Field data (located ASCII file)
Nov. 22	Sandia	Field Notes, and Profile display (jpeg & PDF files)
Dec. 22	Pajarito	
Jan. 16	Los Alamos	
Jan. 19	Pueblo	
Report Schedule (based on current field schedule)	**Item**	**NOTES**
Feb. 10, 2006	Draft Geophysical Survey Report	
Mar. 3, 2006	Draft Final Geophysical Survey Report	
Mar. 17, 2006	Final Geophysical Survey Report	

2.0 Surface Geophysical Data Collection and Reporting

Geophex will be collecting surface geophysical data in Pajarito, Sandia, DP, Los Alamos, and Pueblo canyons (Figure 1). The geophysical method employed will be DC resistivity. Data collection is a continuation of work conducted for the Dept. of Energy in the summer of 2002, and December 2003 in Mortandad and Upper DP Canyon. The survey design and data collection procedures will be the same as previously employed (see section 2.3 and Appendix B for details). No preliminary modeling is needed for this effort. No unique cultural or site-specific conditions exist in this current proposal that will require any change in the survey design or expected quality of the results compared to previous efforts.

2.1 Scope of Work - DC Resistivity

The scope of work for this project is to acquire, process, and interpret surface two-dimensional DC resistivity data to delineate lithologic, hydrogeologic, and other changes that may potentially impact groundwater infiltration, transmissivity, fate and transport of contaminants, and identify the potential existence of groundwater to a depth of 50 meters. The survey results will be used, in part, to identify shallow water bearing units in which to complete monitoring wells.

2.2 DC Resistivity Methodology

Surface DC electrical resistivity surveys are conducted to aid in the characterization of the subsurface by locating changes in geoelectric properties. DC resistivity surveys are performed by sending an electric current into the ground, and measuring the resulting potential difference at the surface. The data are then used to map variations in the subsurface electrical resistivity. The electrical resistivity of any portion of the earth is related to various geologic parameters such as mineralogy, fluid content, and degree of water saturation. In environmental surveys with relatively shallow water tables, resistivity values are governed primarily by soil water content. Low electrical resistivity values correspond to high *in situ* bulk porosity and permeability, rather than to lithology directly. For example, a dry, well-sorted sand (located above the water table) will be highly resistive. The same sand below the water table will have high bulk porosity and may represent a permeability pathway (if conditions allow) and have a low or very low resistivity. Resistivity results are given in units of Ohm-meters ($\Omega \cdot m$).

A typical Geophex surface DC resistivity survey utilizes a SuperSting R8 IP resistivity meter (manufactured by Advanced Geosciences, Inc. (AGI)) with 56 electrodes in the dipole-dipole configuration. In the dipole-dipole array, the potential electrodes are outside of the current electrode pair, and the pairs have the same constant separation. The SuperSting can use several other electrode configurations as well, including Wenner, Schlumberger, Pole-Dipole, and Pole-Pole.

The 2002 and 2003 DC resistivity surveys performed within Mortandad and Upper DP canyons at LANL, identified "moist" zones in the alluvium and upper Bandelier Tuff. These "moist" zones (i.e., low resistivity; < 600 ohm-m)) have been correlated to high moisture weight percent data from nearby core samples. To date, resistivity data are interpreted to be mapping current sediment moisture. It is interpreted that these zones would indicate the preferential groundwater flow pathways during recharge events. In addition to "moist" low-resistivity zones, the observed high resistivities near the surface are interpreted to be either "dry" unconsolidated sediments or "dry" bedrock (e.g., upper portions of the Tshirege Member of the Bandelier Tuff). When

compared with the down-hole gamma geophysical logs, The surface resistivity data show that the top of "dry" bedrock is not uniform in elevation across the profiles. This further supports the potential for structural bedrock influence on groundwater movement. In the deeper parts of the profiles (> 50 ft. bgs), the high resistivity zones represent bedrock. However, the high resistivity values vary laterally across the deeper (i.e. "dry" bedrock) sections of the profiles. This is interpreted to reflect either varying permeability states of the bedrock for resistivity values below 600 ohm-m or clay rich fault zones for values from 600 to 1300 ohm-m. Figure 2 displays 2003 resistivity data collected in Upper Mortandad Canyon and highlights the aforementioned low and high resistivity zones.

Geophysical Survey Plan
for
Surface DC Resistivity Data Collection
in
Pajarito, Sandia, DP, Los Alamos,
and Pueblo Canyons

Los Alamos National Laboratory
Los Alamos, New Mexico

by
Geophex, Ltd.

Prepared For:
Kleinfelder, Inc.
Albuquerque, New Mexico
&
Department of Energy
Office of Los Alamos Site Operations
Los Alamos, New Mexico

October 2005

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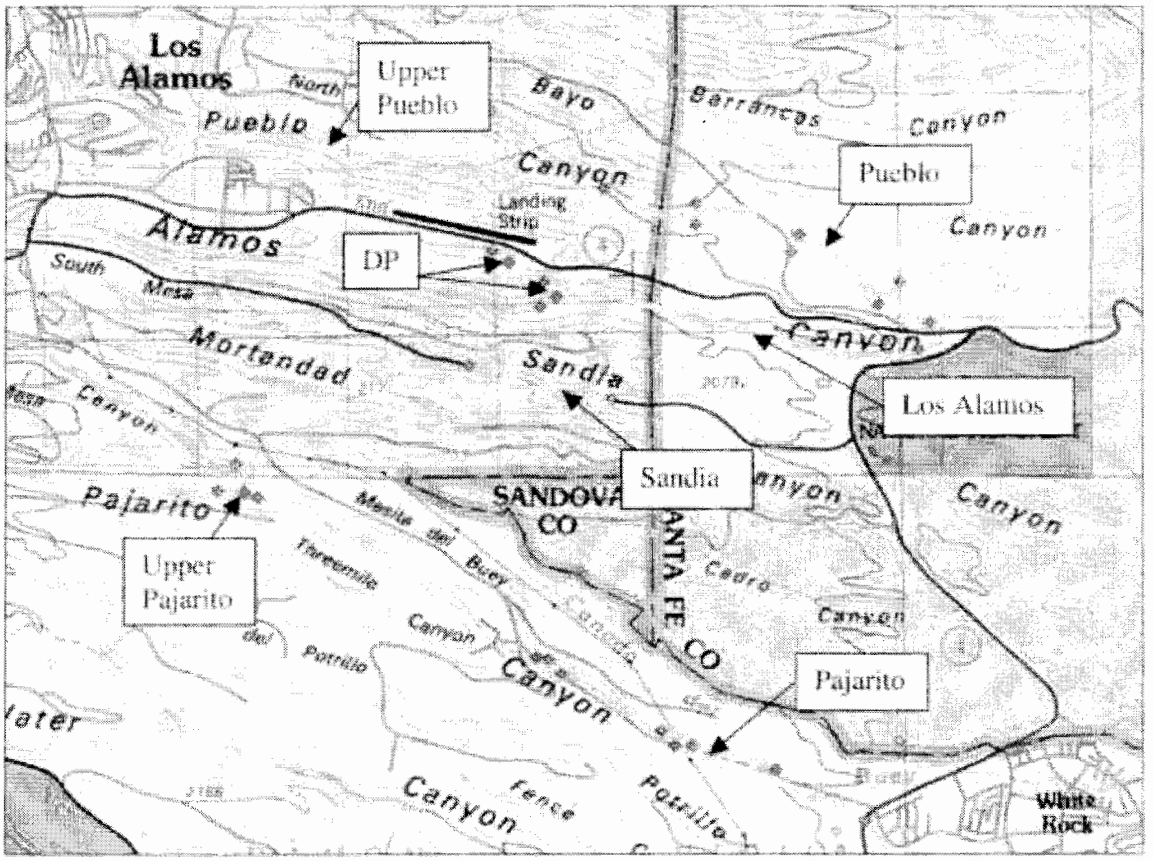

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compared with the down-hole gamma geophysical logs, The surface resistivity data show that the top of "dry" bedrock is not uniform in elevation across the profiles. This further supports the potential for structural bedrock influence on groundwater movement. In the deeper parts of the profiles (> 50 ft. bgs), the high resistivity zones represent bedrock. However, the high resistivity values vary laterally across the deeper (i.e. "dry" bedrock) sections of the profiles. This is interpreted to reflect either varying permeability states of the bedrock for resistivity values below 600 ohm-m or clay rich fault zones for values from 600 to 1300 ohm-m. Figure 2 displays 2003 resistivity data collected in Upper Mortandad Canyon and highlights the aforementioned low and high resistivity zones.

2.3 DC Resistivity Data Acquisition at LANL

DC resistivity data acquisition at LANL will be conducted according to the Geophex Standard Operating Procedure (GSOP) included in Appendix B. Please refer to Appendix B for a description of the field procedures used on these surveys by Geophex. The following discussion describes the specific applications of the GSOP as related to DC resistivity collection at LANL.

DC resistivity data will be collected using an AGI SuperSting R8 IP Earth Resistivity/IP Meter (Figure 3) with a 56-electrode cable (Figure 4). The maximum electrode spacing for the Geophex DC resistivity cable is seven meters. Data will be recorded using a Dipole-Dipole array configuration in a linear, 5 to 6 meter wide electrode spacing to maintain consistency with the 2002 and 2003 LANL DC resistivity data sets of Mortandad Canyon (Figure 5). This spacing results in DC resistivity profiles with an image depth of approximately 76 m (250 ft). DC resistivity profiles will be collected along the long axis of the canyons, as close to the current stream channel as possible. Data collection will be conducted from west to east or south to north as allowed.

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Figure 3. AGI R8 IP Earth Resistivity/IP Meter owned by Geophex

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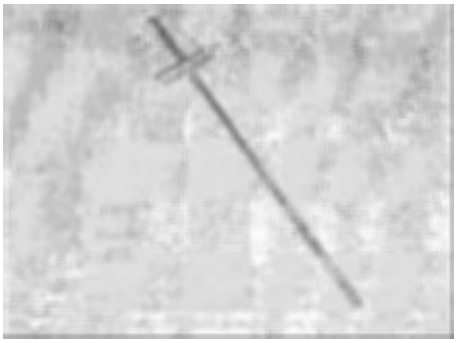


Figure 6. Stainless steel stake

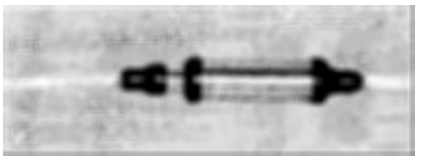
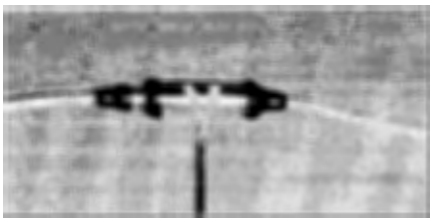


Figure 7. Dual mode electrode



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The output from the system is:

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Figure 9. Warning cover placed over electrode

2.4 Outline of Report for Geophysical Survey Report

Upon completion of the field work, the collected data will be evaluated and a report will be prepared. The general format of the report is as follows:

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List of Figures
List of Tables
List of Acronyms
List of Definitions
Executive Summary
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- *1.1 Profile Locations*
- *1.2 Fieldwork Procedures and Parameters*

2.0 Methods and Data Processing
- *2.1 DC Resistivity*
- *2.2 Position and Elevation Surveying*
- *2.3 Data Processing*

3.0 Results and Interpretations
- *3.1 Summary of 2002 & 2003 Resistivity Profiling at LANL*
- *3.2 Pajarito Canyon*
  - *3.3.1 Upper Pajarito Canyon*
  - *3.3.2 Pajarito Canyon*
- *3.3 Sandia Canyon*
- *3.4 DP Canyon*
- *3.5 Los Alamos Canyon*
- *3.6 Pueblo Canyon*

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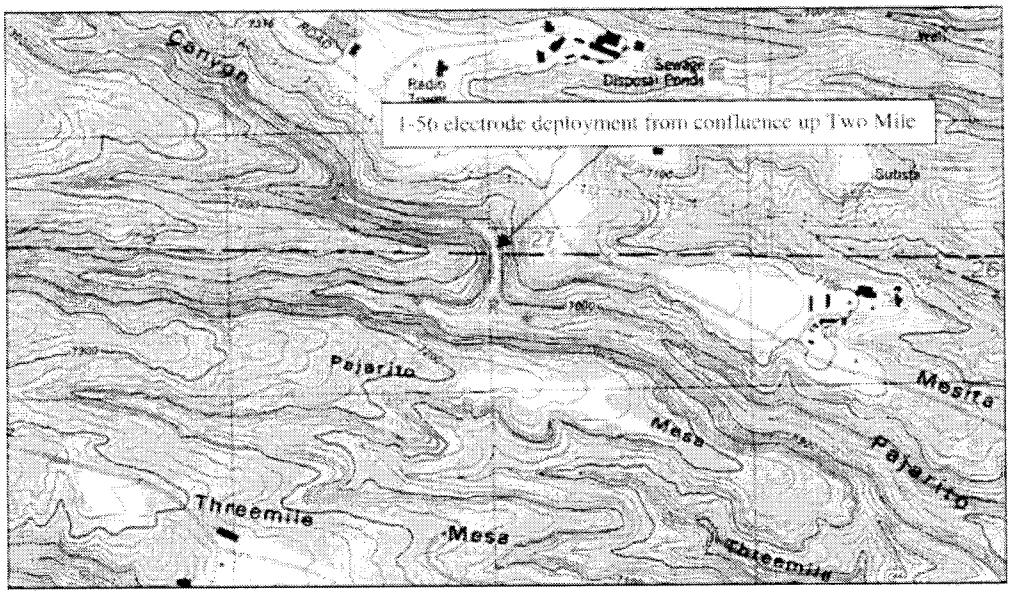
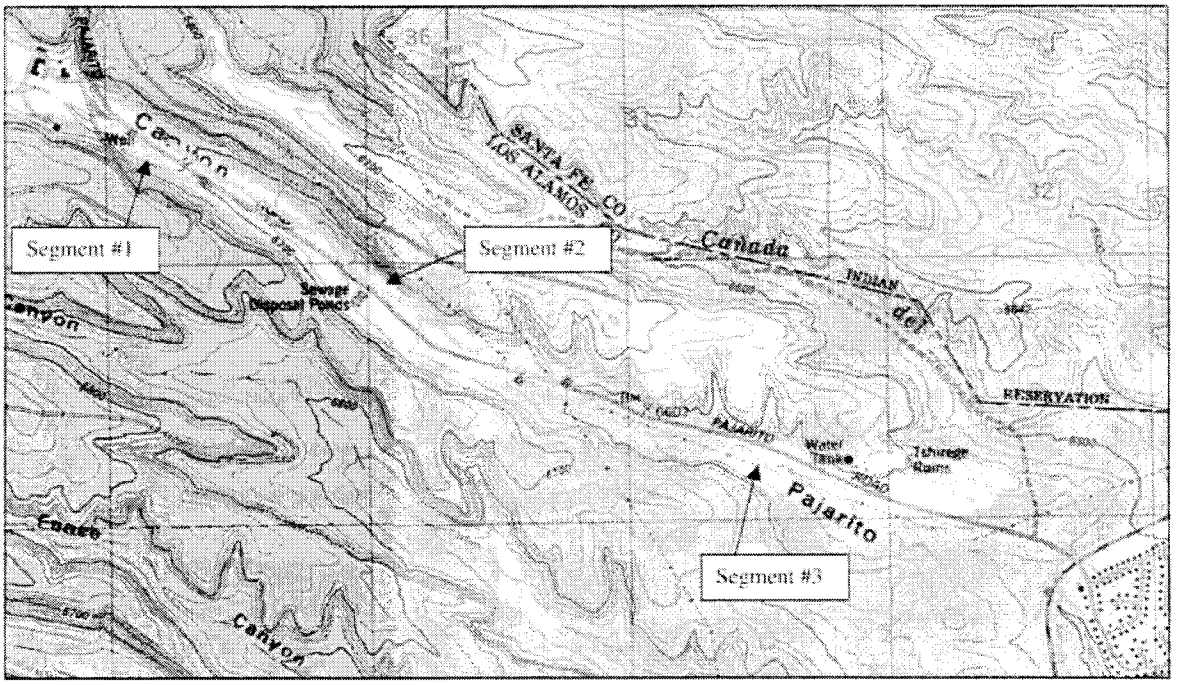
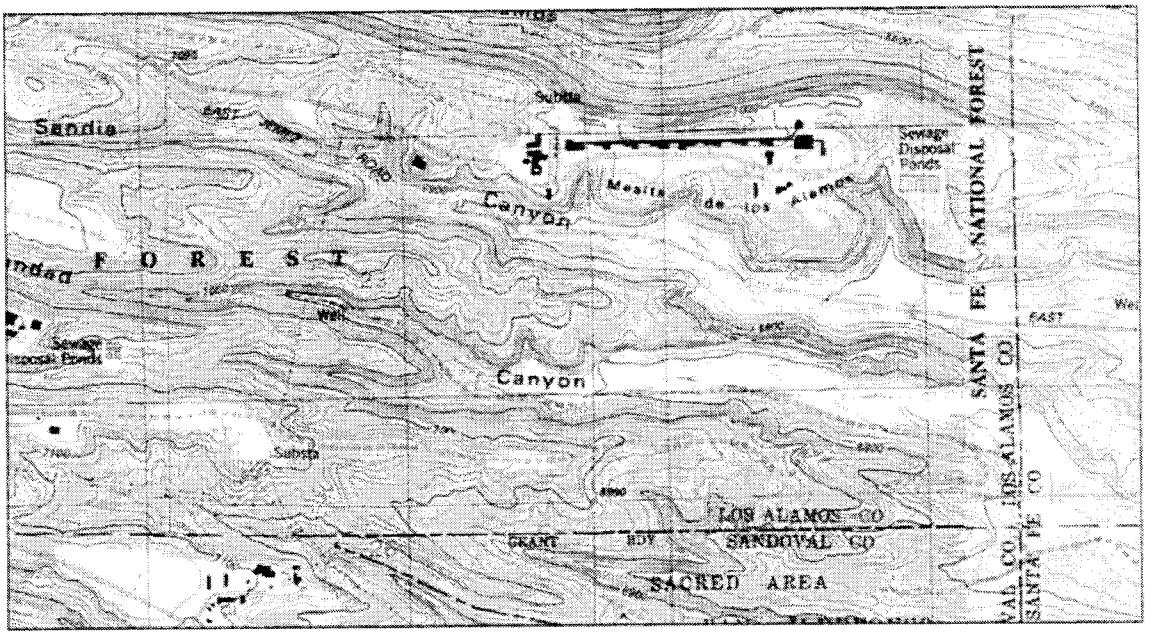


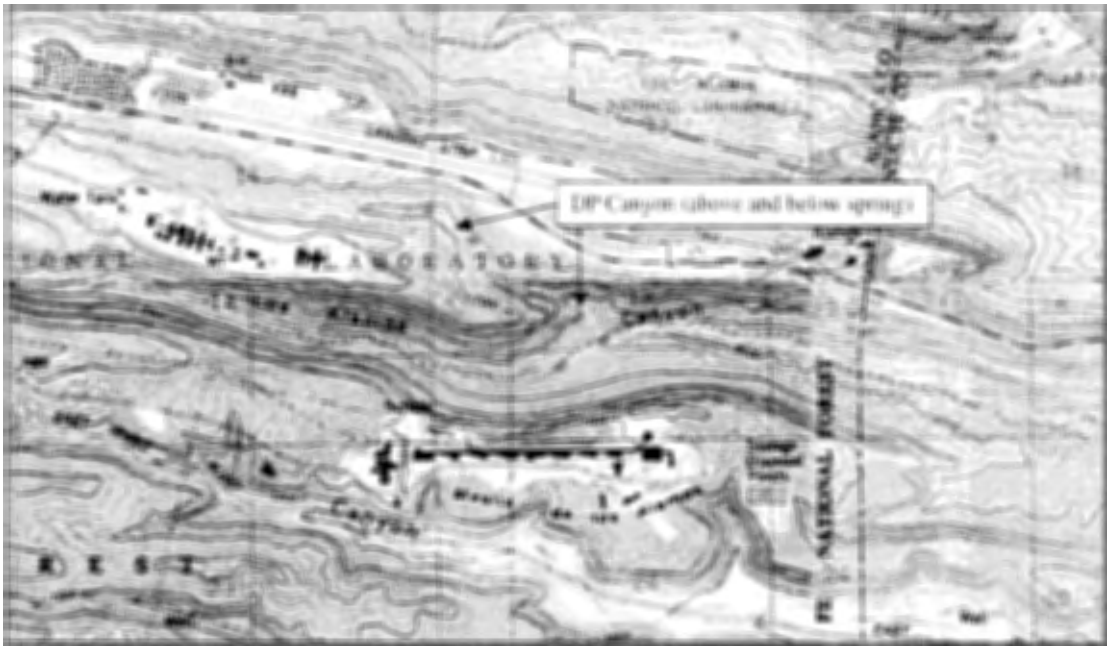
Appendix A - 1. Planned 2005/2006 DC Resistivity Profile in Upper Pajarito Canyon, LANL



Appendix A - 2. Planned 2005/2006 DC Resistivity Profile in Pajarito Canyon, LANL



Appendix A - 3. Planned 2005/2006 DC Resistivity Profile in Sandia Canyon, LANL



Appendix A - 4. Planned 2005/2006 DC Resistivity Profile in DP Canyon, LANL

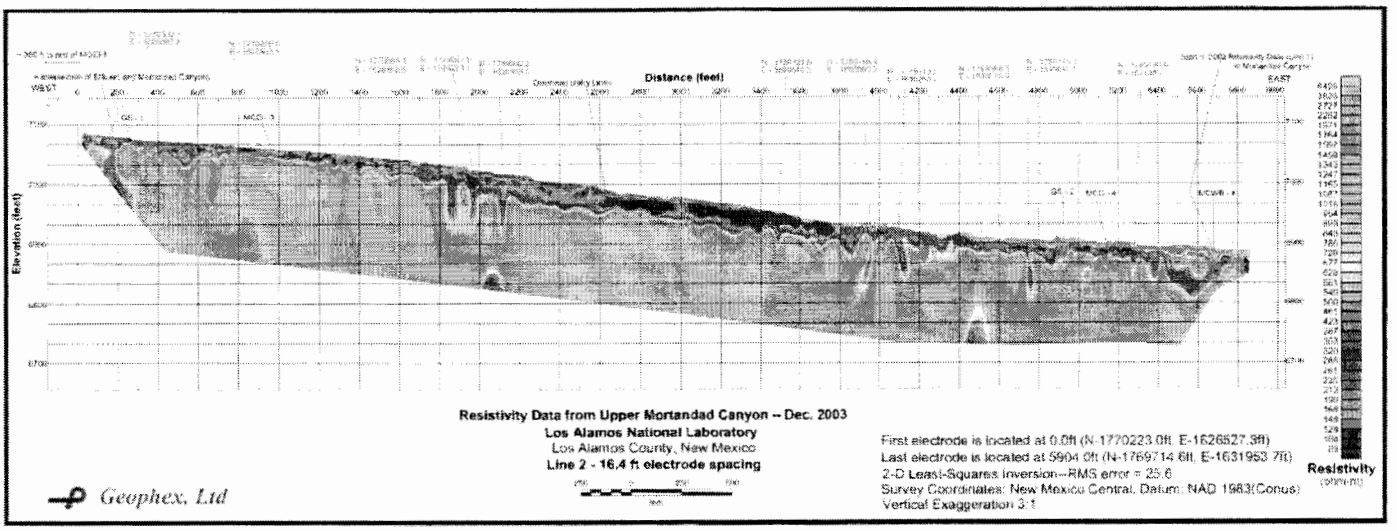


Figure 2. DC resistivity profile from Upper Mortandad Canyon. Note the low resistivity zones (blue - green) that extend to depth (particularly at the western edge, the 2000 ft mark, and the eastern end of the profile) and the lateral variability in the high resistivity values within bedrock depths.

Geophex, Ltd., Raleigh, North Carolina

STANDARD OPERATING PROCEDURE

Surface Direct Current Electrical Resistivity Surveys

Approved by: **Date:**

Dr. Bradley J. Carr

10/3/2005

Dr. Bradley J. Carr, PhD
Senior Geophysicist

Management Approval: **Date:**

Robert K. Davis

10/3/2005

R. Kim Davis
General Manager

Controlled Copy No: 11

SURFACE DIRECT CURRENT ELECTRICAL RESISTIVITY SURVEYS

1.0 SCOPE AND OBJECTIVES

1.1 **Scope** – This Standard Operating Procedure (SOP) describes procedures for conducting surface direct current electrical resistivity (DCRES) surveys. Surface direct current electrical resistivity surveys are conducted to aid in the characterization of the subsurface. The purpose of surface DCRES surveys is to determine depth to bedrock/thickness of overburden, depth of groundwater; to map stratigraphy, paleochannels, clay aquitards, confined aquifers, saltwater intrusion zones, fault and fractures zones; and to delineate heavy metal soil contamination. Surface DCRES surveys can also be used to determine the vertical extent of conductive contaminants, to monitor groundwater contaminant plume movement with time, to determine the vertical extent of groundwater plumes contaminated with dissolved phase organics, to delineate landfill boundaries, and to locate voids.

This procedure shall be utilized at known or new sites, identified by Geophex, for surface direct current electrical resistivity survey investigations. DCRES surveys will be conducted by a qualified Geophex geophysics field crew and shall be performed in accordance with this SOP.

1.2 **Objectives** – The objectives of this SOP are to provide instructions for: (1) site preparation, (2) DCRES survey field procedures, and (3) DCRES data processing.

2.0 DEFINITIONS

2.1 **Anomaly** – A feature distinguished in geophysical data that is different from the general surroundings, i.e., a departure from the expected or normal.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

3.1 **Geophex General Manager** – The Geophex General Manager is responsible for ensuring the surface DC resistivity survey crew is trained and indoctrinated in the content of this procedure. The Geophex General Manager is responsible for ensuring that the DCRES survey activities are performed in accordance with this SOP.

3.2 Geophex Project Manager – The Geophex Project Manager will supervise all on-site field data collection activities. The Geophex Project Manager shall be responsible for ensuring the completion of all applicable forms and for notifying the Geophex General Manager or designee of site-specific activities about DCRES survey progress, problems, and results on a weekly basis. The Geophex Project Manager is responsible for the interpreted results of the surface DCRES survey and for supervising the report effort. The Geophex Project Manager is responsible for ensuring that DCRES survey activities are performed in accordance with this SOP.

3.3 Geophex DC Resistivity Survey Field Crew – Each DCRES survey crew shall consist of at least two trained and qualified personnel, as determined by the Geophex General Manager. The Geophex DCRES survey field crew is responsible for ensuring that surface direct current electrical resistivity survey activities are performed in accordance with this SOP.

4.0 MATERIALS/EQUIPMENT AND CALIBRATION

4.1 Materials and Equipment – Specific equipment used to conduct DCRES surveys may consist of one or more of the following items shown in Table 1. Specific parts and equipment used with this system are listed in detail in the Inventory of DC Resistivity/IP Measurement and Test Equipment form (Attachment B-1).

Table 1
DCRES Survey Equipment

Equipment	
Name	**Type**
Advanced Geosciences, Inc. (AGI) SuperSting R8 IP	Multi-channel resistivity imaging system

The following is a list of additional equipment that may be used during a surface DC resistivity survey:

- Laptop computer w/ AGI SSAdmin and RES2DINVor EARTHIMAGER, software dongle, and diskettes
- Compass
- Measuring tapes
- Toolkit
- Wooden stakes and hammer
- Surveyor's paint/chalk and plastic pin flags
- Flagging, cones, and barricades
- Field notebook and project file
- Extra instrument batteries and chargers
- Standard health and safety supplies
- Global Positioning System (GPS)
- Hammer drill and tar patch
- Work gloves
- Level prism and staff, or laser level and tripod
- Digital camera and diskettes
- Inverter and power strip
- Printer
- All-Terrain Vehicle (ATV)

4.2 Calibration Requirements – Calibration and use of the instruments shall be in accordance with manufacturer's instructions. A forward and reverse test profile shall be conducted at Geophex prior to commencement of field activities. A contact resistance check shall be performed prior to each profile collection to ensure the signal-to-noise ratio is at an acceptable level.

5.0 METHODOLOGY, APPLICATIONS, AND FIELD PROCEDURES

5.1 DC Resistivity Theory and Applications – Surface direct current electrical resistivity surveys are conducted to aid in the characterization of the subsurface by locating changes in geoelectric properties. DCRES surveys are acquired by sending an electric current into the ground, and measuring the resulting potential difference at the surface. Differences occurring in rock types or soil variations affect the measured potential, resulting in resistivity values that delineate subsurface variations. Resistivity results are given in units called Ohm-meters (Ω·m). A typical Geophex surface DCRES survey utilizes a SuperSting R8 IP resistivity meter (manufactured by Advanced Geosciences, Inc.) with 56 electrodes in the dipole-dipole configuration. In the dipole-dipole array, the potential electrodes are outside of the current electrode pair, and the pairs have the same constant separation. The SuperSting can use several other electrode configurations as well, including Wenner, Schlumberger, Pole-Dipole, and Pole-Pole.

The DCRES survey design used to conduct a geophysical investigation varies according to site-specific objectives and target depth. The depth of penetration is dependent on site conditions, the power of the current source, the length of the

DCRES line, and electrode spacing. Smaller electrode separation and short line length will yield shallower results with better resolution. As the electrode spacing and line length increase, a greater percentage of current can penetrate deeper, resulting in a deeper resistivity profile. The objectives of a DCRES survey and expected results are discussed in the project proposal. However, the following issues and concerns are routinely evaluated:

- Review existing site surface and subsurface information.
- Evaluate the potential influence of cultural features (e.g., utilities, fences, structures, monitoring wells, etc.).
- Define any health and safety hazards.
- Evaluate the data quality and depth of penetration. Adjust acquisition parameters, if needed, to obtain the optimal results for that particular site.

5.2 DC Resistivity Survey Field Procedures – The standard field procedures for conducting a surface DCRES survey are described below.

5.2.1 Site Preparation – Prior to conducting a surface DCRES survey, a base grid should be established with a measuring tape. The base grid shall be marked with wooden stakes, pin flags, or surveyor's paint to provide spatial control for the DCRES survey. The DC resistivity survey base grid will typically consist of a single line, or multiple intersecting lines, along which data will be collected. Subsequently, these lines shall be filled in with appropriate point spacing for the electrode configuration by the DCRES survey field team. To the extent possible, the survey area should be cleared of all surface metallic debris. The debris shall be moved to a location where it will not affect the DCRES survey instrument measurements.

All DCRES profile lines shall be surveyed with a Global Positioning System (GPS) instrument for positional control. The instrument operation will be in accordance with the methods and procedures developed in the Geophex SOP, Section 13: Global Positioning System Surveys. GPS procedures require at least one point in the geophysical survey area be of known X, Y coordinates. This point may be surveyed in conjunction with the geophysical investigation, or may be a previously surveyed benchmark/monument.

All DCRES profile lines shall also be surveyed for elevations using level surveying equipment (Geophex SOP, Section 14: Level Surveys).

5.2.2 Field Procedures

5.2.2.1 A visual survey will be conducted along the proposed survey lines. The visual survey shall include:

- Review of site utility plans,
- Check for overhead features such as power lines and wires,
- Check for manhole covers, wells, and surface metal,
- Preparation of a hand-sketched site map showing any surface features at the site or near the boundary that could affect the geophysical data.

5.2.2.2 Instrument batteries will be checked for sufficient charge and the instrument will be tested according to manufacturer's instructions. This shall be performed prior to commencement of collection of each profile in the form of a contact resistance check. If contact resistance is above the acceptable level for that particular site, then the DCRES survey field crew shall treat the electrodes with salt water and/or bentonite until they reach an acceptable level. Instrument check and contact resistance test results shall be recorded in the Field Project Report Log (FPRL) (Attachment B-2).

5.2.2.3 Surface DCRES survey data, corresponding line and station numbers, electrode spacing, profile collection name, command file name, and time of acquisition shall be stored in the internal memory of the unit, and/or manually recorded on the DC Resistivity Data Acquisition Form (Attachment B-3) or on the FPRL (Attachment B-2). Instrument operation shall be in accordance with manufacturer's operation instructions.

5.2.2.4 Surface DCRES survey data shall be downloaded to a laptop computer at least once a day. Checks to ensure correct data transfer shall be performed. Field team comments and file names assigned to the data files during downloading shall be recorded on the DC Resistivity Data Editing Form (Attachment B-4) or on the FPRL (Attachment B-2). At the end of the field day, survey data shall be backed up onto diskettes and/or the Geophex server for further processing and archival purposes.

5.3 DC Resistivity Data Processing and Interpretation – This section presents data tracking, processing, and interpretation procedures for surface DCRES data.

5.3.1 DCRES field data shall be tracked by recording the dates of acquisition and site-specific field data file names on the FPRL (Attachment B-2) and DC Resistivity Data Editing Form (Attachment B-4).

5.3.2 Before processing, all DCRES field survey files shall be reviewed to ensure data quality. Resistivity data file names, line numbers, station ranges, field errors, corrections made to the files, corrected file names, and file conversion parameters shall be documented on the DC Resistivity Data Editing Form (Attachment B-4).

5.3.3 Data shall be processed and modeled using RES2DINV or EARTHIMAGER software. Data points shall be edited to eliminate points that are unreasonable or do not make sense geologically. Topographic data shall be entered to account for changes in elevation along the profile. Inverse modeling shall be done to generate a model that best approximates the edited data and represents the geologic conditions of the site. Inversion file name and percent error shall be documented on the DC Resistivity Data Processing Form (Attachment B-5).

5.3.4 Contour maps of DCRES data shall be generated using the Geosoft OASIS Montaj geophysical mapping system. The data will be gridded, optionally filtered, contoured, and printed. The names of the files generated and the processing parameters used shall be recorded on the Geosoft OASIS Montaj Data Processing Form (Attachment B-6). Contour maps will be color-enhanced to facilitate recognition and interpretation of anomalies.

6.0 ACCEPTANCE CRITERIA

If instrument problems are suspect, the resistivity data will be reacquired over the affected area, and reassessed to ensure it meets acceptance criteria. If single DCRES data points are unreasonable or do not make sense geologically, they may be eliminated from the data set during data processing.

7.0 RECORDS

All project records generated in the field through the performance of this SOP shall be temporarily filed in a designated project folder and kept with the field crew while in the field. Following the conclusion of field activities, all project records shall be submitted to the project central files for storage according to Geophex SOP, Section 15: Geophysical Data Management. The following is a list of the forms generated by this procedure:

- Inventory of DC Resistivity/IP Measurement and Test Equipment (Attachment B-1).
- Field Project Report Log (Attachment B-2).
- DC Resistivity Data Acquisition Form (Attachment B-3).
- DC Resistivity Data Editing Form (Attachment B-4).
- DC Resistivity Data Processing Form (Attachment B-5).
- Geosoft OASIS Montaj Data Processing Form (Attachment B-6).

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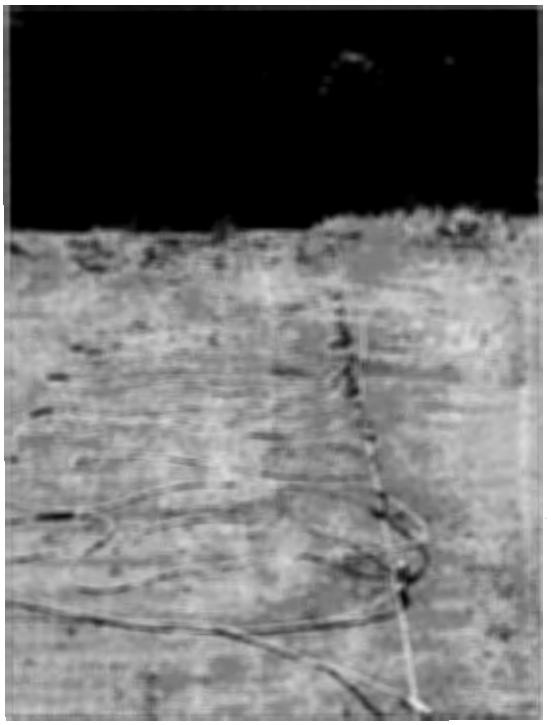

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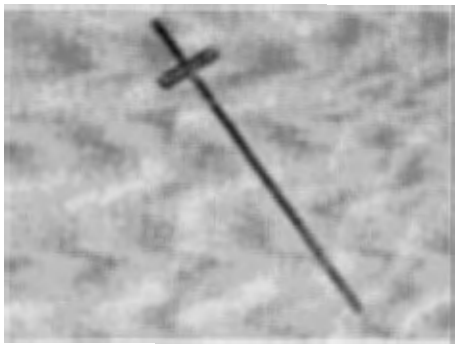

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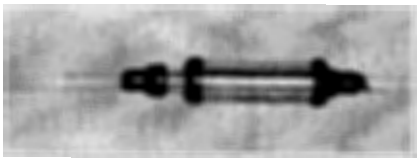

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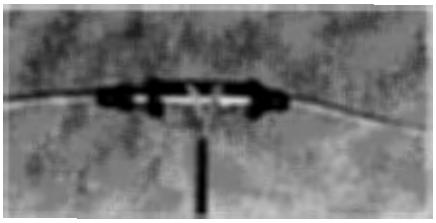

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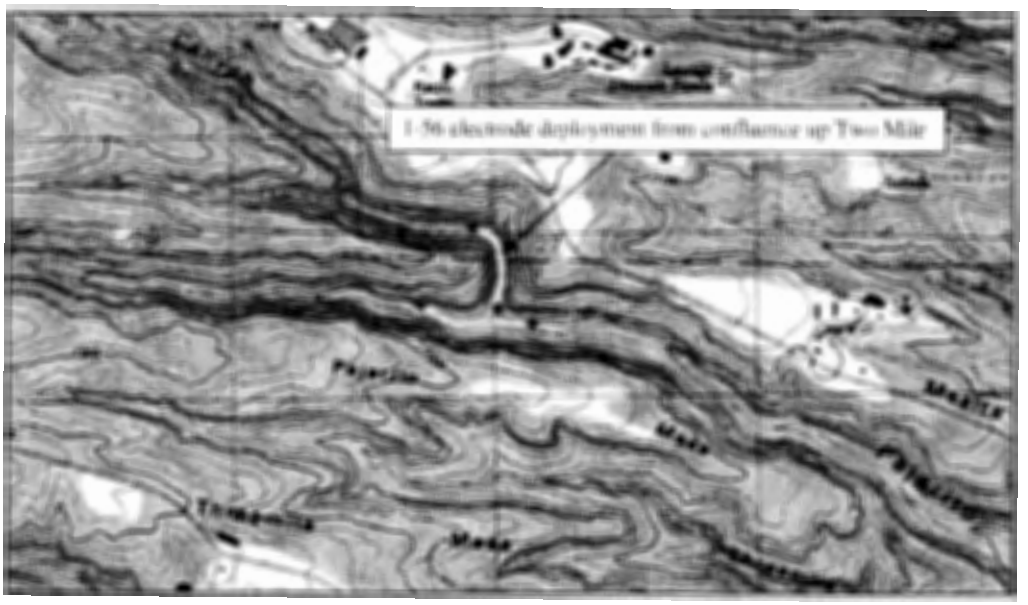
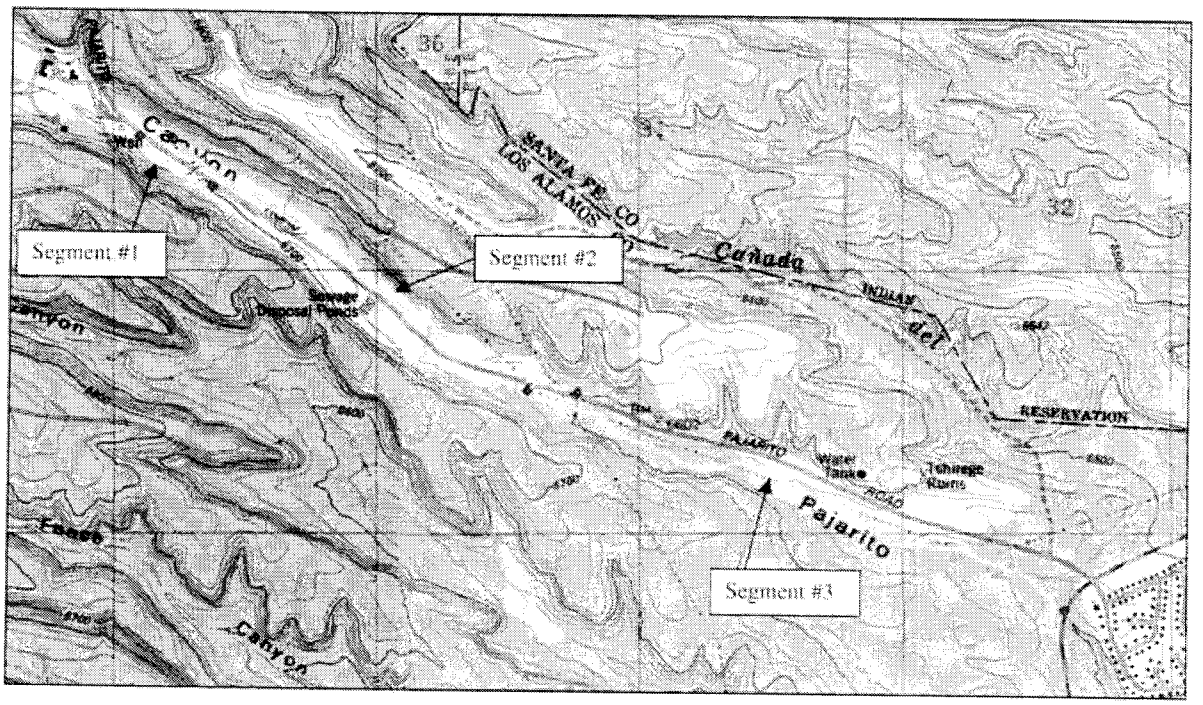
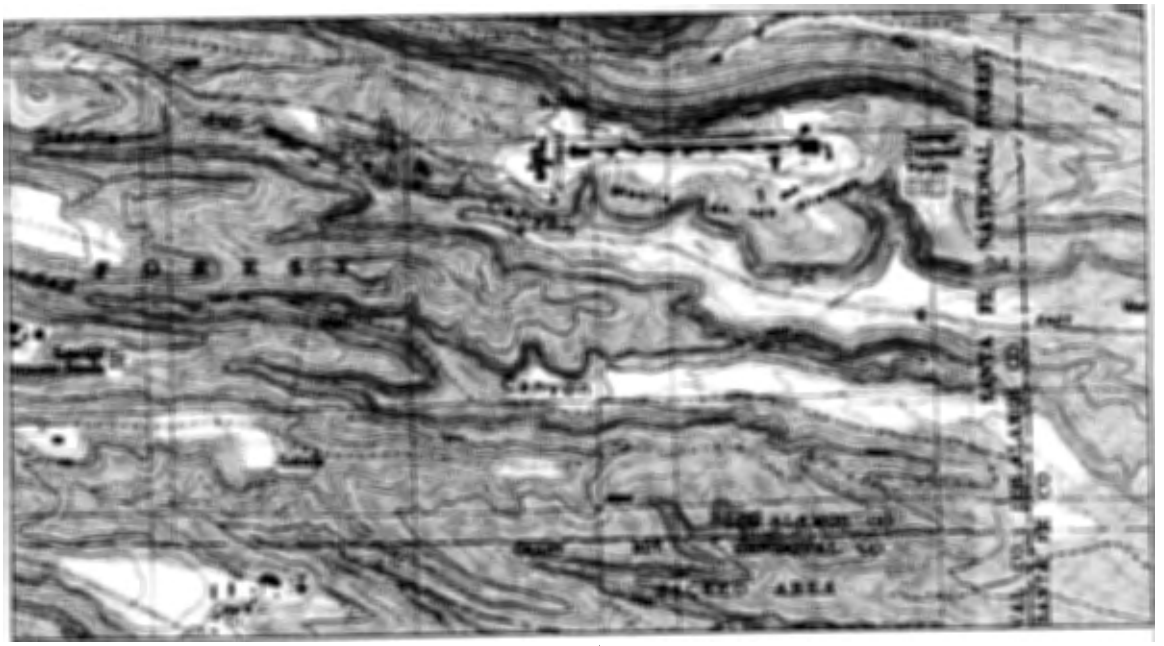
APPENDIX A. Maps of LANL Canyons in 2005/2006 DC Resistivity Survey



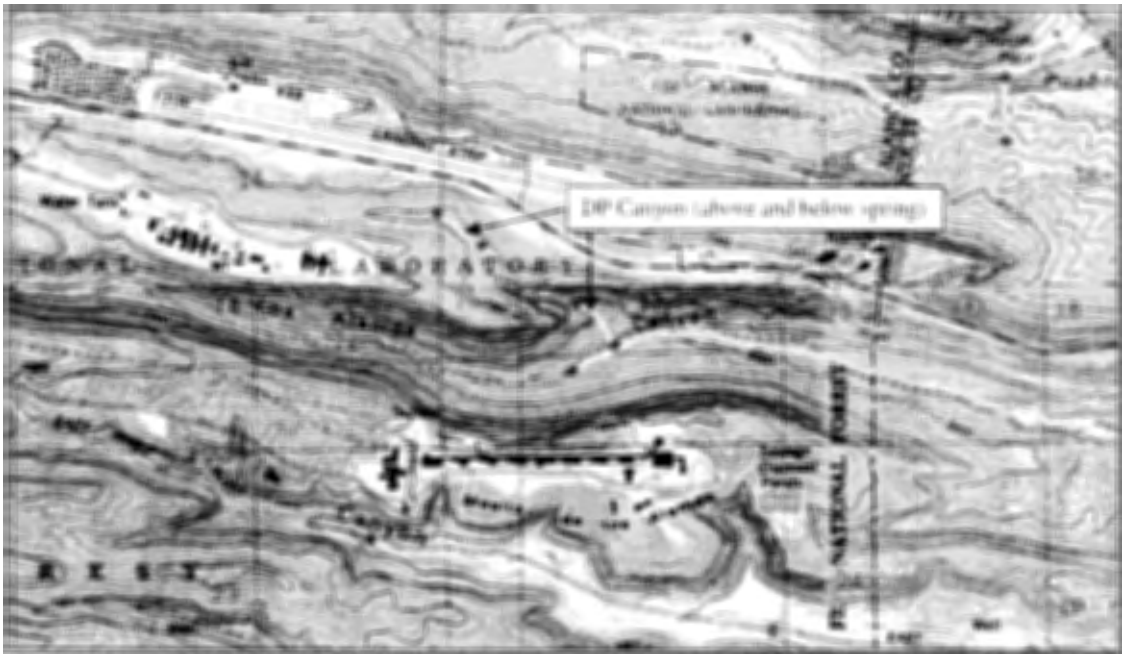
Appendix A - 1. Planned 2005/2006 DC Resistivity Profile in Upper Pajarito Canyon, LANL



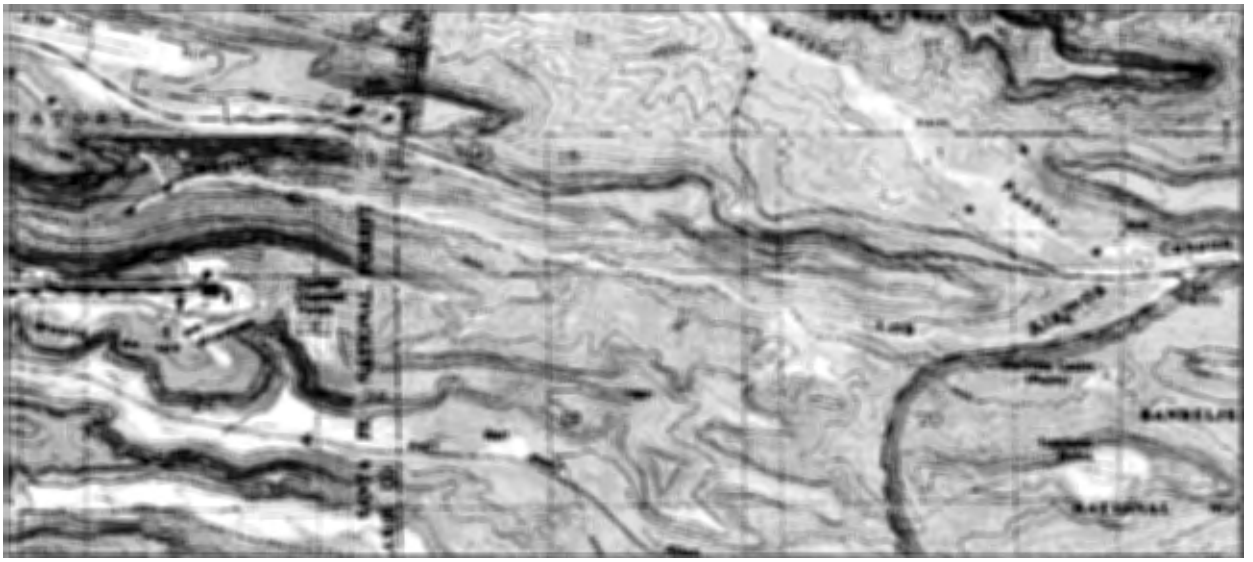
Appendix A - 2. Planned 2005/2006 DC Resistivity Profile in Pajarito Canyon, LANL



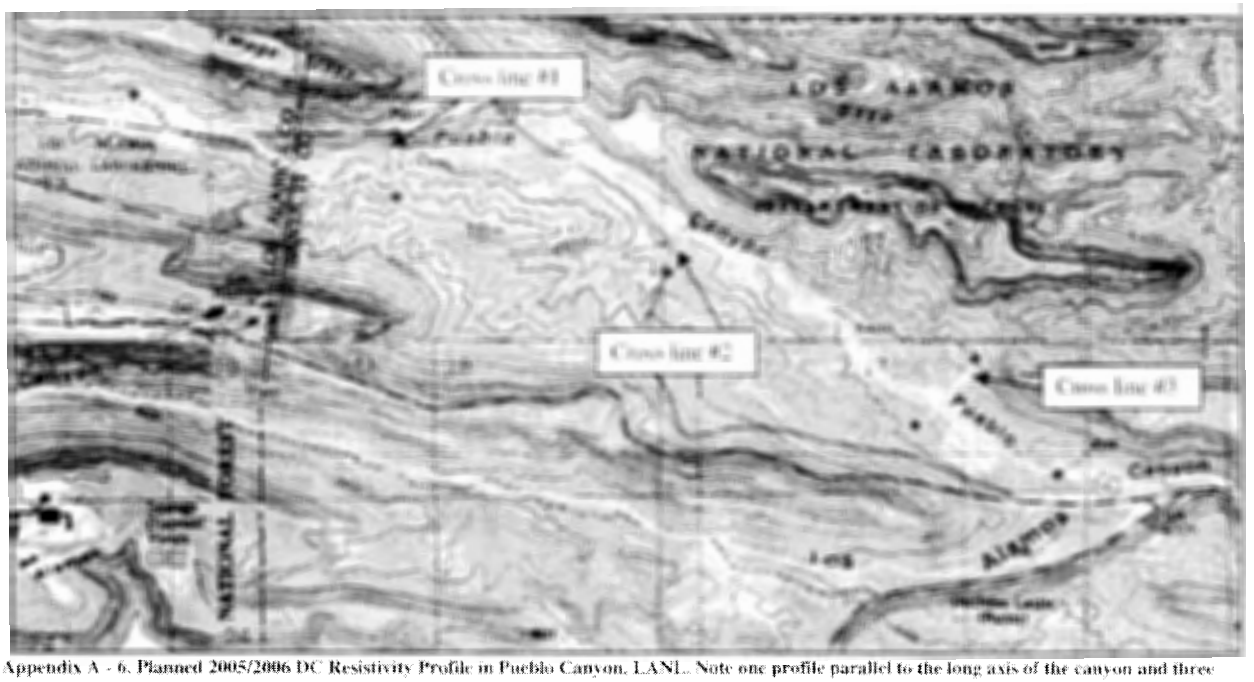
Appendix A - 3. Planned 2005/2006 DC Resistivity Profile in Sandia Canyon, LANL



Appendix A - 4. Planned 2005/2006 DC Resistivity Profile in DP Canyon, LANL



Appendix A - 5. Planned 2005/2006 DC Resistivity Profile in Los Alamos Canyon, LANL



Appendix A - 6. Planned 2005/2006 DC Resistivity Profile in Pueblo Canyon, LANL. Note one profile parallel to the long axis of the canyon and three cross line profiles.

Appendix A - 7. Planned 2005/2006 DC Resistivity Profile in Upper Pueblo Canyon, LANL

APPENDIX B. Geophex Standard Operating Procedure for Surface DC Resistivity Surveys

Geophex, Ltd.

Geosoft OASIS® Montaj
Data Processing Form

Job Number: _____ Job Name: _____

Location: _____ Date: _____

Processed By: _____

Data Type: _____

Workspace (path and name):

INPUT FILE(S)	(.XYZ)					Comments:
DATABASE	(.GDB)					
CHANNEL NAME	(FROM .GDB)					
XYZSTAT	(LZ-HZ)					LZ=Low Z Value HZ=High Z Value
TEMPLATE NAME (MARGINS)						
MAP AND SCALE	(.MDF)					Scale:
GRID NAME	(.CON) (.GRD)					
GRID MASK	(.PLY) (.GRD)					Inside or Outside?
COLOR LEVEL PLOT	(.AGG) Linear Equal Area Normal					L, EA,or M? CI=Contour Interval EF=Expansion Factor M=Mean
CONTOUR	(.CON) (CI)					CI=Contour Interval
WARP FILE	(.WRP)					

Geophex, Ltd.

DC Resistivity Data Processing Form

Sheet ____ of ____

Job Number: _____ Job Name: _____

Location: _____

Date: _____

Processed By: _____

Original Converted Data File Name (.DAT)	Edited Data File Names	Data With Topography File Names	Inverted Data File Names	Inverted Data With Topography File Names	Final Data File Name & Inversion Error

Geophex, Ltd.

DC Resistivity Data Editing Form

Job Number: _____ Job Name: _____

Location: _____

Date: _____

Edited By:

Sting Raw Data File Name (.STG)	Output File Type (2D or 3D?) (Array Type?)	Keep Negative Values? (Y/N)	Remove Large Errors > ____%	RES2DINV Output File Name (.DAT)

Geophex, Ltd.

DC Resistivity Data Acquisition Form

Job Number: _____ Job Name: _____

Location: _____

Date: _____

Acquired By: _____

Instrument Type:

Profile Name				
Electrode Spacing (meters)				
Number of Electrodes				
Command File Name				
Measure Time (ns)				
Number of Cycles				
Date				
Start & End Time				
Comments				
Profile Name				
Electrode Spacing (meters)				
Number of Electrodes				
Command File Name				
Measure Time (ns)				
Number of Cycles				
Date				
Start & End Time				
Comments				

Geophex, Ltd.

Field Project Report Log

This form is to be used to record project-related field activities.
The original, completed form is to be archived and maintained as a permanent record with the project files.

Job Number: _____ Job Name: _____

Location: _____

Date(s) covered by this Report Log: _____

Geophex Personnel On-site: _____

Geophex Vehicles Used: _____

Purpose of Job: _____

RESOURCE CHART

GEOPHYSICAL EQUIPMENT (check each instrument used). o None

o Magnetometer	o Resistivity	o VSP
o EM	o IP	o Cross-hole Shear
o Gravity	o SP	o Borehole Log
o GPR	o Seismic	o Other (comment below)

Other: _____

SUBCONTRACTOR/CONSULTANT (list name, service provided, and time on site). o None

_____

SUMMARY OF ACTIVITIES

Instrument Check/Calibration

_____

_____

_____

_____

_____

_____

FILES ACQUIRED AND ADDITIONAL COMMENTS

_____

_____

_____

_____

_____

_____

Signature: _____ Date: _____

Geophex, Ltd.

Inventory of DC Resistivity/IP Measurement and Test Equipment

Job Number: _____ Job Name: _____

Location: _____ Check Out Date: _____

Checked Out By: _____ Check In Date: _____

Equipment	Check Out	Condition	Check In	Condition
SuperSting R8 IP Console w/ Download & Battery Cables				
Cart A with Cable & Switches (28)				
Cart B with Cable & Switches (28)				
Regular Stakes (2 Sets of 57)				
Long Stakes (58)				
Rubber Bands				
Small Sledge Hammers				
Water Tanks & Caps (2)				
Water Hose				
Salt				
5-Gallon Buckets (8)				
Bentonite & Mixing Stick				
High Voltage Electrode Covers				
Dust Covers for Connectors				
Batteries (3)				
Battery Chargers (3)				
RES2DINV Software Dongle				

Also remember to check the list in Geophex SOP, Parts 6 & 7, Section 4.1 for additional equipment needed.

9.0 ATTACHMENT B

9.1 Attachment B-1 – Inventory of DC Resistivity/IP Measurement and Test Equipment

9.2 Attachment B-2 – Field Project Report Log

9.3 Attachment B-3 – DC Resistivity Data Acquisition Form

9.4 Attachment B-4 – DC Resistivity Data Editing Form

9.5 Attachment B-5 –DC Resistivity Data Processing Form

9.6 Attachment B-6 – Geosoft OASIS Montaj Data Processing Form

8.0 REFERENCES

8.1 Requirements and Specifications

8.1.1 *A Compendium of Superfund Field Operations*, EPA/540/P-87/001, December 1987.

8.1.2 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA, Interim Final, October 1988.

8.1.3 *RCRA Facility Investigation Guidance*, EPA, Interim Final, May 1989.

8.1.4 Keller, G. V. and F.C. Frischknecht, 1966, *Electrical Methods in Geophysical Prospecting*, International Series in Electromagnetic Waves, Volume 10, Pergamon Press, Oxford, England.

8.1.5 Sharma, P. V., 1997, *Environmental and Engineering Geophysics*, Cambridge University Press, Cambridge, England.

8.2 Related Procedures

8.2.1 Geophex Standard Operating Procedure (SOP), Section 13: Global Positioning System Surveys.

8.2.2 Geophex Standard Operating Procedure (SOP), Section 14: Level Surveys.

8.2.3 Geophex Standard Operating Procedure (SOP), Section 15: Geophysical Data Management.

8.3 Others

8.3.1 Advanced Geosciences, Inc., 2000, *Instruction Manual for The SuperSting R8 IP with Swift*, Austin, Texas.

8.3.2 Geotomo Software, 1998, RES2DINV Geoelectrical Imaging 2D and 3D, Penang, Malaysia.

8.3.3 Geosoft Inc., 1999, *OASIS Montaj Quick Start Tutorials*, Toronto, Canada.