DCE-5

Final Report

o n

Geophysical Characterization of Two UXO Test Sites

submitted to

DPW-Logistics Division USACE Waterways 3909 Halls Ferry Road Vicksburg, MS 3 9 180-6 199

by

Geophex, Ltd 605 Mercury Street Raleigh, North Carolina 27603

Geophex Job No. 677

Submitted December 1996; Revised June 1997





Final Report

on

Geophysical Characterization of Two UXO Test Sites

submitted to

DPW-Logistics Division USACE Waterwavs 3909 Halls Ferry Road Vicksburg, MS 3 9 1 80-6 199

by

Geophex, Ltd 605 Mercurv Street Raleigh, North Carolina 27603

Geophex Job No. 677

Submitted December 1996; Revised June 1997

June 17 1997

Dr. Dwain Butler U. S. Army Corps of Engineers Waterways Experiment Station 3909 Halls Ferry Road Vicksburg, MS 39180-6199

Subject: Geophysical Characterization of Two UXO Test Sites; Revised Final Report Purchase Order No. DACA39-96-M-1922; Reference: BAA-96-2789 Geophex Job No. 677

Dear Dr. Butler:

This submittal describes Geophex's activities in support of the Geophysical Characterization of Two UXO Test Sites. Geophex was contracted to acquire electromagnetic and magnetic data at prepared UXO-test sites at Ft. Carson, CO, the week of October 28, 1996, and at Ft. A.P. Hill, VA, the week of November 11, 1996. The deliverable is the data product as specified in the Background Data Collection Test Plan (DARPA, 1996).

Participants from Geophex for the fieldwork included two geophysicists, Drs. David Hanson and Dean Keiswetter, and an electrical engineer, Mr. Dave Chen. We were assisted by personnel from Waterways Experiment Station (WES) at the Seabee and Turkey Creek sites, Ft. Carson, and from WES and the Night Vision Electronic Sensors Directorate (NVESD), at the Firing Point 20 and 22 sites, Ft. A.P. Hill. Dr. Tom Altshuler, Institute for Defense Analysis (IDA), was the test consultant. The fieldwork, which was truly a joint effort, was enjoyable.

We acquired electromagnetic data using Geophex's prototype GEM-3 sensor (Figure 1). The GEM-3 is a monostatic. multi-frequency, lightweight (less than 10 lb.), electromagnetic induction instrument. The instrument, which uses two co-located transmit coils to create a magnetic cavity and a centrally-positioned receive coil. is designed for efficient field logistics. The GEM-3 transmits a primary electromagnetic field that induces a secondary current in electrically conductive targets. It measures the secondary magnetic field produced by these induced currents. The primary transmitted field is generated by a multi-frequency composite waveform, allowing different penetration depths in the earth depending on conductivity structure. The GEM-3 consists of a transmitter- and receiver-coil assembly, a digitally controlled transmitter, a low-noise analog receiver, an analog-to-digital converter, and a custom digital signal-processing unit. Although the GEM-3 can function as a time- or tiequency-domain EMI sensor, we exclusively used the frequency domain capabilities for the described surveys. Data acquisition parameters for all test sites included a IO-Hz sampling rate and two transmit frequencies, 4,050 Hz and 12,270 Hz.



Figure 1. Photograph of the GEM-3 sensor at the Seabee Site, Ft. Carson. CO.

We acquired magnetic data using a commercially available, cesium vapor magnetometer (Figure 2; Geometries model G-858). We configured the G-858 magnetometer to record total-field data from two sensors that were positioned vertically and separated by 0.5 m. A five-hertz sampling rate was used at all four sites.

The recorded data are included on IOMega Zip cartridges and formatted according to the Background Standard Format (Background Data Collection Test Plan, 1996). Tables 1 and 2 detail the Target Side Bars and the extent of coverage in the center square region.

Site	Side Bars (0.5-m line spacing)	Center Square (x coordinates in meters; 0.5-m line spacing)
Seabee Site	Blue, Yellow. Orange	15 to 105
Turkey Creek	Blue, Yellow? Orange	15 to 105
Firing Point 20	Blue, Yellow, Orange	15 to 90
Firing Point 22	Blue, Yellow, Orange	15 to 45 and 95 to 165

 Table 1. GEM-3 Coverage



Figure 2. Photograph of the Geometrics G-858 magnetometer at the seabee Site, Ft. Carson, CO.

Table	2.	Magnetic	Coverage

Site	Side Bars (0.5-m line spacing)	Center Square (x coordinates in meters; f-m line spacing)
Seabee Site	Blue, Orange	15 to 95
Turkey Creek	Blue, Orange	15 to 95
Firing Point 20	Blue, Orange	15 to 90
Firing Point 22	Blue, Orange	15 to 45 and 95 to 165

The enclosed disks (one each for Ft. AP Hill and Ft. Carson) contain numerous data (image; *.dat) and header (*.hdr) files. To minimize confusion, we have adopted the following naming convention:

Filename=(Site Descriptor)(Geophysical Instrument)(Cell Designator)(Calibration Pass)

Site Descriptor s = Seabee Site; Ft. Carson t = Turkey Creek; Ft. Carson 20 = Firing Point 20; Ft. A.P. Hill 22 = Firing Point 22; Ft. A.P. Hill

<u>Geophysical Instrument</u> g = GEM-3 m = Geometics G-858 magnetometer

<u>Cell Designator</u> b = blue calibration y = yellow calibration o = orange calibration cs = center square (scatter data)

> Calibration Pass fp = first pass sp = second pass

For example, the file "sgbfpdat" represents Seabee site, GEM-3 sensor, blue calibration cell, first pass. In addition to data in the Background Standard Format, we have included data files that are generated by the Geometrics (MagMapper) and GEM-3 operating software. A "d" in front of the described filename indicates that the data have been converted to the Background Standard Format (BSF) (viz., dsgbfp.dat represents BSF, Seabee site. GEM-3 sensor, blue calibration cell, first pass). The complimentary header file for each data (image) set consists of the same first eight (8) characters with an extension of ".hdr".

The measured GEM-3 data are expressed in part-per-million (ppm). This sensor-dependent unit is defined as the ratio of the measured field to the theoretically-calculated unbucked primary field. When expressed in this manner. the data are useful for "bump hunting", not for absolute conductivity measurements. The prototype GEM-3 sensor does not time stamp the recorded data (required to correlate the infrared laser tracking measurements to the GEM-3 raw data). To mitigate correlation problems, IDA and Geophex agreed to employ an impromptu, but uniform acquisition technique.

The spatial registry information (x,y coordinates) of the submitted data have not been corrected using the laser tracking data. The spatial coordinates were assigned during post processing using

the "dead reckoning" approach. The dead reckoning method involves continuous recording while walking between to known locations (i.e., the starting and end-points of each survey lane). After the survey is complete, the data are linearly interpolated between the known locations. We estimate that the spatial coordinates assigned using the dead-reckoning method are accurate to within one meter.

The prototype GEM-3 is currently in a rapidly evolving developmental stage. These data are among the first acquired by this exciting design. We are working to improve the magnetic cavity and, therefore, the overall performance of the GEM-3 instruments.

Plots of the electromagnetic (12,270 Hz) and magnetic data are included in Appendices A through D. These data do not incorporate the laser tracking measurements and are plotted using site-consistent color scales. Circles identify the locations of the center-square registration targets.

We believe that each data file has been appropriately converted to BSF guidelines and has a complimentary header file. If problems arise during data analysis. however, please feel free to contact me at telephone number (919) 839-85 15 or via e-mail at keiswetter@geophex.com.

Sincerely,

Dean leimetter

Dean Keiswetter, Ph. D. Deputy Manager, R&D Division

cc. Vivian George, Walcoff & Associates. 1429 N. Quincy Street, Suite 201, Arlington. VA 22207.

Appendix A

Seabee Site, Ft. Carson, Colorado



Seabee Site: GEM-3 data, 12,270 Hz Inphase

Distance (m)



ÎN

Seabee Site: GEM-3 data, 12,270 Hz Quadrature





Seabee Site: Magnetic, Vertical Gradient

Appendix B

Turkey Creek Site, Ft. Carson, Colorado





ÎN

Turkey Creek Site: GEM-3 data, 12,270 Hz Quadrature





Turkey Creek Site: Magnetic, Vertical Gradient

Appendix C

Firing Point 20, Ft. A.P. Hill, Virginia





FP20 Site: GEM-3 data, 12,270 Hz Quadrature







Firing Point 20: Magnetic, Vertical Gradient

Appendix D

Firing Point 22, Ft A.P. Hill, Virginia

FP22 Site: GEM-3 data, 12,270 Inphase



FP22 Site: GEM-3 data, 12,270 Quadrature



Firing Point 22: Magnetic, Total Field



