HILL AIR FORCE BASE 3-D EXPERIMENT

High-resolution 3-D Seismic Reflection Investigations at a Groundwater Contamination Site

Prepared by

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Attached to the dataset

HILLAFB.SEGY

ID 06-007

DATA REPORT

FOR

THE 2000 HILL AIR FORCE BASE (UT) 3-D REFLECTION SEISMIC EXPERIMENT

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ABSTRACT

Rice University conducted a 3-D reflection seismic investigation of the shallow subsurface at Hill Air Force Base, Ogden, UT, in the context of groundwater contamination and remediation. The purpose of the survey was to map the geometry of a paleo-channel eroded in a clay layer at a depth of 10-15 m from the topography. The channel acts as contaminant trap for polluting dense non-aqueous phase liquids (DNAPLs), and consequently a detailed map of its geometry, lateral boundaries and depth is crucial to the remediation effort.

This report describes the data from the 2000 experiment, collected using REF TEK 125A single channel seismic recorders with 40 Hz geophones. As a source, a .223 rifle in a ~0.2 m pre-drilled hole was used. Data format, acquisition parameters, experiment layout and trace geometry are discussed.

INTRODUCTION

In July and August 2000, Rice University conducted 3-D reflection seismic survey at Operable Unit 2 (OU2), Hill Air Force Base in Ogden, Utah. Approximately 3000 shot records were taken in an area of about 95m by 36m.

OU-2 was used for the open trench disposal of chlorinated solvents, which migrated into the shallow aquifer and accumulated in topographic lows of a low permeability clay layer. The top of the clay was incised by paleo-streams, which both deposited sediments on the clay, and left a paleo-channel crossing the site approximately North-South. The paleo-channel acts as a contaminant trap. The channel is filled with a mix of sands, gravels, and clays characterized by different compaction and water saturation. The purpose of the experiment was the to expand and improve the understanding of the subsurface environment developed from well data, and to development of high-resolution seismic methods for characterizing the shallow subsurface and identifying traps for contaminants.

The seismic data were acquired using about 610 REF TEK 125A single channel seismic recorders with 40 Hz geophones. Because of the extra hard soil, most of the geophones were planted into pre-drilled holes. As for the seismic source, a .223 caliber rifle in a ~20 cm shot hole was used. The source produced frequencies from 40Hz to greater than 400Hz. The 3-D seismic survey was completed in 18 days and involved 15 Rice and other university personnel and 4 PASSCAL Center personnel. Before each of the 8 recording days, a preparation day was taken to drill the shot holes, plant the geophones and program the seismometers. This preparation allowed continuous acquisition and receiver line repositioning of up to six swaths per day. Following a day of shooting, the instruments were collected and the data downloaded prior to reprogramming for the next day. The source and receiver points were surveyed using a laser-geodolite system positioned on a reference benchmark. The actual coordinates were adjusted for offsets in the surveyed configuration due to obstacles.

DESCRIPTION OF THE DATA

The seismic dataset is in standard SEG-Y format (IEEE), time zero corrected and sorted into common shot gathers (FFID) as primary header word, and channel number (CHAN)

as secondary header word. The maximum number of traces per shot is 720. The coordinates of the sources and receivers have already been uploaded into the trace headers for each trace. The coordinates are in Easting and Northing (meters) and referenced to the Utah Coordinate System of 1927.

The acquisition parameters (Table 1) were designed taking into account previous on site experience and expected results, equipment availability, and logistic limitations. The seismic survey has dimensions of approximately 36 x 92 meters and shape of a rectangle, except for the very southern part where it becomes a parallelogram to adjust for obstacles, and it is centered on the paleo-channel as imaged by boring logs. The 3-D reflection data were acquired along 45 receiver lines in the East-West direction, approximately 36.5 meters long. The field layout is a non-orthogonal (or slanted) brick pattern, where the source lines are at an angle of 45° from the receiver lines. Each patch has 6 active receiver lines with a spacing of 2.1 m. The source points for each patch lie in the center of the patch between two adjacent receiver lines. The source line spacing is 2.1 m and repeats every other patch (Figure 1). Both the receivers and the source stations interval are 0.35 meters in the inline direction. The source points are stretched out in the source line direction, consequently the midpoints fall into the center of the bins using a natural bin size of 1/2 the source/receiver increment. The slanted acquisition geometry has a maximum source-receiver offset of about 36 m and maximum nominal fold of 52, in 0.175 m square bins. Because of source and receivers gaps due to bad shots and obstacles such as propane tanks, pipelines, cement well pads and trailers, the actual fold is non-uniform (Figure 2).

ACKNOWLEDGMENTS

The study was sponsored by DOE/EMSP program under grant DE-FG07-97ER14827. The authors thank Hans Meinardus of Duke Power, who acted as a liaison with HAFB, and the personnel at HAFB, including John Ginn, who made access to the OU-2 site possible. Thanks go to all field crewmembers from nine countries for their teamwork. Special thanks go to IRIS/PASSCAL and UTEP for providing seismic recording instruments and field support.

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FIGURES & TABLES

Table 1. Acquisition parameters for the 3-D seismic survey

	Nominal	Actual
Survey dimensions	3363 m²	3331 m²
Survey shape	Rectangle	Rect.-Paral.
Rec. inline direction	EW	
Rec. inline interval	2.1 m	
Rec. spacing	0.35 m	
Number of rec. points	4725	4520
Length of rec. lines	36.4 m	36.05 m
Source line direction	NE-SW	
Source line interval	2.1 m	
Source spacing	0.5	
Number of source points	4752	3126
Length of source lines	2.5	
Number of rec. lines	45	
Number of chan. per line	120	104
Patch	6x120	6x104
Geophones	40 Hz	
Source	.223 rifle	
Hole depth	0.3 m	
Bin size	0.175x0.175 m	
Number of traces	3402000	1816958
Record length	200 ms	
Sample rate	1 ms	

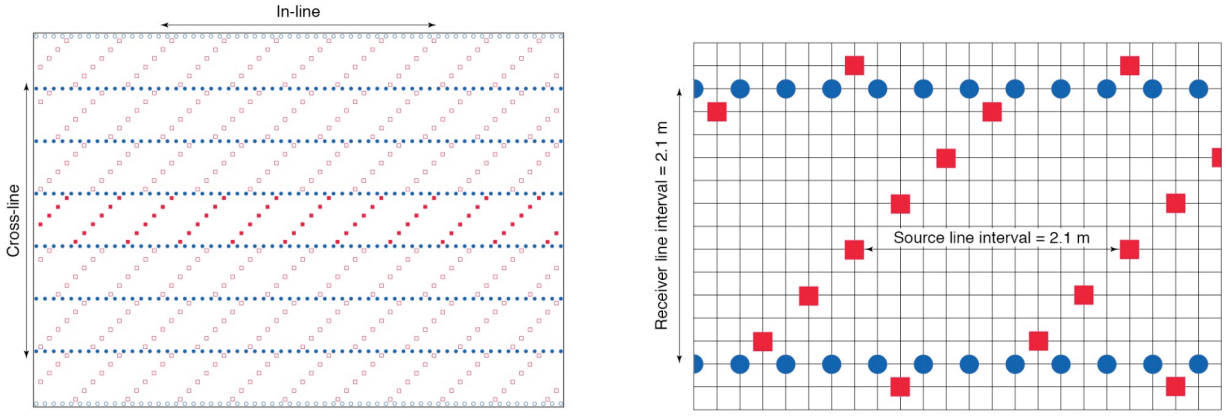

***Figure 1**: Acquisition swath and patch for the 3-D experiment. The red squares represent the sources and the blue circles represent the receivers. Six receiver lines were active for each shot line. Except for rolling in and rolling out at the northern and southern ends of the seismic array, all shot lines were recorded by 3 receiver lines to the north and 3 receiver lines to the south, giving a total of 630 (maximum) channels.*

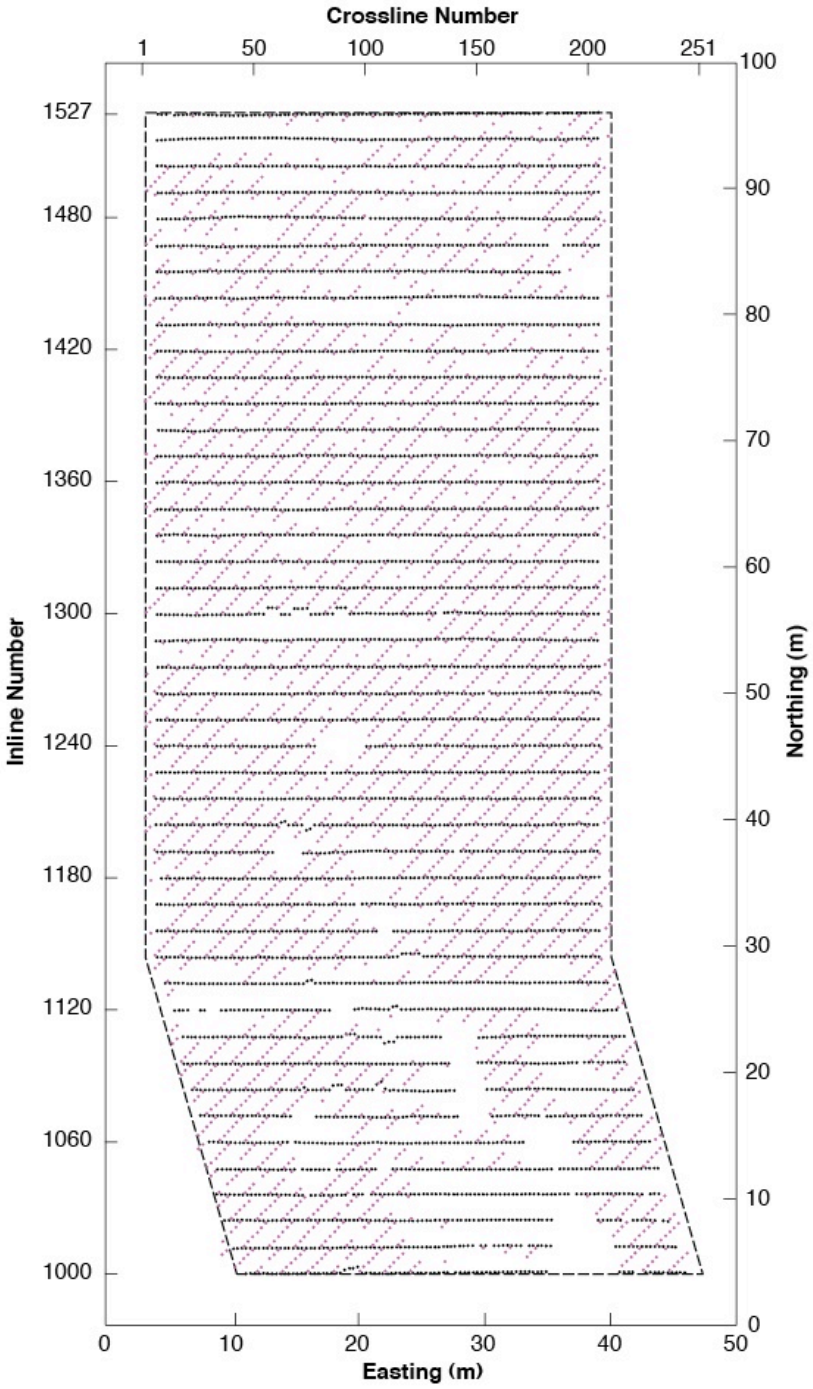

Figure 2*: Acquisition layout for the 3-D experiment. The black dots represent the receiver lines and the red dots represent the source points. The inline and crossline numbering is consistent with the one presently in the data trace headers. Northing and Easting are relative to the southwestern corner of the survey area for display purpose only. The data tracer headers contain the absolute coordinates. The white areas are gaps in the acquisition.*