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QUARTERLY TECHNICAL PROGRESS REPORT

**TITLE: ENHANCED OIL RECOVERY UTILIZING HIGH-ANGLE WELLS IN
THE FRONTIER FORMATION, BADGER BASIN FIELD, PARK
COUNTY, WYOMING**

COOPERATIVE AGREEMENT No. DE-FC22-93BC14950

UNIVERSITY/INSTITUTION/LABORATORY: Sierra Energy Company

DATE OF REPORT: 10 July 1993

AWARD DATE: 21 October 1992

ANTICIPATED COMPLETION DATE: 31 December 1994

GOVERNMENT AWARD (for Fiscal Year 1993): \$1,124,127

PROGRAM MANAGER: John N. Augustine

**PRINCIPAL INVESTIGATORS: Richard G. Fortmann
Jerome P. Walker**

TECHNICAL PROJECT OFFICER (TPO): Ms. Edie Allison

REPORTING PERIOD: 1 March 1993 to 30 June 1993

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**"US/DOE Patent Clearance is not required prior to the publication of this
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QUARTERLY TECHNICAL PROGRESS REPORT

1 March 1993 - 30 June 1993

A. OBJECTIVES

Sierra Energy Company's targeted goals during the third quarter of this Cooperative Agreement included the following objectives from the Statement of Work: in Phase 2A, completion of Subtask 2.1.2 - Acquire field data; and, initiation of Subtask 2.1.3 - Process data; both of Task 2.1 - Acquire 3-D seismic data.

TASK 2.1 - SEISMIC IMPLEMENTATION

Subtask 2.1.2 - Acquire field data: The goal of this subtask was to acquire the best possible data in the 3-D seismic program, through proper supervision.

Subtask 2.1.3 - Process data: The goal of this subtask was to process the acquired 3-D seismic data, using a suitable geophysical contractor, to provide output ready for interpretation.

B. SUMMARY OF TECHNICAL PROGRESS

TASK 2.1 - SEISMIC IMPLEMENTATION

Subtask 2.1.2 - Acquire field data: Geophysical Systems' crew arrived in Cody, Wyoming April 1, 1993. Final permitting; archaeological clearance; layout of cables, geophones and array terminals; and testing took place from April 2 through April 9. Production shooting began April 10, and was completed May 18, 1993. Acquisition required 25 shooting days, averaging 46 vibrating points (VP's) per day. There were 14 days in which the crew was shut down due to weather conditions. Though 1,183 VP's were planned, 1,148 VP's (97%) were actually acquired.

The following summary of general information and parameters is presented for this seismic program.

SURVEY SIZE: 17.0625 sq. mi. (17,160' x 27,720')

CONTRACTOR: Geophysical Systems Corporation (Pasadena, CA)

RECORDING INSTRUMENT: 2,048-channel GEOCOR IV Model 2

ENERGY SOURCE: Vibroseis

VIBRATORS: 4 Litton Model 311 in box pattern, unless prohibited by topography; remained stationary at VP during sweeps

NUMBER OF SWEEPS: 8 per VP
SWEEP FREQUENCIES: 12-26-100-132 hertz Varisweep™ composite
(Varisweep™ is a Geophysical Systems' proprietary technique
for clarifying the correlation wavelet by using different
parameters for each sweep at a single source point
SWEEP LENGTH: 12 seconds
RECORD LENGTH: 4 seconds
SAMPLE INTERVAL: 2 milliseconds
CORRELATED RECORD: 4 seconds
GEOPHONES: 6 per channel
RECEIVER GROUP (GEOPHONE) ARRAY: potted in a 1 to 2-foot
diameter circle
RECEIVER GROUP INTERVAL: 165'
RECEIVER LINE SPACING: 660'
ACTIVE CHANNELS PER LINE: 104
ACTIVE LINES: 10
TOTAL ACTIVE CHANNELS PER RECORD: 1,040
SOURCE INTERVAL: 330'
SOURCE LINE SPACING: 1,320'
TOTAL RECEIVER POINTS: 4,472 planned, 4,464 actual
TOTAL VIBRATING POINTS: 1,183 planned, 1,148 actual
BIN SIZE: 82.5' by 82.5' (with offset chatter), 82.5' Receiver by
165' Source (without offset chatter)
NOMINAL FOLD: 16 to 20 in main survey area

Testing showed that serious ground roll occurred when the sweep contained frequencies of 12 hertz and below. A linear geophone array, consisting of the 6 geophones spaced at 30' intervals parallel to the receiver line, was tested for its effect on reducing ground roll. Although it successfully reduced ground roll when the vibrators were in-line, it was not successful when the vibrators were placed off to the side of the receiver lines, as expected. After consultation with the processing contractor, it was decided to acquire the program as originally planned, with a "point source/point receiver" geometry, using a 12 hertz low-end frequency for the Vibroseis signal and processing capabilities inherent to 3-D seismic to minimize ground roll.

The final Varisweep™ design consisted of the following frequencies for the 8 individual sweeps that are composited at each source point: sweep #1 - 12 to 132 hertz, sweep #2 - 14 to 132, sweep #3 - 16 to 132, sweep #4 - 18 to 132, sweep #5 - 20 to 132, sweep #6 - 22 to 132, sweep #7 - 24 to 132, and sweep #8 - 26 to 132 hertz.

Sixty-cycle noise, introduced into the records by power lines, was a particular problem in the northwest portion of the survey. Attempts were made to control the interference with breakers in the cables, with success limited only by the number of breakers available. However, this noise can be easily handled during the processing stage.

The survey began with shooting "rolling in" to the first five receiver lines, thus, acquiring the VP's in an "S"-shaped pattern between this set of lines. The main body of the program was shot by snaking the vibrator trucks between 3 adjacent receiver lines in

the same "S"-shaped pattern. When all 56 VP's were acquired between a set of receiver lines, the equipment was moved further into the survey. "Roll off" consisted of acquiring VP's between the last 5 receiver lines. Ten receiver lines, consisting of 104 channels per line for a total of 1,040 channels, were active at all times during shooting. Data were demultiplexed, correlated, composited and written to field tapes. After acquiring 30 reels (approximately 240 VP's) that filled 3 boxes, the field tapes were shipped by "next-day air" to the processing contractor in Denver.

Subtask 2.1.3 - Process data: Vector Seismic Data Processing, Inc. began processing the 3-D seismic data in May 1993. Processing to date consists of 3-D geometry assignment, preliminary data analyses, gain recovery, and brute stacks using both datum and refraction statics. Currently, Vector is running surface-consistent 3-D autostatics via Ronen-Claerbout method. Resolving the statics problem has been made difficult by the poor first breaks in the data, a predicament common to seismic acquired with a Vibroseis source. Assuming a successful resolution to the statics question by the autostatics approach, Vector expects final output from a conventional processing flow by the end of July 1993.

C. REFERENCES/PUBLICATIONS

None.

D. ATTACHMENTS

None.

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