X

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: Distribution

DATE: September 12, 1983

THRU: R. H. Hendron
D. W. Brown
B. R. Dennis

MAIL STOP/TELEPHONE: J979/7-7811

FROM: C. O. Grigsby

SYMBOL: ESS-4/83/327

SUBJECT: EXPERIMENT 2033: INJECTION TEST OF UPPER EE-3 FRACTURE ZONE

This experiment is designed to investigate the apparent lithologic boundary between the low-opening-pressure fracture system (upper EE-3 fracture and Phase I system) and the high-opening-pressure fracture system (lower fractures in EE-3 and in EE-2). The experiment will test for resistance to breakthrough into the lower EE-2 fracture system at relatively low pressure and will define the venting behavior of the low pressure system. Further objectives of this experiment include testing of existing elements of the preCambrian net, determining the operational lifetime of a triaxial geophone, testing the slim-line detonator package and attempting to calibrate the preCambrian net with two string shots.

The microseismic coverage for this pump test will consist of two deep 3-axis geophone tools -- one in EE-1 and the other in EE-2 (through the pressure lock and packoff), the preCambrian (pG) net, and a 4-station surface net. The pG station in the GRI hole is being eliminated to allow us to deploy the second large 3-axis geophone tool deep in EE-2, within the upper Phase II reservoir region.

It would be very desirable to extend the downhole lifetime of the large geophone packages so that these tools could survive an extended pump test without having to be replaced. To this end, the dewar and its contents for the EE-2 geophone package are being removed for Expt. 2033 to:

1. assess the effectiveness of detonator shots only for package orientation.
2. compare the amplified (EE-1) and unamplified (EE-2) seismic signal sets for the same hydraulic fracturing experiment (does amplification help or hurt, considering that we usually work with only the larger amplitude signals?)

In order to protect the tensioned 9-5/8-in. casing in EE-3, it is required that we heat the injection water to ~70°C. This heating will begin one day in advance of fracturing operations with hot water storage in the frac tanks. The fracturing experiment will consist of pumping 200,000 gallons (4760 barrels) of heated water into EE-3 at a nominal rate of 10 bpm. Following the pump, EE-3 will be vented at a constant flow rate of 50

gpm. We should have the provision available to shut-in EE-3 during the vent in order to look at far-field pressures. The geophone tools in EE-1 and EE-2 will remain downhole for at least 24 hours after the start of pumping for the lifetime test. The tool in GT-2 should be retrieved during the venting operation.

On the following day, two string shots (OWP) of 75 grams and 150 grams will be run in GT-2 on the ESS-6 wireline. The string shots may give signals similar in magnitude to microseismic signals and may provide better frequency content than the 88 perf shot. These string shots will be used in an attempt to calibrate the GT-1 geophone.

PROCEDURE:

Three hot oiler trucks will rig up on the frac tanks as shown in Figure 1. They will start heating the water on Sunday afternoon, September 25th.

Tuesday, September 27th

1. Park the 3-axis geophone package at 9760 ft in EE-1. Activate the 4-station surface net, and the GT-1 geophone.
2. Run the large detonator tool in EE-2 and fire the necessary calibration shots at 10,170 ft.
3. Pull the large detonator tool and park the second 3-axis geophone package at 11,000 ft in EE-2. Set packoff.
4. Run the slim-line detonator tool in GT-2 and fire the two calibration shots at TD (~8900 ft).
5. If the slim-line detonator tool fails, the large detonator tool will be run in GT-2, and the necessary calibration shots fired.
6. The detonator tool will be pulled and the accelerometer tool run in GT-2 to 2500 ft.
7. Dowell will rig up and pressure test to 3000 psi prior to 1200 hrs. Then the ESS-6 surface monitoring equipment will be installed, and Dowell will retest to 3000 psi.

The equipment will monitor:

A. Injection temperature, pressure, and flow rate.
B. Vent temperature, pressure and flow rate.
C. Gas and liquid flow rate at separator.
D. EE-2 wellhead pressure.
E. Water levels in EE-1 and GT-2. (Casing will be filled with water and the fluid levels visually monitored.)

8. Start pumping into EE-3 and slowly increase the rate to 10 bpm. Do not exceed 3000 psi.
9. Pump approximately 200,000 gals of water at or above 63°C. Collect a water sample from between the blender and pump trucks after pumping 100,000 gals.

10. When pumping has been completed, prepare to vent back through the separator system.
11. Vent the well back at a constant flow rate of 50 gpm by adjusting the choke valves on the EE-3 choke manifold. Maintain 20 psi on the separator system by adjusting the water pressure valve and the gas pressure valve. This will take very close supervision. (Steady flow and pressures are more important than exact numbers given.)
12. Monitor the separator pressure, temperature, and flow rate during the vent. Collect gas and water samples during the vent. Collect the first vent sample after venting back 15,000 gals of water. Collect an additional sample every 5,000 gals.
13. Continue monitoring pressure, temperature, flow rate, and seismic activity until the well no longer flows or as determined by the experimental manager and scientific advisor.
14. A post-frac calibration of the EE-2 geophone package will be conducted by pulling the accelerometer from GT-2 and running the slim-line detonator tool. Fire two shots at TD for post calibration.

Wednesday, September 28

1. ESS-6 will rig up OWP on a LANL wireline. Run a 75 gram string shot (primer cord) into the GT-2 open hole section at TD.
2. Detonate the string shot and record the signal.
3. Pull the wireline out of GT-2 and rig up a 150 gram string shot.
4. Run the string shot to the same depth and detonate it.
5. Record the signal.
6. Pull the wireline from GT-2 and the geophone package from EE-2.
7. Run the slim-line detonator tool in EE-2 and fire two shots.
8. Pull the detonator tool from the hole.
9. Pull the geophone from EE-1 when the electronics begin to fail.

EQUIPMENT REQUIRED:

SURFACE MEASUREMENTS

EE-3 Wellhead

Wellhead Pressure	-- 0-3000 PSI/Strip Chart Display
Fluid Injection Temperature	-- 0-100°C
Fluid Injection Flow	-- 40-400 GPM/Strip Chart Display

EE-2 Wellhead

Wellhead Pressure	-- 0-3000 PSI
Wellhead Temperature	-- 0-200°C

Separator (Vent)

Gas Temperature	-- 0-250°C
Water Temperature	-- 0-250°C
Gas Flow P1	-- 0-200 psi
Gas Flow P2	-- 0-200 psi
Water Flow	-- 0-1000 gpm/Clampatron
Water Flow	-- 10-100 gpm/2-in. turbine

All surface measurements are recorded on the HP9835. All surface instrumentation can be set up and checked out prior to Tuesday except the EE-3 wellhead instruments which must be installed after/during Dowell hookup.

SURFACE SEISMIC NET

Limited surface seismic system will be installed using four surface stations including Q1 and Q2 from the on-site net and LFM-3 and JEPT. The LFM-3 and JEPT stations will require FM telemetry.

LFM-3	Lake Fork Mesa	FM
JEPT	Jeep Trail Station	FM
Q-1	North On-Site Station	Hard Wire
Q-3	South On-Site Station	Hard Wire

Surface seismic data (vertical geophones on S13 seismometer) will be recorded on the PR2200 magnetic tape recorder and HP 8-channel strip chart. Note: The gain on the S13's (Q1, Q3) have been reduced for detection of large signals.

PRECAMBRIAN SEISMIC NET

The following stations will be deployed for the Precambrian Net.

GT-1 -- existing downhole vertical geophone.
GT-2 -- downhole accelerometer package.

DOWNHOLE MICROSEISMIC STATIONS

EE-1 station at 9760 ft. using the standard triaxial geophone package deployed with the EE-1 offshore rig. (Geophone Package Nr. 1).

EE-2 station near 11,000 ft (TBD) using stripped (no downhole electronics) triaxial geophone package deployed with the TFE cable on WSSU #4. (Geophone Package Nr. 2).

Data from the EE-1 geophone system will be recorded on the Biomation and HP 9845 system with the vertical geophone from EE-2. All data channels will be recorded on mag tape.

ON LINE MICROSEISMIC ANALYSIS

ESS-4 HP 9845 calculator with 2 disk drives
Blank tapes
Hans Keppler's location notebook

VENT CHEMISTRY
Sample ports on both the gas line and the liquid line of the gas/liquid separator.

COG/de

Requester Robert Potter

SURFACE MEASUREMENT REQUEST

Experiment Thief Zone No. 2033 Date 9/6/83

Measurement	Location	Range	Recording	Comments
EE-3 WELLHEAD				
Wellhead Press	EE-3	0-3000 PSI	35/SC	
Fluid Inj Temp	EE-3	0-100°C	35	
Inlet Flow	EE-3	40-400 GPM	35/SC	
Outside Annulus	EE-3	0-200 PSI	35	
EE-2 WELLHEAD				
Wellhead Press	EE-2	0-3000 PSI	35	
Wellhead Temp	EE-2	0-200°C	35	
VENT SYSTEM				
Gas Temp	Separator	0-250°C	35	
Water Temp	Separator	0-250°C	35	
Water Flow	Separator	0-1000 GPM	35	Clampatron
Water Flow	Separator	10-100 GPM	35	2-In. Turbine
Gas Flow Press 1	Separator	0-200 PSI	35	ΔP
Gas Flow Press 2	Separator	0-200 PSI	35	ΔP

Approvals

Scientific Advisor _____

ESS-4 Group Leader _____

ESS-6 Measurements Advisor _____

Requester Robert Potter

SURFACE MEASUREMENT REQUEST

Experiment Thief Zone Pump No. 2033 Date 9/13/83

Measurement	Location	Range	Recording	Comments
V Geo	EE-1/9760	1 volt	PR 3020	Track 1
V Geo	EE-1	10 volts	PR 3020	Track 2
U Horiz	EE-1	1 volt	PR 3020	Track 3
U Horiz	EE-1	10 volts	PR 3020	Track 4
L Horiz	EE-1	1 volt	PR 3020	Track 5
L Horiz	EE-1	10 volts	PR 3020	Track 6
V Geo	EE-2	1 volt	PR 3020	Track 7
U Horiz	EE-2	1 volt	PR 3020	Track 8
L Horiz	EE-2	1 volt	PR 3020	Track 9
V Accel	GT-2	1 volt	PR 3020	Track 10
V Geo	GT-1	1 volt	PR 3020	Track 11
Fire Signal	GT-2/EE-2	1 volt	PR 3020	Track 12
Time Code	IRIG	2 volts	PR 3020	Track 13
Time Code	IRIG	2 volts	PR 3020	Track 14
Tape Speed	7½ IPS			

Approvals

Scientific Advisor _____

ESS-4 Group Leader _____

ESS-6 Measurements Advisor _____

Requester Robert Potter

SURFACE MEASUREMENT REQUEST

Experiment Thief Zone Pump No. 2033 Date 9/13/83

Measurement	Location	Range	Recording	Comments
V Geo	GT-1	4 volts	PR 2200	Track 1
V Geo	EE-2	4 volts	PR 2200	Track 2
V Accel	GT-2	4 volts	PR 2200	Track 3
Spare				Track 4
Spare				Track 5
Spare				Track 6
Seismic	JEPT	4 volts	PR 2200	Track 7
Seismic	LFM -3	4 volts	PR 2200	Track 8
Spare				Track 9
Seismic	Q1 (vert)	4 volts	PR 2200	Track 10
Spare				Track 11
Seismic	Q3 (vert)	4 volts	PR 2200	Track 12
Time Code	DAT	IRIG	PR 2200	Track 13
Time Code	DAT	IRIG	PR 2200	Track 14
Tape Speed 15/16	IPS			

Approvals

Scientific Advisor _____

ESS-4 Group Leader _____

ESS-6 Measurements Advisor _____

Requester Robert Potter

SURFACE MEASUREMENT REQUEST

Experiment Thief Zone Pump No. 2033 Date 9/13/83

Measurement	Location	Range	Recording	Comments
V Geo	GT-1	500 MS Delay	Bio 3	Long Time Bas
V Accel	GT-2	500 MS Delay	Bio 3	Long Time Bas
V Geo	EE-2	500 MS Delay	Bio 3	Long Time Bas

NOTE: The delay time may be changed during the pump depending upon signal arrivals.

Approvals

Scientific Advisor _____

ESS-4 Group Leader _____

ESS-6 Measurements Advisor _____

Requester Robert Potter

DOWNHOLE MEASUREMENT REQUEST

Experiment Thief Zone No. 2033 Date 9/6/83

Downhole Measurement DOWNHOLE TRIAXIAL ACOUSTIC

Borehole EE-1/EE-2

Depth	Resolution Samples Per Ft	No. Surveys Per Interval
Station at 9670 Ft in EE-1	Normal Gains and Recording	
Station at ∿11,000 Ft in EE-2	Vert Geo only on Biomation	
	Upper Horiz and Lower Horiz	
	On Mag Tape PR3020	

Special Requirements Three axis recorded on Biomation #1 with pretrig delay ≃5 Msec, short time base 20 Msec. Three axis recorded on Biomation #2 with pretrig ≃100 Msec, long time base 500 Msec. Record on mag tape also.

Approvals

Scientific Advisor _____

ESS-4 Group Leader _____

ESS-6 Measurements Advisor _____

EE-3 FRAC SCHEMATIC