132058

B

Appendix B
Borehole Geophysical Logs

TABLE OF CONTENTS

B.1	*BOREHOLE GEOPHYSICAL INVESTIGATION*	*1*
B.1.1	*METHODOLOGY*	*1*
B.2	*RESULTS AND CONCLUSIONS*	*3*
B.3	*INSTRUMENT THEORY*	*5*
B.3.1	*CALIPER LOG*	*5*
B.3.2	*SPONTANEOUS POTENTIAL (SP) LOG*	*5*
B.3.3	*NATURAL GAMMA RAY LOG*	*6*
B.3.4	*16-INCH AND 64-INCH NORMAL LOGS*	*7*
B.3.5	*48-INCH LATERAL*	*8*
B.3.6	*TEMPERATURE LOGS*	*8*
B.3.7	*SONIC OR ACOUSTIC-VELOCITY LOGS*	*9*

ATTACHMENTS

B.1 *ERM Geophysical Logs for Intermediate and Deep Wells*
B.2 *welenco Geophysical Logs for Production Wells*

B.1 BOREHOLE GEOPHYSICAL INVESTIGATION

A borehole geophysical investigation was conducted at the Middletown Airfield Site to characterize the hydrostratigraphy under the Site. The primary objective was to identify highly weathered and/or fractured zones that may affect the local hydrologic system and distinct lithologic units that may be used to correlate water-bearing zones between nearby wells.

In order to meet this objective, geophysical measurements were obtained using three different downhole tools. The down hole tools included a caliper tool, sonic tool and a combination tool (Hydro Tool). These instruments provide information concerning the acoustic, electrical, radioelement, and temperature characteristics of the formations and/or borehole fluids, as well as borehole size deviations.

B.1.1 METHODOLOGY

A Compulog II, borehole geophysics unit by Century Geophysical Corporation was used to acquire downhole information for the intermediate and deep wells. The logs recorded with this system (Attachment B.1) include the caliper, gamma ray, spontaneous potential (SP), 16-inch normal, 64-inch normal, temperature, differential temperature, single point resistance, borehole fluid resistivity, sonic porosity, delta t and borehole compensated velocity. In addition, a 48-inch lateral curve was computed from the 16-inch normal and 64-inch normal responses. Three runs into the borehole were required at each well location to obtain all log information.

A prerequisite for recording electric logs is that the borehole must contain a conductive fluid such as formation water or drilling fluids. Normal, lateral, SP, and resistance devices require direct contact between the transmitter/receiver, fluid, and materials to be measured. Further, it is not possible to record accurate electric log data within metal casing materials due to their high conductivity. Section B.3 gives a brief description of the theory of each log.

As part of the depth specific sampling of HIA production wells HIA-2, HIA-9, and HIA-13, borehole logs were obtained by welenco, Inc. Those logs are provided in Attachment B.2. The tools used included temperature, fluid resistivity, caliper, spinner flow meter, neutron log, and natural gamma log.

B.2 RESULTS AND CONCLUSIONS

The interpretations provided on the geophysical logs, Attachment B1, are based upon the composite responses of all curves from each well. the primary logs that indicate the presence of a fracture or weathered zone include the caliper log, resistivity logs, and the temperature logs. Typically, these zones are characterized by abrupt variations in borehole size, decreased electrical resistivity, and variations in the fluid resisitivity gradient and temperature gradient. The gamma ray and SP instruments are lithologic indicators, and are sensitive to variations in shale and/or silt content in sediments or rocks. The acoustic logs indicate changes in lithologies and porosites based upon seismic velocity. When viewed with other logs they can identify bedding and fracture zones that are potentially water bearing.

The specific interpretation for each well is provided in graphical format on the attached logs. The following general conclusions are drawn from the data collected during this investigation:

- The caliper logs indicate that borehole diameter is generally more variable in the siltstone lithologies than the sandstone lithologies. This may be because the siltstones are more friable in nature and easily broken and dislodged during drilling.
- Most fractures observed on the caliper logs cover 1 to 2 feet of the borehole length, although some fracture zones are observed to b e up to 5 to 8 feet of borehole length.
- Generally, the acoustic logs indicate that the unit velocities are greater in sandstone units than in siltstone units.
- The predominate lithology at the site is siltstone. Thin layers (several feet thick) of siltstone and sandstone are commonly distributed cyclically throughout the wells. The cyclic nature of the beds are best displayed in the 16(N) and gamma logs. The 64(N) log defines the predominate lithology of thicker units.
- Wells ERM 7D, ERM 8D and ERM 9D are predominately sandstone.
- Sandstones at this site are characterized by having a normal resistivity [16(N) and 64(N)] of greater than 120 ohm-m and natural gamma readings of less than 90 cps. Siltstones at this site usually have a

resistivity of less than 120 ohm-m and natural gamma readings of more than 90 cps.

- Based on the natural gamma logs, the matrix of the sandstones contain a noticeable amount of clay mineralogies.

B.3 INSTRUMENT THEORY

B.3.1 Caliper Log

The caliper log measures variations in borehole size as a function of depth in the well. The log data enables (a) the detection of competent or fractured geologic units, (b) the location of washouts or tight zones, (c) the optimal placement of well screen, sand, and bentonite, and (d) the establishment of appropriate borehole correction factors to be applied to other well log curves. Further, when run in combination with other logs, the caliper log may be an indicator of lithologic makeup and degree of consolidation. The typical caliper response in a fractured, weathered, or karstic unit is a relatively abrupt increase in borehole size.

B.3.2 Spontaneous Potential (SP) Log

The SP log measures the natural voltages that are created within the borehole due to the presence of drilling muds, formation fluids, and formation matrix materials. It is recorded by measuring the difference in electrical potential in millivolts between an electrode in the borehole and a grounded electrode at the surface. The SP log is considered an excellent lithologic descriptor under normal borehole conditions, where the highest relative potentials are observed in fine grained clays and shales, and the lowest readings are found in coarser grained sandstones or limestones. The constant SP readings observed in thicker clay units define the shale base line, a reference line from which further formation matrix and formation fluid property calculations may be completed.

The SP log enables the direct detection of bed boundaries due to the fact that the greatest potential drop occurs directly adjacent to the bed interface. Theoretically, the bed boundary is located at the inflection point of the SP curve, or that point where the SP curve exhibits maximum curvature. Further, it is possible to estimate the shale content of a particular formation, and the approximation of formation water resistivities which are directly related to the concentration of conductive ions (salts or metals) within the water matrix.

The SP log deflection is dependent upon the relative resistivity (or salinity) values of the borehole fluid and the formation fluid. If the

formation fluid resistivity is less than the borehole fluid resistivity, then the relative SP values will decrease in a porous, coarse-grained unit. Alternately, if the formation fluid resistivity is greater than the borehole fluid resistivity, the relative SP values will increase in the same body, and the curve shape is referred to as a "reversed SP". If both fluid resistivities are equal, no SP deflection will occur.

A number of factors affect the shape and amplitude of the SP curve. These include bed thickness, bed resistivity, borehole diameter, fluid invasion from the borehole, and the magnitude of the fines content. Generally, the SP amplitude will decrease in the presence of thin, resistive beds, and in instances where the borehole diameter is large and the amount of fluid invasion is high.

B.3.3 *Natural Gamma Ray Log*

The natural gamma ray log is a passive instrument that measures the amount of naturally occurring radioactivity from geologic units within the borehole. Commonly occurring radio-elements include potassium, thorium, and uranium; the two former elements are predominant within a common fine-grained rock sequence. The gamma ray instrument is also an excellent lithologic indicator because fine-grained clays and shales contain a higher radioelement concentration than limestones or sands. Gamma ray values are often used to assess the percentage of clay materials (indurated or non-indurated) that are present within a formation by utilizing empirically derived equations and sand-shale base line information.

Several factors affect the response of the gamma ray measurement. The type of detector is important because each is different in the amount of radiation that is measured. Generally, the larger the detector and the higher the count efficiency, the greater the precision of the gamma ray log output. The Compulog system utilizes a scintillation detector which is extremely efficient in a borehole environment, and is the standard for borehole geophysical work.

The logging speed and time constant are important parameters which determine how much radiation is measured, and the degree to which the recorded gamma ray curve is statistically smoothed. As the logging speed increases, the amount of gamma rays measured per foot of well decreases, and the final curve is smoother than the curve obtained at a slower logging speed. A larger time constant, or effective sampling rate has the same effect.

Normal borehole size variations do not affect the gamma ray response appreciably, however considerable deviations (large washouts) may cause a slight decrease in the gamma ray amplitude.

The presence of steel casing reduces the amount of gamma ray radioactivity by approximately 30 percent depending upon casing makeup and thickness. Valuable information can be obtained in casing however, and the amplitude decrease is an important consideration when evaluating the log.

The presence of grout or cement will affect the gamma ray response because these materials are often composed of clay, which is radioactive in its own right. Unless the gamma ray response can be directly correlated to a known clay content within the grout or cement, it is difficult to determine a corrected response.

Thin beds tend to exhibit a lower gamma ray response due to the averaging effect of the detector. The radioactivity count contributions (positive or negative) from adjacent formations do not allow the gamma ray curve to reach a full scale deflection within the thin bed. This is similar to SP and resistivity responses in a thin bed situation.

Finally, the measurement of gamma ray emissions from a formation is a random process, thereby subjecting the readings to natural statistical variations. The overall appearance of the gamma ray log is similar, however small scale variations in the number of counts are noticeable.

B.3.4 *16-Inch and 64-Inch Normal Logs*

The normal logs are generated by non-focused current resistivity instrumentation within the well bore. The ultimate objective of these measurements is to determine the true resistivity of the formation (matrix and fluids). The normal electrode configuration assumes a point source of current from which the voltage drop is measured by a potential electrode in the well. A second current and potential electrode are positioned at a large distance (ground surface) from the downhole electrodes to complete the circuit. The distance between the downhole current electrode and the downhole voltage electrode is either 16 inches or 64 inches. The volume of material measured is approximately two times the electrode separation; 32 inches and 128 inches, respectively. The calculation of resistivity is determined by applying Ohm's Law and known electrode separations.

Since the 64-inch normal utilizes a greater electrode separation, the instrument will measure more deeply into the formation and obtain resistivity values that closely approximate the true formation resistivity. Conversely, the 16-inch normal device will record resistivities that are found in a zone that is at least partially invaded by borehole fluids. In the case where borehole mud pressures are greater than formation water pressures, a comparison of these curves gives an indication of the depth of invasion of borehole fluids and formation permeability. If formation pressures are greater, the true resistivity values are easier to attain due to the lack of influence of the borehole fluids.

Several important factors affect the normal resistivity responses in a borehole environment, that include borehole size, bed thickness, fluid invasion characteristics, and resistivities of the surrounding beds.

The normal curves cannot be used to determine formation resistivity if (a) the borehole fluid is nonconductive, (b) the borehole is cased, and (c) the bed thickness is equal to or less than the electrode spacing. Water-bearing zones are typically characterized by lower resistivities due to the conductive nature of water.

B.3.5 *48-Inch Lateral*

The 48-inch lateral information is computed form the 16-inch normal and 64-inch normal readings. The curve is generated through the relation, L48 = (N16*4 - N64)/3, where L48 is the 48-inch lateral value, N16 is the measured 16-inch normal resistivity reading, and N64 is the 64-inch normal resistivity reading.

B.3.6 *Temperature Logs*

Temperature logs measure the change in fluid temperature within the borehole as a function of depth. The utility of this log is that it can provide information on the location of water-bearing strata or fracture zones within the well. The inherent assumptions of this technique are that the fluids entering the borehole from the water zones are either cooler or warmer than the mud fluids used for drilling purposes. In this case, it is possible to relate a temperature anomaly to a depth range in which waters of different temperature are emanating from a water-bearing or fractured lithologic unit.

Differential temperature values are computed and presented on the same plot due to their greater sensitivity and improved visual clarity.

Temperature anomalies are more easily recognized because differences of only a few degrees translate to large scale deflections of the differential temperature curve.

Correlation of the temperature and differential temperature curves with other logs such as the caliper log or resistivity logs will act to confirm or deny suspected formation characteristics.

B.3.7 *Sonic or Acoustic-Velocity Logs*

Sonic logs measure the transit time of elastic waves over a short distance. The velocity that an elastic wave travels as a function of the lithology, density and porosity of the geologic medium. The acoustic logging tool consists of an elastic wave transmitter and two receivers. The instrument measures the time it takes for the sound pulse to travel to each of the receivers. The measurement unit is referred to as "Delta T" or DT and is measured in microseconds/foot. Usually, higher DT values indicate that the sound wave is traveling slower, and this implies this is a less dense formation. This could indicate an increase in formation porosity or a change in lithology. In some instances, fractures and/or vuggy porosity can be determined.

Sonic logs can be used to estimate formation porosity, identify lithologic changes and locate fractures. Fractures are commonly identified as an abrupt delta T high caused by the lower velocity that the sound wave travels through the infilling medium (usually fluid or weathered formation material).

Attachment B.1
ERM Geophysical Logs for Intermediate and Deep Wells:
ERM-7I
ERM-7D
ERM-8D
ERM-9D
ERM-21I
ERM-21D
ERM-22I
ERM-22D
ERM-23I
ERM-23D
ERM-24I
ERM-24D
ERM-25I
ERM-25D
ERM-26I
ERM-26D

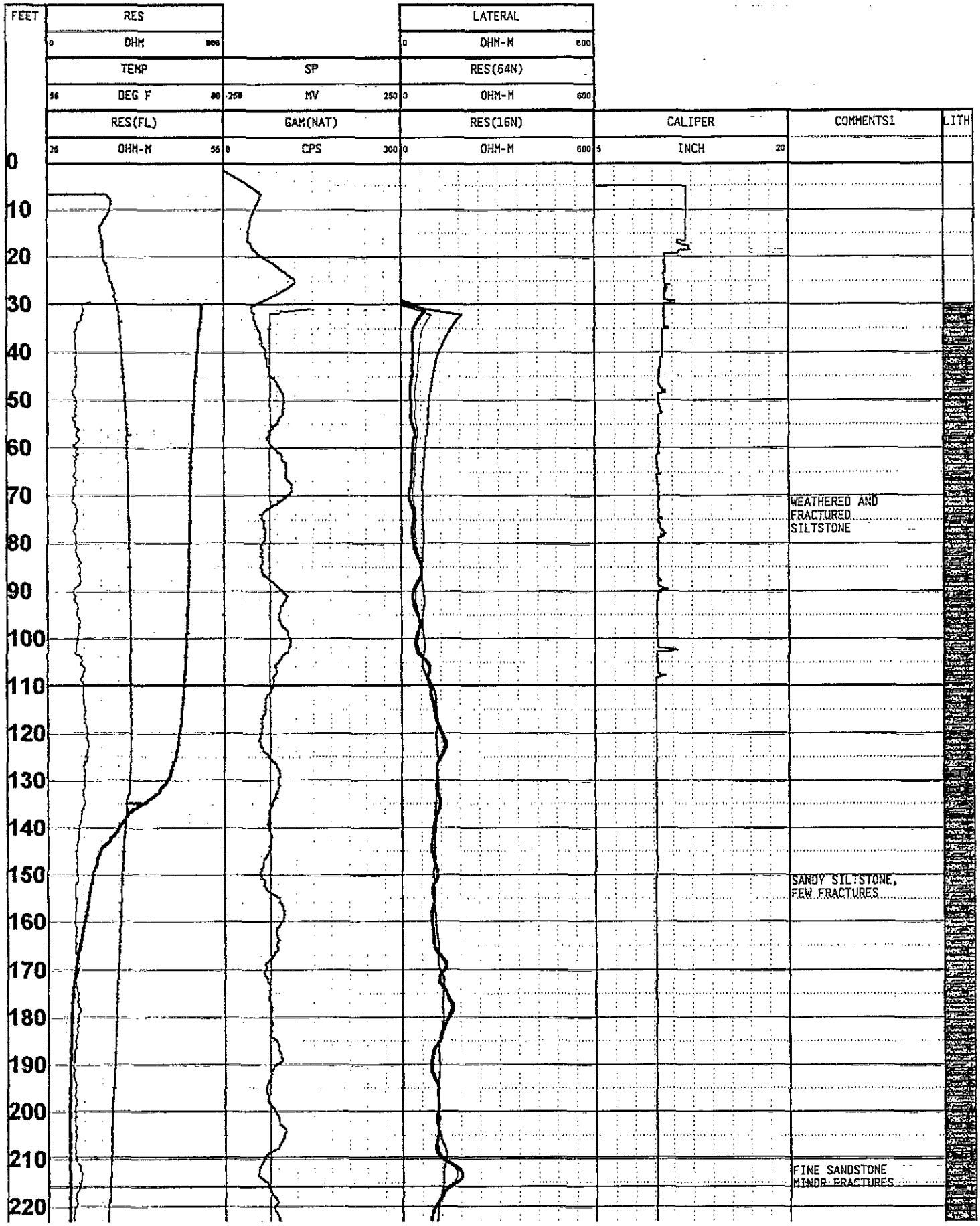
Environmental Resources Management, Inc.

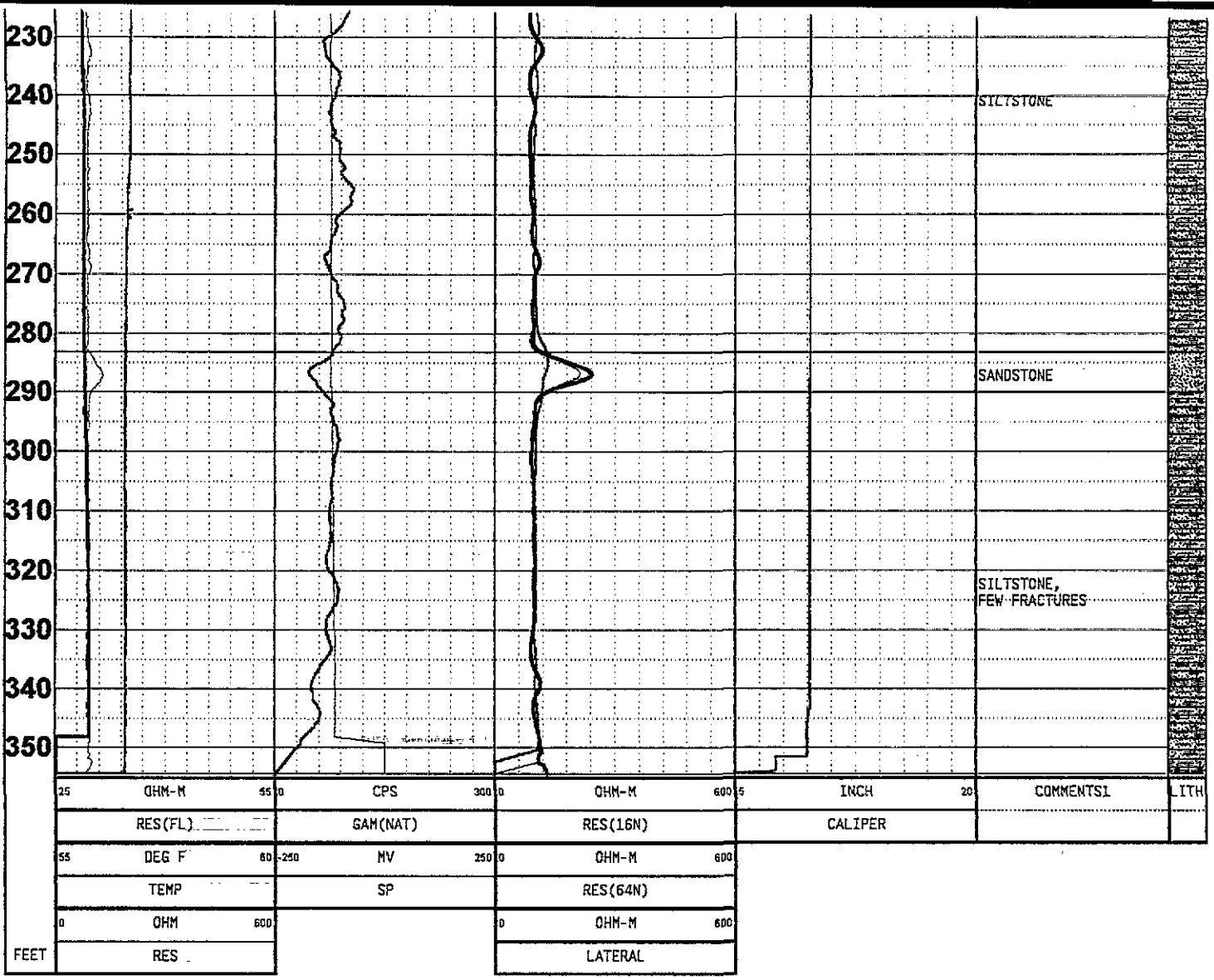
Geophysical Services

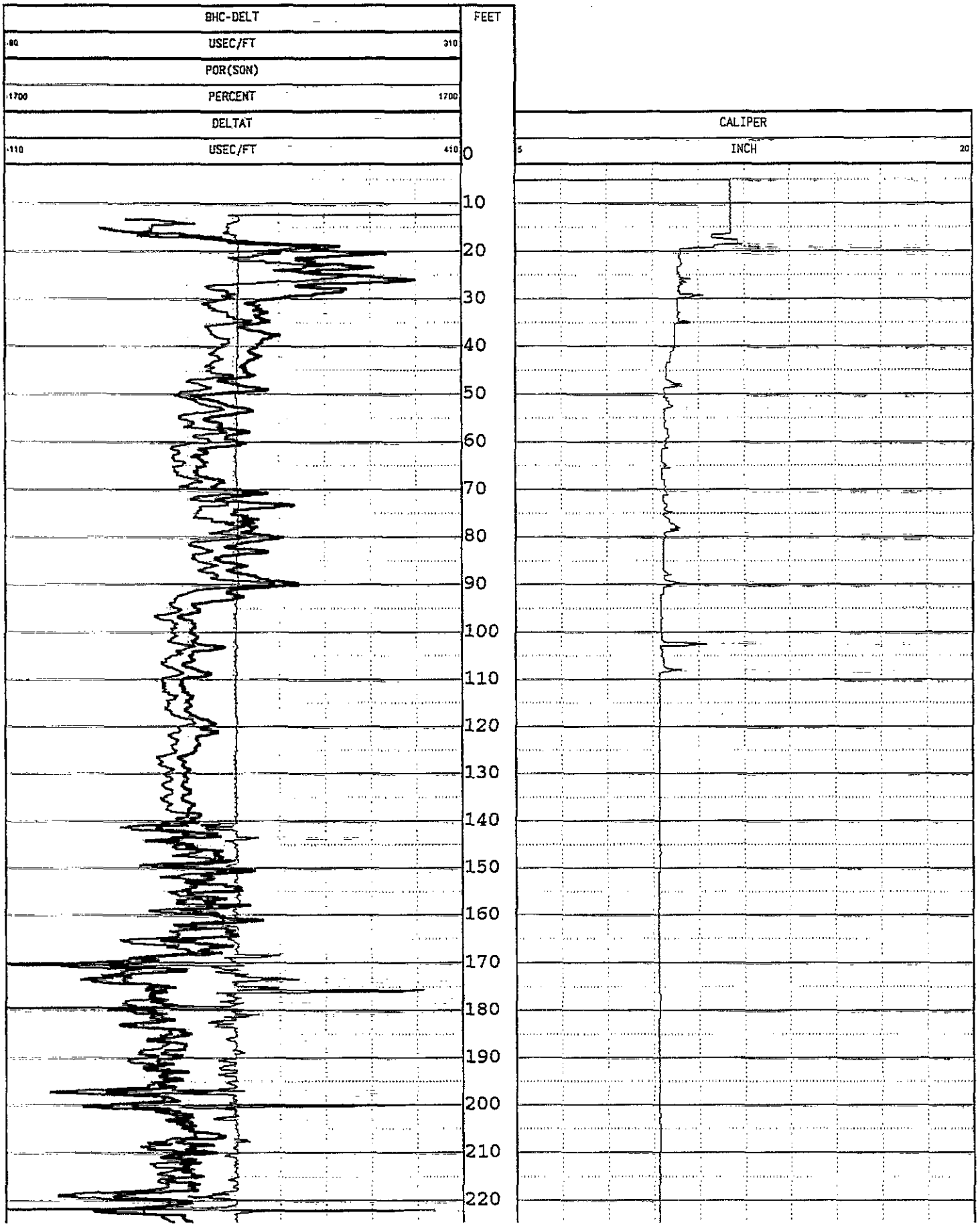
ERM

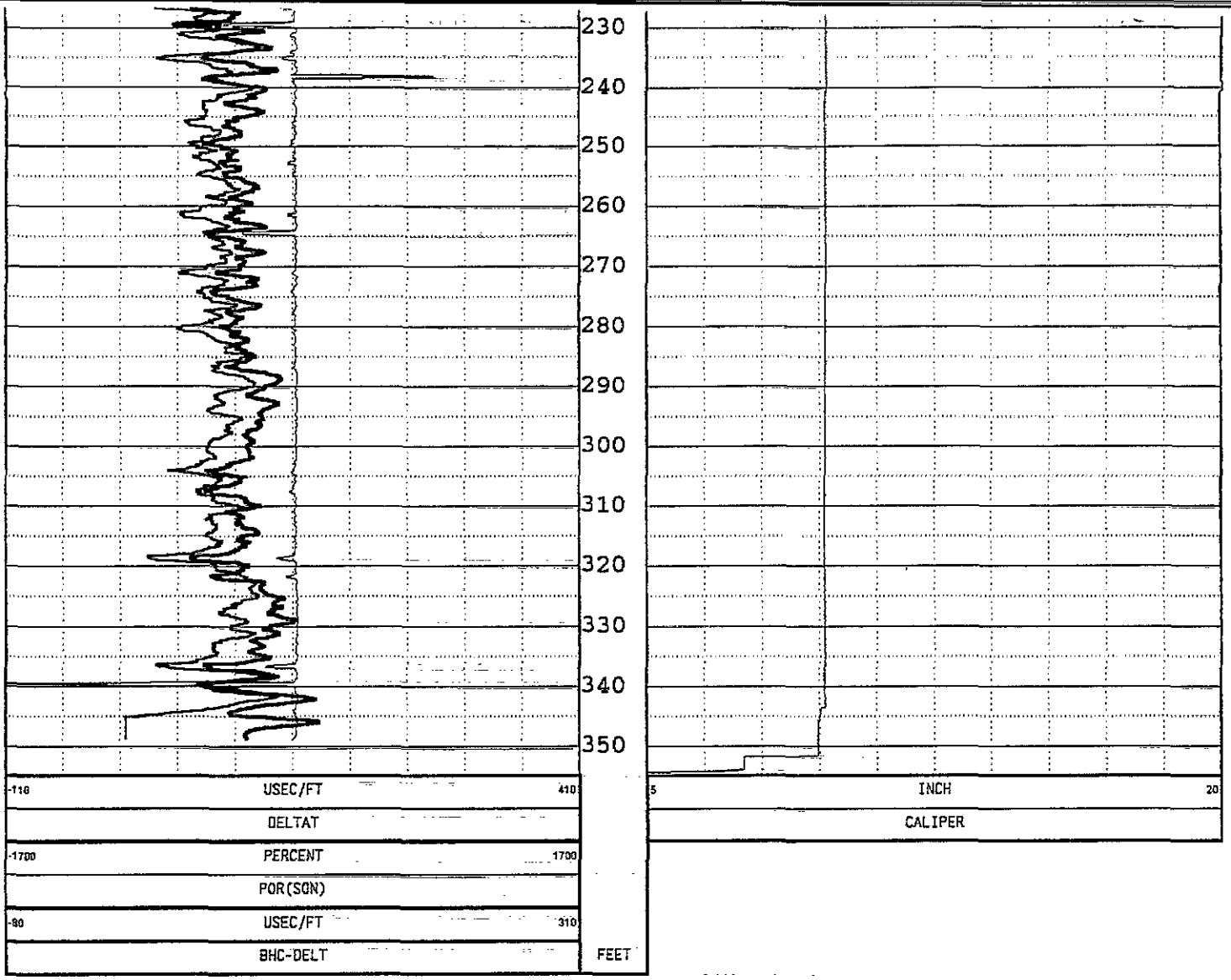
Borehole Geophysical Log

CLIENT	:	Middletown
WELL	:	ERM-7I
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	350
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-7I
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok


FEET
RES
0 OHM 500
TEMP
56 DEG F 80
RES(FL)
26 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
WEATHERED AND FRACTURED SILTSTONE
SANDY SILTSTONE, FEW FRACTURES
FINE SANDSTONE MINOR FRACTURES


230
240
250
260
270
280
290
300
310
320
330
340
350
SILTSTONE
SANDSTONE
SILTSTONE,
FEW FRACTURES
25 OHM-M 55
RES(FL)
55 DEG F 60
TEMP
0 OHM 600
RES
0 CPS 300
GAM(NAT)
-250 MV 250
SP
0 OHM-M 600
RES(16N)
0 OHM-M 600
RES(64N)
0 OHM-M 600
LATERAL
5 INCH 20
CALIPER
COMMENTS1
LITH
FEET


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-90
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

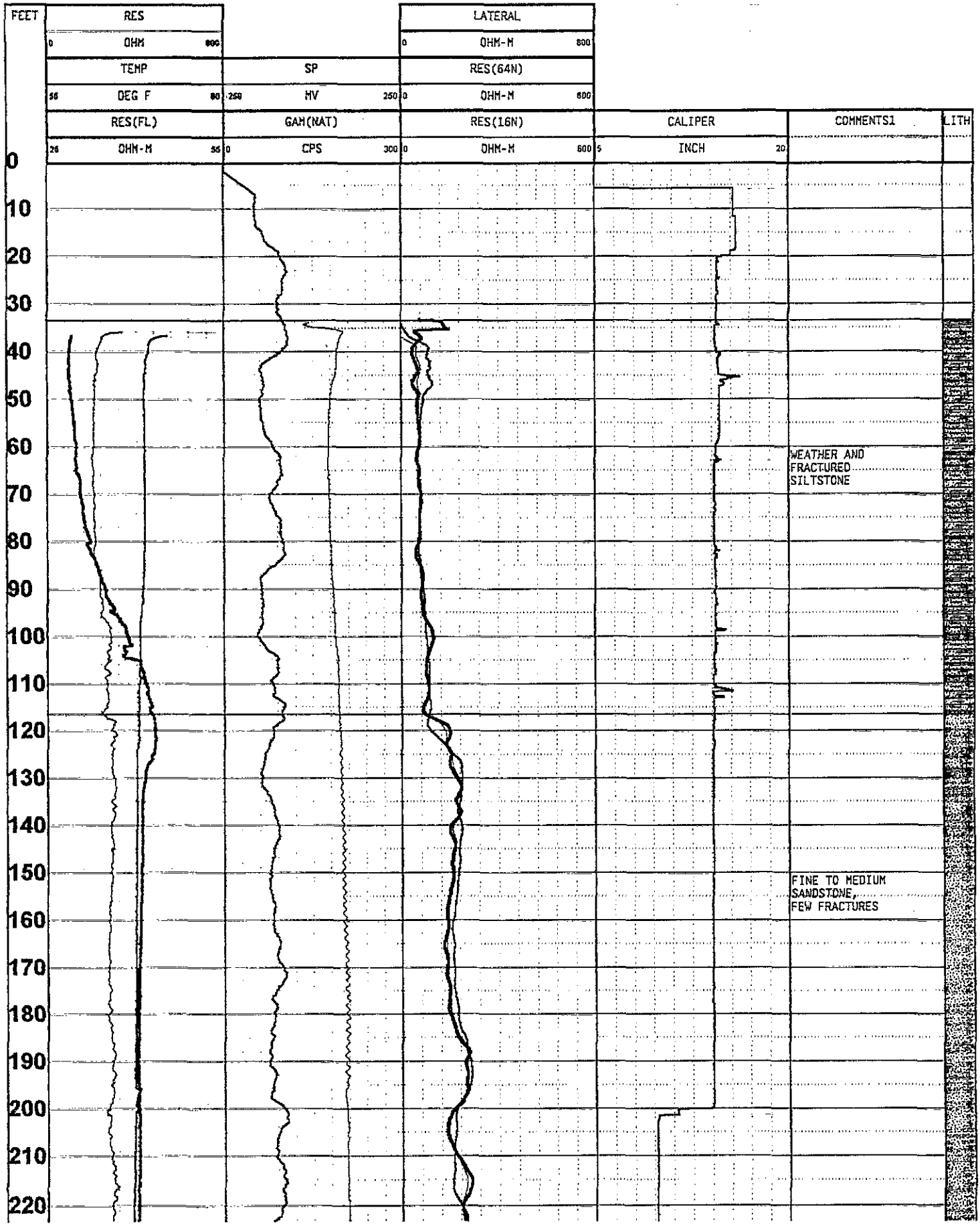
Environmental Resources Management, Inc.

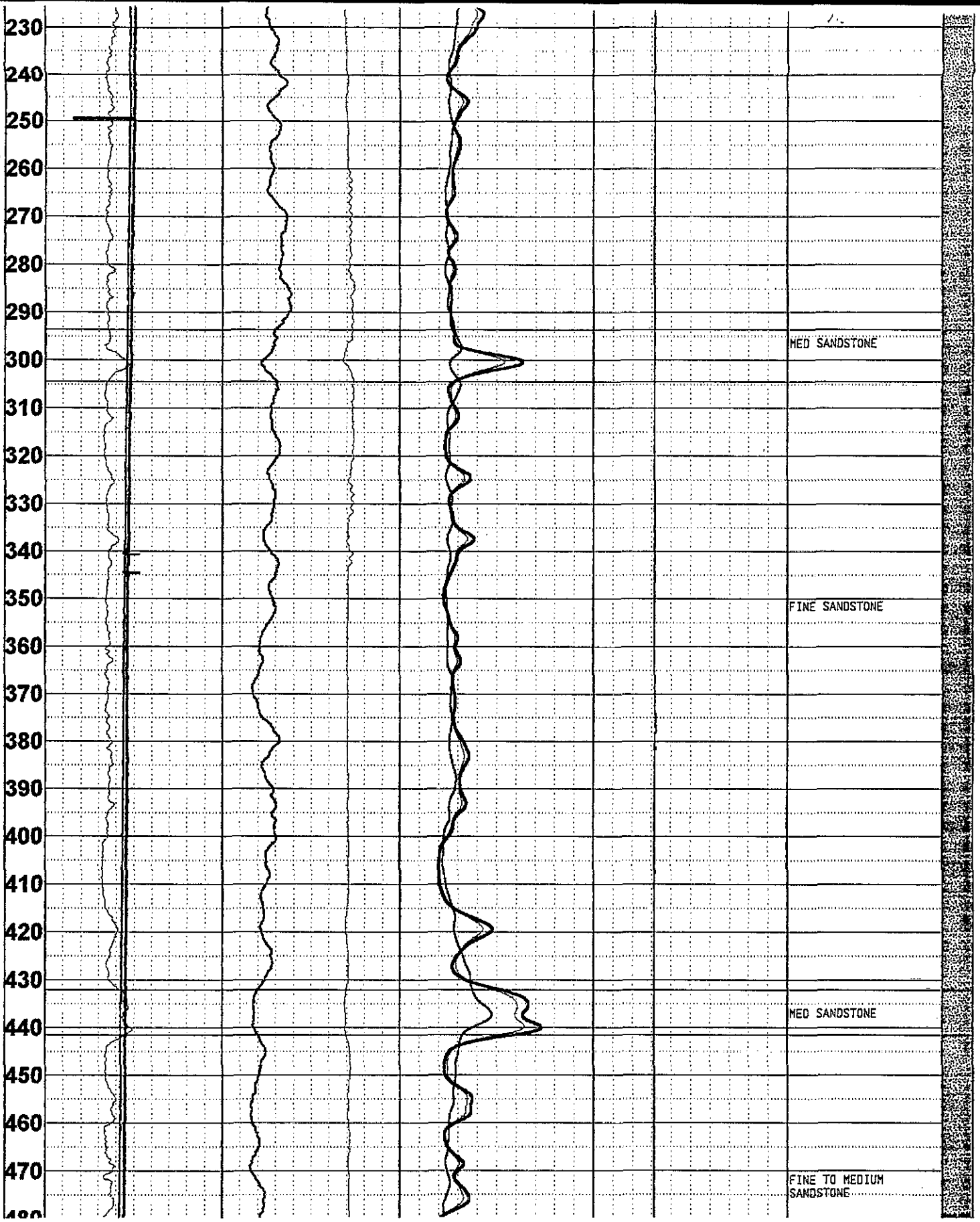
Geophysical Services

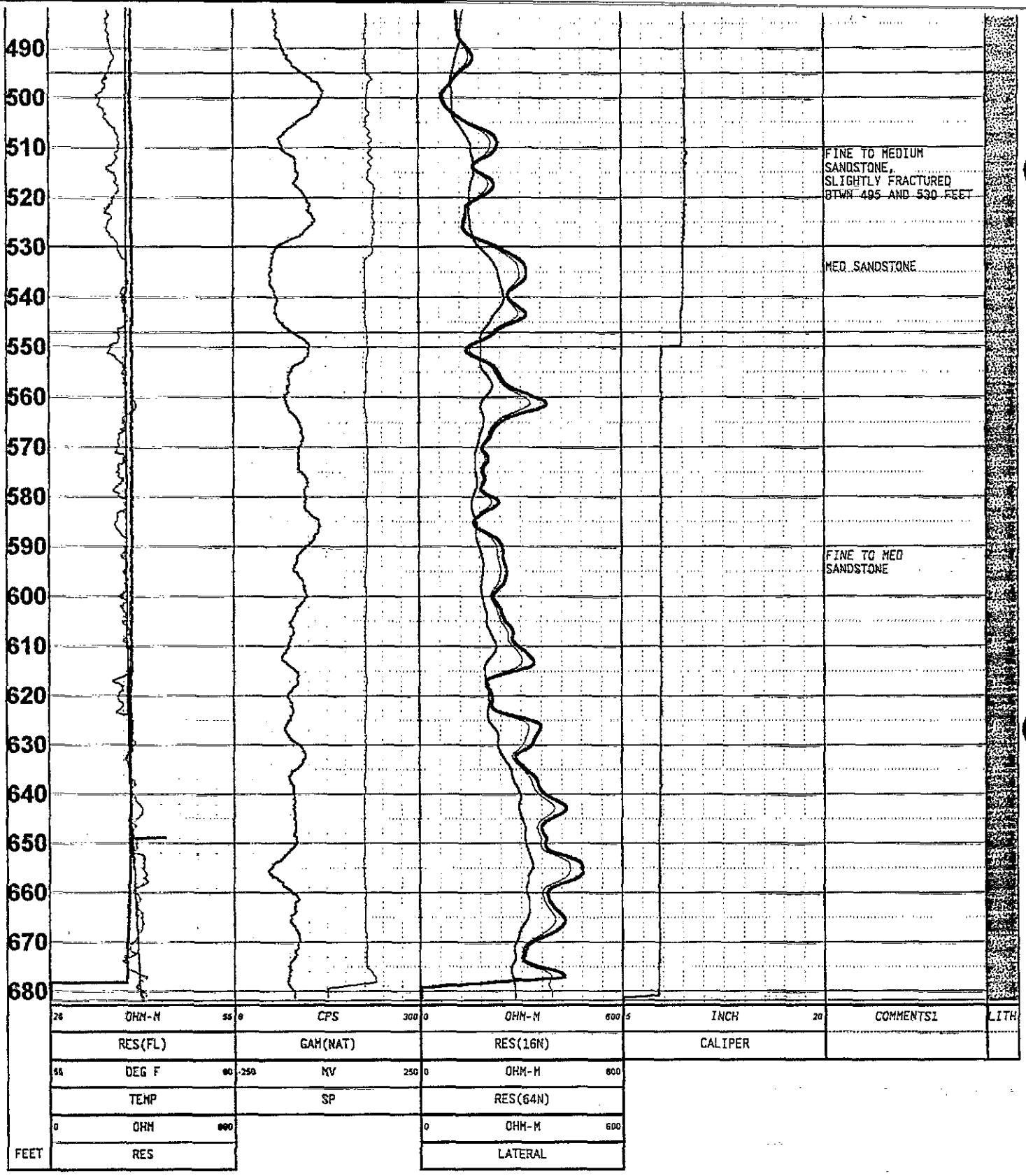
ERM

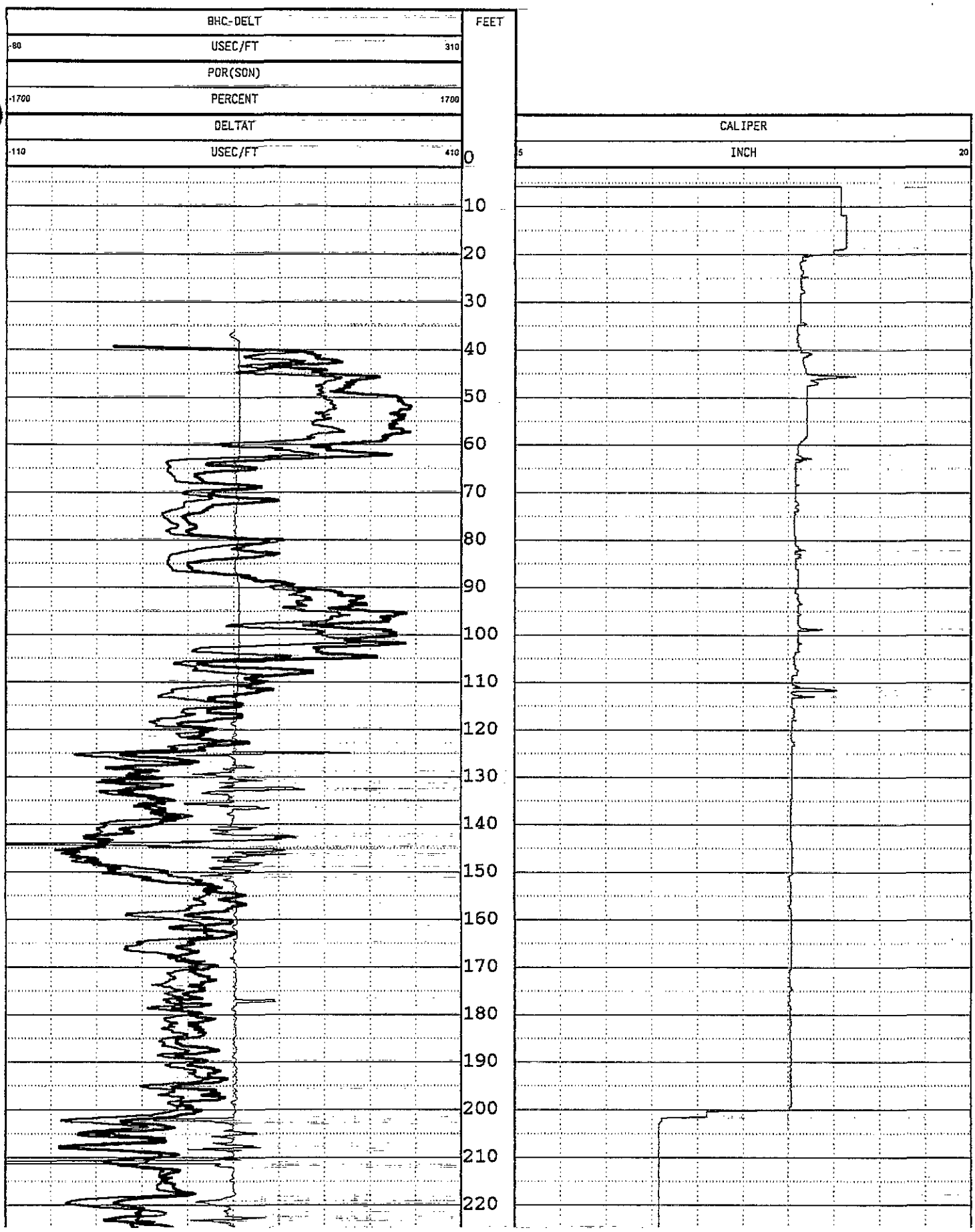
Borehole Geophysical Log

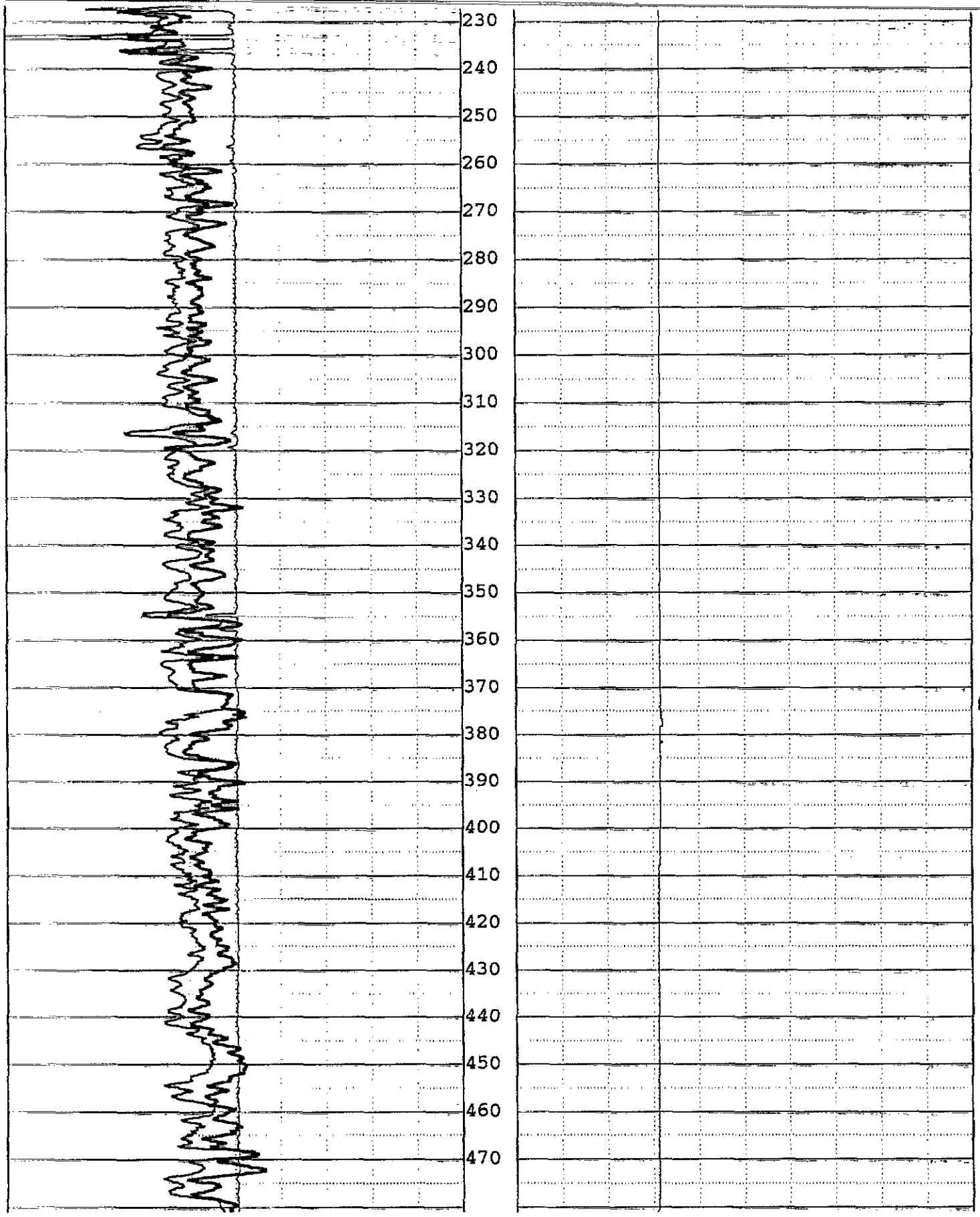
CLIENT	:	**Middletown**
WELL	:	**ERM-7D**
LOCATION/FIELD	:	
CITY	:	**Middletown**
STATE	:	**Pa.**
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	**680**
LOG TOP	:	**0**
ELEV. PERM. DATUM	:	
FILE NAME	:	**c:\acl\logs\mdtn\erm-7D**
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	**George Pfeiffer**
INTERPRETED BY	:	**Don Jagel**
COMMENTS	:	**HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok**

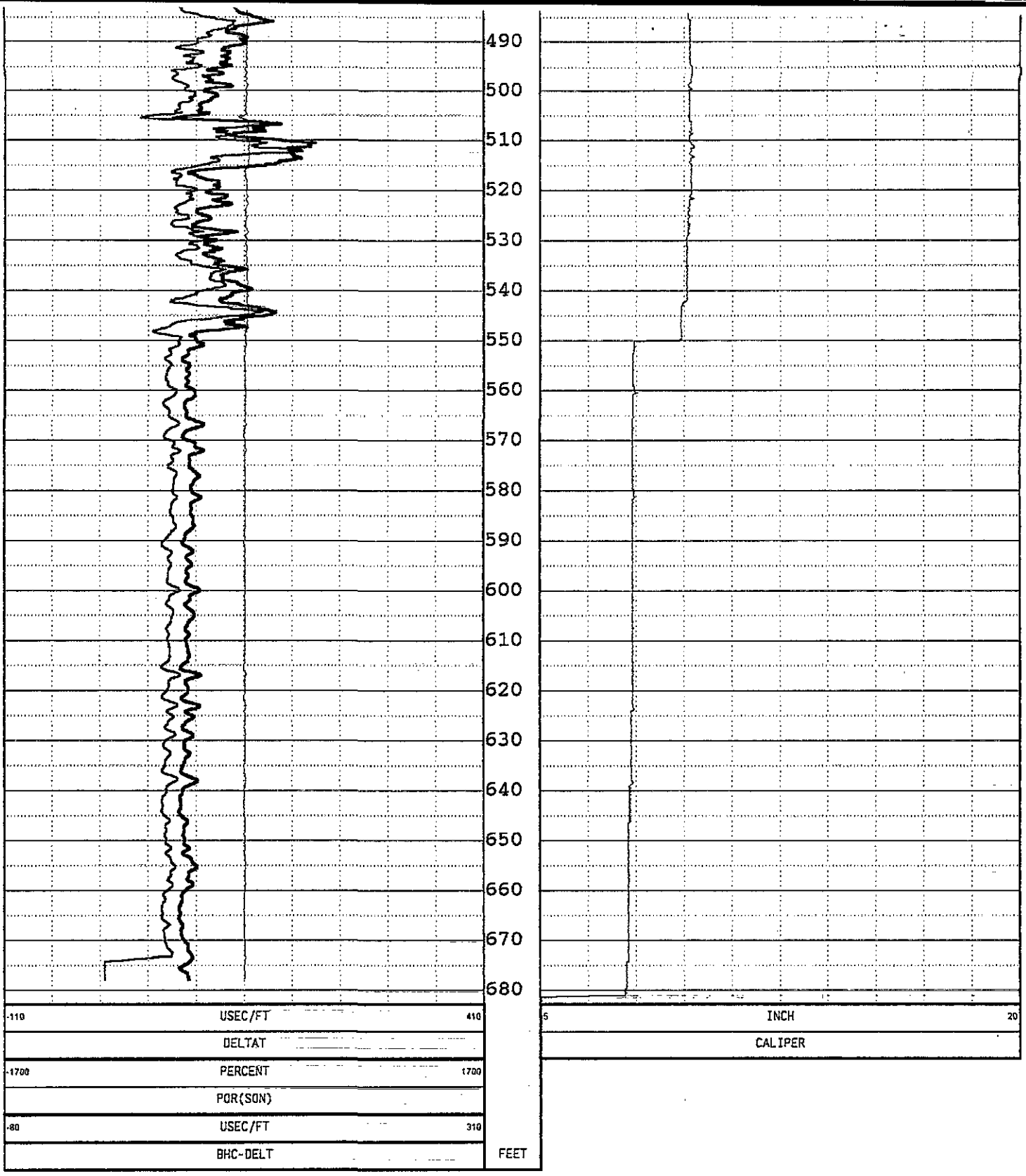

FEET
RES
0 OHM 800
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
WEATHER AND FRACTURED SILTSTONE
FINE TO MEDIUM SANDSTONE, FEW FRACTURES


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
MED SANDSTONE
FINE SANDSTONE
MED SANDSTONE
FINE TO MEDIUM SANDSTONE


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
FINE TO MEDIUM SANDSTONE, SLIGHTLY FRACTURED BTWN 495 AND 530 FEET
MED SANDSTONE
FINE TO MED SANDSTONE
26 OHM-M 55
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 90
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 800
RES
0 OHM-M 600
LATERAL
FEET


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

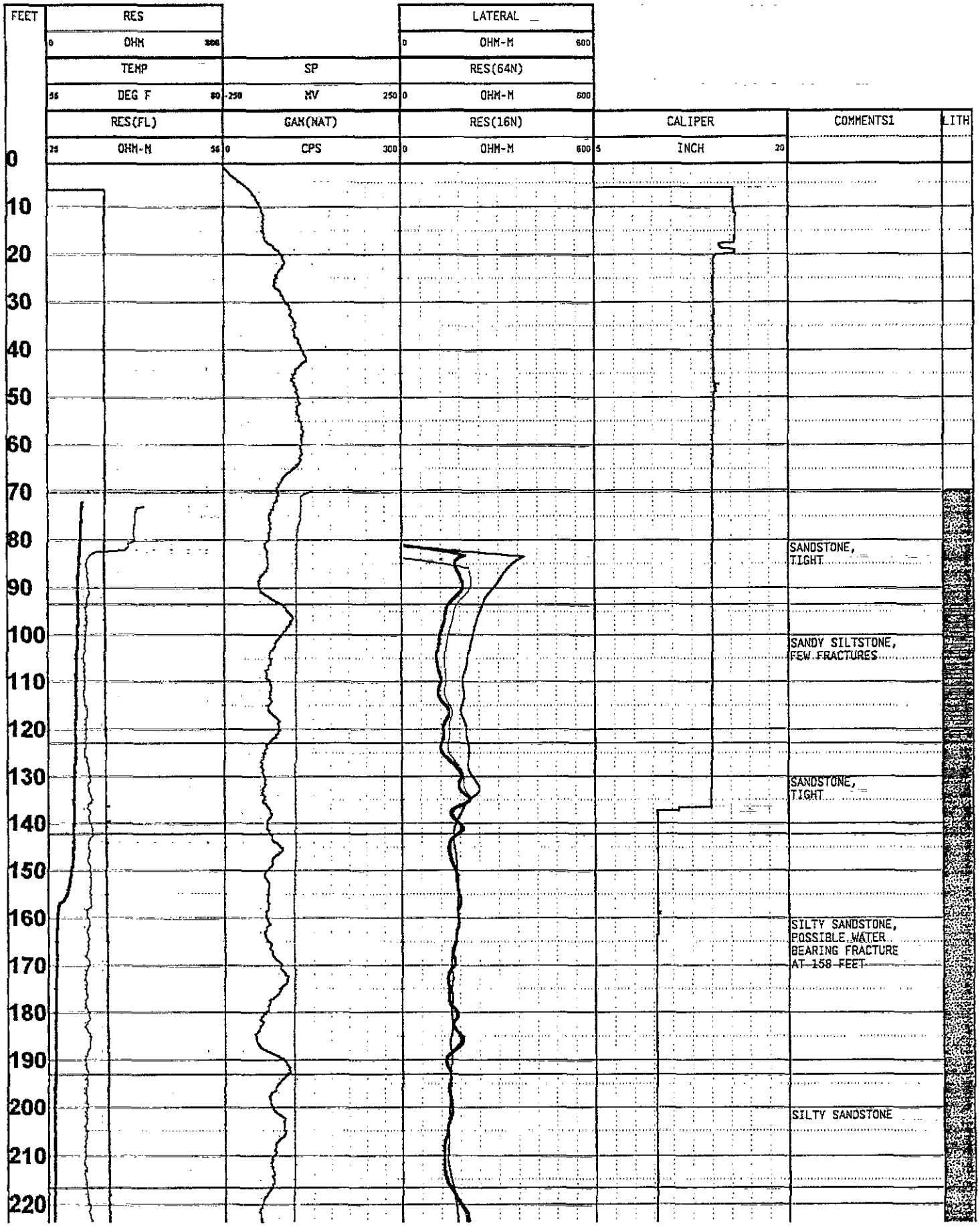
Environmental Resources Management, Inc.

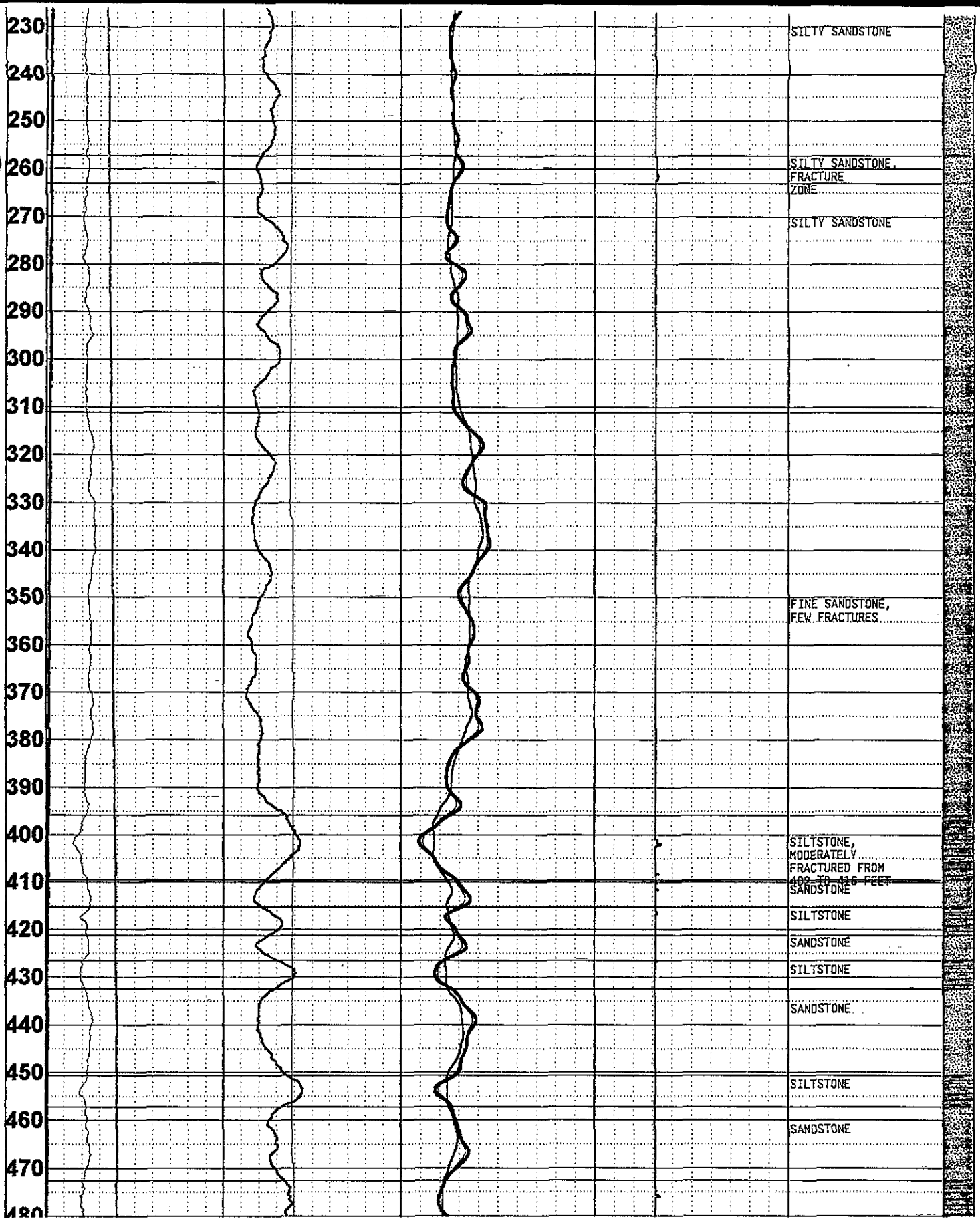
Geophysical Services

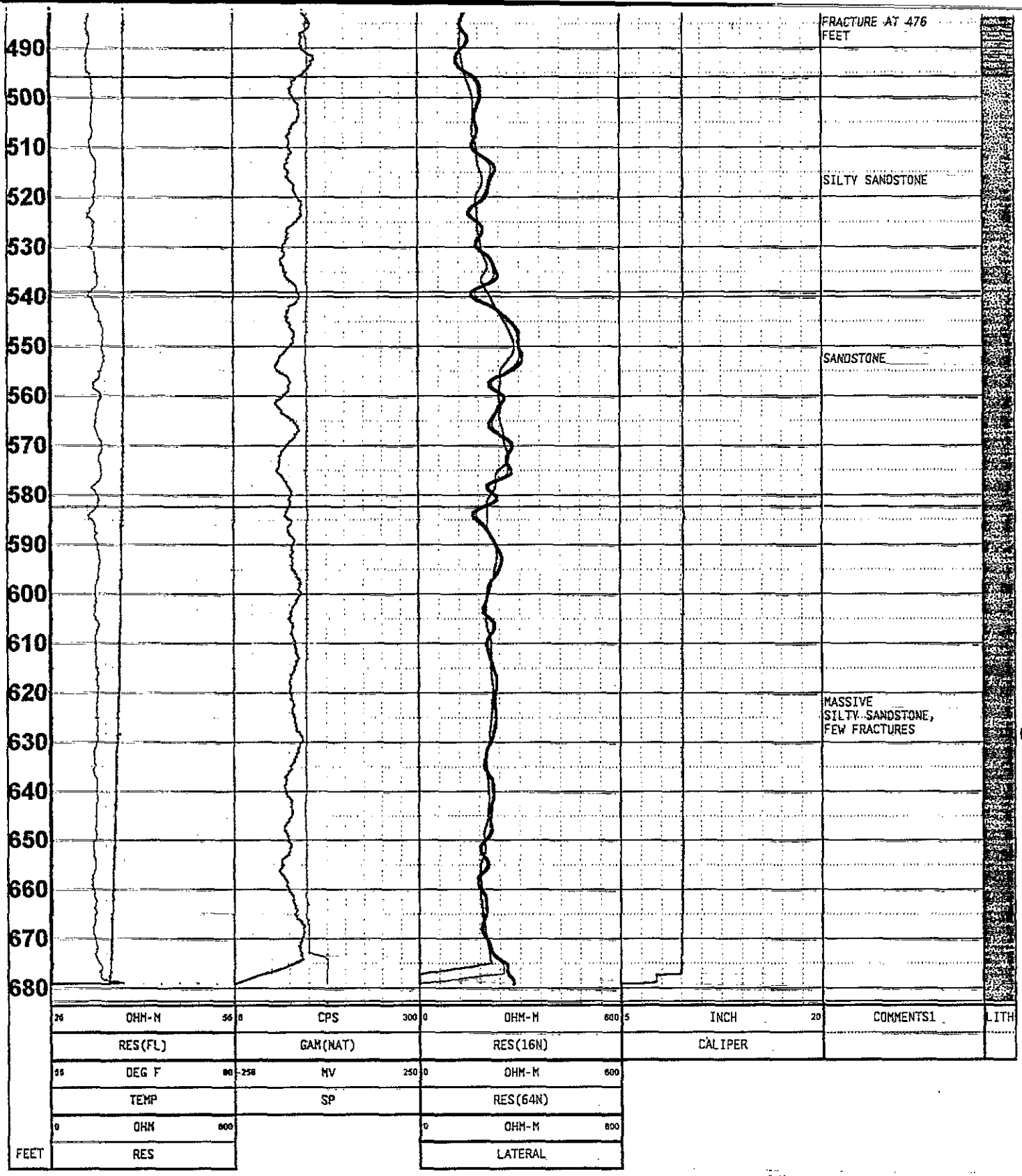
ERM

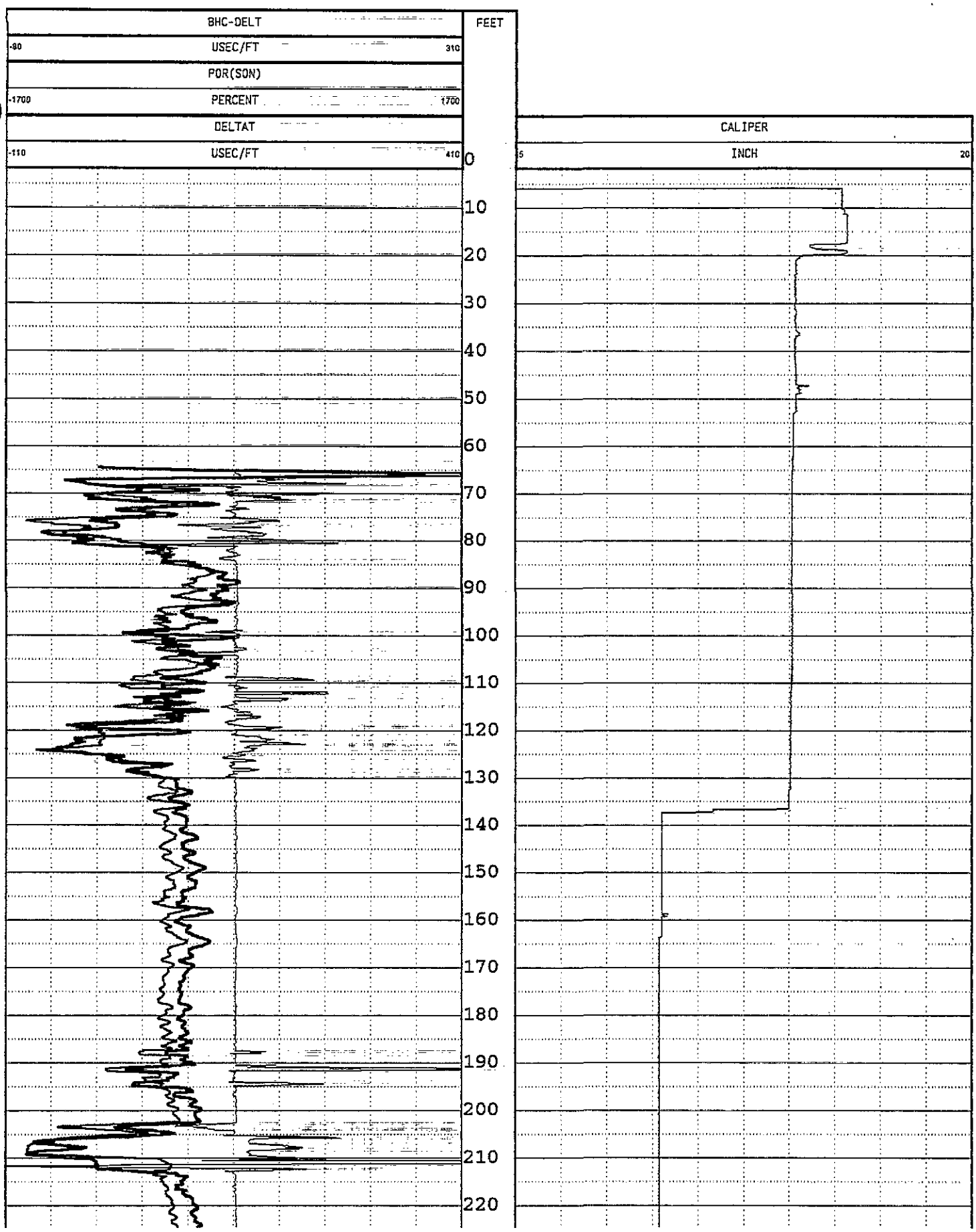
Borehole Geophysical Log

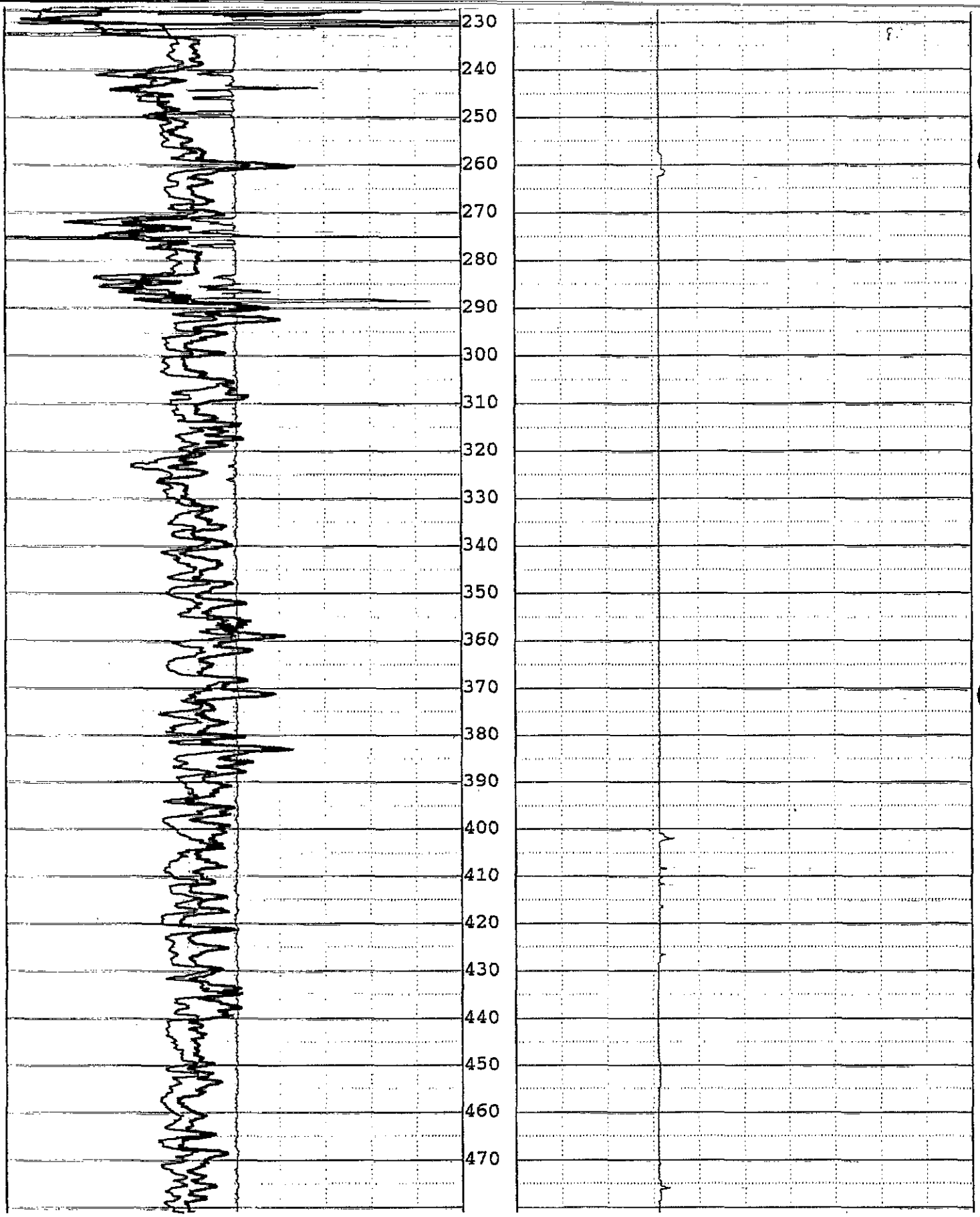
CLIENT	:	Middletown
WELL	:	ERM-8D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	680
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-8D
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok

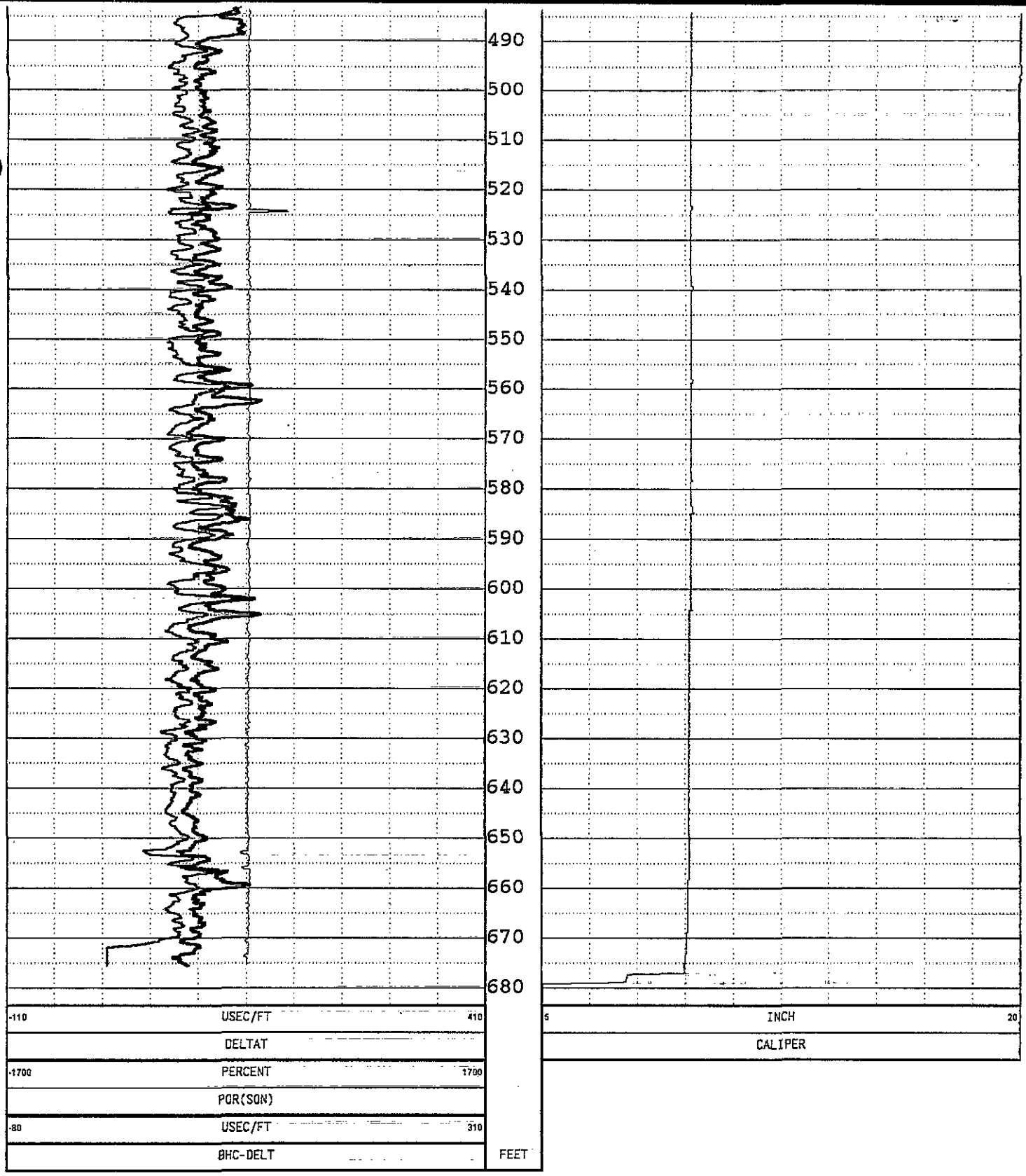

FEET
RES
0 OHM 300
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
SANDSTONE, TIGHT
SANDY SILTSTONE, FEW FRACTURES
SANDSTONE, TIGHT
SILTY SANDSTONE, POSSIBLE WATER BEARING FRACTURE AT 158 FEET
SILTY SANDSTONE


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
SILTY SANDSTONE
SILTY SANDSTONE, FRACTURE ZONE
SILTY SANDSTONE
FINE SANDSTONE, FEW FRACTURES
SILTSTONE, MODERATELY FRACTURED FROM 402 TO 416 FEET
SANDSTONE
SILTSTONE
SANDSTONE
SILTSTONE
SANDSTONE
SILTSTONE
SANDSTONE


FRACTURE AT 476 FEET
SILTY SANDSTONE
SANDSTONE
MASSIVE SILTY SANDSTONE, FEW FRACTURES
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
FEET
26 OHM-M 56
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 80
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 600
RES
0 OHM-M 600
LATERAL


BHC-DELT
-90
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
PGR(SGN)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

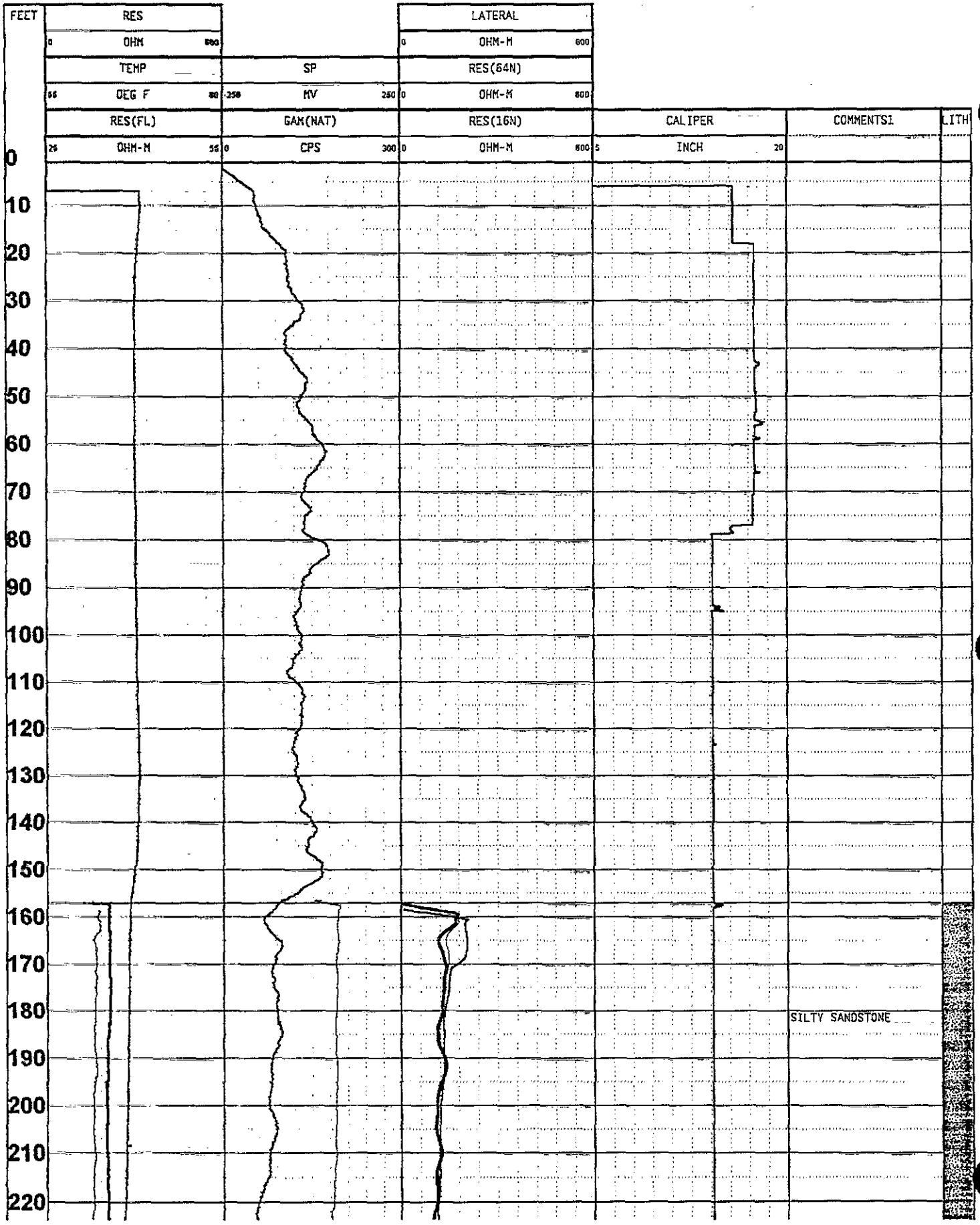
Environmental Resources Management, Inc.

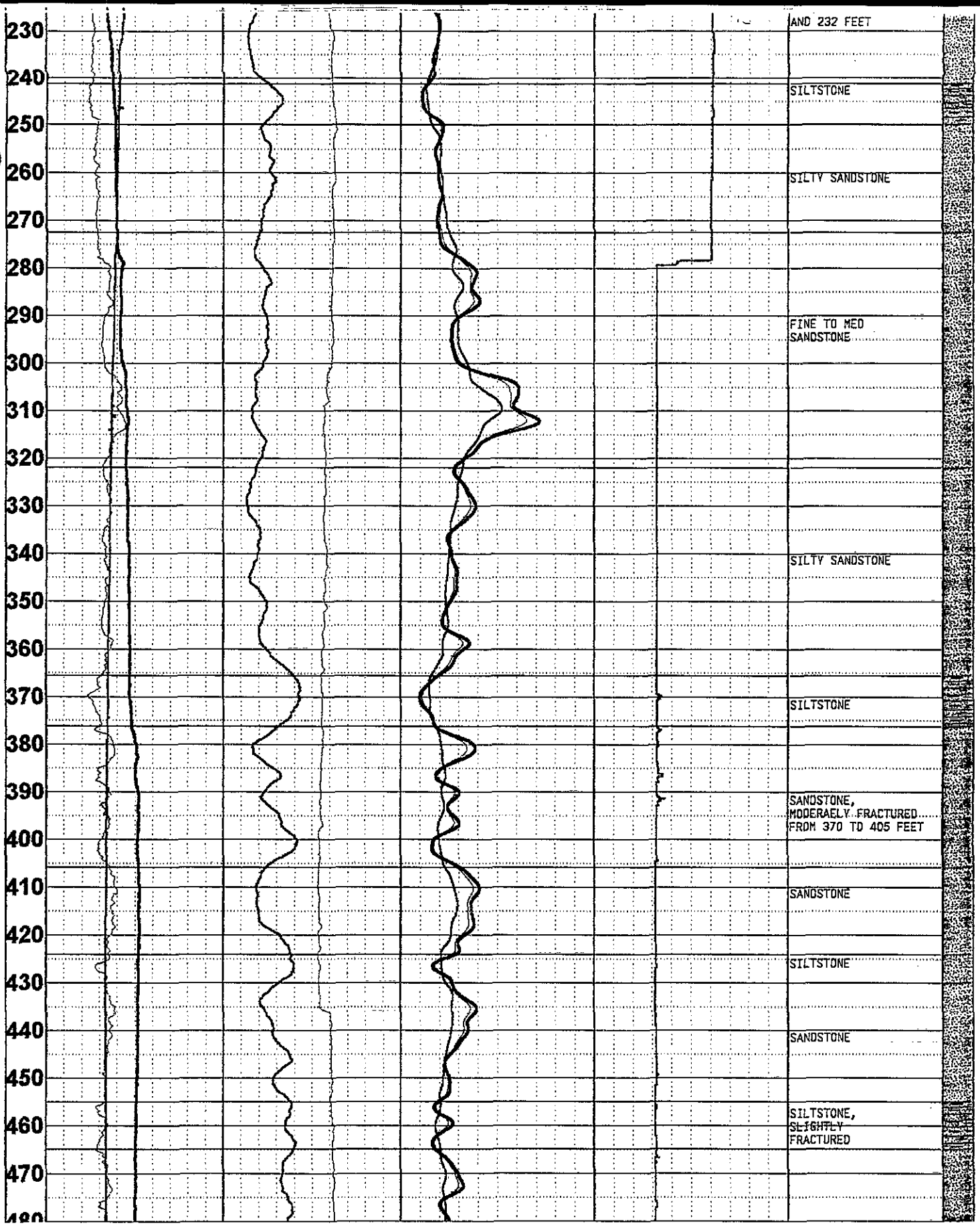
Geophysical Services

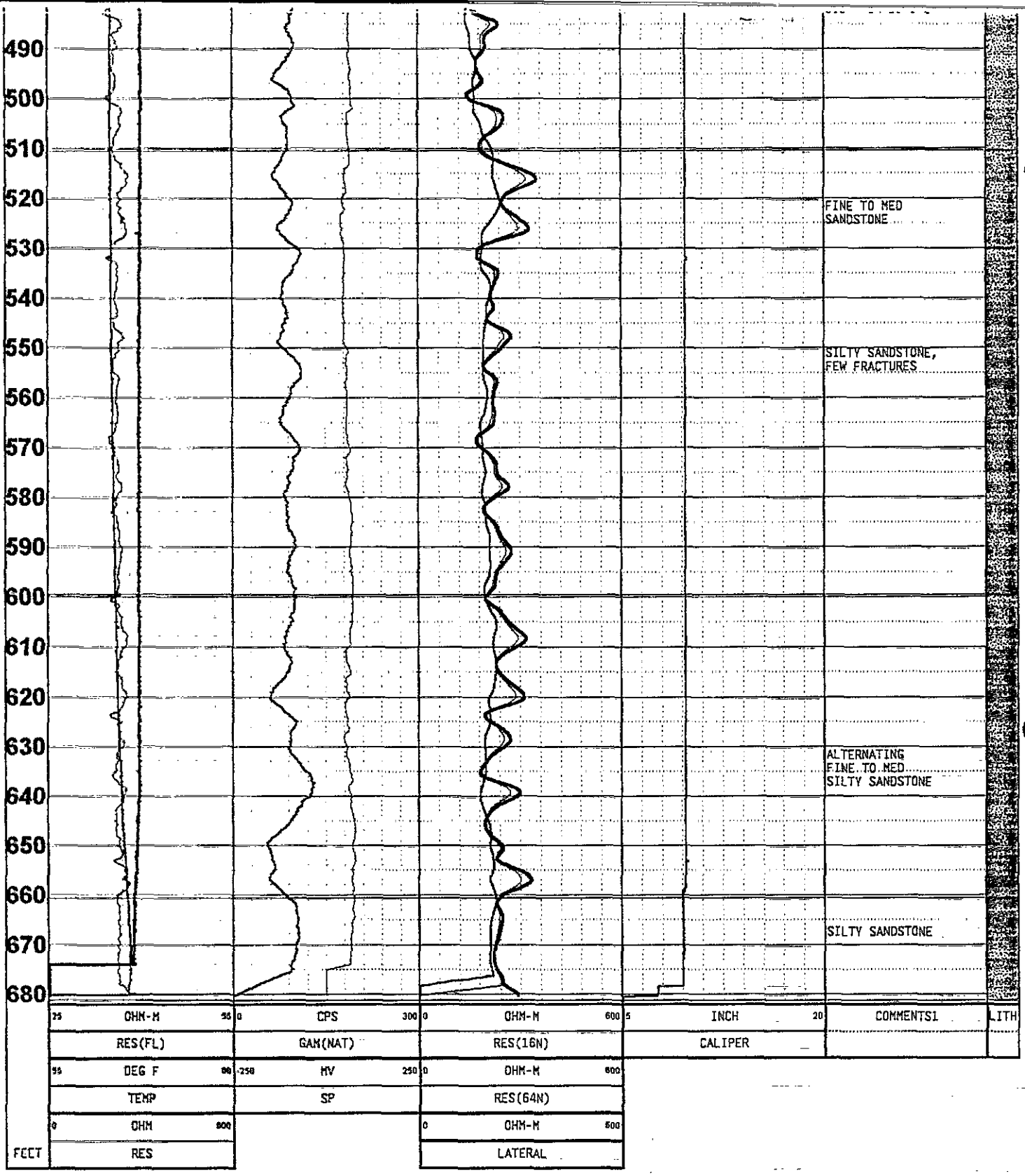
ERM

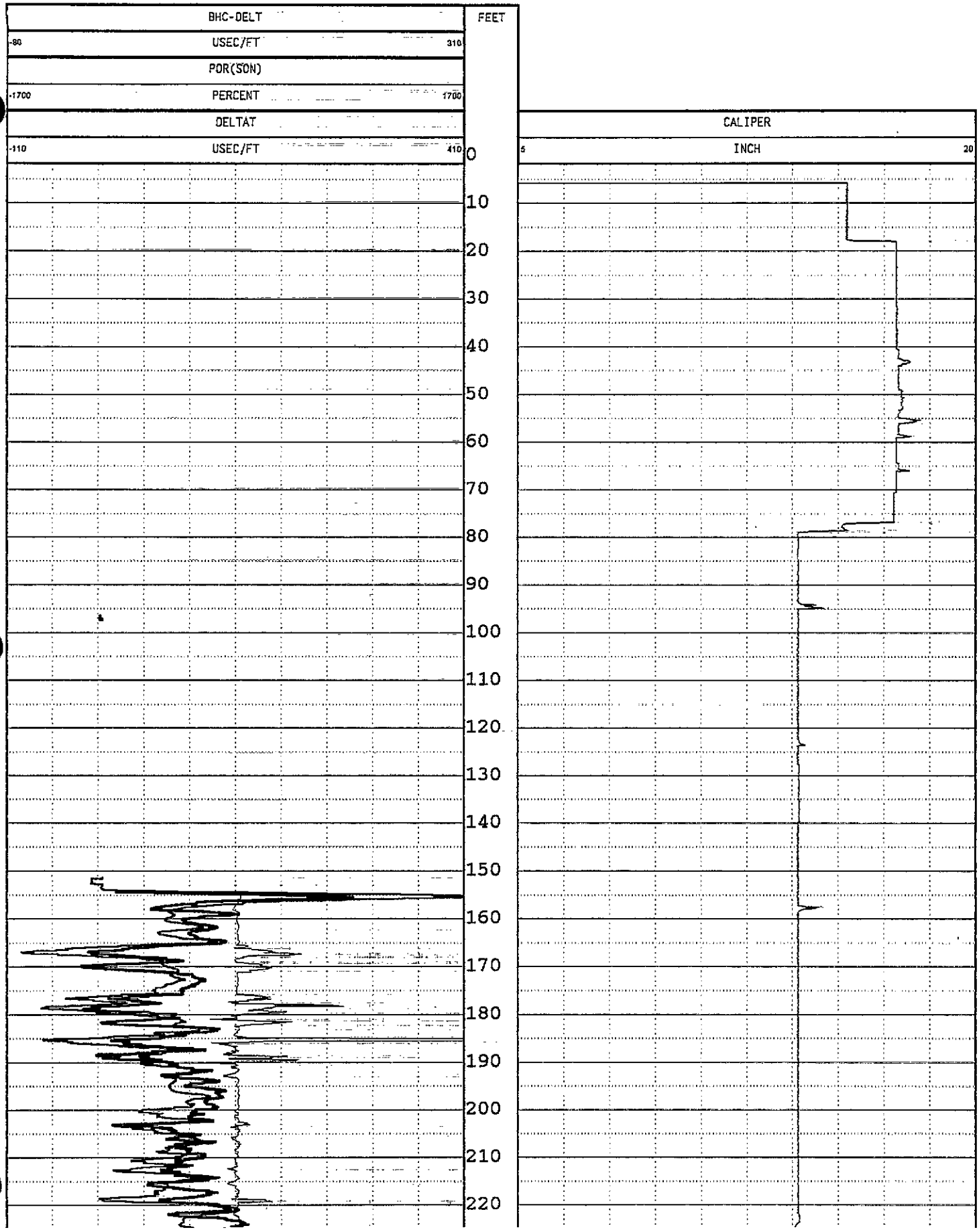
Borehole Geophysical Log

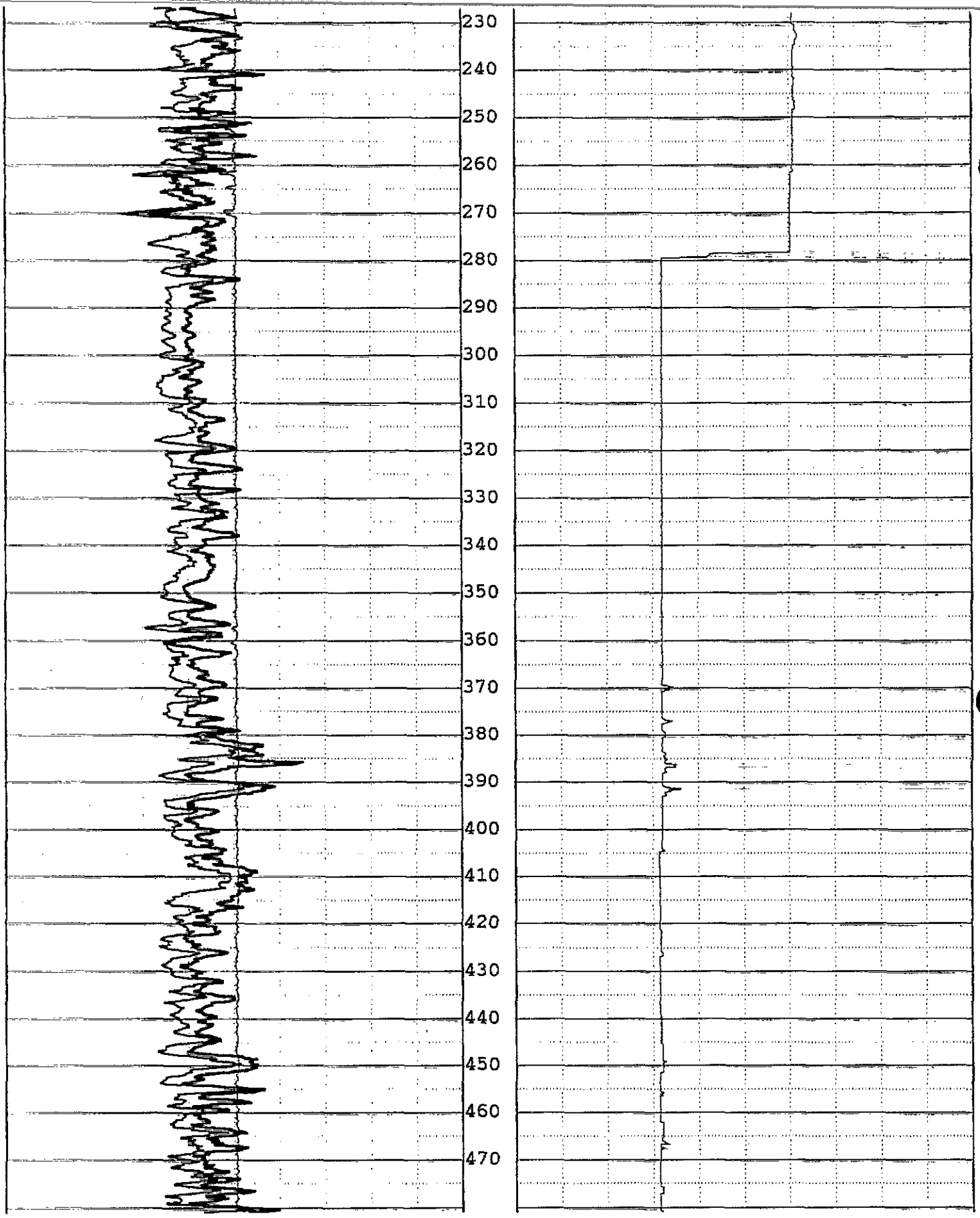
CLIENT	:	Middletown
WELL	:	ERM-9D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	680
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-9d
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok

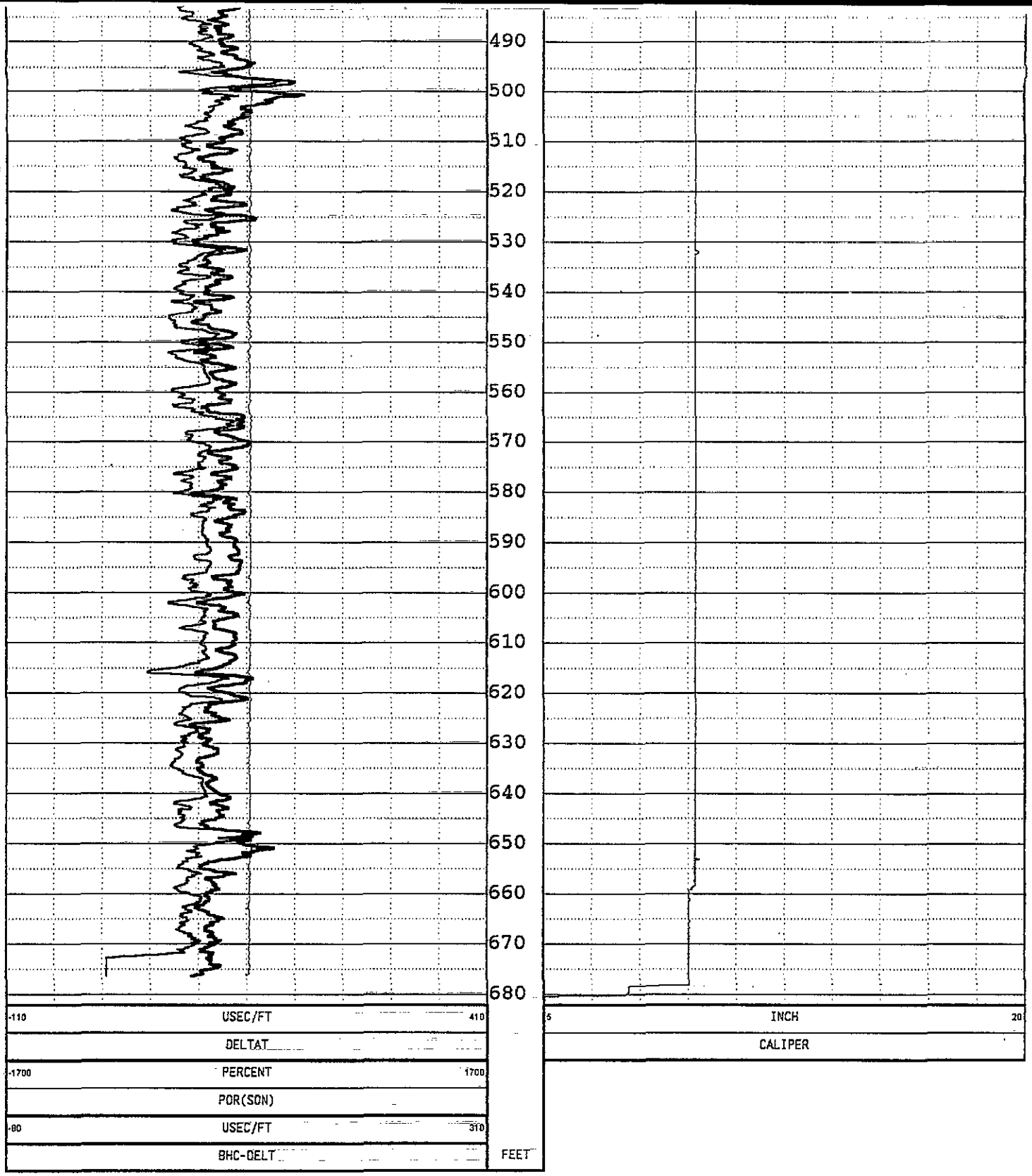

FEET
RES
0 OHM 600
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
SILTY SANDSTONE


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
AND 232 FEET
SILTSTONE
SILTY SANDSTONE
FINE TO MED
SANDSTONE
SILTY SANDSTONE
SILTSTONE
SANDSTONE,
MODERAELY FRACTURED
FROM 370 TO 405 FEET
SANDSTONE
SILTSTONE
SANDSTONE
SILTSTONE,
SLIGHTLY
FRACTURED


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
FINE TO MED SANDSTONE
SILTY SANDSTONE, FEW FRACTURES
ALTERNATING FINE TO MED SILTY SANDSTONE
SILTY SANDSTONE
25 OHM-M 55
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 80
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 500
RES
0 OHM-M 500
LATERAL
FEET


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

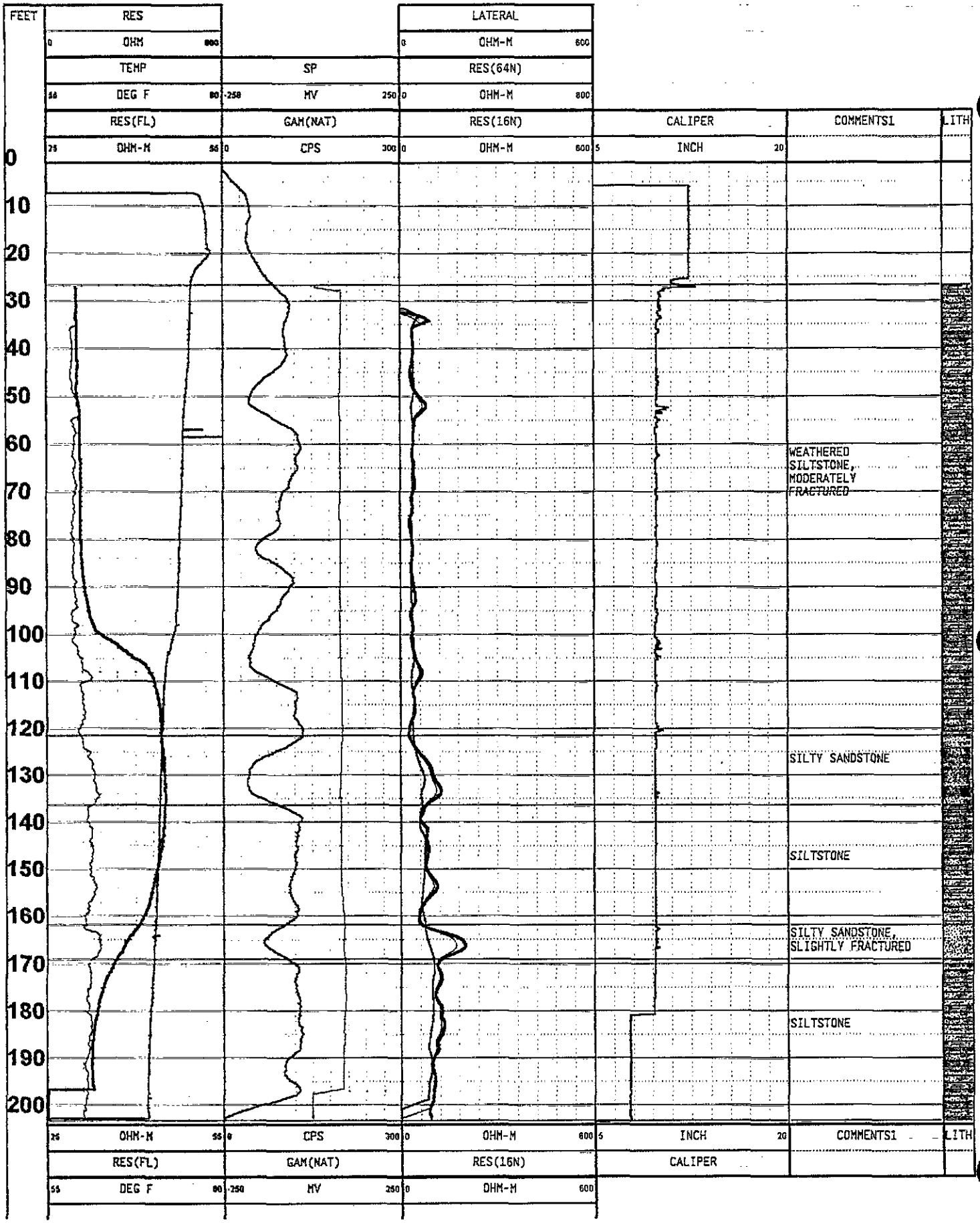
Environmental Resources Management, Inc.

Geophysical Services

ERM

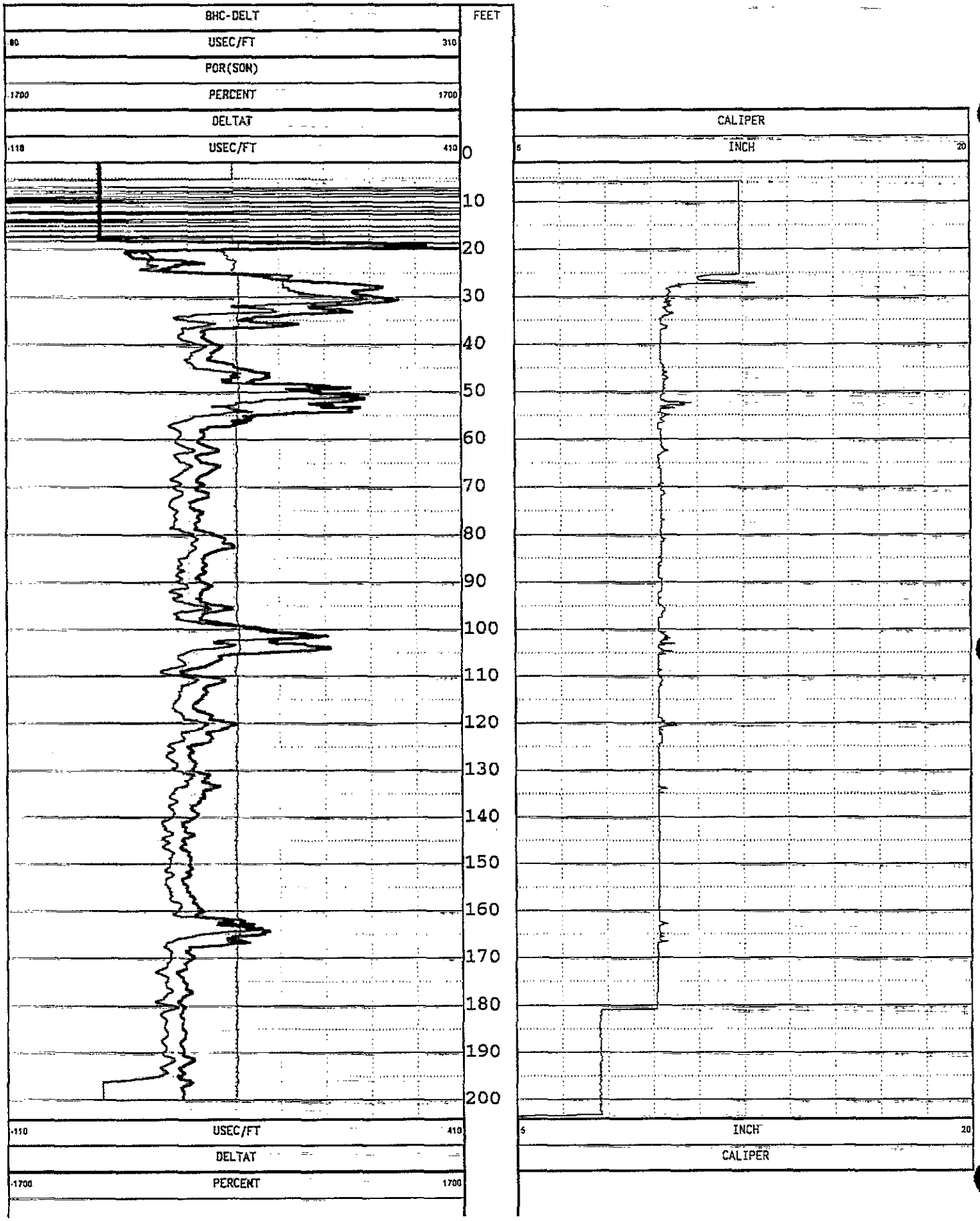
Borehole Geophysical Log

CLIENT	:	**Middletown**
WELL	:	**ERM-21I**
LOCATION/FIELD	:	
CITY	:	**Middletown**
STATE	:	**Pa.**
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	**200**
LOG TOP	:	**0**
ELEV. PERM. DATUM	:	
FILE NAME	:	**c:\acl\logs\mdtn\erm-21I**
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	**George Pfeiffer**
INTERPRETED BY	:	**Don Jagel**
COMMENTS	:	**HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok**


FEET
RES
0 OHM 800
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 800
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
WEATHERED SILTSTONE, MODERATELY FRACTURED
SILTY SANDSTONE
SILTSTONE
SILTY SANDSTONE, SLIGHTLY FRACTURED
SILTSTONE

FEET	0 OHM 600
	RES

0 OHM-M 600
LATERAL


BHC-DELT
FEET
80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
CALIPER
5
INCH
20
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
5
INCH
20
CALIPER

-80	USEC/FT	310	
	BHC-DELT		FEET

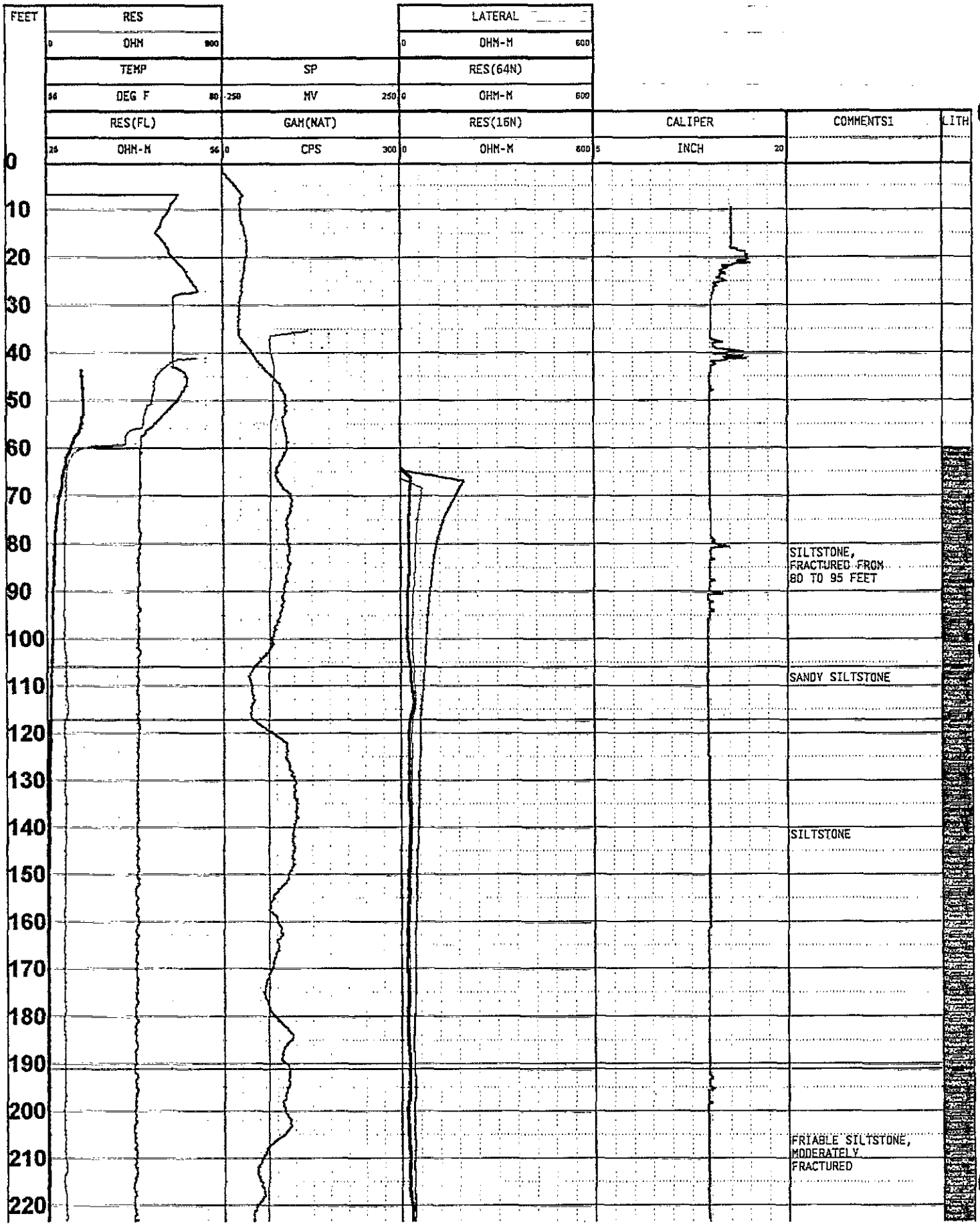
Environmental Resources Management, Inc.

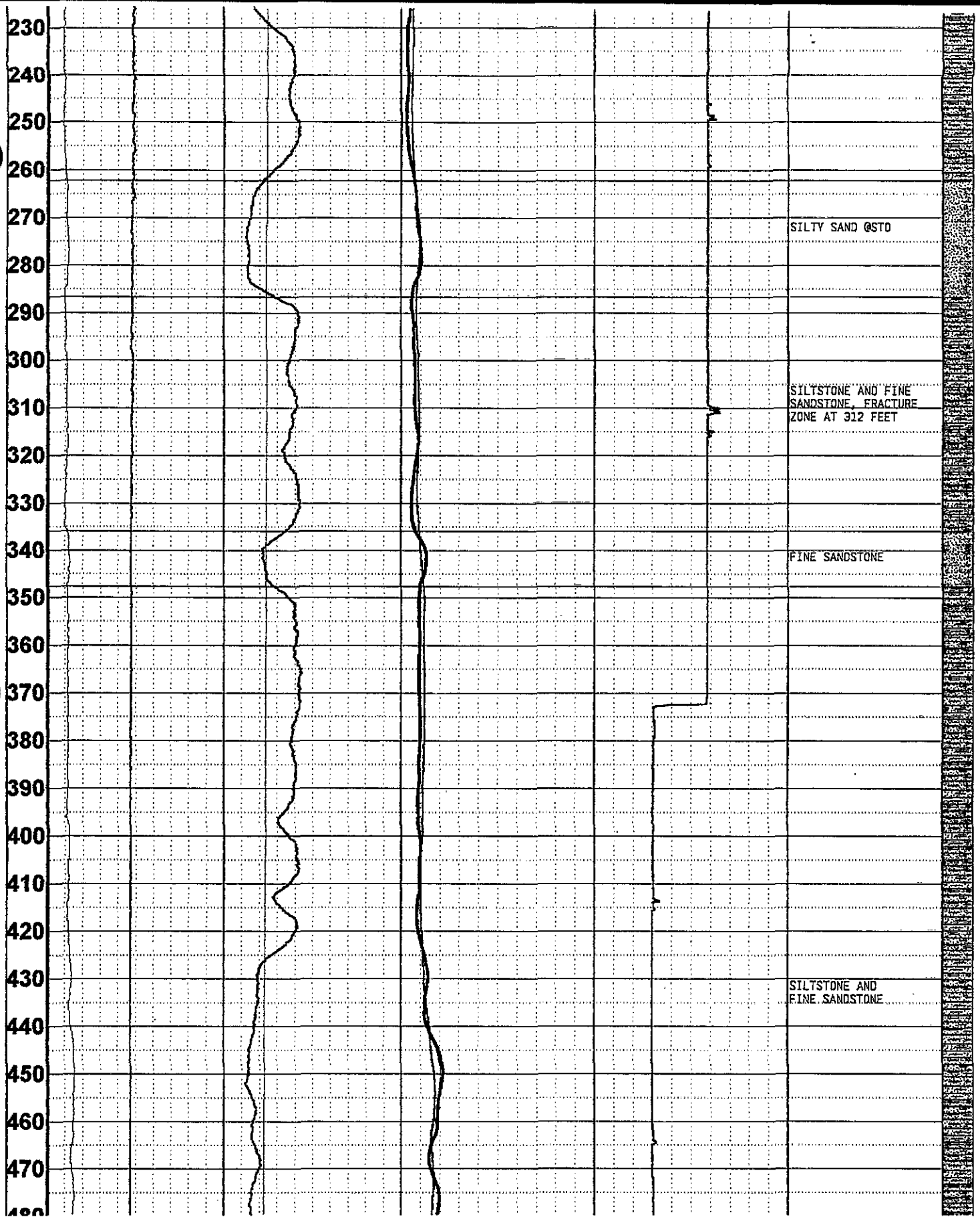
Geophysical Services

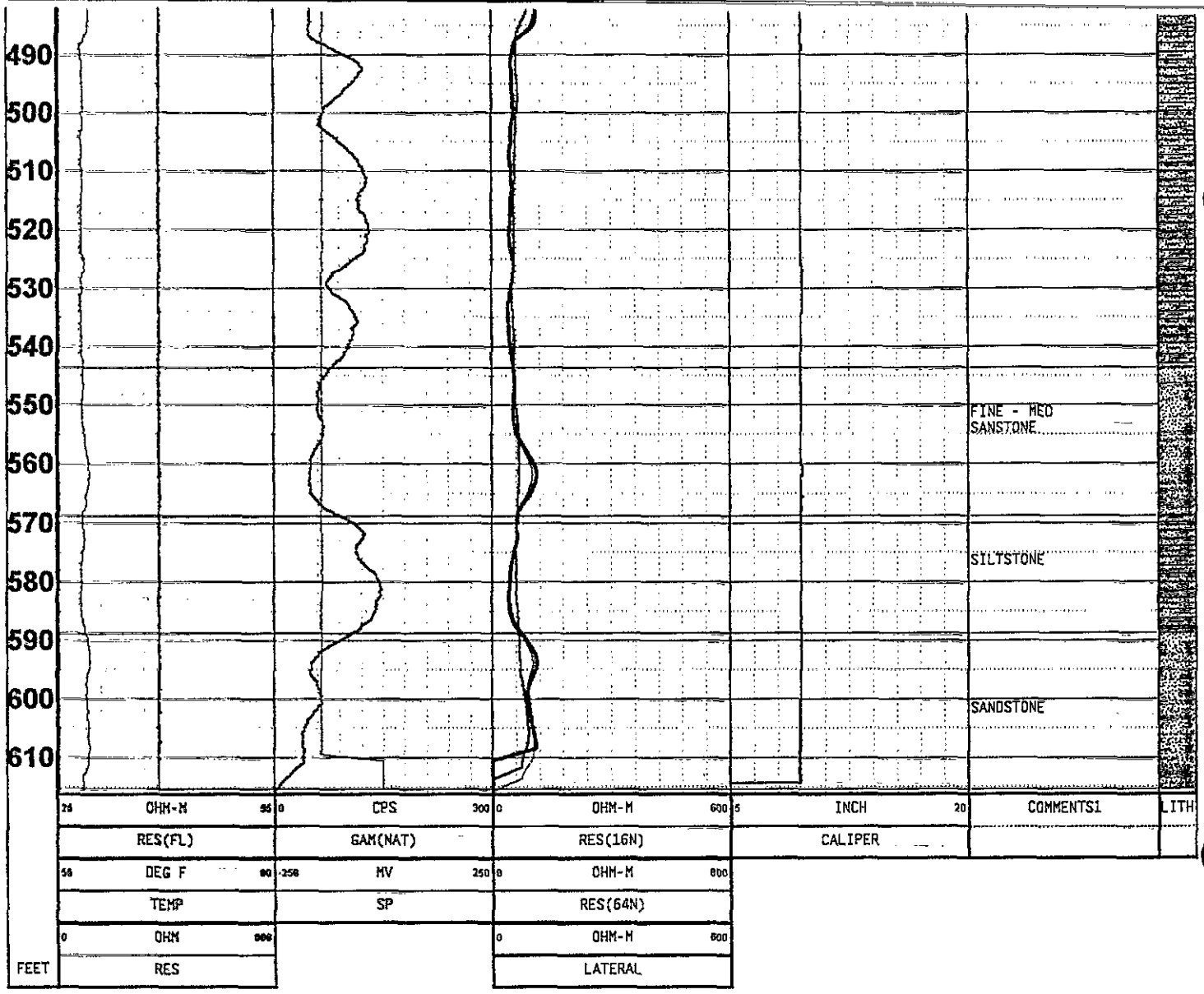
ERM

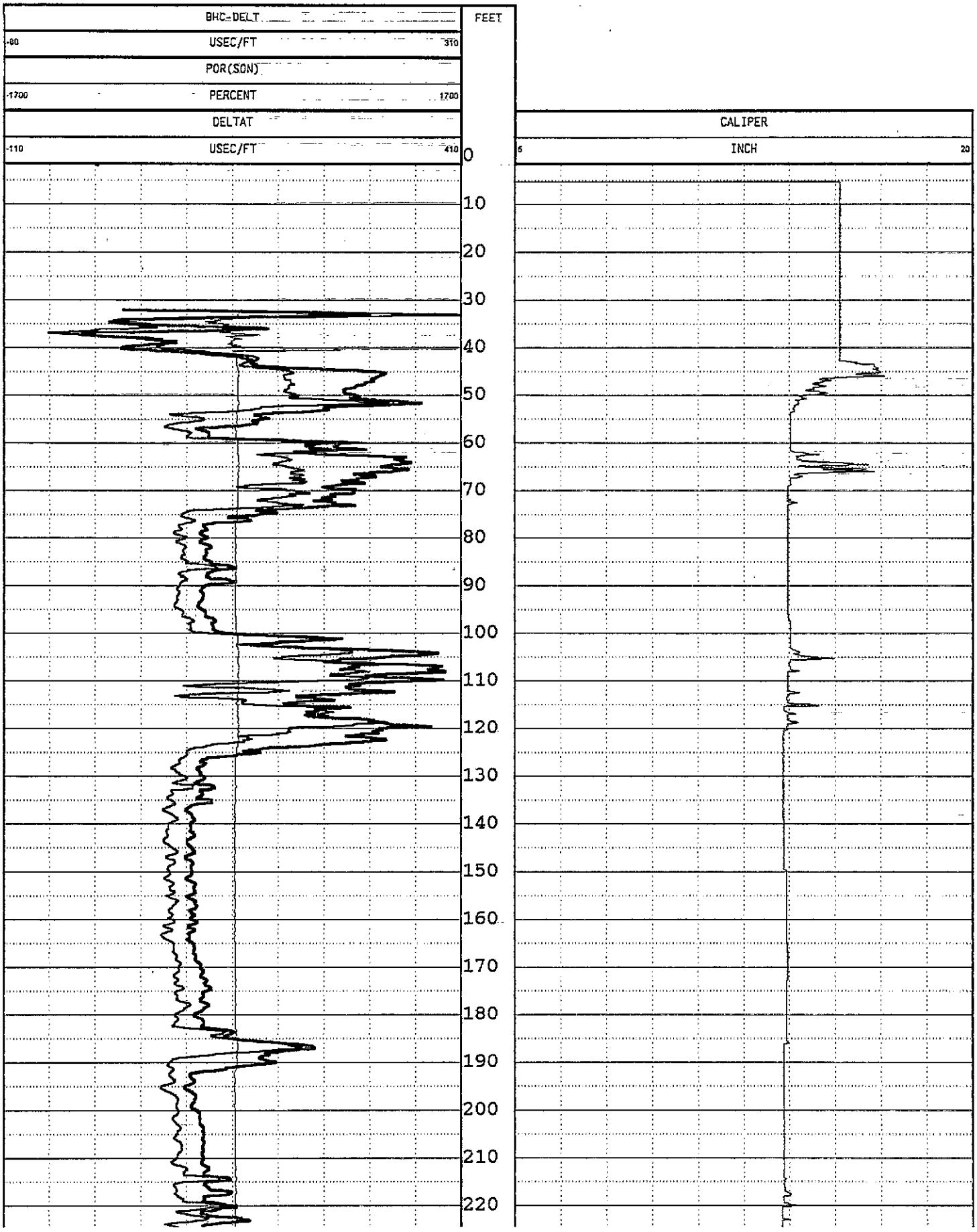
Borehole Geophysical Log

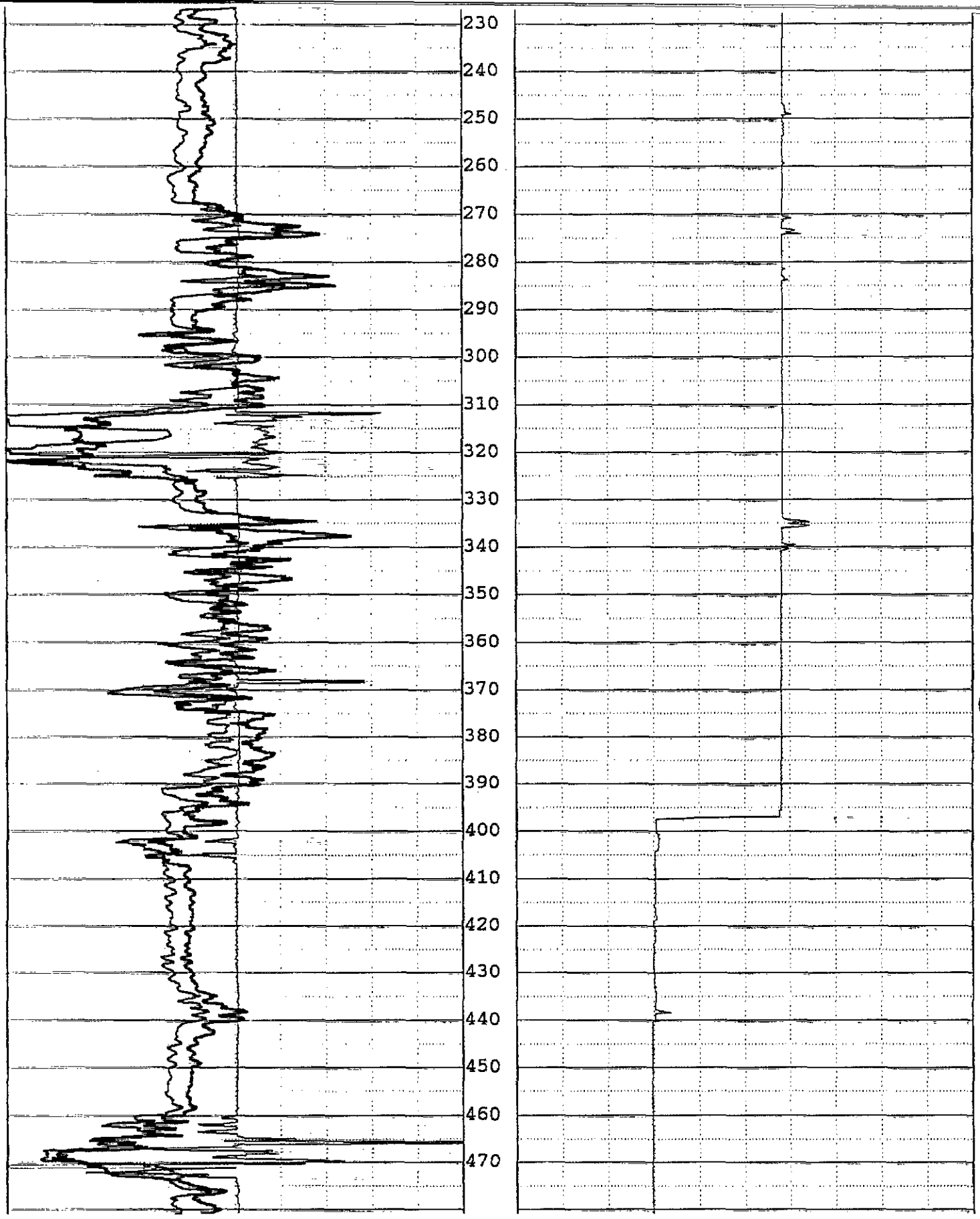
CLIENT	:	Middletown
WELL	:	ERM-21D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	610
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-21d
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok

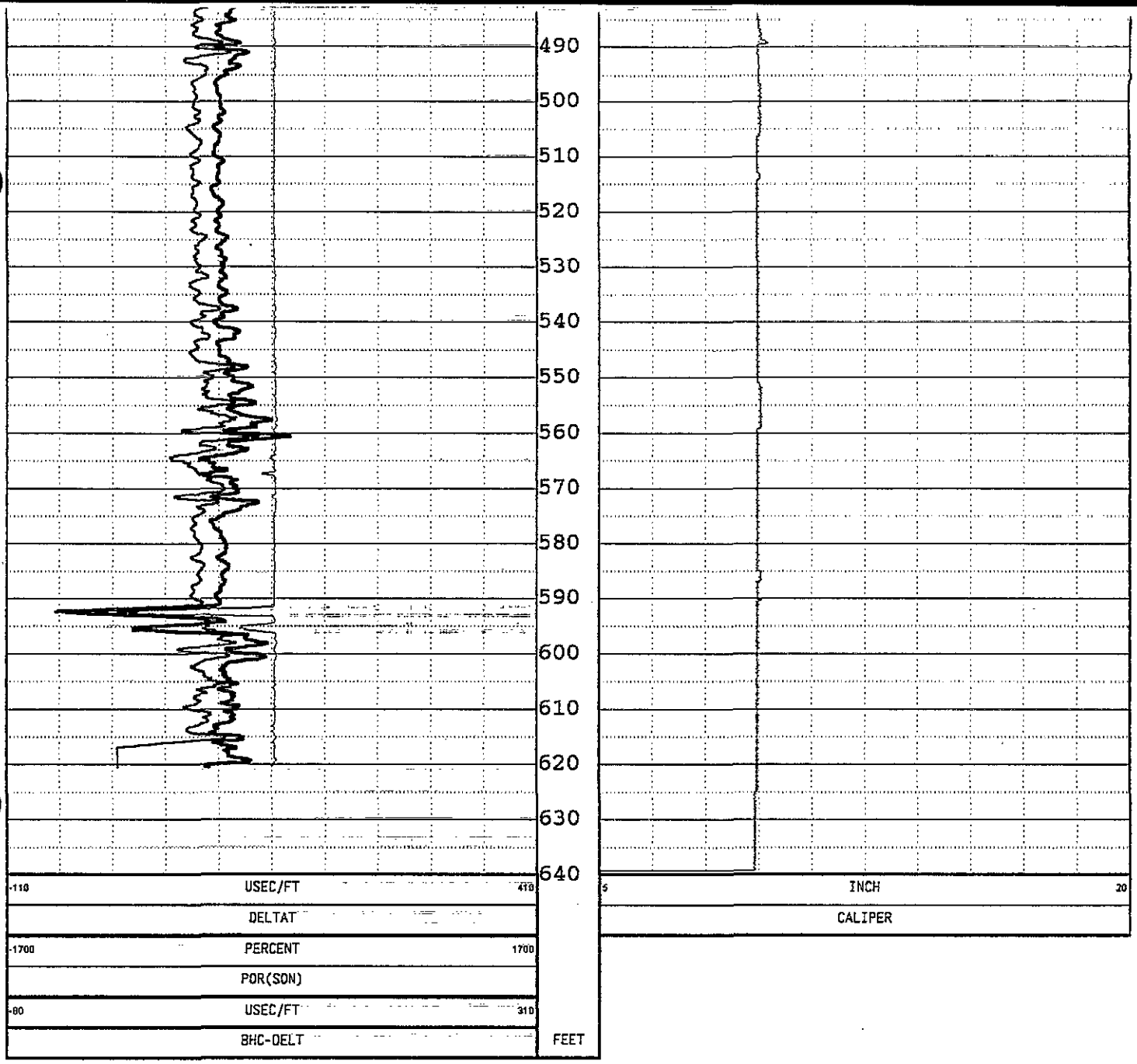

FEET
RES
0 OHM 800
TEMP
56 DEG F 80
RES(FL)
25 OHM-M 56
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
SILTSTONE, FRACTURED FROM 80 TO 95 FEET
SANDY SILTSTONE
SILTSTONE
FRIABLE SILTSTONE, MODERATELY FRACTURED


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
SILTY SAND @STD
SILTSTONE AND FINE SANDSTONE, FRACTURE ZONE AT 312 FEET
FINE SANDSTONE
SILTSTONE AND FINE SANDSTONE


490
500
510
520
530
540
550
560
570
580
590
600
610
FINE - MED SANSTONE
SILTSTONE
SANDSTONE
FEET
25 OHM-M 95
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
50 DEG F 90
TEMP
-250 MV 250
SP
0 OHM-M 800
RES(64N)
0 OHM 800
RES
0 OHM-M 600
LATERAL


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
6
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

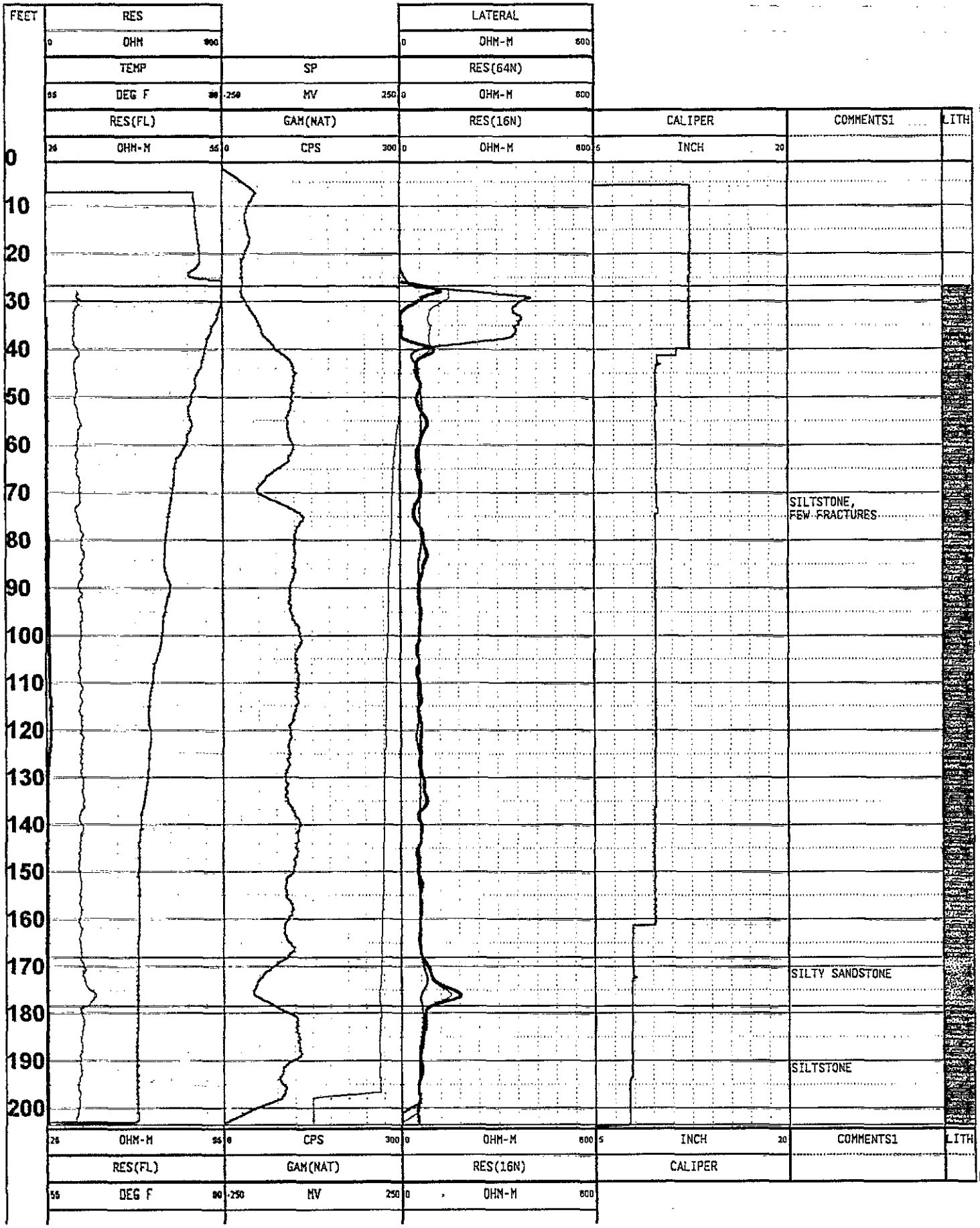
Environmental Resources Management, Inc.

Geophysical Services

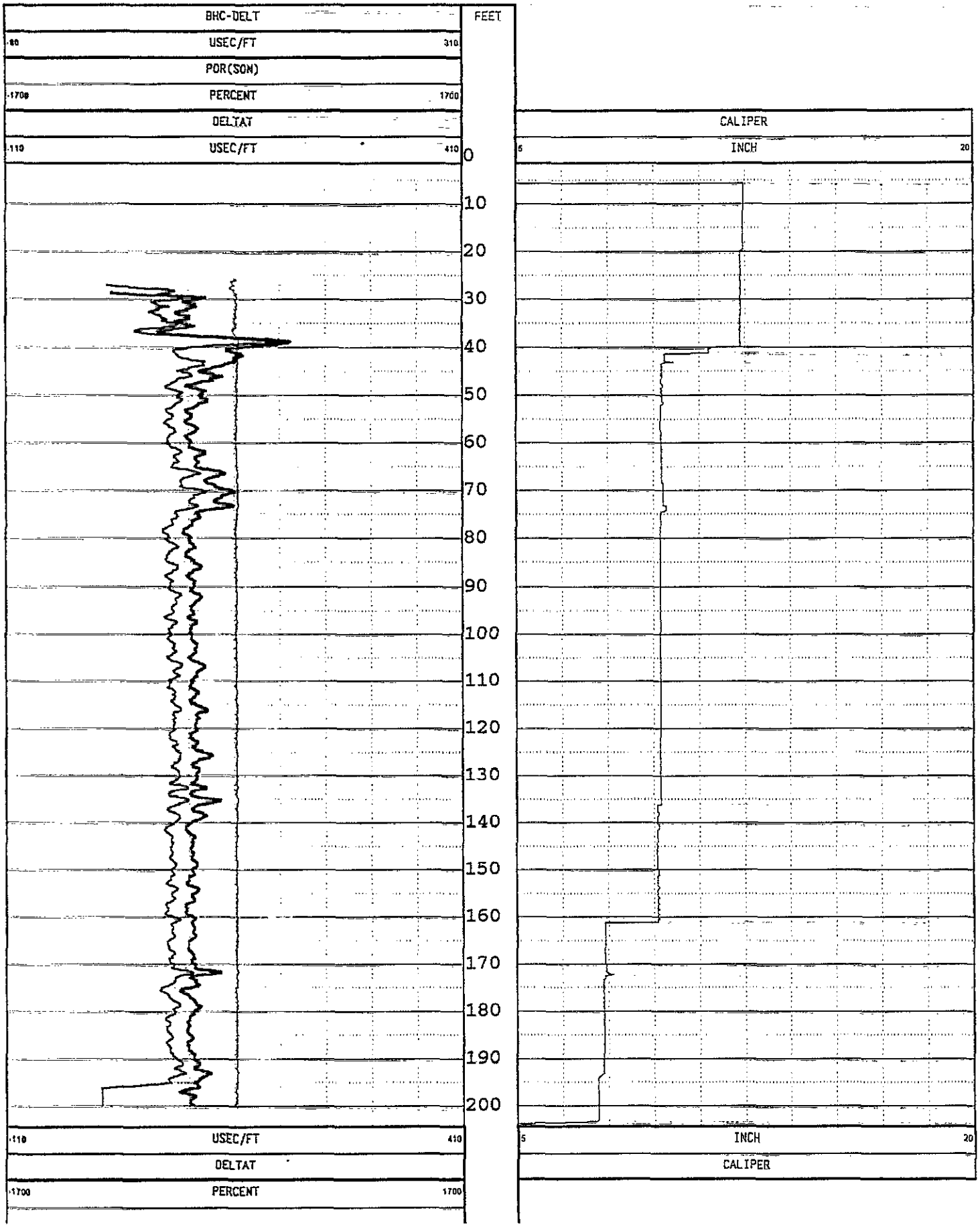
ERM

Borehole Geophysical Log

CLIENT	:	Middletown
WELL	:	ERM-22I
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	200
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-22I
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok


FEET
RES
0 OHM 900
TEMP
55 DEG F 80
RES(FL)
26 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
SILTSTONE,
FEW FRACTURES
SILTY SANDSTONE
SILTSTONE

FEET	0 OHM 600	0 OHM-M 600
	RES	LATERAL


BHC-DELT
FEET
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
CALIPER
5
INCH
20
5
INCH
20
CALIPER

80	USEC/FT	310	
	BHC-DELT		FEET

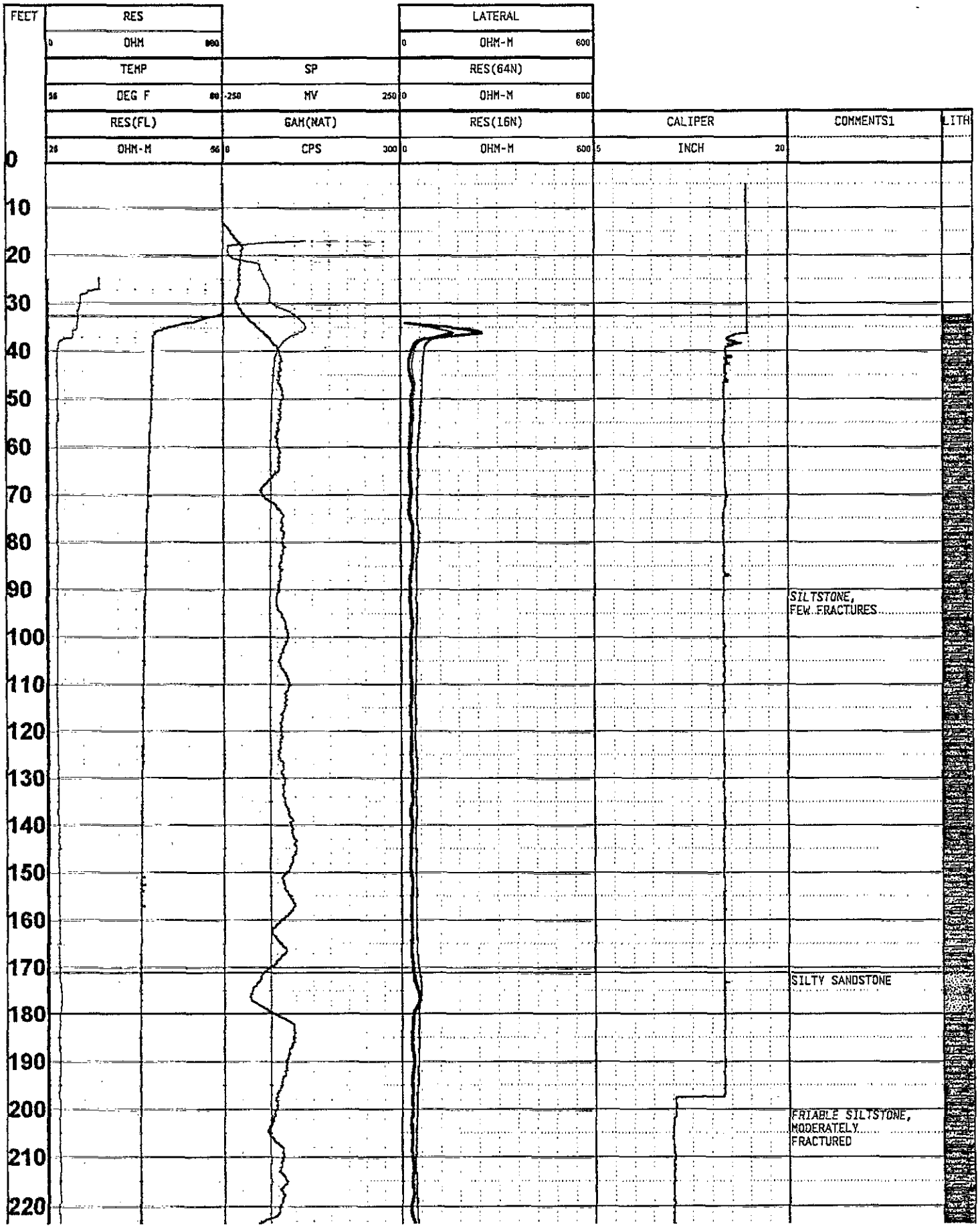
Environmental Resources Management, Inc.

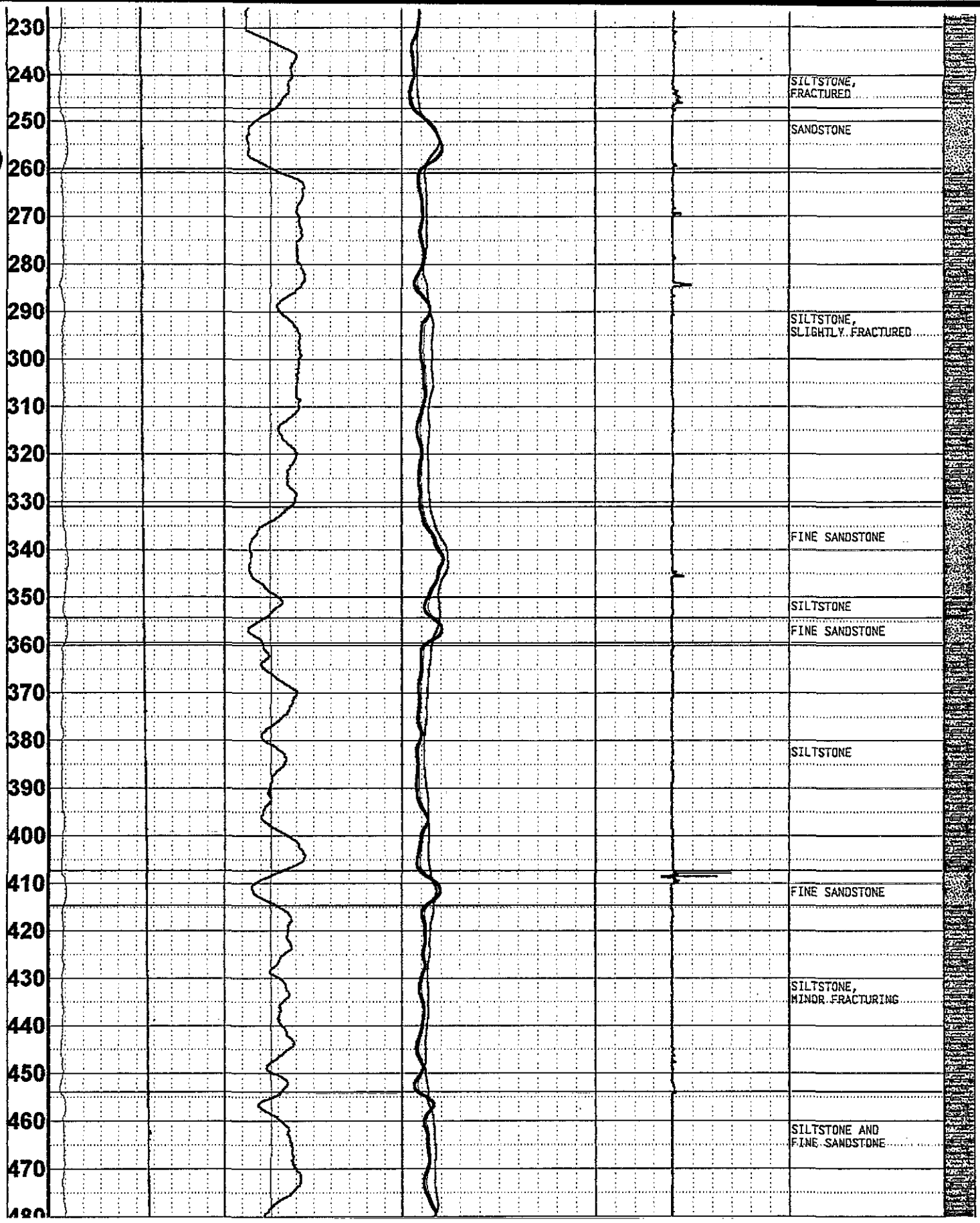
Geophysical Services

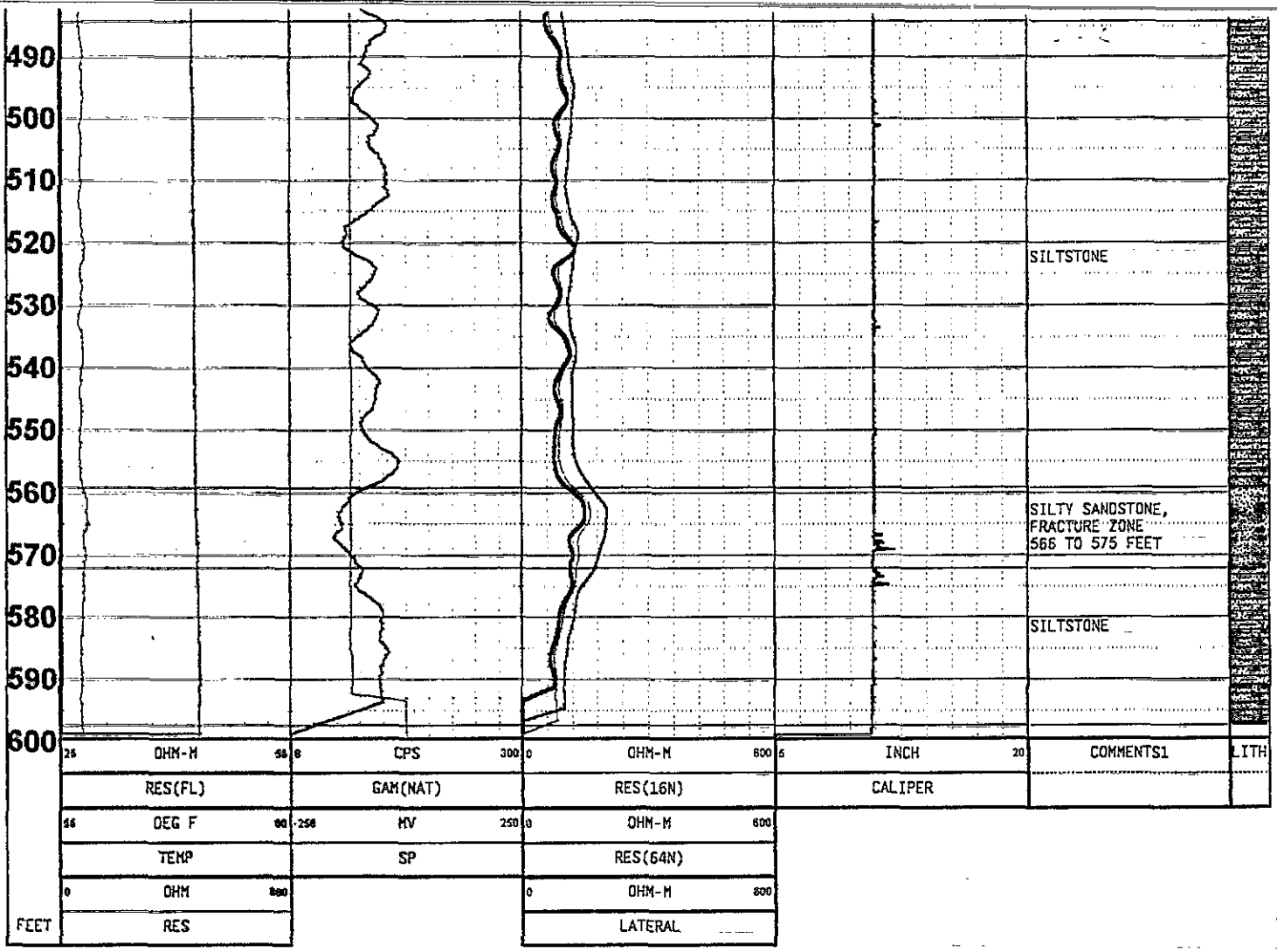
ERM

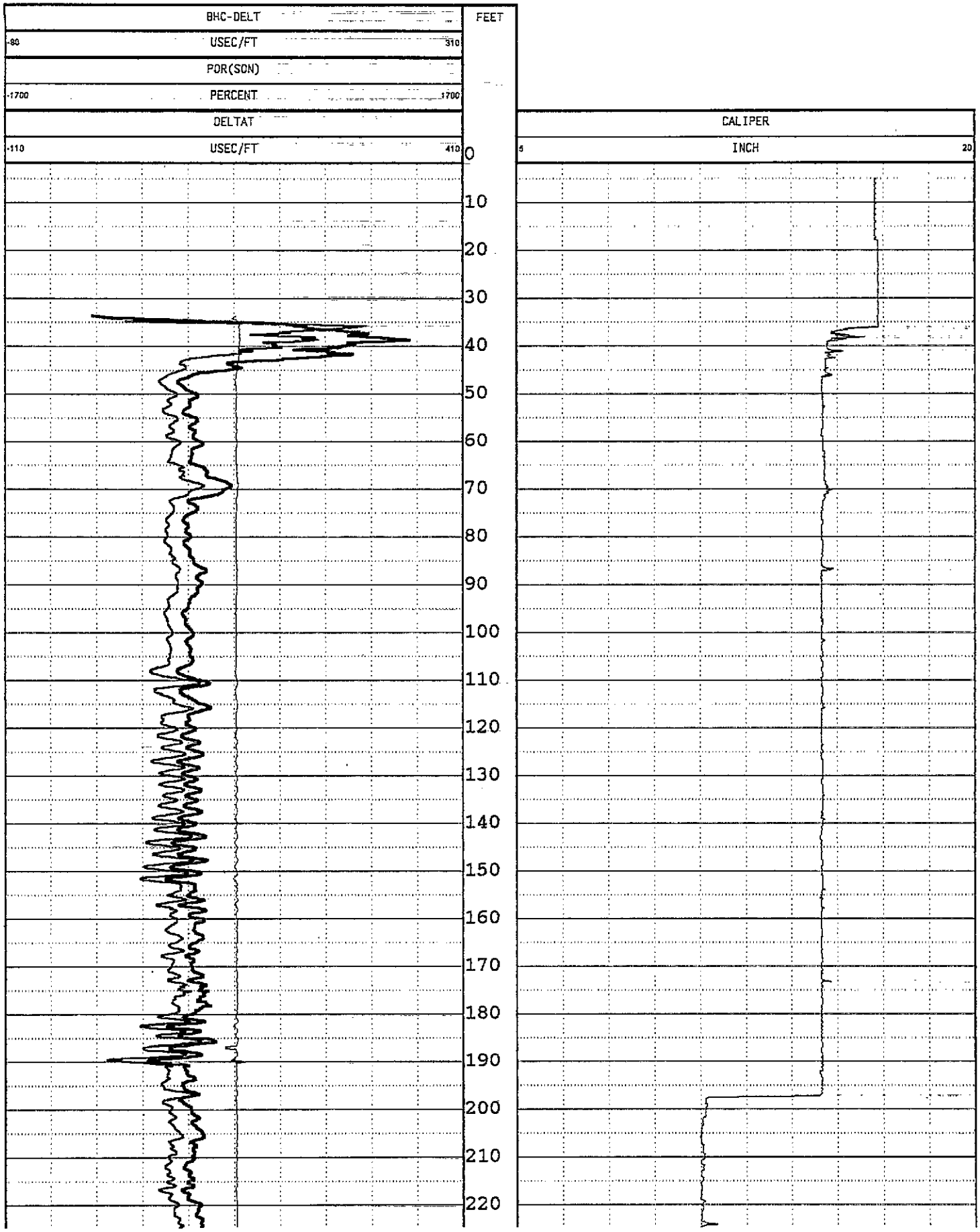
Borehole Geophysical Log

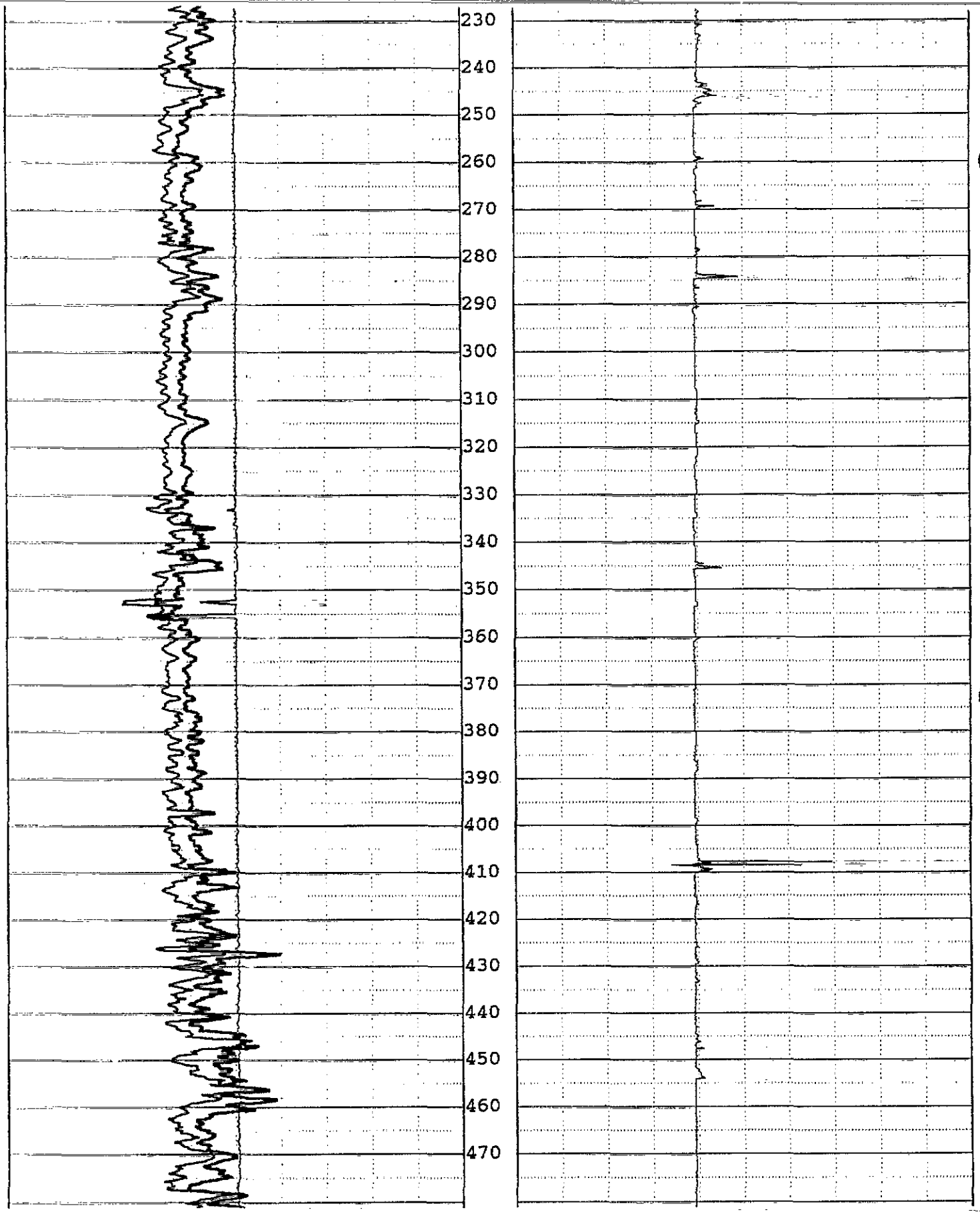
CLIENT	:	Middletown
WELL	:	ERM-22D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	600
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-22D
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok

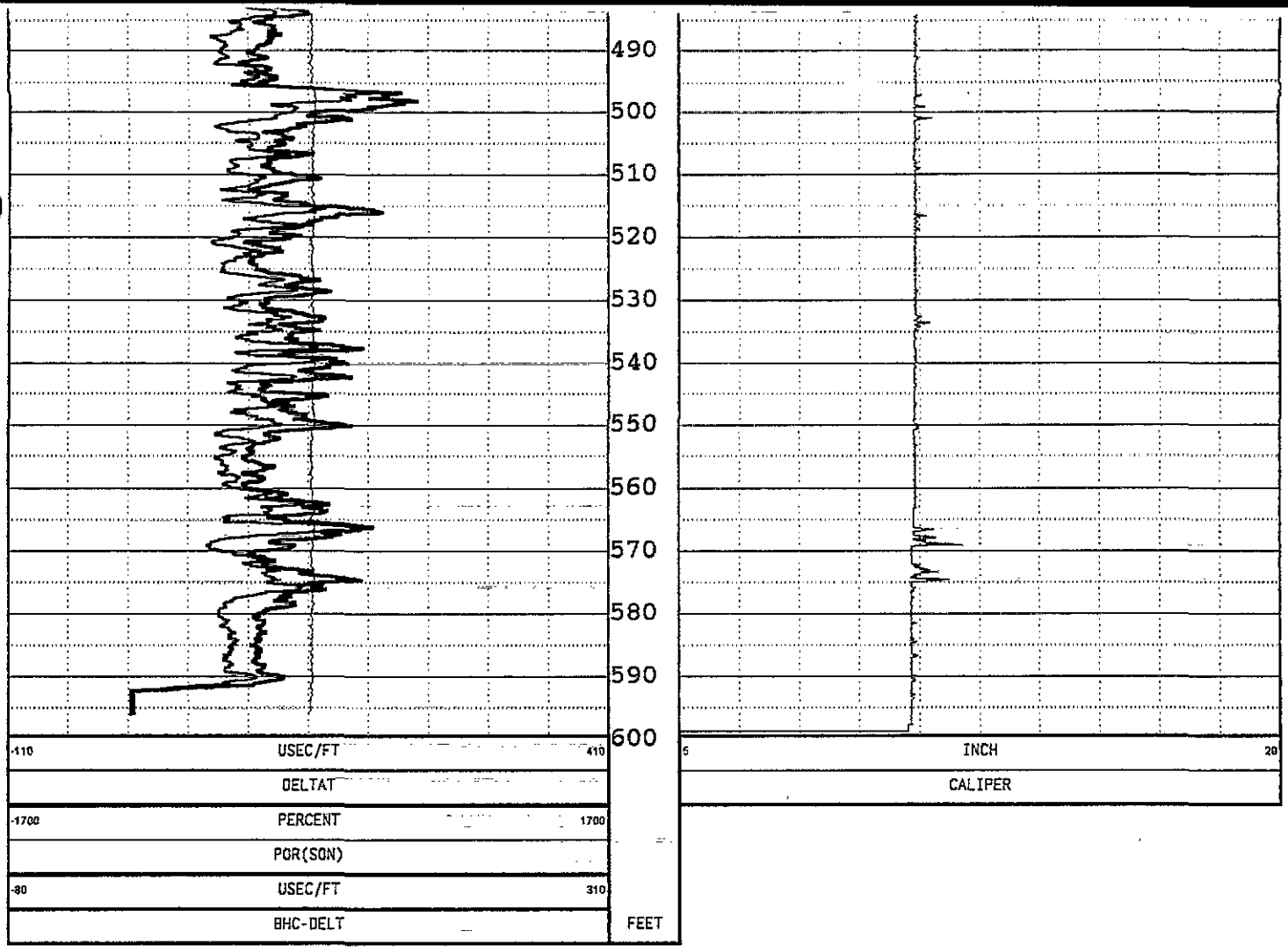

FEET
RES
0 OHM 800
TEMP
56 DEG F 80
RES(FL)
26 OHM-M 56
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
SILTSTONE, FEW FRACTURES
SILTY SANDSTONE
FRIABLE SILTSTONE, MODERATELY FRACTURED


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
SILTSTONE, FRACTURED
SANDSTONE
SILTSTONE, SLIGHTLY FRACTURED
FINE SANDSTONE
SILTSTONE
FINE SANDSTONE
SILTSTONE
FINE SANDSTONE
SILTSTONE, MINOR FRACTURING
SILTSTONE AND FINE SANDSTONE


490
500
510
520
530
540
550
560
570
580
590
600
SILTSTONE
SILTY SANDSTONE,
FRACTURE ZONE
566 TO 575 FEET
SILTSTONE
25 OHM-M 55
RES(FL)
8 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 90
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 500
RES
0 OHM-M 600
LATERAL
FEET


BHC-DELT
FEET
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
CALIPER
5
INCH
20
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

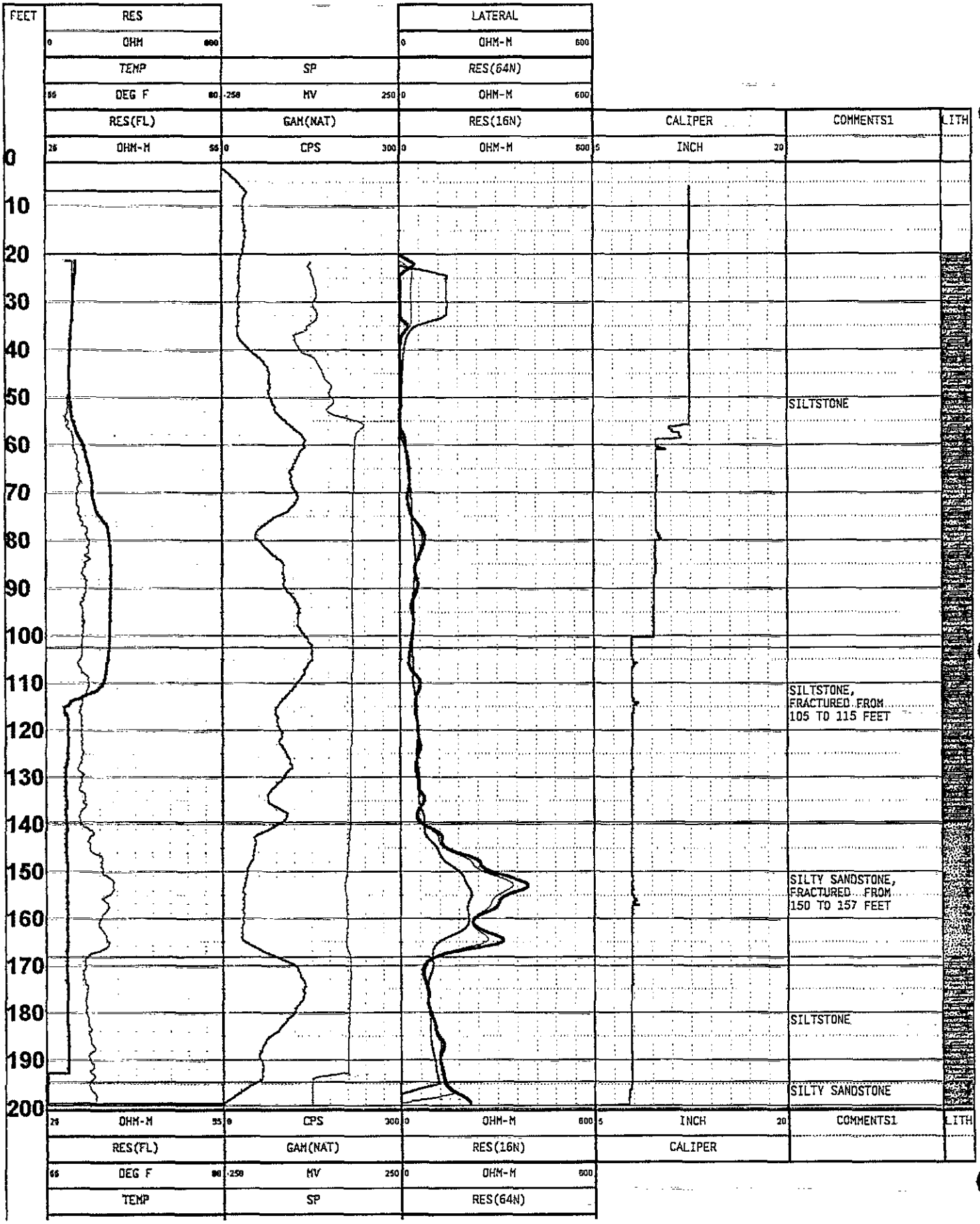
Environmental Resources Management, Inc.

Geophysical Services

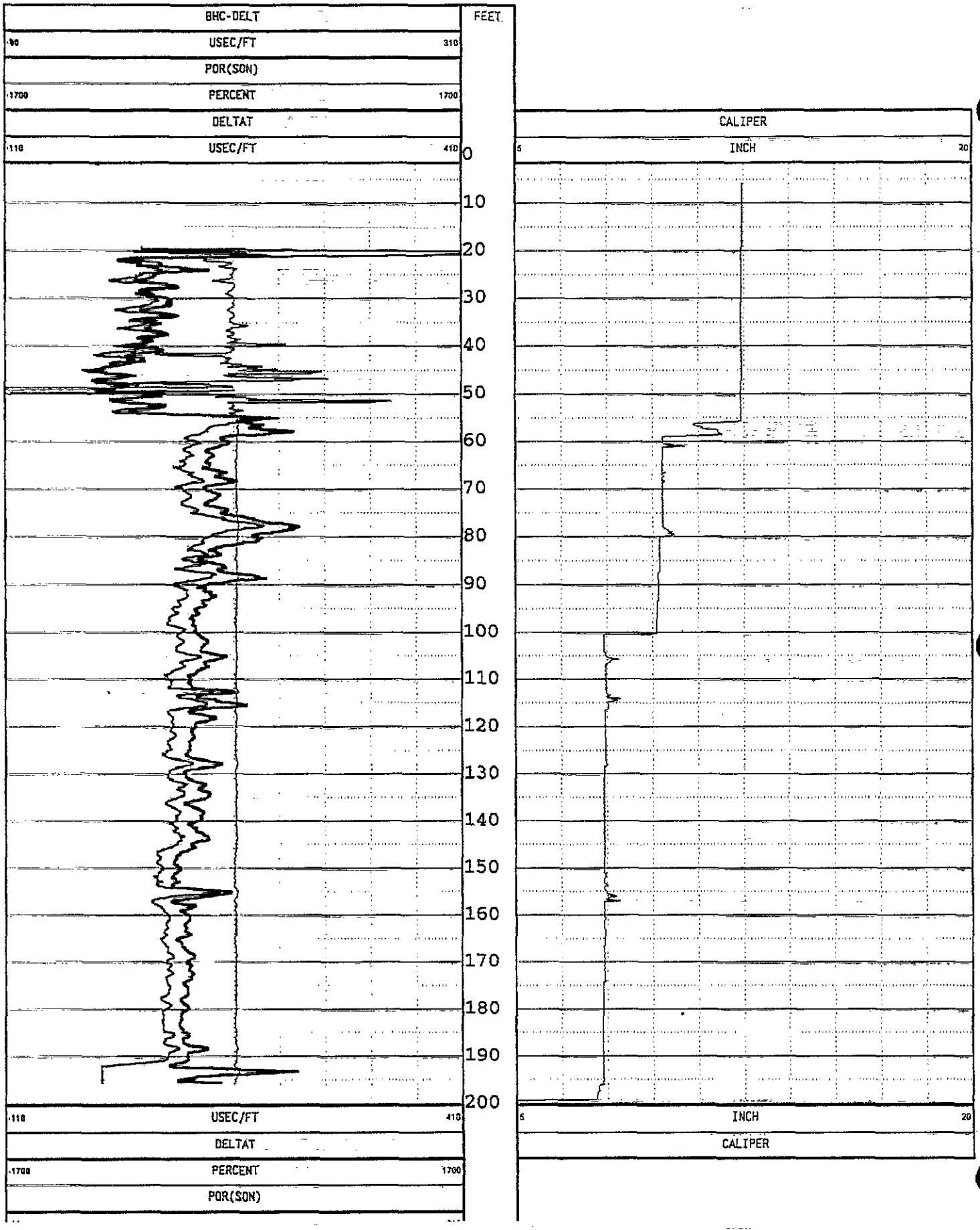
ERM

Borehole Geophysical Log

CLIENT	:	Middletown
WELL	:	ERM-23I
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	200
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-23I
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok


FEET
RES
0 OHM 600
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
SILTSTONE
SILTSTONE, FRACTURED FROM 105 TO 115 FEET
SILTY SANDSTONE, FRACTURED FROM 150 TO 157 FEET
SILTSTONE
SILTY SANDSTONE

FEET	RES	LATERAL


BHC-DELT
-90
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
CALIPER
6
INCH
20
6
INCH
20
CALIPER

BHC-DELT	FEET

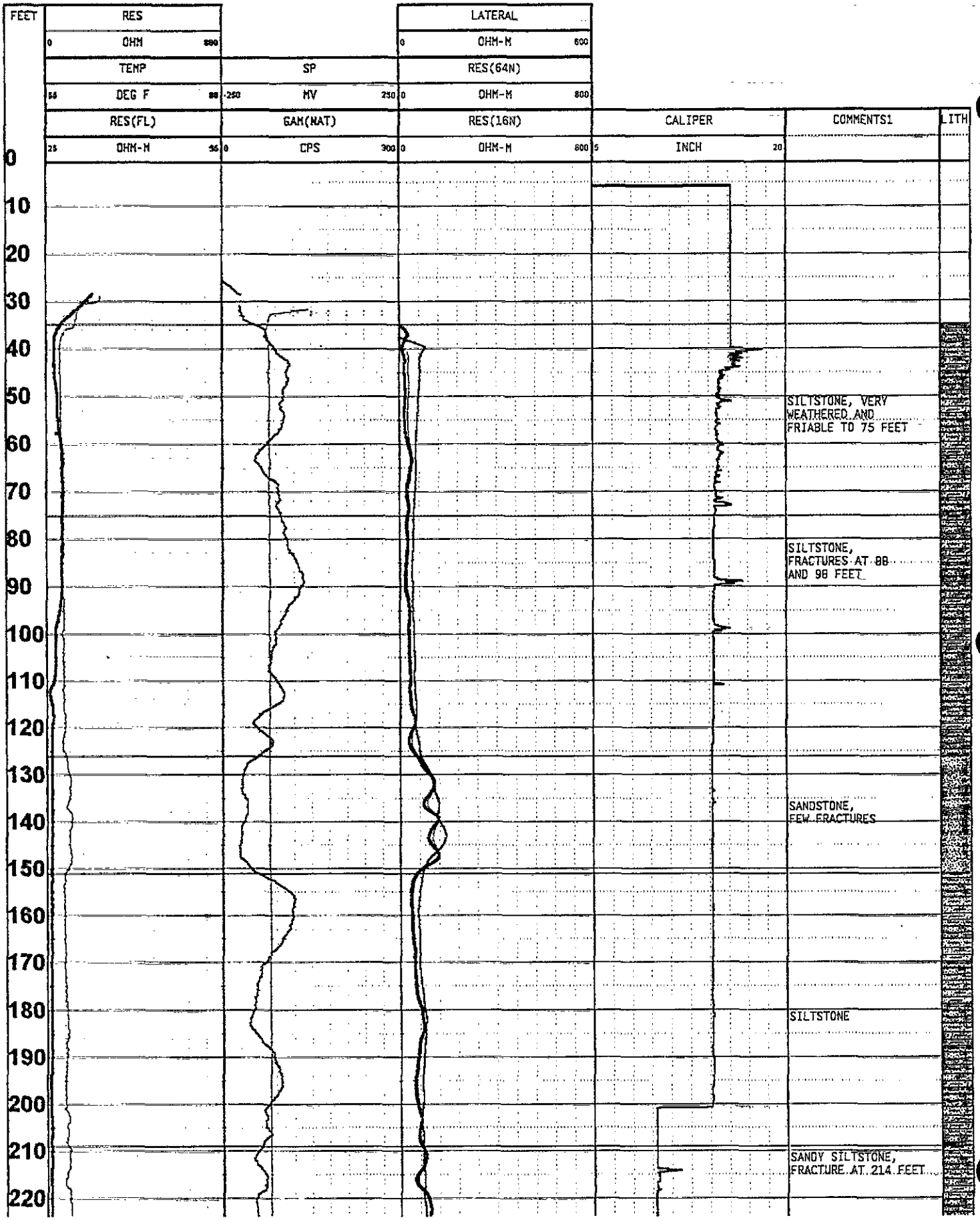
Environmental Resources Management, Inc.

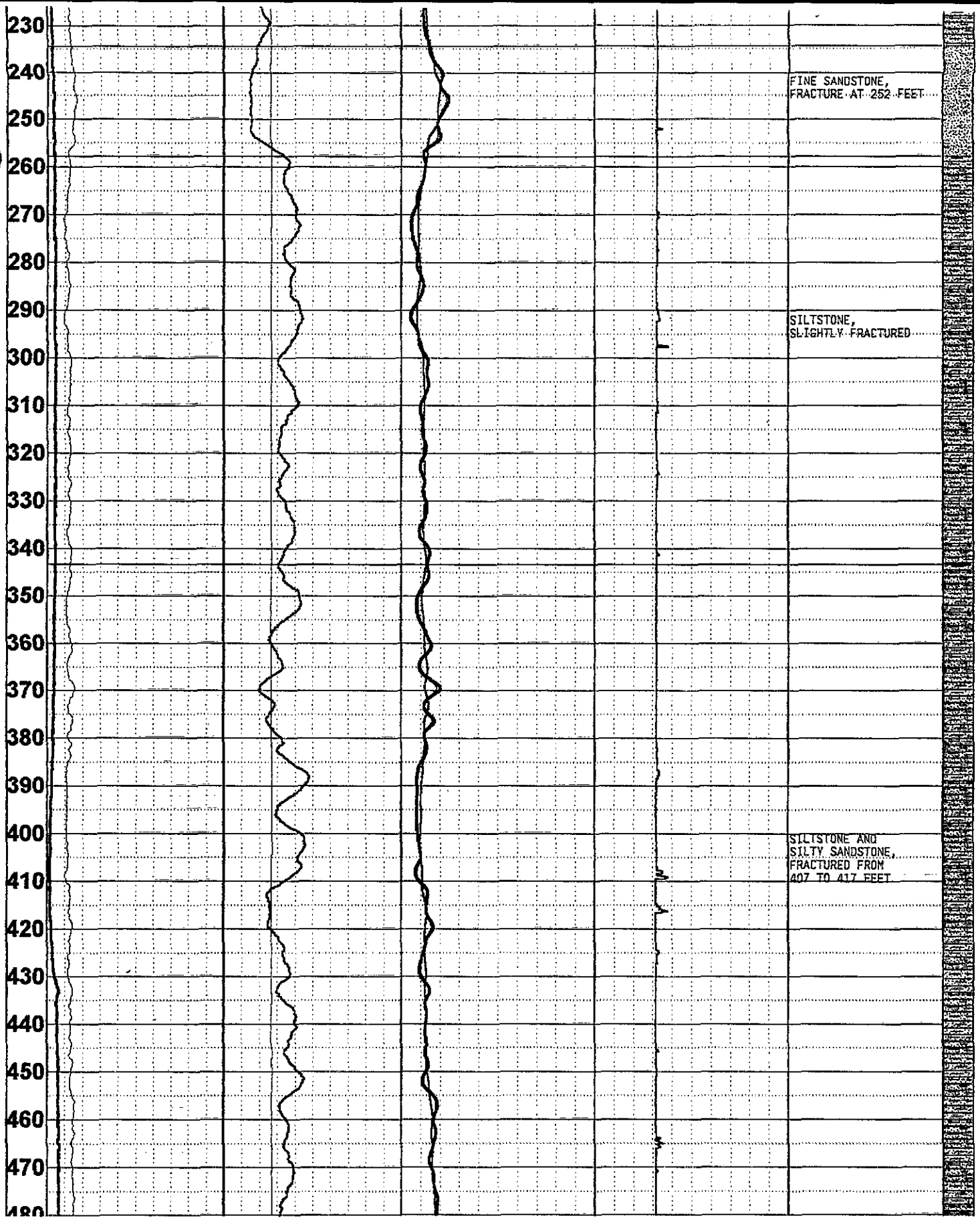
Geophysical Services

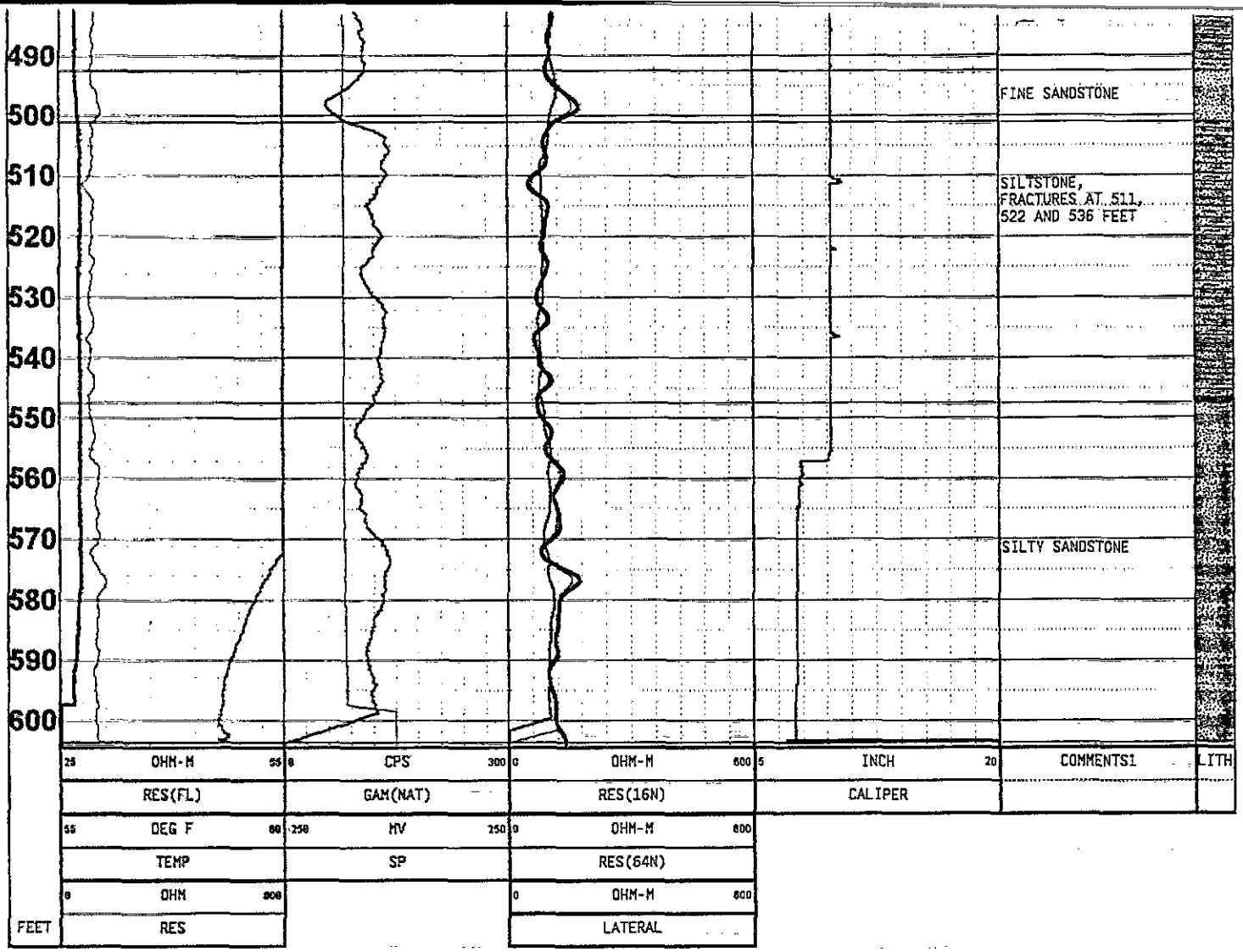
ERM

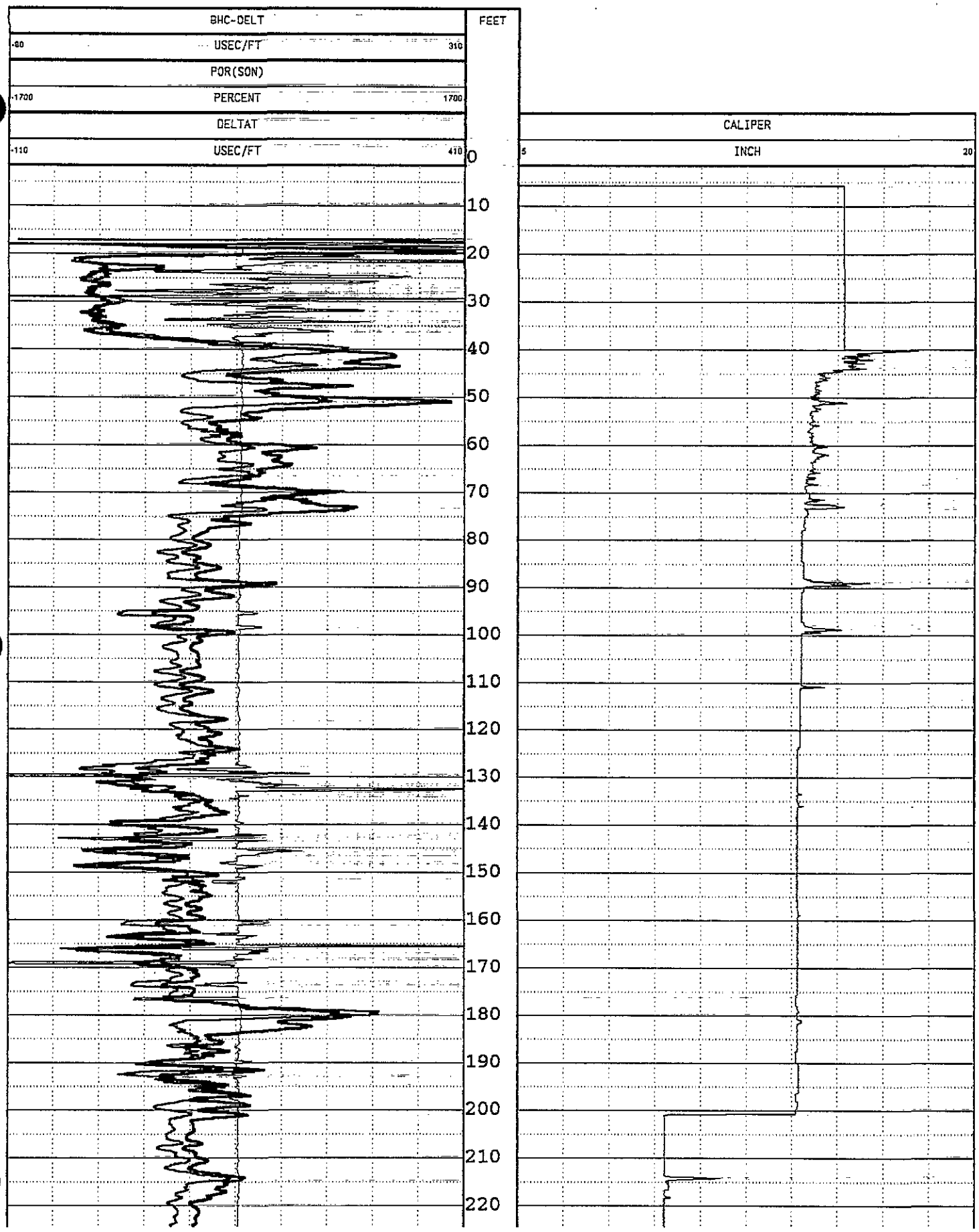
Borehole Geophysical Log

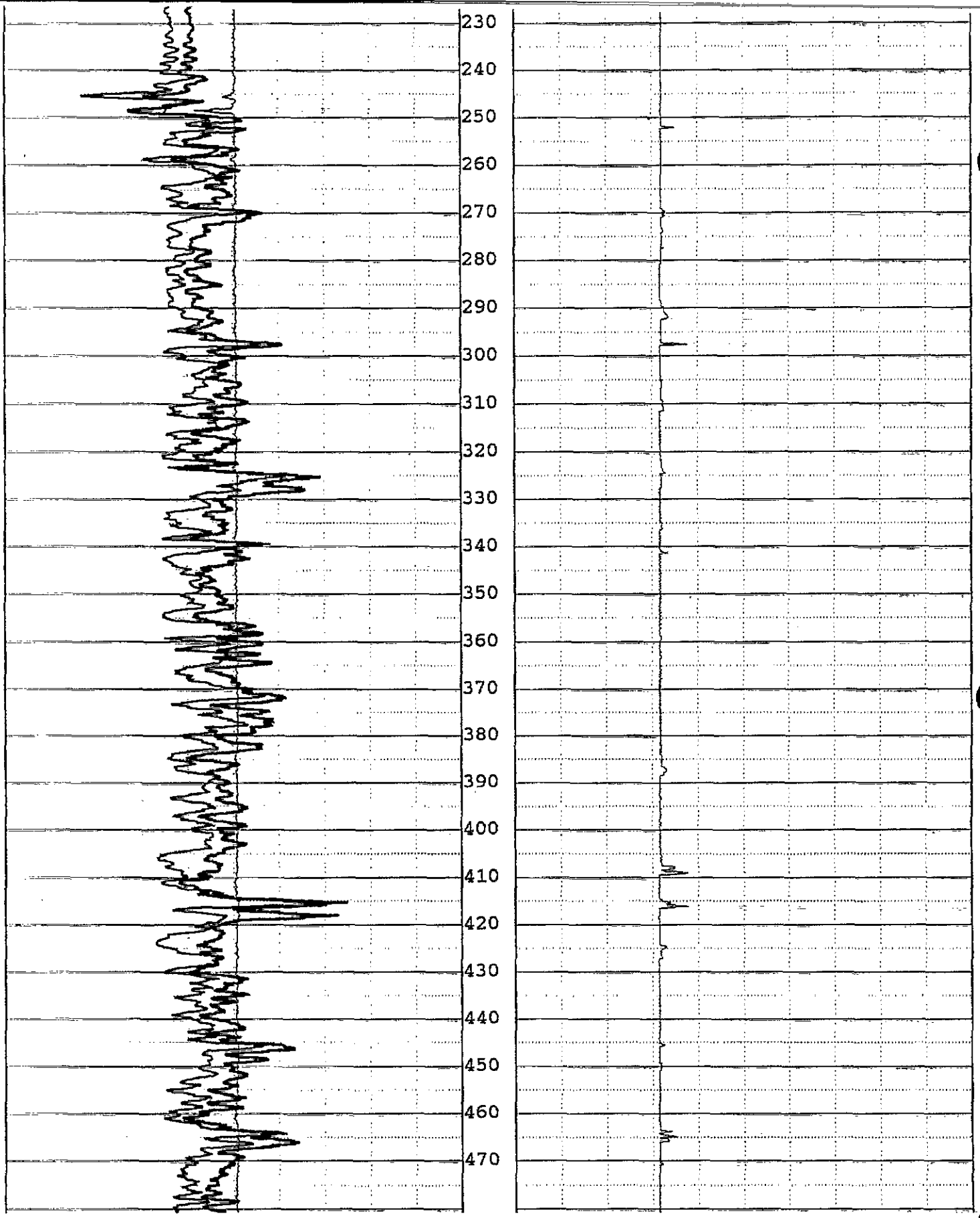
CLIENT	:	**Middletown**
WELL	:	**ERM-23D**
LOCATION/FIELD	:	
CITY	:	**Middletown**
STATE	:	**Pa.**
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	**600**
LOG TOP	:	**0**
ELEV. PERM. DATUM	:	
FILE NAME	:	**c:\acl\logs\mdtn\erm-23D**
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	**George Pfeiffer**
INTERPRETED BY	:	**Don Jagel**
COMMENTS	:	**HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok**

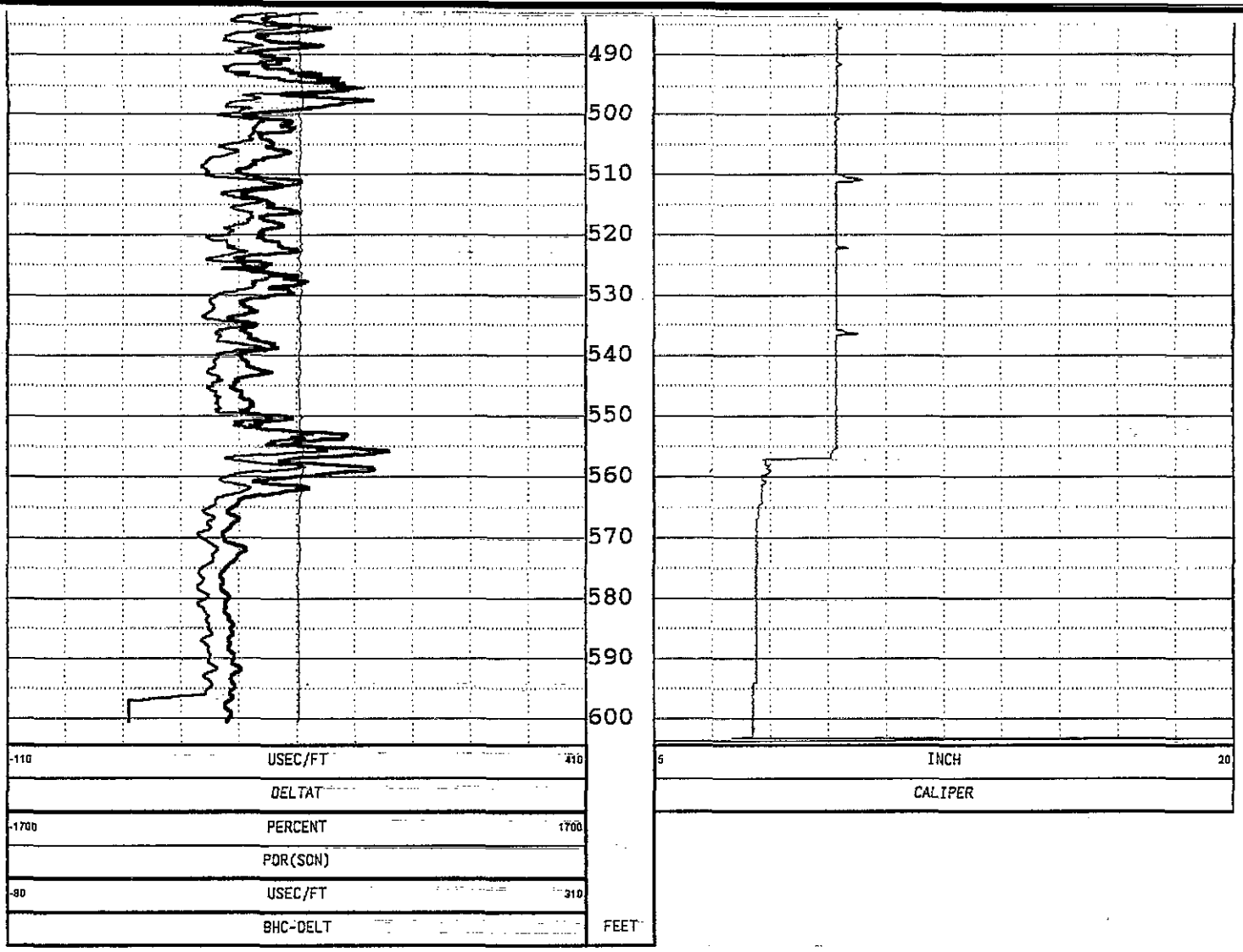

FEET
RES
0 OHM 800
TEMP
56 DEG F 88
RES(FL)
25 OHM-M 95
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 800
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
SILTSTONE, VERY WEATHERED AND FRIABLE TO 75 FEET
SILTSTONE, FRACTURES AT 88 AND 98 FEET
SANDSTONE, FEW FRACTURES
SILTSTONE
SANDY SILTSTONE, FRACTURE AT 214 FEET


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
FINE SANDSTONE,
FRACTURE AT 252 FEET
SILTSTONE,
SLIGHTLY FRACTURED
SILTSTONE AND
SILTY SANDSTONE,
FRACTURED FROM
407 TO 417 FEET


490
500
510
520
530
540
550
560
570
580
590
600
FINE SANDSTONE
SILTSTONE, FRACTURES AT 511, 522 AND 536 FEET
SILTY SANDSTONE
25 OHM-M 55
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 80
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 200
RES
0 OHM-M 600
LATERAL
FEET


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
6
INCH
20
CALIPER

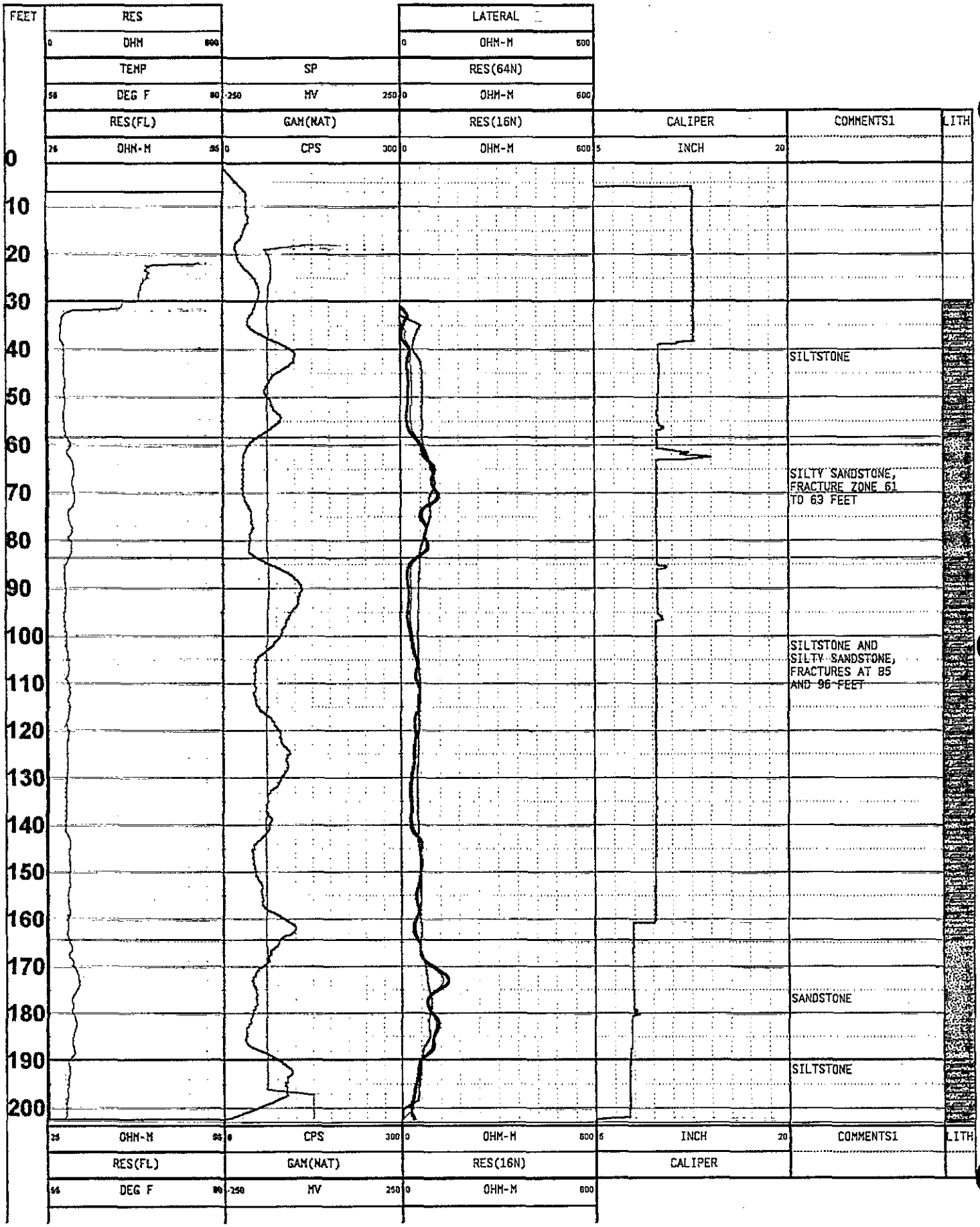
Environmental Resources Management, Inc.

Geophysical Services

ERM

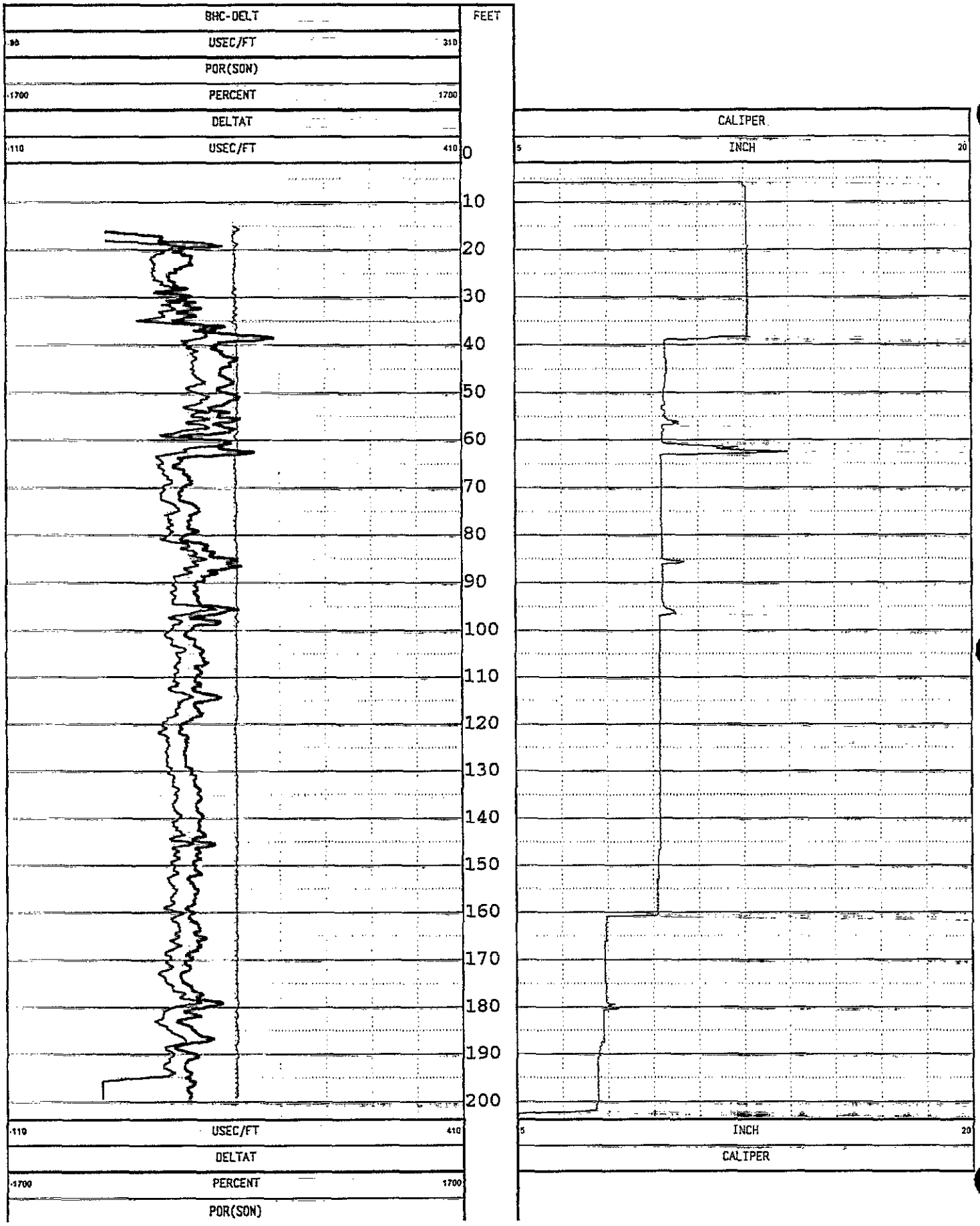
Borehole Geophysical Log

CLIENT	:	**Middletown**
WELL	:	**ERM-24I**
LOCATION/FIELD	:	
CITY	:	**Middletown**
STATE	:	**Pa.**
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	**200**
LOG TOP	:	**0**
ELEV. PERM. DATUM	:	
FILE NAME	:	**c:\acl\logs\mdtn\erm-24I**
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	**George Pfeiffer**
INTERPRETED BY	:	**Don Jagel**
COMMENTS	:	**HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok**


FEET
RES
0 OHM 600
TEMP
56 DEG F 80
RES(FL)
26 OHM-M 35
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
SILTSTONE
SILTY SANDSTONE, FRACTURE ZONE 61 TO 63 FEET
SILTSTONE AND SILTY SANDSTONE, FRACTURES AT 85 AND 96 FEET
SANDSTONE
SILTSTONE

FEET	0 OHM 600
	RES

0 OHM-M 600
LATERAL


BHC-DELT
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
CALIPER
5
INCH
20
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
5
INCH
20
CALIPER

-80 USEC/FT 310	
BHC-DELT	FEET

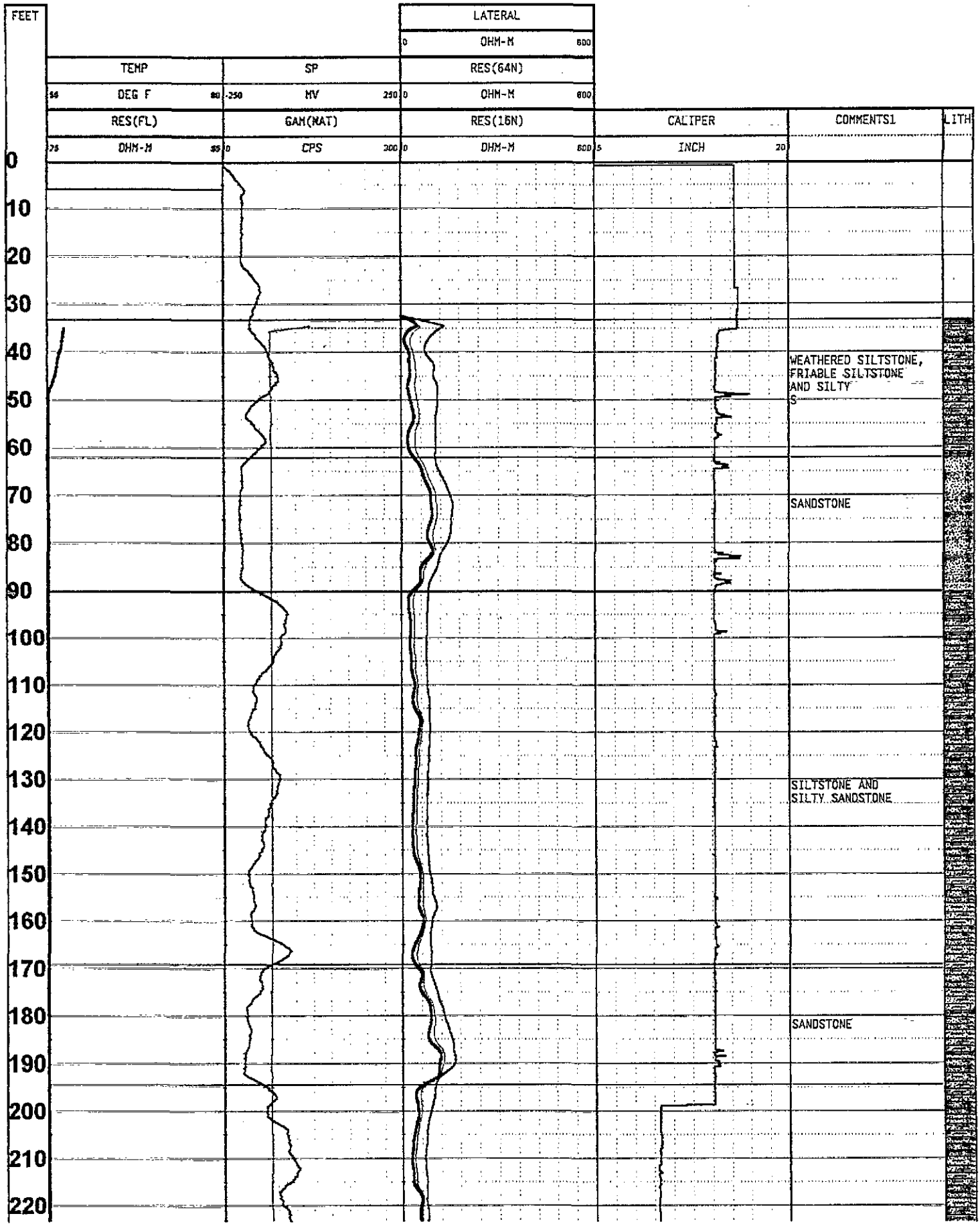
Environmental Resources Management, Inc.

Geophysical Services

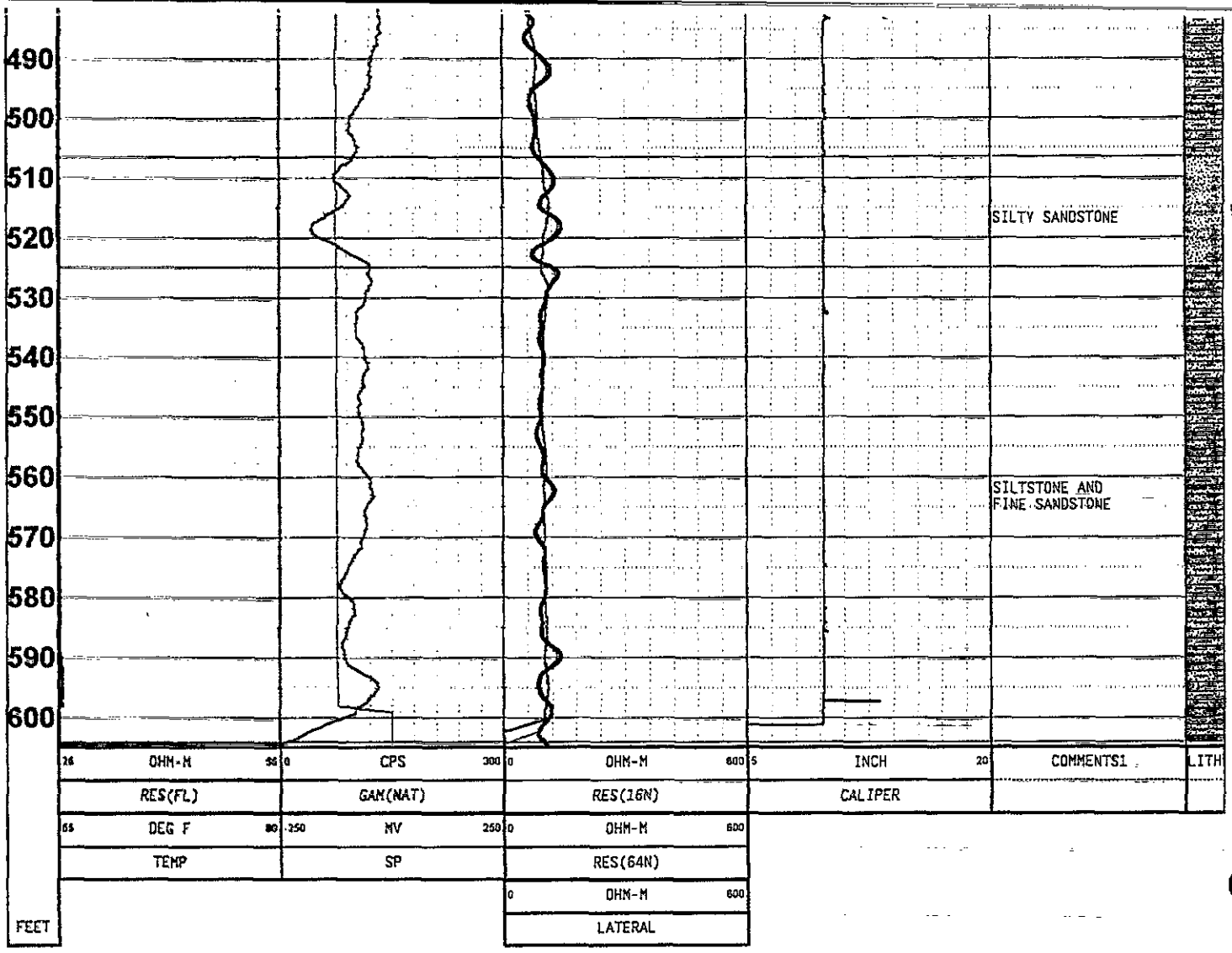
ERM

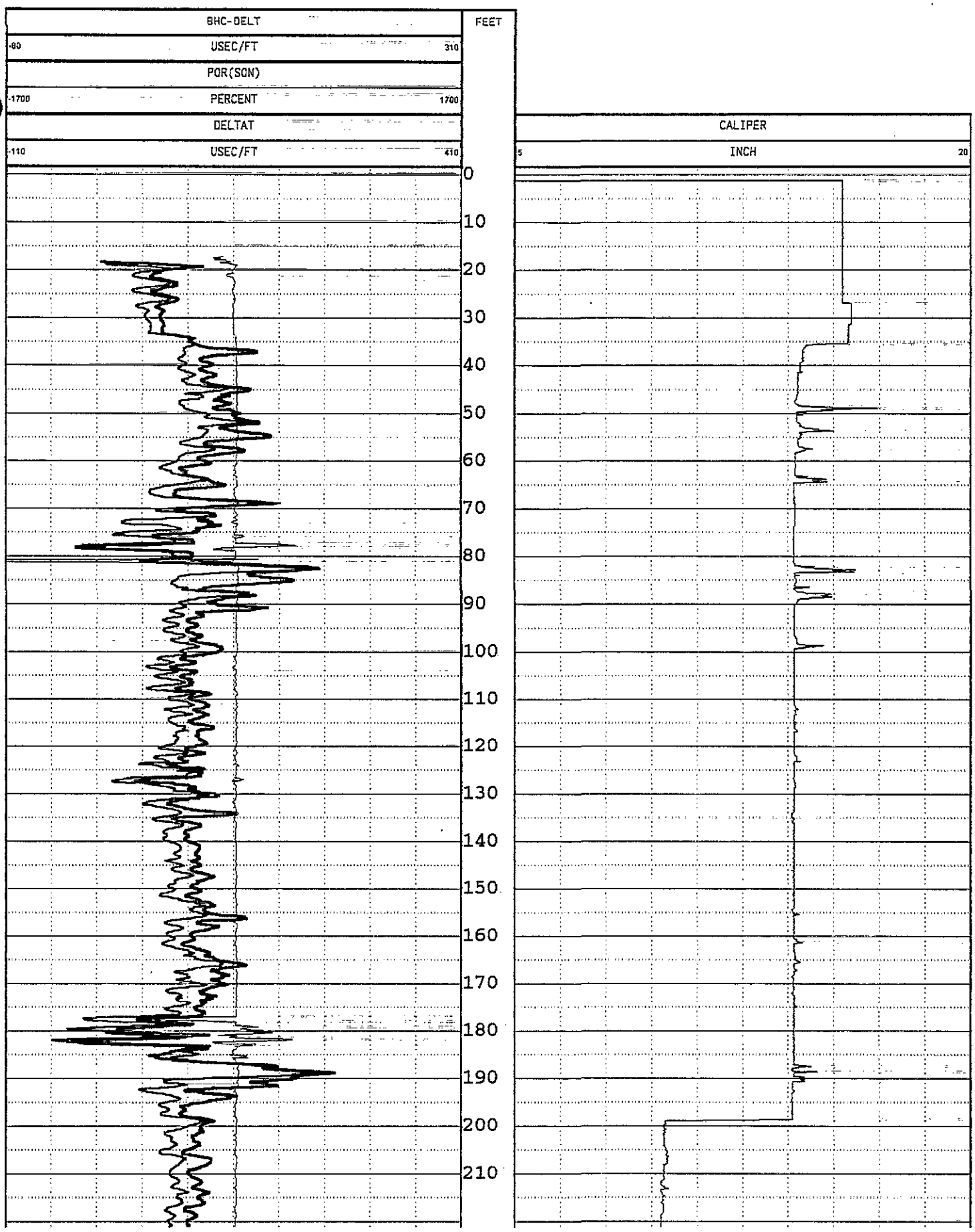
Borehole Geophysical Log

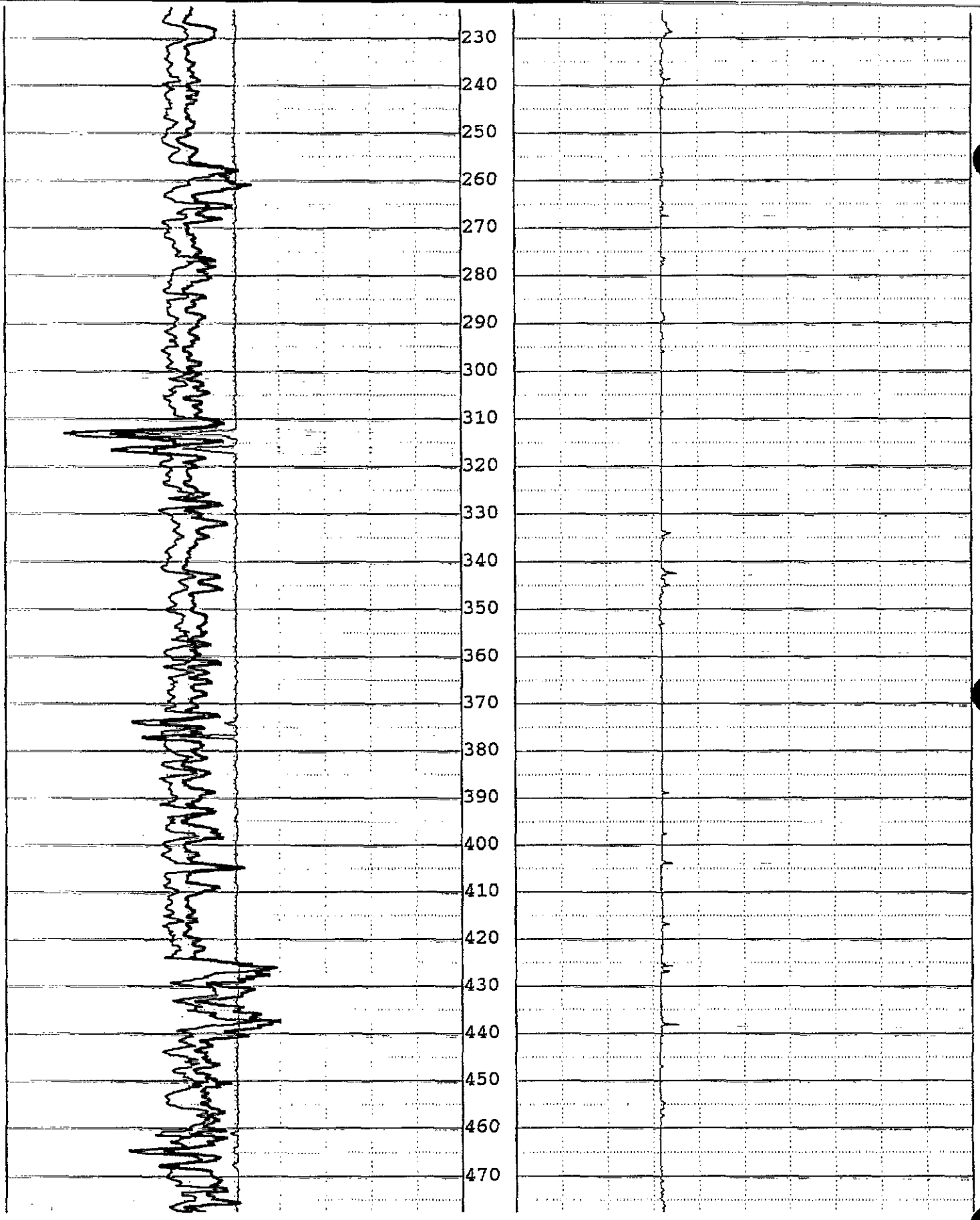
CLIENT	:	Middletown
WELL	:	ERM-24D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	600
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-24D
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok

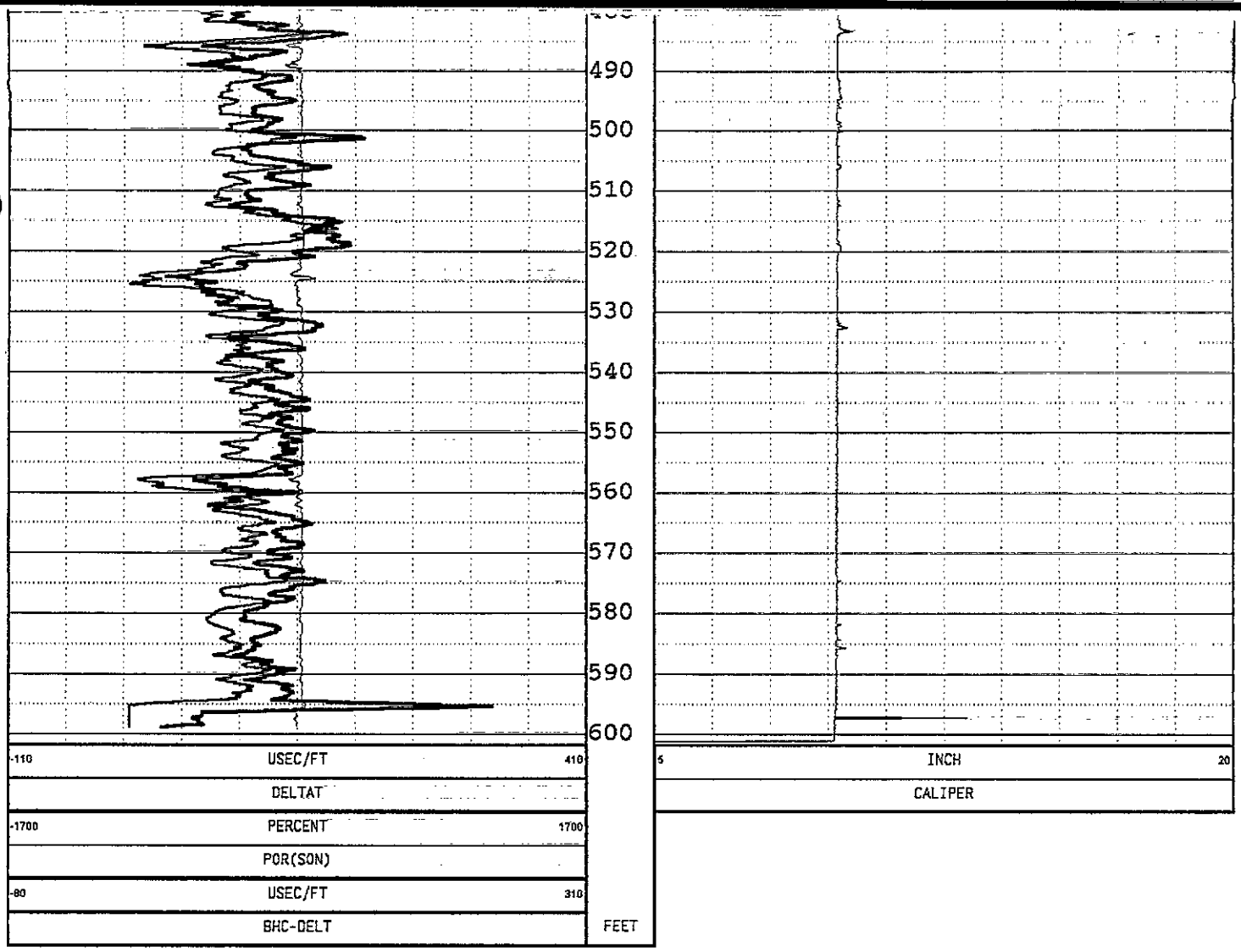

FEET
LATERAL
0 OHM-M 600
TEMP
56 DEG F 80
SP
-250 MV 250
RES(64N)
0 OHM-M 600
RES(FL)
75 OHM-M 95
GAM(NAT)
0 CPS 300
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
WEATHERED SILTSTONE, FRIABLE SILTSTONE AND SILTY S
SANDSTONE
SILTSTONE AND SILTY SANDSTONE
SANDSTONE

230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
FRIABLE SILTSTONE AND SILTY SANDSTONE
FINE SANDSTONE
SILTSTONE, MINOR MINOR FRACTURES AT 388, 398, 403 AND 416 FEET
FINE SANDSTONE


490
500
510
520
530
540
550
560
570
580
590
600
SILTY SANDSTONE
SILTSTONE AND
FINE SANDSTONE
26 OHM-M 56
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 80
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM-M 600
LATERAL
FEET


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

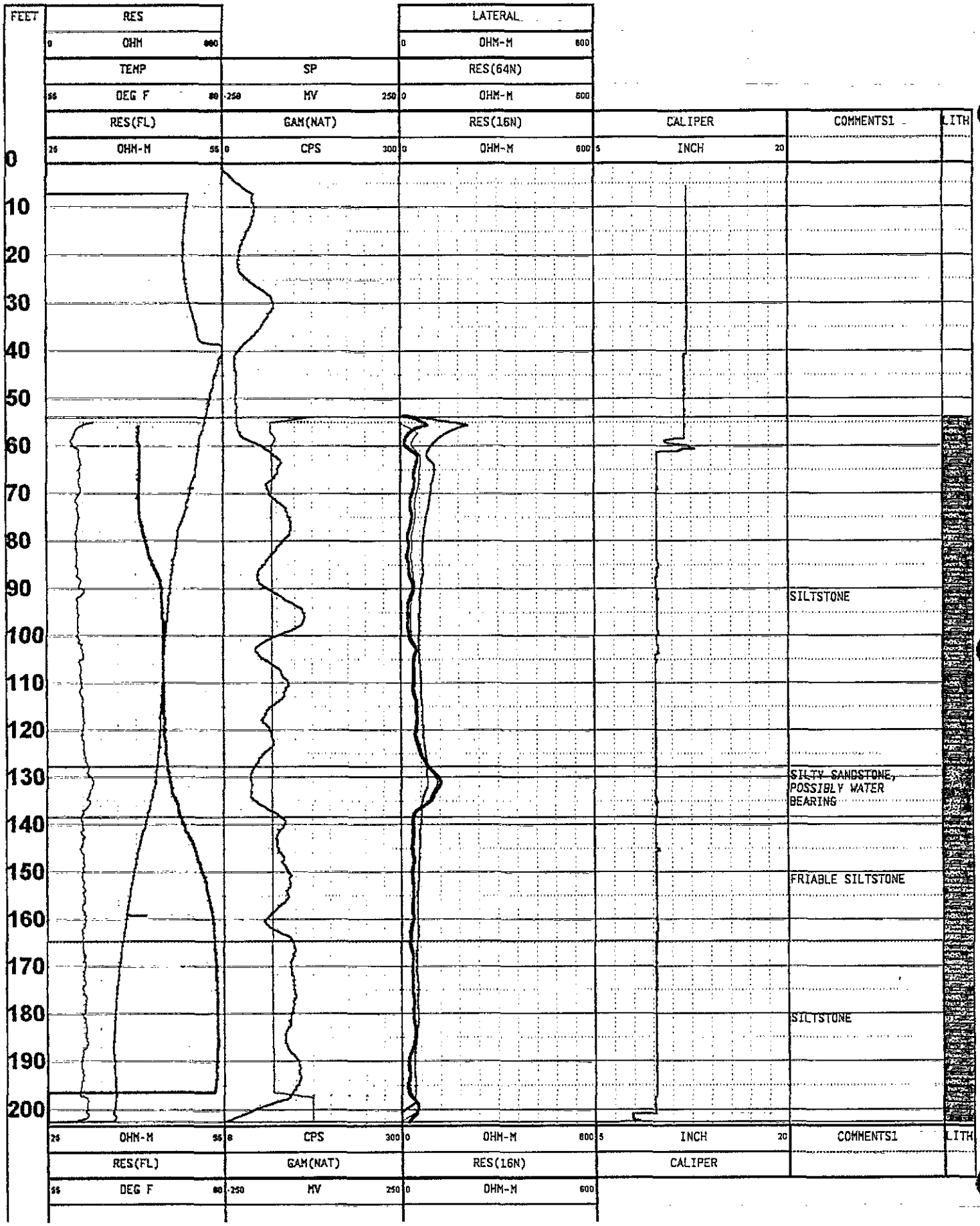
Environmental Resources Management, Inc.

Geophysical Services

ERM

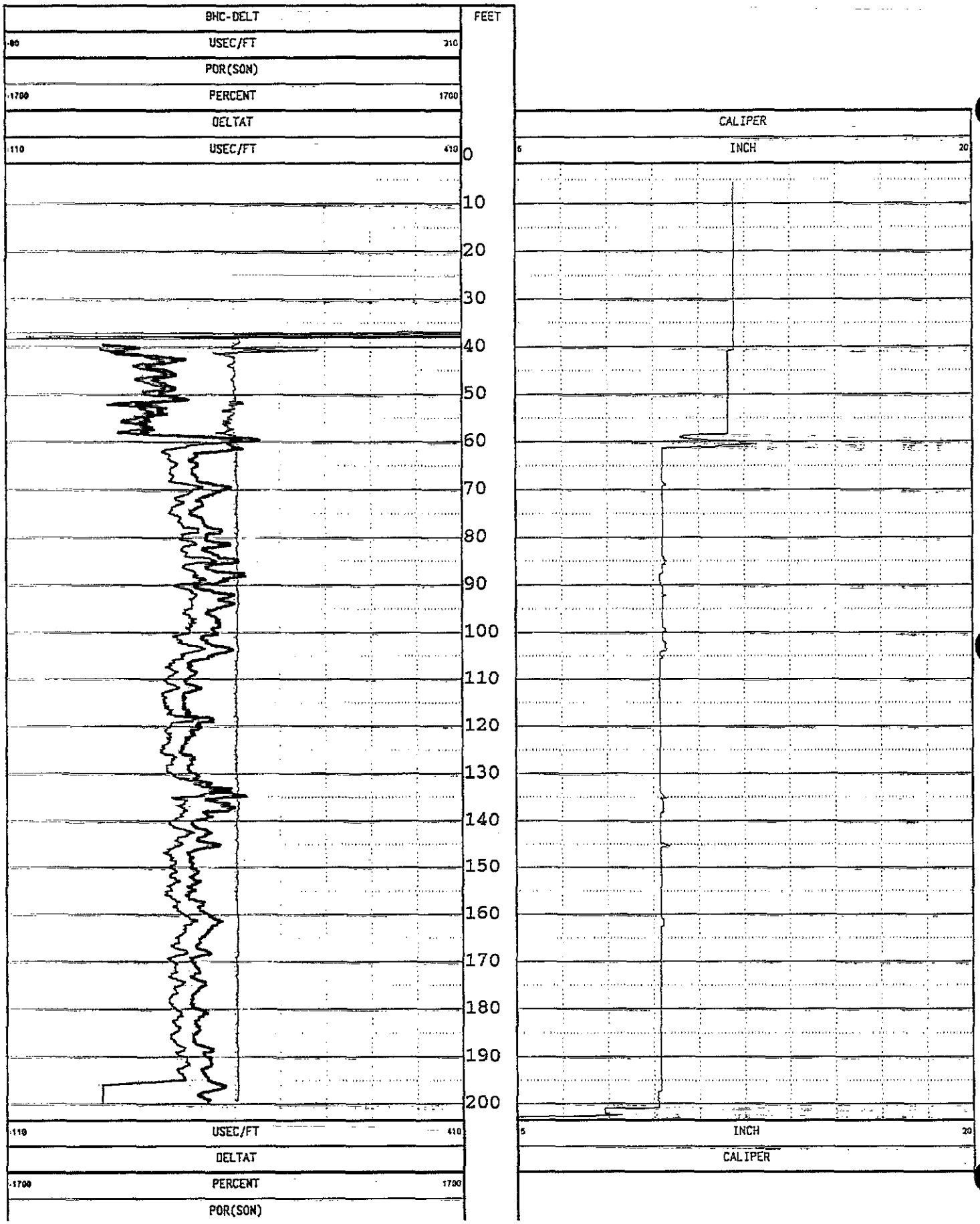
Borehole Geophysical Log

CLIENT	:	Middletown
WELL	:	ERM-25I
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	200
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-25I
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok


FEET
RES
0 OHM 600
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
SILTSTONE
SILTY SANDSTONE, POSSIBLY WATER BEARING
FRIABLE SILTSTONE
SILTSTONE

FEET	0 OHM 600
	RES

0 OHM-M 600
LATERAL


BHC-DELT
-80
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
CALIPER
6
INCH
20
5
INCH
20
CALIPER

80	USEC/FT	310	
	BHC-DELT		FEET

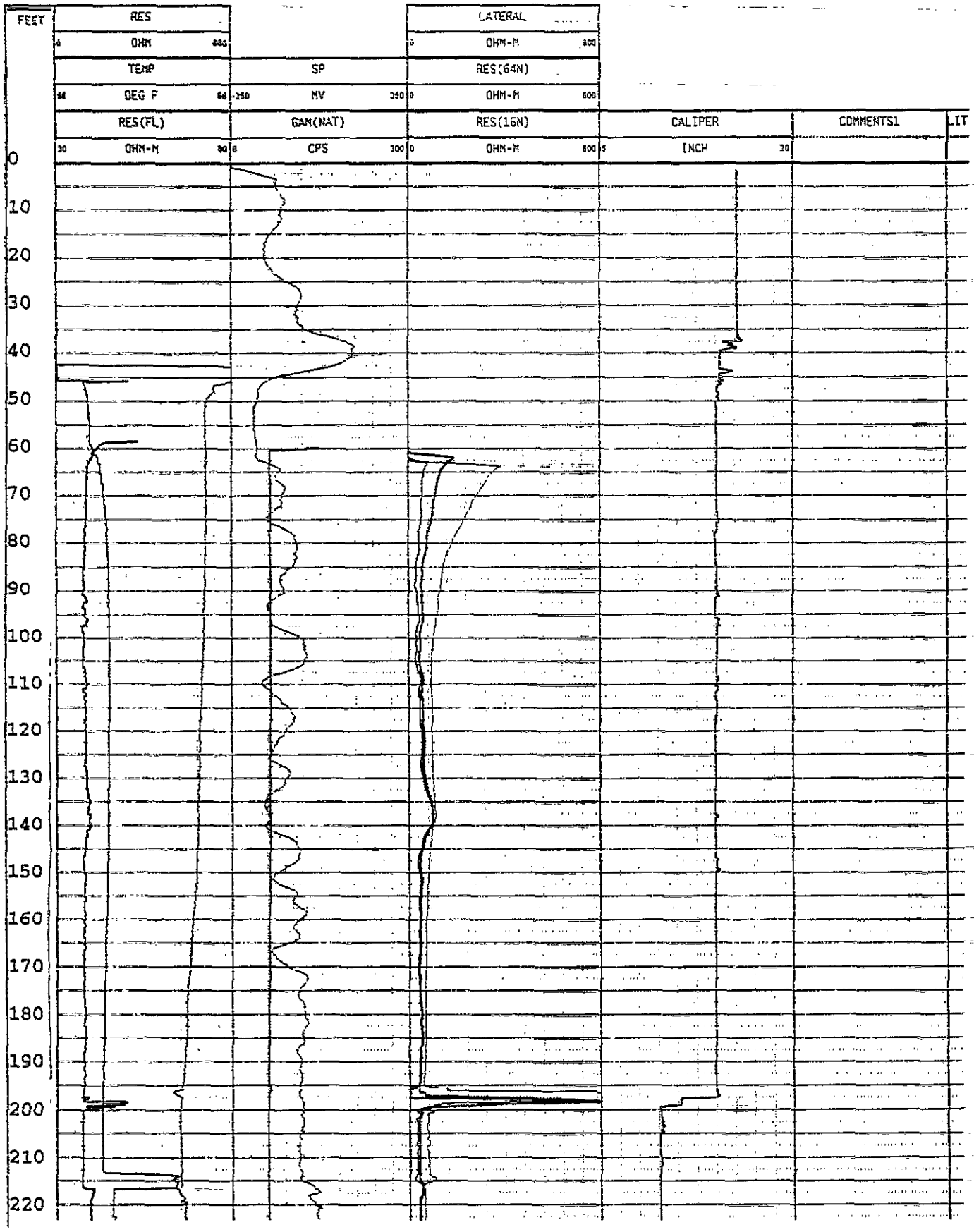
Environmental Resources Management, Inc.

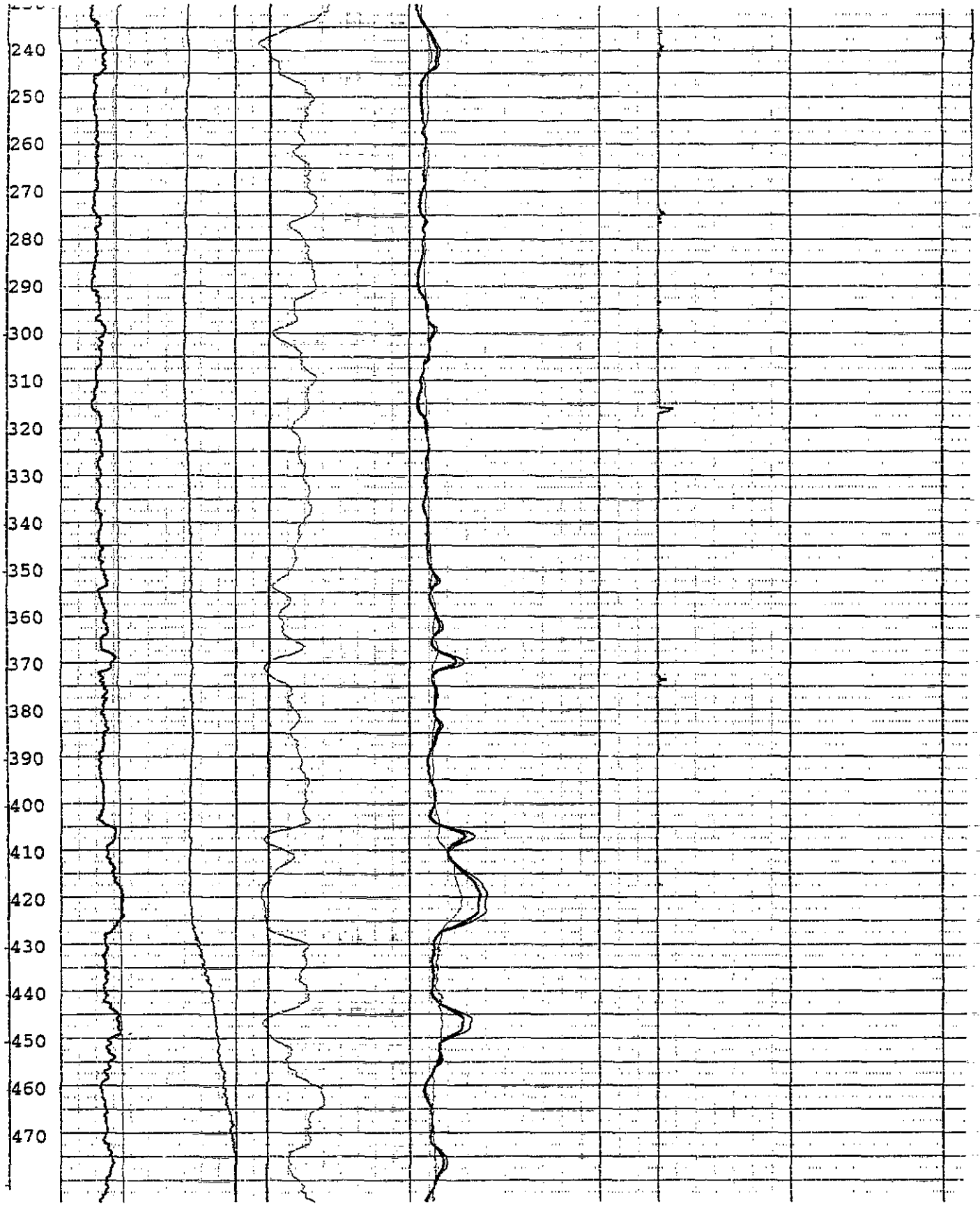
Geophysical Services

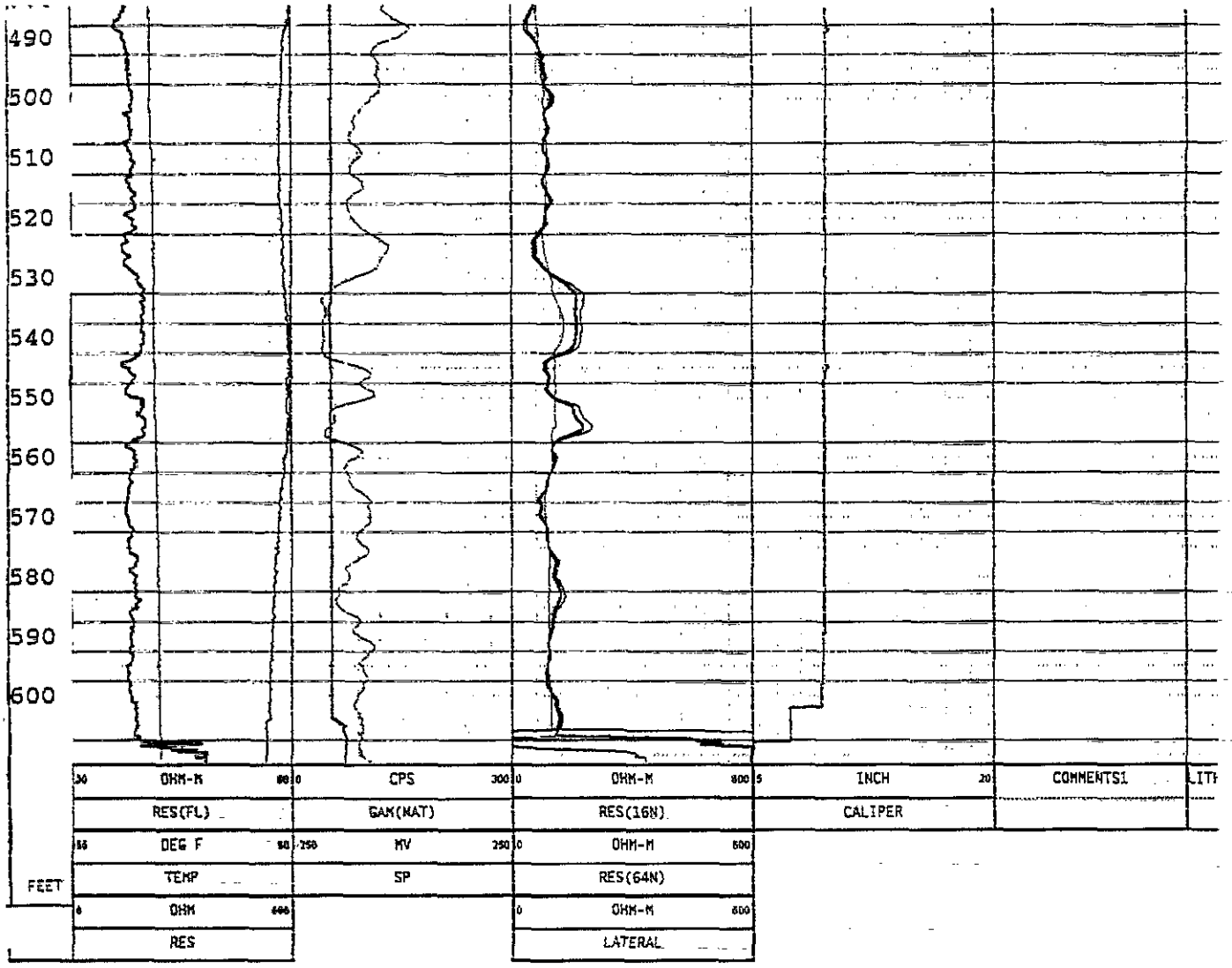
ERM

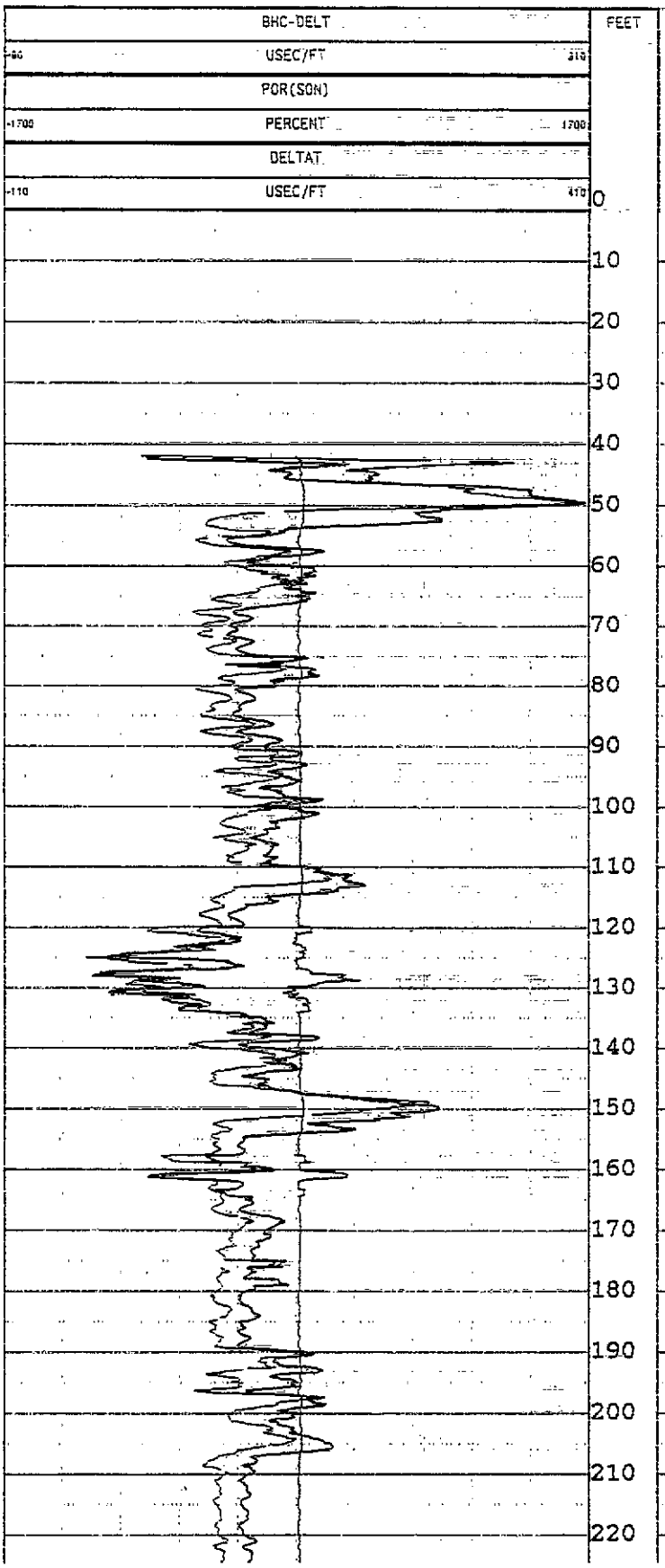
Borehole Geophysical Log

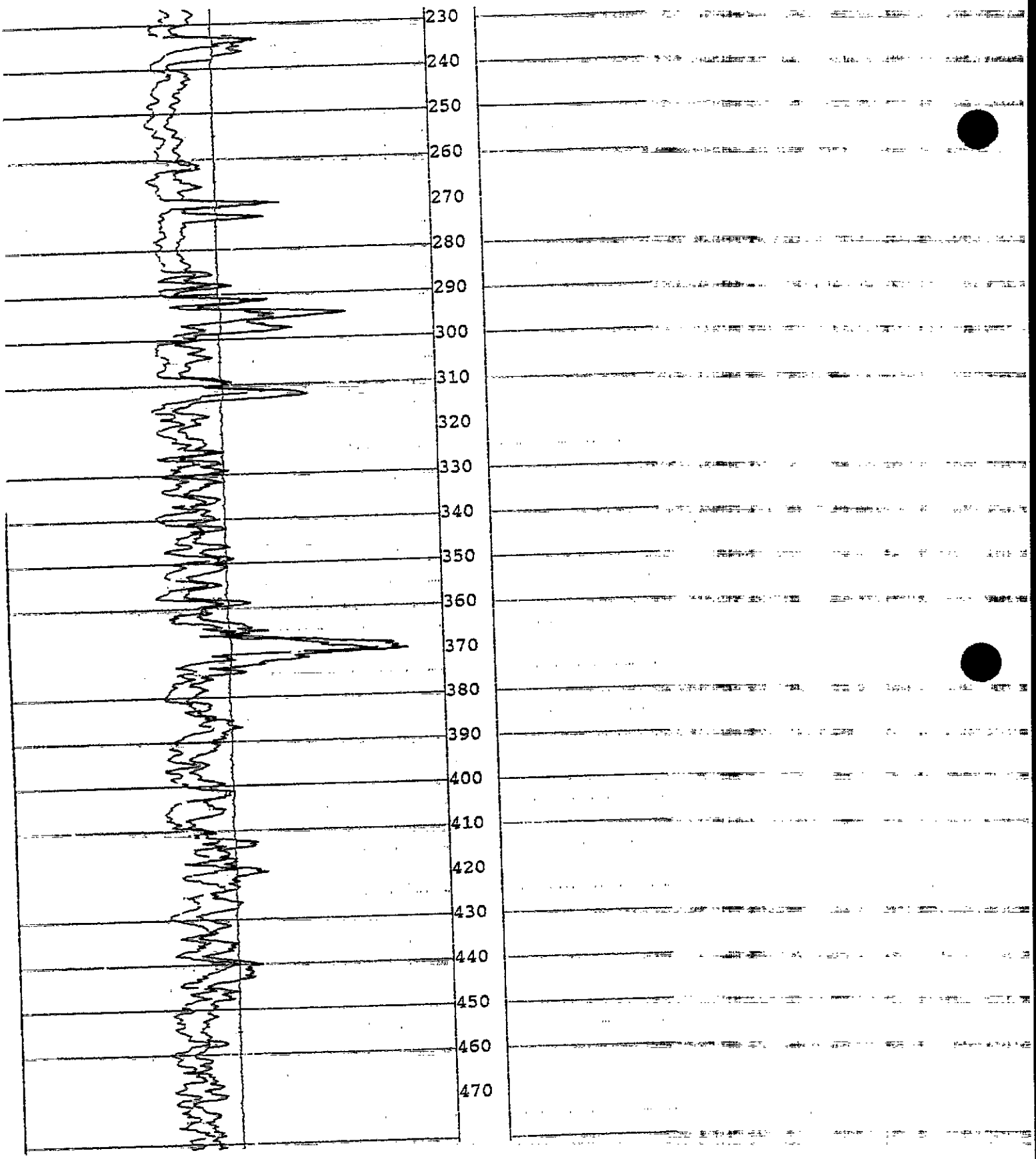
CLIENT	:	Middletown
WELL	:	ERM-25D
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	600
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-25D
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☐ Comments ☐ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Scott McQuown
COMMENTS	:	

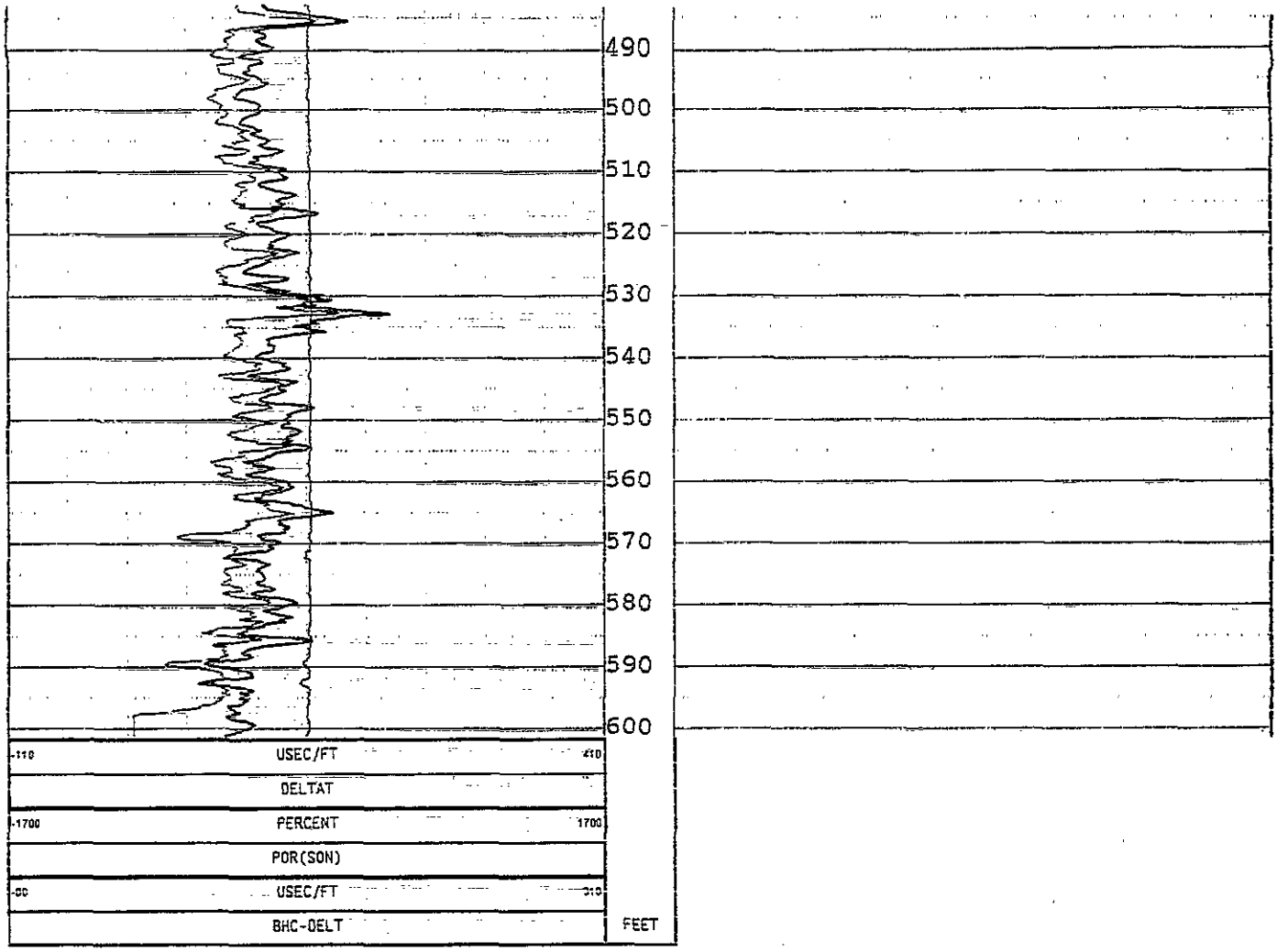

FEET
RES
0 OHM 800
TEMP
54 DEG F 66
RES(FL)
30 OHM-M 90
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LIT
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220


240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
FEET
30 OHM-M 80
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 800
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 90
TEMP
-250 MV 250
SP
0 OHM-M 800
RES(64N)
0 OHM 600
RES
0 OHM-M 800
LATERAL


BHC-DELT
USEC/FT
POR(SON)
PERCENT
DELTAT
USEC/FT
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470

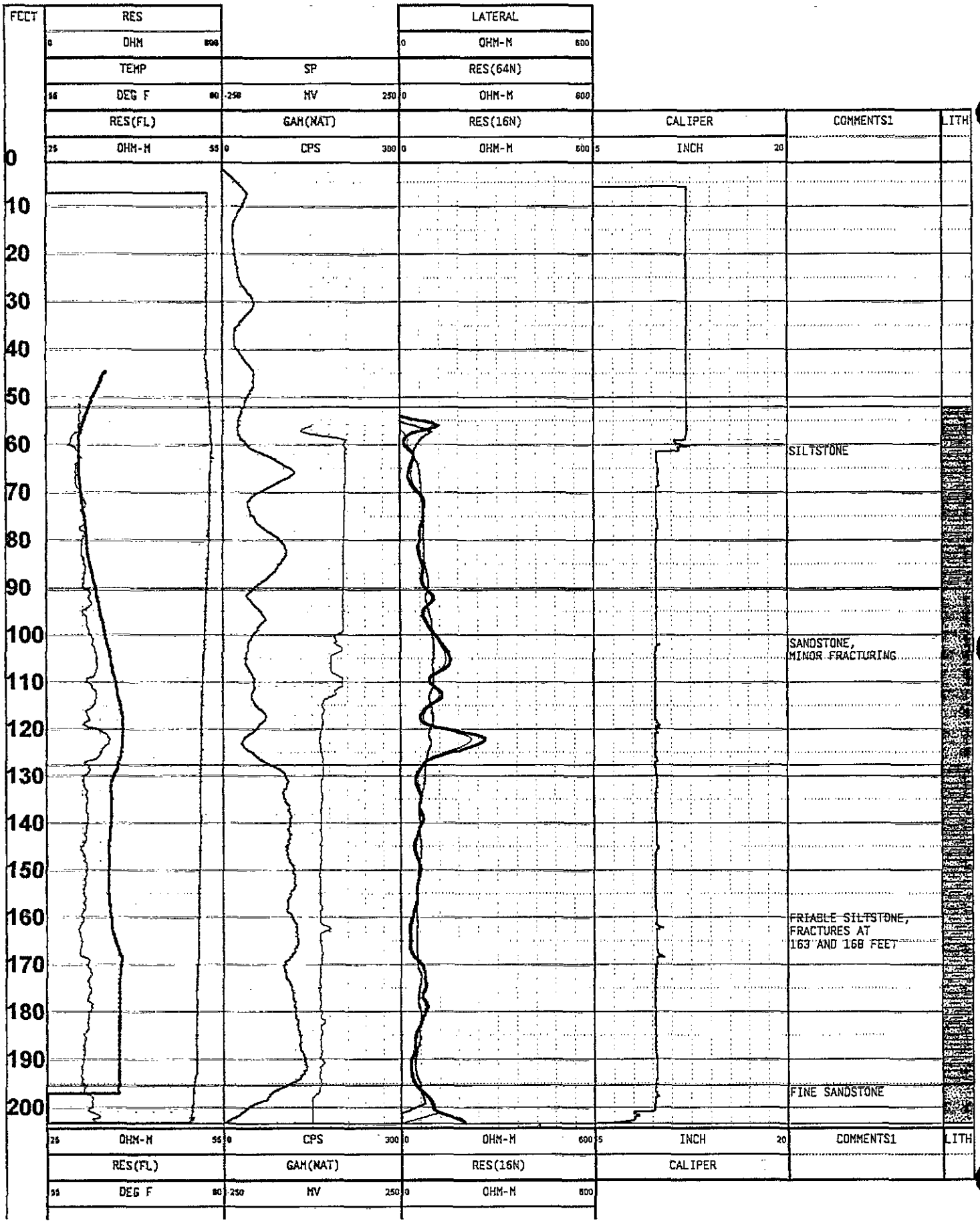

490
500
510
520
530
540
550
560
570
580
590
600
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-00
USEC/FT
BHC-DELT
FEET

Environmental Resources Management, Inc.
Geophysical Services

ERM

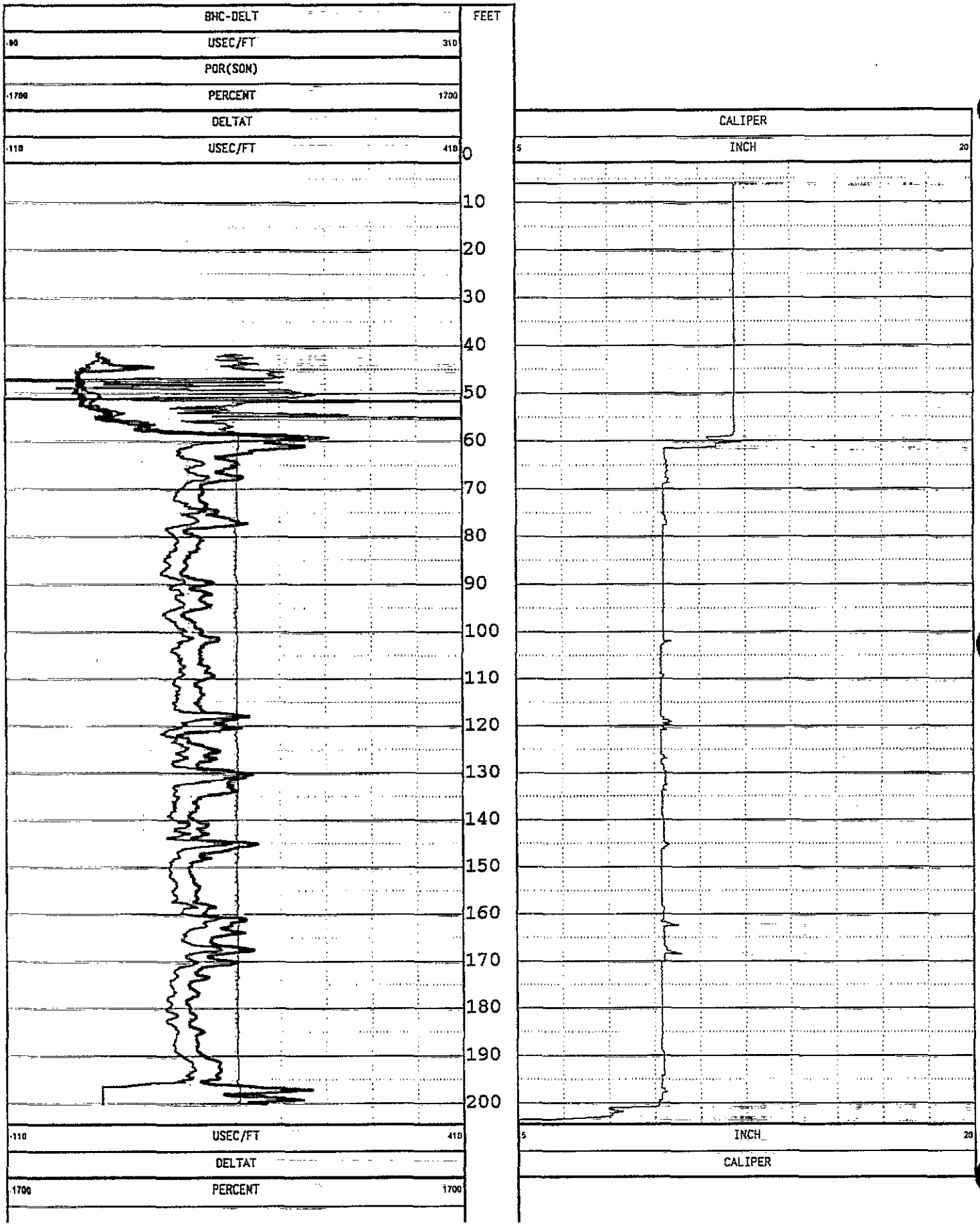
Borehole Geophysical Log

CLIENT	:	Middletown
WELL	:	ERM-26I
LOCATION/FIELD	:	
CITY	:	Middletown
STATE	:	Pa.
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	200
LOG TOP	:	0
ELEV. PERM. DATUM	:	
FILE NAME	:	c:\acl\logs\mdtn\erm-26I
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	George Pfeiffer
INTERPRETED BY	:	Don Jagel
COMMENTS	:	HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok


FEET
RES
0 OHM 600
TEMP
55 DEG F 80
RES(FL)
25 OHM-M 55
SP
-250 MV 250
GAM(NAT)
0 CPS 300
LATERAL
0 OHM-M 600
RES(64N)
0 OHM-M 600
RES(16N)
0 OHM-M 600
CALIPER
5 INCH 20
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
SILTSTONE
SANDSTONE,
MINOR FRACTURING
FRIABLE SILTSTONE,
FRACTURES AT
163 AND 168 FEET
FINE SANDSTONE

FEET	0	OHM	600	
		RES		

0	OHM-M	600
	LATERAL	


BHC-DELT
FEET
-90
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
CALIPER
5
INCH
20
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
5
INCH
20
CALIPER

80	USEC/FT 310	
	BHC-DELT	FEET

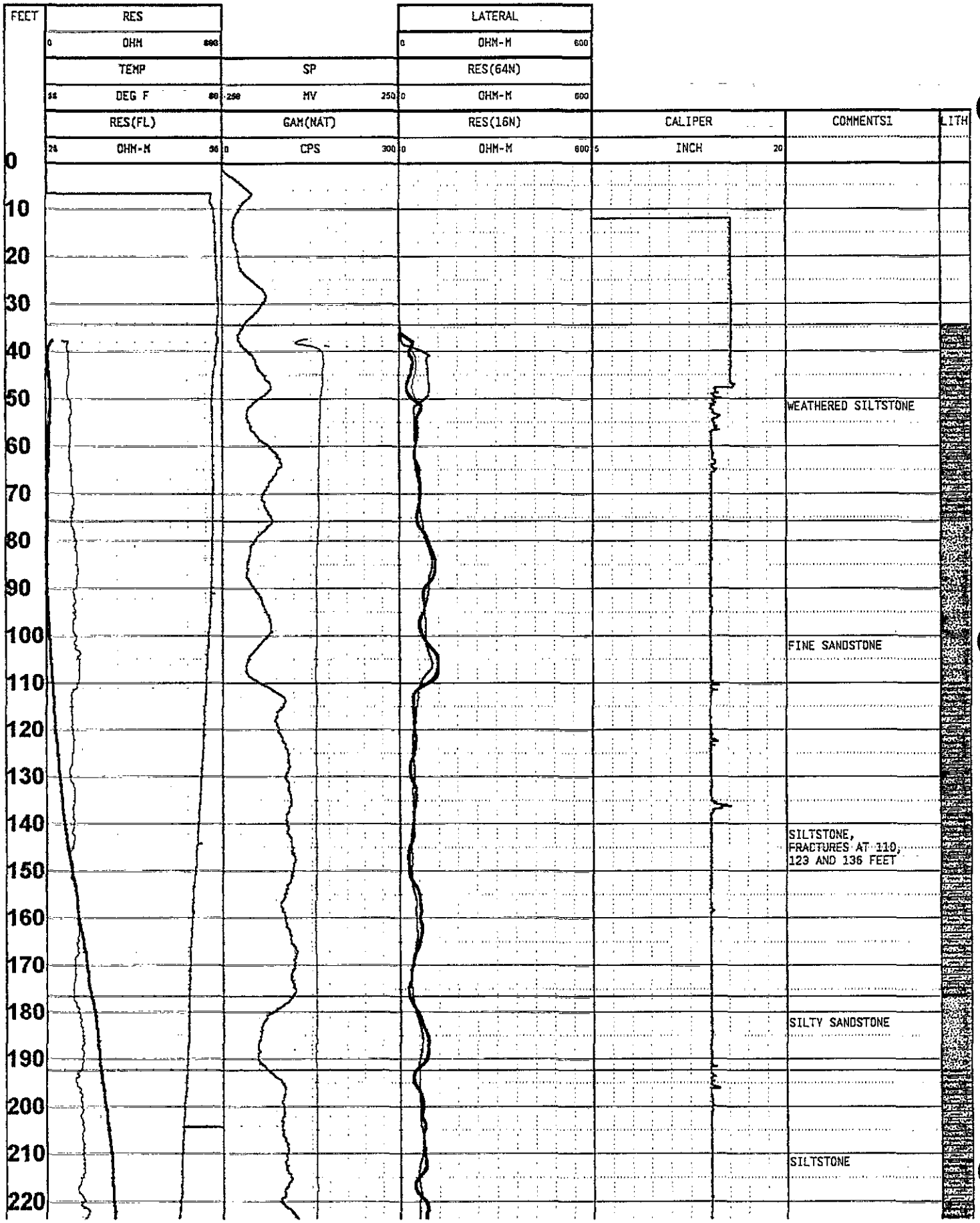
Environmental Resources Management, Inc.

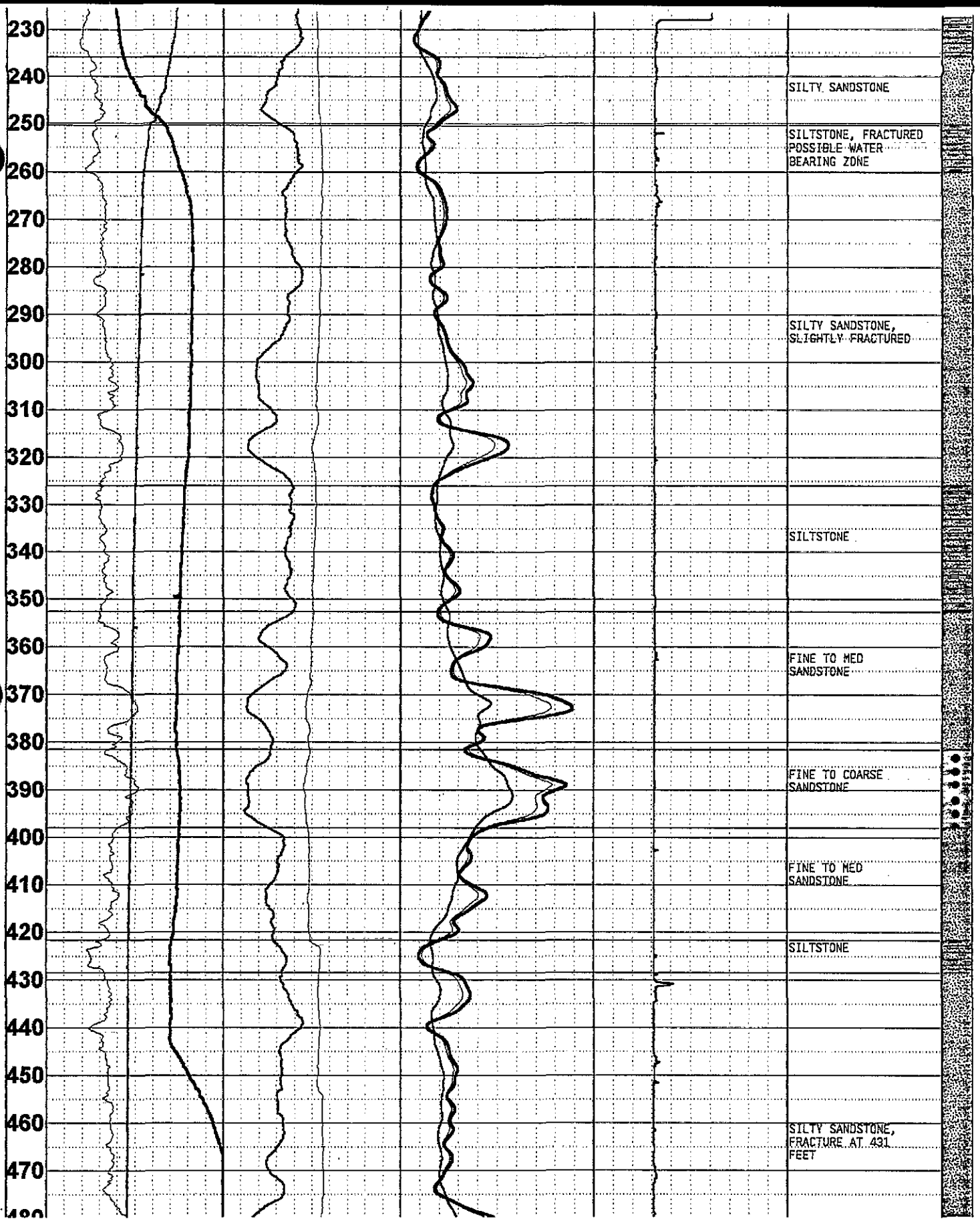
Geophysical Services

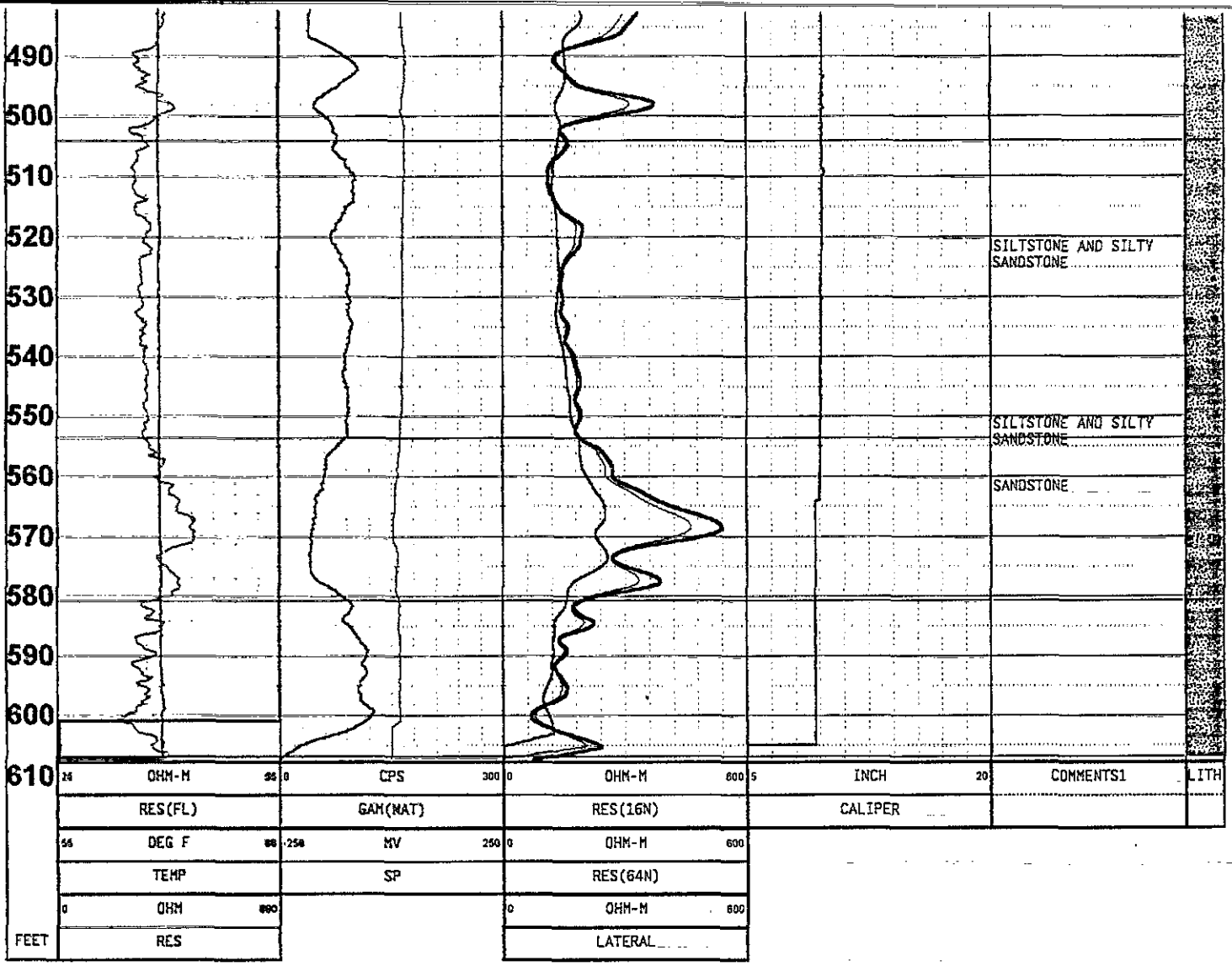
ERM

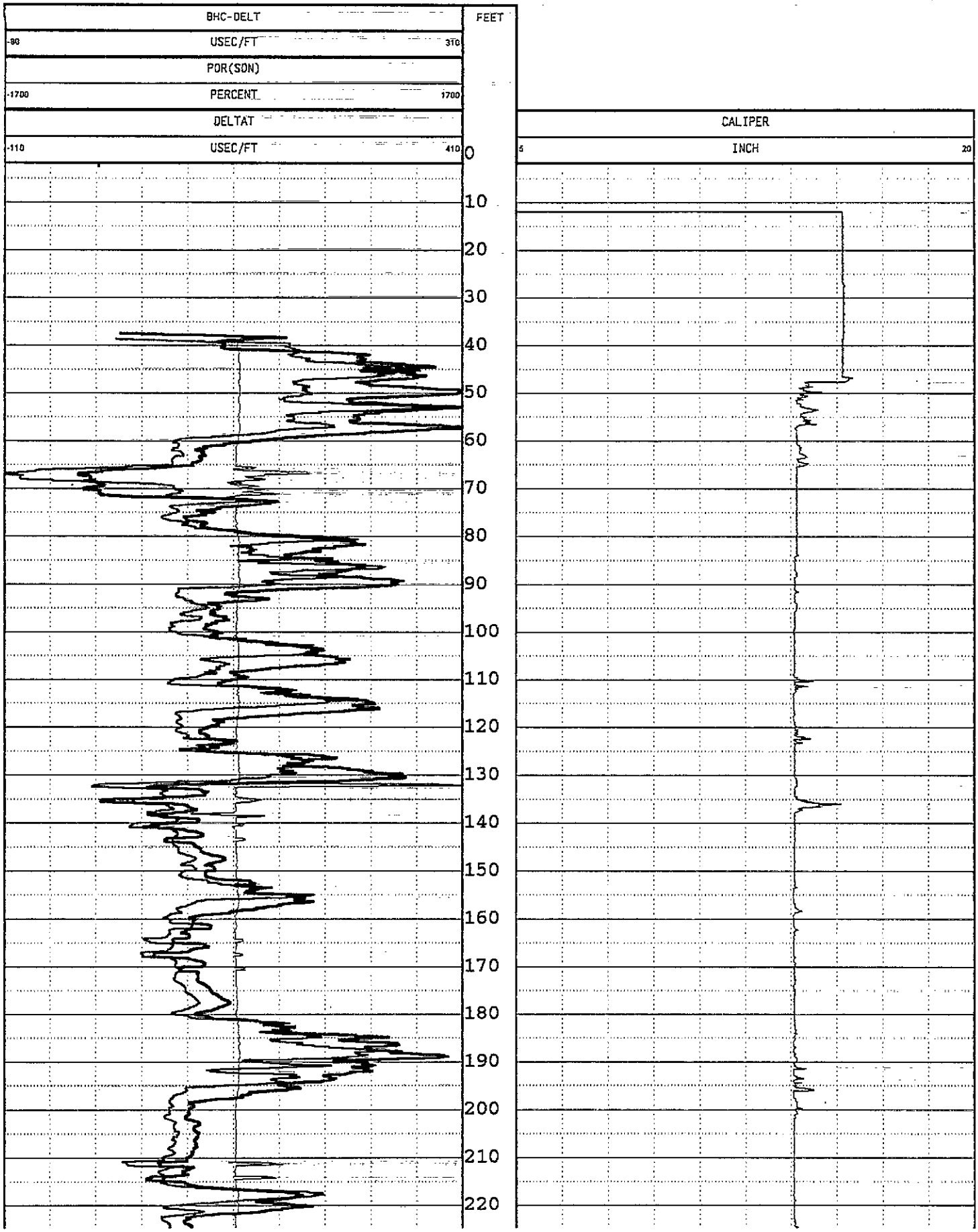
Borehole Geophysical Log

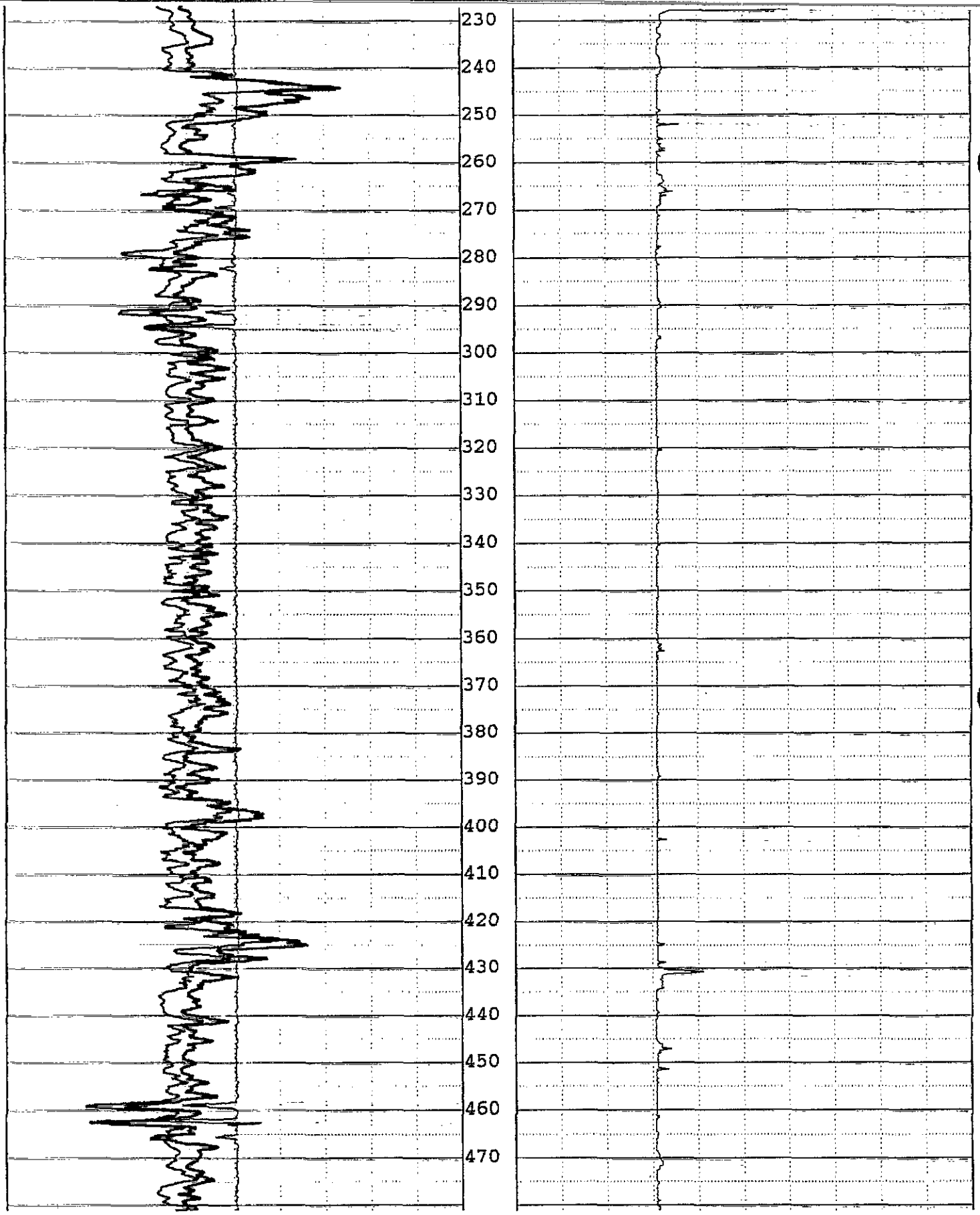
CLIENT	:	**Middletown**
WELL	:	**ERM-26D**
LOCATION/FIELD	:	
CITY	:	**Middletown**
STATE	:	**Pa.**
DATE	:	
DEPTH DRILLER	:	
LOG BOTTOM	:	**600**
LOG TOP	:	**0**
ELEV. PERM. DATUM	:	
FILE NAME	:	**c:\acl\logs\mdtn\erm-26D**
TYPE		☒ Resistance ☒ Fluid Resistivitiy ☒ Temperature ☒ SP ☒ Nat. Gamma ☒ Lateral Res. ☒ Resistivity (64N) ☒ Resistivity (16N) ☒ Caliper ☒ Comments ☒ Interpreted Lithology ☒ Acoustic ☐ Dipmeter
RECORDED BY	:	**George Pfeiffer**
INTERPRETED BY	:	**Don Jagel**
COMMENTS	:	**HydroTool calibration 08-Apr-91 by Century Geophysical Corp., Tulsa, Ok**

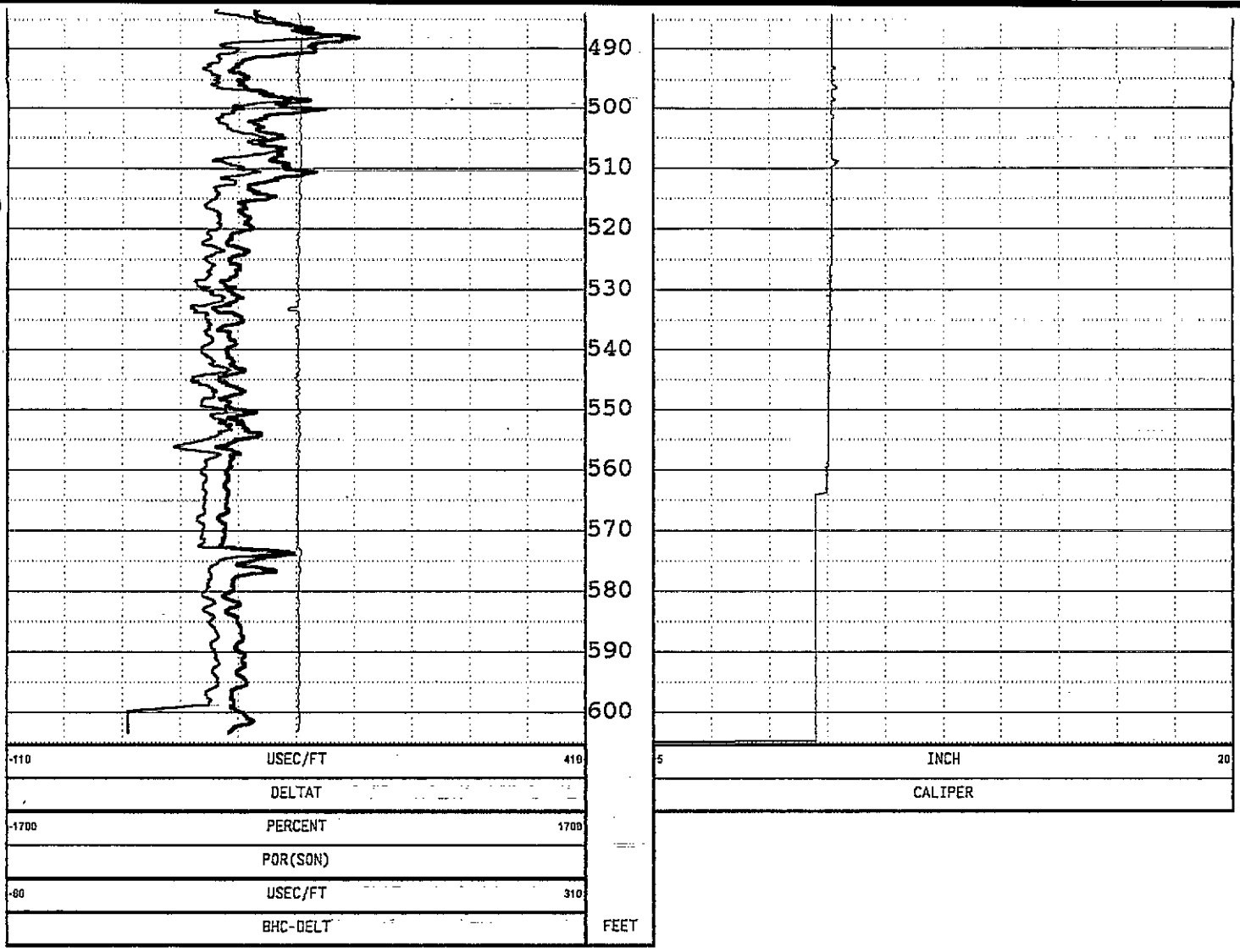

FEET
RES
0 OHM 600
TEMP
DEG F
RES(FL)
OHM-M
SP
MV
GAM(NAT)
CPS
LATERAL
OHM-M
RES(64N)
OHM-M
RES(16N)
OHM-M
CALIPER
INCH
COMMENTS1
LITH
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
WEATHERED SILTSTONE
FINE SANDSTONE
SILTSTONE,
FRACTURES AT 110,
123 AND 136 FEET
SILTY SANDSTONE
SILTSTONE


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
SILTY SANDSTONE
SILTSTONE, FRACTURED POSSIBLE WATER BEARING ZONE
SILTY SANDSTONE, SLIGHTLY FRACTURED
SILTSTONE
FINE TO MED SANDSTONE
FINE TO COARSE SANDSTONE
FINE TO MED SANDSTONE
SILTSTONE
SILTY SANDSTONE, FRACTURE AT 431 FEET


490
500
510
520
530
540
550
560
570
580
590
600
610
FEET
SILTSTONE AND SILTY SANDSTONE
SILTSTONE AND SILTY SANDSTONE
SANDSTONE
24 OHM-M 96
RES(FL)
0 CPS 300
GAM(NAT)
0 OHM-M 600
RES(16N)
5 INCH 20
CALIPER
COMMENTS1
LITH
55 DEG F 88
TEMP
-250 MV 250
SP
0 OHM-M 600
RES(64N)
0 OHM 800
RES
0 OHM-M 600
LATERAL


BHC-DELT
-90
USEC/FT
310
POR(SON)
-1700
PERCENT
1700
DELTAT
-110
USEC/FT
410
FEET
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
CALIPER
5
INCH
20


230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470


490
500
510
520
530
540
550
560
570
580
590
600
-110
USEC/FT
410
DELTAT
-1700
PERCENT
1700
POR(SON)
-80
USEC/FT
310
BHC-DELT
FEET
5
INCH
20
CALIPER

Attachment B2
welenco Geophysical Logs for Production Wells:
HIA-2
HIA-9
HIA-13

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 113

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY DIFFERENTIAL TEMPERATURE - FLUID RESISTIVITY (PUMPING) JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 114

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY SPINNER LOG (NON-PUMPING) JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 115

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FFS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY DIFFERENTIAL TEMPERATURE - FLUID RESISTIVITY (PUMPING)
JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 116

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT — VOLUME II, APPENDIX B — PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY DIFFERENTIAL TEMPERATURE - FLUID RESISTIVITY (NON-PUMPING) JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 117

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY SPINNER LOG (PUMPING)

JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 118

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY GAMMA RAY - CALIPER - SONIC - VDL LOG
JOB NO. 23417

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 119

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY NON-PUMPING SPINNER LOG (JOB NO. 23418)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 120

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT – VOLUME II, APPENDIX B, – PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY PUMPING SPINNER STOP COUNTS (JOB No. 23418)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 121

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY PUMPING SPINNER LOG (JOB NO. 23418

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 122

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY NON-PUMPING DIFFERENTIAL TEMPERATURE-FLUID RESISTIVITY (JOB No. 23418)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 123

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY GAMMA RAY - CALIPER - SONIC - VDL LOG (JOB No. 23418)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 123

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FFS) REPORT – VOLUME II, APPENDIX B – PART 4 OF 4

DATE OF DOCUMENT 01 – JUL – 96

DESCRIPTON OF IMAGERY PUMPING – DIFFERENTIAL TEMPERATURE – FLUID RESISTIVITY (JOB NO. 2341(8))

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 124

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY PUMPING SPINNER STOP COUNTS (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 125

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN ARMED NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY NON-PUMPING SPINNER LOG (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 126

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT - VOLUME II, APPENDIX B - PART 4 OF 4

DATE OF DOCUMENT 01 - JUL - 96

DESCRIPTON OF IMAGERY PUMPING - DIFFERENTIAL TEMPERATURE - FLUID RESISTIVITY (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 127

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** II

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT – VOLUME II, APPENDIX B – PART 4 OF 4

DATE OF DOCUMENT 01 – JUL – 96

DESCRIPTON OF IMAGERY NON-PUMPING DIFFERENTIAL TEMPERATURE – FLUID RESISTIVITY (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 128

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FFS) REPORT – VOLUME II, APPENDIX B – PART 4 OF 4

DATE OF DOCUMENT 01-JUL-96

DESCRIPTON OF IMAGERY PUMPING SPINNER LOG (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP

EPA REGION III
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID 132058
PAGE # 129

IMAGERY COVER SHEET
UNSCANNABLE ITEM

SITE NAME MIDDLETOWN AIRFIELD NPL

OPERABLE UNIT FOCUSED FEASIBILITY STUDY

ADMINISTRATIVE RECORDS- SECTION _____ **VOLUME** 11

REPORT OR DOCUMENT TITLE FOCUSED FEASIBILITY STUDY (FS) REPORT – VOLUME II, APPENDIX B – PART 4 OF 4

DATE OF DOCUMENT 01 – JUL – 96

DESCRIPTON OF IMAGERY GAMMA RAY – CALIPER – SONIC – VDL LOG (JOB NO. 23419)

NUMBER AND TYPE OF IMAGERY ITEM(S) 1 OVERSIZED MAP