

CLIFFS MINERALS, INC.
EASTERN GAS SHALES PROJECT
PENNSYLVANIA #2 WELL - ALLEGHENY COUNTY

PHASE II REPORT
PRELIMINARY LABORATORY RESULTS
JUNE 1980

T A B L E O F C O N T E N T S

	<u>PAGE</u> <u>NO.</u>
1.0 INTRODUCTION	1
2.0 SCOPE OF WORK	1
3.0 LABORATORY PROCEDURES	3
3.1 Review of Geophysical Logs	3
3.2 Photographic Log	4
3.3 Detailed Lithologic Log	4
3.4 Stratigraphic Section	5
3.5 Color Histogram	5
3.6 Fracture Logs	8
3.7 Measurement of Shore Hardness	10
4.0 REPORTING OF RESULTS	10
5.0 DISCUSSION OF RESULTS	11
5.1 General	11
5.2 Geologic Setting	13
5.3 Stratigraphy	13
5.4 Fracture Analysis	18

A P P E N D I C E S

A	DETAILED LITHOLOGIC DESCRIPTION
B	SYMBOLS, TERMS, AND ABBREVIATIONS USED IN FRACTURE LOGGING
C	FRACTURE LOGS
	BIBLIOGRAPHY
	PLATE IN POCKET

L I S T O F F I G U R E S

<u>FIGURE NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
1	TEXTURAL CLASSIFICATION OF FINE CLASTIC SEDIMENTARY ROCKS	6
2	TEXTURAL CLASSIFICATION OF LIMESTONE (After Dunham, 1962)	7
3	LOCATION OF THE EGSP PA #2 WELL IN ALLEGHENY COUNTY, PENNSYLVANIA	12
4	CONTOURED DIAGRAM OF POLES TO FAULTS	20
5	CONTOURED DIAGRAM OF POLES TO JOINTS	21
6	CONTOURED DIAGRAM SHOWING THE BEARING AND PLUNGE AT SLICKENLINES	22

L I S T O F T A B L E S

<u>TABLE NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
1	FORMATION THICKNESSES	14
2	DISTRIBUTION OF NATURAL FRACTURES	18

1.0 INTRODUCTION

The U. S. Department of Energy is funding a research and development program entitled the Eastern Gas Shales Project designed to increase commercial production of natural gas in the eastern United States from Middle and Upper Devonian Shales. The program's objectives are as follows:

1. To evaluate recoverable reserves of gas contained in the shales.
2. To enhance recovery technology for production from shale gas reservoirs.
3. To stimulate interest among commercial gas suppliers in the concept of producing large quantities of gas from low-yield, shallow Devonian Shale wells.

The Pennsylvania #2 well was drilled during February and March of 1979 under a cooperative cost-sharing agreement between the Department of Energy and Combustion Engineering Power Systems, Inc.

This report summarizes the results of core characterization work performed at the Eastern Gas Shales Project Core Laboratory on core retrieved from the Allegheny County well designated EGSP PA #2.

2.0 SCOPE OF WORK

The objective of work performed at the Eastern Gas Shales Project's Core Laboratory is to provide a detailed characterization of cores recovered from the EGSP PA #2 gas well. Data are acquired from several sources for analysis. At the well site, suites of wet and dry hole geophysical logs were run which included the following:

Dry Hole Logs: Gamma Ray
Compensated Formation Density
Induction
Sidewall Neutron Porosity
Sibilation
Caliper
Temperature
Variable Density

Wet Hole Logs: Borehole Compensated Sonic
Cement Bond - Variable Density
Compensated Neutron
Continuous Dipmeter
Continuous Directional Sonic
Dual Induction - S.F.L.
Fracture Identification Log
Coriband - Kerogen
Coriband - Physical Properties
Seriband
Compensated Formation Density
Sidewall Neutron Porosity

At the EGSP Core Laboratory, the core was laid out, washed, measured, oriented, and photographed prior to description and sampling. Characterization work performed includes photographic logs, detailed lithologic logs, fracture logs (both natural and induced types), measurement of core color

variation, and stratigraphic interpretation of the cored intervals. In addition, the physical properties samples were prepared for testing by Michigan Technological University. Physical properties data obtained from specimen tests include:

- ° Ultrasonic Velocity
- ° Directional Tensile Strength
- ° Strength in Point Load
- ° Trends of Microfractures
- ° Hydraulic Fracturing

3.0 LABORATORY PROCEDURES

3.1 Review of Geophysical Logs:

During the initial stages of processing the core through the laboratory, wet and dry hole geophysical logs from the well are examined and compared with published reference sections. Using the gamma ray and density logs a preliminary stratigraphic section is prepared for the cored interval. These two logs have proved to be the most useful correlation tools within the Devonian Shale sequence. Much of the development of existing formation nomenclature for the Devonian Shales is based on the recognition of characteristic features of these logs. Consequently, formation boundaries and thicknesses are, in some cases, more readily determined from gamma ray and density logs than from visual examination of the core itself.

Several other logs often provide information useful for core characterization. The fracture identification log and sonic log frequently indicate the occurrence of zones of structural discontinuity (joints, faults,

concretions, zones of increased friability, etc.) within the core. The sibilation and temperature logs are useful for locating significant flows of gas into the well from isolated fracture systems.

The interpretation of prominent features on the geophysical logs in advance of core description is a means to assure that these features will receive adequate recognition.

3.2 Photographic Log:

After the core was laid out, washed, and oriented on a group of tables, a series of photographs were taken to record the "as-received" condition. A photographic log was then compiled for subsequent documentation. One copy of the log is to be forwarded to the Morgantown Energy Technology Center, under separate cover, together with this report.

3.3 Detailed Lithologic Log:

After detailed visual examination, the core was described in intervals which vary from about 5 feet to 10 feet in length. The first sentence of the description contains a brief summary of lithology, color, and sedimentary structure. Additional remarks are recorded to describe unique features observed within the interval. These remarks may concern any (or all) of the following:

1. Coarse clastic interbeds with scour surfaces, sole marks, cross-stratification, ripple lamination, etc.
2. Macroscopic fossils such as carbonaceous and pyritized vegetal constituents, conodonts, invertebrate shell fragments and casts, fish scales and teeth, etc.
3. Bioturbation, as discrete burrows or as mottled stratification, with emphasis on distribution and association with other rock fabric features.

4. Concretions, slump features, clasts and rip-up structures, gas pits, and other inorganic structures.
5. Modes of pyritization: as disseminated occurrences, nodules, coatings on shell fragments or plant tissue fragments; as accessory mineralization with concretions or clastic interbeds; and as primary irregular lenses or laminae in euxinic black shales.
6. Occurrence of fissility and friability.
7. Carbonate content.

Lithologic terminology applied to the shales is summarized in Figure 1. The classification scheme in use at the Core Laboratory for describing limestones is that of Dunham (1962), shown in Figure 2. Core colors are described using the Rock Color Chart published by the Geological Society of America (1948).

3.4 Stratigraphic Section:

A stratigraphic section for the cored interval was prepared after the gamma ray and density logs had been examined and the detailed lithologic log had been completed. Formation thicknesses were measured, contacts located as precisely as possible, and age relationships determined from published sources.

The locations of certain formation boundaries in the Devonian Shales are difficult to establish with precision. In some cases a contact between two units is gradational, or the nature of a contact may be problematical.

3.5 Color Histogram:

The color histogram is compiled to provide a relative measure of the distribution of light and dark shales through the cored interval. Using

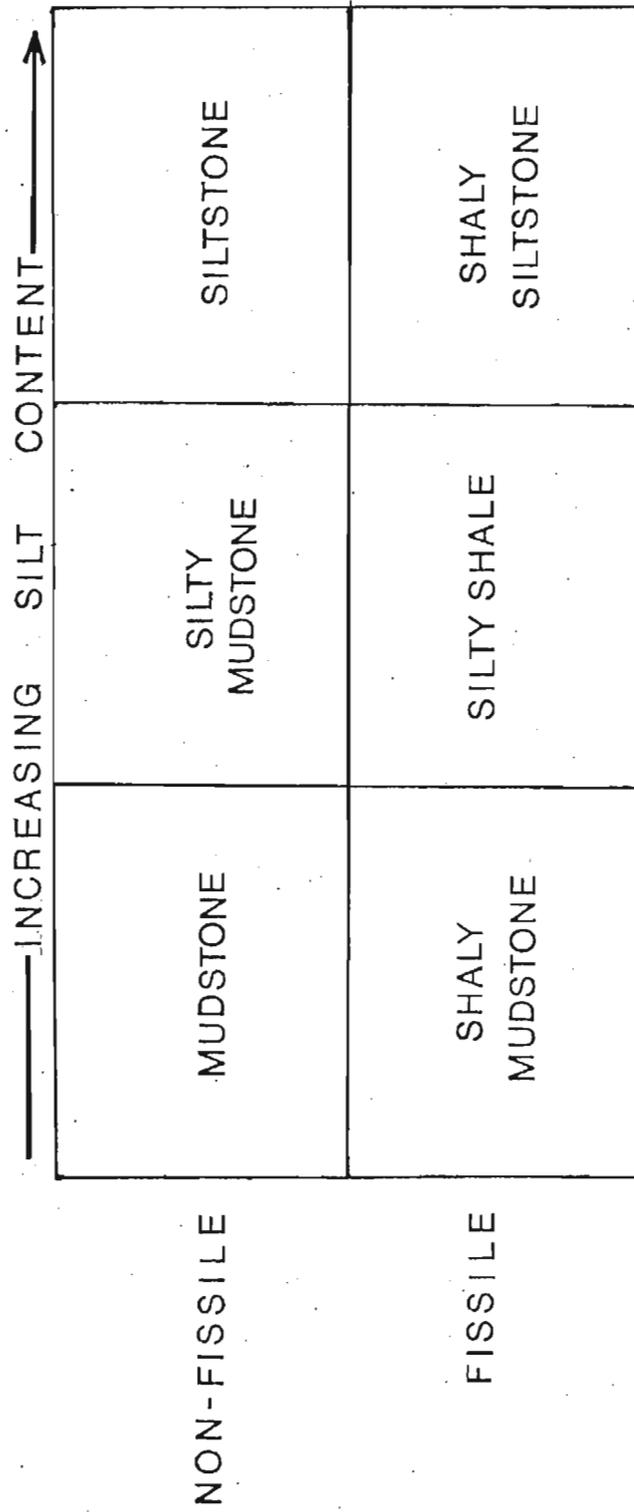
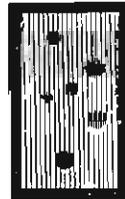


FIGURE 1

TEXTURAL CLASSIFICATION OF FINE CLASTIC SEDIMENTARY ROCKS

MUD SUPPORTED (Sand-size carbonate grains suspended in carbonate mud)		GRAIN SUPPORTED (Sand-size carbonate grains with interstitial carbonate mud)	
< 10% SAND-SIZE GRAINS	> 10% SAND-SIZE GRAINS	MUD PRESENT	NO MUD
Lime Mudstone	Wackestone	Packstone	Grainstone



BIOGENICALLY CEMENTED GRAINS: Boundstone
 NO RECOGNIZABLE TEXTURE: Crystalline Limestone

FIGURE 2

TEXTURAL CLASSIFICATION OF LIMESTONE (after Durham, 1962)

the G.S.A. Rock Color Chart, the net length of each color present within each 5-foot segment of the core is recorded. Colors with values darker than N3 are grouped together for each segment to determine the percentage of dark shale, and colors with values lighter than or equal to N3 are combined to determine the percentage of light shale. Use of the term "value" refers to the Munsell system of color identification wherein a specific color is defined by a unique hue, value, and chroma designation.

3.6 Fracture Logs:

Methods of fracture analysis employed at the EGSP Core Laboratory are similar to those described by Kulander, et al (1977). A standardized logging procedure has been developed by the Morgantown Energy Technology Center. Abbreviations and symbols used in conjunction with the EGSP Standard Core Fracture Logging Format are listed and defined in Appendix B.

Determination of the number, location, orientation, and character of natural fractures intercepted in the cored interval is of vital interest for the selection of appropriate well completion and stimulation techniques. Criteria applied to distinguish natural fractures from fractures induced during coring and handling are listed below (quoted from Evans, 1978):

CORING-INDUCED FRACTURES EXHIBIT THE FOLLOWING CHARACTERISTICS

1. Fracture origin within the core or on the core margin.
2. Hackle plumes diverging from the origin to intersect the core margin or preexisting fracture surface orthogonally.
3. Hackle marks becoming progressively coarser in the vicinity of the core margin or preexisting fracture surface.

4. Twist hackle originating near the core margin or preexisting fracture surface.
5. Hackle plumes diverging in a spiral pattern from the central part of the core on a subhorizontal fracture surface; indicative of torsional stress.
6. Closely spaced arrest lines on a vertical or near-vertical planar fracture; arrest lines are convex down core and exhibit approximate bilateral symmetry.
7. Hackle marks on a vertical or near-vertical planar fracture diverging down core from the center of the plane toward the margins.
8. An abrupt change in the direction of fracture propagation (hook) near the core margin or preexisting fracture surface.

NATURAL FRACTURES EXHIBIT THE FOLLOWING CHARACTERISTICS

1. Smooth, polished planar fracture faces, with or without slickensides.
2. Mineralization coating fracture surfaces, or filling a closed fracture.
3. A smooth fracture extending across the core against which later fractures terminate.
4. Small conchoidal chips or hook features at the intersection of an inclined fracture plane and the core margin; the chips hook to meet the inclined fracture orthogonally.

Coring- and handling-induced fractures also are logged in detail. This information provides additional documentation regarding the condition of the core as received from the field, and it is useful for assessing the effects of problems encountered during drilling. The frequency of disc fractures (generally the most prevalent and least diagnostic type of induced fracture) is recorded in the form of a histogram.

3.7 Measurements of Shore Hardness:

The Shore Hardness tests were discontinued due to high equipment maintenance requirements in addition to questionable accuracy and nonreproducibility of results. Alternative testing methods are being considered for future core characterization work.

4.0 REPORTING OF RESULTS

A correlation chart has been compiled at a scale of 1 inch to 20 feet which provides a visual display of the following data recorded for the EGSP PA #2 core:

1. Stratigraphic Column
2. Lithology
3. Color Histogram
4. Gamma Ray Log
5. Compensated Density Log
6. Sonic Log
7. Temperature Log
8. Orientation/Distribution of Natural Fractures
9. Frequency of Induced Fractures

The correlation chart accompanies this report as an enclosure.

Discussions of core stratigraphy, lithology, and the occurrence of fractures are provided in Section 5. Appendix A contains a detailed lithologic description of the core. Terminology applied in describing natural and induced fractures is provided in Appendix B, and the fracture data are presented in Appendix C:

One copy of the photographic log is to be submitted as a separate document to the Morgantown Energy Technology Center. A second copy is available for inspection at the EGSP Core Laboratory.

When physical properties testing of samples from the EGSP PA #2 core has been concluded, a final (Phase III) report will be issued containing an analysis of those data together with a summary of the information already compiled at the core laboratory.

After characterization was completed the core was sealed in a moisture barrier and packaged in 3-foot core boxes for temporary archiving at the EGSP core laboratory. Eventually, the core will be transferred to the Pennsylvania Geological Survey.

5.0 DISCUSSION OF RESULTS

5.1 General:

The well, designated EGSP PA #2, is located 0.5 miles north of the town of Monongahela, Pennsylvania on the east side of the Monongahela River (Figure 3). Monongahela, Pennsylvania is located approximately 17 miles south of Pittsburgh, Pennsylvania.

Although there are numerous Devonian Shale gas shows in neighboring Beaver and Westmoreland Counties, gas shows in Allegheny County are limited to a single well near Imperial, Pennsylvania, 25 miles to the northwest of the well site (Piotrowski, et al 1978).

Above the core point (6,951 feet), the well deviated as much as 13° from vertical. Corrective attempts were unsuccessful and the deviation

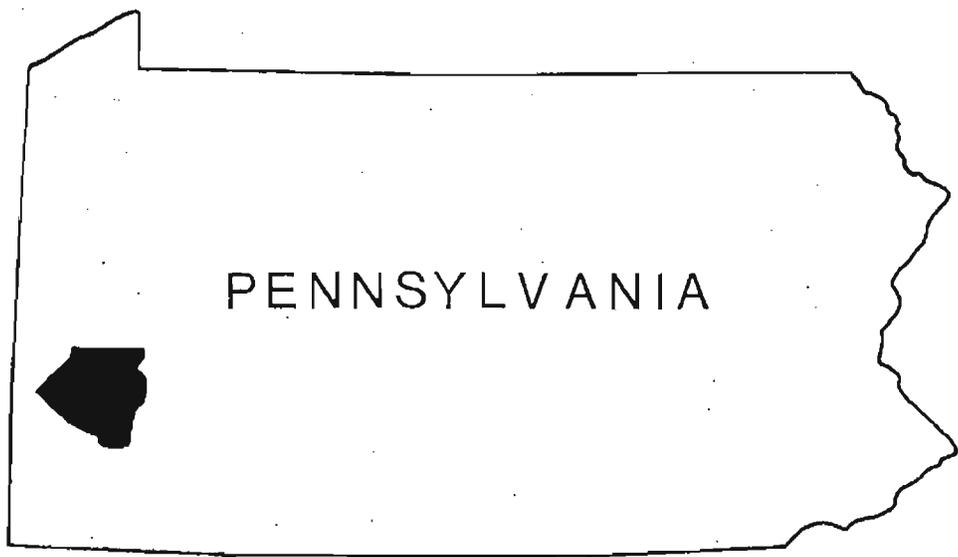


FIGURE 3

LOCATION OF THE EGSP PENNSYLVANIA #2 WELL
IN ALLEGHENY COUNTY, PENNSYLVANIA

of the cored interval varied from 8° to 14°.

5.2 Geologic Setting:

The EGSP PA #2 well site is situated in the Appalachian Plateau 15 miles east of the central axis of the Appalachian Basin. The topography at the drill site consists of steep hills and ridges dissected by deep v-shaped valleys. Major drainage features in the area include the Monongahela River, adjacent to the drill site, and the Youghiogheny River, 15 miles to the east.

Major structural features in the area include several very gently folded anticlines and synclines (Bennison, 1976; Gray, et al 1960) and possibly the Rome Trough (Harris, 1978). Sandstones and shales of the Washington, Monongahela, and Conemaugh Group outcrop in the near vicinity of the well site. The hilltops are commonly capped by the more resistant sandstones of the Pittsburgh Formation (Washington Group). Valley floors are probably underlain by sandstones of the Glenshaw Formation (Conemaugh Group). However, as is typical throughout much of the Appalachian Basin, the surface outcrops are commonly masked by a thickly vegetated alluvial cover.

5.3 Stratigraphy:

A total of 545 feet of core was retrieved from the Allegheny County well designated EGSP PA #2. Coring began at 6,951 feet in the upper part of the Harrel Formation and was terminated at 7,496 feet in the upper part of the Onondaga Limestone. The entire interval was cored. Core retrieval was successful throughout the length of the cored interval except for numerous zones of rubble which most probably originated during coring. Formation thicknesses are summarized in Table 1. A brief summary description for each formation or member is provided below.

TABLE 1
FORMATION THICKNESSES

<u>Formation</u>	<u>Depths</u>	<u>Formation Thickness</u>	<u>Depths Cored</u>
Harrel Formation:			
Undifferentiated	6,928'-7,061'	133'	6,951'-7,061'
Burkett Shale	7,061'-7,084'	23'	7,061'-7,084'
Hamilton Group:			
Tully Limestone	7,084'-7,144'	60'	7,084'-7,144'
Mahantango Shale	7,144'-7,332'	188'	7,144'-7,332'
Marcellus Shale	7,332'-7,496' (?)	164'	7,332'-7,496'
Onondaga Limestone:	7,496' (?) - *	-	7,496'-7,496.2'

* Contact Undetermined

Harrel Formation:

The Harrel Formation is present in the EGSP PA #2 well between 6,928 (?) feet and 7,084 feet. The cored portion (6,951' to 7,084') includes the lower 80% of the formation and one identifiable member, the Burkett Shale, which occurs between 7,061 and 7,084 feet.

The Harrel Formation consists mainly of grayish black (N2) to medium dark gray (N4), thinly to thickly laminated silty mudstones and mudstones. Occasionally, slightly calcareous siltstone laminae are present in the upper 1/2. The interval contains numerous calcareous and shaly zones. Fossils contained in the interval include inarticulate and articulate brachiopods, cephalopods, and plant fragments. Pyritized and mud-filled burrows are common in the upper 1/3, but are rare at the base of the interval. Pyrite occurs as lenses, nodules, and disseminated grains throughout, but is most common in the lower 1/2.

The contact between the Harrel Formation and the underlying Tully Limestone (Hamilton Group) is marked by a decrease in gamma radiation from ~300 API units (Burkett Shale Member) to ~100 API units (Tully Limestone). This contact is gradational in the core but can be distinguished by a change to lighter colors (N2 changing to N4) and by an increase in carbonate content.

Hamilton Group:

The Hamilton Group is composed of three formations: the Tully Limestone, Mahantango Shale, and Marcellus Shale. It is present in the core between 7,084 and 7,496 (?) feet, which comprises the entire group.

Tully Limestone:

The Tully Limestone is present in the core from 7,084 to 7,144 feet. It consists of thin to thick bedded, dark gray (N3) to medium gray (N5), lime mudstone and calcareous mudstone. The lime mudstones are present throughout but are most common between 7,095 and 7,127 feet. Zones of mottling, numerous large pyritized burrow structures, and pyrite nodules and lenses occur throughout. Fossils contained in the interval include sparse pyritized shell fragments in the upper 1/4 and a single articulate brachiopod at the base of the interval. Disc fracture frequency is much lower in this formation than in the adjacent formations.

The Tully Limestone is easily recognized by its relatively low gamma count (~75 - 100 API units) on the geophysical logs, and by its lighter rock color and high carbonate content in the core.

Mahantango Shale:

The Mahantango Shale is present in the core between 7,144 and 7,332 feet. It can be divided into two parts on the basis of rock color and fossil content.

The upper part (7,144' to 7,235') is composed of thinly laminated, grayish black (N2) mudstone. Fossils contained in this interval include abundant finely divided carbonaceous fragments, occasional large plant fragments, and mud lumps (fecal pellets?). Pyrite is infrequently present and occurs as lenses, nodules, and disseminated grains. The interval contains zones which are fissile and weakly calcareous.

The lower part (7,235' to 7,332') also is composed of thinly laminated mudstone but is slightly lighter in color (dark gray N3) than the overlying interval. This interval contains a varying assortment of fossils and biogenic structures which include articulate and inarticulate (Orbiculoides sp.) brachiopods, cephalopods, pelecypods, unidentified fossil fragments, finely divided carbonaceous fragments, zones of bioturbation, and mud- and pyrite-filled burrow structures. Numerous calcareous concretions are also present.

The contact between the Mahantango Shale and the underlying Marcellus Shale is gradational in the core. This contact can be distinguished by a gradual color change from dark gray (N3) to grayish black (N2). On the geophysical logs the contact is marked by a slight increase in gamma radiation from ~150 to ~200 API units.

Marcellus Shale:

The Marcellus Shale, the lowest formation of the Hamilton Group, is present in the core from 7,332 to 7,496 (?) feet. The Marcellus Shale generally is composed of thinly laminated, black (N1), to grayish black (N2), mudstone and shaly mudstone. Thinly laminated to thin bedded, olive gray (5Y 4/1), lime mudstones also are present at 7,381 feet, 7,416 feet, 7,442 feet, and between 7,483 feet and the base of the core. Fossils contained

within the formation include articulate and inarticulate (Orbiculoides sp.) brachiopods, pelecypods, and fecal pellets in addition to coral and shell fragments. These fossils are most commonly present between 7,371 and 7,417 feet, and below 7,460 feet. Zones containing fossils and biogenic structures commonly are less shaly, more calcareous, and occasionally contain calcareous concretions. Pyrite occurs as lenses, nodules, and disseminated grains, as coatings on shell fragments and fecal pellets, and as mineralized burrow structures.

The contact between the Marcellus Shale and the underlying Onondaga Limestone is difficult to determine. In the core, no distinct contact is present. Near the base of the Marcellus, numerous thin interbedded limestones, mudstones, and calcareous mudstones are present.

On the geophysical logs there is a decrease in gamma count below 7,496 feet. This is the sole reason for picking the contact at 7,496 feet. However, the gamma ray log only extends down to 7,500 feet so there remains the possibility of additional mudstones interbedded with limestones below 7,500 feet.

Onondaga Limestone:

The Onondaga Limestone is composed of thin bedded, medium dark gray (N4) wackestone and packstone. Sand size, unidentified skeletal fragments, mud-filled burrows, and sparse pyrite nodules and lenses occur throughout. As noted above, there is some doubt as to whether the cored interval extends into the main body of the Onondaga or only into a transitional zone between the Onondaga and the overlying Marcellus.

5.4 Fracture Analysis:

Both natural and induced fractures present in the core were examined in detail. The resulting fracture logs are reproduced in Appendix C. Terminology and abbreviations used in log compilation are summarized in Appendix B.

Approximately 226 natural fractures (165 faults, 19 microfaults, 35 simple joints, and 7 compound joints) are present in the core. The distribution of natural fractures throughout the cored interval is shown in Table 2.

The greatest concentration of natural fractures occurs within the Marcellus Shale where natural fracture frequency exceeds 1.0 fractures per foot.

TABLE 2
DISTRIBUTION OF NATURAL FRACTURES

<u>Formation</u>	<u>Depths Cored</u>	<u>Core Length</u>	<u>Number of Fractures</u>	<u>Frequency Per Foot</u>
Harrel Formation:				
Undifferentiated	6,951'-7,061'	110'	41	0.37
Burkett Shale	7,061'-7,084'	23'	1	0.04
Hamilton Group:				
Tully Limestone	7,084'-7,144'	60'	2	0.03
Mahantango Shale	7,144'-7,332'	188'	8	0.04
Marcellus Shale	7,332'-7,496'	164'	174	1.06
Onondaga Limestone:	7,496'-7,496.2'	0.2'	0	0.00

Fractures contained in the Marcellus Shale are generally low angle to near horizontal faults. Slickenlines are common on the fault plane surfaces.

Natural fracture frequency also is relatively high in the Harrel Formation. Fractures contained in this formation are usually faults or micro-faults. Frequency within the interval is 0.32 fractures per foot. Slickensides are common and well developed.

All planar fractures were analyzed to identify common structural trends in the core. Figures 4 and 5 are graphic representations of the data plotted in polar form on Schmidt (Equal Area) stereonet. Stereographic adjustments were made to compensate for the deviated well bore using the methods described by Ragan (1968). One major fault trend and three minor joint trends are evident in Figures 4 and 5.

Trend 1: Faults striking between $N30^{\circ}E$ and $N60^{\circ}W$, dipping $\sim 15^{\circ}$ NE.

Trend 2: Joints striking between $N10^{\circ}W$ and $N10^{\circ}E$, near-vertical.

Trend 3: Joints striking $\sim N90^{\circ}E$, near-vertical.

Trend 4: Joints striking $N40^{\circ}W$ and $N50^{\circ}W$, near-vertical.

Trend 1 represents the greatest number of individual fractures. The majority of fractures in this set are near horizontal bedding plane faults with well developed slickenlines present on most of the fault surfaces.

Trends 2 and 3, which are poorly defined, appear to be near-vertical conjugate joint sets. The fractures in these sets vary in length from 0.1 foot to 2.4 feet and are mineralized with either calcite or pyrite.

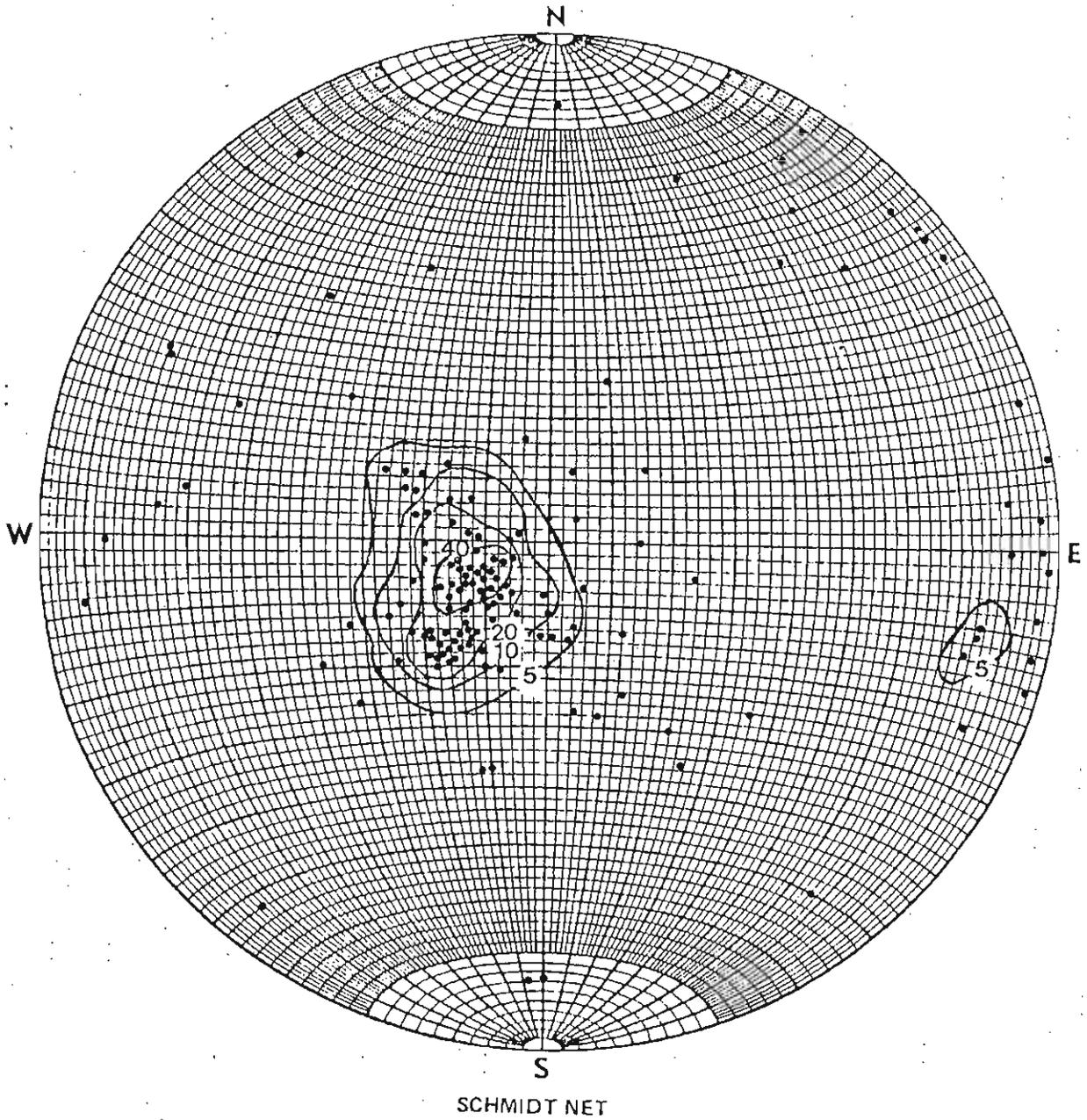


FIGURE 4

CONTOURED DIAGRAM OF POLES TO FAULTS

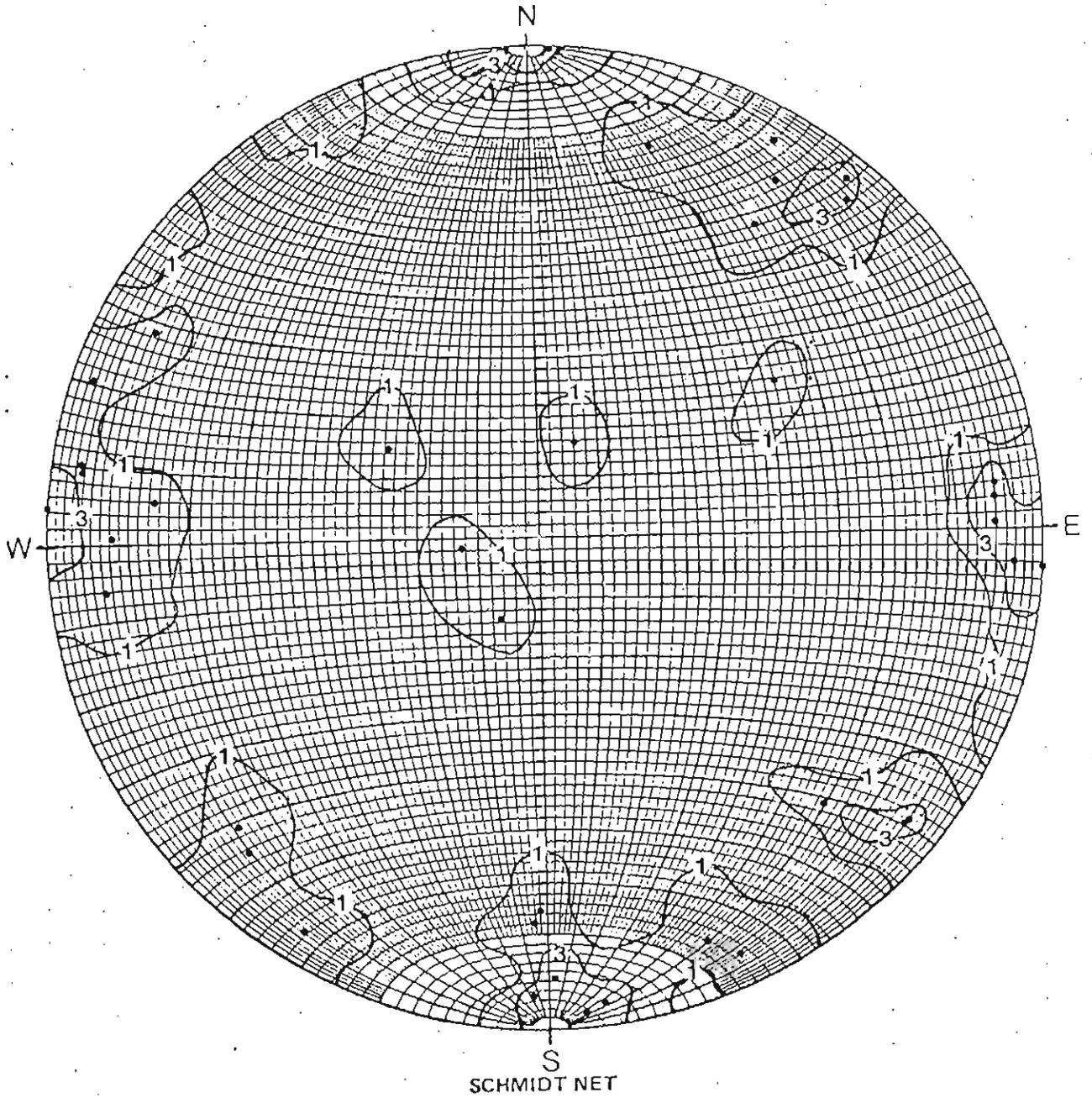


FIGURE 5

CONTOURED DIAGRAM OF POLES TO JOINTS

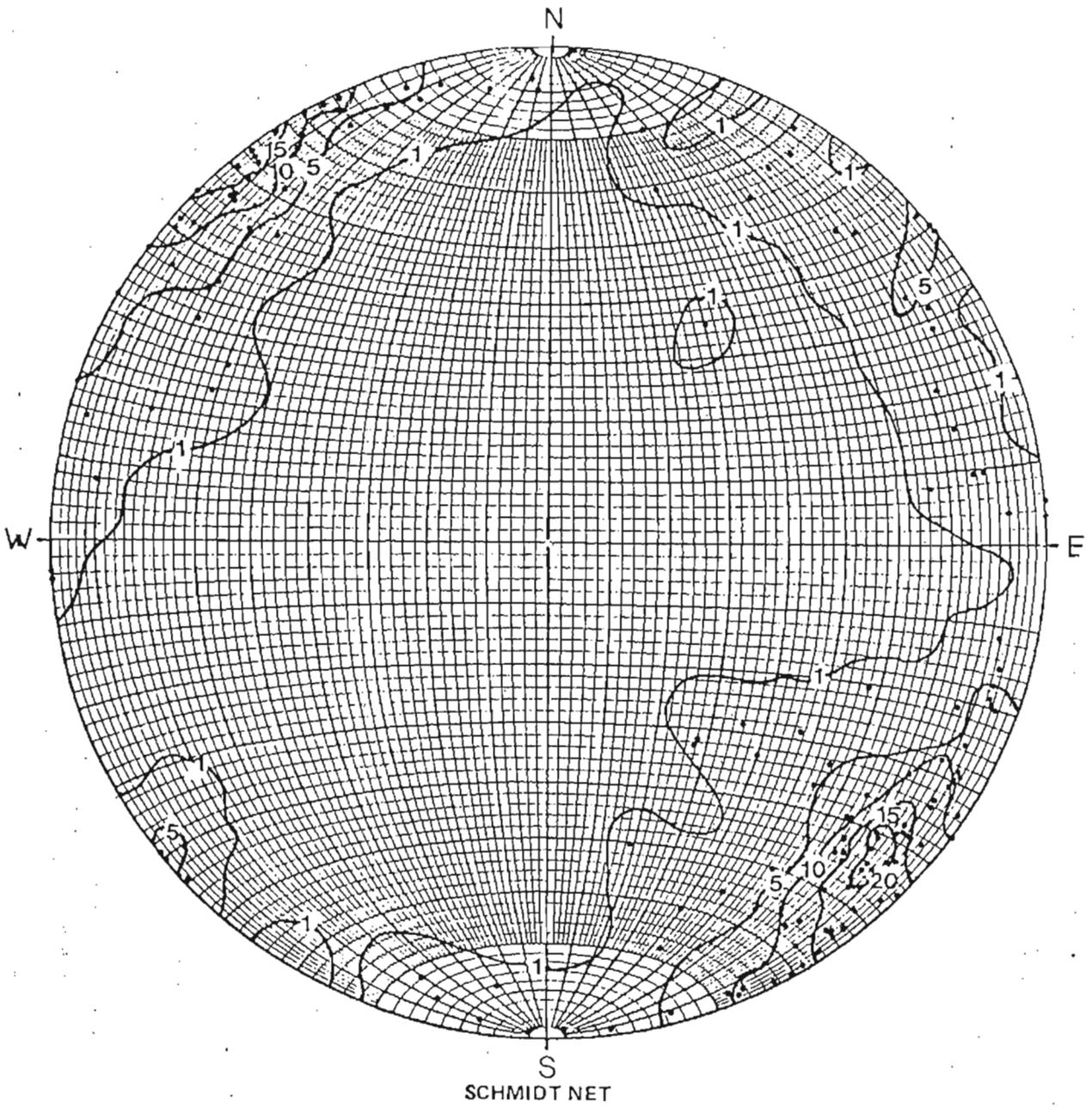


FIGURE 6

CONTOURED DIAGRAM SHOWING THE
BEARING AND PLUNGE OF SLICKENLINES

Trend 4, which is also poorly defined, is composed of near-vertical joints, of which some are calcite mineralized.

Figure 6 is a graphic representation of the bearing and plunge of slickenlines plotted on a Schmidt (Equal Area) stereonet. The direction of movement, as indicated by slickenlines, ranges between N15°W and N71°W with a concentration within this trend plunging 8° in the direction S26°E. These slickenlines are approximately perpendicular to the fold axes of the local anticlines (Bennison, 1976; Gray, et al, 1960). Also a minor concentration of near-horizontal slickenlines trend between N46°E and N51°E and both dip-slip and oblique-slip movement is evident in both slickenline trends. It should be noted that numerous (~20%) fractures present in the core do not fit into the defined trends. This is probably due to a relative lack of structural control resulting from very low dips associated with the regional structures. Due to the excessive "poker chipping", rubble zones, and low angle dips involved, the data could be considered somewhat speculative.

Of the total number of fractures examined in the Pennsylvania #2 core, more than 90% were interpreted to be coring or handling induced. Disc fractures were the most common type observed. Because these fractures are less diagnostic than other types, they were not recorded individually. However, disc fracture frequency does provide a rough measure of the flexural rigidity of the core parallel to bedding. These data are shown on the correlation chart.

APPENDIX A

DETAILED LITHOLOGIC DESCRIPTION

EGSP PENNSYLVANIA #2 WELL - ALLEGHENY COUNTY

<u>INTERVAL</u>	<u>DESCRIPTION</u>
6,951.0' - 6,955.5' (4.5')	Silty mudstone and siltstone, grayish black (N2), and medium dark gray (N4), thinly to thickly laminated. Siltstone laminae are noncalcareous. The interval is weakly to moderately fissile in the lower 1/3 and is barren of fossils, biogenic structures, and pyrite.
6,955.5' - 6,959.5' (4.0')	Silty mudstone, grayish black (N2), thinly laminated. The interval exhibits weak to moderate fissility throughout and is slightly calcareous between 6,959.0' and 6,959.5'. No pyrite, fossils, or biogenic structures were observed.
6,959.5' - 6,967.0' (7.5')	Silty mudstone and siltstone, grayish black (N2), and medium dark gray (N4), thinly to thickly laminated. Several thick laminae of weakly calcareous siltstone occur in the upper 1/3. A zone from 6,962.5' to 6,963.3' is shaly. Casts of small articulate brachiopod shells occur at 6,961.9' and 6,963.9'. The interval exhibits weak fissility throughout.
6,967.0' - 6,971.7' (4.7')	Silty mudstone, shaley mudstone, and siltstone, grayish black (N2), and medium dark gray (N4), thinly laminated to thin bedded. Three thin beds of medium dark gray (N4) silty mudstone occur between 6,968.4' and 6,970.4'. Pyritized burrow structures are present in the two upper beds. Thick siltstone laminae are distributed throughout the interval. An inarticulate (?) brachiopod shell fragment occurs at 6,971.1'.
6,971.7' - 6,977.0' (5.3')	Silty mudstone, grayish black (N2) and dark gray (N3), thinly laminated to thin bedded. A single very thin bed of calcareous siltstone, medium dark gray (N4), is present at 6,972.8'. Two zones of rubble were recovered in the core from 6,975.3' to 6,975.6', and from 6,975.7' to 6,975.9'. Pyritized burrow structures are present near 6,976.0' and pyrite occurs as irregular laminae and as small nodules elsewhere in the interval. A cast of a large plant fragment is present at 6,976.9'.
6,977.0' - 6,983.2'	Silty mudstone and mudstone, grayish black (N2), thinly laminated. Mudstone is the dominant lithologic type in the lower 1/2. The core is weakly calcareous between 6,979.5' and 6,979.7'. Poorly preserved casts of small unidentified inarticulate brachiopod, articulate brachiopod, and cephalopod shells are distributed throughout. A large vitrinite fragment occurs at 6,979.2'.

<u>INTERVAL</u>	<u>DESCRIPTION</u>
6,983.2' - 6,989.5' (6.3')	Siltstone, silty mudstone, and mudstone, medium dark gray (N4), grayish black (N2), and olive black (5Y 2/1), thinly laminated. A number of small diameter pyritized burrow structures occur in the upper 2.0'. Larger lime filled horizontal burrows are present at 6,986.6'. A single, very thin bed of siltstone at 6,986.4' overlies a sharp scour surface with flute casts. Several small, unidentified articulate brachiopod shell casts are present on the same scour surface. The zone between 6,987.0' and 6,988.0' is shaly and contains numerous casts of small articulate brachiopods.
6,989.5' - 6,995.0' (5.5')	Silty mudstone and mudstone, grayish black (N2), thinly to thickly laminated. Thin, calcareous siltstone laminae, medium dark gray (N4), are distributed throughout. A single lime concretion occurs between 6,994.6' and 6,994.8'. The zone below 6,991.5' features distorted laminae, contains several calcite-mineralized laminae, and microfaults at 6,993.1' and 6,993.4'. Fissility is weak to moderate throughout. Casts of small unidentified articulate and inarticulate brachiopod shells occur in the upper 1/2.
6,995.0' - 7,005.0' (10.0')	Silty mudstone and silty shale, grayish black (N2), thinly laminated. The entire interval is weakly fissile (shaly between 6,996.5' and 6,999.0') and weakly to moderately calcareous. Several calcite-mineralized laminae occur between 7,003.0' and 7,004.0'. A parting at 6,995.1' contains a number of small unidentified cephalopod casts. Casts of large carbonaceous fragments occur at 6,998.0' and 7,004.5'. Poorly preserved shell casts occur on several partings near the base of the interval.
7,005.0' - 7,015.0' (10.0')	Silty mudstone and shaly mudstone, grayish black (N2), thinly laminated. The entire interval is weakly to moderately calcareous. Shaly mudstone (N2) occurs between 7,005.5' and 7,008.5' in a zone which contains casts of invertebrate shells (articulate brachiopods and others unidentified) and plant tissue fragments. Casts of plant tissue fragments and brachiopod shells also are present occasionally in the lower 1/3 of the interval. Several thin siltstone and pyrite laminae are distributed throughout.
7,015.0' - 7,020.0' (5.0')	Silty mudstone, grayish black (N2) and black (N1), thinly laminated, weakly fissile and weakly to moderately calcareous throughout. A single lime concretion is present between 7,015.8' and 7,016.4', with slickensides and calcite-mineralized laminae above and below. No fossils or biogenic structures are present.

INTERVALDESCRIPTION

- 7,020.0' - 7,030.0'
(10.0')
- Shaly mudstone and silty mudstone, grayish black (N2), thinly laminated. The entire interval is weakly to moderately calcareous. Fissility is moderately to strongly developed in the upper 1/2, and strongly developed throughout the lower 1/2. A small lime concretion occurs between 7,026.1' and 7,026.2'. Slickensides, distorted stratification containing calcite-mineralized laminae, and minor pyrite mineralization are associated with the concretion. A small cephalopod cast occurs at 7,024.2'. Occasional casts of plant tissue fragments and small articulate brachiopod shells are present throughout.
- 7,030.0' - 7,040.0'
(10.0')
- Shaly mudstone and silty shale, black (N1) and grayish black (N2), thinly laminated. The core becomes progressively darker from the top of the interval toward the base; it is moderately to strongly fissile and weakly calcareous throughout. Casts of small articulate brachiopods are common in the upper 1/3 and occur infrequently in the lower part.
- 7,040.0' - 7,050.0'
(10.0')
- Shaly mudstone, black (N1), thinly laminated. The interval is weakly calcareous and moderately fissile throughout. Casts of small cephalopods and articulate brachiopods are common. A thin irregular pyrite lamina is present at 7,049.8'. A thick calcareous siltstone lamina with disseminated pyrite occurs at 7,048.1'. Pyrite also is present as coatings on small fossil fragments.
- 7,050.0' - 7,058.0'
(8.0')
- Shaly mudstone and mudstone, black (N1), thinly laminated. The interval is moderately fissile in the upper 1/2 and weakly calcareous throughout. Lime content in the mudstone diminishes near the base. Several small cephalopod and brachiopod casts are present in the upper 1.0'. A single small pyrite nodule or pyritized burrow structure occurs at 7,051.5'. Small flakes of pyrite are present at several locations in the interval. Two large vitrinite fragments are present near 7,055.0'. A large (1 cm) coiled-cephalopod cast occurs at 7,056.9'. A single irregular pyrite lamina is present at 7,057.3'.
- 7,058.0' - 7,063.0'
(5.0')
- Silty mudstone, black (N1), thinly laminated. The interval is weakly fissile and noncalcareous. A near-vertical natural fracture intersects the core between 7,058.0' and 7,060.3'. Disseminated pyrite is present on a number of partings between 7,060.3' and 7,061.6'. No fossils or biogenic structures are present.

INTERVALDESCRIPTION

- 7,063.0' - 7,071.0'
(8.0') Silty mudstone, grayish black (N2) and black (N1), thinly laminated. The upper 1/2 of the interval is grayish black and is noncalcareous except for a zone from 7,063.1' to 7,063.4' (weakly calcareous). The interval becomes darker and is weakly calcareous in the lower 1/2, and is shaly near the base. A zone from 7,067.5' to 7,067.8' was rubblized during coring. Casts of two large plant tissue fragments are present near 7,066.0'. A single Orbiculoidea sp. shell occurs at 7,066.9'. Several small pyrite nodules occur near the top of the interval; occasional pyrite flakes and pyritized fossil fragments are present throughout.
- 7,071.0' - 7,077.0'
(6.0') Shaly mudstone and mudstone, black (N1), thinly laminated, noncalcareous. The upper 1/3 of the interval is shaly. Pyrite occurs as thin, discontinuous laminae and as small nodules (pyritized burrow structures?) in a zone from 7,074.0' to 7,074.5'. A zone of rubble was recovered between 7,071.3' and 7,071.6'. A single small inarticulate brachiopod shell cast (Orbiculoidea sp.?) is present at 7,076.8'.
- 7,077.0' - 7,081.1'
(4.1') Lime mudstone (after Dunham, 1962), mottled medium dark gray (N4) and olive gray (5Y 4/1) in the upper 1.5', and medium light gray (N6) in the lower part; weakly bedded. Fossil fragments (shell fragments and other skeletal grains) are common in the upper 1/2; the lower 1/2 contains a few mud-filled burrows. The limestone becomes increasingly argillaceous near the base.
- 7,081.1' - 7,083.2'
(2.1') Calcareous mudstone, dark gray (N3), weakly bedded, gradational upward into the overlying limestone interval. Weakly pyritized burrow structures occur throughout. Articulate brachiopod shell fragments and casts are common. The zone from 7,081.8' to 7,082.8' contains numerous pyrite laminae, pyrite nodules, and pyritized burrows.
- 7,083.2' - 7,090.0'
(6.8') Impure lime mudstone, mottled medium dark gray (N4) to medium light gray (N6), thin to thick bedded. A thin, strongly bioturbated zone containing large (8 mm) lime-filled burrows is present at the top of the interval. Isolated pyrite nodules (1 cm in diam) and weakly pyritized burrow structures occur throughout. Skeletal fragments are sparse.
- 7,090.0' - 7,095.5'
(5.5') Calcareous mudstone and lime mudstone, dark gray (N3) to medium dark gray (N4), mottled and weakly bedded in the upper 1/2, thin-bedded in the lower 1/2. The interval contains occasional pyritized burrow structures, pyrite nodules, and fossil fragments (unidentified). A single, large (2 cm) irregular pyrite nodule is present at 7,094.1'.

INTERVALDESCRIPTION

- 7,095.5' - 7,106.6'
(11.1')
- Lime mudstone, dark gray (N3) to medium dark gray (N4), thin bedded. Parts of the interval are mottled and weakly bedded. Purity of the limestone varies considerably between adjacent beds. An erosional surface, indicative of a possible diastem or minor paraconformity within the Tully (?) Limestone, is present at the base of the interval. Pyritized burrow structures are common throughout as well as a few large (to 1 cm) pyrite nodules.
- 7,106.6' - 7,120.0'
(13.4')
- Lime mudstone, dark gray (N3) to medium dark gray (N4), mottled and weakly bedded to thick-bedded. A single thin bed of medium light gray (N6) lime mudstone, containing a number of small pyrite nodules, is present at the top of the interval below the irregular erosional surface. Pyritized burrow structures and isolated pyrite nodules (to 3 cm) are common throughout. Skeletal fragments are sparse.
- 7,120.0' - 7,127.0'
(7.0')
- Lime mudstone, dark gray (N3) to medium gray (N5), thin- to thick-bedded. Weakly pyritized burrow structures are present throughout. A thin zone between 7,123.1' and 7,123.5' is moderately to strongly bioturbated with heavily pyritized burrows. Rubble was recovered from a thin zone at 7,127.0'.
- 7,127.0' - 7,135.3'
(8.3')
- Impure lime mudstone and strongly calcareous mudstone, dark gray (N3) to medium gray (N5), thin-bedded generally. The interval becomes progressively more argillaceous through the lower 1/2 toward the base. Small pyrite nodules are present throughout but are more common in the lower 1/2. Beds of calcareous mudstone contain numerous pyritized burrow structures.
- 7,135.3' - 7,145.0'
(9.7')
- Mudstone and calcareous mudstone, dark gray (N3), grayish black (N2), and dark olive gray (5Y 2/1), weakly bedded in the upper 1.5' and weakly laminated through the remainder of the interval. The upper 1.5' is moderately to strongly calcareous, contains numerous pyritized burrow structures between 7,135.3' and 7,135.7', and grades into the overlying limestone. The remainder is noncalcareous and nonfossiliferous, except for a few poorly preserved articulate brachiopod casts near 7,137.5'.
- 7,145.0' - 7,154.8'
(9.8')
- Mudstone and shaly mudstone, grayish black (N2), weakly and thinly laminated. The interval is noncalcareous. Fissility is weak to moderate throughout. Several thin shaly zones are present in the lower 2/3. Abundant, very finely divided carbonaceous particles are visible on most partings. A few thin discontinuous pyrite laminae and small (2-3 mm) pyrite nodules are present. Small mud (fecal?) pellets occur on a parting at 7,153.0'.

INTERVALDESCRIPTION

- 7,154.8' - 7,165.0'
(10.2')
- Mudstone and shaly mudstone, grayish black (N2), weakly laminated but splits readily. The upper 1/2 is moderately to very weakly calcareous. Shaly mudstone is restricted to a zone from 7,163.6' to 7,165.0'. Most partings exhibit abundant, very finely divided carbonaceous particles. A thin lamina of pyrite occurs above mud lumps and curvilinear slickensides at 7,156.3'. Small lenses of pyrite occur at 7,154.8', 7,160.4', and 7,163.0'. A large mud pellet (coprolite?) occurs at 7,159.5'. No fossils or biogenic structures are present.
- 7,165.0' - 7,175.0'
(10.0')
- Mudstone, grayish black (N2), thinly laminated. The interval is noncalcareous except for a few thin, very weakly calcareous zones in the upper 1.0' and in the lower 1.0'. Shaly zones occur between 7,166.4' and 7,167.4', and between 7,169.4' and 7,170.6'. The mudstone contains abundant carbonaceous particles, generally very finely divided, as noted above. Pyrite, fossils, and biogenic structures are absent.
- 7,175.0' - 7,184.6'
(9.6')
- Mudstone, grayish black (N2), thinly laminated. Between 7,175.0' and 7,178.6', the core is very weakly to weakly calcareous. The interval contains many small (1 to 3 mm) carbonaceous fragments, as well as a number of larger carbonaceous fragments or coatings on partings near 7,184.0'. The latter fragments are possibly of algal origin. A single pyritized shell (?) fragment occurs at 7,176.4'.
- 7,184.6' - 7,195.0'
(10.4')
- Mudstone and shaly mudstone, grayish black (N2), thinly laminated and weakly laminated, noncalcareous. The upper 2.2' consists of shaly mudstone; between 7,186.0' and 7,186.3' the core was rubblized during drilling. Partings in the upper 1/2 exhibit very finely divided carbonaceous particles and larger carbonaceous plant tissue fragments. A single small (5 mm) calcite-pyrite nodule is present at 7,189.1'.
- 7,195.0' - 7,205.0'
(10.0')
- Mudstone and shaly mudstone, grayish black (N2), thinly laminated and weakly laminated, noncalcareous. A thin zone of rubble occurs between 7,196.2' and 7,196.4', above a connection made at 7,196.5'. Several thin (5 to 10 cm) shaly zones occur below 7,201.8'. No fossils, biogenic structures, or pyrite occurrences are present.
- 7,205.0' - 7,214.2'
(9.2')
- Mudstone and shaly mudstone, grayish black (N2), thinly laminated, noncalcareous. The upper part of the interval (above 7,211.0') exhibits variable weak to moderate fissility. The interval is barren of megascopic fossils, biogenic structures, and pyrite.

<u>INTERVAL</u>	<u>DESCRIPTION</u>
7,214.2' - 7,225.0' (10.8')	Mudstone and shaly mudstone, grayish black (N2), thinly laminated. A dark gray (N3) lime concretion with septarian cracks occurs from 7,222.5' to 7,223.1'. Another zone, between 7,219.7' and 7,220.1', is weakly calcareous. A small (3 mm diam) nodule or solitary burrow structure exhibiting calcite-pyrite mineralization is present at 7,217.1'. Partings near 7,220.0' contain numerous, very finely divided carbonaceous particles. Disseminated pyrite and a cast of a small plant fragment occur at 7,220.4'.
7,225.0' - 7,235.0' (10.0')	Shaly mudstone and mudstone, grayish black (N2), thinly laminated. Below 7,226.5', the core exhibits well-developed fissility. The interval is noncalcareous. Between 7,225.9' and 7,226.0' are several mud lumps (some weakly pyritized) of unknown origin which occur within a zone of locally distorted laminations. Three very small (2 cm) lime concretions occur between 7,227.0' and 7,227.4'. Two of the concretions contain thin septarian cracks mineralized with calcite and pyrite. A thin zone of rubble occurs in the vicinity of a connection made near 7,227.8'.
7,235.0' - 7,245.0' (10.0')	Mudstone, grayish black (N2) grading to dark gray (N3) over the upper 1/3 of the interval, thinly laminated throughout. Several thin shaly zones (5 to 10 cm) occur within the interval. A number of partings near 7,238.0', 7,244.0', and 7,245.0' exhibit poorly preserved biogenic structures which may be either trails or mud-filled burrow structures oriented parallel with stratification. Very finely divided carbonaceous particles are abundant on partings below 7,242.0'. Carbonaceous plant fragments (1-5 mm) are common between 7,244.0' and 7,245.0'.
7,245.0' - 7,255.0' (10.0')	Mudstone, dark gray (N3), thinly laminated to weakly laminated. The interval is noncalcareous with the exception of two thick laminae of moderately calcareous mudstone at 7,252.9' and 7,254.4'. The upper 1.0' is weakly to moderately fissile. Numerous carbonaceous plant fragments, casts, and films occur on partings throughout the interval. Very finely divided carbonaceous particles are exposed on many partings in the upper part. A mud (fecal?) pellet and a small articulate brachiopod cast are present at 7,246.1'. A single cephalopod cast occurs at 7,251.1'.

INTERVALDESCRIPTION

- 7,255.0' - 7,265.0'
(10.0')
- Mudstone, dark gray (N3), thinly laminated throughout. The interval contains a number of small (1-3 cm) spheroidal lime concretions and thin (1-2 cm) calcareous lenses which generally are olive gray (5Y 4/1) in color. The surrounding mudstone is noncalcareous. Shells of the inarticulate brachiopod genus Orbiculoidea occur near the top (7,255.2') and the bottom (7,264.6') of the interval. A single poorly preserved cast of an articulate brachiopod also occurs near the base. Several partings in the upper 1/2 exhibit very finely divided carbonaceous particles in the mudstone. Near a connection point at 7,259.0', a thin zone of rubble was recovered.
- 7,265.0' - 7,275.0'
(10.0')
- Mudstone, dark gray (N3), thinly laminated. A single small lime concretion occurs at 7,273.3', and one very thin (2.5 cm) bed of impure lime mudstone is present below 7,274.0'. Otherwise, the interval is noncalcareous. Shell fragments and casts occur at several locations. Casts of pelecypod (?) shells occur at 7,265.8' and 7,267.8'. Several small Orbiculoidea sp. shells also are present at 7,267.8'. A cast of a cephalopod (?) shell fragment occurs at 7,271.2'. A single mineralized calcite-pyrite nodule or burrow structure is at 7,269.5'.
- 7,275.0' - 7,285.0'
(10.0')
- Mudstone, dark gray (N3), thinly laminated. Two small lens-shaped lime concretions, olive gray (5Y 4/1) in color, occur at 7,275.6' and 7,276.6'. A cast of a large (3 cm) coiled cephalopod was observed at 7,279.2'. Very finely divided carbonaceous particles are visible on partings in the lower 1/3. With the exception of the two concretions near the top, the interval is noncalcareous.
- 7,285.0' - 7,295.0'
(10.0')
- Mudstone, dark gray (N3), thinly laminated. At 7,289.3' is a single thin (3 cm) zone of strongly calcareous mudstone. The interval contains a number of other zones, from 1 cm to 15 cm thick, which are very weakly to weakly calcareous. Casts of unidentified fossil fragments occur on partings at 7,288.5' and 7,294.2'. A zone of rubble recovered between 7,289.5' and 7,289.8' was induced by a connection made during drilling.
- 7,295.0' - 7,305.0'
(10.0')
- Mudstone, dark gray (N3), thinly laminated. Several small, lens-shaped, olive gray (5Y 4/1), lime concretions are distributed throughout. A single thin bed of calcareous mudstone occurs between 7,296.8' and 7,297.1'. A small unidentified fossil-fragment cast occurs at 7,300.9'. A few small (1-2 mm) isolated pyrite nodules or pyritized burrow structures occur in the lower 1/2.

<u>INTERVAL</u>	<u>DESCRIPTION</u>
7,305.0' - 7,315.0' (10.0')	Mudstone, dark gray (N3), thinly laminated. The upper 1.0' and the lower 5.0' contain numerous thin (1-2 cm) lens-shaped lime concretions. Two zones of rubble were recovered in the upper 1/2 of the interval, from 7,306.2' to 7,306.7' and from 7,308.0' to 7,308.3'. Two small (5 mm) coiled-cephalopod casts were observed at 7,305.4' and at 7,305.7'. Several partings in the lower 1.0' of the interval exhibit very finely divided carbonaceous particles.
7,315.0' - 7,326.0' (11.0')	Mudstone, dark gray (N3) and grayish black (N2), thinly laminated. With the exception of three thin lens-shaped lime concretions in the upper 2.0', the interval is non-calcareous. The mudstone grades from dark gray to grayish black at about 7,321.2'. Between 7,321.2' and 7,322.0' the core is weakly fissile. The upper 1/2 contains a few isolated small pyrite nodules and (cephalopod?) shell fragments. Below 7,321.9', shells of the invertebrate brachiopod genus <u>Orbiculoidea</u> and pyritized burrow structures are common.
7,326.0' - 7,330.4' (4.4')	Mudstone, olive gray (5Y 4/1) and grayish black (N2), thinly laminated and thin bedded. Two thin beds of strongly calcareous mudstone are present from 7,326.0' to 7,327.0' and from 7,327.9' to 7,328.3'. The upper bed is a very impure lime mudstone. The top of the upper bed is mottled by bioturbation and contains numerous large (1 cm) shell fragments. Between 7,326.0' and 7,328.2', the interval contains abundant small diameter (1-2 mm) pyritized burrow structures. The grayish black mudstones in the interval also are moderately calcareous and contain <u>Orbiculoidea</u> sp. shells and casts of other shell fragments.
7,330.4' - 7,336.3' (5.9')	Mudstone and shaly mudstone, grayish black (N2) grading to black (N1) below 7,330.8', thinly laminated. The upper 1.0' is weakly to very weakly calcareous. Below 7,334.0', the core is shaly. Development of fissility in the lower part is attributable to faulting with approximately 10 subhorizontal fault planes in the lower 1/2 of the interval. Between 7,335.0' and 7,335.3', core was recovered as rubble containing slickensided fragments and possible fault breccia. The interval is barren of megascopic fossils or biogenic structures.

INTERVALDESCRIPTION

- 7,336.3' - 7,342.5'
(6.2')
- Shaly mudstone, black (N1), thinly laminated, noncalcareous. Fissility is moderately developed in the upper 1/2, strongly developed in the lower 1/2. The upper 1/2 contains a number of isolated (2 to 3 mm) pyrite nodules. A fault zone is present between 7,339.7' and 7,342.5'; much of the core in the fault zone was recovered as rubble. Nearly all partings in the lower 1/2 are coated with slickensides.
- 7,342.5' - 7,348.0'
(5.5')
- Shaly mudstone, black (N1); thinly laminated. A single thin bed of dark gray (N3) calcareous mudstone occurs from 7,342.9' to 7,344.4'. The shaly mudstone contains a number of small (2 mm) calcite-pyrite nodules or mineralized burrow structures. A fault intersects the calcareous mudstone bed at an oblique angle. The fault occupies a 1-inch-wide zone containing fragments of fault breccia cemented in place with sparry calcite. Fissility in the interval is faulting-induced; many partings are coated with slickensides.
- 7,348.0' - 7,358.5'
(10.5')
- Shaly mudstone with some silty shale, black (N1), thinly laminated and friable. Most of the interval is weakly to moderately calcareous. Zones of rubble were recovered between 7,348.0' and 7,350.0', and between 7,352.0' and 7,358.5'. Silt content appears to be greater than in overlying intervals, but the distribution of silty shale is uncertain due to poor recovery and lime content.
- 7,358.5' - 7,367.2'
(8.7')
- Silty mudstone and shaly mudstone, black (N1), thinly laminated. The upper 2.0' of the interval is shaly and friable. Between 7,360.5' and 7,362.0', silty mudstones are weakly calcareous. A lime concretion probably was present between 7,362.0' and 7,362.4'. The concretion was not recovered, but characteristic concretionary features are present in surrounding segments of the core (distorted laminae with curvilinear slickensided surfaces and lime content in overlying silty mudstones). A thin lamina of volcanic ash containing a minor amount of disseminated pyrite is present at 7,364.1'. Fossils and biogenic structures are absent.
- 7,367.2' - 7,371.9'
(4.7')
- Silty shale and shaly mudstone, black (N1), thinly laminated. The upper 2.9' is made up of silty shale containing a small, near vertical strike-slip fault. Below the silty shale zone are two small lens-shaped lime concretions, olive gray (5Y 3/1) in color, surrounded above and below by distorted laminae bearing slickensided surfaces. The concretions occur between 7,370.1' and 7,370.8'. The remainder of the interval consists of shale mudstone. No fossils or biogenic structures are present.

INTERVALDESCRIPTIONS

- 7,371.9' - 7,381.3'
(9.4')
- Mudstone and shaly mudstone, grayish black (N2) and black (N1), thinly laminated. Grayish black mudstone comprises the upper 3.6' of the interval. The lower part is black shaly mudstone containing a steeply inclined slickensided natural fracture between 7,377.5' and 7,379.3'. A single cast of a poorly preserved shell fragment (inarticulate brachiopod?) occurs at 7,379.2'. From 7,379.5' to 7,380.0' are several irregular mud lumps (coprolites?), some of which are partially pyritized. The interval is noncalcareous.
- 7,381.3' - 7,389.9'
(8.6')
- Impure lime mudstone, silty mudstone, and mudstone, olive gray (5Y 4/1), dark gray (N3), and grayish black (N2), thinly laminated to thin bedded. The upper 1.6' consists of impure lime mudstone containing numerous pyritized burrow structures in the basal part. Approximately 3' of silty mudstone underlies the limestone; the remainder of the interval is made up of mudstone. Both the mudstones and silty mudstones are weakly to moderately calcareous. Weak fissility is developed in several thin zones within the lower 1/2 of the interval. Orbiculoidea sp. shells occur at 7,381.4' (top of the limestone) and at 7,385.5' (base of the silty mudstone zone). At the latter location, the shells are delicately pyritized. Most of the core between 7,383.5' and 7,384.8' was recovered as rubble.
- 7,389.9' - 7,396.3'
(6.4')
- Shaly mudstone and mudstone, grayish black (N2) and black (N1), thinly laminated. Except for a zone of mudstone between 7,391.4' and 7,392.9', the interval is composed of shaly mudstone. Above 7,393.4' the core is grayish black (N2) and moderately to strongly calcareous (except in the mudstone zone). Fissility appears to be related to faulting, and approximately 30 subhorizontal fault surfaces intersect the core in the upper part. The shaly mudstones within this fault zone contain abundant casts and impressions of inarticulate brachiopod, articulate brachiopod, and a few pelecypod (?) shells. On some partings the shell casts are distorted by shearing. Below 7,393.4' the shaly mudstone is black and friable. The lower part is barren of fossils but contains occasional small pyrite nodules.
- 7,396.3' - 7,405.0'
(8.7')
- Mudstone, black (N1), thinly laminated. The mudstone is not shaly, but is extremely friable and very thinly laminated. Thin zones which are very weakly to weakly calcareous are common throughout. At 7,400.8' are several mud pellets (coprolites?) approximately 1 cm in diameter, surrounded by distorted laminae. Small isolated flakes and grains of pyrite occur throughout the interval.

INTERVALDESCRIPTION

- 7,405.0' - 7,416.2'
(11.2')
- Mudstone, black (N1), thinly laminated. Mudstone in the upper part is very thinly laminated and friable. Most of the core above 7,409.1' is moderately calcareous. Between 7,411.9' and 7,412.1' a single lime concretion or an irregular very thin bed of lime mudstone occurs. A steeply inclined natural fracture with slickensided surfaces intersects the core from 7,413.2' to 7,413.9', and the mudstone is shaly within this zone. A parting at 7,408.2' is covered with calcite-mineralized casts of large (1.5 cm) articulate brachiopods. A number of delicately pyritized casts of articulate brachiopods (the same size and species as those above) occurs at 7,409.1'. Small pyritized burrow structures are present near 7,410.7'. At 7,411.5' a concentration of shells of the inarticulate brachiopod genus Orbiculoidea is present. Pyritized fossil fragments occur near the base of the interval.
- 7,416.2' - 7,417.4'
(1.2')
- Lime wackestone and lime mudstone, olive gray (5Y 4/1), thin-bedded. The interval consists of a single bed of limestone divided into three zones. The upper part (7,416.2'-7,416.5') is lime wackestone containing numerous large (~1 cm) coral and shell fragments. The middle part (7,416.5'-7,417.1') is composed of lime mudstone with sparse fossil fragments. The lower part (7,417.1'-7,417.4') is lime wackestone containing abundant (35-45% vol. ratio) shell fragments which are heavily pyritized. The lower lime wackestone is highly argillaceous. A fault plane intersects the core between 7,416.6' and 7,416.8'; bedding above the fault is distorted.
- 7,417.4' - 7,426.0'
(8.6')
- Silty mudstone, black (N1), thinly laminated throughout. The interval includes several shaly zones (silty shale) near 7,418.0', 7,419.0', and 7,421.5'. Lenticular segregations of disseminated pyrite occur at 7,420.1' and 7,421.5'. A spheroidal calcareous concretion surrounded by a halo of disseminated pyrite is present between 7,425.2' and 7,425.5'. Macroscopic fossils and biogenic structures are absent.
- 7,426.0' - 7,434.0'
(8.0')
- Silty mudstone and mudstone, black (N1), thinly laminated. The upper part of the interval is made up of silty mudstone which grades into mudstone very thinly laminated and friable below 7,429.0'. A thin (2 cm) lens of pyrite occurs between 7,427.4' and 7,427.5'. The interval is noncalcareous. No fossils or biogenic structures are present.

INTERVALDESCRIPTION

- 7,434.0' - 7,442.5'
(8.5')
- Mudstone, black (N1), very thinly laminated. The interval is very friable and contains a number of conical torsional fractures. Pyrite is common as thin (<1 mm) laminae in the upper 2.0' and as small nodules and disseminated grains visible on partings throughout. Recovery was poor in the zone from 7,441.9' to 7,442.5', apparently due to extreme friability of the core. A number of thin (3-6 cm) zones in the lower 3.0' are weakly to moderately calcareous. No fossils or biogenic structures were observed.
- 7,442.5' - 7,450.3'
(7.8')
- Mudstone and shaly mudstone, and impure lime mudstone, black (N1), dark gray (N3), and medium dark gray (N4), thinly laminated to thin bedded. Beds of lime mudstone occur at 7,442.5' (0.2' thick) and at 7,448.9' (0.3' thick). Between 7,447.4' and 7,448.2' a third segregation of lime containing calcite mineralized septarian cracks (either a large concretion or an irregular bed) is present. Black mudstones and shale mudstones occur between the limestones and through the lower 1.1' of the interval. The upper mudstone zone (7,442.7' to 7,447.4') contains very thin pyrite laminae, disseminated pyrite and pyritic nodules increasing in size from 1 mm to 3-8 mm near the base. The larger nodules (possibly fecal pellets) are more irregular in shape than the smaller nodules. A small, lenticular lime concretion occurs at the base of the interval. Rubble was recovered from a zone of extremely friable core between 7,446.1' and 7,446.6'.
- 7,450.3' - 7,460.0'
(9.7')
- Mudstone and silty mudstone, black (N1), thinly laminated. The upper 2.0' is weakly to moderately fissile. Below 7,452.0' most of the interval is weakly to moderately calcareous. Several pyrite lenses are present in the upper and middle parts; small (1-3 mm) pyrite nodules are common throughout. A number of poorly-preserved casts of articulate brachiopod shells occur on a parting at 7,456.5'.
- 7,460.0' - 7,469.0'
(9.0')
- Mudstone, black (N1), thinly laminated and friable. Partings coated with slickensides occur throughout. A fault zone containing rubble, fault breccia, and 5 to 10 planar fault surfaces per foot of core occurs between 7,463.1' and 7,465.8'. The fault zone attenuates through the lower part of the interval. Small (2-4 mm) irregular nodules and lenses of pyrite are common throughout. Delicately pyritized fossil fragments (including articulate brachiopods at 7,461.4') are present in the upper 3.0'. The interval is moderately calcareous above and below the fault.

INTERVALDESCRIPTION

7,469.0' - 7,477.0'
(8.0')

Mudstone, grayish black (N2), and black (N1), thinly to thickly laminated, calcareous. At the top of the interval is a 0.9'-thick zone of grayish black, strongly calcareous mudstone with a granulated appearance (attributable to high carbonate content and intensive microshearing). Below 7,469.9' the interval is composed of black friable mudstone which is moderately calcareous above 7,474.0'. A zone between 7,472.8' and 7,475.1' contains abundant, well rounded sand-size grains (quartz?), but does not appear to have significant silt content. A steeply dipping mineralized natural fracture is confined within the "sandy mudstone" zone. The lower 2.0' exhibits a large number of subhorizontal fault surfaces and two small wrench faults.

7,477.0' - 7,483.0'
(6.0')

Silty shale, black (N1) and grayish black (N2), thinly laminated. Several thin zones distributed throughout the interval contain significant amounts of fine sand grains (quartz). Thin siltstones occur at 7,480.3' and 7,482.2'. A zone of rubble between 7,480.0' and 7,480.2' contains fragments of a pyritic lens. Irregular pyrite nodules and pyritized mud pellets (coprolites?) occur in the upper 2/3 of the interval. The core is very weakly to moderately calcareous.

7,483.0' - 7,488.0'
(5.0')

Shaly mudstone, lime mudstone, and wackestone, grayish black (N2), dark gray (N3), and medium dark gray (N4), thickly laminated to thin-bedded. The lime mudstone and wackestone are interlaminated with shaly mudstone partings throughout. A moderate proportion of clastic, argillaceous material (~10-20%) is present in the carbonate units. The grain component of the wackestones consists of unidentifiable skeletal fragments and very small (<1 mm) Orbiculoidea shells. The grains are coarse-sand size. Several of the lime mudstone units contain mud filled burrow structures. Pyrite nodules and lenses occur sparsely throughout.

7,488.0' - 7,496.2'
(8.2')

Shaly mudstone, lime mudstone, and wackestone, grayish black (N2), dark gray (N3), and medium dark gray (N4), thickly laminated to thin bedded. Lime mudstone is predominant throughout. Thin laminae of lime packstone occur within the wackestone beds. The grain component of the carbonate units consists of sand size, unidentifiable skeletal material. Mud filled burrow structures occur throughout, but are especially common in the lime mudstone units. The carbonate rocks contain approximately 10% clastic, argillaceous material. Pyrite nodules and lenses occur sparsely throughout.

A P P E N D I X B

SYMBOLS, TERMS, AND ABBREVIATIONS USED

IN FRACTURE LOGGING

EGSP PENNSYLVANIA #2 WELL - ALLEGHENY COUNTY

1. CHARACTER: Specifically, the character of the fracture plane.

(P): Planar
(CP): Curvilinear

2. FRACTURE TYPE: These terms are used to classify the different types of fractures into genetic groups.

(N): Natural

Spl. Jt. (Simple Joint): One discrete fracture plane, no displacement.

Cpd. Jt. (Compound Joint): Two or more parallel, closely spaced (approximately 1 cm or less) fracture planes, no displacement.

Flt. (Fault): A shear fracture with demonstrable displacement indicated by displaced primary features or slickensides.

Mcr. Ft. (Micro-Fault): A small-scale shear fracture, generally curvilinear; of the same order of size as the core diameter.

(CI): Coring Induced

PF (Petal Fracture): An oblique fracture, usually planar or slightly curvilinear, which originates at the core margin and terminates against bedding within the core.

PFC (Petal-Centerline Fracture): A fracture originating as a petal fracture which curves down-core and bisects the core as a vertical planar fracture. The strike of the vertical fracture and the petal fracture is identical. The face of the vertical fracture is characterized by regularly spaced arrest lines, convex down-core and symmetrical about the core axis.

DF (Disc Fracture): A subhorizontal fracture originating within the core and displaying hackle plumes radiating from the fracture origin to meet the core margin orthogonally.

- TF (Torsional Fracture): A spiraling or irregular fracture developed when a couple is applied to the core.
- DCS (Disc Fracture with Circular Slickensides): A feature induced by coupling of the inner and outer core barrels, causing core in the barrel to rotate against a stationary core stump.
- KES (Knife Edge Spall): A fracture, typically conchoidal, formed by scribe knives cutting orientation grooves into the core. This fracture type can be used to determine the down-core direction and the relative age of induced fractures.
- CBS (Core Bit Spall): A tiny conchoidal fracture caused by a diamond from the core bit plucking a chip off the edge of a preexisting fracture. When the face of the preexisting fracture is viewed with the core in normal position the spalls should appear along the right-hand margin. This fracture type is useful in inferring relative fracture chronology.

3. FRAC TOGRAPHIC FEATURES:

- Org. (Fracture Origin): A discrete fracture surface irregularity from which hackles originate. Fractures may originate at the boundaries of fossils, concretions, preexisting fractures, etc.
- Hkl. (Hackle): A linear marking on a fracture face, similar to a striation, which trends in the direction of fracture propagation. Hackles radiate away from the origin, are perpendicular to arrest lines, and will curve to meet preexisting surfaces orthogonally.
- Fh. Hkl. Plm. (Fine Hackle Plume): A very fine, wispy plumose structure on an otherwise featureless fracture face.
- Incl. Hkl. (Inclusion Hackle): A hackle trailing an inclusion or obstacle on the fracture plane.
- Cs. Tw. Hkl. (Coarse Twist Hackle): A hackle composed of discrete steps generally appearing as a fringe near the edge of of a fracture face.
- Ar. Ln. (Arrest Line): A crescentic feature with a cusp-like profile which marks the still stand of the fracture front. Two types are noted:
 Term. Ar. Ln.: Terminal Arrest Lines.
 Int. Ar. Ln.: Intermediate Arrest Lines.

Hk. (Hook): The curving of a fracture plane to adjust to a change in the stress field orientation. Fractures hook to meet preexisting free surfaces orthogonally and in the vicinity of the neutral axis developed in bending.

4. TERMINATIONS: These terms are used to describe how a fracture terminates. The upper entry depicts the upper termination, the lower entry depicts the lower.

M: The fracture exits the margin of the core.

Ⓜ : A subhorizontal fracture that exits the margin of the core. This symbol is entered only once straddling the dividing line.

→ : A fracture that terminates within the core as a dying hairline fracture.

↗ : The upper and lower extents of the fracture die out within the core. This symbol is drawn straddling the dividing line.

?: Missing or disrupted core prohibits observation of the mode of termination.

?/M: Same as above, but the fracture probably exits the core margin.

?/ Ⓞ : Same as above, but the fracture probably terminates within the core margin.

BDG: The fracture terminates along a conspicuous bedding plane indicating an abrupt change in lithology.

TAL: The fracture terminates as a terminal arrest line which is visible only on the fracture face.

ⓉAL : The fracture terminates in a terminal arrest line so that the fracture enters one side of the core but does not exit the other. This symbol is entered only once straddling the dividing line.

F22: This symbol is used when one fracture terminates against another (i.e., fracture 23 terminates against fracture 22).

APPENDIX C

FRACTURE LOGS

EGSP PENNSYLVANIA #2 WELL - ALLEGHENY COUNTY

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 1 OF 9
 LOG CLASSIFICATION 8 INDIVIDUALS 0 INTERVALS
 FRACTURE TYPE(S): NATURAL

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 LOG DATE: Apr. 1979
 Dec. 1979

WELL: EG.S.P. Pa-2, Allegheny Co.

NUMBER	DEPTH FEET	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	VERTICAL DIP	FRACTURE TYPE	MINERALIZATION	SILIC- BASIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	6910.5		SALT MOST SH. MOST GRA. BLK. NZ	(M)	CP	N 32° W 12° NE	N 58° E 13°	MCRELT.	MODERATE CALCITE (?)	PRESENT		
2	6915.5		SALT MOST. GRA. SH. GRA. BLK. NZ. CPA. N3	(M)	CP	N 15° W 11° NE	N 57° E 13°	FLT.	SLIGHT CALCITE (?)	9° S 58° E		
3	6915.7	0.2'	A/A	?	P	N 33° W 12° NE		FLT.	CALCITE (?)	PRESENT		INDETERMINATE STRIKE RUDDLE CONTAINING SLICKENSIDES.
4	6915.9		SALT MOST. MOST GRA. BLK. NZ	(M)	P	N 50° E 22° NW		FLT.	CALCITE	5 45° E 20°		
5	6916.6	0.1'	A/A	M	CP	N 32° W 12° NE		MCRELT.	MODERATE CALCITE	N 80° W		
6	6919.2		A/A	(M)	P	N 32° W 12° NE		FLT.	MODERATE CALCITE	PRESENT		
7	6919.3		A/A	(M)	P	N 32° W 12° NE		FLT.	MODERATE CALCITE	7° S 60° E		
8	6919.4		A/A	(M)	CP	N 32° W 12° NE		FLT.	HEAVY CALCITE	PRESENT		
9	6919.4		A/A	(M)	P	N 32° W 12° NE	N 58° E 13°	FLT.	HEAVY CALCITE	PRESENT		
10	6919.4		A/A	(M)	P	N 32° W 12° NE		FLT.	CALCITE	NONE		INDETERMINATE STRIKE
11	6919.5	0.1'	A/A	?	P	N 48° E ~30° SE		CMPTMT.	CALCITE	NONE		
12	6919.6	0.1'	A/A	?	CP	N 8° E		MCRELT.	HEAVY CALCITE	PRESENT		
13	6919.7	0.1'	A/A	(M)	CP	N 18° W 12° NE	N 57° E 13°	FLT.	MODERATE CALCITE	15° N 47° W		FLANK OF CONCRETION
14	6919.9	0.1'	A/A	M	CP	N 28° W 12° NE		FLT.	V. HEAVY CALCITE	NONE		
15	6919.9	0.1'	A/A	(M)	CP	N 10° W 30° SW		FLT.	MODERATE CALCITE	25° N 68° W		FLANK OF CONCRETION
16	6919.9	0.1'	A/A	M	CP	N 18° W 10° NE		FLT.	V. HEAVY CALCITE	NONE		FLANK OF CONCRETION
17	7002.9		SALT MOST. SALT SH. GRA. BLK. NZ	(M)	P	N 90° W 10° NE		FLT.	HEAVY CALCITE	NONE		
18	7003.1		A/A	(M)	CP	N 15° W 15° NE		FLT.	HEAVY CALCITE	NONE		
19	7023.5		A/A	(M)	P	N 16° E 16° SE		FLT.	HEAVY CALCITE	10° S 15° E		
20	7023.6		A/A	(M)	P	N 20° W 10° SE		FLT.	HEAVY CALCITE	NONE		
21	7023.7		A/A	(M)	P	N 20° W 10° NE		FLT.	HEAVY CALCITE	NONE		CLOSED MINERALIZED FRACTURE
22	7015.4		SALT MOST GRA. BLK. NZ	M	CP	N 82° W 2° NE	N 55° E 13°	FLT.	CALCITE	VISIBLE 24° S 32° E		FLANK OF CONCRETION
23	7015.7		A/A	(M)	CP	N 82° W 2° NE		FLT.	V. HEAVY CALCITE	NONE		FLANK OF CONCRETION
24	7016.3		A/A	(M)	CP	N 56° E ~60° SE		FLT.	SLIGHT CALCITE	VISIBLE ~45° S 52° E		CLOSED MINERALIZED FRACTURE
25	7016.4		A/A	(M)	CP	N 50° E ~42° SE		FLT.	SLIGHT CALCITE	~31° S 54° E		FLANK OF CONCRETION
26	7024.1	0.1'	SH. MOST. SALT MOST GRA. BLK. NZ	M	CP	N 60° W 9° NE	N 54° E 13°	MCRELT.	HEAVY CALCITE	NONE		FLANK OF CONCRETION
27	7020.7		SH. MOST. SALT SH. GRA. BLK. NZ	(M)	P	N 60° W 9° NE		FLT.	V. HEAVY CALCITE	VISIBLE		INDETERMINATE STRIKE CLOSED MINERALIZED FRACTURE

EGSP STANDARD CORE FRACTURE LOGGING FORMAT
 WELL: EGSP Pa-2, Allegheny Co.

CORING RUN NO. (S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	Vertical Drift	FRACTURE TYPE	MINERALIZATION	SUCK-ENDES	FRACTOGRAPHIC FEATURES	COMMENTS
28	7031.8 7031.9	0.1'	SH. MDST. BLK. SL. N2 BLK. N1. GFA. BLK. N2	M	C.P.	N 40° E 32° NW	N 54° E 12°	MCRELT.	HEAVY CALCITE	~33° N 59° W		
29	7032.7	0.1'	A/A	M	C.P.	N 48° E 26° SE		ELT.	HEAVY CALCITE	23° S 72° E		
30	7036.5	0.1'	A/A	M	C.P.	N 40° E 23° NW		MCRELT.	HEAVY CALCITE	23° N 54° W		
31	7039.5	0.1'	A/A	M	C.P.	N 36° E 17° SE		ELT.	MODERATE CALCITE	17° S 52° E		
32	7039.4	0.1'	A/A	M	P	N 30° W 7° NE		ELT.	NDONE	7° S 44° E		
33	7039.5		A/A	M	P	N 36° W 9° NE		ELT.	NDONE	PRESENT 6°		
34	7040.8		SH. MDST. BLK. N1	M	P	N 50° W 8° NE		ELT.	NDONE	N 46° W		
35	7048.0		A/A	M	P	N 90° W 9° NE		ELT.	HEAVY CALCITE	PRESENT		
36	7048.2	0.1'	A/A	M	C.P.	N 28° W 20° NE		ELT.	HEAVY CALCITE	NDONE		
37	7048.1	0.2	A/A	M	P	N 60° W ~90°		SPLINT.	HEAVY CALCITE	VISIBLE NDONE		
38	7051.4		SH. MDST. MDST. BLK. N1	F. 3/6 M	P	N 40° W 6° NE		ELT.	V. HEAVY CALCITE	NDONE VISIBLE 19°		
39	7057.4		A/A	M	C.P.	N 10° W 25° NE		MCRELT.	NDONE	S 44° E		
40	7057.7	0.1'	A/A	M	C.P.	N 82° E 7° NE	N 54° E 12°	MCRELT.	NDONE	PRESENT		
41	7058.0	2.4'	SILTY MDST. BLK. N1	M	P	N 80° W 85° SW		C.P.D. JNT.	MODERATE CALCITE	NDONE VISIBLE		
42	7059.0	0.3'	A/A	M	P	N 50° W 81° NE		SPLINT.	HEAVY CALCITE	NDONE VISIBLE		
43	7059.2	0.2'	LM. MDST. BK GRA. N2	M	P	N 45° W 80° SW	N 56° E 12°	SPLINT.	NDONE	NDONE 31°		
44	7108.2	0.2'	L.M. MDST. DK. GRA. N3. MED. BK. GRA. N1	DD4	C.P.	N 23° E 47° SE	N 54° E 10°	MCRELT.	NDONE	S 42° E		INDETERMINATE STRIKE FLANK OF PYRITE NODULE
45	7156.1		MDST. SH. MDST. GRD. BLK. N2	M	C.P.	N 18° E 9° SE	N 55° E 10°	ELT.	MODERATE CALCITE	PRESENT 5°		
46	7202.9		MDST. SH. MDST. GRA. BK. N2	M	P	N 18° E 9° SE		ELT.	NDONE	S 28° E 6°		
47	7204.0		A/A	M	P	N 0° E		ELT.	NDONE	S 28° E 4°		
48	7204.1		A/A	M	P	N 3° E		ELT.	NDONE	S 32° E 6°		
49	7214.8		A/A	M	P	N 12° W 8° NE	N 54° E 9°	ELT.	NDONE	S 53° E 7°		
50	7215.5		A/A	M	P	N 16° W 11° NE		ELT.	NDONE	S 40° E ~10°		
51	7330.5		A/A	M	P	N 40° E 11° NW	N 46° E 7°	ELT.	SPARSE CALCITE	N 54° W 15°		
52	7330.8		A/A	M	C.P.	N 34° E 18° SE		ELT.	NDONE	S 48° E ~4°		
53	7333.7		A/A	M	P	N 8° E 9° NW		ELT.	NDONE	N 40° W 5°		
54	7335.8		A/A	M	P	N 72° E 0° NW		ELT.	NDONE	N 48° E		

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 3 OF 9
 LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): NATURAL

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

WELL: EGSR Pa-2, Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	Vertical drift	FRACTURE TYPE	MINERALIZATION	SLICK-ENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
55	3330.1		MDSH. SH. MDSH. SH. MDSH. SH. MDSH. SH.	(M)	P	N 10° E	N 40° E	MICRELT.	HEAVY CALCITE	PRESENT		INDETERMINATE STRIKE
56	3336.4		SH. MDSH. SH. MDSH. SH.	(M)	P	N 10° SE		ELT.	SLIGHT CALCITE	5 25° E		
57	3336.5		A/A	(M)	P	N 10° SE		ELT.	SLIGHT CALCITE	5 25° E		
58	3337.1		A/A	(M)	P	N 28° E		ELT.	HEAVY CALCITE	6°		
59	3337.4		A/A	(M)	P	N 9° SE		ELT.	NONE	5 16° E		
60	3337.8		A/A	(M)	P	N 6° E		ELT.	NONE	PRESENT		INDETERMINATE STRIKE
61	3339.7		A/A	(M)	P	N 6° SE		ELT.	NONE	N 10° W		
62	3339.9		A/A	(M)	P	N 50° E	N 49° E	ELT.	NONE	5 4° W		INDETERMINATE STRIKE
63	3340.2		A/A	(M)	P	N 70° E		ELT.	NONE	5°		
64	3340.3		A/A	(M)	P	N 4° SE		ELT.	NONE	N 6° E		
65	3340.5		A/A	(M)	P	N 72° E	N 45° E	ELT.	NONE	PRESENT		
66	3341.1		A/A	(M)	P	N 6° SE		ELT.	NONE	N 44° E		
67	3341.8	1.8	A/A	(M)	P	N 60° E		MICRELT.	MODERATE CALCITE	PRESENT		INDETERMINATE STRIKE
68	3341.5	0.4	A/A	(M)	P	N 50° E		ELT.	NONE	5 48° W		PARTIALLY SUBM.
69	3341.4		A/A	(M)	P	N 25° W		MICRELT.	NONE	PRESENT		
70	3342.6		A/A	(M)	P	N 37° W		ELT.	NONE	26°		NO ORIENTATION MARKS ON CORE
71	3342.5		A/A	(M)	P	N 3° NE		ELT.	NONE	NONE		INDETERMINATE STRIKE
72	3342.8	0.3	A/A	(M)	P	N 85° SW		MICRELT.	NONE	N 30° E		NO ORIENTATION MARKS ON CORE
73	3343.2		A/A	(M)	P	N 70° W		ELT.	NONE	NONE		INDETERMINATE STRIKE
74	3343.6		A/A	(M)	P	N 15° NE		ELT.	NONE	PRESENT		NO ORIENTATION MARKS ON CORE
75	3343.7		A/A	(M)	P	N 40° W		MICRELT.	NONE	8 58° E		SLICKENSIDE ANGLE OF SEPARATION = 17°
76	3344.2	2.0	A/A	(M)	P	N 37° W		ELT.	NONE	3°		POSSIBLE EXTENSION OF # 69 INDETERMINATE DWF TO WEST CORE
77	3344.6		A/A	(M)	P	N 3° NE		ELT.	SLIGHT CALCITE	5 50° E		
78	3346.6		A/A	(M)	P	N 85° SW		ELT.	NONE	10°		FAULT GOUGE TWO SETS OF SLICKENSIDES
79	3346.7		A/A	(M)	P	N 45° W		ELT.	SPARSE CALCITE	30°		ANGL. OF SEPARATION = 50°
80	3348.2		A/A	(M)	P	N 90°		ELT.	SLIGHT CALCITE	16°		AT LEAST 3 MINERIALIZED COMPARTS IN INTERVAL
81	3348.7		A/A	(M)	P	N 20° W		ELT.	SLIGHT CALCITE	5 18° E		ALL ≈ PARALLEL. SOME RUDDLS
			A/A	(M)	P	N 20° E		ELT.	NONE	10°		TWO SETS OF SLICKENSIDES
			A/A	(M)	P	N 15° SE		ELT.	NONE	N 50° E		
			A/A	(M)	P	N 55° W		ELT.	SLIGHT CALCITE	N 50° E		
			A/A	(M)	P	N 5° NE		ELT.	SLIGHT CALCITE	N 40° E		
			A/A	(M)	P	N 45° W		ELT.	NONE	5°		
			A/A	(M)	P	N 6° NE		ELT.	NONE	N 85° E		

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

LOG CLASSIFICATION INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): NATURAL

WELL: EG.S.P. Pa-2, Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	Vertical drift	FRACTURE TYPE	MINERALIZATION	SUCK-ENDSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
82	7360.8 7361.2	0.4'	SILT. MUDST. SH. MUDST. SILT. NI	C 7 P 7	P	N 30° E 70° SE	N 43° E 7°	COMPJNT	NONE	NONE		
83	7362.1 7362.4		A/A	(M)	CP	N 50° E ~42° NW		MCFLT.	SLIGHT CALCITE	~40° S 20° E		FLANK OF CONCRETION
84	7363.0		A/A	(M)	CP	N 47° E 25° SE		MCFLT.	NONE	35° S 60° E		INDETERMINATE STRIKE FLANK OF CONCRETION
85	7363.4 7363.5		A/A	(M)	P	N 10° E 78° NW		FLT	NONE	23° S 56° E		FLANK OF CONCRETION
86	7363.6	0.1'	A/A	7/2	P	N 10° E 78° NW		SPLJNT.	SLIGHT CALCITE	NONE		
87	7364.5		A/A	(M)	P	N 40° E 14° SE	N 43° E 7°	SPLJNT.	NONE	NONE		
88	7367.3 7370.2	3.0'	SILT. SH. SH. MUDST. SILT. NI	M	P	N 12° E 36° NW		FLT.	SLIGHT CALCITE	VISIBLE		RELATED TO # 86
89	7368.8		A/A	M	P	N 41° W 7° NE		FLT.	CALCITE	20° N 18° E		
90	7370.2		A/A	(M)	P	N 41° E 5° NE		FLT.	NONE	4° N 16° W		
91	7370.2 7370.3		A/A	(M)	CP	N 41° E 5° NW		FLT.	NONE	4° N 48° W		
92	7370.3 7370.4	0.1'	A/A	M	CP	N 64° W 34° SW		FLT.	NDNF	20° S 22° E		
93	7370.9		A/A	(M)	P	N 54° W 18° SW		FLT.	NONE	PRESENT		
94	7374.8		A/A	(M)	CP	N 43° W 18° NE		FLT.	NDNF	PRESENT		
95	7375.0		MUDST. SILT. MUDST. GORG. SILT. NI. SILT. NI	(M)	P	N 53° W 4° NE		FLT.	NONE	2° N 32° W		
96	7375.0		A/A	(M)	P	N 28° W 9° NE		FLT.	NONE	3° S 30° E		
97	7375.1		A/A	(M)	P	N 9° F 12° SE		FLT.	NONE	6° S 33° E		

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EG.S.P. Pa-2, Allegheny Co.

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	Vertical Drift	FRACTURE TYPE	MINERALIZATION	SLICK-ENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
109	3391.1		SH. MOTT. PART. GSS. BR. M. BLS. N.	(M)	P	N 20° W		FLT.	NONE	10°		
110	3391.2		A/A	(M)	P	12° NE	N 40° E	FLT.	NONE	N 40° E		
111	3391.3		A/A	(M)	P	10° NE	N 41° E	FLT.	NONE	N 41° E		
112	3391.4	0.2	A/A	(M)	P	15° NE		FLT.	NONE			
113	3391.5	0.7	A/A	(M)	P	N 40° E		SPLINT.	SLIGHT CALCITE			
114	3391.6		A/A	(M)	P	~ 75° SE		SPLINT.	CALCITE			
115	3391.7		A/A	(M)	P	N 40° E		FLT.	NONE			
116	3391.8	0.2	A/A	(M)	P	14° SW		FLT.	NONE			
117	3391.9		A/A	(M)	P	~ 90°		SPLINT.	SLIGHT CALCITE			
118	3392.0		A/A	(M)	P	N 10° W		FLT.	NONE			
119	3392.1		A/A	(M)	P	8° NE		FLT.	NONE			
120	3392.2		A/A	(M)	P	N 50° W		FLT.	NONE			
121	3392.3		A/A	(M)	P	7° NE		FLT.	NONE			
122	3392.4	0.1	A/A	(M)	P	N 40° W		FLT.	NONE			
123	3392.5		A/A	(M)	P	9° NE		FLT.	NONE			
124	3392.6	0.4	A/A	(M)	P	N 20° W		FLT.	NONE			
125	3392.7		A/A	(M)	P	10° NE		SPLINT.	SLIGHT CALCITE			
126	3392.8		A/A	(M)	P	50° SW		FLT.	NONE			
127	3392.9	2.3	A/A	(M)	P	N 15° W		FLT.	NONE			
128	3393.0		A/A	(M)	P	5° NE		FLT.	NONE			
129	3393.1		A/A	(M)	P	N 22° E		FLT.	NONE			
130	3393.2		A/A	(M)	P	81° SE		SPLINT.	CALCITE			
131	3393.3	0.5	A/A	(M)	P	N 52° E	N 41° E	FLT.	NONE			
132	3393.4		A/A	(M)	P	12° SE		FLT.	NONE			
133	3393.5		A/A	(M)	P	N 30° W		SPLINT.	HEAVY CALCITE			
134	3393.6	0.2	A/A	(M)	P	N 0° E		FLT.	NONE			
135	3393.7		A/A	(M)	P	N 52° E		SPLINT.	SLIGHT CALCITE			
136	3393.8		A/A	(M)	P	13° SE		FLT.	MODERATE CALCITE			
137	3393.9		A/A	(M)	P	N 70° E	N 43° E	FLT.	CALCITE			
138	3394.0		A/A	(M)	P	52° SE		FLT.	NONE			
139	3394.1		A/A	(M)	P	N 83° E		FLT.	SLIGHT CALCITE			
140	3394.2		A/A	(M)	P	30° NW		SPLINT.	HEAVY CALCITE			
141	3394.3		A/A	(M)	P	N 50° W		FLT.	CALCITE			
142	3394.4		A/A	(M)	P	7° NE		FLT.	NONE			
143	3394.5		A/A	(M)	P	N 15° W		FLT.	NONE			
144	3394.6		A/A	(M)	P	5° NE		FLT.	NONE			
145	3394.7		A/A	(M)	P	N 20° W		FLT.	NONE			
146	3394.8		A/A	(M)	P	10° NE		SPLINT.	SLIGHT CALCITE			
147	3394.9		A/A	(M)	P	50° SW		FLT.	NONE			
148	3395.0		A/A	(M)	P	N 15° W		FLT.	NONE			
149	3395.1		A/A	(M)	P	5° NE		FLT.	NONE			
150	3395.2		A/A	(M)	P	N 22° E		FLT.	NONE			
151	3395.3		A/A	(M)	P	81° SE		SPLINT.	CALCITE			
152	3395.4		A/A	(M)	P	N 52° E		FLT.	NONE			
153	3395.5		A/A	(M)	P	12° SE		FLT.	NONE			
154	3395.6		A/A	(M)	P	N 30° W		SPLINT.	HEAVY CALCITE			
155	3395.7		A/A	(M)	P	N 0° E		FLT.	NONE			
156	3395.8		A/A	(M)	P	N 52° E		SPLINT.	SLIGHT CALCITE			
157	3395.9		A/A	(M)	P	13° SE		FLT.	MODERATE CALCITE			
158	3396.0		A/A	(M)	P	N 70° E		FLT.	CALCITE			
159	3396.1		A/A	(M)	P	52° SE		FLT.	NONE			
160	3396.2		A/A	(M)	P	N 83° E		FLT.	SLIGHT CALCITE			
161	3396.3		A/A	(M)	P	30° NW		SPLINT.	HEAVY CALCITE			
162	3396.4		A/A	(M)	P	N 50° W		FLT.	CALCITE			
163	3396.5		A/A	(M)	P	7° NE		FLT.	NONE			
164	3396.6		A/A	(M)	P	N 15° W		FLT.	NONE			
165	3396.7		A/A	(M)	P	5° NE		FLT.	NONE			
166	3396.8		A/A	(M)	P	N 22° E		FLT.	NONE			
167	3396.9		A/A	(M)	P	81° SE		SPLINT.	CALCITE			
168	3397.0		A/A	(M)	P	N 52° E		FLT.	NONE			
169	3397.1		A/A	(M)	P	12° SE		FLT.	NONE			
170	3397.2		A/A	(M)	P	N 30° W		SPLINT.	HEAVY CALCITE			
171	3397.3		A/A	(M)	P	N 0° E		FLT.	NONE			
172	3397.4		A/A	(M)	P	N 52° E		SPLINT.	SLIGHT CALCITE			
173	3397.5		A/A	(M)	P	13° SE		FLT.	MODERATE CALCITE			
174	3397.6		A/A	(M)	P	N 70° E		FLT.	CALCITE			
175	3397.7		A/A	(M)	P	52° SE		FLT.	NONE			
176	3397.8		A/A	(M)	P	N 83° E		FLT.	SLIGHT CALCITE			
177	3397.9		A/A	(M)	P	30° NW		SPLINT.	HEAVY CALCITE			
178	3398.0		A/A	(M)	P	N 50° W		FLT.	CALCITE			
179	3398.1		A/A	(M)	P	7° NE		FLT.	NONE			
180	3398.2		A/A	(M)	P	N 15° W		FLT.	NONE			
181	3398.3		A/A	(M)	P	5° NE		FLT.	NONE			
182	3398.4		A/A	(M)	P	N 22° E		FLT.	NONE			
183	3398.5		A/A	(M)	P	81° SE		SPLINT.	CALCITE			
184	3398.6		A/A	(M)	P	N 52° E		FLT.	NONE			
185	3398.7		A/A	(M)	P	12° SE		FLT.	NONE			
186	3398.8		A/A	(M)	P	N 30° W		SPLINT.	HEAVY CALCITE			
187	3398.9		A/A	(M)	P	N 0° E		FLT.	NONE			
188	3399.0		A/A	(M)	P	N 52° E		SPLINT.	SLIGHT CALCITE			
189	3399.1		A/A	(M)	P	13° SE		FLT.	MODERATE CALCITE			
190	3399.2		A/A	(M)	P	N 70° E		FLT.	CALCITE			
191	3399.3		A/A	(M)	P	52° SE		FLT.	NONE			
192	3399.4		A/A	(M)	P	N 83° E		FLT.	SLIGHT CALCITE			
193	3399.5		A/A	(M)	P	30° NW		SPLINT.	HEAVY CALCITE			
194	3399.6		A/A	(M)	P	N 50° W		FLT.	CALCITE			
195	3399.7		A/A	(M)	P	7° NE		FLT.	NONE			

EGSP STANDARD CORE FRACTURE LOGGING FORMAT
 WELL: E.G.S.P. Pa-2, Allegheny Co.

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: APR. 1979
 LOG DATE: DEC. 1979

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	VERTICAL DRIFT	FRACTURE TYPE	MINERALIZATION	SUCK-ENDES	FRACTOGRAPHIC FEATURES	COMMENTS
130	7418.8		SILT MDSST BLK N1	(M)	P		N 44° E	FLT	NONE	N 40° W		INDETERMINATE STRIKE
137	7420.9	0.1'	A/A	M	P	N 62° W 85° SW	N 15° E 6°	SMP INT	SLIGHT CALCITE	PRESENT		
138	7420.9		A/A	(M)	P	SEE COMMENTS	N 44° E	FLT	NONE	N 4° W		INDETERMINATE STRIKE
139	7421.9	0.4'	A/A	M/C	P		N 44° E	FLT	HEAVY CALCITE	VISIBLE		3 SETS: N 40° W N 55° W N 0° E ~ 90° 75° SW 85° W
140	7422.8		A/A	(M)	P		N 44° E	FLT	NONE	5°		INDETERMINATE STRIKE
141	7426.0		A/A	(M)	P	N 20° W 20° SE		FLT	HEAVY CALCITE	11°		INDETERMINATE STRIKE
142	7427.4		SILT MDSST BLK N1	(M)	P		N 43° E	FLT	SLIGHT CALCITE	5°		SMALL LENS AT MARGIN
143	7428.9		A/A	(M)	P	N 65° W 6° NE		FLT	NONE	S 38° E		
144	7431.9	0.3'	A/A	TC	P	N 62° SE	N 43° E	SPL INT	NONE	PRESENT		
145	7432.3		A/A	TC	P	N 10° E	N 44° E	SPL INT	NONE	PRESENT		
146	7432.4	0.1'	A/A	(M)	P	57° SE		FLT	HEAVY CALCITE	3°		INDETERMINATE STRIKE
147	7432.5		A/A	(M)	P	N 4° W 5° NE		FLT	HEAVY CALCITE	4°		
148	7432.9		A/A	(M)	P	N 62° W		FLT	HEAVY CALCITE	5.62° E		
149	7434.0		A/A	(M)	P	5° NE	N 43° E	FLT	NONE	5.52° E		
150	7435.3		MDSST BLK N1	(M)	P	N 40° W N 6° W 5° NE	N 43° E 5°	FLT	NONE	5.40° E		
151	7435.8		A/A	(M)	P			FLT	NONE	N 85° E		
152	7436.0		A/A	(M)	P	N 4° E 5° SE	N 44° E	FLT	HEAVY CALCITE	N 42° W		INDETERMINATE STRIKE
153	7441.2		A/A	(M)	P	N 30° E 14° SE		SPL INTS	V. HEAVY CALCITE	3°		
154	7442.5	0.2'	A/A	TC	P	SEE COMMENTS		SPL INTS	SLIGHT CALCITE	NONE		ORTHOGONAL SET
155	7442.7		MDSST BLK N1	(M)	P		N 43° E	FLT	SLIGHT CALCITE	VISIBLE		2 SETS: N 40° W N 88° E ~ 90° 85° NW
156	7443.4	0.1'	A/A	(M)	P	N 80° W 18° E		SMP INT	NONE	PRESENT		INDETERMINATE STRIKE
157	7443.7	2.5'	A/A	C?	P	N 55° W 75° NE		SMP INT	MODERATE CALCITE	VISIBLE		ORTHOGONAL SET
158	7443.7		A/A	(M)	P	N 70° E 25° NW	N 44° E	FLT	NONE	20°		2 SETS: N 40° W N 88° E ~ 90° 85° NW
159	7443.8	0.3'	A/A	C	P			SMP INT	MODERATE CALCITE	N 40° W		INDETERMINATE STRIKE
160	7443.7	0.1'	A/A	C	P			SMP INT	MODERATE CALCITE	VISIBLE		ORTHOGONAL SET
161	7443.2	0.3'	A/A	C	P			SMP INT	MODERATE CALCITE	VISIBLE		ORTHOGONAL SET
162	7443.2		A/A	(M)	P	N 52° E 20° SE		FLT	SLIGHT CALCITE	16°		ORTHOGONAL SET

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP Pa-2, Allegheny Co.

CORING RUN NO. (S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHAR. ACTER	STRIKE DIP	VERTICAL GRIFT	FRACTURE TYPE	MINERALIZATION	SLICK-ENIDES	FRACTOGRAPHIC FEATURES	COMMENTS
163	7448.7		MDST SH. MDST BLK NI	(M)	P	N 53° E 19° SE	N 40° E 5°	FLT.	NONE	110 S 40° E		
164	7448.9		A/A	(M)	P	N 88° E 20° SE		FLT.	NDNE	15° S 45° E		
165	7451.4		MDST SHY. MDST BLK NI	(M)	P	N 20° W 11° NE	N 40° E 5°	FLT.	SLIGHT CALCITE	NONE VISIBLE		INDETERMINATE STRIKE
166	7461.9		MDST BLK NI	(M)	P		N 40° E 5°	FLT.	NONE	PRESENT		INDETERMINATE STRIKE
167	7462.9		A/A	(M)	P		N 41° E 5°	FLT.	SLIGHT CALCITE	PRESENT 3°		INDETERMINATE STRIKE
168	7463.2		A/A	(M)	P			FLT.	NONE	N 40° W		INDETERMINATE STRIKE
169	7463.3		A/A	(M)	P			FLT.	NONE	PRESENT		INDETERMINATE STRIKE
170	7463.4		A/A	(M)	CP			FLT.	NONE	PRESENT		FAULT ZONE WITH NUMEROUS SETS OF SLICKENIDES. SOME HAVE POLISHED SURFACES
171	7463.5		A/A	(M)	CP			FLT.	NONE	PRESENT		INDETERMINATE STRIKE
172	7464.2		A/A	(M)	P			FLT.	SLIGHT CALCITE	4° S 74° E		INDETERMINATE STRIKE
173	7464.3		A/A	(M)	P			FLT.	NONE	3° S 70° E		INDETERMINATE STRIKE
174	7464.4		A/A	(M)	P	N 40° W 8° NE		FLT.	NONE	5° S 74° E		INDETERMINATE STRIKE
175	7464.5		A/A	(M)	P			FLT.	NONE	5° S 70° E		INDETERMINATE STRIKE
176	7464.5		A/A	(M)	P	N 6° E 10° SE		FLT.	NONE	5° S 60° E		INDETERMINATE STRIKE
177	7464.6		A/A	(M)	P			FLT.	NONE	5° S 77° E		INDETERMINATE STRIKE
178	7464.7		A/A	(M)	P			FLT.	NONE	PRESENT		INDETERMINATE STRIKE
179	7465.0		A/A	(M)	P		N 41° E 5°	FLT.	SLIGHT CALCITE	PRESENT		INDETERMINATE STRIKE
180	7464.9		A/A	(M)	P	N 90° E ~90°		FLT.	MODERATE CALCITE	NONE VISIBLE		INDETERMINATE STRIKE
181	7465.1	0.2	A/A	(M)	P			SPJNT.		VISIBLE		
182	7465.2		A/A	(M)	P			FLT.	NONE	PRESENT		INDETERMINATE STRIKE
183	7465.3	0.3	A/A	(M)	P	N 10° W 6° NE		FLT.	SLIGHT CALCITE	NONE VISIBLE		
184	7465.5		A/A	(M)	P			FLT.	NONE	7° S 70° E		
185	7465.8		A/A	(M)	P	N 8° W 11° NE		FLT.	SLIGHT CALCITE	7° S 58° E		INDETERMINATE STRIKE
186	7466.1		A/A	(M)	P	N 22° W 11° NE		FLT.	NONE	PRESENT		
187	7466.3		A/A	(M)	P			FLT.	NONE	PRESENT 3° S 34° E		INDETERMINATE STRIKE
188	7466.3		A/A	(M)	P			FLT.	NONE	16° S 57° W		INDETERMINATE STRIKE
189	7466.4		A/A	(M)	P			FLT.	NONE			INDETERMINATE STRIKE

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EG.S.P. Pa-2, Allegheny Co.

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	VERTICAL DRIFT	FRACTURE TYPE	MINERALIZATION	SUCK-ENDS	FRACTOGRAPHIC FEATURES	COMMENTS
190.	7466.4		MIST BLK NL	(M)	P	N 10° W 15° SW	N 41° E 5°	F.L.T.	NONE	3°		
191	7466.7 7467.3	0.6'	A/A	7/0	P	N 68° E 85° NW		SPL JNT.	V. SLIGHT CALCITE	PRESENT		
192	7466.7 7466.8 7466.9	0.1'	A/A	7 M	P	65° SW		SPL JNT.	V. SLIGHT CALCITE	NONE VISIBLE		
193	7467.4		A/A	(M)	P	N 56° W 8° NE		F.L.T.	NONE	\$ 58° E 5°		INDETERMINATE STRIKE
194.	7469.7		A/A	(M)	P		N 40° E 5°	F.L.T.	NONE	\$ 66° E 3°		
195	7470.3		MIST GRN BLK NL BLK NL	(M)	P		N 41° E 5°	F.L.T.	SLIGHT CALCITE	\$ 3° E 5°		INDETERMINATE STRIKE
196.	7470.5		A/A	(M)	P	N 30° E 9° SE		F.L.T.	NONE	\$ 52° E 18°		
197	7470.6	0.1'	A/A	(M)	P	21° SE		F.L.T.	NONE	\$ 50° E		
198	7474.7	2.0'	A/A	7 C	P	N 48° W 81° SW		SPL JNT.	SLIGHT CALCITE	PRESENT 10°		
199	7475.7		A/A	(M)	P			F.L.T.	NONE	\$ 42° E 0°		INDETERMINATE STRIKE
200.	7475.4		A/A	(M)	P	N 82° E ~90°		F.L.T.	NONE	N 50° E		INDETERMINATE STRIKE
201	7475.5	0.1'	A/A	7 C	P	N 40° E 15° SE		SPL JNT.	SLIGHT CALCITE	NONE VISIBLE		
202	7476.7		A/A	(M)	P	N 30° E 2° SE		F.L.T.	NONE	\$ 50° E		
203	7476.8	0.1'	A/A	(M)	P	N 74° W 86° NE		F.L.T.	SLIGHT CALCITE	11° \$ 32° E		
204	7476.5	0.4'	A/A	7 M	C.P	N 24° E 6° SE		SPL JNT.	MODERATE CALCITE	8° N 70° W 4°		
205	7476.6		A/A	(M)	P	N 90° E 72° N		F.L.T.	NONE	\$ 58° E		
206.	7476.9	0.3'	A/A	7/6	P			SPL JNT.	MODERATE CALCITE	PRESENT		
207	7476.7		A/A	(M)	P			F.L.T.	NONE	\$ 34° E 2°		INDETERMINATE STRIKE
208	7477.0		A/A	(M)	P			F.L.T.	NONE	\$ 40° E 6°		INDETERMINATE STRIKE
209	7477.3		SLTY SW BLK NL 2-3% SW NL	(M)	O	N 35° W 10° SW		F.L.T.	NONE	\$ 5° E		
210.	7477.5 7477.6	0.1'	A/A	(M)	P			F.L.T.	NONE	\$ 20° E 14°		INDETERMINATE STRIKE
211	7477.6		A/A	(M)	P			F.L.T.	V. SLIGHT CALCITE	\$ 44° E 8°		INDETERMINATE STRIKE
212.	7477.7		A/A	(M)	P			F.L.T.	NONE	N 50° W 19°		INDETERMINATE STRIKE
213	7477.6 7477.7	0.1'	A/A	(M)	P			F.L.T.	NONE	\$ 54° E 4°		INDETERMINATE STRIKE
214	7477.9		A/A	(M)	P			F.L.T.	NONE	N 20° W 3°		INDETERMINATE STRIKE
215	7478.8		A/A	(M)	P	N 92° W 6° NE		F.L.T.	NONE	N 47° W 4°		INDETERMINATE STRIKE
216	7479.1		A/A	(M)	P	N 33° W 9° NE		F.L.T.	NONE	N 54° W		

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)

CORING DATE: Apr. 1979
 LOG DATE: Dec. 1979

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 9 OF 9
 LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): NATURAL

WELL: EG.S.P. Pa-2, Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHAR. ACTER	STRIKE DIP	VERTICAL DRIFT	FRACTURE TYPE	MINERALIZATION	SLICK-ENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
217	7479.2		SILTY GR. SLK. N1 GR. SLK. N2	(M)	P	N 68° E 13° NW	N 41° E 5°	FLT.	NONE	S. 52° E 11°		INDETERMINATE STRIKE
218	7479.4		A/A	(M)	P	N 24° E 53° E		FLT.	NONE	N 36° W 45°		
219	7479.5	0.1	A/A	7/6	P	N 10° W 6° NE	N 48° E 5°	MC.RFT.	NONE	S. 54° E 4°		
220	7481.7		A/A	(M)	P			FLT.	NONE	S. 36° E		
221	7482.7		A/A	(M)	P			FLT.	MODERATE CALCITE	PRESENT		INDETERMINATE STRIKE
222	7485.4	0.8	IN MOST CASES, UNKST GR. SLK. N1, N2, N3, N4	C	P	N 64° W ~90°	N 40° E 5°	SPL JNT	SLIGHT CALCITE	NONE VISIBLE		POSSIBLY SEPTARIAN FRACTURES
223	7485.7	0.7	A/A	C	P	N 72° W ~70° SW		SPL JNT	MODERATE CALCITE	NONE VISIBLE		RELATED TO # 222
224	7483.7		A/A	(M)	P			FLT.	SLIGHT CALCITE	5° N 32° W		INDETERMINATE STRIKE
225	7488.5	0.2	A/A	(M)	P	N 75° E 18° SE		FLT.	V. SLIGHT CALCITE	18° S 34° E		
226	7488.7		A/A	(M)	P	N 40° E 77° SE		FLT.	V. SLIGHT CALCITE	15° S. 32° E		

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: APR 79
 LOG DATE: Feb. 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 1 OF 5
 LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): Coring - Included

WELL: EG.S.P. Pa-2 Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICK-ENDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	6933.6		SLTY. MDST. N2, N3	(M)	P		CI	IF				CONNECTION.
2	6935.8		A/A	(M)	P			TF				
3	6936.2		A/A	(M)	P			DC.S.				
4	7013.9	0.1'	SLTY. MDST. SHLY. MDST. N2, N1	M	CP			TF				CONNECTION SOAP PUMP PROBLEMS
5	7014.0		SLTY. MDST. N1	BDG	CP			TF				
6	7042.5		SLTY. MDST. SHLY. MDST. N2, N1	M	CP			TF				CONNECTION.
7	7067.0		SLTY. MDST. N1	BDG	P			TF				
8	7074.7		A/A	M	CP			TF				
9	7076.4	0.2'	LIME MDST. N3, N5	M	P			TF				
10	7126.9	0.1'	LIME MDST. MDST. N3, N5	BDG	CP			TF				
11	7127.0		MDST. SHLY. MDST. N2	M	CP			TF				
12	7202.9		A/A	BDG	CP			TF				
13	7208.4		SHLY. MDST. MDST. N2	M	CP			TF				
14	7223.5		MDST. N3	BDG	CP			TF				
15	7245.7	0.5'	MDST. N3	(M)	P			DC.S.				
16	7307.0		A/A	M	CP			IF				
17	7306.9		A/A	(M)	CP			DC.S.				
18	7330.1		MDST. N2	M	CP			TF				
19	7331.6		MDST. SHLY. MDST. N2, N1	BDG	CP			TF				
20	7331.8	0.2'	A/A	M	CP			TF				
21	7332.4		A/A	BDG	CP			TF				
22	7333.3	0.1'	A/A	M	CP			TF				
23	7333.4		A/A	BDG	CP			TF				
24	7334.0		A/A	M	CP			TF				
25	7334.4	0.1'	A/A	BDG	CP			TF				
26	7334.5	0.1'	A/A	M	CP			TF				
27	7334.6	0.1'	A/A	BDG	CP			TF				
28	7334.7		A/A	M	CP			TF				
29	7335.7		A/A	BDG	CP			TF				
30	7341.7		SHLY. MDST. N1	M	CP			TF				RUBBLE ZONES
31	7344.7	0.1'	A/A	BDG	CP			TF				
32	7344.8		A/A	M	CP			TF				
33	7345.5		A/A	BDG	CP			TF				

CORING RUN NO. (S)
(INDICATE BEGINNING & END)

CORING DATE: 80C 79
LOG DATE: Feb 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 2 OF 5
LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
FRACTURE TYPE(S): Carina Induced

WELL: E.G.S.P. Pa-2 Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SUCK-INSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
28	7396.9 7397.1	0.2'	SHLY. MDST. NI	M BDG	C.P.		C.I.	J.F.				DEPT. UNCERTAIN RUGGLE ZONE
29	7358.0		SHLY. MDST. SHLY. SHALE, NI	M BDG								
30	7358.5 7359.2	0.1'	SHLY. MDST. NI	M BDG								
31	7359.4	0.2'	A/A	M BDG								
32	7364.0 7364.7	0.1'	A/A	M BDG								
33	7364.2 7369.1	0.2'	A/A	M BDG								
34	7371.5 7371.6	0.1'	SHLY. MDST., MDST. NI	M BDG								
35	7372.3 7372.4	0.1'	A/A	M BDG								
36	7373.2 7373.3	0.1'	A/A	M BDG								
37	7373.3		A/A	M								
38	7373.4 7373.5		A/A	M BDG								
39	7373.6	0.1'	A/A	M BDG								
40	7374.1 7374.2		A/A	M BDG								
41	7374.3 7374.4	0.1'	A/A	M BDG								
42	7375.0 7375.2	0.1'	A/A	M BDG								
43	7375.3	0.1'	A/A	M BDG								
44	7375.5		A/A	M BDG								
45	7375.7		A/A	M BDG								
46	7376.1		A/A	M BDG								
47	7376.3		MDST. NI	M BDG								
48	7377.9		A/A	M BDG								
49	7378.0		A/A	M BDG								
50	7377.9 7400.4		A/A	M BDG								
51	7400.5	0.1'	A/A	M BDG								
52	7400.5 7402.7		A/A	M BDG								
53	7402.7 7403.4	0.1'	A/A	M BDG								
54	7403.4 7404.5	0.1'	A/A	M BDG								

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr 79
 LOG DATE: Feb 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 3 OF 5
 LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): Column Induced

WELL: EGSR Pa-2 Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHAR. ACTER	STRIKE DIP	INTER- PRESENTATION	FRACTURE TYPE	MINERALIZATION	SUCK- ENDSIES	FRACTOGRAPHIC FEATURES	COMMENTS
55	7404.7 7404.8	0.1'	MDST N1	M BDG	CP		CI	TF				
56	7405.6		A/A	M BDG								
57	7410.9		A/A	M BDG								
58	7411.0 7411.1	0.1'	A/A	M BDG								
59	7412.1 7412.2	0.1'	A/A	M BDG								
60	7412.3 7412.7		SHTY. MDST. MDST N1	M BDG								
61	7413.0	0.1'	A/A	M BDG								
62	7434.1		MDST N1	M BDG								
63	7435.5		A/A	M BDG								
64	7434.7 7435.0		A/A	M BDG								
65	7435.1 7435.2	0.1'	A/A	M BDG								
66	7435.3 7435.6	0.1'	A/A	M BDG								
67	7435.7	0.1'	A/A	M BDG								
68	7437.3 7437.5		A/A	M BDG								
69	7437.6	0.1'	A/A	M BDG								
70	7438.0		A/A	M BDG								
71	7438.1		A/A	M BDG								
72	7438.4 7438.5	0.1'	A/A	M BDG								
73	7438.8		A/A	M BDG								
74	7439.0		A/A	M BDG								
75	7439.7		A/A	M BDG								
76	7439.3		A/A	M BDG								
77	7439.9		A/A	M BDG								
78	7440.0		A/A	M BDG								
79	7440.3		A/A	M BDG								
80	7440.5		A/A	M BDG								
81	7440.8		A/A	M BDG								

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

PAGE 4 OF 5
 LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): Coring Included

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)
 CORING DATE: Apr. 79
 LOG DATE: Feb. 80

WELL: EGSP Pa-2 Allegheny Co.

NUMBER	DEPTH FEET	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTER- PRETATION	FRACTURE TYPE	MINERALIZATION	SLICK- ENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
82	7410 7411	0.1'	MDST NI	M BDG	CP		CI	TF				
83	7413 7415	0.2'	A/A	M BDG								
84	7413 7414	0.1'	MDST, SLTY, MDST NI N3 N4	M BDG								
85	7445.5		A/A	M BDG								
86	7445.7 7446.7		A/A	M BDG								
87	7446.8	0.1'	A/A	M BDG								
88	7449.2 7449.4		A/A	M BDG								
89	7449.5	0.1'	A/A	M BDG								
90	7449.8 7450.1		A/A	M BDG								
91	7450.2	0.1'	A/A	M BDG								
92	7451.0		MDST, SLTY, MDST NI	M BDG								
93	7451.4		A/A	M BDG								
94	7452.0		A/A	M BDG								
95	7455.5		A/A	M BDG								
96	7455.8		A/A	M BDG								
97	7458.4		A/A	M BDG								
98	7458.5		A/A	M BDG								
99	7458.7		A/A	M BDG								
100	7458.9		A/A	M BDG								
101	7459.2		A/A	M BDG								
102	7459.7		A/A	M BDG								
103	7460.6		MDST NI	M BDG								
104	7463.0		A/A	M BDG								
105	7464.7 7464.9		A/A	M BDG								
106	7465.0	0.1'	A/A	M BDG								
107	7466.0		A/A	M BDG								
108	7467.3		A/A	M BDG								

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

CORING RUN NO.(S) _____
 (INDICATE BEGINNING & END)

CORING DATE: ADL 79
 LOG DATE: Feb 80

LOG CLASSIFICATION
 INDIVIDUALS INTERVALS
 FRACTURE TYPE(S): Calcareo Induced

WELL: EG.S.P. Pa-2 Allegheny Co.

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHAR. ACTER	STRIKE DIP	INTER. PRETATION	FRACTURE TYPE	MINERALIZATION	SUCK-INSIDER	FRACTOGRAPHIC FEATURES	COMMENTS
109	7467.6		MDST NI	M BDG	C P		C I	T F				
110	7468.3		MDST NI	M BDG								
111	7469.9		MDST NI	M BDG								
112	7471.0	0.1	NZ A/A	M BDG								
113	7471.4		A/A	M BDG								
114	7471.5		A/A	M BDG								
115	7472.0	0.1	A/A	M BDG								
116	7472.3		A/A	M BDG								
117	7476.9		SLTY SHALE NI	M BDG								
117	7477.1		NZ	M BDG								

EASTERN GAS SHALES PROJECT

DISC FRACTURE FREQUENCY LOG
PENNSYLVANIA #2 - ALLEGHENY COUNTY, PENNSYLVANIA

<u>Feet</u>	<u>Frequency Per Foot</u>	<u>Feet</u>	<u>Frequency Per Foot</u>	<u>Feet</u>	<u>Frequency Per Foot</u>
6,950	9.5	7,155	10.6	7,355	20.1
6,955	13.4	7,160	16.4	7,360	12.2
6,960	13.4	7,165	15.2	7,365	3.2
6,965	10.8	7,170	13.4	7,370	10.6
6,970	8.2	7,175	8.0	7,375	3.2
6,975	5.2	7,180	9.4	7,380	5.0
6,980	6.2	7,185	12.1	7,385	12.0
6,985	7.3	7,190	9.0	7,390	12.2
6,990	9.8	7,195	6.2	7,395	8.8
6,995	13.0	7,200	12.0	7,400	6.8
7,000	12.0	7,205	10.0	7,405	6.6
7,005	19.8	7,210	10.4	7,410	6.8
7,010	15.9	7,215	10.0	7,415	12.2
7,015	6.8	7,220	9.0	7,420	2.2
7,020	14.0	7,225	18.6	7,425	9.4
7,025	23.0	7,230	13.5	7,430	3.6
7,030	19.6	7,235	8.6	7,435	2.0
7,035	20.2	7,240	8.0	7,440	4.6
7,040	25.0	7,245	11.4	7,445	3.0
7,045	18.6	7,250	7.8	7,450	10.2
7,050	19.0	7,255	7.6	7,455	4.8
7,055	20.2	7,260	5.2	7,460	7.6
7,060	19.0	7,265	4.0	7,465	7.2
7,065	12.8	7,270	2.6	7,470	8.0
7,070	19.2	7,275	3.5	7,475	15.8
7,075	5.2	7,280	2.6	7,480	14.8
7,080	2.2	7,285	1.5	7,485	9.0
7,085	1.6	7,290	3.2	7,490	11.0
7,090	2.0	7,295	1.6	7,495	7.2
7,095	0.8	7,300	0.4	7,500 to	
7,100	2.2	7,305	2.8	7,501.5	0.2
7,105	1.2	7,310	3.6		
7,110	2.0	7,315	4.0		
7,115	0.4	7,320	6.6		
7,120	1.4	7,325	4.8		
7,125	2.2	7,330	9.6		
7,130	2.2	7,335	21.7		
7,135	6.4	7,340	11.0		
7,140	14.0	7,345	12.8		
7,145	11.4	7,350 to	Core Lost		
7,150	12.4	7,355	During Drilling		

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**U. S. DEPARTMENT OF ENERGY
MORGANTOWN ENERGY TECHNOLOGY CENTER
EASTERN GAS SHALES PROJECT**



PREPARED UNDER
CONTRACT NO. DE-AC21-78MC08199

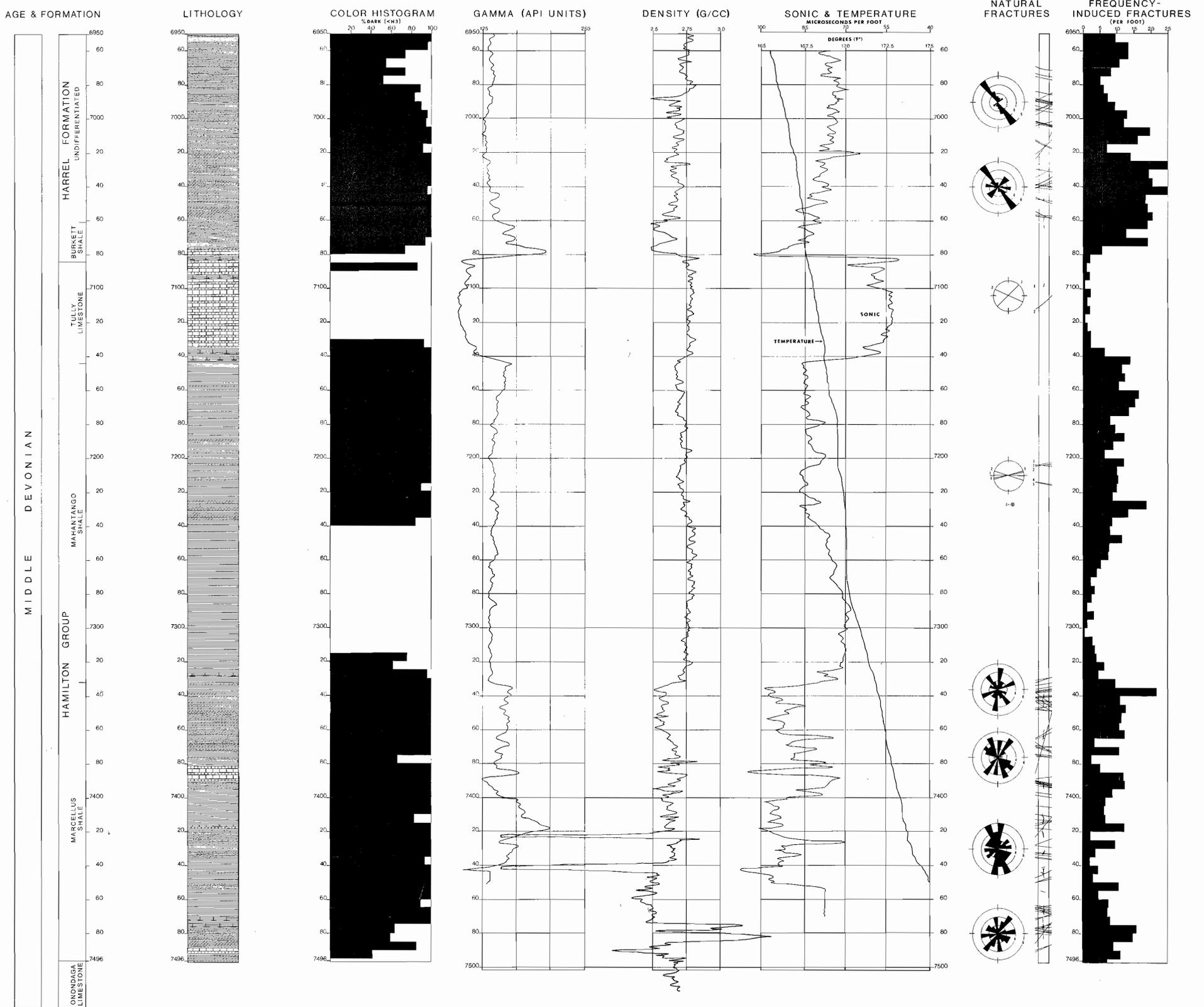
EGSP PA-2, ALLEGHENY CO.

WELL: C.E. #1

A.P.I. NO: 37-003-20980

DRILLING COMPLETED: MARCH, 1979

DRAWN: FEBRUARY, 1980



LEGEND

