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CLIFFS MINERALS, INC.
EASTERN GAS SHALES PROJECT
OHIO #6 SERIES - GALLIA COUNTY

PHASE II REPORT
PRELIMINARY LABORATORY RESULTS
JUNE 1980

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TABLE OF CONTENTS

		PAGE NO.
1.0	INTRODUCTION	1
2.0	SCOPE OF WORK	2
3.0	LABORATORY PROCEDURES	3
	3.1 Review of Geophysical Logs	3
	3.2 Photographic Log	4
	3.3 Detailed Lithologic Logs	4
	3.4 Stratigraphic Section	5
	3.5 Color Histogram	5
	3.6 Fracture Logs	8
	3.7 Measurement of Shore Hardness	9
4.0	REPORTING OF RESULTS	10
5.0	DISCUSSION OF RESULTS	11
	5.1 General	11
	5.2 Geologic Setting	14
	5.3 Stratigraphy	15
	5.4 Fracture Analysis	29

APPENDICES

A DETAILED LITHOLOGIC DESCRIPTIONS

B SYMBOLS, TERMS, AND ABBREVIATIONS USED IN FRACTURE LOGGING

C FRACTURE LOGS

D HISTOGRAMS: FREQUENCY OF DISC FRACTURES; ROCK COLOR

BIBLIOGRAPHY

PLATE IN POCKET

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1	TEXTURAL CLASSIFICATION OF FINE GRAINED, CLASTIC SEDIMENTARY ROCKS	6
2	TEXTURAL CLASSIFICATION OF CARBONATE ROCKS (AFTER DUNHAM, 1962)	7
3	LOCATION OF THE EGSP PROJECT AREA IN GALLIA COUNTY, OHIO	12
4	WELL SITE LOCATIONS IN THE DOE/MITCHELL ENERGY EXPLORATION TRACT IN SOUTHWESTERN GALLIA COUNTY, OHIO	13
5	GENERALIZED LITHOLOGIC COLUMN OF LOWER MISSISSIPPIAN FORMATIONS PRESENT IN THE OHIO #6/4 CORE	16
6	CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES - OHIO #6/1 CORE	33
7	CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES - OHIO #6/2 CORE	34
8	CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES - OHIO #6/3 CORE	35
9	CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES - OHIO #6/4 CORE	36
10	CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES - OHIO #6/5 CORE	37
11	CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES - OHIO #6/1 CORE	42
12	CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES - OHIO #6/2 CORE	43
13	CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES - OHIO #6/3 CORE	44
14	CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES - OHIO #6/4 CORE	45
15	CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES - OHIO #6/5 CORE	46

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1	WET HOLE GEOPHYSICAL LOGS (EGSP-OHIO #6 WELLS)	2
2	FORMATION THICKNESSES - OHIO #6/1 WELL	17
3	FORMATION THICKNESSES - OHIO #6/2 WELL	17
4	FORMATION THICKNESSES - OHIO #6/3 WELL	18
5	FORMATION THICKNESSES - OHIO #6/4 WELL	18
6	FORMATION THICKNESSES - OHIO #6/5 WELL	19
7	DISTRIBUTION OF NATURAL FRACTURES - OHIO #6/1 CORE	30
8	DISTRIBUTION OF NATURAL FRACTURES - OHIO #6/2 CORE	30
9	DISTRIBUTION OF NATURAL FRACTURES - OHIO #6/3 CORE	31
10	DISTRIBUTION OF NATURAL FRACTURES - OHIO #6/4 CORE	31
11	DISTRIBUTION OF NATURAL FRACTURES - OHIO #6/5 CORE	32
12	DISTRIBUTION OF PETAL FRACTURES - OHIO #6/1 CORE	39
13	DISTRIBUTION OF PETAL FRACTURES - OHIO #6/2 CORE	39
14	DISTRIBUTION OF PETAL FRACTURES - OHIO #6/3 CORE	40
15	DISTRIBUTION OF PETAL FRACTURES - OHIO #6/4 CORE	40
16	DISTRIBUTION OF PETAL FRACTURES - OHIO #6/5 CORE	41

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.

On September 28, 1978 the Department of Energy entered into a cooperative agreement with Mitchell Energy Corporation to explore Devonian Shale gas potential in Gallia County, Ohio. Objectives of the cost-sharing contract were the following:

1. To select locations for a series of five wells to be drilled around the periphery of a possible gas reservoir in Gallia County, Ohio.
2. To drill, core, log, case, fracture, clean up, and test each well, and to monitor production from the wells for a five-year period.

This report summarizes the procedures and results of core characterization work performed at the Eastern Gas Shales Project Core Laboratory on core retrieved from the Gallia County EGSP wells, designated OH #6/1, OH #6/2, OH #6/3, OH #6/4, and OH #6/5.

2.0 SCOPE OF WORK

The objective of work performed at the Eastern Gas Shales Project's Core Laboratory is to provide detailed characterization of cores recovered from DOE-sponsored Devonian Shale gas wells. Data are acquired from several sources for analysis. At each well site, a suite of wet hole geophysical logs was run and are summarized below.

TABLE 1

WET HOLE GEOPHYSICAL LOGS RUN
IN OHIO #6 WELLS, GALLIA COUNTY

LOG TYPE	WELL NUMBER				
	OH #6/1	OH #6/2	OH #6/3	OH #6/4	OH #6/5
Comp. Neutron/Fm. Density	x	x	x	x	x
Density + Neut. Borehole Comp.	x		x	x	
Circumferential Microsonic				x	
Borehole Comp. Sonic	x	x	x	x	x
Fracture Identification Log	x	x	x		x
Dual Laterolog/Microlat.	x	x	x	x	x
Dual Induction/S.F.L.	x		x	x	
3-D Velocity Log, (1 foot, 3 foot, & 6 foot spacings)	x	x	x	x	
Induction Electric Log	x		x	x	
Resistivity Log		x			
Temperature Log	x				
Dual-Spacing Thermal Neutron Decay Time Log	x		x		
Computer Processed Log				x	
Natural Gamma Ray Spectroscopy Log				x	

The fluid in each hole consisted of KCL brine.

At the EGSP Core Laboratory, the cores were 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), measurements of core color variation,

and stratigraphic interpretation of the cored intervals. In addition, physical properties specimens were cut from the cores. These samples were tested by Michigan Technological University under subcontract. Data obtained from specimen tests include:

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

3.0 LABORATORY PROCEDURES

3.1 Review of Geophysical Logs:

During the initial stages of processing the OH #6 cores through the laboratory, geophysical logs from the wells were examined and compared with published reference sections. Using the gamma ray and density logs, a preliminary stratigraphic section was prepared for the cored intervals. These two logs have proven 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.

Other geophysical 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 sonic and temperature logs are useful for locating significant flows of gas into the well from isolated fractures or 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 Ohio #6 cores had been laid out, washed, and oriented on a group of tables, a series of consecutive, overlapping color photographs was 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 cores were 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 stratification. Additional remarks were 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 were described using the Rock Color Chart published by the Geological Society of America (1948). Thicknesses of stratification were classified as follows: >2 ft. = thick bedded; 2 ft. to 2 cm = thin bedded; 2 cm to 1 cm = very thin bedded; 1 cm to 1 mm = thickly laminated; <1 mm = thinly laminated.

3.4 Stratigraphic Section:

A stratigraphic section for the cored intervals was prepared after the gamma ray and density logs were 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:

A color histogram was compiled to provide a relative measure of the distribution of light and dark shales through the cored intervals. Using the

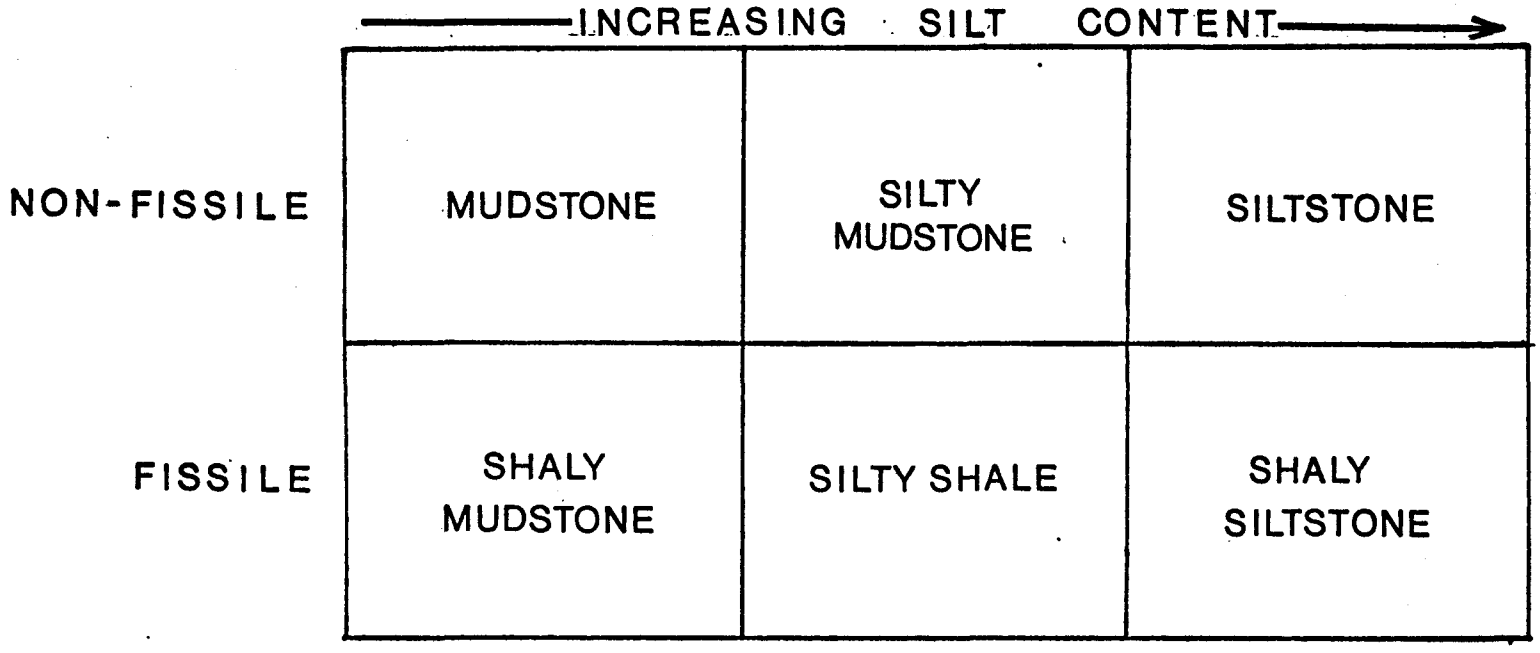


FIGURE 1

TEXTURAL CLASSIFICATION OF FINE-GRAINED, 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 CARBONATE ROCKS (after DUNHAM, 1962)

G.S.A. Rock Color Chart, the net length of each color present within each 10-foot segment of the core was recorded. Colors with values darker than N3 were grouped together for each segment to determine the percentage of dark shale, and colors with values lighter than or equal to N3 were 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 intervals 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 (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 markes 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 were 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 Measurement of Shore Hardness:

The Shore Hardness tests were deleted from core characterization work due to high equipment maintenance requirements. In addition, the accuracy and

reproducibility of the results are questionable. 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 one inch to 20 feet and provides a visual display of the stratigraphic relationships between the five EGSP-Ohio #6 wells. The contact between the Sunbury Shale and the underlying Berea Sandstone was chosen as the common datum for correlating the Gallia County wells. This contact was chosen for two reasons:

1. The contact between the Berea and Sunbury is easily distinguishable on the gamma ray log and in the core; the Sunbury log generally peaks at 300 or more A. P. I. units while the Berea log is usually less than 100.

2. The Berea Sandstone occurs as a sheet sand across southeastern Ohio and is a relatively horizontal rock unit (Dr. J. Schwietering, personal communication, 1979).

The Ohio #6 wells are displayed from west to east (looking north) on the correlation chart. Recorded data include: stratigraphic column, lithology, gamma ray log, and orientation and distribution of natural fractures. The chart accompanies this report as an enclosure.

Discussions of stratigraphy, lithology, and the occurrence of fractures are provided in Section 5. Appendix A contains detailed lithologic descriptions of the cores. Terminology applied in describing natural and induced fractures is provided in Appendix B, and the fracture data are presented in Appendix C. Histograms showing changes in rock color and frequency of disc fractures are contained in Appendix D.

One copy of the photographic log was 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-Ohio #6 cores 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 cores were sealed in a moisture barrier and packaged in 3-foot core boxes for temporary archiving at the EGSP Core Laboratory. Following a 90-day period the Ohio #6 cores will be transferred to the Ohio Geological Survey.

5.0 DISCUSSION OF RESULTS

5.1 General:

The project area (Figures 3 and 4) is located in soth-central Gallia County, Ohio, approximately 13 miles west-southwest of the town of Gallipolis, Ohio. Commercial quantities of gas have been produced for nearly 50 years from the highly fractured Devonian Shales in the Cottageville Field 35 miles to the east (de Wys and Shoemaker, 1978). The five Gallia County wells were drilled into a possible gas reservoir in a supposed structural trap formed by compaction of the shales around a major irregularity on the surface of the underlying Columbus Limestone.

Although numerous, long, open fractures are present in the Ohio #6 cores, no large (near-commercial) quantities of gas were encountered. Several small gas shows were observed on the core; no shows were indicated on the

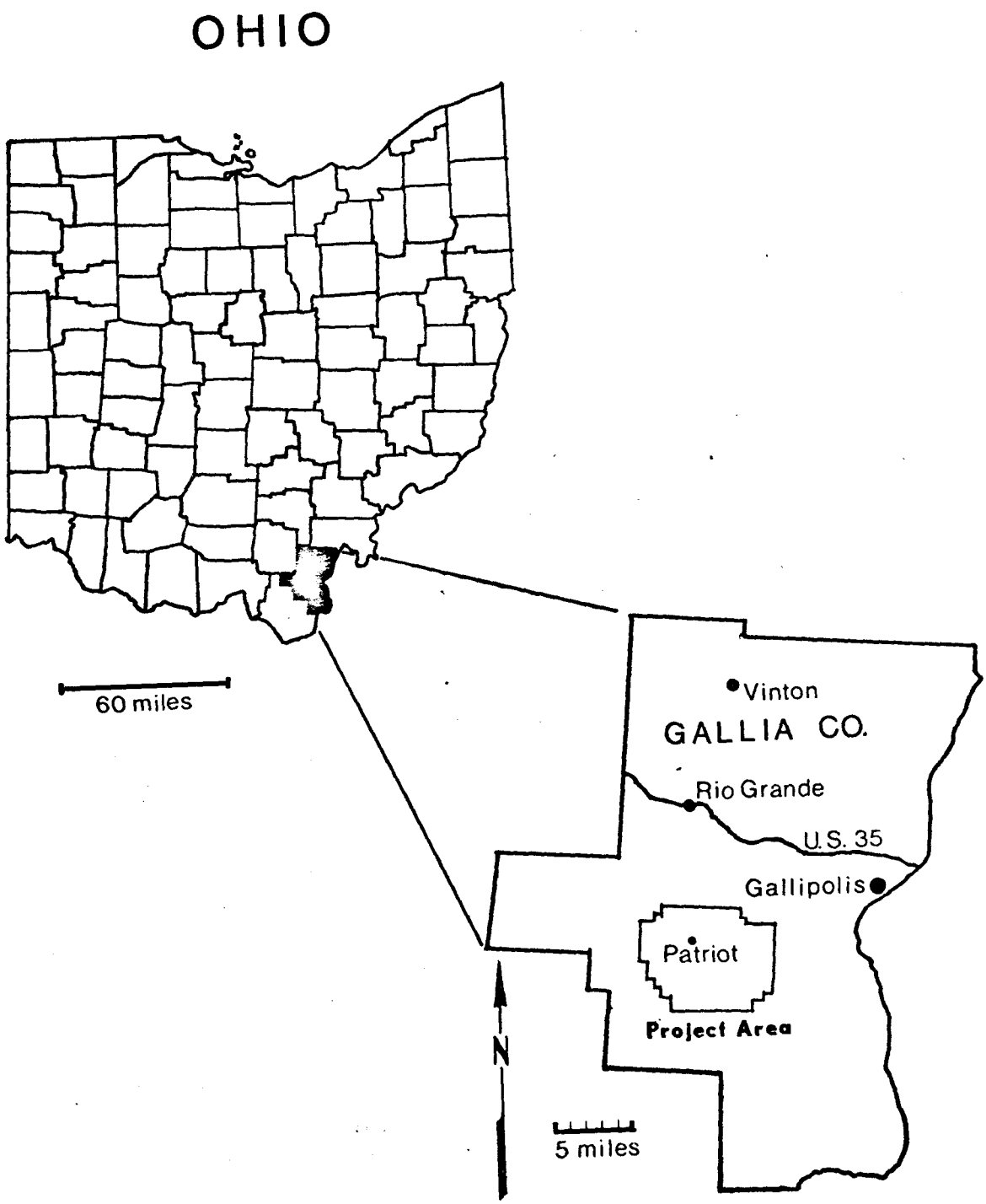
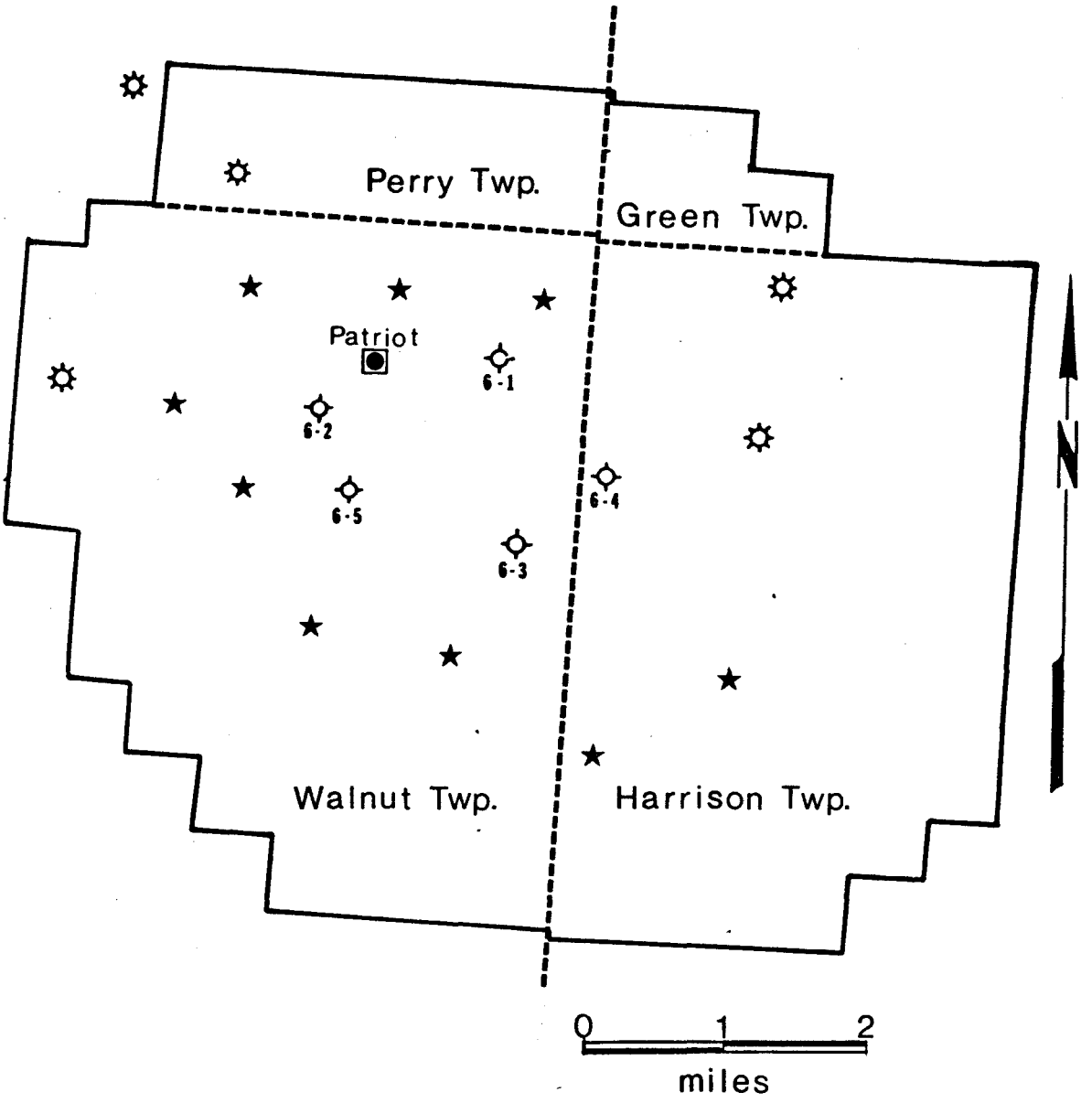


FIGURE 3

LOCATION MAP OF THE EGSP PROJECT AREA
IN GALLIA COUNTY, OHIO



LEGEND

- E.G.S.P wells (Ohio no.6 series)
- Proposed future wells
- Older wells

FIGURE 4

WELL SITE LOCATIONS IN THE DOE/MITCHELL ENERGY EXPLORATION TRACT IN SOUTHWESTERN GALLIA COUNTY, OHIO

geophysical logs. The fractures in this area were so extensive that attempts to seal them with lost circulation material were unsuccessful. Loss of drilling fluid into the fracture system and jamming of the core barrel were common and resulted in premature termination of coring in two of the wells (Ohio #6/3 and #6/4).

5.2 Geologic Setting:

The topography of the project area is stream-dissected and consists of deep v-shaped valleys cut into the Allegheny Plateau. A level alluvial plain, one to three miles wide, borders the Ohio River to the east. The major drainage features in the area are the Ohio River and its tributary, Raccoon Creek, to the north and east. Surface rock units in Gallia County consist of the Pennsylvanian Monongahela, Conemaugh and Allegheny Groups. The younger Monongahela Group rocks occur in the eastern portion of the county and compose the upper parts of the bluffs along the Ohio River (Bennison, et al, 1978). In the western portion of the county the surface is underlain by the Conemaugh and Allegheny Groups.

Bennison, et al, (1978) states that the subsurface strata of southeastern Ohio dip gently to the east. This regional dip coincides with the downslope direction into the deeper portions of the Appalachian Basin (Potter, Maynard, and Pryor, 1980).

A major structural feature recognized in the subsurface 10 miles to the southeast of the project area is the Rome Trough (Harris, 1978). The Rome Trough is a northeast trending graben structure, bounded by multiple normal faults along each margin. Devonian Shale gas fields in eastern Kentucky and southwestern West Virginia are distributed along the projected trend of this trough (de Wys and Shoemaker, 1978).

5.3 Stratigraphy:

A total of 1,521.7 feet of core was recovered from the five Ohio #6 wells. Formation thicknesses and distribution of cored intervals are indicated in Tables 2 through 6. A summary description of each cored formation or member is provided below. A generalized lithologic column for the Sunbury Shale, Berea Sandstone, and Bedford Formation is also presented (Figure 5).

Sunbury Shale:

Approximately 8.4 feet (1,842.0' to 1,850.4') of the Sunbury Shale was cored in the Ohio #6/4 core. The interval consists of slightly fissile, greenish black (5G 2/1), thick-bedded mudstone. Fossils contained include fish scales, conodonts, and unidentified skeletal fragments. Pyrite occurs as numerous nodules and as mineralization in burrows and fecal pellets.

The contact between the Sunbury Shale and the underlying Berea Sandstone is distinct in the core and on geophysical logs. The sharpness of the contact in the core suggests a possible hiatus between Sunbury and Berea deposition. The gamma ray log registers a decrease in gamma radiation, from ∿300 API units to ∿100 API units at this contact.

Vertical Scale: 1 in. = 20 ft.

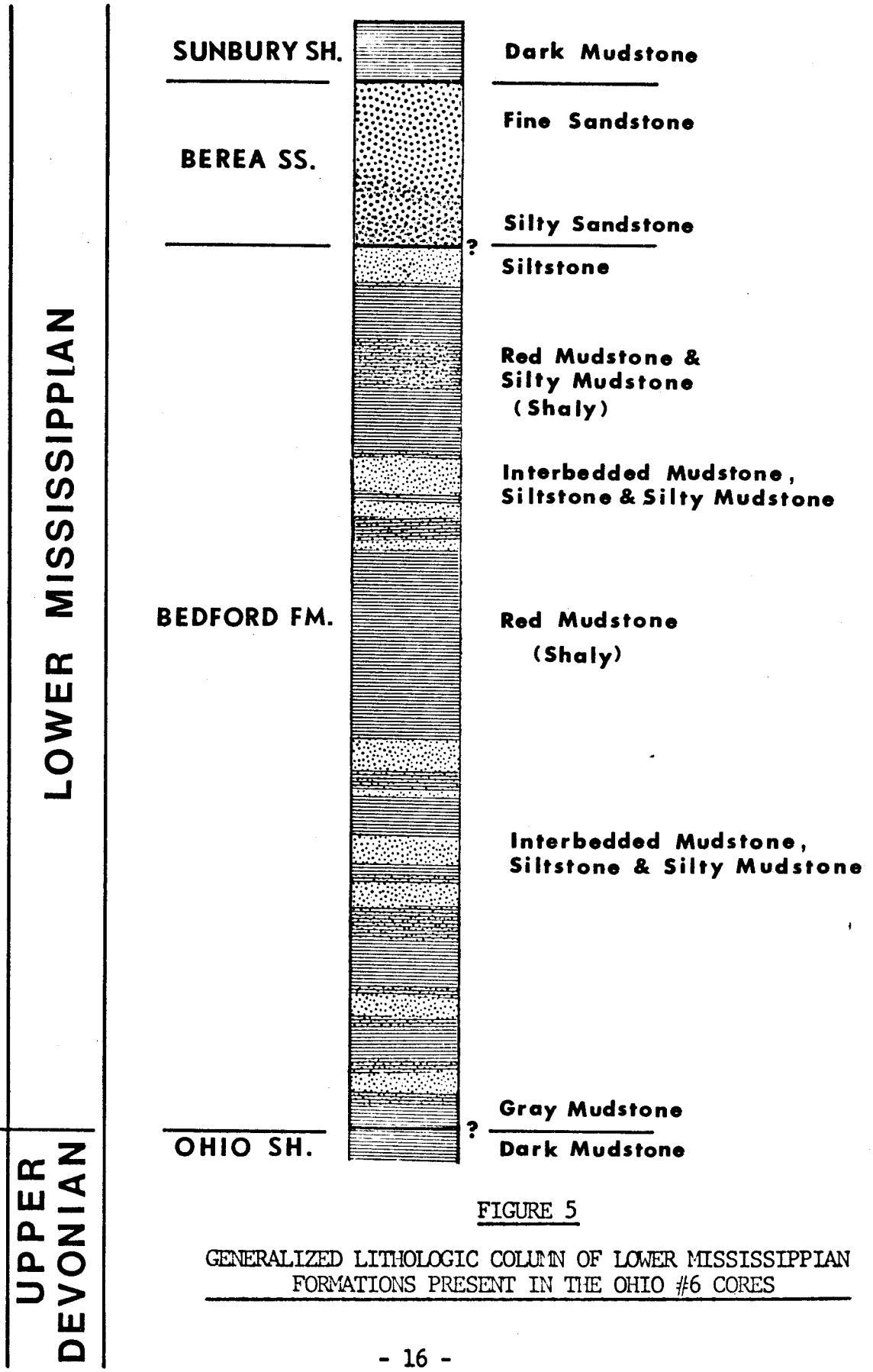


FIGURE 5

GENERALIZED LITHOLOGIC COLUMN OF LOWER MISSISSIPPIAN FORMATIONS PRESENT IN THE OHIO #6 CORES

TABLE 2

FORMATION THICKNESSES-OH #6/1 WELL

Formation	Depths	Formation Thickness	Depths Cored
Ohio Shale:			
Cleveland Shale	1,770'-1,814'	44'	1,810'-1,814'
Chagrin Shale	1,814'-2,007'	193'	1,814'-1,866'
Huron Shale:			
Upper	∿2,007'-2,134'	∿127'	-
Middle	∿2,134'-2,318'	∿184'	2,310'-2,318'
Lower	2,318'-2,563'	245'	2,318'-2,368'
			2,446'-2,501'
Olentangy Shale:			
Upper	2,563'-2,704'	141'	-
Lower	2,704'-2,791'	87'	-
Columbus Limestone	2,791'- *	-	-

* Contact undetermined

NOTE: Approximated contacts were picked from geophysical logs.

TABLE 3

FORMATION THICKNESSES-OH #6/2 WELL

Formation	Depths	Formation Thickness	Depths Cored
Bedford Formation	1,608'-1,728'	120'	1,697'-1,728'
Ohio Shale:			
Cleveland Shale	1,728'-1,764'	36'	1,728'-1,755'
Chagrin Shale	1,764'-1,968'	204'	-
Huron Shale:			
Upper	∿1,968'-2,087'	∿119'	-
Middle	∿2,087'-2,260'	∿173'	-
Lower	2,260'-2,498'	238'	2,282'-2,341'
			2,418'-2,476'
Olentangy Shale:			
Upper	2,498'-2,634'	136'	-
Lower	2,634'-2,715'	81'	-
Columbus Limestone	2,715'- *	-	-

* Contact undetermined

NOTE: Approximated contacts were picked from geophysical logs.

TABLE 4

FORMATION THICKNESSES-OH #6/3 WELL

Formation	Depths	Formation Thickness	Depths Cored
Bedford Formation	1,890'-2,000'	110'	1,988'-2,000'
Ohio Shale			
Cleveland Shale	2,000'-2,040'	40'	2,000'-2,040'
Chagrin Shale	2,040'-2,224'	184'	2,040'-2,046'
Huron Shale:			
Upper	∿2,224'-2,367'	∿143'	-
Middle	∿2,367'-2,546'	∿179'	-
Lower	2,546'-2,791'	245'	2,590'-2,602'
Olentangy Shale:			
Upper	2,791'-2,960'	169'	-
Lower	2,960'-3,020'	60	-
Columbus Limestone	3,020'- *	-	-

* Contact undetermined

NOTE: Approximated contacts were picked from geophysical logs.

TABLE 5

FORMATION THICKNESSES-OH #6/4 WELL

Formation	Depths	Formation Thickness	Depths Cored
Sunbury Shale	1,825'-1,852'	27'	1,840'-1,852'
Berea Sandstone	1,852'-1,875'	23'	1,852'-1,875'
Bedford Formation	1,875'-1,980'	105'	1,875'-1,980'
Ohio Shale:			
Cleveland Shale	1,980'-2,018'	38'	1,980'-2,018'
Chagrin Shale	2,018'-2,200'	182'	2,018'-2,200'
Huron Shale:			
Upper	∿2,200'-2,350'	∿150'	2,200'-2,350'
Middle	∿2,350'-2,543'	∿193'	2,350'-2,543'
Lower	2,543'-2,790'	247'	2,543'-2,775'
Olentangy Shale:			
Upper	2,790'-2,933'	143'	-
Lower	2,933'-3,020'	87'	-
Columbus Limestone	3,020'- *	-	-

* Contact undetermined

NOTE: Approximated contacts were picked from geophysical logs.

TABLE 6

FORMATION THICKNESSES-OH #6/5 WELL

Formation	Depths	Formation Thickness	Depths Cored
Bedford Formation	1,555'-1,678'	123'	1,660'-1,678'
Ohio Shale:			
Cleveland Shale	1,678'-1,714'	36'	1,678'-1,714'
Chagrin Shale	1,714'-1,900'	186'	1,714'-1,718'
Huron Shale:			
Upper	∿1,900'-2,034'	∿134'	1,940'-1,998'
Middle	∿2,034'-2,206'	∿172'	-
Lower	2,206'-2,446'	240'	2,440'-2,446'
Olentangy Shale:			
Upper	2,446'-2,582'	136'	2,446'-2,493'
Lower	2,582'-2,664'	82'	-
Columbus Limestone	2,664'- *	-	-

* Contact undetermined

NOTE: Approximated contacts were picked from geophysical logs.

Berea Sandstone:

The Berea Sandstone is present from 1,850.4' to 1,875' in the Ohio #6/4 core. It is composed of light gray (N4 to N6), greenish gray (5GY 4/1, 5GY 6/1), and pale olive (10Y 6/2) fine-grained sandstone and silty sandstone. The interval is thick bedded, micaceous, and slightly calcareous with slight oil staining present near the top. Cross laminations, sole marks, and load-cast structures are present in the sandstones. Fossils are sparse, consisting of carbonaceous plant debris, pyritized burrow structures, and fish scales. The sandstones become increasingly silty and argillaceous near the base and contain occasional soft sediment deformational structures.

The contact between the Berea Sandstone and the underlying Bedford Formation is gradational in the core and is marked by a moderate increase in gamma radiation on the geophysical logs.

Bedford Formation:

The Bedford Formation averages 117' thick in the five wells (Tables 2 - 6). The entire thickness of the formation was cored in the Ohio #6/4 well. Portions of the Bedford Formation were cored in all remaining wells in the series except for Ohio #6/1.

Examination of the Ohio #6/4 core indicates that the Bedford Formation can be subdivided into three lithologic groups. The most common group is composed of grayish red (10R 4/2 and 5R 4/2), thickly laminated to thin-bedded mudstone which is present from 1,887.3' to 1,910.7' and from 1,924.0' to 1,950.9'. The mudstone is friable, shaly, occasionally silty, and contains few fossils. The upper interval is slightly siltier than the lower. Approximately seven feet of grayish red mudstone was cored in the Ohio #6/2 well. This zone probably correlates with the lower interval in the Ohio #6/4 core. Although portions of the Bedford Formation were cored in the Ohio #6/3 and #6/5 wells, no grayish red mudstone was encountered.

The second lithologic group is composed of an interbedded sequence of siltstones, silty mudstones, and mudstones, and is present in the Ohio #6/4 core from 1,875.0' to 1,887.3', 1,910.7' to 1,924.0', and from 1,950.0' to 1,968.0'. Rock color within these intervals is highly variable and includes the following: light gray (N7), yellowish gray (5Y 7/2) to light olive gray (5Y 6/1), greenish gray (5GY 6/1), medium gray (N5), medium dark gray (N4), and olive black (5Y 2/1). All rock types are thinly laminated to thin bedded

and contain few fossils. The siltstone portion is ripple- to cross-laminated and contains numerous sole marks and scour features. Oil and gas shows are present in several of the siltstone beds within the lower interval. Rocks of similar lithology and color which may be correlative were cored in the following wells: #6/2 (1,706.5' to 1,716.0'), #6/3 (1,988.0' to 1,991.5'), and #6/5 (1,660.0' to 1,665.0').

The third lithologic type present at the base of the Bedford Formation consists of thin to thick bedded, slightly shaly, olive gray (5Y 4/1) mudstone and silty mudstone. Fossils contained in the interval include inarticulate brachiopods (Lingula sp. and Orbiculoides sp.). Fossil occurrence is low, but increases with depth as the olive gray mudstones grade into the olive black mudstones of the underlying Ohio Shale.

The contact between the Bedford Formation and the underlying Cleveland Member of the Ohio Shale is gradational over a distance of four feet in the core and is identified by an increase in gamma radiation on the geophysical logs. This contact marks the boundary between the Lower Mississippian and Upper Devonian systems. Some older studies indicated that the Mississippian-Devonian boundary lies within the Bedford Formation (Cushing, et al, 1931) or within the Ohio Shale (Hass, 1947). This uncertainty is due to the gradational nature of the contact between these two formations plus the similarity of their fauna. Pepper, et al, (1954) considered the Ohio Shale to be Upper Devonian and placed the Mississippian-Devonian boundary at the Bedford-Ohio contact. This interpretation is generally accepted and is used in this report.

Ohio Shale:

The Gallia County wells contain an average of 790 feet of Ohio Shale (Tables 2 - 6). In northern Ohio, the Ohio Shale has been divided into three members: the Cleveland Shale, the Chagrin Shale, and the Huron Shale (Schwietering, 1979). Although this subdivision is generally restricted to northern Ohio, it can be recognized in the subsurface of southeastern Ohio (Provo, 1977) and in the Gallia County cores. Provo, et al (1977), recognized a new unit in the Ohio Shale which was named the Three Lick Bed. According to Schwietering (1979) the Three Lick Bed represents a southern tongue of the uppermost part of the Chagrin Shale. To avoid confusion, the term "Three Lick Bed" is not used in this report.

Cleveland Shale:

The Cleveland Shale, the uppermost member of the Ohio Shale, averages 40 feet thick in the Gallia County wells. All or portions of it were cored in the five wells (Tables 2 - 6).

Within the study area the Cleveland Shale consists of a slightly silty, thin- to thick-bedded mudstone. The dominant colors are brownish black (5YR 2/1) and olive black (5Y 2/1). Numerous thin laminae of olive gray (5Y 4/1) and light olive gray (5Y 6/1) calcareous siltstone occur throughout. They are often ripple- to cross-laminated and contain scour surfaces. Fossil occurrence is varied and includes the following: carbonaceous plant fragments, pyritized and resinous spore bodies (Tasmanites sp.), conodonts, inarticulate brachiopods (Orbiculoides sp. and Lingula sp.), a few pyritized articulate brachiopods (Chonetes sp.), several poorly-preserved pelecypods (?), and numerous fish fragments, including scales, teeth, jaws, and bones. Pyrite occurs as burrow fillings, lenses, nodules, and disseminated crystals.

The contact between the Cleveland Shale and the underlying Chagrin Shale is clearly defined by a color change (from dark to light) in the core and by a decrease in gamma radiation on geophysical logs. In the Ohio #6/1 and #6/3 cores a thin laminae of pyrite is present at this contact. In the remaining wells, the contact was not cored or was lost due to faulty sampling.

Chagrin Shale:

The Chagrin Shale averages 189 feet thick in the Ohio #6 wells. The total thickness of Chagrin was cored in the Ohio #6/4 well, and portions of it were cored in the Ohio # 6/1, #6/3, and #6/5 wells (Tables 2, 4, 5, 6).

The Chagrin Shale consists of interbedded mudstone, siltstone, and silty mudstone. Colors range from light olive gray (5Y 6/1), greenish gray (5GY 6/1), and medium light gray (N6, N5) through dark greenish gray (5GY 4/1, 5G 4/1) to olive black (5Y 2/1) and greenish black (5G 2/1). The strata are thickly laminated to thin bedded. The siltstones contain numerous sedimentary structures, including cross laminations, scour surfaces, solution surfaces, and load-cast structures. Many of the siltstone laminae are calcareous. Bioturbation is prominent with numerous mottled areas throughout the core containing mud, silt, and pyrite-filled burrow structures. Fossil content in the Chagrin is moderate consisting of pyritized spores (Tasmanites sp.), carbonaceous plant fragments, fish teeth and scales, and occasional poorly-preserved cephalopod (?) fragments. Pyrite occurs as lenses, nodules, and burrow fillings.

The contact between the Chagrin and the underlying Huron Shale is problematic. The only perceptible lithologic change in the core is a gradual increase in the amount of dark shale over a vertical distance of thirty feet.

The contact on the gamma ray log is also gradational, showing a slow increase in radiation over a vertical distance of about twenty feet. According to Schwietering (1979), because of the intertonguing relationship of the Chagrin and Huron Shales, it is difficult to define an exact contact between the two. For the purpose of this report, the contact has been estimated based on comparisons and interpretations of the geophysical logs.

Huron Shale:

The Huron Shale is usually subdivided into three informal units on the basis of rock color, lithology, and gamma radiation. In the subsurface of eastern Ohio, the Huron consists of two dark radioactive shales separated by a lighter colored shale and siltstone unit having a relatively lower gamma count (Schwietering, 1979). These three units can be recognized on gamma logs and (with some difficulty) in the core.

The Huron Shale averages 558 feet thick in the five Gallia County wells. Portions of the Huron were cored in all five wells (Tables 2 - 6).

The upper unit of the Huron Shale averages 135 feet thick in the Ohio #6 wells. Core containing portions of the upper Huron was obtained from the Ohio #6/4 and #6/5 wells. It consists of interbedded mudstone, siltstone, and silty mudstone, ranging in color from light and medium light gray (N7, N6), dark greenish gray (5GY 4/1, 5G 4/1) to greenish black (5G 2/1) and olive black (5Y 2/1). The strata are thinly laminated to thick bedded. The siltstone units are slightly to moderately calcareous and many contain graded bedding, sole marks, scour features, and cross lamination. Bioturbation is present throughout but is more common near the top of the unit. Burrow structures are commonly mud or silt filled, although a few pyrite-filled burrows

are present. Fossils occurring in this portion of the upper Huron include Tasmanites sp. spores (both resinous and pyritic), carbonaceous plant fragments, and a few scattered fish fragments (jaws and scales). Pyrite is present throughout as lenses, nodules, pellets, and disseminated crystals.

The contact between the upper and middle units of the Huron Shale is gradational over a vertical distance of eight feet. This contact is expressed on the gamma logs as a gradual decrease in radioactivity from 180 to 150 API units (average). No definitive contact could be determined in the cores.

The middle unit of the Huron Shale averages 180 feet thick in the Gallia County wells. Core containing the middle Huron was obtained from the Ohio #6/1 and #6/4 wells (Tables 2 and 5). The middle Huron consists of interbedded mudstone, silty mudstone, and siltstone which are shaly near the top of the unit. Rock colors range from light and medium gray (N7, N6), dark greenish gray (5GY 4/1, 5G 4/1) to olive black (5Y 2/1). Stratification varies from thinly laminated to thin bedded. Many siltstone laminae are calcareous, cross laminated, and rest on scour surfaces. Calcareous concretionary bands are fairly common near the top of the unit. Pyrite occurs throughout as nodules, lenses, and disseminated crystals. Bioturbation is common, and burrow structures filled with mud, silt, and pyrite are present throughout. The major fossil type present in the middle Huron is Foerstia sp., a small (1 to 5 mm diam) irregular spore case (?) of a marine alga (La Rocque and Marple, 1955). The Foerstia sp. were found only in the Ohio #6/4 core (continuous through the middle Huron) and appear to be restricted to a zone approximately 112 feet thick. The Foerstia sp. in the upper part of the zone are approximately 1 mm in diameter but increase in size to 4 - 5 mm below 2,402.3 feet. Near the

bottom of the zone (2,481.0') the Foerstia sp. decrease in size to 1 mm diam. According to Potter, Maynard, and Pryor (1980), the Foerstia sp. zone appears to be very useful as a biostratigraphic time marker throughout the Appalachian Basin.

Other fossils present in the middle Huron include Tasmanites sp. casts, vitrinitic and pyritic wood fragments (several in the shape of leaves or bark), carbonaceous plant debris, and a few scattered fish teeth and scales.

The contact between the middle and lower portions of the Huron Shale is fairly distinct. On the gamma ray log, the contact is denoted by an increase in gamma radiation from about 150 API units to an average of 250 API units over a vertical distance of approximately eight feet. The contact is identified in the Ohio #6/4 core by a gradual increase in the proportion of dark mudstone over a vertical distance of about four feet (2,536' to 2,540').

The lower unit of the Huron Shale averages 243 feet thick in the Gallia County wells. Core containing the lower Huron was obtained from each Ohio #6 well (Tables 2 through 6). The lower Huron consists primarily of dark mudstone and silty mudstone which are shaly in parts, with a moderate amount of interbedded siltstone. Colors range from medium light gray (N6), light olive gray (5Y 6/1) and greenish gray (5G 6/1) through olive gray (5Y 4/1) and dark greenish gray (5GY 4/1, 5G 4/1) to brownish black (5YR 2/1), olive black (5Y 2/1), and greenish black (5G 2/1). Stratification varies from thinly laminated to thick bedded. The siltstone beds are slightly to moderately calcareous, and many contain cross lamination, sole marks, scour surfaces, and a minor amount of disseminated mica. Pyrite occurs throughout the unit as lenses, nodules, pellets, and disseminated crystals. Bioturbation and mottling are

present throughout, but are especially common at the boundaries between dark mudstone and lighter units. Burrow structures are filled with silt or pyrite; a few contain pyrite fillings with gypsum/anhydrite centers. A few large (up to 3 cm diam) silt-filled burrows intersect the core near the base of the Huron Shale. Fossils present in the lower Huron include Lingula sp. casts (near the base of the unit), resinous and pyritic spores (Tasmanites sp.), conodonts, a few coiled cephalopods, scattered fish jaws, teeth and scales, carbonaceous plant fragments, and a few vitrinitic and pyritic wood fragments.

The contact between the lower unit of the Huron Shale and underlying Olentangy Shale is fairly distinct and appears on the gamma logs as an abrupt decrease in gamma radiation from 330 to 130 API units over a vertical distance of ten feet. The contact appears in the Ohio #6/5 core as a gradational change from interbedded dark mudstone to light greenish mudstone in a vertical distance of about five feet (2,440' to 2,445').

Olentangy Shale:

The Olentangy Shale underlies the Ohio Shale and rests on the Columbus Limestone (Onondaga Group). Schwietering (1979) has divided the Olentangy into two units which are separated by an unconformity, and which are defined on gamma ray-neutron logs by an abrupt drop in gamma ray intensity. The upper unit is Upper Devonian and is equivalent to the West Falls and Java Formations of New York. The lower unit is Middle Devonian and correlates with parts of the Hamilton Group of New York.

Total thickness of the upper and lower Olentangy units, as determined from geophysical logs, is 145 feet and 78 feet, respectively. A portion of

the upper unit was cored only in the Ohio #6/5 well (Table 6). No core was taken from the lower unit or from the underlying Columbus Limestone.

The cored portion of the upper Olentangy consists of interbedded mudstone, slightly silty mudstone, and argillaceous lime mudstone. Colors range from greenish gray (5GY 6/1) and light olive gray (5Y 6/1) through dark greenish gray (5G 4/1) to brownish black (5YR 2/1) and olive black (5Y 2/1). Stratification varies from thickly laminated to thin bedded. Bioturbation is prominent throughout with numerous mottled areas containing lime and silt-filled burrow structures. Scour surfaces are present at the base of several of the silty mudstone beds. Pyrite occurs throughout as nodules and lenses. Fossil content is very sparse, consisting of a few scattered carbonaceous plant fragments and pyritic and resinous spore bodies (Tasmanites sp.).

The contact between the upper and lower parts of the Olentangy appears to be very sharp on the gamma logs. Gamma intensity shows a distinct increase from 140 to 220 API units over a vertical distance of five feet across the contact.

Although no core was taken from the lower portion of the Olentangy Shale, it appears from the high gamma intensity to be a dark, carbonaceous shale, possibly similar to the Cleveland or lower Huron Members of the Ohio Shale. Schwietering (1979) describes the lower part of the Olentangy in eastern Ohio as a gray to dark gray and black shale with thin beds of limestone. He notes (p. 19) that a radioactive, black shale at the base of the Olentangy can be traced into the Marcellus Shale (Hamilton Group). This basal black shale is visible on the Gallia County gamma-ray/neutron logs as an intensity peak of 300 API units 12 feet above the top of the underlying Columbus Limestone.

The contact between the Olentangy Shale and the Columbus Limestone is distinct on the gamma-ray/neutron logs. In a vertical distance of four feet, gamma-ray intensity drops from 260 API units at the base of the Olentangy to 40 API units at the top of the Columbus.

After coring, all five wells in the Ohio #6 series were plug-drilled several feet into the Columbus Limestone to allow geophysical logging of the shale-limestone contact.

5.4 Fracture Analysis:

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

Approximately 139 natural fractures were observed in the cores. Simple and compound joints comprise about 58 percent of this total. The distribution of natural fractures throughout the cored intervals is shown in Tables 7 through 11.

Approximately 96 percent of the natural fractures are nonmineralized; the remainder contain calcite, dolomite or anhydrite (?) mineralization. The open nonmineralized fractures are joints showing no appreciable movement, and are as much as 18.2 feet long.

The greatest concentration of natural fractures in the cored intervals occur in the Bedford Formation. Fracture frequency is also high in the Berea Sandstone and Huron Shale. The majority of natural fractures consist of faults, microfaults, and soft sediment deformation features in

TABLE 7

DISTRIBUTION OF NATURAL FRACTURES-OHIO #6/1 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Ohio Shale:				
Cleveland Shale	1,810'-1,814'	4'	0	0.00
Chagrin Shale	1,814'-1,866'	52'	5	0.09
Huron Shale:				
Upper	-	-	-	-
Middle	2,310'-2,318'	8'	0	0.00
Lower	2,318'-2,368' 2,446'-2,501'	105'	7	0.06
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 8

DISTRIBUTION OF NATURAL FRACTURES-OHIO #6/2 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,697'-1,728'	31'	6	0.19
Ohio Shale:				
Cleveland Shale	1,728'-1,756'	28'	0	0.00
Chagrin Shale	-	-	-	-
Huron Shale:				
Upper	-	-	-	-
Middle	-	-	-	-
Lower	2,282'-2,341' 2,418'-2,460'	101'	10	0.09
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 9

DISTRIBUTION OF NATURAL FRACTURES-OHIO #6/3 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,988'-2,000'	12'	0	0.00
Ohio Shale:				
Cleveland Shale	2,000'-2,040'	40'	0	0.00
Chagrin Shale	2,040'-2,046'	6'	0	0.00
Huron Shale:				
Upper	-	-	-	-
Middle	-	-	-	-
Lower	2,590'-2,602'	12'	8	0.60
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 10

DISTRIBUTION OF NATURAL FRACTURES-OHIO #6/4 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Sunbury Shale	1,840'-1,852'	12'	0	0.00
Berea Sandstone	1,852'-1,875'	23'	8	.34
Bedford Shale	1,875'-1,980'	105'	32	.30
Ohio Shale:				
Cleveland Shale	1,980'-2,018'	38'	0	0.00
Chagrin Shale	2,018'-2,200'	182'	1	0.00
Huron Shale:				
Upper	2,200'-2,350'	150'	0	0.00
Middle	2,350'-2,543'	193'	16	.08
Lower	2,543'-2,775'	232'	46	.19
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 11

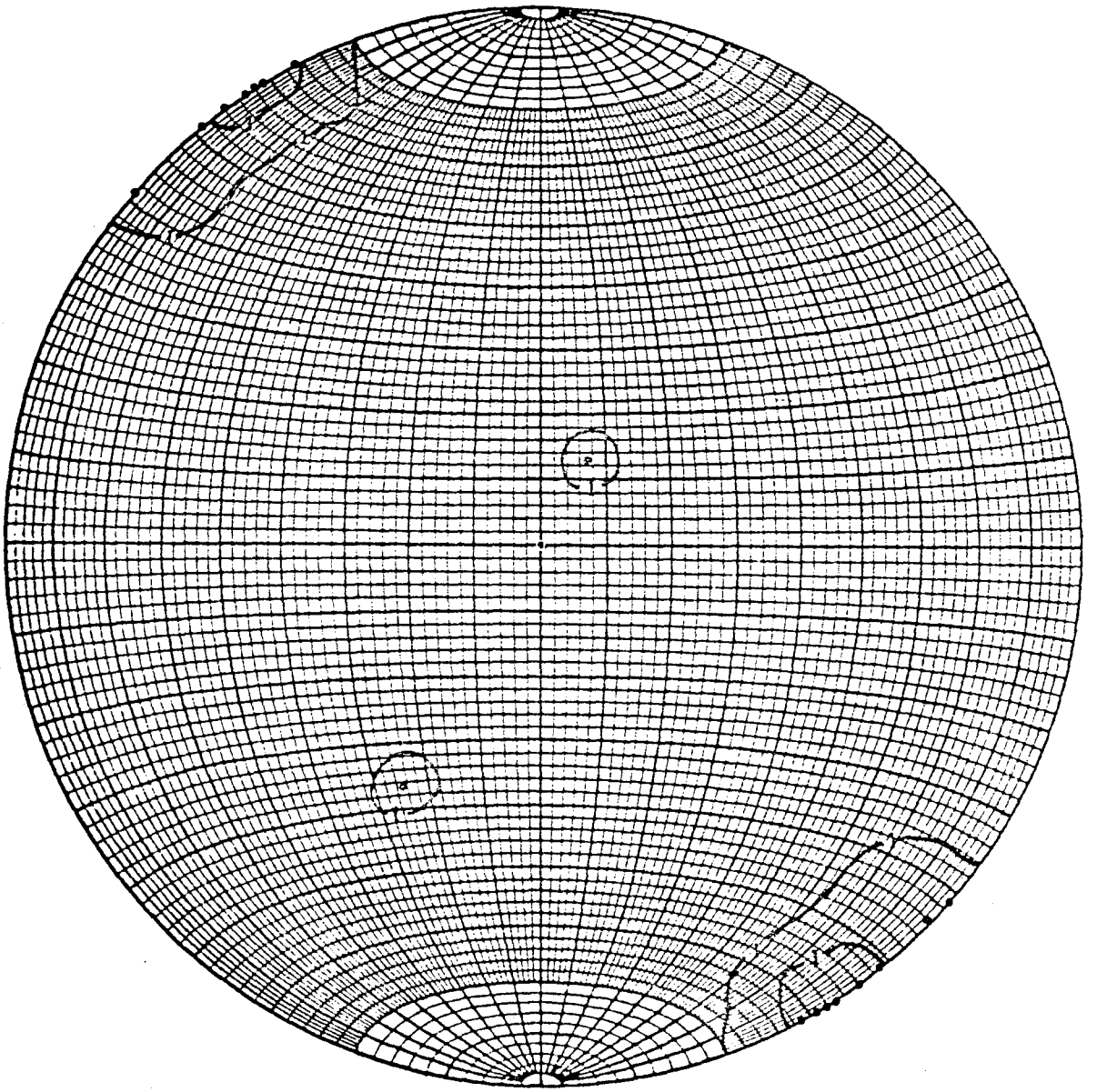
DISTRIBUTION OF NATURAL FRACTURES-OHIO #6/5 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,660'-1,678'	18'	1	0.05
Ohio Shale:				
Cleveland Shale	1,678'-1,714'	36'	5	0.13
Chagrin Shale	1,714'-1,718'	4'	0	0.00
Huron Shale:				
Upper	1,940'-1,998'	58'	4	0.06
Middle	-	-	-	-
Lower	2,440'-2,446'	6'	3	0.50
Olentangy Shale:				
Upper	2,446'-2,493'	47'	3	0.06
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

the Bedford Shale and Berea Sandstone; whereas, in the Huron Shale, the fractures are generally open, nonmineralized joints.

All planar and curviplanar natural fractures were analyzed to identify common structural trends in the cores. Figures 6 to 10 are graphic representations of the data plotted in polar form on Schmidt (equal area) stereonets. The data has been contoured to determine locations of maximum pole density using the method described by Ragan (1968). One common fracture trend (N52°E to N85°E, near-vertical dip) is evident in the Ohio #6/1, #6/2, and #6/4 cores. The average strike of this trend is N60°E. No structural trends are apparent in the Ohio #6/3 and #6/5 cores.

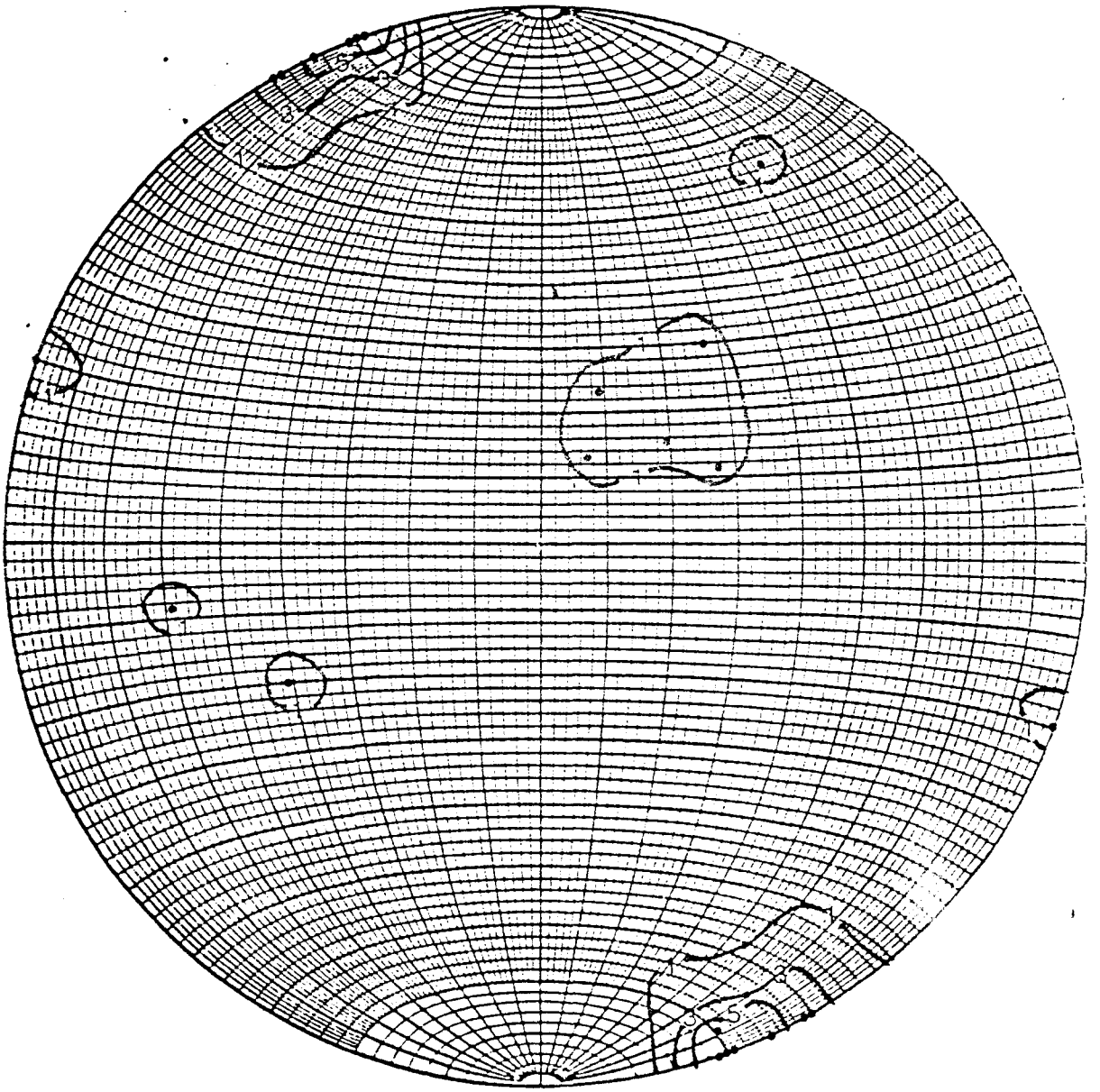
More then 90 percent of the fractures examined were interpreted to be coring or handling induced. Disc fractures were the most common type observed. Because they are less diagnostic than other types of fractures, they were not



SCHMIDT NET

FIGURE 6

CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES
OHIO #6/1 CORE

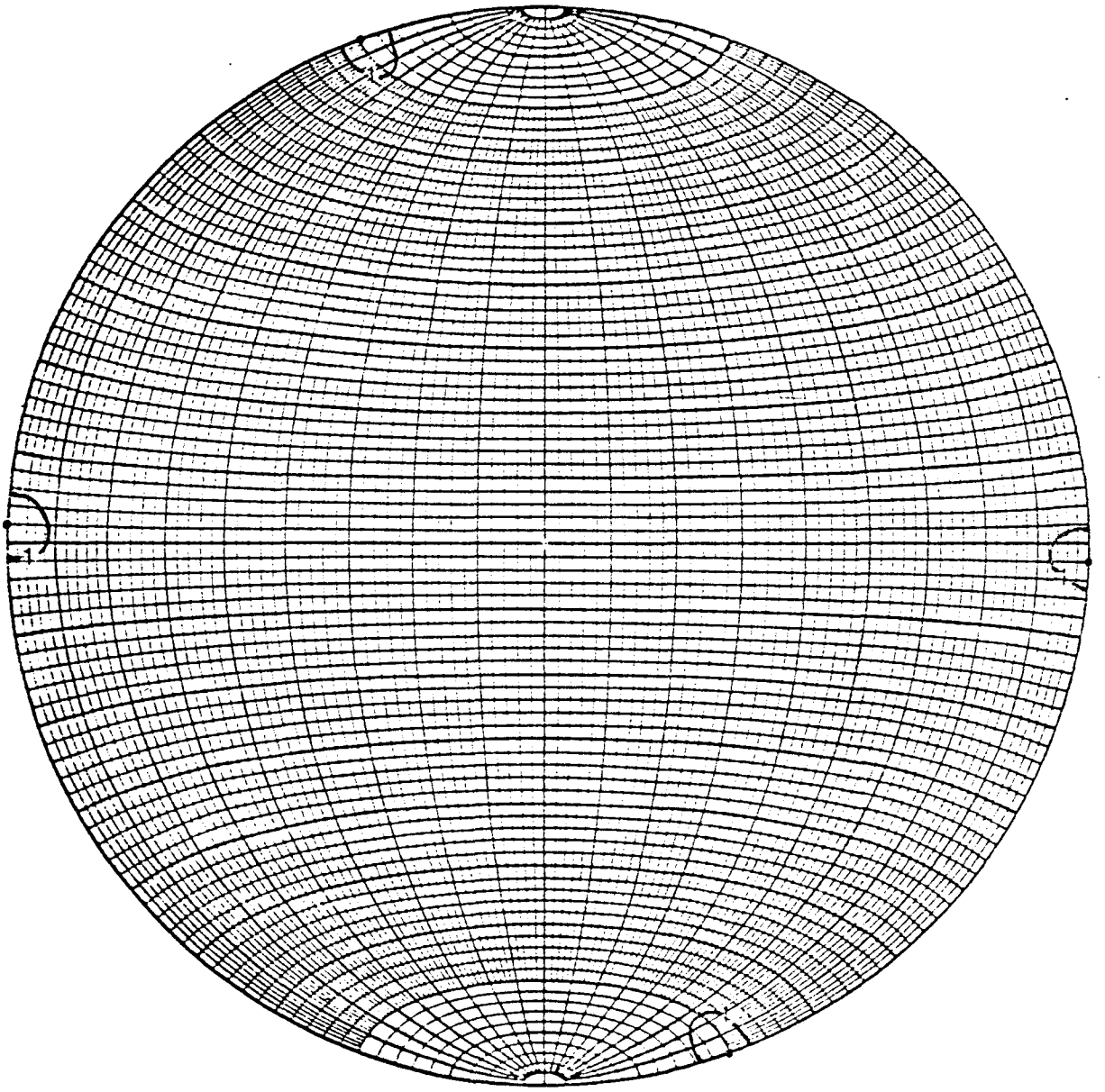


SCHMIDT NET

FIGURE 7

CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES

OHIO #6/2 CORE

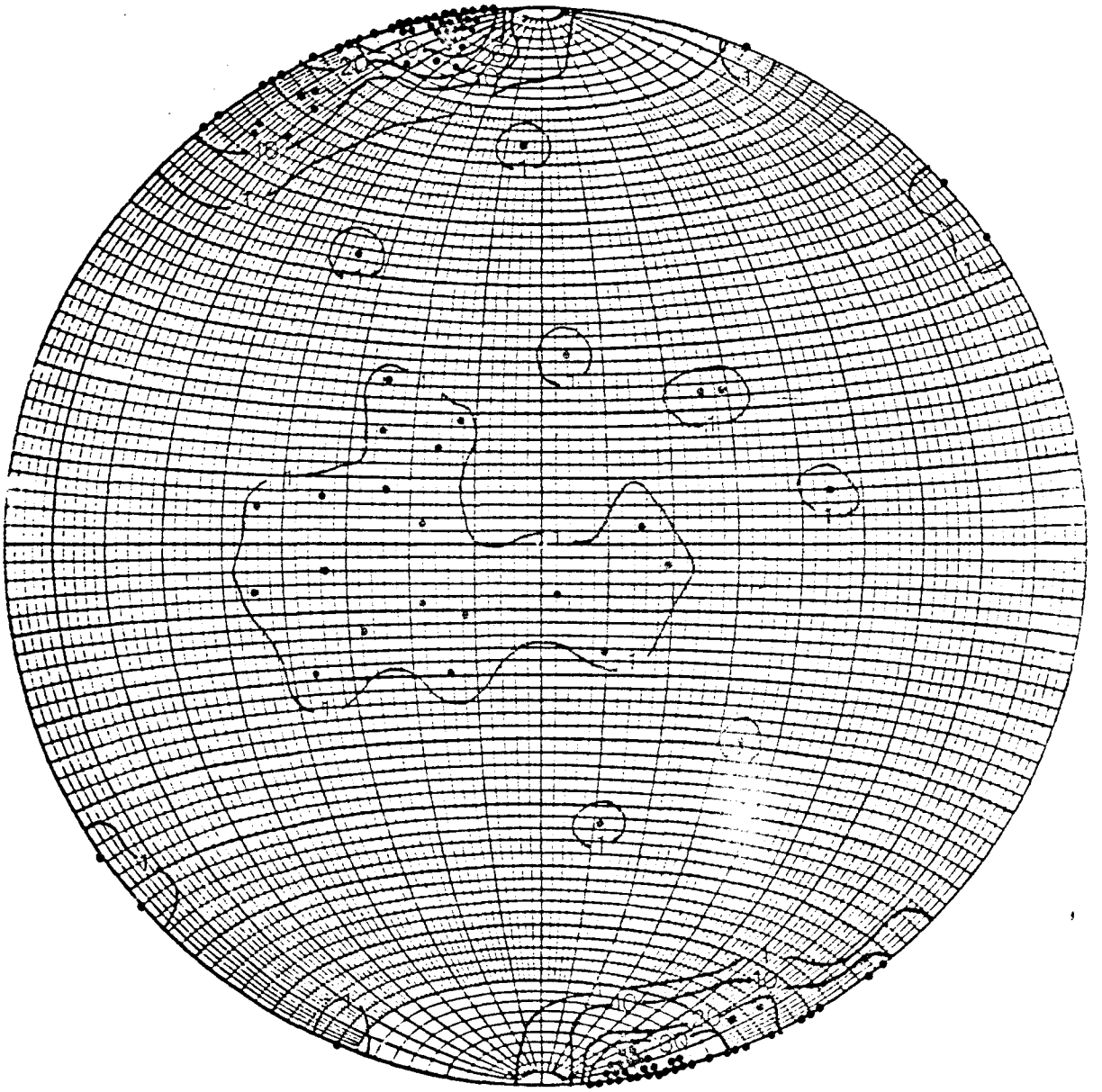


SCHMIDT NET

FIGURE 8

CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES

OHIO #6/3 CORE

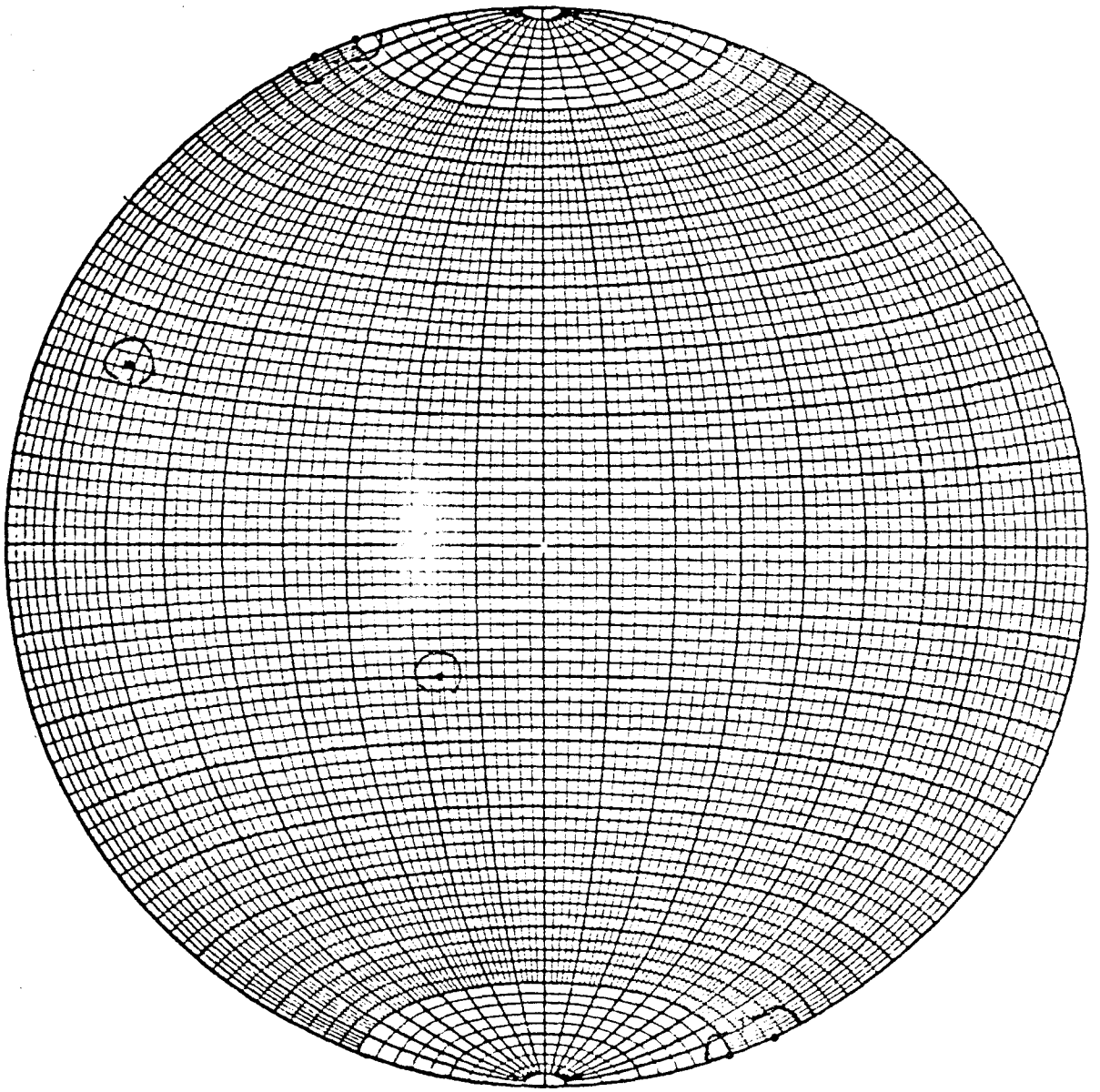


SCHMIDT NET

FIGURE 9

CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES

OHIO #6/4 CORE



SCHMIDT NET

FIGURE 10

CONTOURED DIAGRAM OF POLES TO NATURAL FRACTURES

OHIO #6/5 CORE

recorded individually. However, disc fracture frequency does provide a rough measure of the flexural rigidity of the core parallel to bedding, and these data are reported in Appendix C.

Petal fractures are not common features, although most cores contain a few fractures of this type. Genetic implications of these features are poorly understood. The Ohio #6 series cores are somewhat unique in that they contain numerous petal fractures and petal-centerline fractures. Distribution of these features is shown in Tables 12 through 16.

In the cores some of the petal fractures and petal-centerline fractures exhibit remarkable structural continuity. These fracture orientations were analyzed as shown in Figures 11 to 15. The major trend lies between N57°E and N61°E and dips 50° to 60° to the NW and SE. A minor complementary trend strikes from N37°W to N55°W and dips nearly vertical. These trends represent fracture concentrations, but numerous fractures with differing orientations are present.

Some upper fracture terminations were lost in rubblized zones within the core; thus some fracture origins are obscure. The similarity between open, nonmineralized fractures and the lower, steep-dipping portion of petal-centerline fractures led to difficulties in the analysis.

Petal-centerline fractures are usually measured at core margins and generally dip 30° to 60°. In this instance, the strike of each fracture (or portion thereof) and its dip (~90°) were logged and plotted as coring induced, resulting in near-vertical dips on petal fracture polar diagrams.

TABLE 12

DISTRIBUTION OF PETAL FRACTURES-OHIO #6/1 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Ohio Shale:				
Cleveland Shale	1,810'-1,814'	4'	0	0.00
Chagrin Shale	1,814'-1,866'	52'	1	0.01
Huron Shale:				
Upper	-	-	-	-
Middle	2,310'-2,318'	8'	0	0.00
Lower	2,318'-2,368' 2,446'-2,501'	105'	11	0.10
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 13

DISTRIBUTION OF PETAL FRACTURES-OHIO #6/2 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,697'-1,728'	31'	2	0.06
Ohio Shale:				
Cleveland Shale	-	-	-	-
Chagrin Shale	1,728'-1,756'	28'	0	0.00
Huron Shale:				
Upper	-	-	-	-
Middle	-	-	-	-
Lower	2,282'-2,341' 2,418'-2,476'	117'	14	0.11
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 14

DISTRIBUTION OF PETAL FRACTURES-OHIO #6/3 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,988'-2,000'	12'	0	0.00
Ohio Shale:				
Cleveland Shale	2,000'-2,040'	40'	0	0.00
Chagrin Shale	2,040'-2,046'	6'	0	0.00
Huron Shale:				
Upper	-	-	-	-
Middle	-	-	-	-
Lower	2,590'-2,602'	12'	2	0.16
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 15

DISTRIBUTION OF PETAL FRACTURES-OHIO #6/4 CORE

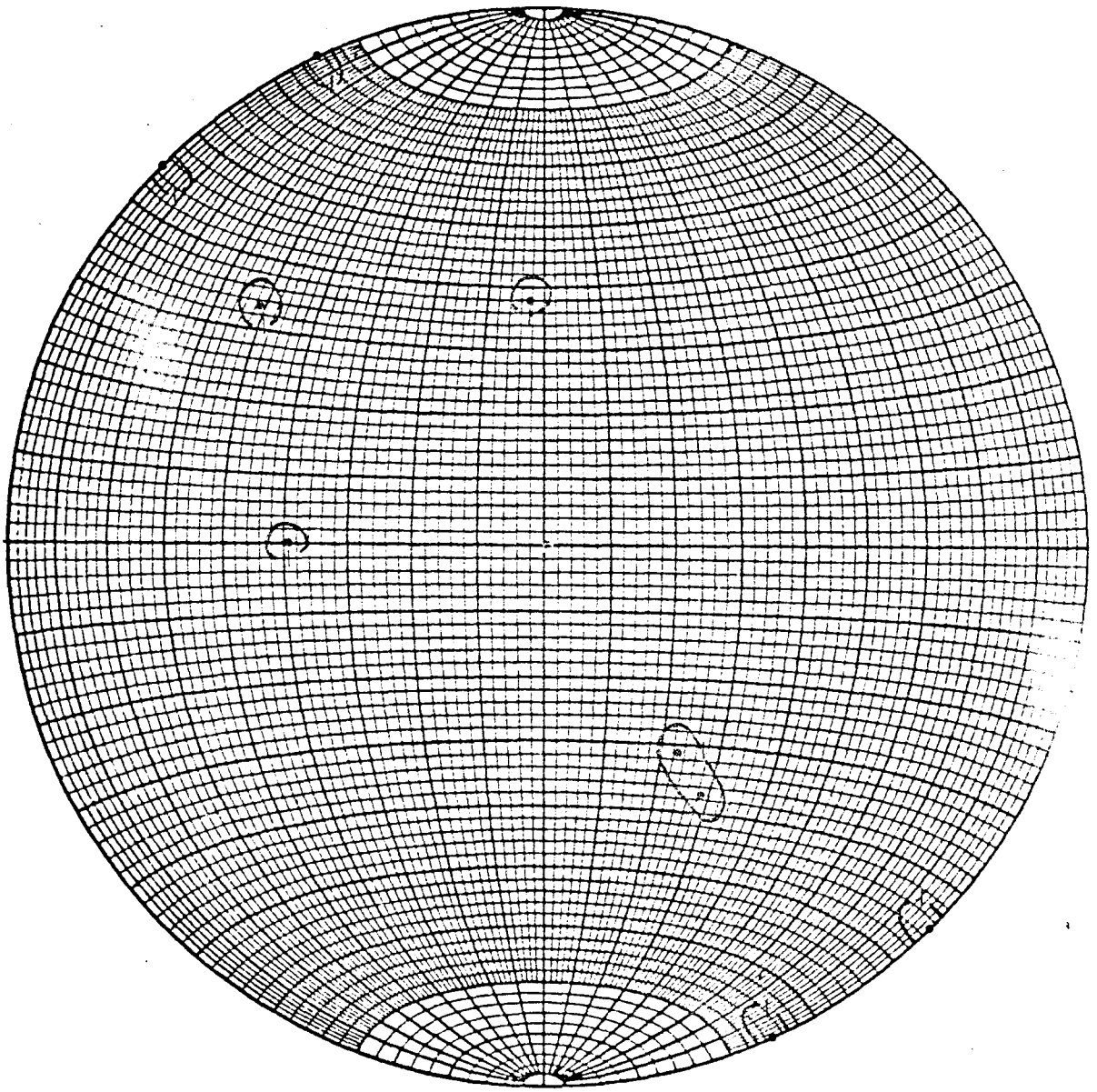
Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Sunbury Shale	1,840'-1,852'	12'	0	0.00
Berea Sandstone	1,852'-1,875'	23'	0	0.00
Bedford Shale	1,875'-1,980'	105'	3	0.02
Ohio Shale:				
Cleveland Shale	1,980'-2,018'	38'	0	0.00
Chagrin Shale	2,018'-2,200'	182'	1	0.00
Huron Shale:				
Upper	2,200'-2,350'	150'	4	0.02
Middle	2,350'-2,543'	193'	4	0.02
Lower	2,543'-2,775'	232'	18	0.07
Olentangy Shale:				
Upper	-	-	-	-
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

TABLE 16

DISTRIBUTION OF PETAL FRACTURES-OHIO #6/5 CORE

Formation	Cored Interval	Core Length	Number of Fractures	Frequency Per Foot
Bedford Shale	1,660'-1,678'	18'	0	0.00
Ohio Shale:				
Cleveland Shale	1,678'-1,714'	36'	1	0.02
Chagrin Shale	1,714'-1,718'	4'	0	0.00
Huron Shale:				
Upper	1,940'-1,998'	58'	0	0.00
Middle	-	-	-	-
Lower	2,440'-2,446'	6'	0	0.00
Olentangy Shale:				
Upper	2,446'-2,493'	47'	1	0.02
Lower	-	-	-	-
Columbus Limestone	-	-	-	-

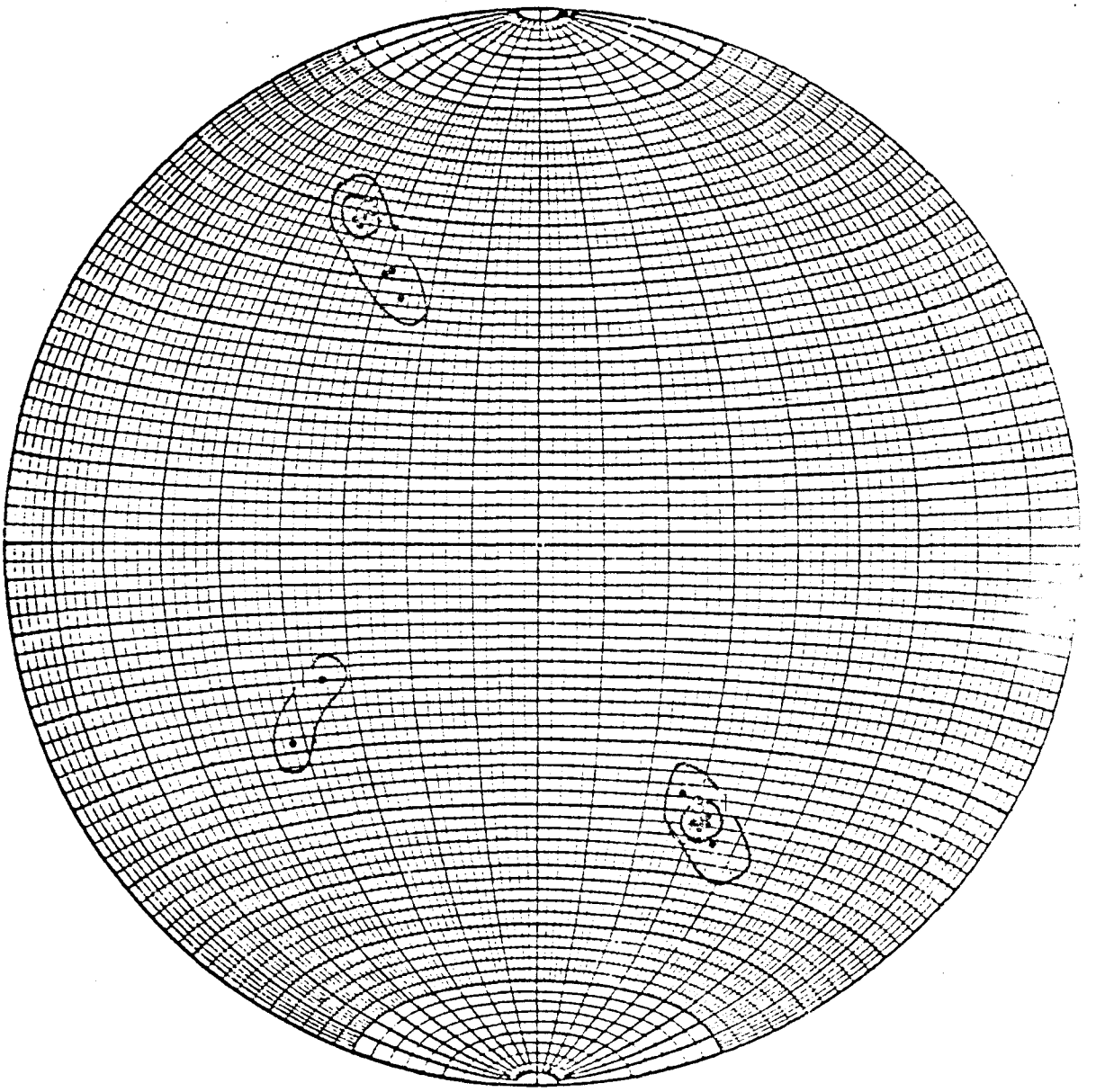
Because of incomplete evidence of fracture origins, the coring-induced interpretation is somewhat speculative. However, resulting trends are approximately parallel to natural fracture orientations, suggesting that the trends are valid.



SCHMIDT NET

FIGURE 11

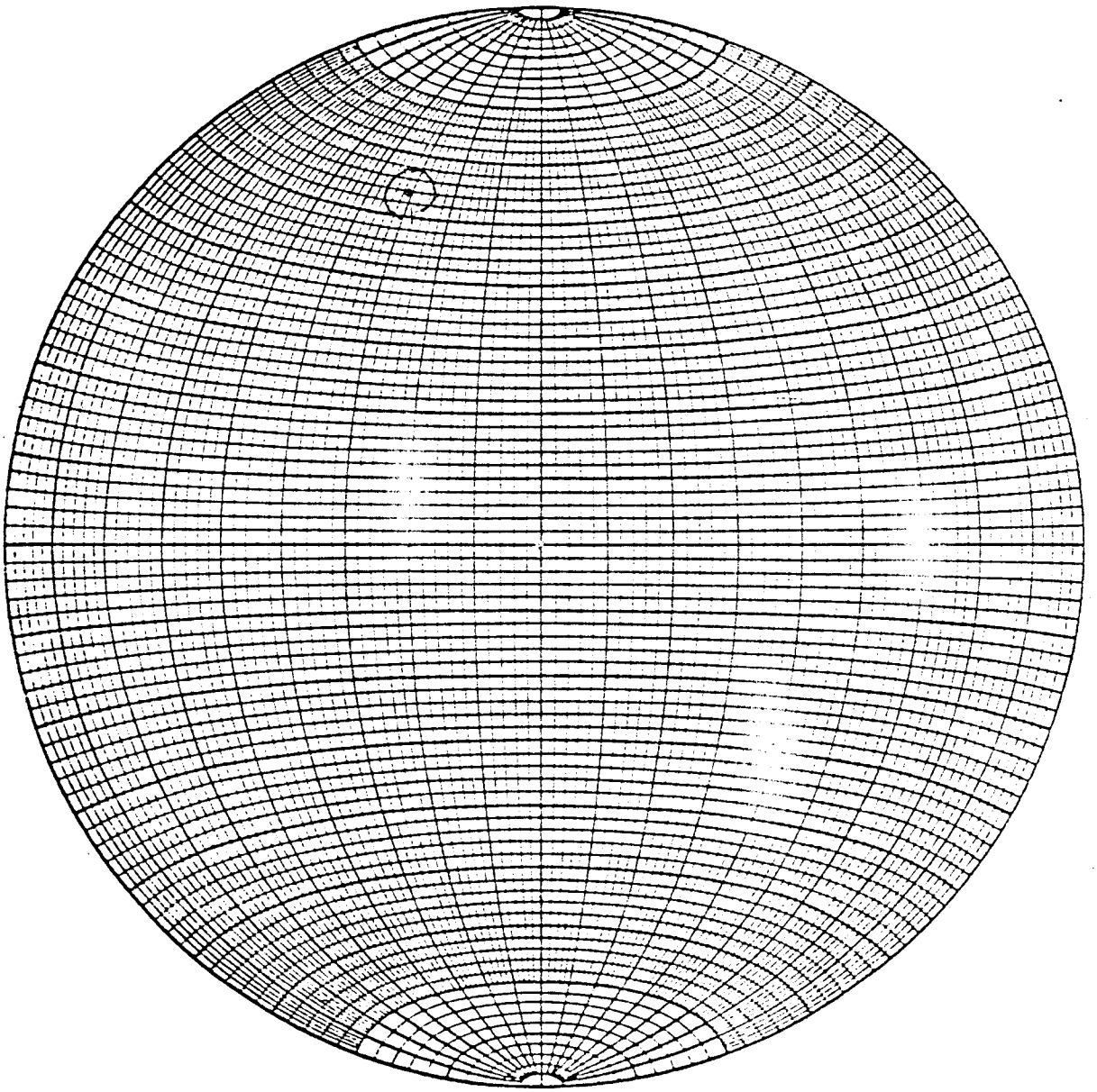
CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES
OHIO #6/1 CORE



SCHMIDT NET

FIGURE 12

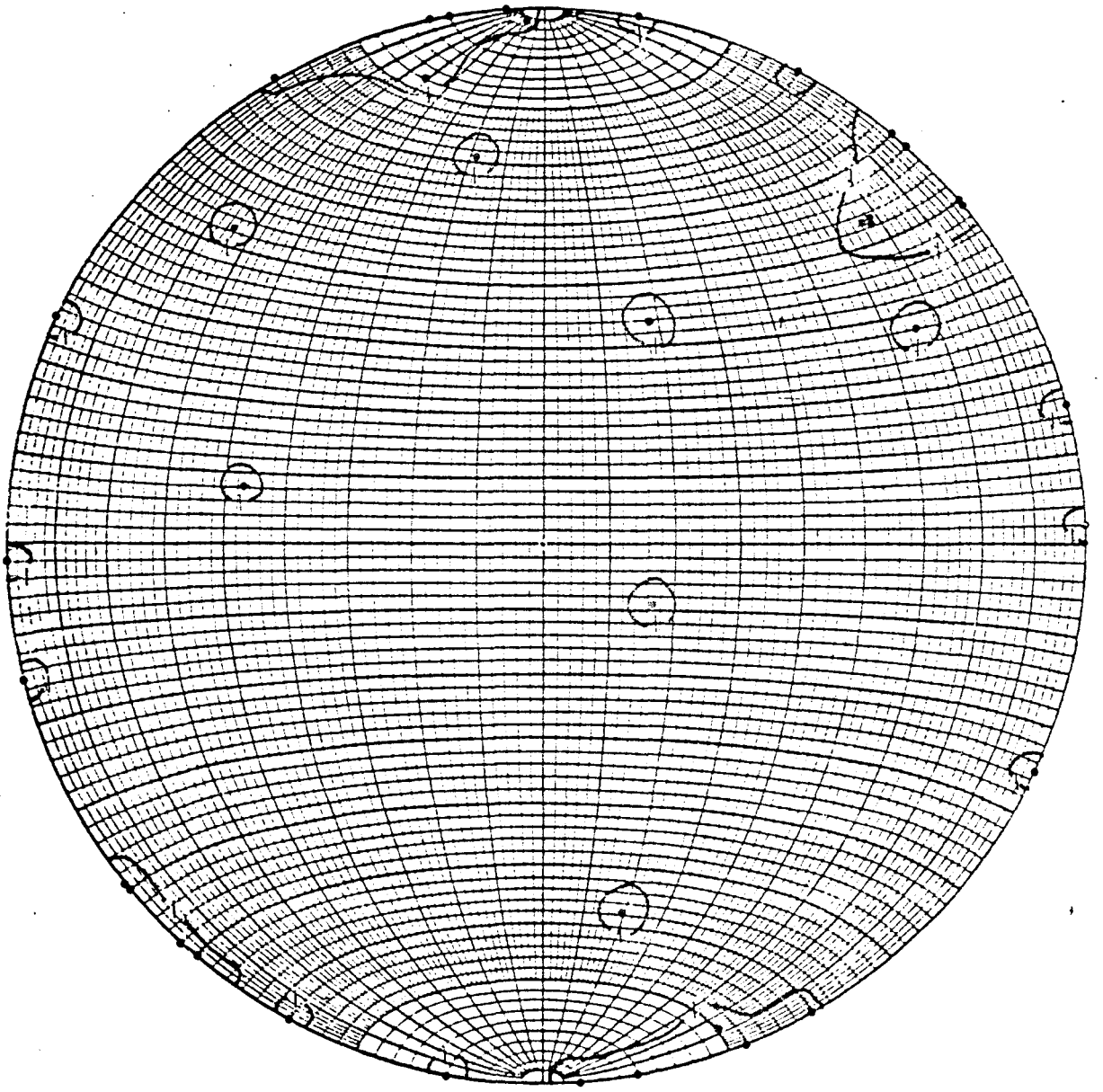
CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES
OHIO #6/2 CORE



SCHMIDT NET

FIGURE 13

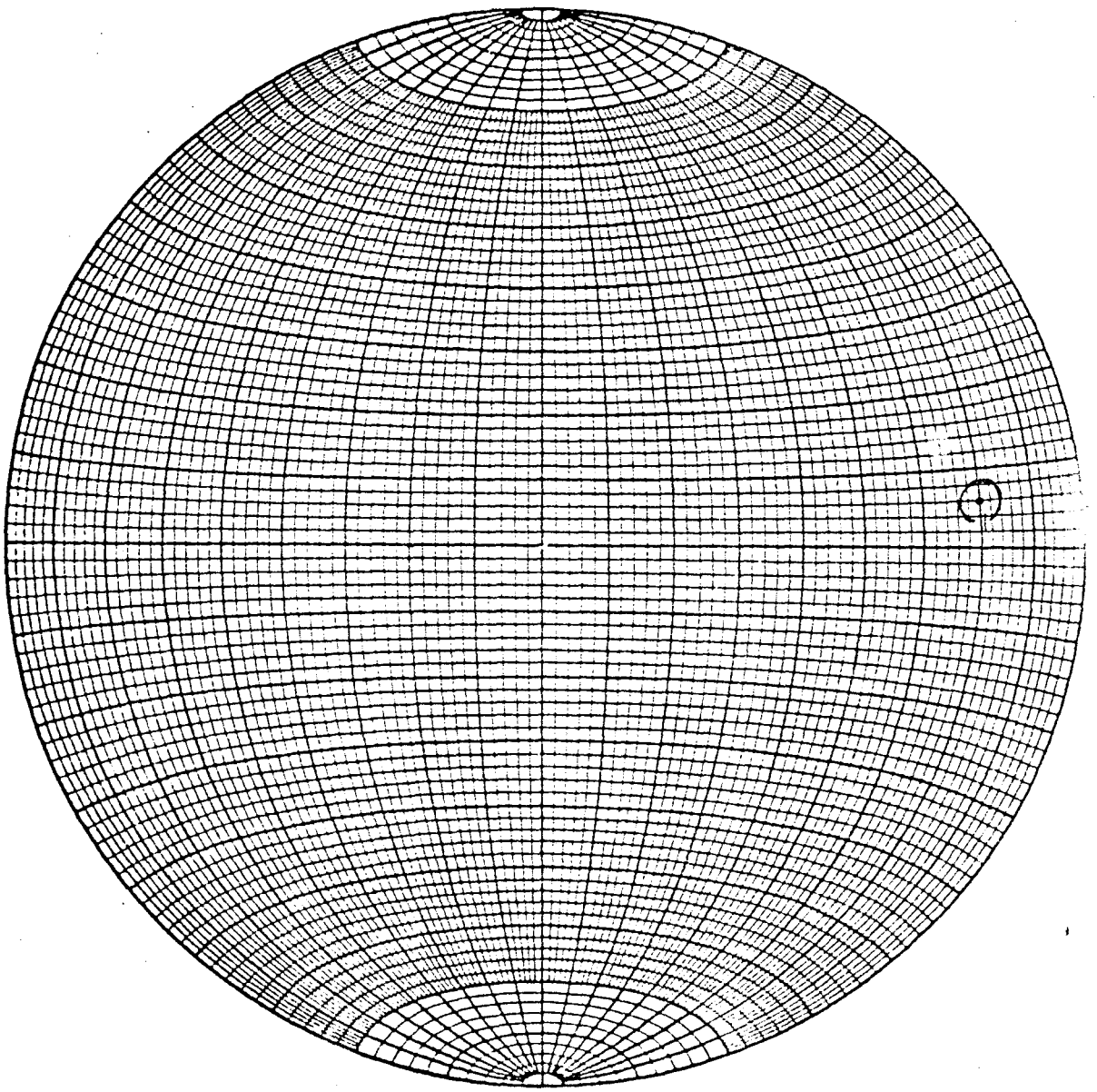
CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES
OHIO #6/3 CORE



SCHMIDT NET

FIGURE 14

CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES
OHIO #6/4 CORE



SCHMIDT NET

FIGURE 15

CONTOURED DIAGRAM OF POLES TO PETAL FRACTURES
OHIO #6/5 CORE

APPENDIX A

DETAILED LITHOLOGIC DESCRIPTION
EGSP-OHIO #6 SERIES

DETAILED LITHOLOGIC DESCRIPTION

EGSP - OHIO #6/1

GALLIA COUNTY

INTERVAL	DESCRIPTION
1,810.0' - 1,813.8' (3.8')	Mudstone, greenish black (5G 2/1), thick bedded, with a few thin laminae of medium light gray (N6) siltstone. The upper 1/2 contains a single, 2-cm-diam pyrite nodule and several pyritic lenses. Inarticulate brachiopod casts of the genus Orbiculoidea are present on several partings in the upper 1/2 of the interval. A cast of a single specimen of the pelecypod genus Grammysia is present at 1,812.0'. Abundant carbonaceous plant fragments and spore resin bodies occur throughout.
1,813.8' - 1,819.4' (5.6')	Mudstone, silty mudstone, and siltstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thin bedded. The siltstone contains ripple laminae, cross-lamination, and occasional scour features. Carbonaceous fragments and pyrite (nodules, lenses, and burrow fillings) occur throughout. Horizontal slickensides are present at 1,818.0'. A single, poorly-preserved coiled-cephalopod (?) cast is present at 1,814.1'.
1,819.4' - 1,826.3' (6.9')	Siltstone, silty mudstone, and mudstone, medium light gray (N6), dark greenish gray (5GY 4/1), and greenish black (5G 2/1), thickly laminated to thin bedded. Ripple laminae, minor cross-lamination, and scour features are associated with the siltstone beds. Partially pyritized burrow structures occur at 1,825.8'. Pyrite nodules and carbonaceous plant fragments are present throughout.
1,826.3' - 1,832.2' (5.9')	Siltstone and silty mudstone, medium light gray (N6) and dark greenish gray (5GY 4/1), thickly laminated to thin bedded. Numerous thin laminae of silty mudstone, light olive gray (5Y 6/1), occur in the interval. Burrow structures and pyrite nodules are prominent at 1,826.4'. Three slightly calcareous siltstone beds, 0.2' to 0.6' thick, occur between 1,829.2' and 1,829.8'. The other siltstone beds in the interval are noncalcareous and contain ripple laminae, cross-lamination, and scour features. Carbonaceous plant fragments and burrow structures (pyrite- and mud-filled) are present throughout.
1,832.2' - 1,836.9' (4.7')	Mudstone, silty mudstone, and siltstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thin bedded. Numerous thick laminae of silty mudstone (1-2 cm thick), light olive gray (5Y 6/1), occur throughout. The siltstone beds are ripple-laminated and cross-laminated, and a scour surface is present at 1,834.3'. The interval contains a mixture of pyritized and mud-filled burrow structures throughout. A large (3 cm) vitrinite fragment is present at 1,835.6'.

INTERVAL	DESCRIPTION
1,836.9' - 1,844.5' (7.6')	Mudstone, silty mudstone, and siltstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thin bedded. Numerous laminae of silty mudstone, light olive gray (5Y 6/1), occur throughout. The siltstone beds are ripple-laminated. The upper 1/3 of the interval contains pyrite lenses and pyritized burrow structures and spores, and carbonaceous plant fragments.
1,844.5' - 1,850.3' (5.8')	Mudstone, siltstone, and silty mudstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thin bedded. An isolated, thickly laminated siltstone bed occurs in the lower 1/3 of the interval. Carbonaceous plant fragments and partially pyritized burrow structures are abundant throughout.
1,850.3' - 1,855.6' (5.3')	Mudstone, silty mudstone, and siltstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thin bedded. Two siltstone beds containing burrow structures are present in the lower 1/3 of the interval. Carbonaceous plant fragments and pyritized spores occur throughout.
1,855.6' - 1,860.1' (4.5')	Mudstone, silty mudstone, and siltstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thin bedded. Ripple laminae and sole marks occur in the siltstone beds. Carbonaceous plant fragments and spore resin bodies are present throughout. Silty mudstone between 1,858.3' and 1,860.0' is shaly.
1,860.1' - 1,866.0' (5.9')	Mudstone, siltstone, and silty mudstone, greenish black (5G 2/1) and dark greenish gray (5GY 4/1), thin bedded. Several siltstone beds in the upper 1/3 of the interval (1,860.5' to 1,860.9') are cross-laminated. Carbonaceous plant fragments, disseminated pyrite, pyritized spores, and burrow structures are present throughout. Pyritized fecal (?) pellets occur on several exposed partings.
1,866.0' - 2,310.0' (444.0')	This interval was plug drilled.
2,310.0' - 2,316.1' (6.1')	Mudstone, silty mudstone, and siltstone, brownish black (5YR 2/1), olive gray (5Y 4/1), and medium gray (N5), thin bedded. Several siltstone beds present between 2,311.8' and 2,313.8' display graded bedding. Occasional burrow structures are present; bedding planes are distinct. Pyrite nodules and carbonaceous plant fragments are distributed sparsely throughout. Several calcareous siltstone laminae occur near the base of the interval.

INTERVAL	DESCRIPTION
2,316.1' - 2,319.8' (3.7')	Mudstone, olive gray (5Y 4/1) and olive black (5Y 2/1), thin bedded, containing numerous thin calcareous (dolomitic?) siltstone laminae. The mudstone is slightly calcareous throughout. The interval is barren of macrofossils but does contain large numbers of spore resin bodies in the lower 1/2.
2,319.8' - 2,334.9' (15.1')	Mudstone, brownish black (5YR 2/1), thin to thick bedded, noncalcareous. Pyrite nodules and lenses are common. A near-vertical natural fracture intersects the core from 2,322.7' to 2,334.1'. Small carbonaceous plant fragments were observed on several isolated partings throughout the interval.
2,334.9' - 2,340.1' (5.2')	Mudstone, silty mudstone, and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1), and greenish black (5G 2/1), thin to thick bedded. This interval consists of interbedded mudstone and silty mudstone with a greenish black (5G 2/1) shaly mudstone at the base. Pyritized burrow structures are common throughout, frequently occurring at the mudstone-siltstone boundaries. Several slightly calcareous siltstone laminae are present in the upper 1/2 of the interval. A poorly preserved pelecypod cast and several unidentified skeletal fragments occur at 2,336.3'. Numerous carbonized spore resin bodies are present in the greenish black shale at the base of the interval.
2,340.1' - 2,347.7' (7.6')	Interbedded siltstone and silty mudstone, light olive gray (5Y 6/1), dark greenish gray (5GY 4/1), and olive black (5Y 2/1), thinly laminated to thick bedded. Thick laminae of siltstone are distributed throughout. The siltstone laminae frequently are calcareous and exhibit cross-laminae and sole marks. Laminae of olive black (5Y 2/1) mudstone occur as shaly partings in the silty mudstone beds. A vitrinite fragment is present at 2,341.4'.
2,347.7' - 2,359.2' (11.5')	Silty mudstone and siltstone, light olive gray (5Y 6/1) and olive gray (5Y 4/1), thinly laminated to thin bedded. Laminae of brownish black (5YR 2/1) mudstone occur as shaly partings in the silty mudstone. The siltstone beds are noncalcareous and contain numerous burrow structures. Isolated silt-filled burrow structures occur within the silty mudstone beds. Pyritized spores, pyrite nodules, and small carbonaceous plant fragments are sparsely distributed throughout.
2,359.2' - 2,368.0' (8.8')	Mudstone, brownish black (5YR 2/1) and olive gray (5Y 4/1), thin to thick bedded. Olive gray mudstone occurs as several light zones distributed within brownish black mudstone. Disseminated pyrite and pyrite nodules are common throughout. The interval is nonfossiliferous with the exception of a few small, carbonized plant fragments scattered sparsely throughout.

INTERVAL	DESCRIPTION
2,368.0' - 2,446.0' (78.0')	This interval was plug drilled.
2,446.0' to 2,455.2' (9.2')	Mudstone and silty mudstone, brownish black (5YR 2/1), dark greenish gray (5GY 4/1), and olive gray (5Y 4/1), thin to thick bedded, interbedded. Dark mudstone beds contain numerous carbonaceous plant fragments, pyrite nodules and lenses, and spore resin bodies. Light zones are slightly calcareous and contain abundant burrow structures. Mineralization within the burrow structures consists of an outer ring of pyrite and an inner core of coarse, crystalline dolomite. Mud-filled burrow structures are numerous and are particularly concentrated in dark mudstone beds immediately beneath light zone boundaries.
2,455.2' - 2,457.5' (2.3')	Mudstone and siltstone, olive black (5Y 2/1), olive gray (5Y 4/1), and light olive gray (5Y 6/1), thickly laminated to thin bedded. Siltstone laminae present at 2,456.1' and 2,457.4' are strongly calcareous and bioturbated. Pyrite nodules occur in the dark zones between 2,456.4' and 2,457.2'. No macrofossils were observed.
2,457.5' - 2,472.0' (14.5')	Mudstone, siltstone, and silty mudstone, olive black (5Y 2/1), light olive gray (5Y 6/1), and olive gray (5Y 4/1), thinly laminated to thin bedded. Siltstone laminae are noncalcareous. Pyrite occurs as mineralization within subhorizontal burrow structures. Some partings contain carbonaceous plant fragments and spore resin bodies.
2,472.0' - 2,478.0' (6.0')	Mudstone and silty mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thick bedded. Pyrite nodules and 5-mm-thick pyritic lenses are common throughout. Vitrinite fragments occur at 2,472.3' and 2,472.7'.
2,478.0' - 2,483.7' (5.7')	Mudstone and silty mudstone, brownish black (5YR 2/1) and olive gray (5Y 4/1), thinly laminated to thin bedded. A near-vertical natural fracture intersects the core throughout the length of the interval. Small, carbonaceous plant fragments are distributed sparsely throughout.
2,483.7' - 2,497.0' (13.3')	Mudstone and silty mudstone, brownish black (5YR 2/1) and olive gray (5Y 4/1), thin to thick bedded. Silty mudstone is highly bioturbated and burrow fillings of silty mudstone (3- to 5-mm-thick) occur in dark mudstone. Vitrinite fragments are present at 2,487.0' and 2,493.9'. Spore resin bodies are common below 2,490'.

INTERVAL	DESCRIPTION
2,497.0' - 2,501.1' (4.1')	Mudstone and silty mudstone, brownish black (5YR 2/1) and olive gray (5Y 4/1), thin bedded. Light zones are intensively burrowed, and boundaries between these zones and underlying dark beds are gradational. A large vitrinite fragment is present at 2,497.3' and a cast of a fossil fish jaw fragment occurs at 2,499.2'.

DETAILED LITHOLOGIC DESCRIPTION

EGSP - OHIO #6/2

GALLIA COUNTY

INTERVAL	DESCRIPTION
1,697.0' - 1,699.6' (2.6')	Mudstone, olive gray (5Y 4/1), thickly laminated to thin bedded. Slickensided fault surfaces are present at 1,698.0' and 1,699.0'. The interval is slightly shaly throughout. No fossils or biogenic structures were observed.
1,699.6' - 1,706.5' (6.9')	Mudstone and shaly mudstone, grayish red (5R 4/2) and olive gray (5Y 4/1), thickly laminated to thin bedded. The reddish zone occurs as a discrete unit between 1,699.7' and 1,703.2'. Slickensided fault surfaces are present at 1,702.7', 1,702.8', 1,703.4', and 1,705.0'. Small, unidentified articulate brachiopod casts are distributed sparsely throughout the olive gray zones. Occasional small, carbonaceous plant fragments occur in the lower 1/3.
1,706.5' - 1,715.9' (9.4')	Mudstone, silty mudstone, and siltstone, olive gray (5Y 4/1), light olive gray (5Y 6/1), and yellowish gray (5Y 7/2), thinly laminated to thin bedded. The siltstone zones are slightly calcareous and occur as thin laminae and occasional thin beds throughout. Siltstone displays cross-lamination, ripple-lamination, and sole marks. Thin laminae of volcanic ash occur at 1,707.4', 1,707.85', and 1,709.25'. A cast of a solution-pitted (?) surface is present on a parting at 1,712.3'. An oil show appears in a siltstone bed that extends from 1,712.9' to 1,713.3'.
1,715.9' - 1,721.8' (5.9')	Mudstone, olive gray (5Y 4/1) at the top of the interval, gradually darkening to olive black (5Y 2/1) at the base, thin bedded, fossiliferous. Fossils include inarticulate brachiopod genera Lingula and Orbiculoidea, articulate brachiopod genera Stropheodonta and Chonetes, and many small fragments of unidentified skeletal material. Most fossils are pyritized.
1,721.8' - 1,727.9' (6.1')	Mudstone, olive black (5Y 2/1), thin bedded. The upper 1/2 contains a few small, unidentified scattered inarticulate brachiopod fossils. Small fish scales are distributed sparsely throughout.
1,727.9' - 1,733.8' (5.9')	Mudstone, brownish black (5YR 2/1) and olive black (5Y 2/1), thin bedded. Several thin (<1 mm) laminae of siltstone, light olive gray (5Y 6/1), slightly calcareous, occur throughout. Pyrite nodules and pyritized brachiopod shell fragments are present in the lower 1/3. Small fish scales, teeth, and carbonaceous plant fragments are distributed sparsely throughout. Several well-preserved Lingula sp. shells are present at 1,732.6' and 1,732.7'. A fossil concentration composed mainly of tiny Orbiculoidea sp. and Lingula sp. shells, occurs at 1,733.3'.

INTERVAL	DESCRIPTION
1,733.8' - 1,743.2' (9.4')	Mudstone, brownish black (5YR 2/1) and olive black (5Y 2/1), thickly laminated to thin bedded. Numerous thin laminae of siltstone, olive gray (5Y 4/1), occur throughout. Siltstone laminae contain disseminated pyrite and/or dolomite. Pyrite nodules, fish scales, and carbonaceous plant fragments are abundant throughout. Unidentified, pyritized inarticulate brachiopods are common in the lower 1/2. A fish jaw cast is present at 1,737.5'.
1,743.2' - 1,755.1' (11.9')	Mudstone, brownish black (5YR 2/1), thickly laminated to thin bedded. Numerous thin laminae of olive gray (5Y 4/1) siltstone occur throughout. Several of the siltstone laminae are calcareous and many exhibit fine irregular structure. The interval is sparsely fossiliferous throughout, containing casts of Lingula sp. fragments, carbonaceous plant debris, fish scales, pyritic fecal (?) pellets, and pyrite-filled burrow structures. A fish vertebra (?) cast occurs at 1,748.45'. A fossil concentration of fish bones, scales, teeth, and jaw fragments is present at 1,754.61'.
1,755.1' - 2,282.0' (526.9')	This interval was plug drilled.
2,282.0' - 2,296.0' (14.0')	Silty mudstone, mudstone, and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1), and light olive gray (5Y 6/1), thinly laminated to thick bedded. The interval is mostly silty mudstone which contains numerous laminae of mudstone. Included siltstone ranges from laminae less than 1 mm thick to beds up to 0.5' thick and exhibits numerous sedimentary structures such as graded bedding, ripple marks, and sole marks. Many of the siltstone units are strongly calcareous. The upper 1' of this interval contains numerous pyritic lenses and laminae, and pyrite-filled burrow structures. Burrow structures filled with silt occur at 2,287.4'. Small carbonaceous plant fragments are distributed sparsely throughout.
2,296.0' - 2,303.3' (7.3')	Silty mudstone, dark greenish gray (5GY 4/1) and olive gray (5Y 4/1), thickly laminated to thin bedded. Thick laminae of mudstone and siltstone, brownish black (5YR 2/1) and light olive gray (5Y 6/1), are distributed at irregular intervals throughout. A single unit of calcareous siltstone occurs at 2,300.2'. Pyrite is especially common in the lower 1/3, although it is present throughout in thin laminae, lenses, and burrow fillings. No macrofossils were observed in this interval except for a few small scattered carbonaceous plant fragments.

INTERVAL	DESCRIPTION
2,303.3' - 2,311.9' (8.6')	Mudstone and silty mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thin bedded. Several thick laminae of siltstone, light olive gray (5Y 6/1), are present in the upper 1'. Disseminated pyrite, pyrite nodules, and small carbonaceous plant fragments occur throughout.
2,311.9' - 2,323.2' (11.3')	Mudstone, siltstone, and silty mudstone, brownish black (5YR 2/1), light olive gray (5Y 6/1), and olive gray (5Y 4/1), thinly laminated and thin to thick bedded. Light olive gray siltstone laminae are restricted to the upper 1/2. Olive gray silty mudstone occurs in two thin beds at 2,322.1' and 2,323.1'. Pyrite, occurring in disseminated form and as nodules, is present in the upper 1/2. Small carbonaceous plant fragments and casts of fish scales, teeth and jaws occur throughout. An exceptionally well preserved fish jaw cast is present at 2,318.3'.
2,323.2' - 2,329.5' (6.3')	Mudstone, silty mudstone, and siltstone, olive black (5Y 2/1), olive gray (5Y 4/1), and light olive gray (5Y 6/1), thinly laminated to thin bedded. The siltstone beds are slightly calcareous; sole marks are present on the lower bounding surfaces of some beds. Bioturbation was observed in several silty mudstone beds. Pyrite nodules with dolomitic centers are present throughout but occur most frequently in the dark mudstone. Pyritized nodules of possible fecal origin are present along some partings.
2,329.5' - 2,335.7' (6.2')	Silty mudstone, olive gray (5Y 4/1) and light olive gray (5Y 6/1), and siltstone, yellowish gray (5Y 8/1), thinly laminated to thin bedded. Numerous thin laminae of olive black (5Y 2/1) mudstone occur throughout. A slickensided fault surface is present between 2,330.6' and 2,330.8'. Carbonaceous plant fragments and pyrite nodules are distributed sparsely throughout.
2,335.7' - 2.340.4' (4.7')	Mudstone, olive black (5Y 2/1), thin bedded. A few thin beds of olive gray (5Y 4/1) silty mudstone are present in the lower 1/2. Pyrite occurs in numerous thin laminae, lenses, and nodules. Small carbonaceous plant fragments are distributed sparsely throughout. A 1-cm-wide vitrinite fragment is present on a parting at 2,340.4'.
2,340.4' - 2,418.0' (77.6')	This interval was plug drilled.

INTERVAL	DESCRIPTION
2,418.0' - 2,429.8' (11.8')	Mudstone, brownish black (5YR 2/1) and olive black (5Y 2/1), thickly laminated to thin bedded. A few thin beds of bioturbated silty mudstone, olive gray (5Y 4/1) are also present. Spore resin bodies, carbonaceous plant fragments, and large pyrite nodules (1 cm diam) are common throughout. A large (4 cm) vitrinite fragment occurs at 2,421.7'. A compound, near-vertical natural fracture extends through the lower 1/3 of the interval.
2,429.8' - 2,443.4' (13.6')	Mudstone, olive black (5Y 2/1), and silty mudstone, olive gray (5Y 4/1), thickly laminated to thin bedded. The dark zones commonly contain disseminated pyrite, large (1-2 cm) pyrite nodules, and numerous carbonaceous plant fragments. The light zones contain many mud-filled burrow structures which frequently extend downward into the underlying dark zones. Spore resin bodies are common throughout.
2,443.4' - 2,452.3' (8.9')	Mudstone, olive black (5Y 2/1), thin bedded, containing occasional thick laminae of silty mudstone, olive gray (5Y 4/1). The silty mudstone contains numerous mud-filled burrow structures. A near-vertical natural fracture extends through the interval. A dolomite-filled compound natural fracture occurs at 2,446.7'. Spore resin bodies were noted throughout the interval.
2,452.3' - 2,460.6' (8.3')	Mudstone, olive black (5Y 2/1), and silty mudstone, olive gray (5Y 4/1), thickly laminated to thin bedded. Due to extensive natural fracturing only fragments of core were recovered between 2,452.3' and 2,453.9'. Large pyrite nodules (1-2 cm diam) are common throughout the dark zones. The light zones contain numerous mud-filled burrow structures. Spore resin bodies occur throughout.
2,460.6' - 2,469.7' (9.1')	Silty mudstone, dark greenish gray (5GY 4/1) and olive gray (5Y 4/1), and mudstone, brownish black (5YR 2/1), thickly laminated to thin bedded. The silty mudstone is extensively bioturbated. Mud-filled burrows frequently extend through the light zones down into the underlying dark mudstones. Carbonaceous plant fragments, fish scales, and pyritized fecal pellets commonly occur in the dark mudstones. A 1-cm-wide fragment of vitrinite is present at 2,463.65'.
2,469.7' - 2,476.6' (6.9')	Mudstone, brownish black (5YR 2/1), thin bedded. Several zones of silty mudstone, olive gray (5Y 4/1), thickly laminated, occur near the base of the interval. Dark mudstone contains numerous pyrite nodules, especially in the upper 1/2; silty mudstone is extensively bioturbated. A 1-cm-wide vitrinite fragment occurs at 2,473.1'. Carbonaceous plant fragments are distributed sparsely throughout.

DETAILED LITHOLOGIC DESCRIPTION

EGSP - OHIO #6/3

GALLIA COUNTY

INTERVAL	DESCRIPTION
1,988.0' - 1,991.3' (3.3')	Siltstone, silty mudstone and mudstone, light olive gray (5Y 6/1), greenish gray (5 GY 6/1) and olive gray (5Y 4/1), and olive black (5Y 2/1), thinly laminated to thin bedded. Siltstone is predominant; it is slightly calcareous and contains graded bedding, sole marks, and small scale (1 - 2 cm) ball-and-pillow structure. Oil shows are present in siltstone units between 1,988.0' and 1,989.0'. Two concretionary bands, pale yellowish brown (10 YR 6/2) and ranging in width from 1 to 2 cm, occur at 1,989.6' and 1,991.0'. No fossils or biogenic structures were observed.
1,991.3' - 1,995.6' (4.3')	Mudstone, olive gray (5Y 4/1), thin bedded, noncalcareous and sparsely fossiliferous. Fossils include casts of inarticulate brachiopods (genus Orbiculoidea), pyritized articulate brachiopods (genus Chonetes), and several fragmented, poorly preserved, unidentified pelecypod (?) shells.
1,995.6' - 2,004.3' (8.7')	Mudstone, olive black (5Y 2/1), thin bedded. Approximately twelve thin laminae (<1 mm) of noncalcareous silty mudstone, light olive gray (5Y 6/1), occur throughout. Fossils are sparse consisting of fish scales and carbonaceous plant fragments. Fish scales, fish teeth, conodonts (?), and unidentified skeletal fragments are prominently concentrated at 1,997.95'. Casts of inarticulate brachiopods (genus Lingula) occur on a parting at 2,004.1'.
2,004.3' - 2,010.2' (5.9')	Mudstone and silty mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thinly laminated to thin bedded. The dark mudstone zones are pyritic and fossiliferous throughout. Pyrite nodules (1 - 3 mm in diam) are common in the upper 1/2 and tend to decrease in size and frequency downward. Pyrite also occurs as a filling in small, shallow, nearly vertical burrow structures in the upper 1/2. Fossils are prevalent and include casts of fish scales and inarticulate brachiopods (Lingula sp.), carbonaceous plant fragments, and small, unidentified skeletal fragments. A well-preserved Lingula cast, 12 mm in length, occurs at 2,005.8'. A fossil concentration at 2,006.0' contains fish teeth and scales, conodonts, and pyritized shell fragments. Spore resin bodies are present throughout. Silty mudstone occurs as numerous thin laminae (<1 mm) in the lower 1/2. A 1-cm-thick bed of calcareous siltstone, light olive gray (5Y 6/1), cross-laminated and sole-marked, occurs at the base.

INTERVAL	DESCRIPTION
2,010.2' - 2,021.2' (11.0')	Mudstone, silty mudstone and siltstone, brownish black (5YR 2/1), olive black (5Y 2/1), and light olive gray (5Y 6/1), thinly laminated to thin bedded. Siltstone laminae are calcareous and display fine, irregular stratification. Pyrite nodules and burrow fillings are sparsely distributed. Fossil occurrence is moderate with spore resin bodies, fish scales, inarticulate brachiopod casts (Lingula sp.), and a well preserved, pyritized articulate brachiopod (Chonetes sp.) at 2,012.38'. Lingula shell fragments, conodonts, fish teeth and scales, and unidentified skeletal fragments are concentrated at 2,012.9'.
2,021.2' - 2,029.1' (7.9')	Mudstone and siltstone, greenish black (5GY 2/1), olive black 5Y 2/1), and light olive gray (5Y 6/1), thinly laminated to thin bedded. Siltstone laminae are calcareous and sparsely distributed. The interval is slightly fossiliferous, containing carbonaceous plant fragments, spore resin bodies (predominantly in the lower 1/2), and a single, pyritized articulate brachiopod (Chonetes sp.) at 2,022.6'. A fossil concentration at 2,021.5' contains casts of shell fragments of inarticulate brachiopods (genera Lingula and Orbiculoidea), conodonts, fish scales, and unidentified skeletal fragments. Thin laminae and lenses of pyrite (<3 mm) are distributed sparsely throughout. Poorly-preserved pelecypods (Grammysia sp.?) are present on partings at 2,027.29' and 2,027.33'.
2,029.1' - 2,040.55' (11.45')	Silty mudstone and siltstone, brownish black (5YR 2/1) and olive black (5Y 2/1), and light olive gray (5Y 6/1), thinly laminated to thin bedded. The siltstone is noncalcareous and occurs throughout in numerous thin laminae, containing fine, undisturbed horizontal layers. Macrofossils are relatively scarce, consisting of spore resin bodies, carbonaceous plant fragments, and a few small concentrations of casts of inarticulate brachiopod shell fragments (Lingula sp. and Orbiculoidea sp.). Small (1 - 2 mm diam) pyrite nodules are distributed sparsely throughout. An irregular, thick lamina of pyrite marks a distinctive lithologic change that occurs between this interval and the one below.

INTERVAL	DESCRIPTION
2,040.55' - 2,045.7' (5.15')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1), and greenish gray (5GY 6/1), very thin to thin bedded, interbedded. The siltstone beds are slightly calcareous and contain prominent cross-lamination, ripple-lamination, sole marks, and irregular layers. Burrow structures filled with mud, silt, and pyrite occur throughout the silty mudstone and siltstone beds. Crystalline pyrite (<1 mm crystal size) is sparsely disseminated throughout the dark mudstone units. Coarse pyrite crystals (>1 mm crystal size) occur on a bedding surface at 2,045.42'. Several silty mudstone beds contain scattered fish scales.
2,045.7' - 2,590.0' (544.3')	This interval was plug drilled.
2,590.0' - 2,601.94' (11.94')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1) and brownish black (5YR 2/1), olive gray (5Y 4/1), and light olive gray (5Y 6/1), thinly laminated to thin bedded. The siltstone zones are slightly calcareous and contain fine, horizontal laminae, small scale sole marks (about 1 mm relief) and a few tiny burrow structures. Pyrite nodules and lenses are common throughout, especially in the darker zones. Macrofossils include spore resin bodies, carbonaceous plant fragments and occasional fish scales. A fish jaw is present at 2,599.075'.

DETAILED LITHOLOGIC DESCRIPTION

EGSP - OHIO #6/4

GALLIA COUNTY

INTERVAL	DESCRIPTION
1,842.0' - 1,850.4' (8.4')	Mudstone, greenish black (5G 2/1), thick bedded. Disseminated mica, carbonaceous fragments, subvertical pyrite-filled burrow structures and pyrite nodules occur throughout. Two oddly shaped cross-sections of subvertical pyrite-filled burrow structures are present at 1,844.5' and 1,845.1'. Pyritized fecal pellets occur at 1,842.05', 1,842.2', and 1,843.8'. Lag deposits of skeletal fragments, fish scales and conodonts occur between 1,849.7' and 1,849.9'.
1,850.4' - 1,858.3' (7.9')	Sandstone and silty sandstone, very fine-grained, pale olive (10Y 6/2) and greenish gray (5GY 6/1), thick bedded and weakly cross-stratified. The pale olive (10Y 6/2) color is probably due to staining by contained oil. The upper one foot is slightly calcareous.
1,858.3' - 1,866.5' (8.2')	Sandstone and silty sandstone, very fine-grained, medium light gray (N6) and dark greenish gray (5GY 4/1), thick bedded and weakly cross-stratified. Disseminated pyrite is present in the upper 1/2. Subvertical pyrite-filled burrow structures and pyrite lenses occur throughout.
1,866.5' - 1,875.0' (8.5')	Sandstone and silty sandstone, very fine-grained, medium light gray (N6) and medium gray (N5), thick bedded. Load-flow structures occur in the sandstone between 1,871.0' and 1,875.0'. The interval is weakly calcareous.
1,875.0' - 1,881.7' (6.7')	Silty sandstone, very fine-grained, medium gray (N5) to medium dark gray (N4), thick bedded. Carbonaceous fragments and disseminated mica occur throughout. A single fish scale was observed at 1,879.0'.
1,881.7' - 1,887.3' (5.6')	Silty sandstone, very fine-grained, brownish gray (5YR 4/1) at the top, darkening downward to medium dark gray (N4), thick bedded. Carbonaceous fragments and disseminated mica are present throughout.
1,887.3' - 1,895.3' (8.0')	Silty mudstone, grayish red (10R 4/2), thick bedded, shaly. Carbonaceous fragments occur throughout. Other fossils and biogenic structures are not present.
1,895.3' - 1,902.9' (7.6')	Silty mudstone, grayish red (10R 4/2), thick bedded, shaly. Carbonaceous fragments occur throughout.
1,902.9' - 1,910.7' (7.8')	Silty mudstone, grayish red (10R 4/2), darkens downward to medium dark gray (N4) in the lowest foot, thick bedded. A few carbonaceous fragments are present. A solution surface, with approximately 2 mm relief, occurs at 1,905.2'.

INTERVAL	DESCRIPTION
1,910.7' - 1,918.7' (8.0')	Silty mudstone, mudstone and siltstone, medium dark gray (N4), and light olive gray (5Y 6/1), thickly and thinly laminated to thin bedded. Carbonaceous fragments are present throughout. A flow structure occurs in the silty mudstone from 1,913.6' to 1,914.1'. Scour features occur in the siltstone at 1,918.0' and 1,918.3'. Ash beds are present at 1,914.9', 1,915.6', and 1,917.4'.
1,918.7' - 1,924.0' (5.3')	Mudstone, silty mudstone and siltstone, medium dark gray (N4) and medium gray (N5), thickly laminated to thin bedded. Carbonaceous fragments are present throughout. Multiple scour surfaces and related bed distortion occurs between 1,923' and 1,924'. A solution structure, with approximately 2 mm relief, occurs at 1,923.5'.
1,924.0' - 1,931.2' (7.2')	Mudstone, silty mudstone and siltstone, grayish red (10R 4/2) and medium gray (N5), thinly laminated to thick bedded. A flow structure occurs in medium gray silty mudstone between 1,929.4' and 1,929.8'. Scour surfaces occur in the thick laminations of medium gray (N5) silty mudstone, grayish red (10R 4/2) mudstone, and light gray (N7) siltstone between 1,924.0' and 1,925.0'.
1,931.2' - 1,938.5' (7.3')	Shaly mudstone, grayish red (10R 4/2), thick bedded. A few carbonaceous fragments are present, but other fossils and biogenic structures are not. A medium gray (N5) silty mudstone zone occurs between 1,937.9' and 1,938.2'.
1,938.5' - 1,947.7' (9.2')	Shaly mudstone, grayish red (10R 4/2), thick bedded. A few carbonaceous fragments are present.
1,947.7' - 1,950.9' (3.2')	Shaly mudstone, grayish red (10R 4/2), thick bedded. A gradational color change from grayish red (10R 4/2) to medium gray (N5) occurs in the last foot.
1,950.9' - 1,960.7' (9.8')	Silty mudstone and siltstone, medium dark gray (N4) and medium gray (N5), thickly laminated to thin bedded. The occasional siltstone laminations are weakly cross-stratified. Thin siltstone beds from 1,955.3' to 1,956.0' and 1,960.2' to 1,960.7' are saturated with oil and are weakly calcareous.
1,960.7' to 1,968.2' (7.5')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1), (5G 4/1), and light gray (N7), thickly laminated to thin bedded. Siltstone beds, from 1,964.9' to 1,965.1' and 1,965.3' to 1,965.5', are saturated with oil. A few siltstone laminations are weakly cross-stratified and a scour feature is present at 1,965.2'.

INTERVAL	DESCRIPTION
1,960.7' - 1,968.2' (Continued)	A concretionary band of silty mudstone, light olive gray (5Y 6/1), occurs at 1,968.1'. Pyrite lenses are present throughout. An ash bed is present at 1,960.35'.
1,968.2' - 1,972.2' (4.0')	Silty mudstone, dark greenish gray (5GY 4/1), thick bedded. Carbonacous fragments and pyritized burrow traces are present. Casts of the inarticulate brachiopod Orbiculoidea sp. and the articulate brachiopod Chonetes sp. are present, some are pyritized. A solution structure, with 2 mm relief, occurs at 1,972.2.'.
1,972.2' - 1,980.8' (8.6')	Mudstone, very slightly silty, and siltstone, grayish black (N2) and medium light gray (N6), thinly laminated to thick bedded. Carbonaceous fragments and pyritized casts of the inarticulate brachiopod Lingula sp. are present throughout. A siltstone containing a basal scour surface occurs at 1,977.0'.
1,980.8' - 1,989.1' (8.3')	Mudstone, very slightly silty, and siltstone, grayish black (N2) and medium light gray (N6), thinly laminated to thick bedded. Carbonaceous fragments, pyritized burrow structures, and specimens of the inarticulate brachiopod Lingula sp. are present throughout. An unidentified, pyritized, inarticulate brachiopod occurs at 1,983.35'.
1,989.1' - 1,996.6' (7.5')	Mudstone, very slightly silty, and siltstone, grayish black (N2) and medium light gray (N6), thinly laminated to thin bedded. Carbonaceous fragments, pyrite nodules (2 cm in diam), pyritized burrow structures, and pyritized plant fragments occur throughout. Pyritized casts of the inarticulate brachiopod Lingula sp. and disseminated pyrite are present throughout.
1,966.6' - 2,004.6' (8.0')	Mudstone, very slightly silty, and siltstone, grayish black (N2) and medium light gray (N6), thinly laminated to thick bedded. Pyritized burrow structures and resin spore bodies occur throughout. A pyritized cast of the articulate brachiopod Chonetes sp. (with spines preserved) is present at 2,001.5'. Solution structures with 2 mm relief occur at 1,998.6' and 1,999.1'. A fossil bed which includes conodonts, fish teeth, scales, and bones, and possibly a portion of a fin, is present at 1,981.9'.

INTERVAL	DESCRIPTION
2,004.6' - 2,016.3' (11.7')	Mudstone, very slightly silty, and siltstone, grayish black (N2) and medium light gray (N6), thinly laminated to thick bedded. Pyrite lenses, pyrite-filled burrow structures, casts of the inarticulate brachiopod Lingula sp., and pyritized and resinated spore bodies are present throughout. At 2,006.0', pyritized casts of the inarticulate brachiopod Chonetes sp. (with spines preserved) were observed.
2,016.3' - 2,027.7' (11.4')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. The siltstone units are cross-stratified and bioturbated with scour surfaces at 2,018.7' and 2,020.8'. Carbonaceous fragments, disseminated mica, pyrite nodules, and disseminated pyrite are present throughout.
2,027.7' - 2,036.3' (8.6')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Siltstone is cross-stratified with scour features at 2,030.3', 2,031.8', and 2,033.8'; several zones contain load casts. Carbonaceous fragments, zones of bioturbation, pyrite-filled and silt-filled burrow structures, and disseminated mica are present throughout. Three concretionary zones of silty mudstone (1 to 2 cm thick), light olive gray (5Y 6/1) occur within the lower 1/2. A flow structure in silty mudstone is present between 2,029.1' and 2,029.6'.
2,036.3' - 2,046.7' (10.4')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1), light olive gray (5Y 6/1), and greenish gray (5GY 6/1), thickly laminated to thin bedded. Siltstone layers, some displaying load casts, are cross-stratified and scoured at 2,036.3'. Carbonaceous fragments, pyrite-filled and silt-filled burrow structures, and disseminated pyrite are present throughout.
2,046.7' - 2,054.1' (7.4')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Siltstone is cross-stratified; some zones contain load casts. Disseminated pyrite and burrow traces are present throughout. A solution structure occurs at 2,049.4'.

INTERVAL	DESCRIPTION
2,054.1' - 2,062.1' (8.0')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. The siltstone units are cross-stratified and some contain load casts. Four concretionary zones of silty mudstone (1 to 3 cm thick) light olive gray (5Y 6/1), occur in the lower 1/2. The lowest zone is lens shaped. Burrow traces and a partially discernable trilobite carapace are present at 2,059.7'.
2,062.1' - 2,070.1' (8.0')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Carbonaceous fragments and burrow traces are present throughout. A scour surface occurs at 2,064.8'.
2,070.1' - 2,078.6' (8.5')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Plant fragments and spore casts appear throughout. Bioturbation is restricted to the siltstone units contained within the lower 1/4. A scoured surface is present at 2,077.9'.
2,078.6' - 2,086.8' (8.2')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Bioturbation occurs at the contacts between siltstone and silty mudstone. The siltstone units are cross-stratified with scour surfaces occurring between 2,080.0' and 2,083.8'. Five concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 3 cm thick, are present in the lower 1/2. Plant fragments and disseminated mica occur throughout the interval.
2,086.8' - 2,095.9' (9.1')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Two concretionary zones of silty mudstone, 1 to 2 cm thick, light olive gray (5Y 6/1), occur in the top 2'. A similar lens-shaped band is present at 2,093.5'.

INTERVAL	DESCRIPTION
2,095.9' - 2,103.6' (7.7')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thickly laminated to thin bedded. Some of the siltstone units contain load casts. A trough-crossbedding sequence occurs at 2,099.8'. Four concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 5 cm thick, occur in the interval. One zone has replaced a load cast in a siltstone lamination. A scour surface occurs at 2,097.2'. Pyritized spore bodies occur throughout.
2,103.6' - 2,111.3' (7.7')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium dark gray (N6), thickly laminated to thin bedded. Load casts and a scour surface at 2,111.5' occur within the siltstone laminations. Five concretionary zones of silty mudstone, 1 to 4 cm thick and light olive gray (5Y 6/1), occur in the lower 1/2. Carbonaceous fragments, pyritized spore bodies, and burrow traces are prevalent.
2,111.3' - 2,121.6' (10.3')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. The siltstone units are cross-stratified and some display load casts. Five concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 5 cm thick, occur. Plant fragments and disseminated mica are prevalent.
2,121.6' - 2,132.4' (10.8')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. The siltstone laminations are bioturbated; scour surfaces occur at 2,122.8' and 2,123.8'. A siltstone bed is heavily indurated between 2,127.2' and 2,127.6' and scoured at 2,132.0'. Six concretionary zones (0.5 to 3 cm thick) were observed in the lower 2/3; two are lens-shaped.
2,132.4' - 2,141.3' (8.9')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. The siltstone units are cross-stratified and bioturbated in the upper 1/2. Thirteen concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 4 cm thick, occur throughout.

INTERVAL	DESCRIPTION
2,141.3' - 2,150.0' (8.7')	Mudstone and siltstone, dark greenish gray (5G 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. Six concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 3 cm thick, are present, Carbonaceous fragments, disseminated mica and resin spore bodies occur throughout. Siltstone is weakly bioturbated and scoured at 2,143.1' and 2,148.6'; some zones display load casts.
2,150.0' - 2,157.8' (7.8')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1), and medium light gray (N6), thickly laminated to thin bedded, weakly bioturbated. Two concretionary zones of silty mudstone, light olive gray (5Y 6/1), 2 cm thick, occur in the lower 1/2. Carbonaceous fragments, disseminated pyrite crystals, and pyritized spores and burrow structures occur throughout. A well preserved fish jaw is present at 2,154.5'.
2,157.8' - 2,166.4' (8.6')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. Three concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 2 cm thick, occur in the upper 1/2. Siltstone laminations are well indurated and scoured between 2,159.7' and 2,166.3'; some display load casts and are moderately bioturbated. Disseminated pyrite crystals occur throughout.
2,166.4' - 2,176.2' (9.8')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded. A 3-cm-thick concretionary band of silty mudstone, light olive gray (5Y 6/1), is present at 2,168.5'. Siltstone laminations (from 2,167.1' to 2,169.8' and 2,174.7') are well indurated; some display load casts and scour features. Carbonaceous fragments, pyritized and resinous spore bodies, and disseminated pyrite crystals occur throughout.
2,176.2' - 2,184.5' (8.3')	Mudstone and siltstone, dark greenish gray (5G 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded. Six concretionary zones of silty mudstone (3 in the upper 1/3 and 3 in the lower 1/4) light olive gray (5Y 6/1), 2 to 5 cm thick, were observed. Carbonaceous fragments, pyrite lenses and pyrite- and silt-filled burrow structures occur throughout. Pyritized spores occur as disseminations and current lag deposits

INTERVAL	DESCRIPTION
2,176.2' - 2,184.5' (Continued)	(at 2,177.2'). Weak bioturbation occurs at the base of the siltstone laminations atop the mudstone. Scour surfaces occur between 2,175.8' and 2,177.4'.
2,184.5' - 2,193.7' (9.2')	Mudstone and siltstone, dark greenish gray (5G 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded, shaly. Some siltstone laminations are weakly to moderately bioturbated; some display load casts. Scour surfaces occur at 2,181.0' and 2,192.8'. Carbonaceous fragments, pyritized burrow structures and resinous spores occur throughout. Pyritic spore bodies occur as current lag deposits. In the upper 1/3, three concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 3 cm thick, were observed.
2,193.7' - 2,201.2' (7.5')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded, shaly. The siltstone laminations are indurated, weakly bioturbated, and scoured at 2,198.3' and 2,199.6'. Pyritic and resinous spores and carbonaceous fragments are present throughout. Disseminated ash occurs at 2,194.0'.
2,201.2' - 2,210.2' (9.0')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly laminated to thin bedded. Weakly calcareous siltstone laminae are present in the olive black (5Y 2/1) silty mudstone. Carbonaceous fragments and pyritic and resinous spores occur throughout. An irregular "mud lump" (with curviplanar slickensides) was observed on a parting at 2,205.1' (pyrite crystals coat the upper surface). The siltstone laminations are weakly bioturbated, and a scour feature occurs at 2,208.3'.
2,210.2' - 2,218.5' (8.3')	Silty mudstone, mudstone, and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly and thickly laminated to thin bedded. Weakly calcareous, moderately bioturbated siltstone laminae occur in the olive black (5Y 2/1) silty mudstone. Scour surfaces appear at 2,217.1' and 2,218.0'. Pyrite nodules, pyritic and resinous spores, and current lag deposits of pyritic spores occur throughout.

INTERVAL	DESCRIPTION
2,218.5' - 2,227.2' (8.7')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and medium light gray (N6), thickly and thinly laminated to thin bedded, shaly. Siltstone laminations are weakly to slightly calcareous downard; slightly bioturbated and weakly cross-stratified. Subhorizontal, pyritic burrow structures, pyrite nodules, and pyritic and resinous spores occur throughout. An irregular pyrite nodule (with vertical lineations) is present at 2,219.7'. A crossbedding sequence occurs in a siltstone lamination at 2,224.2' and a scour surface is present at 2,219.0'.
2,227.2' - 2,235.1' (7.9')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and medium light gray (N6), thinly laminated to thick bedded. The siltstone is weakly calcareous, weakly bioturbated, and cross-stratified, with a scour surface at 2,229.0'. Carbonaceous fragments, pyrite nodules, and pyritic and resinous spores occur throughout. Pyritized fecal pellets are present at 2,234.8'.
2,235.1' - 2,243.4' (8.3')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and medium light gray (N6), thinly laminated to thick bedded. Very slightly calcareous siltstone laminae occur in the olive black (5Y 2/1) silty mudstone. The siltstone laminations are weakly bioturbated and cross-stratified. Carbonaceous plant fragments, pyrite nodules and resinous spores occur throughout. Scour features occur at 2,238.5', 2,239.0', and 2,243.0' with upward fining silt grains.
2,243.4' - 2,252.7' (9.3')	Silty mudstone, mudstone and upward-fining siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly and thickly laminated to thin bedded. The siltstone laminations are slightly calcareous increasing to calcareous downward, and weakly bioturbated. Carbonaceous fragments, pyrite- and mud-filled burrow structures, pyrite nodules and resinous spores occur throughout. Scour surfaces occur at 2,245.5' and 2,251.0'.

INTERVAL	DESCRIPTION
2,252.7' - 2,259.9' (7.2')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly laminated to thin bedded. Calcareous siltstone laminae occur in olive black silty mudstone. The siltstone laminations are weakly bioturbated in the lower 1/3; a scour surface occurs at 2,254.5'. Pyrite nodules and resinous spores are present throughout.
2,259.9' - 2,268.7' (8.8')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly laminated to thin bedded. Calcareous siltstone laminae occur throughout the olive black silty mudstone. Resinous spores are present and a fish jaw appears at 2,262.1'.
2,268.7' - 2,276.7' (8.0')	Silty mudstone, siltstone and mudstone, olive black (5Y 2/1), medium light gray (N6) and dark greenish gray (5GY 4/1), thinly laminated to thin bedded. Calcareous siltstone laminae occur in the olive black silty mudstones. Pyrite nodules and resinous spores are present. Occasional fish scales and a scour surface at 2,269.9' were observed.
2,276.7' - 2,285.9' (9.2')	Silty mudstone, mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly laminated to thick bedded. The siltstone occurs as very thin laminations and is slightly calcareous. Two irregular pyrite nodules occur at 2,277.9' and 2,278.3'. Carbonaceous fragments, pyrite lenses, and resinous spores are present throughout.
2,285.9' - 2,294.0' (8.1')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thinly laminated to thick bedded. The siltstone laminations are calcareous and display load casts. Pyrite lenses and nodules are present throughout.
2,294.0' - 2,297.8' (3.8')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thickly laminated to thin bedded. A few carbonaceous plant fragments, pyritic and resinous spores, and disseminated ash occurrences were observed.

INTERVAL	DESCRIPTION
2,297.8' - 2,305.1' (7.3')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5GY 6/1), thickly laminated to thin bedded. Siltstone is calcareous and scoured at 2,300.4', 2,303.3', and 2,304.2'. Carbonaceous plant fragments, disseminated ash and burrow traces occur throughout. Spore casts and pyritic spores (as disseminations and current lag deposits), and a cluster of pyrite crystals are present. Pyritized fecal pellets occur at 2,299.8', 2,301.1', and 2,302.5'.
2,305.1' - 2,312.6' (7.5')	Mudstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1), thickly laminated to thick bedded. A silt bed at 2,306.3' (to 2,306.8') and a silty nodule at 2,306.3' are calcareous. Carbonaceous plant fragments and pyrite lenses are present. Pyritic fecal pellets occur at 2,305.6'; pyritic and resinous spores occur at 2,310.3'.
2,312.6' - 2,319.9' (7.3')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thickly and thinly laminated to thin bedded. Siltstone laminations are calcareous, cross-stratified, and display load casts. Carbonaceous plant fragments occur throughout. An ash bed is present at 2,316.6'.
2,319.9' - 2,328.1' (8.2')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thickly and thinly laminated. Siltstone laminae in the olive black mudstone are very slightly to slightly calcareous downward. Carbonaceous plant fragments occur throughout. Pyritic spores appear as mats at 2,320.6' and 2,321.6'. A weak scour surface was observed at 2,320.4'.
2,328.1' - 2,336.6' (8.5')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thinly laminated to thin bedded. Some siltstone laminations are slightly calcareous and some display load casts. Slightly calcareous siltstone laminae occur in the upper 2/3 of the olive black mudstone. Carbonaceous fragments, spore casts, and pyritic spores are present throughout. Scour surfaces occur at 2,328.2', 2,328.3', and at 2,333.9'.
2,336.6' - 2,345.4' (8.8')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thinly laminated to thin bedded. Some siltstone laminations are slightly calcareous. Carbonaceous plant fragments, pyritic burrow structures, pyritic spores, and disseminated pyrite crystals occur throughout. An unidentified massive yellowish mineral (2 mm diam) is present at 2,338.0'. A scour surface occurs at 2,343.2'.

INTERVAL	DESCRIPTION
2,345.4' - 2,353.0' (7.6')	Mudstone, slightly silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thickly and thinly laminated to thin bedded. A 5-cm-thick concretionary zone of silty mudstone, light olive gray (5Y 6/1), is present; carbonaceous fragments, burrow traces, and spore casts are prevalent. Other features noted are: a weakly bioturbated siltstone lamination at 2,347.3'; pyritized fecal pellets and fish scales at 2,346.9' and 2,347.5'; pyritic plant fragments at 2,349.8'; and a scour surface at 2,350.5'.
2,353.0' - 2,362.6' (9.6')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thinly laminated to thin bedded. Two siltstone laminations are very slightly calcareous. Carbonaceous fragments, burrow traces and spore casts are present throughout. Other features noted are a 1-cm-long (shark?) tooth at 2,353.1' and a scour surface at 2,361.3'.
2,362.6' - 2,370.1' (7.5')	Mudstone, silty mudstone and thinly laminated siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and light gray (N7), thickly laminated to thin bedded. Three concretionary zones of silty mudstone, light olive gray (5Y 6/1), 6 cm thick, are evenly spaced throughout. Carbonaceous fragments and pyritic spores are prevalent. A scour surface is present at 2,365.0'.
2,370.1' - 2,377.9' (7.8')	Mudstone and silty mudstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1), thickly laminated to thick bedded. A few thin laminations of siltstone, light gray (N7) are present in the lower 1/2. One concretionary band of silty mudstone, light olive gray (5Y 6/1), 3 cm thick, is present at 2,373.0'. A single carbonaceous wood fragment (2 cm long) occurs at 2,377.6'.
2,377.9' - 2,385.6' (7.7')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and light gray (N7), thinly laminated to thick bedded. Three concretionary zones of silty mudstone, light olive gray (5Y 6/1), 2 to 5 cm thick, occur in the upper 1/2. Siltstone displays load casts at 2,382.8' and is weakly bioturbated in the lower 1/3. Other features noted are: a scour surface at 2,383.8'; pyritic burrow structures, lenses, and disseminated crystals below 2,384.6'; a cluster of pyrite crystals at 2,385.1'; conodont remnants and pyritic spores (disseminations and current lag deposits) at 2,385.3'.

INTERVAL	DESCRIPTION
2,385.6' - 2,395.6' (10.0')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thinly laminated to thin bedded. Numerous calcareous siltstone laminae (weakly bioturbated) occur in the olive black mudstone in the lower 1/2. Several lenses of calcite/pyrite, carbonaceous wood fragments, spore casts, and pyritized spores are present. Fish teeth occur at 2,387.3', a point that marks the top of a "Foerstia" marine algal zone. Algae are widespread, occur singly and in beds, and are approximately 1 mm in diameter. A pyrite nodule (fecal pellet?) outlined by slickensides, occurs at 2,387.4'. A few pyritized burrow structures occur below 2,394.6' and a piece of vitrinite (1 cm wide, 6 cm long) is present at 2,394.9'.
2,395.6' - 2,405.9' (10.3')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thick bedded, shaly in the lower 1/2. A cross-stratified siltstone bed at 2,401.1' has a basal scour surface. Some siltstone laminations are weakly bioturbated. Siltstone/pyrite lenses occur at 2,399.1' to 2,399.4'. Pyritized burrow structures, pyrite lenses, pyritized spores (as disseminations and in current lag deposits) and Foerstia algae occur throughout. Pyritized fecal pellets are present at 2,397.9'. A size increase from 1 mm to 4 - 5 mm diam in the Foerstia occurs at 2,402.3'.
2,405.9' - 2,415.5' (9.6')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded, shaly. Foerstia algae, spore casts and pyritized spores, pyritized burrow structures, clusters of pyrite crystals, and carbonaceous fragments are present in the lower 1/2. A scour surface occurs at 2,413.9'.
2,415.5' - 2,425.9' (10.4')	Shaly mudstone, silty shale, and silty mudstone, dark greenish gray (5GY 4/1) and olive black (5Y 2/1), thickly laminated to thin bedded. Six concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 to 3 cm thick, occur in the upper 1/2. Pyrite lenses and pyritized spores along with carbonaceous fragments and Foerstia algae occur throughout.
2,425.9' - 2,435.6' (9.7')	Shaly mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated; minor bioturbation in siltstone laminations. Foerstia algae, spore casts, and pyritized spores are present throughout.

INTERVAL	DESCRIPTION
2,435.6' - 2,441.8' (6.2')	Shaly mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. A single lamination of siltstone at 2,437.6' is calcareous. Foerstia algae beds, spore casts and pyritized spores occur throughout.
2,441.8' - 2,451.6' (9.8')	Shaly mudstone and silty mudstone, dark greenish gray (5GY 4/1) and olive black (5Y 2/1), thickly laminated. Very thin laminations of calcareous siltstone occur in the lower 1/3 of the olive black silty mudstone. Carbonaceous fragments, spore casts and pyritized spores, and Foerstia algae are present throughout.
2,451.6' - 2,460.7' (9.1')	Mudstone, silty mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. A few siltstone laminations are calcareous and occur in the olive black silty mudstones. Spore casts, pyritized burrow structures and Foerstia algae occur throughout. One piece of vitrinite is present at 2,459.1'. Scour surfaces are present at 2,458.9' and 2,459.7'.
2,460.7' - 2,471.6' (10.9')	Mudstone and siltstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated. A few siltstone laminations are calcareous and occur in the lower 1/3 of the olive black mudstone. Carbonaceous fragments, spore casts and pyritized spores, and Foerstia algae occur throughout.
2,471.6' - 2,475.5' (3.9')	Mudstone and silty mudstone, dark greenish gray (5GY 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated. Calcareous siltstone laminae occur in the olive black silty mudstone. Pyrite nodules, spore casts and Foerstia occur throughout.
2,475.5' - 2,485.0' (9.5')	Mudstone, olive black (5Y 2/1) and dark greenish gray (5GY 4/1), thickly laminated to thin bedded. Calcareous siltstone laminae occur throughout the upper 1/2 of the olive black mudstone zones. Spore casts are present throughout. Occasional pyritized burrow structures occur near the middle of the interval. Foerstia algae decrease below 2,481.0'.
2,485.0' - 2,493.8' (8.8')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and light gray (N7), thickly laminated to thin bedded. Some of the siltstone laminations are calcareous. Occasional pyrite burrow

INTERVAL	DESCRIPTION
2,485.0' - 2,493.8' (Continued)	structures occur in the lower 1/4. Resinous spores and spore casts and small carbonaceous wood fragments occur throughout. A fecal pellet (with slickensided circumference) is present at 2,492.7'. The last Foerstia bed in the interval occurs at 2,486.9'.
2,493.8' - 2,503.5' (9.7')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thickly laminated to thin bedded. A few siltstone laminations are calcareous. A dolomite lens (with minor pyritic inclusions) is present at 2,494.4'. Carbonaceous fragments, pyritized spores and spore casts are present throughout. The Foerstia algae zone ends at 2,499.8'.
2,503.5' - 2,511.2' (7.7')	Mudstone, olive black (5Y 2/1) and dark greenish gray (5GY 4/1), thickly laminated. Two siltstone beds are weakly cross-stratified. Carbonaceous fragments, resinous and pyritic spores, and pyritic fecal pellets are present. A scour surface occurs at 2,505.6' and a single fish scale at 2,510.7'.
2,511.2' - 2,520.5' (9.3')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and greenish gray (5G 6/1), thickly laminated to thin bedded. Pyrite- and silt-filled burrow structures, resinous spores and disseminated pyrite occur throughout. The siltstone beds and laminae are calcareous. Scour surfaces occur at 2,511.4' and 2,519.8'.
2,520.5' - 2,529.6' (9.1')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and medium light gray (N6), thickly laminated to thin bedded. Siltstone laminae are calcareous in the lower two feet. Pyrite lenses, pyritic burrow structures, pyritic spores and spore casts, carbonaceous fragments and occasional pyritic wood fragments occur throughout. One fragment at 2,525.2' is leaf shaped. Vitrinite fragments occur at 2,526.9' (bark of tree) and 2,527.8', and pyritic fecal pellets at 2,524.2'. A scour surface is present at 2,528.2'.
2,529.6' - 2,537.4' (7.8')	Mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and greenish gray (5G 6/1), thickly laminated to thin bedded. The siltstones are slightly calcareous. Pyrite lenses, pyritized burrow structures, and pyritic and resinous spores occur throughout. A vitreous wood fragment appears at 2,334.1' and scour surfaces are present at 2,530.0' and 2,533.7'.

INTERVAL	DESCRIPTION
2,537.4' - 2,547.9' (10.5')	Mudstone, olive black (5Y 2/1), thick bedded with occasional thick laminations of dark greenish gray (5G 4/1) mudstone. Calcareous siltstone laminae occur throughout the olive black (5Y 2/1) mudstone. Carbonaceous fragments, silt- and pyrite-filled burrow structures, and pyritic and resinous spores occur throughout. A large crystalline pyrite nodule was observed at 2,539.4'. Three well preserved fish jaws and a single fish scale are present.
2,547.9' - 2,556.8' (8.9')	Mudstone, olive black (5Y 2/1), thick bedded. Two thick laminations of dark greenish gray (5G 4/1) mudstone are present. Calcareous siltstone laminae occur throughout the olive black mudstone. Carbonaceous fragments, pyrite nodules, pyritized burrow structures, and fish jaws are present throughout. A vitrinite fragment (3 mm thick) appears at 2,549.3'.
2,556.8' - 2,565.6' (8.8')	Mudstone and silty mudstone, olive black (5Y 2/1) and dark greenish gray (5G 4/1), thickly laminated to thin bedded. One concretionary zone of silty mudstone, light olive gray (5Y 6/1), 3 cm thick, occurs at 2,564.1'. Weak mottling is present at 2,562.0' at the contact of the olive black and dark greenish gray zones. Pyritized and silt-filled burrow structures, pyrite lenses, pyritized spores and aggregates of pyrite crystals occur throughout. Occasional fish teeth are present.
2,565.6' - 2,575.6' (7.8')	Mudstone and siltstone, dark greenish gray (5G 4/1), olive black (5Y 2/1) and medium light gray (N6), thickly laminated to thin bedded. A calcareous siltstone bed occurs at 2,567.0'. Pyrite lenses and pyritized burrow structures are present throughout.
2,575.6' - 2,583.4' (7.8')	Mudstone, silty mudstone and siltstone, dark greenish gray (5G 4/1), olive black (5Y 2/1) and medium light gray (N6), thinly laminated to thin bedded. Pyrite lenses are spaced approximately 0.1' apart in the upper 1/2 extending to approximately one foot in the lower 1/2. The siltstone laminae in the upper 1/2 are weakly bioburbated. Carbonaceous fragments, pyritized burrow structures, pyritized spores and spore casts occur throughout. A vitrinite fragment is present at 2,579.2' and fish scales occur at 2,581.6'.

INTERVAL	DESCRIPTION
2,583.4' - 2,593.5' (10.1')	Mudstone and silty mudstone, olive black (5Y 2/1), dark greenish gray (5G 4/1), thin to thick bedded. A single siltstone lamination is calcareous. Vitreous wood fragments occur in the lower 1/2. Pyrite nodules and pyritized burrow structures are present throughout.
2,593.5' - 2,602.1' (8.6')	Silty mudstone and mudstone, dark greenish gray (5G 4/1), olive black (5Y 2/1), thickly laminated to thick bedded. Disseminated pyrite, pyrite lenses and pyritized burrow structures occur in the lower 2' of the dark greenish gray silty mudstones. Vitreous wood fragments are prevalent. Weak mottling is present in a rubblized zone at 2,598'.
2,602.1' - 2,610.8' (8.7')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), dark greenish gray (5G 4/1) and medium light gray (N6), thinly laminated to thin bedded. The siltstone laminations and olive black mudstones are calcareous. Disseminated pyrite, pyrite lenses and pyritized burrow structures are present in the upper 1/2; vitreous and partially pyritized wood fragments occur in the lower 1/3. Two concretionary zones of silty mudstone, light olive gray (5Y 6/1), 1 cm thick, occur at 2,606.2' and 2,607.1'. Scour surfaces are located at 2,607.9' and 2,608.8'. Burrow structures at 2,604.6' are pyrite-lined with gypsum-anhydrite centers.
2,610.8' - 2,618.5' (7.7')	Silty mudstone, olive black (5Y 2/1), thick bedded. Two laminae (0.5 cm thick) of silty mudstone, dark greenish gray (5G 4/1) and occasional laminae of silty mudstone, olive gray (5Y 4/1) are present. Pyrite lenses (<1 mm thick) and vitrinite fragments occur in the upper 1/2. Spore casts and fish scales occur throughout.
2,618.5' - 2,627.9' (9.4')	Silty mudstone, olive black (5Y 2/1), thick bedded. Occasional thick laminations of dark greenish gray (5G 4/1) and olive gray (5Y 4/1) silty mudstone are present. The interval is strongly contaminated with drill pipe-joint lubricant. Vitreous wood fragments are contained in the upper 1/2. A large pyritized coprolite (0.2' diameter, 1 cm thick) occurs at 2,621.6'.
2,627.9' - 2,636.5' (8.6')	Mudstone and silty mudstone, olive black (5Y 2/1), dark greenish gray (5GY 4/1) and greenish gray (5G 6/1), thickly laminated to thin bedded. Scour surfaces occur at the base of thin siltstone beds at 2,633.4' and 2,633.7'. Weak bioturbation at the olive black and

INTERVAL	DESCRIPTION
2,627.9' - 2,636.5' (Continued)	dark greenish gray contacts increase to moderate mottling at 2,630.7'. Thin pyrite lenses (<1 mm thick) occur throughout. Occasional pyritized burrow structures, pyritized wood fragments, carbonaceous wood fragments and spore casts are present. A vitrinite fragment (of bark (?)) was observed at 2,630.7'. A small "mud lump" occurs at 2,633.2'. Disseminated pyrite crystals and burrow traces are located below 2,634.0'.
2,636.5' - 2,645.8' (9.3')	Mudstone, olive black (5Y 2/1) and greenish gray (5G 6/1), thickly laminated to thick bedded, shaly in the lower 1/2. Moderate bioturbation (mottled blocks up to 2 cm wide, 5 cm long) occurs at the greenish gray - olive black contacts. Occasional pyrite lenses, carbonaceous fragments, burrow traces and pyritized burrow structures occur in the upper 1/2. Circular pyrite nodules (3 mm diam) and clusters of disseminated pyrite crystals are present. A vitrinite fragment is located at 2,636.5'; a poorly-preserved coiled cephalopod is at 2,640.2'. A poorly-preserved nautoloid (?) is at 2,242.9', and well-preserved conodonts (attached upper and lower jaws and teeth) are present at 2,645.1'.
2,645.8' - 2,655.5' (9.7')	Mudstone, silty mudstone and siltstone, greenish gray (5G 6/1), olive black (5Y 2/1) and greenish gray (5G 6/1). The upper 1/2 is thick bedded, the lower 1/2 is thickly laminated; disseminated mica is present. Slightly calcareous siltstone beds occur at 2,649.3' and 2,650.9'. Weak bioturbation occurs at the green-black contacts, with extreme mottling between 2,647.3' and 2,649.0'. Vitrinite fragments occur at 2,649.3' and 2,652.6' (cross-section of a branch and bark). A "mud lump" occurs at 2,652.8'.
2,655.5' - 2,665.2' (9.7')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), and greenish gray (5G 4/1), thickly laminated to thin bedded. Moderate bioturbation and occasional pyrite lenses occur at the green-black contacts. Disseminated mica, carbonaceous fragments, and resinous spore bodies are present. Calcareous siltstone laminations occur at 2,656.0' and 2,658.0', and a vitrinite fragment (1/2 diam of the core) at 2,658.8'. A well-preserved set of conodonts (upper and lower jaws) is present at 2,656.1', and a scour surface is noted at 2,659.8'.

INTERVAL	DESCRIPTION
2,665.2' - 2,674.9' (9.7')	Silty mudstone and mudstone, greenish gray (5G 6/1), and olive black (5Y 2/1), thickly laminated to thick bedded. Two laminations of olive gray (5Y 4/1) silty mudstone are in the lower 1/2. The green units in the upper 1/2 are very slightly calcareous and contain large bioturbation features (up to 1 cm wide, 2 cm long), mostly pyritized and weakly mottled. Moderate mottling is present at the greenish gray - olive black contacts in the lower 1/2. Disseminated pyrite and pyrite lenses occur throughout. A large vertical fracture runs through the interval with pyrite nodules (1 to 2 cm diam) captured in the plane. A set of conodonts is present at 2,670.3' and a vitrinite fragment (2/3 diam of core) is at 2,673.5'.
2,674.9' - 2,682.7' ((7.8')	Mudstone, silty mudstone and siltstone, olive black (5Y 2/1), greenish gray (5G 6/1) (upper 1/2) to olive gray (5Y 4/1) (lower 1/2), and light olive gray (5Y 5/2). The upper siltstone bed contains a grayish olive (10Y 4/2) streak. The lower siltstone bed is medium light gray (N6). The interval is thick bedded throughout and thickly laminated in the lower 1/2. Weak mottling occurs at the greenish gray - olive black contacts. Pyritized burrow structures (1.5 cm diam) are present in the upper and lower 1/4. Carbonaceous wood fragments, resinous plant spores and spore casts occur in the lower 1/3. A "mud lump" was observed at 2,678.1' and a scour surface at 2,682.6'.
2,682.7' - 2,691.0' (8.3')	Mudstone, occasionally slightly silty, greenish gray (5G 6/1) and olive black (5Y 2/1), thickly laminated to thin bedded, shaly in the lower 1/2. Pyritized burrows occur in the upper 1'. Pyrite lenses occur at the green-black contacts throughout. Occasional pyritized wood fragments are present in the mid-section. Carbonaceous fragments, resinous spores and spore casts, and disseminated mica (in the olive black zones) occur in the lower 1/2.
2,691.0' - 2,700.0' (9.0')	Mudstone, occasionally silty, olive black (5Y 2/1), olive gray (5Y 4/1), dark greenish gray (5G 4/1) and greenish gray (5G 6/1), thickly laminated to thick bedded. Weak mottling occurs at the dark greenish gray - olive black and olive gray - olive black contacts. Pyrite nodules are present in the olive black zones. Vitreous and carbonaceous fragments were observed in the upper 1/4 and disseminated mica in the lower 1/2. Occasional fish scales occur in the lower 1/4.

INTERVAL	DESCRIPTION
2,700.0' - 2,709.9' (9.9')	Slightly silty mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thick bedded. Mottling at the olive gray - olive black contacts increases downward from weak to moderate. Occasional pyritized burrow structures occur in the lower 2/3, along with carbonaceous films and fragments. A vitrinite fragment (3 cm into the core) was observed at 2,708.9'.
2,709.9' - 2,719.7' (9.8')	Slightly silty mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thick bedded. The olive gray fades downward to light olive gray (5Y 5/2). Three thin olive gray units are calcareous. Occasional pyrite nodules (0.5 cm diam) and carbonaceous films are present throughout. Resinous plant spores occur in the lower 1/2, with carbonaceous fragments in the lower 1/4.
2,719.7' - 2,727.6' (7.9')	Slightly silty mudstone, olive black (5Y 2/1), olive gray (5Y 4/1) and greenish gray (5GY 6/1), thickly laminated to thick bedded. Moderate mottling occurs at the greenish gray - olive black contacts. Pyritized burrow structures are present in the olive black zones. Carbonaceous fragments occur throughout. One fragment appears as a 'frond' at 2,722.1'. A vitrinite fragment (2 cm into the core) with dolomite-filled fractures is present at 2,722.6'. Resinous plant spores occur in the lower 1/3.
2,727.6' - 2,737.8' (10.2')	Slightly silty mudstone changing downward to mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thin bedded. A silty bed at 2,731.2' is calcareous and contains a zone of resinous plant spores and conodont remnants. Occasional pyrite nodules occur throughout. A subvertical dolomite-/pyrite-filled fracture (0.3' long), associated with a vitrinite fragment containing dolomite-filled fractures, occurs at 2,735.7'.
2,737.8' - 2,747.6' (9.8')	Mudstone, olive black (5Y 2/1) and olive gray (5Y 4/1), thickly laminated to thick bedded. The olive gray units occur in mottled zones. Occasional pyritic burrow structures and resinous plant spores are present. A very thin calcareous zone (<1 mm thick) occurs at 2,738.0' and a vitrinite fragment with dolomite-filled fractures is present at 2,741.9'.

INTERVAL	DESCRIPTION
2,747.6' - 2,756.8' (9.2')	Mudstone, olive black (5Y 2/1), olive gray (5Y 4/1) and greenish gray (5G 6/1), thickly laminated to thin bedded. Moderate mottling occurs at the greenish gray - olive black contacts. Carbonaceous fragments and occasional pyrite nodules are present. A single inarticulate brachiopod, Lingula sp., occurs at 2,756.2'.
2,756.8' - 2,763.4' (6.6')	Mudstone (slightly silty), olive black (5Y 2/1) and dark greenish gray (5G 4/1), thickly laminated to thick bedded. The dark greenish gray silty mudstones are moderately mottled and the olive black units contain occasional pyrite nodules. Occasional shell fragments of inarticulate brachiopods (Lingula) are present. A vitrinite fragment (1.5 cm into the core) occurs at 2,756.8'.
2,763.4' - 2,769.8' (6.4')	Mudstone (slightly silty), olive black (5Y 2/1) and dark greenish gray (5G 4/1), thickly laminated to thick bedded. The olive black unit is moderately mottled in the upper 1'. Resinous plant spores, occasional pyrite nodules, and one thin calcareous lens were observed. Two vitrinite fragments (each 3 cm into the core) occur at 2,765.1' (with dolomite-filled fractures) and 2,769.3'. A single inarticulate brachiopod Lingula occurs at 2,768.9'.
2,769.8' - 2,775.4' (5.6')	Mudstone, olive black (5Y 2/1) and dark greenish gray (5G 4/1), thickly laminated to thick bedded; the dark greenish gray units are weakly mottled. Occasional pyritized burrow structures are present; carbonaceous films occur in the lower 1/2. A vitrinite fragment (2 cm into the core) appears at 2,770.1'. A calcareous zone exists between 2,771.0' and 2,771.8'.

DETAILED LITHOLOGIC DESCRIPTION

EGSP - OHIO #6/5

GALLIA COUNTY

INTERVAL	DESCRIPTION
1,660.0' - 1,669.2' (9.2')	Mudstone, silty mudstone, fine sandstone, and siltstone, dark greenish gray (5GY 4/1), medium dark gray (N4), pale yellowish brown (10YR 6/2), and medium gray (N5), thickly laminated to thick bedded. The upper three feet of the interval contains two upward-fining sandstone beds (6 - 15 cm thick), resting on scour surfaces and containing oil shows. A micaceous zone occurs at the top of the upper sandstone unit. Scour surfaces and pyrite lenses occur at the contacts of the cross-laminated siltstone and silty mudstone zones from 1,662.3' to 1,664.6'. Numerous fossils occur in the dark greenish gray (5GY 4/1) mudstones in the lower 1/2. These include casts of inarticulate brachiopods (Orbiculoidea sp.?), and articulate brachiopods (Chonetes sp.?), (Ptychospira sp.), and (Camarotochia sp.?). Two pale yellowish brown (10YR 6/2), concretionary bands (2 cm thick) occur at 1,664.0' and 1,664.5'.
1,669.2' - 1,676.4' (7.2')	Mudstone, greenish black (5G 2/1), thick bedded. Several pyrite nodules and pyritized shell fragments occur in the lower two feet of the interval. A fossil concentration, including conodonts, fish scales and teeth, skeletal fragments, and pyritized spore bodies, occurs at 1,675.9'.
1,676.4' - 1,682.8' (6.4')	Mudstone, greenish black (5G 2/1), and olive black (5Y 2/1), thick bedded. A pyrite-filled fracture (7 cm long) occurs from 1,680.9' to 1,681.2'. Two poorly preserved pyritized gastropods (?) were observed at 1,679.6' and 1,680.1', and a cast of an inarticulate brachiopod was observed at 1,680.0'. A fossil concentration, including conodonts, fish scales and teeth, and shell fragments occurs at 1,681.0'. Carbonaceous plant fragments and pyrite nodules occur throughout.
1,682.8' - 1,692.7' (9.9')	Mudstone and siltstone, greenish black (5G 2/1), and medium dark gray (N4), thickly laminated to thick bedded. A calcareous siltstone lamina (ripple-marked and cross-laminated) rests on a scour surface at 1,683.5'. Several calcareous pyrite laminae occur through the lower 1/2 of the interval. Two zones of fossil concentration, including conodonts, pyritized spore bodies, fish teeth and scales, and shell fragments occur at 1,683.6' and 1,687.5'. Inarticulate brachiopods (genus Lingula?) were observed at 1,684.0' and 1,688.8'. Carbonaceous plant fragments and pyrite nodules occur throughout.
1,692.7' - 1,703.0' (10.3')	Mudstone, greenish black (5G 2/1), and olive black (5Y 2/1), thick bedded. Calcareous pyrite laminae occur in the greenish black (5G 2/1) mudstone. The upper 1/2 of the interval contains an inarticulate brachiopod (genus Lingula?) and articulate brachiopods (Chonetes sp.?). Pyrite nodules and carbonaceous plant fragments occur throughout. Resinous spore bodies are present throughout the lower 2/3 of the interval.

INTERVAL	DESCRIPTION
1,703.0' - 1,712.6' (9.6')	Mudstone, greenish black (5G 2/1) and olive black (5Y 2/1), thick bedded. Zones of fossil concentration including conodonts, fish scales, shell fragments, and pyritized spore bodies occur at 1,707.1', 1,708.1', and 1,712.4'. Carbonaceous plant fragments, pyrite nodules and lenses, and resinous spore bodies are present throughout the interval.
1,712.6' - 1,717.7' (5.1')	Mudstone, silty mudstone, and siltstone, dark greenish gray (5G 4/1), greenish black (5G 2/1), and medium gray (N5), thickly laminated to thin bedded. Mudstone occurs in repeated beds of dark greenish gray (5G 4/1) grading upward to greenish black (5G 2/1). The limits of each bed are defined by sharp contacts. Siltstone and silty mudstone rest on sharp scour surfaces, display ripple marks and cross laminations, and appear to fine upward. Pyritized spore bodies and disseminated pyrite occur throughout.
1,717.7' - 1,940.0' (22.3')	This interval was plug drilled.
1,940.0' - 1,947.3' (7.3')	Mudstone and siltstone, greenish black (5G 2/1), dark greenish gray (5G 4/1), and medium light gray (N6), thinly laminated to thin bedded. Mudstone in the upper 1/2 of the interval occurs in repeated beds of dark greenish gray (5G 4/1) grading upward to greenish black (5G 2/1). Sharp contacts define the limits of each bed. Cross-laminated siltstones rest on scour surfaces. Two zones of calcareous, silty stringers occur in greenish black (5G 2/1) mudstone from 1,940.7' to 1,940.8', and from 1,945.8' to 1,947.0'. Two pyrite nodules (1 x 3 cm) surrounded by deformed bedding occur at 1,945.1'. Pyritized spore bodies appear throughout the interval.
1,947.3' - 1,955.7' (8.4')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5G 4/1), greenish gray (5GY 6/1), and medium light gray (N6), thinly laminated to thin bedded. Silty mudstone rests on scour surfaces and is cross laminated; it grades upward in repetitive sequences, through dark greenish gray (5G 4/1) mudstone to greenish black (5G 2/1) mudstone. Two zones of calcareous silty laminae occur in greenish black (5G 2/1) mudstone in the lower 1/2 of the interval. A pyrite lens (6 x 0.5 cm) occurs at 1,947.8', and a zone of spherical (3 mm diam) pyrite nodules occurs at 1,953.05'. Pyritized spore bodies appear throughout.

INTERVAL	DESCRIPTION
1,955.7' - 1,962.8' (7.1')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and greenish gray (5GY 6/1), thickly laminated to thin bedded. Silty mudstone (<1 cm to 3 cm) rests on scour surfaces and is cross laminated. Resinous spore bodies occur throughout the interval. A solution surface, with ∿0.5 cm relief, is present at 1,958.2'.
1,962.8' - 1.970.4' (7.6')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5G 4/1), and greenish gray (5GY 6/1), thickly laminated to thin bedded. Silty mudstone rests on scour surfaces and is cross laminated. A zone of calcareous silty laminae occurs in a greenish black (5G 2/1) mudstone from 1,965.7' to 1,967.4'. Resinous spore bodies occur throughout.
1,970.4' - 1,979.0' (8.6')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thick bedded. Two zones of calcareous silty laminae occur in greenish black (5G 2/1) mudstone from 1,973.3' to 1,973.8', and from 1,976.2' to 1,977.1'. Resinous spore bodies occur throughout. Carbonaceous fragments increase in frequency toward the base of the interval. A fossil concentration, containing fish scales and conodonts, occurs at 1,979.5'. Several small (3 - 5 mm) pyrite nodules are present at 1,978.2'.
1,979.0' - 1,987.9' (8.9')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5G 4/1), and medium light gray (N6), thinly laminated to thick bedded. Silty mudstone is present as several thin laminae in the lower two feet of the interval. A fossil concentration, containing fish scales and conodonts, occurs at 1,981.2'. Carbonaceous fragments and resinous spore bodies are present throughout.
1,987.9' - 1,995.6' (7.7')	Mudstone and silty mudstone, greenish black (5G 2/1), dark greenish gray (5GY 4/1), and medium light gray (N6), thickly laminated to thick bedded. The silty mudstones are cross laminated, rest on scour surfaces, and grade upward to dark greenish gray (5GY 4/1) mudstone. A calcareous silty mudstone unit occurs at 1,993.2'. Resinous spore bodies, carbonaceous fragments, and a few pyritized spore bodies occur throughout. Bitumens were observed at 1,989.4' and 1,990.5'.
1,995.6' - 1,998.6' (3.0')	Mudstone, greenish black (5G 2/1) and dark greenish gray (5GY 4/1), thickly laminated to thin bedded. A zone of calcareous silty laminae occurs in greenish black (5G 2/1) mudstone from 1,997.2' to 1,997.8'. Carbonaceous fragments and pyritized spore bodies appear throughout the interval.

INTERVAL	DESCRIPTION
1,998.6' - 2,440.0' (441.4')	This interval was plug drilled.
2,440.0' - 2,445.6' (5.6')	Mudstone, brownish black (5YR 2/1) and grayish olive green (5GY 3/2), thin bedded. Alternating beds of brownish black (5YR 2/1) and grayish olive green (5GY 3/2) mudstone are sharply defined in the upper 1/2 and less distinct in the lower 1/2 of the interval. Lime filled burrow structures occur in grayish olive green (5GY 3/2) mudstone from 2,443.2' to 2,443.8'. A cast of a cephalopod (?) fragment (1.5 x 3 cm) is present at 2,443.35', and some unidentified fossil imprints occur at 2,444.1'. A thin pyrite lamina (1 mm) occurs in the brownish black (5YR 2/1) mudstone at 2,444.75'.
2,445.6' - 2,453.0' (7.4')	Mudstone and lime mudstone, dark greenish gray (5G 4/1), greenish black (5G 2/1), and greenish gray (5GY 6/1), thickly laminated to thin bedded. The interval is moderately mottled. A lenticular-shaped calcareous concretion (2 x 5 cm) surrounded by pyrite occurs at 2,447.4'. Several pyrite nodules (>1 cm) were observed in the upper 1/2 of the interval, and disseminated pyrite occurs throughout. A vertical flow structure (?) occurs in a greenish gray (5GY 6/1) limey mudstone from 2,451.5' to 2,451.9'.
2,453.0' - 2,460.0' (7.0')	Mudstone, lime mudstone, and silty mudstone, dark greenish gray (5G 4/1), greenish gray (5GY 6/1), and olive black (5Y 2/1), thickly laminated to thin bedded. The interval is strongly mottled with burrow structures throughout. A greenish gray (5GY 6/1) limey mudstone occurs from 2,455.2' to 2,455.7'. Several silty mudstone laminae with pyrite occur in olive black (5Y 2/1) mudstone from 2,456.6' to 2,457.5'.
2,460.0' - 2,468.0' (8.0')	Mudstone, dark greenish gray (5G 4/1), and brownish black (5YR 2/1), thickly laminated to thin bedded. The interval is strongly mottled, and burrow structures are present throughout. Pyrite nodules and pyritic and resinous spore bodies occur in the brownish black (5YR 2/1) mudstone.
2,468.0' - 2,475.0' (7.0')	Mudstone and limey mudstone, dark greenish gray (5G 4/1), greenish gray (5GY 6/1), and brownish black (5YR 2/1), thickly laminated to thin bedded. The interval is strongly mottled with burrow structures throughout. A lenticular shaped (1 x 6 cm) greenish gray (5GY 6/1) lime mudstone occurs at 2,469.6'. Pyrite nodules and pyritic and resinous spore bodies occur in the brownish black (5YR 2/1) mudstone.

INTERVAL	DESCRIPTION
2,475.0' - 2,482.0' (7.0')	Mudstone, greenish gray (5GY 6/1), dark greenish gray (5G 4/1), and brownish black (5YR 2/1), thickly laminated to thin bedded, strongly mottled. Burrow structures are present throughout. Pyrite nodules, resinous spore bodies, and a few carbonaceous plant fragments occur in the brownish black (5YR 2/1) mudstones.
2,482.0' - 2,490.0' (8.0')	Mudstone and lime mudstone, greenish gray (5GY 6/1), dark greenish gray (5G 4/1), and brownish black (5YR 2/1), thickly laminated to thin bedded. The interval is strongly mottled with burrow structures present throughout. A zone of lime mudstone and mudstone with lime filled burrow structures occurs from 2,484.4' to 2,485.5'. Pyrite nodules (<0.5 cm) and pyritized spore bodies occur in the brownish black (5YR 2/1) mudstone.
2,490.0' - 2,498.3' (8.3')	Mudstone, lime mudstone, and silty mudstone, dark greenish gray ((5G 4/1), greenish gray (5GY 6/1), brownish black (5YR 2/1), and light olive gray (5Y 6/1), thickly laminated to thin bedded. The interval is strongly mottled with lime filled burrow structures present in the greenish gray (5GY 6/1) mudstones. Pyrite nodules and pyritized spore bodies occur in the brownish black (5YR 2/1) mudstones. A light olive gray (5Y 6/1) silty mudstone, which occurs from 2,497.0' to 2,497.35', rests on a sharp scour surface and fines upward. A few carbonaceous plant fragments appear throughout.

APPENDIX B

SYMBOLS, TERMS, AND ABBREVIATIONS USED IN FRACTURE LOGGING

Appendix B

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

   (P): Planar
   (CP): Curviplanar

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

   (CI): Coring Induced

   PF (Petal Fracture): An oblique fracture, usually planar or slightly curviplanar, 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 with 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. FRACTOGRAPHIC FEATURES:

Orig. (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.

Fn. 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 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.

(TAL): 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-OHIO #6 SERIES

FRACTURE LOGS

EGSP-OHIO #6/1

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

CORING DATE: SEPT. 79
LOG DATE: APR. 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/1 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Natural

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1817.9 1818.0	0.1'	MOST. GRN. BLK. (5G 2/1) SLTY. MOST. DK GRN GY (5G 3/1)	?→ m	P-CP	SEE COMMENTS	N	FLT.		PRESENT		NON-ORIENTED
2	1826.3 1827.2	1.1'	SLTST. MED. LT. GRY (N6)	BDG →	P	N47°E ~90°		SPL. JT.			CS. TW. HKL.	
3	1829.1 1830.2	0.1'	SLTY. MOST., DK. GRN GRY (5GY 4/1)	↙↗	P	N60°W 42°NE		FLT.		40° N30°E		~2 mm DISPLACEMENT
4	1830.1 1830.2	0.1'	A/A	?m F.3	P-CP	N60°W 15°SW		FLT.		14° S20°W		
5	1833.5 1833.6	0.1'	MOST. GRN BLK. (5G 2/1) SLTY. MOST., DK GRN GRY	?↗ ↙	P	N41°E ~90°		SPL. JT.				
6	2329.2 2329.2	3.0'	MOST., BRN. BLK. (5YR 2/1)	PFC m	P	N44°E 89NW		SPL. JT.				POSSIBLE TAL. ABUTTING PFC.
7	2342.9 2348.0	5.1'	MOST. BRN BLK (5YR 2/1) DL. GRY. (5Y 4/1)	?→ →	P	N58°E ~90°		SPL. JT.			FN. HKL. PLM.	NUMEROUS PETALS ABUTTING FRAC.
8	2447.6 2450.7	3.1'	MOST., BRN. BLK (5YR 2/1)	?→ →	P	N54°E ~90°		SPL. JT.				
9	2449.1 2451.1	2.0'	A/A	→ PF	P	N61°E ~90°		SPL. JT.				
10	2455.2 2457.7	1.5'	MOST. DL. BLK. (5Y 2/1) DL. GRY. (5Y 4/1)	?→ →	P	N51°E ~90°		CPD. JT.				PARALLEL JTS.
11	2456.7 2458.4	1.7'	A/A	↙↗	P	N57°E ~90°		CPD. JT.				PARALLEL JTS.
12	2477.5 2489.2	11.7'	MOST., DL. BLK. (5Y 2/1)	↗↙	P	N59°E ~90°	↓	SPL. JT.			FN. HKL. PLM.	

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/1 Gallia Co.

PAGE 1 OF 1
LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1835.2		MOST. GRN. BLK (5G 4/1) SLTY. MOST. (5GY 4/1)	(m)	P	⊕	CI	DCS		PRESENT CIRCULAR		NON-ORIENTED CORE 1835.2' TO 1855.8' DUE TO ROTATION AND SHAVING BY KNIVES
2	1855.4 1855.5	0.1'	A/A	m ⟶	P	N86°E 38°SE		PF				
3	2322.5 2325.4	29'	MOST. OL. BLK (5Y 2/1) DK. GRN. GRY (5GY 4/1)	? NAT. F/C	P	N45°E ~90°		PF?				
4	2328.2 2328.4	0.2'	MOST. BRN. BLK. (5YR 2/1)		CP			TF			FN. TW. HKL.	
5	2328.8 2330.3	15'	A/A	m F7	P-CP	INDETERMINATE ~90°		PCF			FN. TW. HKL. ARREST LINES	ARREST LINES, PROPAGATION UP-CORE NON-ORIENTED CORE
6	2329.8 2330.4	0.6'	A/A	m F7	P	A/A		PF			FN. TW. HKL. ARREST LINES	ARREST LINES, PROPAGATION UP-CORE NON-ORIENTED CORE
7	2331.4		A/A	(m)	CP	A/A		TF			CS. TW. HKL.	
8	2330.4 2330.7	0.3'	A/A	F7 ?m	P	A/A		PF?			FN. TW. HKL. CS. TW. HKL.	POSSIBLE CONTINUATION OF TFB
9	2330.4 2334.2	3.8'	A/A	F7 ?⟶	P	A/A		PFC				ORIGIN OR TOP IS GROUND UP BY TORSIONAL FRAC.?
10	2336.1		MOST OL BLK (5Y 2/1) SLTY MOST (5GY 4/1)	⟶ m	CP	N24°W 70°SW		KES			CS. TW. HKL.	
11	2338.5		A/A	⟶ m	CP	INDETERMINATE		TF				
12	2343.4 2343.5	0.1'		⟶ m	CP	INDETERMINATE		KES			CS. TW. HKL.	
13	2360.2 2360.7	0.5'	MOST. BRN. BLK. (5YR 2/1) OL. GRY. (5Y 4/1)	⟶ TF IS	CP	INDETERMINATE		TF			CS. TW. HKL.	
14	2360.4 2360.7	0.3'	A/A	m TF IS	CP	INDETERMINATE		TF			CS. TW. HKL.	3 TF ALONG MARGIN IN INTERVAL
15	2360.7 2361.0	0.3'	A/A	⟶ m	CP	INDETERMINATE		TF				3 TF ALONG MARGIN IN INTERVAL
16	2363.0 2363.1	0.1'	A/A	m NAT. F/C	CP	N58°E ~32°NW		PF			FN. TW. HKL.	TERMINATES AGAINST NATURAL FRACTURE
17	2363.6 2363.7	0.1'	A/A	m NAT. F/C	CP	N58°E 45°NW		PF			FN. TW. HKL.	TERMINATES AGAINST NATURAL FRACTURE
18	2451.1 2452.4	1.3'	MOST. BRN. BLK. (5YR 2/1)	m ⟶	P	N45°E ~90°		PFC			FN. TW. HKL.	
19	2455.2 2455.3	0.1'	A/A	?⟶ m?	CP	INDETERMINATE		TF			FN HKL. PLM.	POSSIBLE TERMINATION AGAINST NAT. FRAC. ID
20	2471.6 2471.8	0.2'	SLTY MOST OL GRY (5Y 4/1) MOST OL BLK (5Y 2/1)	m m?	CP-P			KES			CS. TW. HKL.	SEVERAL CAS, KES, & TF IN INTERVAL
21	2473.1 2473.3	0.2'	A/A	m m	CP			KES			CS. TW. HKL.	
22	2475.9 2475.4	0.5'	A/A	?m m	P	N81°E 85°NW		TF				
23	2480.6 2481.1	0.5'	MOST. BR. BLK. (5YR 2/1)	?m ?m	CP	INDETERMINATE		TF?			CS. TW. HKL.	
24	2483.4 2486.7	3.3'	A/A	?m ?m	P-CP	INDETERMINATE		PFC			CS. TW. HKL., FN. HKL. PLM.	POSSIBLE ORIGIN W/ TF NON-ORIENTED CORE
25	2484.4 2486.7	2.3'	A/A	?m ?m	P-CP	INDETERMINATE		PFC			CS. TW. HKL., FN. HKL. PLM.	>3 PFC IN INTERVAL; NO COMMON STRIKE NON-ORIENTED CORE
26	2493.8 2495.0	0.2'	MOST. OL. BLK (5Y 2/1) DK. GRN. GRY. (5GY 4/1)	m ?⟶	P	N40°E 60°SE		PF			CS. TW. HKL.	
27	2500.9 2501.0	0.1'	A/A	⟶ m	CP	N0°E ~32°E	↓	PF			CS. TW. HKL	

EASTERN GAS SHALES PROJECT

OHIO #6/1 WELL

FREQUENCY OF DISC FRACTURES

Depth Per Interval	Number of Fractures	Frequency Per Foot
1,810-20	37	3.7
1,820-30	29	2.9
1,830-40	52	5.2
1,840-50	50	5.0
1,850-60	70	7.0
1,860-66	36	6.0
1,866' to 2,310': Plug Drilled		
2,310-20	56	5.6
2,320-30	43	4.3
2,330-40	73	7.3
2,340-50	80	8.0
2,350-60	52	5.2
2,360-68	40	5.0
2,368' to 2,446': Plug Drilled		
2,450-60	41	4.1
2,460-70	61	6.1
2,470-80	45	4.5
2,480-90	27	2.7
2,490-2,501.5	33	2.9

BASE OF CORE: 2,501.5'

FRACTURE LOGS

EGSP-OHIO #6/2

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P OH-6/2 Gallia Co.

PAGE 1 OF 1
LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): NATURAL

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
	1697.9		MDST	M		N 60° W				24°		
1	1698.0	0.1′	5Y 4/1	M	P	70° SW	N	FLT.		S 23° W		
	1698.9		A/	M		N 70° W				25°		
2	1699.1	0.2′	/A	M	P	25° SW		FLT.		S 12° W		
	1702.6		MDST 5R 4/2	M		N 40° W				25°		
3	1702.7	0.1′	SHLY MDST 5Y 4/1	M	P	25° SW		FLT.		S 40° W		
	1702.7		A/	M		N 50° W						
4	1702.8	0.1′	/A	?/M	CP	90° SW		MCR FLT.		PRESENT		ASSOC. WITH F 3
	1703.2		A/	M		N 22° W				23°		
5	1703.4	0.2′	/A	M	CP	30° SW		FLT.		S 51° W		
	1704.9		A/	M		N 30° W				41°		
6	1705.2	0.3′	/A	M	P	45° NE		FLT.		N 42° E		
	2305.3		MDST 5Y 3/1	?/C		N 70° E						
7	2306.5	1.2′	SLTY MDST 5Y 4/1	→	P	~90°		SPL. JT.				OPEN FRACTURE
	2305.8		A/	M		N 70° E						
8	2308.6	2.8′	/A	→	P	~90°		SPL. JT.				OPEN FRACTURE
	2306.3		A/	→		N 70° E			V. SLIGHT			
9	2307.3	1.0′	/A	M	P	85° NW		SPL. JT.	CARBONATE			OPEN FRACTURE
	2309.9		A/	M		N 65° E					INCL. HKL.	
10	2310.0	2.1′	/A	BDG	P	~90°		SPL. JT.			INT. AR. LN.	PRPG SW → NE
	2314.6		MDST	M		N 70° E					FN TW HKL	OPEN FRACTURE
11	2315.5	0.9′	5YR 3/1	?/C	P	~90°		SPL. JT.			INT. AR. LN.	PRPG W → E
	2330.6		SLTY MDST 5Y 4/1	?/C		N 10° W						
12	2330.7	0.1′	SLTSN 5Y 4/1	→	CP	60° NE		MCR FLT.		PRESENT		
	2330.8		MDST	M		N 60° W				40°		
13	2330.9	0.1′	5GY 3/2	→	CP	15° SW		MCR FLT.		N 30° E		
	2339.9		MDST	→		N 30° E					FN HKL PLM	
14	2340.4	0.5′	5Y 3/1	?/C	P	~90°		SPL. JT.			INT AR LN	PRPG E → W
	2425.4		MDST 5Y 3/1	?/C		N 60° E					FN HKL PLM INT AR LN	
15	2937.1	11.7′	5YR 3/1	→	P	~90°		CPD. JT.			T.A.L.'s (?)	2 FRACTURE PLANES IN INTERVAL
	2943.5		MDST 5Y 3/1	↙		N 60° E	↓		MODERATE			SEVERAL PARALLEL FRACTURES
16	2961.7	18.2′	5Y 4/1		P	~90°		CPD. JT.	DOLOMITE			IN INTERVAL

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

CORING DATE: OCT 79
LOG DATE: APR 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/2 Gallia Co.

PAGE 1 OF 1
LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1697.0		MDST 5Y 3/1	(M)	CP	⊕	CT	DCS		CIRCULAR	CS TW HKL	
2	1704.7 1704.8	0.1'	MDST. 5R 4/2 SHLY MDST 5Y 4/1	M ?/C	CP	N 40° W 50° NE	CT	PF			CS TW HKL HKL PLM	HORIZONTAL DISC. FRACTURE HOOKS DOWNCORE — TRENDS N 30°E
3	1705.3		A/A	(M)	P	⊕	|	DF			HKL PLM CS TW HKL	
4	1705.5 1705.6	0.1'	A/A	M BDG	P	N 32° W 40° NE		PF			CFS TW HKL INT. AR. LN.	
5	1709.9		MDST. 5Y 4/1 SLTY MDST. 5Y 6/1	(M)	P	⊕		TF			CS. TW. HKL. INCL. HKL. HKL PL.	
6	1743.2		MDST. 5Y 3/1	(M)	CP	⊕		TF			CS. TW. HKL INT. AR. LN.	6 FRACTURE PLANES SPIRALING DOWNCORE
7	2282.0		MDST. 5Y 3/1 SLTY MDST. 5GY 4/1	(M)	CP	⊕		DCS		CIRCULAR	CS. TW. HKL.	
8	2301.1		SLTY MDST. 5GY 4/1	(M)	P	⊕		TF			INT. AR. LN. CS TW HKL	12 FRACTURE PLANES SPIRALING DOWNCORE
9	2331.9 2332.5	0.6'	SLTY MDST. 5Y 4/1 SLTSN 5Y 6/1	M M	CP	N 80° E ~90°		TF			CS. TW. HKL HKL PLM	AT A CONNECTION
10	2332.1 2332.4	0.3'	A/A	→ M	CP	N 32° W ~90°		TF			CS TW HKL	AT A CONNECTION
11	2418.0		MDST 5YR 3/1 5Y 3/1	(M)	CP	⊕		DCS		CIRCULAR	CS TW HKL	
12	2432.2 2432.3	0.1'	MDST 5Y 3/1 SLTY MDST. 5Y 4/1	M NAT. JT.	CP	N 60° E 55° NW		PF			CS TW HKL	FRACTURES #12 THROUGH #16 TERMINATE AGAINST CMP. JT #15
13	2432.9 2433.0	0.1'	A/A	M CMP. JT.	CP	N 60° E 50° NW		PF			AR LN CS TW HKL	
14	2434.2 2434.3	0.1'	A/A	M CMP JT.	CP	N 60° E 50° NW		PF			INT. AR. LN.	
15	2434.6 2434.8	0.2'	A/A	M CMP JT.	CP	N 60° E 45° NW		PF			HKL PLM CS TW HKL	
16	2435.4 2435.5	0.1'	A/A	M CMP JT.	CP	N 60° E 50° NW		PF			INT. AR. LN. CS TW HKL.	
17	2445.8 2446.0	0.2'	MDST. 5Y 3/1	M CMP. JT.	CP	N 60° E 60° SE		PF			INT. AR. LN. CS. TW. HKL.	FRACTURES #17 THROUGH #22 TERMINATE AGAINST CMP. JT #16
18	2494.8 2495.0	0.2'	A/A	M CMP JT.	CP	N 60° E 50° NW		PF			INT. AR. LN.	
19	2495.1 2495.2	0.1'	A/A	M CMP JT.	CP	N 60° E 50° NW		PF			INT. AR. LN.	
20	2446.5 2446.8	0.3'	A/A	M CMP JT.	CP	N 60° E 60° SE		PF			INT. AR. LN. CS. TW. HKL.	
21	2447.1 2447.2	0.2'	A/A	M CMP JT.	CP	N 60° E 60° SE		PF			INT. AR. LN.	
22	2449.3 2449.4	0.1'	A/A	M CMP JT.	CP	N 60° E 60° SE		PF			CS TW HKL	
23	2453.0 2455.5	2.5'	A/A	?M ?M	CP	N 60° E ~90°		KES TF				TF INITIATED BY A KES
24	2459.6 2459.7	0.1'	MDST. 5Y 3/1 SLTY MDST 5Y 4/1	M CMP JT.	CP	N 60° E 50° SE		PF			CS TW HKL	
25	2459.8 2459.9	0.1'	A/A	M CMP JT	CP	N 60° E 50° SE		PF			CS TW HKL	
26	2460.3 2460.4	0.1'	A/A	M CMP JT	CP	N 60° E 45° SE		PF			CS TW HKL	
27	2476.4 2476.6	0.2'	MDST. 5Y 3/1	M ?/C	CP	N 20° W 90° SW	↓	TF			INT. AR. LN. CS [illegible]	

EASTERN GAS SHALES PROJECT

OHIO #6/2 WELL

FREQUENCY OF DISC FRACTURES

Depth Per Interval	Number of Fractures	Frequency Per Foot
1,700-10	68	6.8
1,710-20	57	5.7
1,720-30	38	3.8
1,730-40	42	4.2
1,740-50	34	3.4
1,750-55.1	20	3.9
1,755.1' to 2,282': Plug Drilled		
2,280-90	40	4.0
2,290-2,300	53	5.3
2,300-10	54	5.4
2,310-20	21	2.1
2,320-30	42	4.2
2,330-40.4	49	4.7
2,340.4' to 2,418': Plug Drilled		
2,420-30	24	2.4
2,430-40	27	2.7
2,440-50	29	2.9
2,450-60	21*	2.1
2,460-70	29	2.9
2,670-76.6	18	2.7

BASE OF CORE: 2,476.6'

* Rubble Zone: 2,453.1' to 2,453.9'

FRACTURE LOGS

EGSP-OHIO #6/3

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/3 Gallia Co.

PAGE 1 OF 1
LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): All

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1988.0		SLTSTN. SLTY MDST. + MDST., 5Y 6/1, 5Y 2/1	(m)	CP	⊕	CI	DCS		CIRCULAR	CS. TW. HKL., CS. HKL. PLM.	TOP OF RUN 1
2	1993.6		MDST., DL. GY (5Y 4/1)	(m)	CP		CI	TF			CS. TW. HKL., FN. HKL. PLM.	9 SMALL FRACTURES SPIRALLING DOWN-CORE
3	2590.0		MDST. + SLTY MDST. (5YR 2/1) (5Y 2/1)	(m)	CP	⊕	CI	DCS		CIRCULAR	CS. TW. HKL., CS. HKL. PLM.	TOP OF RUN 2
4	2590.1 2590.2	0.1'	A/A	m →	P		CI	PF				CLOSED FRACTURE THROUGHOUT MOST OF LENGTH. NON-ORIENTED CORE DUE TO KNIFE SHAVING
5	2592.2 2592.9	0.7'	A/A	BDG. → ?	P	N 70°E ~90°	N	SPLIT			FN. HKL. PLM., FN. TW. HKL	PROPAGATION: SW → NE
6	2595.0		A/A	(m)	P	⊕	CI	DCS		CIRCULAR		
7	2596.1 2596.7	0.6'	A/A	→ BDG.	P	N 2°E ~90°	N	SPLIT			FN. HKL. PLM.	PROPAGATION: S → N
8	2600.0 2600.3	0.3'	A/A	BDG F. 9	CP		CI	TF				
9	2600.3		A/A	(m)	P	⊕	CI	DCS		CIRCULAR	CS. TW. HKL.	
10	2600.8 2600.9	0.1'	A/A	BDG. m	CP	N 70°E 60°SE	CI	PF			INT. AR LN., CS. TW. HKL.	PROPAGATION: UP-CORE

EASTERN GAS SHALES PROJECT

OHIO #6/4 WELL

FREQUENCY OF DISC FRACTURES

Depth Per Interval	Number of Fractures	Frequency Per Foot
1,990-2,000	15	1.5
2,000-10	28	2.8
2,010-20	28	2.8
2,020-30	27	2.7
2,030-40	19	1.9
2,040-45.7	10	1.7
2,045.7' to 2,590': Plug Drilled		
2,590-2,601.9	32	3.2

BASE OF CORE: 2,601.94'

FRACTURE LOGS

EGSP-OHIO #6/4

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): NATURAL

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1851.9		V. FN. SS	→		—						
	1852.3	0.4′	10Y 6/2 5GY 5/1	? →	P	—	N	SPL. JT.				CLOSED FRACTURE
2	1853.5		A/A	↗	P	—		CMP JT.				2 PARALLEL JNTS. IN INTERVAL
	1854.5	1.0′				—						
3	1864.9		A/A	↗	CP	—		MCR FLT.		PRESENT		
4	1865.6		A/A	(M)	P	—						
	1866.1	0.5′				30°		FLT.				~5 FLTS IN INTERVAL
5	1866.9		FN. SS. N6 N5	M M	P	— 60°		FLT.				MUD CLAST BRECCIA ALONG FLT. SOFT SEDIMENT DEFORMATION
	1867.5	0.6′										
6	1869.6		A/A	M M	P	— ~60°		FLT.				A/A
	1870.1	0.5′										
7	1871.5		A/A	M ?M	P	— ~55°		FLT.				A/A
	1872.0	0.5′										
8	1873.4		A/A	M ?M	CP	— ~85°		FLT.		PRESENT		FLANK OF CONCRETION
	1875.0	1.6′										
9	1875.0		SLTSN. N5 N4	M M	P	— ~53°		FLT.		PRESENT		5 PARALLEL FLTS IN INTERVAL
	1875.4	0.4′										
10	1875.6		A/A	(M)	P	— ~35°		FLT.		PRESENT		4 PARALLEL FLTS IN INTERVAL
	1876.4	0.8′										
11	1878.5		A/A	? → ? →	P	— 40°		FLT.		PRESENT		
12	1880.0		A/A	M →	P	— 30°		FLT.		PRESENT		
13	1881.0		A/A	M →	P	— 30°		FLT.		PRESENT		
14	1881.8		A/A	M →	P	— 45°		FLT.				
15	1882.1		SLTSN. 5YR 4/1 N4	(M)	P	— 30°		FLT.				
	1882.3	0.2′										
16	1884.9		A/A	(M)	P	— 36°		FLT.				
	1885.1	0.2′										
17	1885.3		A/A	(M)	P	— 30°		FLT.				
	1885.5	0.2′										
18	1891.9		SLTY. MDST. 10R 4/2	M F19	P	— 50°		FLT.				
	1892.1	0.2′										
19	1892.1		A/A	(M)	P	— 40°		FLT.				
20	1895.7		A/A	(M)	P	— 35°		FLT.				3 FLTS IN INTERVAL
	1895.9	0.2′										
21	1897.7		A/A	M M	P	N 13° E 35° SE		FLT.		30° N 80° E		
	1897.8	0.1′										
22	1905.6		A/A	↗	P	N 11° W 45° SW		MCR FLT.		40° S 90° W		2 SMALL MCR FLTS IN INTERVAL
23	1908.2		SLTY. MDST. 10R 4/2 N4	↗	P	N 9° W 55° NE		MCR FLT.		PRESENT		
	1908.3	0.1′										
24	1907.5		A/A	(M)	P	N 24° W 20° NE		FLT.		18° N 69° E		
	1907.6	0.1′										
25	1909.1		A/A	(M)	P	N 26° W 30° NE		FLT.		27° N 70° E		
	1909.2	0.1′										
26	1909.6		A/A	(M)	P	N 7° W 33° NE		FLT.		30° N 80° E		
	1909.8	0.2′										
27	1913.0		A/A	↗	P	N 42° W ~90°	↓	SPL. JT.				
	1913.1	0.1′										

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

CORING DATE: OCT. 79
LOG DATE: APR. 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): NATURAL

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
28	19228 19229	0.1'	MDST., SLTY. MDST. N4 N5	↗ ↙	P	N 45° E 43° NW	N	FLT.				4MM DISPLACEMENT
29	19231 19232	0.1'	A / A	↗ ↙	P	N 58° E 55° SE		FLT.				5 MM DISPLACEMENT
30	19237 19239	0.2'	A / A	↗ ↙	P	N 9° E 45° SE		FLT.	V. SLIGHT ANHYDRITE (?) A / A	PRESENT 30° N 37° E		3 MM DISPLACEMENT
31	19241 19243	0.2'	MDST., SLTY. MDST. 10R 4/2 N5	M →	P-CP	N 30° W ~40° NE		FLT.		8° N 30° W		10 MM DISPLACEMENT
32	19249 19250	0.1'	A / A	M F 33	P	N 69° E 10° NW		FLT.		19° N 13° W		
33	19250 19251	0.1'	A / A	F 32 M	P	N 60° E 20° NW		FLT.				
34	19297 19299	0.2'	A / A	M M	P	N 79° E 45° NW		FLT.		PRESENT		
35	19300 19301	0.1'	A / A	→ M	CP	N 60° E 23° SE		FLT.		PRESENT		
36	19309 19312	0.3'	A / A	(M)	P	N 49° E 35° SE		FLT		32° S 32° E		
37	19326 19328	0.2'	SHLY. MDST. 10R 4/2	(M)	P	N 21° E 25° SE		FLT.		22° S 63° E		
38	19516 19517	0.1'	SLTY. MDST., SLTSN N4 N5	↗ ↙	P	N 82° W 30° SW		MCR FLT.		25° S 4° E		
39	19522 19523	0.1'	A / A	↗ ↙	P	N 46° E 22° SE		MCR FLT.		20° S 37° E		
40	19530 19532	0.2'	A / A	(M)	P	N 37° E 30° SE		FLT.		28° S 59° E		
41	21301 21318	1.7'	MDST., SLTSN 5GY 4/1 5Y 3/1	↗ ↙	P	N 68° W ~90°		SPL. JT.				
42	23643 23760	11.7'	MDST., SLTY. MDST. 5GY 4/1 5Y 3/1 N7	? M M	P	N 80° E 85° SE		CPD. JT.				3 PARALLEL PLANAR JOINTS IN INTERVAL
43	24013 24022	0.9'	MDST., SLTY. MDST. 5GY 4/1 5Y 3/1	? → →	P	N 82° E ~90°		SPL. JT.				
44	24236 24250	1.4'	SHLY. MDST. 5GY 4/1 5Y 3/1	? → ? →	P	N 78° E ~90°		SPL. JT.				
45	24416 24530	11.4'	A / A	M →	P	N 81° E ~90°		SPL. JT.				
46	24555 24580	4.5'	A / A	F 45 →	P	N 82° E ~90°		SPL. JT.				
47	24532 24547	1.5'	MDST., SLTY. MDST. 5GY 4/1 5Y 3/1 N6	M →	P	N 78° E ~90°		SPL. JT.				
48	24565 24578	1.3'	A / A	M ? →	P	N 85° E ~90°		SPL. JT.				
49	24603 24623	2.0'	A / A	M →	P	N 80° E ~90°		SPL. JT.				
50	24685 24706	2.1'	MDST., SLTY. MDST. 5GY 4/1 5Y 3/1 N6	→ M	P	N 81° E ~90°		CPD. JT.				2 PARALLEL PLANAR JOINTS IN INTERVAL
51	24715 24729	1.4'	A / A	↗ ↙	P	N 76° E ~90°		SPL. JT.				
52	24733 24789	5.6'	A / A	M M	P	N 78° E ~90°		CPD. JT.				3 PARALLEL PLANAR JOINTS IN INTERVAL
53	24827 24874	4.7'	A / A	M →	P	N 76° E ~90°		SPL. JT.				
54	24866 24883	1.7'	A / A	M M	P	N 78° E ~90°	↓	SPL. JT.				PARALLEL TO F 53

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): NATURAL

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMIN-ATIONS	CHAR-ACTER	STRIKE / DIP	INTER-PRETATION	FRACTURE TYPE	MINERALIZATION	SLICK-ENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
55	2497.2 2500.5	3.3'	MDST., SLTSN 5Y 2/1, 5GY 4/1	M F56 (M)	P	N 81° E ~90°	N	SPL JT.				
56	2500.5 2502.6	2.1'	A / A	F55 (M) M	P	N 80° E ~90°		SPL JT.				
57	2530.6 2531.5	0.9'	MDST SLTSN 5G 4/1, 5G 4/1	M M	P	N 85° E ~90°		SPL JT.				
58	2548.8 2550.0	1.2'	MDST 5Y 2/1	M F59 (M)	P	N 81° E 85° SE		SPL JT.				
59	2550.0 2550.5	0.5'	A / A	F58 (M) KES	P	N 78° E ~90°		SPL JT.				
60	2559.0 2560.1	1.1'	MDST., SLTY. MDST 5Y 2/1, 5G 4/1	M M	P-CP	N 76° E ~90°		SPL JT.				
61	2563.7 2564.1	0.4'	A / A	M →	CP	N 75° E ~90°		SPL JT.				
62	2564.5 2567.1	2.6'	A / A	? M F63 (M)	P	N 80° E ~90°		SPL JT.				
63	2567.1 2569.1	2.0'	A / A	F62 (M) M	P	N 80° E ~90°		SPL JT.				
64	2573.2 2575.4	2.2'	A / A	M M	P	N 81° E ~90°		SPL JT.				
65	2585.8 2585.9	0.1'	A / A	? M ? M	P	N 42° W 36° SW		FLT.		34° S 72° W		
66	2586.0 2586.1	0.1'	A / A	M F67	P	N 44° W 34° SW		FLT.		30° S 52° W		
67	2586.1		A / A	F66 M	P	N 44° W 15° NE		FLT.		10° N 40° E		
68	2586.2 2586.3	0.1'	A / A	(M)	P	N 55° W 23° NE		FLT.		20° N 34° E		
69	2586.5 2587.3	0.9'	A / A	→ KES	P	N 35° W ~90°		SPL JT.				
70	2589.3 2592.4	3.1'	A / A	M M	P	N 80° E ~90°		SPL JT.				
71	2598.3 2599.1	0.1'	A / A	M M	P	N 80° E 80° SE		CPD JT.				↓ 2 PARALLEL PLANAR JOINTS IN INTERVAL ↑
72	2598.3 2598.9	0.6'	A / A	M →	P	N 87° E 64° SE		CPD JT.				
73	2602.1 2602.8	0.7'	A / A	M →	P	N 78° E 82° SE		SPL JT.				
74	2603.1 2604.2	1.1'	A / A	M M	P	N 74° E 84° SE		SPL JT.				
75	2607.7 2607.8	0.1'	A / A	F76 M	P	N 10° E 20° NW		FLT.		17° N 78° W		
76	2607.7 2607.8	0.1'	A / A	F75 M	P	N 10° E 18° SE		FLT.		15° S 72° E		
77	2607.8		A / A	→ M	P	N 8° W 15° SW		FLT.		14° N 88° W		
78	2609.1 2609.8	0.7'	A / A	M →	P	N 38° E ~90°		SPL JT.				
79	2612.0 2615.6	3.6'	SLTY. MDST. 5Y 2/1	M →	P	N 82° E ~90°		CPD JT.				↓
80	2613.2 2619.0	5.8'	A / A	↗	P	N 79° E ~90°		CPD JT.				3 PARALLEL PLANAR JOINTS IN INTERVAL
81	2618.7 2624.1	5.4'	A / A	M M	P	N 80° E ~90°	↓	CPD JT.				↑

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

CORING DATE: OCT. 79
LOG DATE: APR. 80

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): NATURAL

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
82	2628.0 2634.9	6.9'	MDST, SLTY MDST 5Y 2/1, 5G 4/1	M ?→	P	N 80° E ~90°	N	SPL. JT.				
83	2629.2 2633.0	3.8'	A/A	M M	P	N 74° E ~90°		SPL. JT.				
84	2651.1 2651.4	0.3'	A/A	→ ?→	P	N 80° E ~90°		SPL. JT.				
85	2661.7 2674.1	12.4'	MDST, SLTY MDST. 5Y 2/1, 5G 4/1	M M	P	N 60° E ~90°		CPD. JT.				↓
86	2672.4 2674.5	2.1'	A/A	M ?M	P	N 63° E 85° SE		CPD. JT.				3 PARALLEL PLANAR JOINTS IN INTERVAL
87	2673.9 ~2674.9	~1.0'	A/A	M ?F86	P	N 62° E 85° SE		CPD. JT.				↑
88	2680.1 2682.5	2.4'	A/A	→ →	P	N 59° E ~90°		SPL. JT.				
89	2686.2 2692.2	6.0'	MDST. 5G 4/1, 5Y 2/1	M M	P	N 68° E ~90°		SPL. JT.				
90	2693.3 2695.8	2.5'	MDST 5Y 2/1, 5Y 4/1, 5G 4/1	?/C M	P	N 72° E ~90°		SPL. JT.				
91	2715.7 2719.0	3.3'	SLTY. MDST. 5Y 2/1, 5Y 4/1	M →	P	N 65° E ~90°		SPL. JT.				
92	2719.7 2720.4	0.7'	A/A	M →	P	N 68° E 85° NW		SPL. JT.				
93	2722.7 2723.1	0.4'	A/A	M ?→	P	N 58° E 80° SE		SPL. JT.				
94	2722.8 2723.1	0.3'	A/A	M →	P	N 56° E 85° SE		SPL. JT.				
95	2729.2 2730.7	1.5'	A/A	→ →	P	N 69° E ~90°		SPL. JT.				
96	2730.2 2730.7	0.5'	A/A	→ →	P	N 69° E ~90°		SPL. JT.				
97	2733.7 2735.3	1.6'	A/A	M ?→	P	N 51° E ~90°		SPL. JT.				
98	2735.5 2735.9	0.4'	A/A	↗ ↙	CP	— ~90°		CPD. JT.	V. HEAVY DOLOMITE			DENDRITIC FRACTURE PATTERN
99	2744.9 2745.9	1.0'	MDST 5Y 2/1, 5Y 4/1	↗ ↙	P	N 61° E ~90°		CPD. JT.				2 PARALLEL JNTS IN INTERVAL
100	2747.9 2749.9	2.0'	A/A	M →	P	N 65° E 85 NW		SPL. JT.				
101	2751.3 2754.1	2.8'	A/A	?→ M	P	N 62° E 82° SE		SPL. JT.				
102	2767.8 2772.3	4.5'	SLTY MDST 5Y 2/1, 5G 4/1	M M	P	N 55° E 85° SE		SPL. JT.				
103	2767.8 2771.0	2.2'	A/A	M ?M	P	N 53° E ~90°	↓	CPD. JT.				2 PARALLEL JOINTS IN INTERVAL

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EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1853.6 1853.9	0.3'	FN.GR.SS. (10YR 7/1)+(5GY 6/1)	m ?→	CP	—	CI	TF				TF SURROUNDING SPL. JT.
2	1854.1 1854.2	0.1'	A/A	(m) (m)	CP	—		TF		PRESENT		CIRCULAR SLICKS ON CONICAL SURFACE
3	1862.8 1862.9	0.1'	FN.GR.SS (N6), (5GY 4/1)	m m	CP	—		DCS TF		CIRCULAR PRESENT	CS. TW. HKL	COMBINATION TF + DCS DUE TO LOOSE KNIVES
4	1863.5 1864.6	1.1'	A/A	m m	CP	—		TF	— NON-ORIENTED —		CS. TW. HKL	SEVERAL TF'S DUE TO JTING IN INTERVAL
5	~1864.6 1865.0	~0.4'	A/A	? m	CP	—		TF ?	CORE SHAVED BY KNIVES		CS. TW. HKL	
6	1865.7 1866.1	0.4'	A/A	→ m	CP	—		KES TF			V. CS. TW. HKL.	TF INITIATED BY KES
7	1866.9		FN.GR.SS (N6), (N5)	(m)	CP	~⊕		TF				
8	1868.2 1868.5	0.3'	A/A	m ?m	CP	—		TF				COARSE IRREG. SURFACE
9	1869.4		A/A	(m)	CP	~⊕		TF				
10	1883.4 1883.5	0.1'	V.FN.GR.SS. (5YR 4/1)	m ?→	P	—		PF			CS. TW. HKL.	
11	1889.1 1890.0	0.9'	SLTY. MOST. (10R 4½)	→ E12	P-CP	—					CS. TW. HKL.	PLANAR CI FRACTURE
12	1890.0 1890.4	0.4'	A/A	E11 m	CP	—		KES TF			CS. TW. HKL.	COMB. KES + TF DUE TO LOOSE KNIVES
13	1891.4 1891.7	0.3'	A/A	m E14	CP	—		TF			CS. TW. HKL., AR LN	
14	1891.7		A/A	(m)	P	⊕		DCS		PRESENT CIRCULAR		
15	1893.0 1893.2	0.2'	A/A	→ m	CP	—		TF			CS. TW. HKL.	BELOW RUBBLE ZONE
16	1894.7 1894.8	0.1'	A/A	m DE	CP	—		PF TF			CS. TW. HKL.	COMB. PF + TF DUE TO KNIFE PROBS.
17	1894.8 1895.0	0.2'	A/A	m m	CP	—		TF ?			CS. TW. HKL.	
18	1899.0 1899.1	0.1'	A/A	m m	CP	SEE COMMENTS		PF				FRAC. ENTERS N11°E 52°SE EXITS AT N11°E 70° NW
19	1900.8 1901.0	0.2'	A/A	m m	P	N9°E 25°SE						ORIENTATION IS OFFSET PLANE ~5mm TO WEST (LOWER)
20	1905.1 1905.3	0.2'	A/A	m m	CP	—		TF				TF + RUBBLE ZONE
21	1914.0		A/A	(m)	CP	~⊕		TF				
22	1916.2		A/A	(m)	P	⊕						CORE OFFSET 10 mm TO NORTH
23	1932.3		A/A	(m)	P	~⊕		TF			CS. TW. HKL.	
24	1935.1 1935.2	0.1'	A/A	m m	CP			KES TF	— KNIVE PROBS.		CS. TW. HKL.	TF ORIGINATED AS KES
25	1940.0 1940.2	0.2'	A/A	m m	CP			KES TF				TF ORIGINATED AS KES
26	1940.4 1940.7	0.3'	A/A	m m	CP			KES TF				TF ORIGINATED AS KES
27	1944.0		A/A	(m)			↓	TF			CS. TW. HKL.	

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LOG CLASSIFICATION
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FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
28	1944.6 1944.8	0.2'	SHLY. MDST. (10 R 4/1)	m m	CP-P	—	CT	TF		CIRCULAR FAINT	CS. TW. HKL.	
29	1945.7 1945.8	0.1'	A/A	m m	CP-P	—	|	KES TF		CIRCULAR FAINT	CS. TW. HKL.	TF ORIGINATED AS KES
30	1947.6 1947.7	0.1'	A/A	m m	CP-P	—	|	KES TF		CIRCULAR FAINT		TF ORIGINATED AS KES
31	1949.5 1949.6	0.1'	A/A	m m	CP-P	—	|	KES TF		CIRCULAR FAINT		TF ORIGINATED AS KES
32	1952.0		SLTY. MDST. + SLTST. (N4), (N5)	(m)	CP	—	|	TF		CIRCULAR FAINT		
33	1955.3 1956.4	1.1'	A/A	?→ ?→	P	N2°W ~90°SW	|					PLANAR CI FRACTURE
34	1958.1		A/A	(m)	P	⊕	|					OFFSET 5mm TO S. SOUTHEAST
35	1959.8		A/A	(m)	P	⊕	|					OFFSET 5mm TO S. SOUTHEAST
36	1961.0		A/A	(m)	P	⊕	|					OFFSET 5mm TO S. SOUTHEAST
37	1964.5		MDST. SLTY. MDST. SLTST. (5GY 4/1), (5G 4/1), (N7)	(m)	P	⊕	|					OFFSET 6mm TO N. NORTHEAST
38	1965.9		A/A	(m)	P	⊕	|					TF WITH POSSIBLE OFFSET
39	1977.3		SLTY MDST, SLTST. (N2), (N6)	(m)	P	⊕	|	DCS		PRESENT CIRCULAR		OFFSET 6mm TO E. SOUTHEAST
40	1980.8		A/A	(m)	P	⊕	|			CIRCULAR V. FAINT		
41	1982.6 1982.8	0.2'	A/A	m m	P-CP	—	|	KES TF				SEVERAL TF + KES IN INTERVAL
42	1986.9		A/A	(m)	P	⊕	|	DCS		CIRCULAR FAINT		OFFSET 5mm TO EAST
43	1998.7		A/A	→ m	CP	—	|	TF				
44	1999.1		A/A	(m)	P	⊕	|					
45	1999.1 1999.5	0.4'	A/A	F46 →	P	N76°E 80°SE	|				FN. HKL. PLM., AR. LN.	PLANAR CI FRACTURE
46	2010.0		A/A	(m)		⊕	|	DCS		PRESENT CIRCULAR	TW. HKL.	
47	2010.0 2010.5	0.5'	A/A	F46 m	CP	—	|	TF			TW. HKL.	ORIGINATES AT F46
48	2039.1 2039.3	0.2'	MDST. SLTY. MDST. SLTST. (5Y 4/1), (5GY 4/1), (5Y 4/1), (5GY 4/1)	m →	CP	N86°E ~90°	|				AR. LN., CS. TW. HKL.	PLANAR CI FRACTURE
49	2042.1 ~2042.2	~0.1'	A/A	m ?→	CP	—	|	PF			CS. TW. HKL.	
50	2044.4		A/A	(m)	P	⊕	|				CS. TW. HKL., TF's, KES	3mm OFFSET TO NORTHEAST
51	2109.5 2110	1.0'	MDST. SLTST. (5GY 4/1), (5Y 4/1), (N6)	m m	~P	—	|	KES			CS. TW. HKL.	SEVERE SPALLING DUE TO LOOSE KNIVES
52	2140.7		A/A	(m)	CP	⊕	|	TF			CS. TW. HKL.	
53	2157.2 2157.3	0.1'	A/A	BDG. m	CP	—	|	KES			CS. TW. HKL., INT. AR. LN.	
54	2188.0 2188.1	0.1'	A/A	BDG. BDG.	CP	—	↓	KES		—	CS. TW. HKL., FN. HKL. PLM.,	STRIKE OF VERT. FRACTURE RUNS BETWEEN

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EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
55	2188.2		MDST, SLTST, (5GY4/1), (5Y4/1), (N6)	(m)	CP	⊕	CT	TF			CS. TW. HKL., INT. AR. LN., INCL. HKL.	
56	2203.6		SLTY MDST, MDST, SLTST (5Y4/1), (5GY4/1), (N6)	(m)	CP	⊕		TF?			CS. TW. HKL., INT. AR. LN.	
57	2216.2 2216.3	0.1'	A/A	BDG m	CP	N64°W 38°SW		PF?			CS. TW. HKL., INT. AR. LN.	
58	2234.8		SLTY MDST, MDST, SLTST (5Y4/1), (5G4/1), (N6)	(m)	CP	⊕		KES		CIRCULAR MODERATE	CS. TW. H[illegible], INT. AR. LN., CBS	POSSIBLE LOOSE KNIVES
59	2246.3 2246.5	0.2'	SLTY, MDST, MDST, SLTST (5Y4/1), (5G4/1), (N6)	m m	CP	N30°E 20°NW		PF			CS. TW. HKL., INT. AR. LN., FN. HKL. PLM.	
60	2265.0 2265.1	0.1'	A/A	?/C m	CP			KES			CS. TW. HKL., INT. AR. LN.	POSSIBLE LOOSE KNIVES
61	2294.4 2294.5	0.1'	MDST, SLTST, (5Y4/1), (5GY4/1), (N6)	m m	CP			KES			CS. TW. HKL., FN. HKL. PLM., INT. AR. LN.	POSSIBLE LOOSE KNIVES
62	2354.5 2354.6	0.1'	MDST, SLTST (5Y4/1), (5GY4/1), (5GY4/1)	(m)	CP	⊕		DCS		CIRCULAR	CS. TW. HKL., INT. AR. LN., CBS	POSSIBLE LOOSE KNIVES
63	2324.4 2324.9	0.5'	MDST, SLTST, (5Y4/1), (5GY4/1), (N7)	?/m? ?/C	CP	N30°W 70°SW		PF?			CS. TW. HKL., FN. HKL. PLM.	POSSIBLE LOOSE KNIVES
64	2324.5 2324.9	0.4'	A/A	m? ?/C	CP	N45°E 72°SE		PF?			CS. TW. HKL., INT. AR. LN.	POSSIBLE LOOSE KNIVES
65	2324.9		MDST. + SLTST. (5Y4/1), (5GY4/1), (N7)	(m)	CP	⊕		KES		CIRCULAR	CS. TW. HKL., CBS	POSSIBLE LOOSE KNIVES
66	2333.5		A/A	(m)	CP	⊕		TF			CS. TW. HKL., HKL. PLM.	
67	2354.3 2358.9	4.6'	MDST, SLTY MDST, SLTST (5Y4/1), (5GY4/1), (N7)	m? BDG	CP	N50°W ~90°		PFC			CS. TW. HKL., INT. AR. LN., HKL. PLM.	
68	2357.0 2358.8	1.8'	A/A	m? BDG	CP			KES			CS. TW. HKL., INT. AR. LN., HKL. PLM.	
69	2358.0 2359.3	1.3'	A/A	m? BDG	CP			KES			CS. TW. HKL., INT. AR. LN., HKL. PLM.	
70	2361.4 2361.9	0.5'	A/A	m? BDG	CP			KES			CS. TW. HKL., INT. AR. LN.	
71	2362.5 2363.4	0.9'	A/A	?/m m?	CP			KES			CS. TW. HKL., INT. AR. LN. HKL. PLM.	
72	2420.8 2421.2	0.4'	SHLY. MDST, SLTY. MDST. (5GY4/1), (5Y4/1)	m? ?/C	CP			KES			CS. TW. HKL., INT. AR. LN.	
73	2421.2		A/A	(m)		⊕		TF KES		CIRCULAR	CS. TW. HKL., CBS	BELOW CONNECTION AT 2420'
74	2423.4 2423.6	0.2'	A/A	m m	CP	—		TF			CS. TW. HKL., INT. AR. LN. HKL. PLM.	
75	2423.8 2424.0	0.2'	A/A	m SPLIT	CP	N80°E 63°SE		PFC			CS. TW. HKL., INT. AR. LN.	TERMINATES AGAINST A PRE-EXISTING NATURAL JOINT
76	2431.8 2431.9	0.1'	SHLY. MDST, SLTY. MDST. + SLTST. (5GY4/1), (5Y4/1), (N6)	m m	CP	N20°E ~90°		PF?			INT. AR. LN., CS. TW. HKL.	
77	2451.6		A/A	(m)	CP	⊕		DCS?		CIRCULAR	CS. TW. HKL., CBS	BELOW CONNECTION AT 2450'
78	2453.1 2453.2	0.1'	A/A	m NAT. FRT	CP	N38°E 60°NW		PF			CS. TW. HKL., INT. AR. LN.	
79	2481.8 2481.9	0.1'	MDST. (5Y4/1), (5GY4/1)	m m	CP	—		TF			INT. AR. LN., CS. TW. HKL., FN. HKL. PLM.	
80	2540.5		MDST. (5Y4/1)	(m)	CP	~⊕		DCS?		CIRCULAR	CS. TW. HKL., INT. AR. LN., CBS	
81	2548.1 2548.3	0.2'	A/A	m m	CP	—	↓	KES			CS. TW. HKL., INT. AR. LN.	

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LOG CLASSIFICATION
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FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
82	2548.4 2548.6	0.2'	mdst. (SY4/1)	m m?	CP	N45°W 75°SW	CT	PF?			CS. TW. HKL., INT. AR. LN.	
83	2550.2 2550.4	0.2'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
84	2550.8 2555.0	4.2'	A/A	m m				KES?			CS. TW. HKL., INT. AR. LN.	
85	2555.0 2555.1	0.1'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
86	2555.1 2559.1	4.0'	A/A	m m				KES?			CS. TW. HKL., INT. AR. LN.	
87	2557.2 2557.4	0.2'	mdst. + slty. mdst. (SY4/1), (SG4/1)	m m				KES			CS. TW. HKL., INT. AR. LN.	
88	2557.5 2557.6	0.1'	A/A	m m		N45°W 75°SW		PF?			CS. TW. HKL., INT. AR. LN.	
89	2557.9 2558.1	0.2'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
90	2558.4 2558.6	0.2'	A/A	m m		N45°W 75°SW		PF?			CS. TW. HKL., INT. AR. LN.	
91	2558.9 2559.1	0.2'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
92	2578.3		mdst. slty. mdst. sltst (SG4/1), (SY4/1), (NW)	(m)		⊕		TF			CS. TW. HKL., INT. AR. LN., CBS	CONNECTION AT 2578.0'
93	2580.9 2581.1	0.2'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	ORIGIN AT ORIENTATION GROOVE
94	2581.7 2581.9	0.2'	A/A	m m		N30°E 85°NW		PF?			CS. TW. HKL., INT. AR. LN., EN. HKL. PLM.	ORIGIN AT ORIENTATION GROOVE
95	2582.9 2583.2	0.3'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
96	2585.3 2585.5	0.2'	mdst., slty. mdst. (SY4/1), (SG4/1)	m m		N20°E 32°SE		TF			CS. TW. HKL., INT. AR. LN.	
97	2587.3 2587.7	0.4'	A/A	?/c m				KES			CS. TW. HKL., INT. AR. LN.	
98	2589.0 2589.4	0.4'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN., EN. HKL. PLM.	
99	2593.5 2594.1	0.6'	A/A	?/m m		N40°W ~90°		TF?			CS. TW. HKL., INT. AR. LN.	
100	2593.5 2594.5	1.0'	A/A	m m		N80°E 88°SE		PF?			CS. TW. HKL., INT. AR. LN.	
101	2594.1 2594.4	0.3'	A/A	m ?/m		N40°W ~90°		TF			CS. TW. HKL., INT. AR. LN.	
102	2595.7 2596.2	0.5'	A/A	m? m				KES			CS. TW. HKL., INT. AR. LN.	
103	2597.2 2597.5	0.3'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	ORIGINS AT ORIENTATION GROOVE
104	2597.4 ?	?	A/A	m ?		N80°E 50°SE		TF			CS. TW. HKL., INT. AR. LN.	BASE OF FRACTURE LOST IN RUBBLE ZONE
105	2597.7 2598.3	0.6'	A/A	F104 →				DF			V. CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE; CONNECTION AT 2598.0'
106	2598.3		A/A	(m)		⊕		DCS		CIRCULAR	CS. TW. HKL., CBS	RUBBLE ZONE
107	2602.9 2602.1	0.2'	A/A	m m				TF			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE; CONNECTION AT 2608.0'
108	2608.1		A/A	(m)		⊕		DCS		CIRCULAR	CS. TW. HKL., CBS	

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
109	2608.6		mDST, SLTY mDST, SLTST (5Y4/1), (5G4/1), (N6)	(m)	CP	⊕	CI	TF			CS. TW. HKL., INT. AR LN., CBS	
110	2611.4 2611.6	0.2'	SLTY mDST., (5Y4/1)	m? m				KES?			CS. TW. HKL., INT. AR. LN.	
111	2615.9 2616.1	0.2'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
112	2617.4 2617.7	0.3'	A/A	m m				KES			CS. TW. HKL., INT. AR. LN.	
113	2633.3 2633.6	0.3'	A/A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
114	2636.5 2636.8	0.3'	mDST., (5Y4/1), (5G4/1)	m? m		N80°W ~90°		PF?			CS. TW. HKL., INT. AR. LN.	
115	2642.3 2642.5	0.2'	A/A	m m?		N15°W ~90°		PF?			CS. TW. HKL., INT. AR. LN., FN. HKL PLM.	
116	2643.8 2644.1	0.3'	A/A	m? →		N78°E ~90°		PFC			CS. TW. HKL., STRONG INT. AR. LN.	
117	2656.7 2658.0	1.3'	mDST, SLTY mDST, SLTST (5Y4/1), (5G4/1)	m DCS		—		TF			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE
118	2658.0		A/A	(m)		⊕		DCS		CIRCULAR	CS. TW. HKL., CBS	
119	2658.3 2658.4	0.1'	A/A	m m		N25°E ~90°		PF			CS. TW. HKL., INT. AR LN	
120	2658.8 2659.0	0.2'	A/A	m m?		N25°W ~90°		PF?			CS. TW. HKL., INT. AR. LN.	
121	2670.7 2671.5	0.8	SLTY mDST., mDST. (5G4/1), (5Y3/1)	?/c m		—		PF			CS. TW. HKL., INT. AR. LN.	OCCURS WITHIN RUBBLE ZONE
122	2670.7 2671.5	0.8	A/A	?/c F123		—		TF			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE
123	2671.5		A/A	(m)		⊕		DCS?		CIRCULAR	CS. TW. HKL., CBS	
124	2679.0 2679.3	0.3'	mDST, SLTY mDST, SLTST (5Y4/1), (5G4/1), (5Y5/1)	m m?				KES			CS. TW. HKL., INT. AR. LN.	
125	2679.0 2679.6	0.6'	A/A	m? m				KES			V. CS. TW. HKL., STRONG INT. AR. LN.	
126	2682.4 2682.7	0.3'	A/A	m m?		—		PF?			CS. TW. HKL., INT. AR. LN.	UNORIENTED CORE
127	2691.6 2692.0	0.4'	mDST., (5Y4/1), (5Y4/1), (5G4/1), (5G4/1)	m ?/m		—		TF			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE: UNORIENTED CORE
128	2692.0 2692.3	0.3	A/A	F123 m		—		PF?			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE: UNORIENTED CORE
129	2692.6 2692.8	0.2'	A/A	m ?/c		—		TF?			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE: UNORIENTED CORE
130	2692.4 2692.6	0.2'	A/A	? m		—		PF?			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE: UNORIENTED CORE
131	2692.8		A/A	(m)		⊕		DCS		CIRCULAR	CS. TW. HKL.	
132	2692.8 2693.3	0.5'	A/A	? ?/m		—		TF			CS. TW. HKL., INT. AR. LN.	RUBBLE ZONE
133	2693.3		A/A	(m)		⊕		DCS		CIRCULAR	CS. TW. HKL.	
134	2696.2 2696.3	0.1'	A/A	m ?				KES			CS. TW. HKL., INT. AR. LN.	
135	2696.6 2696.9	0.3'	A/A	? m	↓	N62°W ~90°	↓	PF?			CS. TW. HKL., INT. AR. LN.	

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
136	2698.6 2698.8	0.2'	MOST (5Y4/1), (5Y4/1) (5G4/1), FS	m m?	CP		CI	KES			CS. TW. HKL., INT. AR. LN.	
137	2698.7 2699.9	0.2'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
138	2700.0 2700.4	0.4'	SLTY MOST (5Y4/1) (5Y4/1)	m? m				KES			CS. TW. HKL., INT. AR. LN.	
139	2700.5 2700.8	0.3'	A A	m? m				KES?			CS. TW. HKL., INT. AR. LN.	
140	2700.9 2701.1	0.2'	A A	m m				KES			CS. TW. HKL., INT. AR. LN.	
141	2702.3 2702.4	0.1'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
142	2702.5 2702.9	0.4'	A A	m m?		N48°W ~90°		PF?			CS. TW. HKL., INT. AR. LN.	
143	2703.3 2703.4	0.1'	A A	m ?				KES			CS. TW. HKL., INT. AR. LN.	
144	2703.9 2704.1	0.2'	A A	m m?	↓			KES			CS. TW. HKL., INT. AR. LN.	
145	2705.0		A A	(m) m?	P	⊕		DF		CIRCULAR	CS. TW. HKL.	CONNECTION AT 2703'
146	2706.0 2706.2	0.2'	A A	m? m	CP	N45°E ~90°		KES?			CS. TW. HKL., INT. AR. LN.	
147	2706.7 2706.9	0.2'	A A	m m?		N40°W ~90°		PF?			CS. TW. HKL., INT. AR. LN.	
148	2707.9 2708.2	0.3'	A A	m m				KES			CS. TW. HKL., INT. AR. LN.	
149	2709.0 2710.5	1.5'	A A	m m				KES			CS. TW. HKL., INT. AR. LN.	
150	2712.2 2712.6	0.4'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
151	2712.7 2713.1	0.4'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
152	2713.3 2714.9	0.6'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
153	2720.9 2721.1	0.2'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
154	2721.1 2721.4	0.3'	A A	m m				KES			CS. TW. HKL., INT. AR. LN.	
155	2722.8 2723.0	0.2'	A A	m m?		N60°E ~90		PF?			CS. TW. HKL., INT. AR. LN.	
156	2724.4 2724.7	0.3'	A A	m m?				KES?			CS. TW. HKL., INT. AR. LN.	
157	2725.3 2725.6	0.3'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
158	2727.3 2727.4	0.2'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
159	2730.3 2730.5	0.2'	SLTY MOST MOST (5Y4/1), (5Y4/1)	m m?				KES			CS. TW. HKL., INT. AR. LN.	
160	2730.9 2731.0	0.1'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
161	2731.3 2735.1	0.4'	A A	m m?				KES			CS. TW. HKL., INT. AR. LN.	
162					↓		↓					

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: EGSP OH-6/4 Gallia Co.

LOG CLASSIFICATION
☐ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): Coring Induced

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE / DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
	2731.1		SLTY MDST. MDST	M								
163	2731.3	0.2'	5Y 3/1 5Y 4/1	M	CP		CT	KES			CS. TW. HKL.	
	2741.4		MDST	M								
164	2741.8	0.4'	5Y 3/1 5Y 4/1	M				KES TF			CS TW HKL	
	2742.1		A/A	M								
165	2742.6	0.5'	A/A	M				KES			CS TW HKL	
	2742.5		A/A	M								
166	2743.0	0.5'	A/A	M				KES			CS TW HKL	
	2746.9		A/A	M								
167	2747.3	0.4'	A/A	M				KES			CS TW HKL	
	2748.4		A/A	M							INT. AR. LN.	
168	2749.5	1.1'	A/A	M				KES			CS. TW HKL	
	2750.8		A/A	?M							FAINT CIRCULAR SLICKS.	
169	2751.3	0.5'	A/A	?				TF		PRESENT	CS TW HKL	RUBBLE ZONE
	2754.2		A/A	M								
170	2754.7	0.5'	A/A	M				KES			CS. TW. HKL.	
	2755.6		A/A	M								
171	2755.9	0.3'	A/A	M				KES			CS TW. HKL.	
	2758.8		SLTY. MDST.	M								
172	2759.2	0.4'	5Y 3/1 5G 4/1	M				KES				
	2761.9		A/A	M								
173	2762.0	0.1'	A/A	M				TF			CS. TW. HKL. HKL. PLM	
	2763.6		A/A	M								
174	2764.1	0.5'	A/A	M				KES				
	2765.5		A/A	M								
175	2765.9	0.4'	A/A	M				KES				
	2768.5		A/A	M								
176	2768.6	0.1'	A/A	M				KES				
	2768.7		A/A	M								
177	2768.8	0.1'	A/A	M				KES				
	2770.2		MDST	M								
178	2770.6	0.4'	5Y 3/1 5G 4/1	M				KES				
	2771.7		A/A	M								
179	2772.0	0.3'	A/A	M				KES				
	2771.9		A/A	M								
180	2772.2	0.3'	A/A	M				KES				
	2772.2		A/A	M								
181	2772.4	0.2'	A/A	M				KES			CS. TW. HKL.	
	2774.0		A/A	M								
182	2774.6	0.6'	A/A	M				KES				
	2774.4		A/A	M							INT. AR. LN.	
183	2774.5	0.1'	A/A	M				TF			CS. TW. HKL.	
	2774.4		A/A	M								
184	2774.9	0.5'	A/A	M				KES				
185	2775.5		A/A	(M)	↓	⊕	↓	DCS		CIRCULAR		

EASTERN GAS SHALES PROJECT

OHIO #6/4 WELL

FREQUENCY OF DISC FRACTURES

Depth Per Interval	Number of Fractures	Frequency Per Foot
1,840-50	18	1.8
1,850-60	10	1.0
1,860-70	20	2.0
1,870-80	37	3.7
1,880-90	42	4.2
1,890-1,900	42	4.2
1,900-10	28	2.8
1,910-20	44	4.4
1,920-30	57	5.7
1,930-40	57	5.7
1,940-50	55	5.5
1,950-60	54	5.4
1,960-70	50	5.0
1,970-80	32	3.2
1,980-90	25	2.5
1,990-2,000	22	2.2
2,000-10	27	2.7
2,010-20	24	2.4
2,020-30	23	2.3
2,030-40	39	3.9
2,040-50	42	4.2
2,050-60	36	3.6
2,060-70	41	4.1
2,070-80	35	3.5
2,080-90	33	3.3
2,090-2,100	36	3.6
2,100-10	52	5.2
2,110-20	69	6.9
2,120-30	35	3.5
2,130-40	36	3.6
2,140-50	55	5.5
2,150-60	55	5.5
2,160-70	36	3.6
2,170-80	52	5.2
2,180-90	57	5.7
2,190-2,200	33	3.3
2,200-10	31	3.1
2,210-20	38	3.8
2,220-30	34	3.4
2,230-40	40	4.0

Continued

FREQUENCY OF DISC FRACTURES
(Continued)

Depth Per Interval	Number of Fractures	Frequency Per Foot
2,240-50	45	4.5
2,250-60	28	2.8
2,260-70	31	3.1
2,270-80	29	2.9
2,280-90	32	3.2
2,290-2,300	37	3.7
2,300-10	30	3.0
2,310-20	28	2.8
2,320-30	27	2.7
2,330-40	34	3.4
2,340-50	39	3.9
2,350-60	38	3.8
2,360-70	33	3.3
2,370-80	27	2.7
2,380-90	27	2.7
2,390-2,400	31	3.1
2,400-10	40	4.0
2,410-20	50	5.0
2,420-30	45	4.5
2,430-40	62	6.2
2,440-50	60	6.0
2,450-60	37	3.7
2,460-70	54	5.4
2,470-80	46	4.6
2,480-90	51	5.1
2,490-2,500	48	4.8
2,500-10	68	6.8
2,510-20	70	7.0
2,520-30	62	6.2
2,530-40	63	6.3
2,540-50	35	3.5
2,550-60	30	3.0
2,560-70	34	3.4
2,570-80	37	3.7
2,580-90	18	1.8
2,590-2,600	26	2.6
2,600-10	38	3.8
2,610-20	15	1.5
2,620-30	33	3.3
2,630-40	24	2.4
2,640-50	24	2.4
2,650-60	35	3.5
2,660-70	31	3.1
2,670-80	26	2.6

Continued

FREQUENCY OF DISC FRACTURES
(Continued)

Depth Per Interval	Number of Fractures	Frequency Per Foot
2,680-90	60	6.0
2,690-2,700	47	4.7
2,700-10	21	2.1
2,710-20	19	1.9
2,720-30	27	2.7
2,730-40	17	1.7
2,740-50	16	1.6
2,750-60	34	3.4
2,760-70	20	2.0

BASE OF CORE: 2,775.4'

FRACTURE LOGS

EGSP-OHIO #6/5

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

EGSP STANDARD CORE FRACTURE LOGGING FORMAT

WELL: E.G.S.P. OH-6/5 Gallia Co.

PAGE 1 OF 1
LOG CLASSIFICATION
☒ INDIVIDUALS ☐ INTERVALS
FRACTURE TYPE(S): All

NUMBER	DEPTH EXTENT	LENGTH	LITHOLOGY	TERMINATIONS	CHARACTER	STRIKE DIP	INTERPRETATION	FRACTURE TYPE	MINERALIZATION	SLICKENSIDES	FRACTOGRAPHIC FEATURES	COMMENTS
1	1660.0		MDST, SLT. MDST. + FN. SS. (5GY 4/1) (N4)	(m)	CP	⊕	CI	DCS		CIRCULAR		TOP OF RUN 1
2	1679.7 1680.0	0.3'	MDST. GR. BLK. (5G 2/1) + OL. BLK. (5Y 2/1)	BDG. m	CP		CI	TF			CS. TW. HKL.	
3	1680.95 1681.14	0.19'	A/A	?/C →	P	N24°E 72°SE	N	SPLJT	PYRITE			PYRITE - FILLED, CLOSED FRACTURE
4	1309.5 1309.6	0.1'	A/A	m BDG.	CP		CI	TF			CS. TW. HKL.	
5	1311.81		A/A	↙	CP		N	MCRFLT	PYRITE (?) SLIGHT	PRESENT		SLICKEN LINES AROUND 3cm x 5cm PYRITE (?) NODULE; NODULE MISSING (MOUND SAMPLE)
6	1313.0 1314.2	1.2'	MDST. SLT MDST + SLTST (5G 4/1) (5G 2/1) LNS	m BDG.	CP	N55°E ~90°	CI	PFC			CS. TW. HKL., PRONOUNCED INT. AR. LN.	PROPAGATION: UP-CORE
7	1940.0		MDST + SLTST. (5G 2/1) (5G 4/1) + (N6)	(m)	CP	⊕	CI	DCS		CIRCULAR	CS. TW. HKL.	TOP OF RUN 2.
8	1945.2		A/A	↙ (?)	CP		N	MCRFLT		PRESENT		SLICKEN LINES AROUND GROUP OF 3 PYRITE NODULES (3 cm. DIAM.)
9	1958.2		MDST. + SLTY MDST. (5G 2/1) (5GY 4/1)	(m)	CP	⊕	CI	TF			C.B.S., HKL. PLM.	CONNECTION WITH CORE OFFSET
10	1973.2		A/A	(m)	CP	⊕	CI	TF			C.B.S.	CONNECTION WITH CORE OFFSET
11	2440.0		MDST, GR BLK (5YR 2/1) + OL. GR. (5GY 2/1)	(m)	CP	⊕	CI	DCS		CIRCULAR	CS. TW. HKL.	TOP OF RUN 3
12	2440.0(?) 2441.55	1.55'	A/A	?/C →	P	N65°E 90°	N	SPLJT	SLIGHT: CALCITE			OPEN FRACTURE
13	2444.3 2445.45	1.15'	A/A	→ ?/C	P	N70°E 90°	N	SPLJT				CLOSED FRACTURE
14	2451.9 2452.05	0.15'	MDST + LIME MDST. (5G 4/1) (5G 2/1)	BDG. →	CP	~N50°W ~25°NE	N	MCRFLT		PRESENT		SLUMP STRUCTURE IN SILTY MUDSTONE BENEATH SILTSTONE BED
15	2463.85 2463.95	0.1'	MDST. GR GY (5G 4/1) + BR. BLK. (5YR 2/1)	m BDG.	CP	N5°W 70°SW	CI	PF			CS. TW. HKL.	
16	2491.6 2491.8	0.2'	MDST. LIME MDST + SLTY MDST. (5GY 4/1)	BDG. m	CP		CI	TF			CS. TW. HKL.	

EASTERN GAS SHALES PROJECT

OHIO #6/5 WELL

FREQUENCY OF DISC FRACTURES

Depth Per Interval	Number of Fractures	Frequency Per Foot
1,660-70	35	3.5
1,670-80	31	3.1
1,680-90	37	3.7
1,690-1,700	35	3.5
1,700-10	26	2.6
1,710-18	31	3.9
1,718' to 1,940': Plug Drilled		
1,940-50	33	3.3
1,950-60	30	3.0
1,960-70	36	3.6
1,970-80	28	2.8
1,980-90	33	3.3
1,990-1,998.6	41	4.8
1,998.6' to 2,440': Plug Drilled		
2,440-50	27	2.7
2,450-60	18	1.8
2,460-70	30	3.0
3,470-80	21	2.1
2,480-90	24	2.4
2,490-2,498.3	36	4.3

BASE OF CORE: 2,498.3'

APPENDIX D

HISTOGRAMS:

FREQUENCY OF DISC FRACTURES

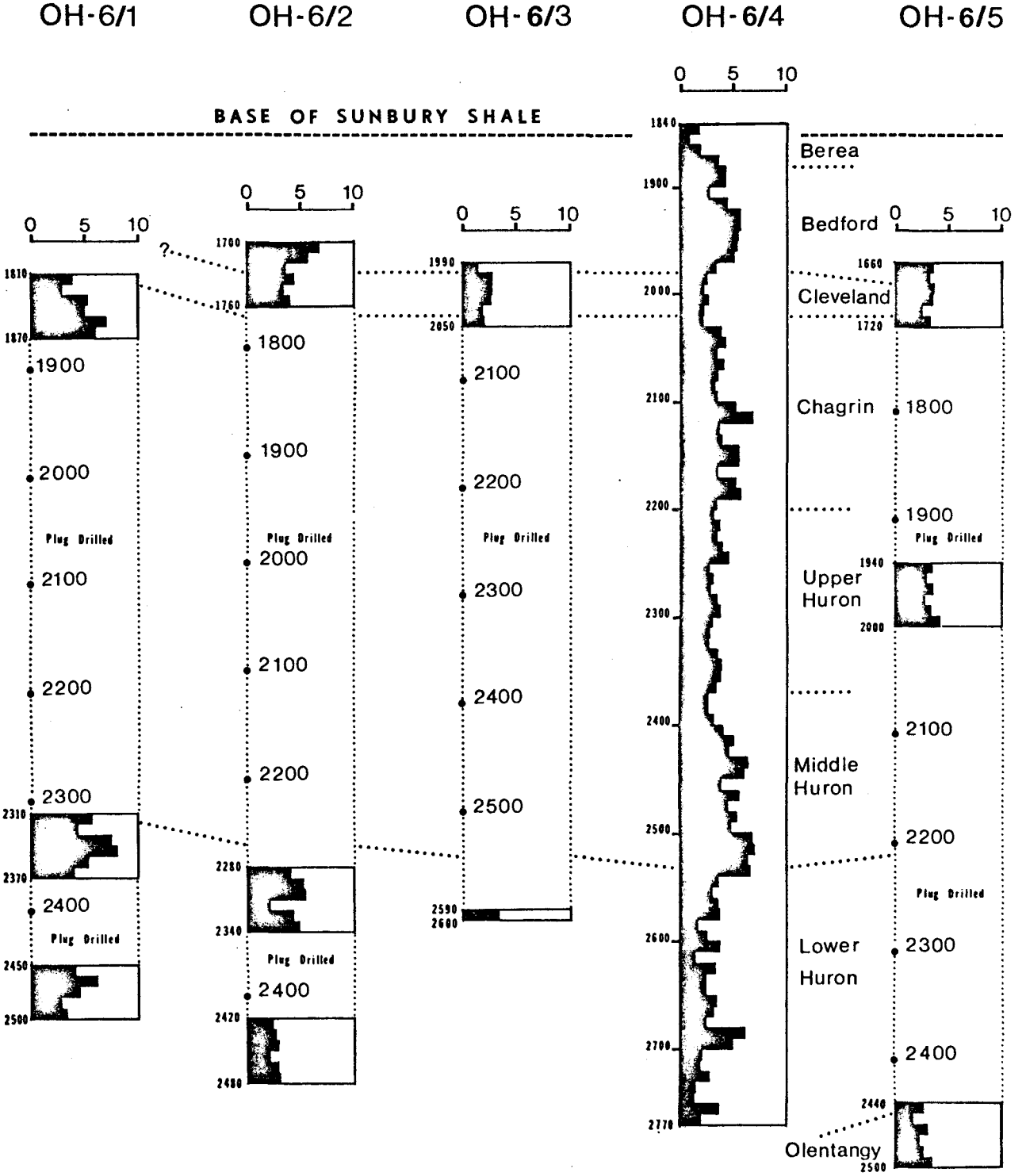
ROCK COLOR

EGSP-OHIO #6 SERIES

DISC FRACTURES

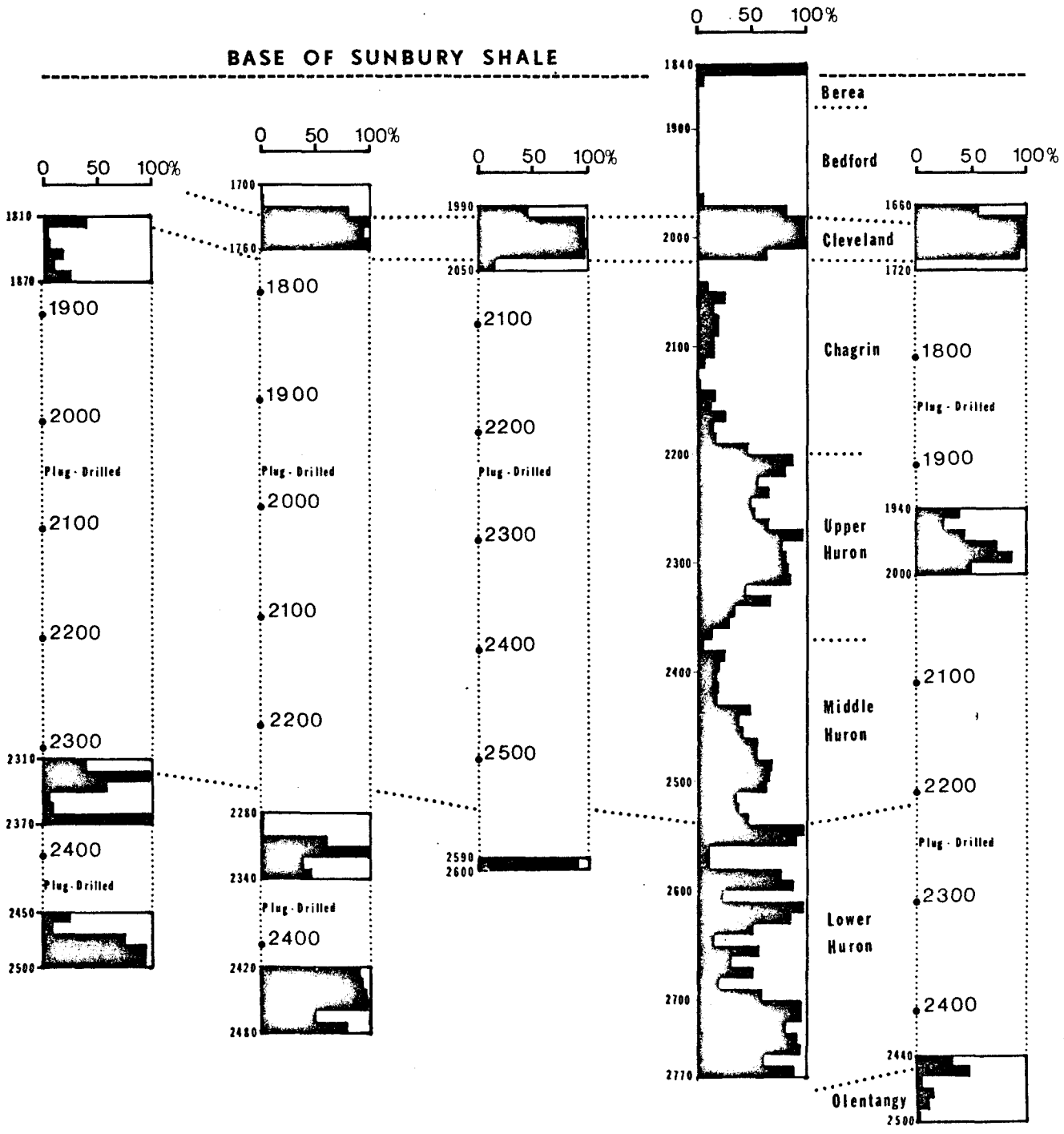
E.G.S.P. OHIO-6 SERIES: FREQUENCY PER FOOT

(OVER 10-FOOT INTERVALS)



COLOR HISTOGRAMS

E.G.S.P. OHIO-6 SERIES: % DARKER THAN N3



BIBLIOGRAPHY

Bennison, A. P., et al, 1978, Geological Highway Map of the Great Lakes Region: Am. Assoc. Petrol. Geol. (publ.), Tulsa, Oklahoma.

Cushing, H. P., et al, 1931, Geology and mineral resources of the Cleveland District, Ohio: U. S. Geol. Survey Bulletin 818, 138 p.

deWys, J. M., and Shumaker, R. C., 1978, Eastern Kentucky Gas Field, Structural-stratigraphic cross sections and potential production patterns: Second Eastern Gas Shales Symposium, v. 1, pp. 66-69, Morgantown, West Virginia.

Dunham, R. J., 1962, Classification of carbonate rocks according to depositional texture: in W. E. Ham (ed.), Classification of Carbonate Rocks, pp. 108-201, Am. Assoc. Petrol. Geol., Tulsa, Oklahoma.

Evans, M., 1979, Fracture density and orientation study of the Reel Energy #3 D/K core from Mason County, West Virginia: (Unpublished Contract Report, U. S. Department of Energy Contract No. DE-AC21-76MC05194), Morgantown, West Virginia.

Geological Society of America, Rock Color Chart: Geological Society of America, Boulder, Colorado, 1948.

Harris, L. D., 1978, The Eastern Interior Aulacogen and its relation to Devonian shale gas production: Second Eastern Gas Shales Symposium, v. 1, p. 36, Morgantown, West Virginia.

Hass, W. H., 1947, Conodont zones in Upper Devonian and Lower Mississippian Formations of Ohio: Jour. Paleontology, v. 21, pp. 131-141.

Kulander, et al, 1977, Fractographic Logging for Determination of Pre-Core and Core-Induced Fractures - Nicholas Combs No. 7239 Well, Hazard, Kentucky, MERC CR 77/3 under contract MEG-P-2820, Morgantown Energy Research Center.

LaRocque, A., and Marple, M. F., 1955, Ohio Fossils: Ohio Geological Survey Bulletin 54, 152 p.

Pepper, J. F., et al, 1954, Geology of the Bedford Shale and the Berea Sandstone in the Appalachian Basin: U. S. Geol. Survey Prof. Paper 259, 111 p.

Potter, P. E., Maynard, J. B., and Pryor, W. A., 1980, Final Report of Special Geological, Geochemical, and Petrological Studies of the Devonian Shales in the Appalachian Basin: U. S. Department of Energy, Eastern Gas Shales Project report, U.S.D.O.E. Contract No. DE-AC21-76MC05201, Department of Geology, University of Cincinnati, Cincinnati, Ohio.

Provo, L. J., 1977, Stratigraphy and sedimentology of radioactive Devonian-Mississippian Shales of the Central Appalachian Basin: University of Cincinnati, Ph.D. dissert. (unpubl.) 128 p.

Provo, L. J., et al, 1977, Three Lick Bed: useful stratigraphic marker in the Upper Devonian Shale in eastern Kentucky: E.R.D.A., Morgantown Energy Research Center, MERC/CR-77-2, 56 p.

Schwietering, J. F., 1979, Devonian Shales of Ohio and their eastern and southern equivalents, U. S. Department of Energy Contract EY-76-C-05-5199, Morgantown Energy Technology Center, Morgantown, West Virginia.

U. S. DEPARTMENT OF ENERGY

MORGANTOWN ENERGY TECHNOLOGY CENTER

EASTERN GAS SHALES PROJECT

EGSP OH-6 SERIES, GALLIA CO.

CLIFFS MINERALS INC.

PREPARED UNDER
CONTRACT NO. DE-AC21-78MC08199

WELL: OH-6-1 (CARPENTER #1-5)
OH-6-2 (WHITE PRICE NEWBERRY UNIT #1-7)
OH-6-3 (L. MCCOMBS #1-6)
OH-6-4 (STRAIGHT-WISEMANDLE UNIT #1-8)
OH-6-5 (M. CARTER #1-9)

API NO.: 34-053-20482
34-053-20479
34-053-20474
34-053-20477
34-053-20478

DRILLING COMPLETED: DECEMBER 5, 1979

DRAWN: MAY, 1980

OH-6/2 | OH-6/5 | OH-6/1 | OH-6/3 | OH-6/4

GAMMA (API UNITS)
LITHOLOGY
NATURAL FRACTURES

AGE & FORMATION

LOWER MISS
SUNBURY SH.
BEREA SS.
BEDFORD FM.
CLEVELAND MEMBER
CHAGRIN MEMBER
UPPER DEVONIAN
HURON SH.
UPPER MEMBER
MIDDLE MEMBER
LOWER MEMBER
OLENTANGY SH.

LOCATION OF EGSP WELLS
OHIO NO. 6 SERIES

OHIO
GALLIA CO.
Gallipolis
Ironton
Portsmouth
PERRY TWP.
GREEN TWP.
WALNUT TWP.
HARRISON TWP.
0 miles

LEGEND

MUDSTONE
SILTY MUDSTONE/SILTY SHALE
SHALY MUDSTONE
SILTSTONE
ARGILLACEOUS LIMESTONE
VOLCANIC ASH
SANDSTONE

CORRELATION DATUM: BASE OF SUNBURY