

NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT
U. S. NAVY
EAST TESHEKPUK NO. 1

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: Gordon W. Legg

For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
AUGUST 1983

TABLE OF CONTENTS

	<u>Page</u>
GEOLOGIC SUMMARY	
Introduction	1
Pre-Drilling Prognosis	1
Post-Drilling Summary	1
Location Map (Figure 1)	2
Topographic Map Showing Staked Location (Figure 2)	3
WELLSITE GEOLOGIST'S REPORT	
Introduction	4
Stratigraphy	
Wireline Tops	4
Cretaceous	
Colville Group (undifferentiated)	5
Nanushuk Group (undifferentiated)	5
Torok Formation	6
"Pebble Shale"	6
Jurassic	
Kingak Formation	7
Triassic	
Sag River Sandstone	7
Shublik Formation	8
Triassic-Permian	
Sadlerochit Group	
Ivishak Formation	8
Kavik Shale Member	8
Echooka Formation	8
Late Mississippian-Middle Pennsylvanian	
Lisburne Group (undifferentiated)	9
Pre-Mississippian(?)	
Granite	9
Hydrocarbon Shows and Potential Reservoir	10
Conclusions	10
LIST OF FIGURES	
Figure 1 - Location Map	2
Figure 2 - Topographic Map Showing Staked Location	3

PERTINENT DATA AND APPENDICES

<u>Appendix</u>	<u>Page</u>
A. Summary Pertinent Data, Operations and Analysis	A-1-2
B. Drill Cuttings and Core Descriptions	B-1-73
C. Occurrence of Granitic Basement (Memo, Ken Bird, USGS)	C-1-2

COMPOSITE LITHOLOGY LOG (In Pocket)

GEOLOGIC SUMMARY

INTRODUCTION

The U. S. Navy, East Teshekpuk No. 1 well is located in the NW 1/4 of protracted Section 16, T14N, R4W, Umiat Meridian, North Slope Borough, Alaska. The surveyor's plat locates the well 675' FWL and 1650' FNL of the section (see Figures 1 and 2). The East Teshekpuk well was drilled in early 1976, and was the first well to be drilled by Husky Oil NPR Operations, Inc. as a contractor on the Naval Petroleum Reserve No. 4.

The well was spudded on March 12, 1976. The well was plugged and abandoned after reaching a total depth of 10,664 feet (driller). The date of abandonment and subsequent rig release was May 11, 1976.

A slight show of oil was encountered in the Kuparuk Sandstone equivalent. The sandstone was thin and the porosity was poor. Only a few, scattered, minor gas shows were recorded in other parts of the drilled section. None of these gas shows was significant, nor did any of the shows occur in a section with reservoir potential. No coring or testing was done in the well.

PRE-DRILLING PROGNOSIS

The East Teshekpuk No. 1 well was drilled in order to test a broad, low-relief structure interpreted from seismic data. The primary objectives were sandstones of the Sadlerochit Group and carbonates of the Lisburne Group. Secondary objectives were the Kuparuk Sandstone equivalent and the Sag River Sandstone.

POST-DRILLING SUMMARY

The primary objectives of the East Teshekpuk No. 1 well, sandstones of the Sadlerochit Group and carbonates of the Lisburne Group, were both present in the well, but contained porosities well below those needed for a potential producing reservoir. In addition, neither of the primary objectives had shows of hydrocarbons except for very minor gas shows. There were slight shows of oil in the Kuparuk Sandstone equivalent, but the thin sandstone present (15 feet net) and its relatively low porosity of 7-14%, precluded any attempt to evaluate the zone by testing. No other zones had shows of significance.

Probably, the most interesting result in drilling the East Teshekpuk No. 1 well was the unexpected presence of apparent basement of "fresh granite" (see Appendix C). This was the first well on the North Slope known to have encountered such basement. The nature of this basement, and, indeed, the question of whether or not the granite is actually basement, could have a profound effect upon seismic interpretation in the area. Understanding the orogenic history and possible post-orogenic depositional history of the granite, could be a key element in developing any future prospects in the area.

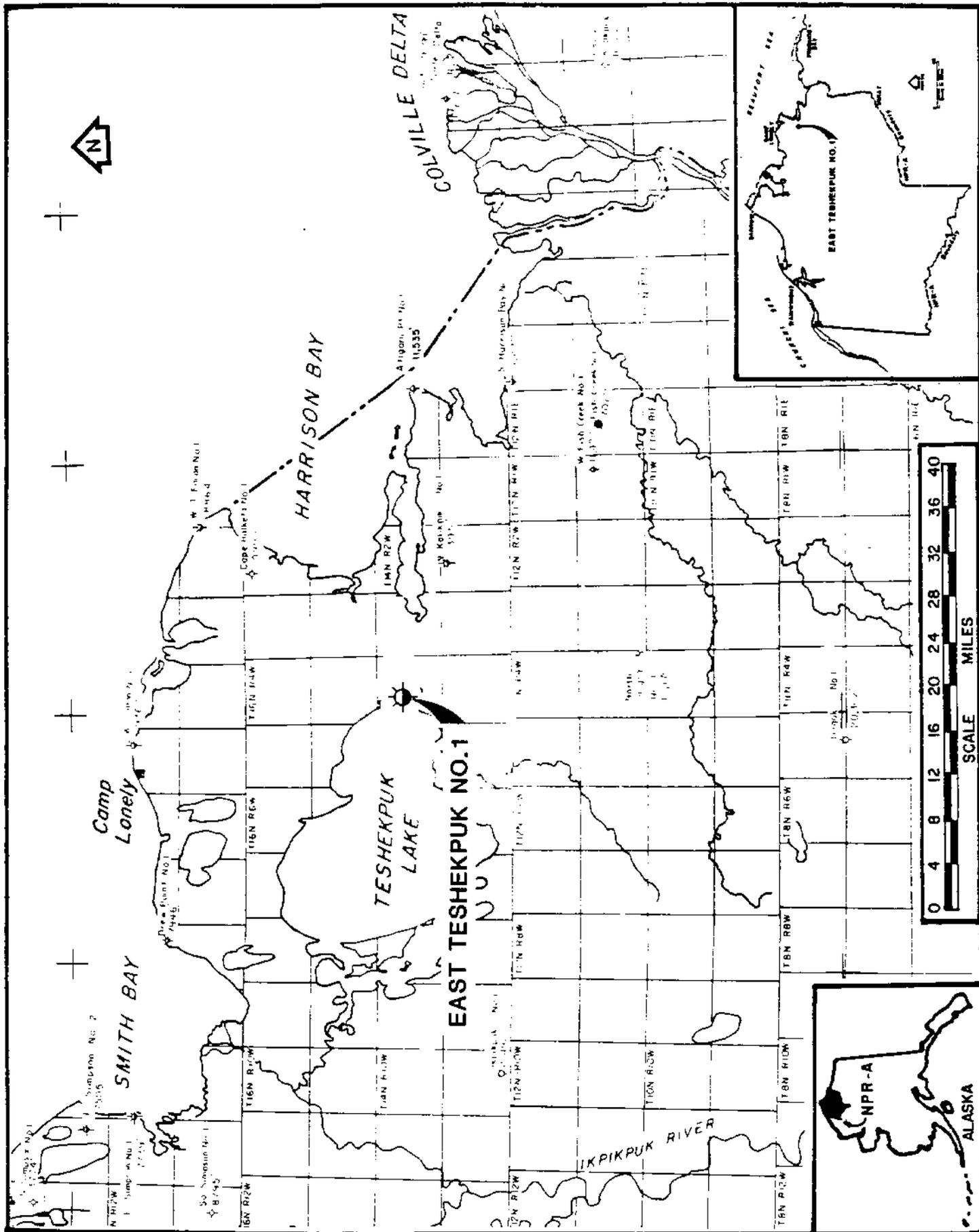


FIGURE 1 - LOCATION MAP - EAST TESHEKPUK NO. 1

WELLSITE GEOLOGIST'S REPORT
(No Report in Files)
LATER REPORT BY: GORDON W. LEGG

INTRODUCTION

The U. S. Navy, East Teshekpuk No. 1 well was drilled near the eastern shore of Lake Teshekpuk during the 1976 drilling season. This well was the first one to be drilled by Husky Oil NPR Operations, Inc. as a contractor to the U. S. Navy on the Naval Petroleum Reserve No. 4 (now designated the National Petroleum Reserve in Alaska, and under the administration of the Department of the Interior).

Drilling was commenced on March 12, 1976 and a total depth of 10,664 feet was reached on May 6, 1976. The well was plugged and abandoned and the rig was released on May 11, 1976. At the time of abandonment, the well was drilling in granitic rocks, although the correct lithology was not detected by the wellsite geologist. The granite has been described in some detail by Ken Bird of the USGS in a memorandum dated March 14, 1977 (see Appendix C). Whether this granite is an eroded basement complex, an up-faulted basement block, or is of some other occurrence, is not known at this time.

The minor hydrocarbon shows in the East Teshekpuk No. 1 well were restricted to the "Pebble Shale" and to parts of the Kingak Formation. These shows were primarily gas, with some scattered, very poor oil shows. None of the shows were significant, nor did they occur in any potential reservoir rocks. The primary objectives, sandstones of the Sadlerochit Group, and carbonates of the Lisburne Group, did not contain shows, and exhibited very poor reservoir potential due to low porosities.

None of the shows in the well were considered worthy of additional evaluation.

STRATIGRAPHY

WIRELINE TOPS*

No samples caught	0- 533'
CRETACEOUS	
Colville Group (undifferentiated)	533- 1,940'
Nanushuk Group (undifferentiated)	1,940- 3,122'
Torok Formation	3,122- 6,850'
"Pebble Shale"	6,850- 7,266'
JURASSIC	
Kingak Formation	7,266- 8,545'

TRIASSIC	
Sag River Sandstone	8,545- 8,669'
Shublik Formation	8,669- 8,855'
TRIASSIC-PERMIAN	
Sadlerochit Group	
Ivishak Formation	8,855- 9,611'
Kavik Shale Member	9,443- 9,611'
Echooka Formation	9,611- 9,649'
LATE MISSISSIPPIAN-MIDDLE PENNSYLVANIAN	
Lisburne Group (Undifferentiated)	9,649-10,620'
PRE-MISSISSIPPIAN(?)	
Granite (possible basement)	10,620-10,664'

- * Tops have been changed from the original data in many instances in order to conform to present usage; paleontological tops are used exclusively in rocks younger than the Torok Formation.

CRETACEOUS

Colville Group (undifferentiated): 533-1940'

The sedimentary section within the Colville Group is represented primarily by claystones and siltstones, which are typically carbonaceous and frequently sandy. The claystones are gradational to siltstones, and the siltstones occasionally grade to very fine grained, silty sandstones. The sandstones frequently contain very fine grains of glauconite. Scattered throughout the section are laminae and sometimes thin beds (1-6') of lignitic to subbituminous coal. Rocks of the Colville Group are predominantly of nonmarine to inner neritic origin (Anderson, Warren & Associates, Inc.). The presence of glauconite in the section suggests a near-shore, shallow marine environment, perhaps alternating with nonmarine interludes as evidenced by the coal beds.

Nanushuk Group (undifferentiated): 1940-3122'

The base of the Colville Group/Top of the Nanushuk Group (1940') is chosen strictly on the basis of paleontological determinations, but the base of the Nanushuk Group/Top of the Torok (3122') has been picked on the basis of electric log characteristics. Anderson, Warren & Associates, Inc. picks the base of the Nanushuk/Top of Torok at 3110'.

Rocks of the Nanushuk Group are composed, for the most part, of claystones, which are interbedded with minor sandstones and siltstones. The claystones are soft and poorly indurated, becoming clay-like which disperse in the mud system. The sandstones and siltstones appear to be gradational, with the sandstones being inevitably very fine-grained, and containing abundant silt and clay within the matrix. Glauconite is again common, as are darker mafic minerals which gives a "salt and pepper"

appearance to the sandstones and siltstones. The rocks all contain varying amounts of carbonaceous material; coal seams and laminations are common. The major lithological differences between rocks of the Nanushuk Group and those of the overlying Colville Group appear to be the decrease in siltstones in the Nanushuk and the pervasive presence in the Nanushuk of chemical precipitates of siderite, accompanied occasionally by calcite. Pyrite is also common. The chemical precipitates indicate a somewhat more marine environment for the Nanushuk Group, as opposed to the Colville Group. This increased marine condition is supported by Anderson, Warren & Associates, Inc.'s classification of an inner to middle neritic environment for the Nanushuk.

Torok Formation: 3122-6850'

Anderson, Warren & Associates, Inc. has classified the interval of 3110' to 6930' as Early Cretaceous, Albian age, Torok Formation. As previously discussed, a top of the Torok at 3122' (electric log) is a more exact pick. As for the variance between the electric log pick of 6850' for the Base of the Torok/Top of the "Pebble Shale" and the paleontological determination of 6930', the electric log pick is to be preferred since there is a dramatic increase in the gamma-ray response at 6850'. This "hot" gamma-ray response is used by most Alaskan geologists as the top of the "Pebble Shale".

The lithology of the Torok is not significantly different from that of the overlying Nanushuk Group. It is predominantly claystone, interbedded with siltstones and sandstones. Carbonaceous material is common, and pyrite is present everywhere within the section. The claystones are frequently bentonitic and contain abundant siderite, probably as a chemical precipitate. The abundance of pyrite, in association with the high organic content of the claystones, siltstones and sandstones, points to a strongly reducing environment. Anderson, Warren & Associates, Inc. assigns a middle to outer shelf depositional environment to the interval 3110-5100', with the zone from 5100' to 5700' probably representing a change to marginal marine or even nonmarine conditions, and a return to marine, inner neritic to middle neritic, for the interval below 5700'. The evidence for these depositional environments is mostly furnished by faunal assemblages and is not strongly supported by lithological evidence. No reservoir quality sandstones were present in the Torok.

"Pebble Shale": 6850-7266'

The "Pebble Shale" is characterized by a very strong gamma-ray response on the electric log for the top 150 feet. This gamma-ray zone is a dark gray to brownish-gray, very organic shale which is rich in petroliferous content as evidenced by the cut and fluorescence when treated with the solvent, chloroethane. Occasional "floating", frosted, rounded quartz grains are present within the shale. The presence of these quartz grains is characteristic of the "Pebble Shale".

The interval from 7110-7127' contains a clean sandstone, which is probably the Kuparuk Sandstone equivalent. This sandstone was fine grained, containing grains of both quartz and chert. Some of the chert appeared as black grains, and gave the sandstone a "salt and pepper" appearance. The sandstone was calcareous and, generally, argillaceous. The reservoir quality was poor to fair, with reported porosities ranging from 7% to 14%. Two sidewall cores in the interval yielded a light brown stain and pale yellow-white fluorescence. The "Pebble Shale" section below the sandstone appears to be thinly interbedded shales, siltstones and very argillaceous sandstones.

JURASSIC

Kingak Formation: 7266-8545'

Anderson, Warren & Associates, Inc. assigns the interval from 7200' to 8670' to the Kingak Formation of Jurassic age although some Triassic fossils were detected below 8,505 feet. On the basis of log characteristics and correlations, the top of the Kingak should probably be picked at 7266' at the base of the thinly bedded, alternating sequences of shale, siltstone and sandstone. The section below a depth of 7266' demonstrates a marked decrease in the indicated density porosity, and an assumption of a relatively stable sonic travel time. These factors indicate a change in lithology, grain-packing, and gas content.

The base of the Kingak was chosen to be 8545' rather than the depth of 8670' as picked by Anderson, Warren & Associates, Inc. in order to provide a separate stratigraphic classification for the Sag River Sandstone.

The Kingak Formation was represented almost entirely by shale, which was gray to dark gray, carbonaceous, frequently silty, blocky to fissile, and, generally, micromicaceous. No sandstones, except for minor laminations or turbidites, were observed in the Kingak.

TRIASSIC

Sag River Sandstone: 8545-8669'

The Sag River Sandstone was chosen, on the basis of electric log characteristics, as occurring in the interval 8545-8669'. At a depth of 8545', there is a strong increase in resistivity, a decrease in the gamma-ray, and a marked increase in the interval velocity time of the sonic. The lithology at this point has changed from shale to sandstone and siltstone. The actual "clean", slightly more porous, section of the Sag River Sandstone occurred in the interval from 8585' to 8625'. The porosities in the "best" part of the Sag River Sandstone (coinciding with the best S.P. development) range from 12-15%, with an overall average for the unit as a whole of about 8%.

The sandstone was light gray, very silty, very fine grained to fine grained, calcareous, well indurated, and contained rare glauconite grains. Only minor gas shows were encountered within the Sag River Sandstone, and the sandstone body, itself, is not a potential reservoir rock at this location.

Shublik Formation: 8669-8855'

The Sag River Sandstone grades gradually into the very hard, very calcareous (grading to limestone and exhibiting high resistivity on the electric log) Shublik Formation. The lithology of the Shublik is represented by an upper silty shale unit, a middle limestone unit, and a lower siltstone unit. The upper silty shale unit is dark gray in color and contains some sandstone and limestone. The middle unit is predominantly an argillaceous, fine crystalline limestone; this grades into the lower siltstone unit, which contains thin beds of hard, calcareous sandstone. Only a few slight gas shows were encountered in the Shublik.

TRASSIC-PERMIAN

Sadlerochit Group

Ivishak Formation: 8855-9611'

The primary objective of the East Teshekpuk No. 1 well was the Ivishak Formation of the Sadlerochit Group. The top of the Ivishak was picked at 9000' by paleontological determinations; however, log correlations are good through this zone, and the log pick of 8855' for the Ivishak is preferred to the faunal pick at 9000'.

The sandstones of the Ivishak were generally gray to light gray, fine grained, subangular, and were well cemented with silica, and with a slight amount of dolomitic cement, in the upper portion. There were occasional coarser grained streaks present as well as a few zones which were slightly conglomeratic. The section contained some red, lateritic siltstones below 9170'. According to Anderson, Warren & Associates, Inc., the Ivishak appears to be almost entirely marine in East Teshekpuk, as opposed to its nonmarine occurrence in the Cape Halkett well located approximately 18 miles to the northeast.

Porosities in the Ivishak were low, averaging around 7%. The low porosities were due mostly to the secondary cementation, consisting mostly of silica, and, to a lesser extent, dolomite and tripolitic clay. There were no visual shows and only a few very slight increases in the gas were noted from the mud logger.

From 9443' to 9611', the Kavik Shale Member of the Ivishak Formation was encountered. This shale was silver-gray to dark gray to brown-gray, silty, blocky to platy to fissile, and was, generally, very micaceous. A few sandstone and siltstone streaks were scattered throughout the section.

Echooka Formation: 9611-9649'

A thin section (38') identified as the Echooka Formation from log correlations was present in the basal part of the Sadlerochit Group. Anderson, Warren & Associates, Inc. also suggested that the interval from 9600' to 9660' might be Echooka on the basis of its lithology.

The sandstones of the Echooka were gray to dark gray, frequently mottled green from glauconite, fine grained, well consolidated and tight with both siliceous and dolomitic cement.

LATE MISSISSIPPIAN-MIDDLE PENNSYLVANIAN

Lisburne Group (undifferentiated): 9649-10,620'

Both the log derived picks, and the paleontological determinations by Anderson, Warren & Associates, Inc. agree very closely for the Lisburne Group. The log picks were from 9649-10,620' and the paleontological picks were from 9655' to 10,590'.

Carbonates of the Lisburne Group, along with the sandstones of the Sadlerochit Group, were the primary objectives of the East Teshekpuk well. The Lisburne carbonates, although present and well developed, had no visible shows and contained low porosities (generally less than 6%, with little or no secondary porosity).

The lithologies of the Lisburne Group range from calcarenitic limestones, representing reefoid equivalents, to forereef and backreef calcarenites, detrital limestone, calcilutites (lime muds) and, finally, to sandy and silty limestones. Dolomite was present in the top 15-20' of the Lisburne. An environmental analysis of the East Teshekpuk well has divided the Lisburne Group into forereef, reefoid and backreef facies. There appears to be little discussion of the basis for these classifications, and there does not appear to be a great deal of documentation. Additional studies need to be done, in order to definitely establish such an environmental pattern for the Lisburne, since this would be the first well on the North Slope to have forereef, reef, and backreef facies identified.

PRE-MISSISSIPPIAN(?)

Granite: 10,620-10,664'

The rocks present in this interval have been classified as granite on the basis of work done by Ken Bird of the USGS (see Appendix C). The original descriptions done by the wellsite geologist called this interval a "quartz agglomerate", and led to a great deal of confusion. This interval had been classified as Kekiktuk Conglomerate (Mississippian), until Mr. Bird's work.

The interval from 10,620' to 10,664' is a granite, consisting of roughly equal amounts of quartz and plagioclase feldspar, with minor amounts of biotite; quartz fragments are angular, with distinct crystal contacts with the feldspars; crystal size varies from 0.1 mm to 2 mm or more. There is no evidence of rounding or frosting of grains and, also, no evidence of interstitial material. Without such evidence, the rock cannot be classified as sedimentary in origin.

HYDROCARBON SHOWS AND POTENTIAL RESERVOIRS

There were no shows of any significance in the East Teshekpuk No. 1 well. There was slight staining and fluorescence in two sidewall cores (7112, 7117') taken in the Kuparuk Sandstone equivalent. The sandstone was thin (15 feet net) and had marginal porosities, which ranged from 7% to 14%.

The primary objectives, sandstones of the Sadlerochit Group and carbonates of the Lisburne Group, had no visible shows, nor can they be considered to be potential reservoirs, exhibiting porosities averaging less than 7%, and less than 6%, respectively.

CONCLUSIONS

The East Teshekpuk No. 1 well did not encounter any reservoir rocks capable of commercial production. Results from drilling East Teshekpuk, however, have posed two very important questions:

- (1) Does the Lisburne Group of carbonates have reefal potential at some location on the North Slope?
- (2) What is the origin of the granite encountered?

The first question, if satisfactorily answered, could lead to possible drilling prospects based solely on the reefal build-up and subsequent reservoir potential of the Lisburne. The second question should be addressed by additional seismic work to determine if the granite could be an erosional high, in which case, possible reservoir sandstones could have been developed on its periphery; additionally, the "granite erosional high" could have served, at some location, as a platform for reef-building organisms in the Lisburne. Finally, if the granite is present as a basement-faulted segment, which has brought the granite into fault contact with the Lisburne, then the period of fault movement could be important. The importance of the timing of the faulting, would be in the possibility of the movement having been contemporaneous with deposition, and thus favorably influencing the development of reservoir rocks in the Lisburne or in the Sadlerochit.

PERTINENT DATA AND APPENDICES

<u>Appendix</u>	<u>Page</u>
A. Summary Pertinent Data, Operations and Analysis	A-1-2
B. Drill Cuttings and Core Descriptions	B-1-73
C. Occurrence of Granitic Basement (Memo, Ken Bird, USGS)	C-1-2

SUMMARY OF PERTINENT DATA*

WELL NAME: East Teshekpuk No. 1
 API NO.: 50-103-20006
 OPERATOR: Husky Oil NPR Operations, Inc.
 LOCATION: 675' FWL, 1650' FNL, NW 1/4,
 protracted Section 16, T14N, R4W,
 Umiat Meridian, North Slope Borough, Alaska
 COORDINATES: Latitude: 70°34'12"N
 Longitude: 152°56'37"W
 X = 628,717.502
 Y = 6,059,194.847
 Zone 5
 ELEVATION: 27.6' Kelly Bushing, 6' Ground
 DATE SPUDDED: March 12, 1976
 TOTAL DEPTH: 10,664 feet (driller)
 10,660 feet (Schlumberger DIL/SP)
 DATE REACHED
 TOTAL DEPTH: May 6, 1976
 RIG RELEASED: May 11, 1976
 STATUS: Plugged and abandoned
 CASING: 30" @ 60'
 20" @ 517'
 16" @ 2575'
 10-3/4" @ 8345'

LOGGING RECORD:

DIL/SP	2,572- 8,324'
	8,349-10,554'
BHC/GR	517- 2,606'
BHC/GR/CAL	2,569- 8,320'
	8,348-10,650'
CNL/FDC/GR/CAL	2,574- 8,330'
	8,348-10,659'
HDT	2,572- 8,322'
	8,348-10,662'
HDT Arrow Plot	2,590- 8,311'
	8,365-10,639'

LOGGING RECORD: (Continued)

Saraband	2,580- 8,300'
Coriband	8,349-10,620'
Mudlog	530-10,664'
Geologist's Lithology Log	530-10,664'
SRS Velocity Survey	1,000-10,660'

SIDEWALL CORES: Run No. 1, 46 shot, 33 recovered.
Run No. 2, 30 shot, 17 recovered.

CONVENTIONAL CORES: None taken.

WELLSITE GEOLOGIST: S. P. Burden

WELL LOG ANALYST: None

DRILLING CONTRACTOR: Parco, Inc., Rig 128

MUDLOGGERS: Borst and Giddens

BIOSTRATIGRAPHIC ANALYSIS: Anderson, Warren & Associates, Inc.

* Copies and/or reproducibles of all geologic data are available from:

National Oceanic and Atmospheric Administration
EDIS/NGSDC (D62)
325 Broadway
Boulder, CO 80303

EAST TESHEKPUK NO. 1
DRILL CUTTINGS AND CORE DESCRIPTIONS
BY: BUD BURDEN
EDITED BY: GORDON W. LEGG

DRILLED DEPTH
(FEET BELOW
KELLY BUSHING)

- 0- 533 No samples recovered.
- 533- 540 Sample is 90% cement; Siltstone: dark gray, argillaceous, with scattered, coarser quartz grains; scattered quartz nodules: white to very light yellowish-white, occurring in the siltstone, a Quartz Conglomerate; trace of Shale: dark gray, very carbonaceous.
- 540- 550 Cement cavings; Siltstone: as above, grading to a fine grained, "salt and pepper" Sandstone: argillaceous, with some sericite and some phlogopite inclusions; increased quartz nodules in an indurated siltstone matrix.
- 550- 560 Decreased cement, 40%; Siltstone, grading to a Sandstone: as above; some brownish-gray siltstone, with streaks of lignitic material; quartz nodules, as above.
- 560- 570 Cement cavings, 10%; Siltstone and Sandstone: as above, in part, with carbonaceous inclusions; slight increase in quartz nodules, as above, in part, light yellow and translucent, some frosted, some clear, in part, subrounded; small amount of coal; trace of bentonite.
- 570- 580 Siltstone to Sandstone: as above, fine to medium grained, with carbonaceous inclusions; trace of coal; trace of bentonite; quartz nodules, as above.
- 580- 590 As above; trace of brownish-gray, silty Shale: rough texture, irregular fracture.
- 590- 600 Claystone: gray, firm, unctuous, 60%; Sandstone: gray to light gray, "salt and pepper", slightly more friable than above; trace of coal.
- 600- 620 Claystone: as above, 50%; Sandstone: as above, very fine to medium grained, subangular, poorly sorted, with rare siderite and very rare glauconite grains, no shows; trace of finely crystalline pyrite; trace of bentonite.
- 620- 640 Claystone: as above, 60%; Sandstone: as above; some black, tarry material, with light yellow fluorescence; Coal, 2%; trace of finely crystalline pyrite; trace of Limestone: light brownish-gray, cryptocrystalline.

640- 660 As above.

660- 680 Claystone: as above, 80%; friable Sandstone: slightly sideritic, less argillaceous; trace of coal; trace of quartz nodules.

680- 700 Claystone: as above, 80%; friable Sandstone: as above, poorly sorted, with considerable weathered glauconite grains; trace of coal; trace of sideritic siltstone.

700- 720 Claystone: 80%; increased Sandstone: "salt and pepper", quartz and chert, with scattered glauconite and rare, finer siderite grains, fine to medium grained, subangular, poorly sorted, poorly consolidated, calcareous matrix, poor to fair porosity, no shows; trace of Sandstone: white, "salt and pepper", bentonitic; trace of tarry material, as above.

720- 740 Claystone: as above, 85%; Sandstone: as above; small amount of Siltstone: gray, "salt and pepper", argillaceous; trace of bentonite; increase in Coal: black, high luster, subconchoidal fracture; becomes soft and fluid on heating.

740- 760 Claystone: gray, bentonitic, firm, unctuous, 70%; glauconitic Sandstone: as above, with some kaolinitic infilling; trace of Siltstone: gray, hard, slightly more argillaceous; trace of soft, tarry coal.

760- 780 No sample.

780- 820 Claystone, 95%; Sandstone: as above; trace of coal.

820- 840 Sample practically all claystone; trace of friable Sandstone: as above.

840- 860 As above; claystone is softer.

860- 880 Sample practically all soft claystone; trace of Sandstone: "salt and pepper", with some siderite grains.

880- 900 As above.

900- 920 Claystone: as above, 100%.

920- 940 Claystone: gray, bentonitic.

940- 960 Claystone: as above, 100%.

960- 980 Claystone: as above; trace of unconsolidated, glauconitic sandstone.

980- 1000	Claystone: as above.
1000- 1020	Claystone; trace of unconsolidated sand.
1020- 1040	Claystone, 100%.
1040- 1060	As above.
1060- 1080	Claystone: gray, firm, bentonitic; no visible sandstone.
1080- 1100	Claystone: as above.
1100- 1120	Claystone: as above; trace of Sandstone: light gray, "salt and pepper", very fine grained, sideritic, very poorly consolidated; trace of Shale: dark gray, smooth texture, subconchoidal fracture; slightly rounded; so could be reworked.
1120- 1140	Claystone: as above, but softer, less compact, more brownish-gray.
1140- 1160	As above.
1160- 1180	Claystone: as above.
1180- 1200	Claystone: as above, but more chunky.
1200- 1220	Claystone: as above.
1220- 1240	Claystone: dark gray, dense, compact, bentonitic.
1240- 1260	As above.
1260- 1280	Claystone: as above; trace of light gray Sandstone: micromicaceous, poorly consolidated; trace of sideritic siltstone, and coal.
1280- 1300	As above.
1300- 1320	Claystone: as above; trace of dark gray, smoky chert; coal, with a high luster; Siltstone: dark gray, hard, argillaceous; and very fine grained, unconsolidated sandstone.
1320- 1340	Claystone: as above; some specks of tarry material, looks like dead, residual oil, but does not dissolve in chloroethane; trace of coal.
1340- 1360	As above; trace of Sandstone: gray, "salt and pepper", clear quartz and chert grains, with traces of phlogopite and sericite, fine grained, subangular, poorly sorted, fairly well consolidated, calcareous matrix, no shows;

- trace of sideritic siltstone; light gray siltstone; and yellowish, rounded quartz nodules.
- 1360- 1380 Claystone: as above; slight increase in Sandstone: as above, with some weathered glauconite and rare siderite grains; in general, less argillaceous; traces of dark gray shale, in part, silty; Shale, reddish-brown, soft, bentonitic, with small pyrite-cube inclusions, coal and sideritic siltstone.
- 1380- 1400 Claystone: as above; Sandstone: as above, in general, finer, more evenly sorted; traces of Shale, brownish-gray, with a slight reddish tinge, sideritic siltstone, coal, and heavy, residual, dead oil in the sandstone.
- 1400- 1420 Claystone: gray, firm, bentonitic; trace of Sandstone: as above; sandstone occurs in thin, even bands rather than being lenticular; slight increase in brownish-gray shale, in part, slightly silty; slight increase in coal; trace of sideritic siltstone.
- 1420- 1440 Claystone; trace of Sandstone: more friable, softer; trace of coal; in part, with very thin bands of pyrite, probably a reducing environment; trace of brownish-gray shale, and bentonite; some loose sand.
- 1440- 1460 Claystone; Sandstone, Shale, sideritic Siltstone, and Coal: as above; sandstone is more poorly sorted and more friable; trace of light gray siltstone; some loose sand.
- 1460- 1480 Claystone: as above; reduced sandstone; increased light gray siltstone; increased coal.
- 1480- 1500 Claystone; slight increase in Siltstone: brownish-gray, argillaceous; trace of "salt and pepper" Sandstone: as above; trace of coal, trace of sideritic siltstone, and bentonite.
- 1500- 1520 Claystone: as above; increased light gray to light brownish-gray siltstone; traces of Shale: reddish-brown, slightly silty, coal and sideritic siltstone.
- 1520- 1540 Claystone: as above; trace of Sandstone: "salt and pepper", with scattered glauconite grains; Siltstone: light gray and brownish-gray, argillaceous; traces of dark gray, silty shale, coal, and sideritic siltstone.
- 1540- 1560 Claystone: as above, 80%; Claystone: gray to dark gray, soft, with thin bands of carbonaceous material, 15%; bentonite, 5%; trace of calcite.

- 1560- 1580 Claystone, 60%; Siltstone: gray to brownish-gray, argillaceous, with scattered sericite, 30%; bentonite and light gray, bentonitic shale, 10%; trace of calcite and coal.
- 1580- 1600 Claystone, 60%; Siltstone: as above, soft, argillaceous, almost a silty shale; small amount of light gray siltstone; bentonite; trace of calcite.
- 1600- 1620 Claystone, 65%; Sandstone: "salt and pepper", light gray, fine grained, glauconitic, tight; Sandstone: light brown, "salt and pepper", quartz and chert grains, with a sideritic matrix; Siltstone: as above, soft, argillaceous, with some brown, calcite veinlets; some Shale: gray, fairly smooth texture, in part, slightly silty, in part, with a brownish tinge.
- 1620- 1630 Claystone, 40%; Sandstone: "salt and pepper", fine grained, subangular, calcareous matrix, in part, glauconitic, in part, sideritic, 30%; Shale: brown, in part, silty, 30%; reduced bentonite; trace of calcite.
- 1630- 1640 Clay, 35%; Sandstone: as above, mainly glauconitic, in general, darker, 45%; Shale: brownish-gray; Siltstone: as above, with some calcite veinlets; traces of bentonite, calcite, and siderite.
- 1640- 1660 Clay: as above, 40%; Sandstone: "salt and pepper", quartz and chert grains, in part, with rare siderite grains, fine grained, subangular, fairly well sorted, well consolidated, calcareous matrix; no shows, in part, darker gray and more argillaceous; Shale: brownish-gray, rough texture, irregular fracture, very silty; trace of sideritic siltstone; small amount of bentonite; trace of calcite.
- 1660- 1680 Claystone, 40%; Sandstone: as above, in general, finer grained, more silty, in part, glauconitic; Shale: as above, grading to an argillaceous siltstone, in part, lignitic; traces of sideritic siltstone, bentonite, calcite, and finely crystalline pyrite.
- 1680- 1700 Claystone, 35%; reduced Sandstone: as above; Siltstone: brownish-gray, argillaceous, with carbonaceous and lignitic streaks and specks; trace of gray, argillaceous siltstone; small amount of bentonite; trace of calcite, and pyrite.
- 1700- 1720 Claystone, 30%; Siltstone: gray to dark gray, "salt and pepper", argillaceous, grading to a fine, less argillaceous sandstone; Shale: brownish-gray to dark brownish-gray, with carbonaceous specks, 30%; small amount of bentonite; trace of siderite, sideritic siltstone, and light gray, bentonitic shale.

- 1720- 1740 Increased Claystone, 50%; Sandstone: as above, "salt and pepper", with less glauconite grains; Shale: as above; small amount of siltstone; traces of bentonite, finely crystalline pyrite with octahedrons, and coal.
- 1740- 1760 Increased Claystone: dark gray, firm, 70%; sandstone, siltstone and Shale: as above; trace of glauconite in the sandstone; trace of bentonite, and coal.
- 1760- 1780 Increased Claystone: gray, softer, less unctuous, 80%; Sandstone: "salt and pepper", fine grained, subangular, poorly sorted, well consolidated, calcareous matrix, tight; Shale: brownish-gray, smoother texture, with carbonaceous specks; Siltstone: dark brownish-gray; trace of bentonite, and finely crystalline pyrite.
- 1780- 1800 Claystone: as above, 90%; reduced sandstone; Shale: brownish-gray to dark brownish-gray, subconchoidal fracture, fairly smooth texture; Siltstone: light gray, mainly quartz grains; traces of bentonite, calcite, siderite, sideritic siltstone, and finely crystalline pyrite.
- 1800- 1820 Claystone: as above, but more compact, 80%; "salt and pepper" sandstone; light gray siltstone; brownish-gray shale; slight increase in coal; trace of lignite.
- 1820- 1840 Claystone: as above, 80%; reduced sandstone; Shale: as above, in part, sideritic; reduced siltstone; trace of siderite, sideritic siltstone, bentonite, and coal.
- 1840- 1860 Claystone, 90%; Sandstone: as above, glauconitic; shale and siltstone; small amount of calcite; trace of Coal: soft, bituminous.
- 1860- 1880 Reduced Claystone, 50%; Sandstone: as above, but finer, more argillaceous, in part, glauconitic, in part, contains carbonaceous streaks in the bedding planes; Shale: brownish-gray, hard, sideritic, with carbonaceous specks; Siltstone: gray, argillaceous; small amount of bentonite; traces of coal, sideritic siltstone, and calcite.
- 1880- 1900 Increased Claystone, 80%; reduced sandstone; shale and Siltstone: as above; some dark gray shale; traces of bentonite, pyrite, and soft, lignitic coal.
- 1900- 1920 Claystone, as above, 60%; Sandstone: as above, but finer grained, more argillaceous, in part, containing lignitic material; Shale: brownish-gray, with carbonaceous specks; traces of gray to light gray, bentonitic shale, dark gray shale, bentonite, siderite, sideritic siltstone, and coal.

1920- 1940	Claystone, 50%; increased sandstone with more chert grains; trace of calcite.
1940- 1960	Claystone, 70%; Sandstone, as above, but in part coarser grained, more poorly sorted, in part, with carbonaceous specks; Siltstone: gray, argillaceous; Shale: brownish-gray; traces of siderite, sideritic siltstone, bentonite, coal, calcite, and pyrite.
1960- 1980	Claystone: as above, 70%; Sandstone: as above; Siltstone: gray, argillaceous; Shale: gray to dark gray and brownish-gray, with rare carbonaceous inclusions; small amount of bentonite; small amount of siderite with lesser sideritic siltstone; trace of coal.
1980- 2000	Claystone, 80%; reduced sandstone, Shale: gray to dark gray, in part, silty; small amount of siderite and sideritic siltstone; trace of coal.
2000- 2020	Claystone, 80%; reduced Sandstone: more argillaceous; increased gray, argillaceous siltstone; traces of gray and dark gray shale, siderite, sideritic siltstone, marcasite, and aragonite.
2020- 2040	Claystone, 80%; Siltstone: gray to dark gray, and Siltstone: "salt and pepper", argillaceous; Shale: dark gray to brownish-gray; traces of sandstone, siderite, sideritic siltstone, and calcite.
2040- 2060	Mainly claystone; trace of sandstone; traces of dark gray shale, siderite, sideritic siltstone, and finely crystalline pyrite.
2060- 2070	Mainly claystone; trace of Sandstone: "salt and pepper", quartz and chert with scattered siderite grains and a traces of sericite, siderite, sideritic siltstone, dark gray siltstone, finely crystalline pyrite, and pyritized worm casts.
2070- 2080	Claystone: as above; Sandstone: as above, but finer grained, more argillaceous; Siltstone: gray to dark gray, argillaceous; traces of dark gray shale, bentonite, calcite, and coal.
2080- 2100	Mainly claystone.
2100- 2120	Mainly claystone; traces of glauconitic sandstone, siltstone, dark gray shale, and finely crystalline pyrite.
2120- 2140	Claystone, 70%; Sandstone: as above, very fine to fine grained, glauconitic in part; Siltstone: gray, argillaceous; trace of Shale: dark gray; small amount of

- siderite and sideritic siltstone; traces of bentonite, calcite, aragonite, and finely crystalline pyrite.
- 2140- 2160 Claystone, 85%; argillaceous Sandstone: as above; traces of siltstone, shale, dark gray, silty, siderite, sideritic siltstone, and coal.
- 2160- 2180 Claystone, 85%; Sandstone: as above, in part, argillaceous; traces of gray, argillaceous siltstone, gray silty, shale, siderite, sideritic siltstone, and coal.
- 2180- 2200 Claystone, 85%; increased sandstone; trace of Siltstone: light gray to gray and brownish-gray, with carbonaceous specks; trace of Shale: brown, hard, very calcareous, almost a shaly limestone; traces of dark brown shale, siderite, sideritic siltstone, light gray, bentonitic shale, and coal.
- 2200- 2220 Claystone, 80%; Sandstone: as above, very fine grained, in part argillaceous; Siltstone: light gray to gray, in part, argillaceous; Shale: dark gray and dark brownish-gray, in part, silty; trace of siderite and sideritic siltstone; trace of finely crystalline pyrite; trace of coal; some walnut shells in the sample.
- 2220- 2240 As above; sandstone is glauconitic in part; trace of bentonite.
- 2240- 2260 Claystone, 65%; Sandstone: as above, in part, with rare, scattered siderite grains; slight increase in Siltstone: light gray to gray; Shale: as above, in part, blocky; increased siderite and sideritic siltstone.
- 2260- 2280 Claystone: gray, firm, bentonitic, 90%; siderite and sideritic siltstone; Sandstone: as above; Shale: gray to brownish-gray; trace of light gray, bentonitic shale; trace of calcite.
- 2280- 2300 As above; trace of finely crystalline pyrite.
- 2300- 2320 Claystone, 80%; Sandstone: as above, "salt and pepper", in part, with some sericite, in part, with some carbonaceous inclusions; trace of Shale: dark brownish-gray, with thin lignitic layers in the bedding planes; traces of coal, siderite, and bentonite.
- 2320- 2340 Claystone, 85%; "salt and pepper" Sandstone: as above; Siltstone: gray to brownish-gray, argillaceous; trace of Shale: dark gray to dark brownish-gray, small amount of siderite and sideritic siltstone; trace of calcite, and pyrite.

- 2340- 2360 Mainly claystone; trace of Sandstone: argillaceous; traces of argillaceous siltstone, silty shale, siderite, pyrite, and pyritized worm casts.
- 2360- 2380 Claystone: as above; trace of sandstone, in part, glauconitic; trace of siltstone and Shale: as above; trace of mudstone, with lignitic partings; traces of siderite, sideritic siltstone, pyrite, and coal.
- 2380- 2400 Claystone, 95%; Sandstone: as above, glauconitic, with scattered siderite grains; Shale, gray to dark gray and brownish-gray, in part, silty; traces of siderite, sideritic siltstone, coal, and bentonite.
- 2400- 2420 Mainly claystone; trace of Sandstone: glauconitic, and Sandstone: light gray, "salt and pepper"; trace of Shale: brownish-gray to gray, with carbonaceous specks; traces of bentonite, siderite, and pyrite.
- 2420- 2440 Mainly claystone; argillaceous Sandstone: as above; trace of Shale: gray and dark brownish-gray; traces of bentonite, pyrite, siderite, and sideritic siltstone.
- 2440- 2460 Mainly claystone; trace of siderite and sideritic siltstone; trace of Siltstone: light gray to gray, "salt and pepper", argillaceous.
- 2460- 2480 Mainly claystone; traces of sandstone, shale, siderite, sideritic siltstone, and finely crystalline pyrite.
- 2480- 2500 Claystone; trace of siltstone, and siderite.
- 2500- 2520 Mainly claystone.
- 2520- 2540 Claystone: as above; traces of sandstone, siltstone, shale, siderite, and sideritic siltstone.
- 2540- 2560 As above; claystone is more compact, more unctuous.
- 2560- 2580 Mainly claystone; small amount of Sandstone: "salt and pepper", quartz and chert grains; fine grained, subangular, well sorted, well consolidated, calcareous matrix, no shows; trace of sideritic siltstone, and pyrite.
- 2580- 2600 Claystone: gray, firm, bentonitic, 95%; Sandstone: "salt and pepper", quartz and chert; fine grained, subangular, calcareous, no shows; trace of sideritic siltstone.
- 2600- 2613 No sample.

- 2613- 2620 Mainly cement; trace of Shale: gray, rough texture, and Shale: darker gray, smoother texture; traces of coal, siderite, and quartz nodules, in part, in a siltstone matrix.
- 2620- 2640 Mainly cement; small amount of Shale: gray to dark gray, silty; trace of Siltstone: gray, "salt and pepper"; slight increase in quartz nodules, rounded, in part, slightly yellow, in part, frosted; could be from the siltstone; trace of pyritized worm casts.
- 2640- 2660 Cement, 85%; shale and Siltstone: as above; siltstone is slightly calcareous; trace of Sandstone: "salt and pepper", quartz and chert grains; fine grained, subangular, well sorted, calcareous matrix, tight; quartz nodules, in part, subrounded; trace of limonite.
- 2660- 2680 Cement, 30%; Claystone, 25%; Sandstone: as above, 10%; Shale: as above, in part, with lignitic streaks; Siltstone: as above; traces of quartz nodules, coal, and finely crystalline pyrite.
- 2680- 2700 Claystone, 70%; Cement, 30%; small amount of sandstone; Shale: dark gray, in part, with a brown cast; trace of Siltstone: as above; quartz nodules, as above, some occurring in an indurated siltstone.
- 2700- 2720 Claystone, 75%; Cement, 15%; Sandstone: as above, in part, with carbonaceous streaks, no glauconite grains; shale and Siltstone: as above; quartz nodules; trace of marcasite.
- 2720- 2740 Claystone, 80%; Cement, 10%; sandstone, siltstone and Shale: as above; trace of marcasite.
- 2740- 2760 Claystone, 85%; Cement, 10%; Sandstone: as above, in part, glauconitic; shale and Siltstone: as above; trace of coal; considerable quartz nodules.
- 2760- 2780 Claystone, 60%; Cement, 20%; Sandstone: "salt and pepper", as above; Shale: dark gray, in part, slightly silty; Siltstone: gray, argillaceous; quartz nodules, as above, in part, in an indurated, very argillaceous siltstone.
- 2780- 2800 Claystone, 70%; Cement, 20%; Sandstone: "salt and pepper", as above; Shale: dark gray, in part, with carbonaceous streaks; siltstone; quartz nodules; traces of finely crystalline pyrite, siderite, and sideritic siltstone.

- 2800- 2820 Claystone, 70%; Cement, 20%; Sandstone: "salt and pepper", quartz and chert grains; fine grained, subangular, well sorted, well consolidated; Shale: dark gray; Siltstone: as above; traces of siderite, pyrite, and yellow to white, frosted, rounded quartz nodules.
- 2820- 2840 Claystone, 60%; Cement, 15%; Sandstone: as above; Shale: dark gray; Siltstone: gray to dark gray, argillaceous; traces of siderite, pyrite, and white to amber quartz nodules, rounded to subrounded.
- 2840- 2860 Claystone, 80%; Cement, 10%; Sandstone: "salt and pepper", with some carbonaceous material; Shale: as above, in part, dark gray, with a smooth texture; Siltstone: as above; considerable quartz nodules, in part, as inclusions in a dark gray siltstone; trace of siderite.
- 2860- 2880 Claystone, 80%; Cement, 10%; Sandstone: "salt and pepper", in general, darker gray, more argillaceous; shale and Siltstone: as above; traces of finely crystalline pyrite, siderite, and quartz nodules.
- 2880- 2900 Claystone, 60%; Cement, 5%; Sandstone: as above, but more poorly sorted; shale and Siltstone: as above; trace of volcanic Tuff: dark gray, with scattered feldspar crystals; increased siderite, 4%; trace of marcasite, and pyrite.
- 2900- 2920 Claystone, 85%; small amount of cement; Sandstone: as above; trace of dark gray shale, fairly smooth texture; Siltstone: dark gray, argillaceous; traces of volcanic tuff, finely crystalline pyrite, siderite and quartz nodules, as above.
- 2920- 2940 Reduced Claystone, but firmer, 70%; trace of cement; reduced Sandstone; Shale and Siltstone: as above; small amount of siderite; trace of tuff with feldspar inclusions; increased pyrite, with a trace of marcasite; quartz nodules, as above, mainly light yellow.
- 2940- 2960 Claystone: as above, 70%; trace of cement; Sandstone: as above, argillaceous, poorly sorted; Shale: dark gray and brownish-gray; small amount of siderite; trace of pyrite; quartz nodules, as above.
- 2960- 2980 Claystone: as above; trace of cement; Sandstone: as above, poorly sorted; shale and Siltstone: as above; small amount of siderite; trace of pyrite; quartz nodules, as above.

- 2980- 3000 Reduced Claystone, 40%; trace of cement; Sandstone: "salt and pepper", quartz and chert grains; fine to medium grained, poorly sorted, well consolidated, calcareous matrix; Shale: dark gray, in part, with a brownish tinge; siderite, 10%; Siltstone: dark gray, argillaceous; traces of volcanic tuff, pyrite, pyritized worm casts, and quartz nodules, as above, less well rounded.
- 3000- 3020 Claystone, 40%; Cement, 10%; Sandstone: as above, in general, finer, argillaceous; shale and siltstone; small amount of siderite; trace of pyrite; some quartz nodules.
- 3020- 3040 Claystone, 60%; Cement, 10%; sandstone, shale and siltstone; small amount of siderite; trace of pyrite; some quartz nodules.
- 3040- 3060 Claystone, 60%; Cement, 5%; sandstone, shale and Siltstone: as above; small amount of siderite; trace of pyrite; trace of Coal: black, high luster, subconchoidal fracture; reduced quartz nodules.
- 3060- 3080 Claystone, 40%; Cement, 5%; Sandstone: as above, in part, with some carbonaceous inclusions; Shale: dark gray, in part; trace of Coal: soft; coal breaks down on heating to a tarry, viscous mass; small amount of siderite; trace of pyrite; some quartz nodules.
- 3080- 3100 Claystone, 40%; Cement, 5%; Sandstone: as above; Siltstone: dark gray, and Siltstone: light brown and light gray; small amount of siderite; trace of pyrite and marcasite; some rounded quartz nodules; trace of coal.
- 3100- 3120 Claystone, 35%; small amount of cement; increased Sandstone: as above, gray, "salt and pepper", quartz and chert; fine grained, subangular, poorly sorted, well consolidated, calcareous; shale and Siltstone: as above; small amount of siderite; slight increase in pyrite; some quartz nodules; trace of coal.
- 3120- 3140 Claystone, 40%; Cement, 5%; Sandstone: as above, better sorted, with rare glauconite grains; shale and siltstone; increased pyrite and marcasite, 5%; small amount of siderite; some quartz nodules; trace of coal.
- 3140- 3160 Claystone, 40%; Cement, 5%; increased Sandstone: as above; trace of Shale: dark gray, in part, silty; Siltstone, 15%; small amount of soft coal; small amount of siderite; trace of quartz nodules.

- 3160- 3180 As above; slight increase in dark gray shale; increased coal; trace of pyrite; trace of quartz nodules.
- 3180- 3200 Increased Claystone, 85%; remainder as above; trace of calcite.
- 3200- 3220 Decrease in Claystone, 50%; Sandstone: as above; siltstone; trace of shale; small amount of siderite; traces of pyrite, pyritized worm casts, marcasite, and quartz nodules.
- 3220- 3240 Claystone, 60%; sandstone, siltstone and Shale: as above; small amount of siderite; trace of pyrite; increased quartz nodules.
- 3240- 3260 Claystone, 60%; trace of cement; Sandstone: as above, fairly well sorted, calcareous; Siltstone: gray, argillaceous; trace of shale; small amount of siderite; increased pyrite; reduced quartz nodules.
- 3260- 3280 As above; shale is silty in part; traces of pyrite, marcasite, black chert nodules, and coal.
- 3280- 3300 Claystone, 60%; small amount of cement; Sandstone: as above; Siltstone: gray, argillaceous; trace of Shale: dark brown, higher luster, slightly calcareous; small amount of siderite; traces of coal, pyrite, and marcasite.
- 3300- 3320 Claystone, 50%; Cement, 5%; Sandstone: "salt and pepper"; quartz and chert grains; fine grained, subangular, well sorted, well consolidated, calcareous matrix; Siltstone: dark gray and dark brownish-gray; small amount of siderite; small amount of pyrite; trace of calcite; small amount of rounded quartz nodules; trace of tarry coal.
- 3320- 3340 As above; Claystone, 45%; Cement, 5%; Sandstone: in general, finer, more argillaceous; trace of pyritized worm casts.
- 3340- 3360 Claystone, 40%; Cement, 5%; Sandstone: "salt and pepper"; quartz and chert grains with rare, scattered glauconite grains; fine to medium grained, subangular, poorly sorted, well consolidated, calcareous; Shale and Siltstone: as above; increased pyrite; trace of coal; some quartz nodules; trace of jasper with pyrite veinlets.
- 3360- 3380 As above; reduced sandstone; some coarser sandstone, with rare siderite grains; considerable pyrite; trace of coal.

- 3380- 3400 Reduced Claystone, 30%; Cement, 5%; Sandstone: as above, "salt and pepper", fine grained, subangular; Siltstone: as above; increased siderite; increased pyrite; trace of soft coal; bright yellow fluorescence when cut with chloroethane.
- 3400- 3420 Claystone, 30%; Cement: as above; Sandstone and Siltstone: as above; Siderite, 10%; Pyrite, 5%; quartz nodules; trace of coal.
- 3420- 3440 As above; increased coal.
- 3440- 3460 As above; slight decrease in sandstone; slight increase in siltstone; Siderite, 10%; Pyrite, 5%.
- 3460- 3480 Claystone, 40%; Cement, 5%; Sandstone: as above, poorly sorted, in part, glauconitic; Siltstone: gray, argillaceous; Shale: dark gray and brownish-gray, in part, calcareous; Siderite, 20%; Pyrite, 5%.
- 3480- 3500 Claystone, 40%; Siltstone: gray, argillaceous, grading to a Sandstone: "salt and pepper", with rare glauconite grains; fine grained, well sorted, well consolidated, calcareous, tight; Siderite, 10%; Pyrite, 5%; trace of Shale: dark gray to dark brownish-gray; trace of Coal: soft, with a high luster; some rounded quartz nodules.
- 3500- 3520 Claystone, 35%; sandstone and Siltstone: as above; some coarser, glauconitic sandstone, more poorly sorted; trace of shale; Siderite, 5%; Pyrite, 3%; Marcasite, 1%; trace of coal.
- 3520- 3540 Claystone, 30%; Sandstone: as above, glauconitic and sideritic; Siltstone: as above; trace of shale; small amount of siderite and sideritic siltstone; trace of light brown claystone; small amount of pyrite; trace of tarry coal.
- 3540- 3560 Claystone, 30%; Sandstone: as above, glauconitic; Siltstone: as above, argillaceous; trace of Shale: dark gray, in part, silty; Siderite, 3%; Pyrite, 2%; some quartz nodules; trace of coal; increased Cement, 10%.
- 3560- 3580 Claystone: as above, 30%; Cement, 10%; sandstone is more glauconitic, with rare siderite grains; Siltstone: as above; trace of dark gray, fissile shale; siderite and pyrite, as above; trace of coal.
- 3580- 3600 Claystone, 25%; Cement, 10%; Siltstone, 50%; small amount of Sandstone: slightly coarser, more glauconitic, more poorly sorted; small amount of siderite; small amount of pyrite; trace of coal.

- 3600- 3620 Claystone, 20%; trace of cement; Sandstone: "salt and pepper", fine grained, subangular, glauconitic; Siltstone: gray to dark gray; trace of dark gray shale; Pyrite, 8%; Siderite, 5%; trace of tarry coal, almost a heavy residual oil.
- 3620- 3640 Claystone, 20%; slight increase in siltstone; decrease in sandstone, in general, more argillaceous, finer grained; decrease in siderite and pyrite; small amount of tarry coal.
- 3640- 3660 Claystone, 15%; Siltstone: gray, argillaceous; reduced sandstone; trace of shale; considerable Pyrite, 15%; Siderite: as above; traces of coal, calcite, and black chert pebbles.
- 3660- 3680 Claystone, 10%; Siltstone: as above; increase in Sandstone: in part, coarser, 20%; Siderite, 5%; Pyrite, 5%; trace of calcite; trace of gray, cryptocrystalline dolomite; trace of coal, and gray chert pebbles.
- 3680- 3700 Claystone, 15%; siltstone and Sandstone: as above; slight increase in dark gray shale; Pyrite: as above, 10%; Siderite, 5%; trace of tarry coal.
- 3700- 3720 Claystone, 30%; reduced sandstone and siltstone; Shale: as above; considerable pyrite and siderite; trace of coal, and marcasite.
- 3720- 3740 As above; trace of marcasite.
- 3740- 3760 Claystone, 50%; Siltstone: gray to dark gray and brownish-gray, argillaceous; reduced Sandstone: argillaceous, in general, finer grained; trace of dark gray shale; considerable pyrite and siderite; some quartz nodules; trace of coal.
- 3760- 3780 Claystone, 20%; siltstone and Sandstone: as above; trace of shale, in part, carbonaceous; Pyrite, 10%; Siderite, 5%.
- 3780- 3800 Mainly cement; Siltstone: gray to dark gray, argillaceous; small amount of Shale: gray to dark gray, fairly smooth texture; small amount of pyrite; trace of siderite; Claystone, 20%.
- 3800- 3820 Mainly cement; trace of siltstone, sandstone, shale, pyrite and siderite.
- 3820- 3840 As above; Cement, 90%.

- 3840- 3860 Cement, 50%; Claystone, 30%; Siltstone: as above; increased Shale: dark gray, fairly smooth texture, irregular fracture, in part, with carbonaceous inclusions; small amount of Sandstone: "salt and pepper", quartz and chert with scattered glauconite grains; fine grained, subangular, fairly well sorted, well consolidated, calcareous matrix, tight; trace of siderite; reduced pyrite; trace of coal; considerable rounded quartz nodules, in part, loose, in part, as inclusions in a dark gray, indurated siltstone.
- 3860- 3880 Claystone, 40%; Cement, 15%; Siltstone: as above, 30%; shale and Sandstone: as above; trace of siderite, and pyrite; slight increase in coal.
- 3880- 3900 Claystone, 35%; reduced Cement, 5%; Siltstone: gray to dark gray, with minor light gray; small amount of Shale: as above; Sandstone: as above, 10%; trace of pyrite, marcasite, and siderite; rounded, clear to frosted quartz nodules; trace of black chert nodules.
- 3900- 3920 Claystone, 90%; trace of cement; Siltstone: as above; Shale: gray to dark gray and brownish-gray, 4%; trace of argillaceous sandstone; small amount of siderite; trace of pyrite and coal; rare quartz nodules.
- 3920- 3940 As above; Claystone, 80%; shale is silty in part; increased Pyrite, 5%.
- 3940- 3960 Claystone, 50%; increased Sandstone: "salt and pepper", calcareous, scattered glauconite grains, with some carbonaceous material; reduced siltstone; trace of pyrite; trace of coal; trace of calcite.
- 3960- 3980 Claystone, 60%; Sandstone: "salt and pepper", quartz and scattered chert grains, fine grained, subangular, well sorted, well consolidated, calcareous matrix, tight; Siltstone: as above; trace of shale; small amount of pyrite and marcasite; trace of pyritized worm casts; some loose quartz nodules.
- 3980- 4000 Claystone, 60%; remainder as above; some pyritized worm casts; some glauconite associated with pyrite; slight increase in coal.
- 4000- 4020 Claystone, 40%; Siltstone: gray to brownish-gray, argillaceous; decrease in Sandstone: glauconitic, 10%; Shale: dark brownish-gray, in part, slightly silty; trace of brownish-gray claystone, in part, with some carbonaceous specks; considerable marcasite and pyrite; some sideritic siltstone; trace of siderite, coal, and pyritized and carbonized wood.

- 4020- 4040 Claystone, 60%; siltstone, sandstone and minor Shale: as above; increased pyrite and marcasite with some pyritized worm casts, 10%; increased Siderite, 5%; trace of rounded quartz nodules; trace of coal.
- 4040- 4060 Claystone, 40%; siltstone and Sandstone: as above; increased pyrite and marcasite; slight increase in siderite.
- 4060- 4080 Claystone, 70%; remainder as above; sandstone is glauconitic in part; increased pyrite and marcasite; trace of coal; some rounded quartz nodules; trace of pyritized worm casts.
- 4080- 4100 Claystone, 60%; Siltstone: as above, 25%; Sandstone, 10%; trace of shale; small amount of pyrite; small amount of coal; small amount of siderite.
- 4100- 4110 Claystone, 70%; Siltstone: gray to dark gray, argillaceous; Sandstone: "salt and pepper", quartz and chert grains, very fine to fine grained, subangular, fairly well sorted, well consolidated, calcareous matrix, tight, 10%; Shale: gray to brownish-gray, fairly smooth texture; considerable pyrite; small amount of siderite; trace of Inoceramus prisms.
- 4110- 4120 Claystone, 70%; remainder as above; in general, the sandstone is more argillaceous and contains more glauconite grains.
- 4120- 4130 Claystone, 50%; Siltstone: gray to brownish-gray, slightly calcareous, argillaceous, in part, carbonaceous, in part, sandy; trace of calcite and shale; small amount of pyrite.
- 4130- 4140 Claystone, 40%; remainder as above; some Claystone: light gray, soft, fissile, with some carbonaceous inclusions.
- 4140- 4150 As above.
- 4150- 4160 Claystone, 60%; Siltstone: as above, in part, light gray, with carbonaceous specks; Sandstone: as above, less glauconitic; pyrite and Marcasite, 10%; siderite and sideritic Siltstone, 5%.
- 4160- 4170 Claystone, 70%; Siltstone: as above, 15%; Sandstone: as above, in part, more friable; considerable pyrite and marcasite; trace of smoky chert.

- 4170- 4180 Claystone, 70%; siltstone, sandstone and Shale: as above; pyrite, marcasite and siderite; trace of Limestone: dark brownish-gray, microcrystalline, argillaceous; trace of bentonite and light gray, bentonitic shale.
- 4180- 4190 Claystone, 70%; Siltstone: as above; trace of glauconitic sandstone; trace of shale; Pyrite, 10%; Siderite, 5%.
- 4190- 4200 Claystone: gray, bentonitic, unctuous, 70%; Siltstone: as above, in part, brownish-gray and very argillaceous; slight increase in sandstone; pyrite and siderite; trace of limestone, and coal.
- 4200- 4210 Claystone, 75%; Siltstone: as above, gray and brownish-gray; Sandstone: as above; small amount of claystone, with carbonaceous inclusions; pyrite and Marcasite, 7%; reduced siderite and sideritic Siltstone, 3%; trace of coal, limestone, and bentonite.
- 4210- 4220 Claystone, 75%; Siltstone: as above, gray to dark gray and brownish-gray, argillaceous; trace of Shale: dark gray to dark brownish-gray; Sandstone: gray, as above; pyrite and Marcasite, 10%; siderite and sideritic Siltstone, 5%.
- 4220- 4230 Claystone, 70%; Siltstone: as above, 20%; sandstone and shale; slight reduction in pyrite and siderite; trace of gray chert.
- 4230- 4240 Claystone, 70%; siltstone, sandstone and shale; pyrite and Marcasite: as above.
- 4240- 4250 Claystone, 70%; siltstone is more argillaceous in general; sandstone and Shale: as above; still considerable pyrite and marcasite; trace of bentonite.
- 4250- 4260 Claystone, 70%; siltstone is more argillaceous; Shale: dark gray, in part, silty; Sandstone: fine grained, with less chert grains; pyrite and Marcasite, 10%; siderite and sideritic Siltstone, 5%; trace of bentonite and calcite.
- 4260- 4270 Claystone, 80%; Siltstone: as above; Sandstone: as above, in part, glauconitic; trace of Shale: as above; pyrite and Marcasite, 10%; siderite and sideritic siltstone; trace of bentonite; trace of calcite.
- 4270- 4280 Claystone, 65%; Siltstone: as above, less argillaceous, 20%; trace of Shale: in part, dark gray, very hard; pyrite and Marcasite, 7%; small amount of siderite and sideritic siltstone; trace of bentonite; trace of limestone.

- 4280- 4290 Claystone, 55%; siltstone, grading to a fine sandstone; Mudstone: gray to brownish-gray, soft, smooth texture, irregular fracture; pieces show rounding as if reworked, but has not been encountered up the hole; pyrite and siderite, as above; trace of bentonite and limestone; a few rounded quartz nodules.
- 4290- 4300 Claystone, 80%; remainder as above; trace of gray, mottled limestone; trace of bentonite.
- 4300- 4310 As above; trace of Limestone: brownish-gray, cryptocrystalline; trace of bentonite, calcite, and quartz nodules.
- 4310- 4320 Claystone, 60%; Siltstone: gray, argillaceous; small amount of Sandstone: "salt and pepper", fine grained, subangular, argillaceous; reduced pyrite.
- 4320- 4330 As above; increased Pyrite, 5%; trace of calcite and limestone.
- 4330- 4340 Claystone, 80%; Siltstone: gray and brownish-gray, argillaceous, very slightly friable; trace of sandstone; small amount of Shale: gray to dark gray, in part, silty; reduced pyrite; trace of siderite, sideritic siltstone, limestone, bentonite, and coal; some quartz nodules.
- 4340- 4350 Claystone, 70%; Siltstone, grading to a very fine grained Sandstone: subangular, well sorted, calcareous matrix; Mudstone: gray, soft; pyrite and Marcasite, 5%; trace of siderite and bentonite; some quartz nodules.
- 4350- 4360 Claystone, 65%; siltstone, sandstone and Shale: as above; pyrite and Marcasite: as above; slight increase in siderite; trace of limestone and bentonite; increased quartz nodules.
- 4360- 4370 As above; slight increase in siltstone; slight decrease in pyrite.
- 4370- 4380 Claystone, 50%; Siltstone: as above; small amount of Sandstone: less argillaceous than the siltstone; trace of Shale: dark gray, in part, slightly silty; trace of gray mudstone; trace of bentonite; slight increase in quartz nodules, in part, milky, in part, frosted.
- 4380- 4390 Claystone, 50%; Siltstone: gray to brownish-gray, argillaceous; small amount of sandstone; increased shale, grading to a Mudstone, 15%; trace of pyrite; reduced siderite; trace of bentonite; some quartz nodules.

- 4390- 4400 Claystone, 70%; remainder mainly siltstone; small amount of sandstone; small amount of shale; trace of pyrite, siderite, and bentonite, some quartz nodules.
- 4400- 4410 Claystone, 70%; Siltstone, 20%; Shale, 10%; reduced pyrite and siderite; some quartz nodules.
- 4410- 4420 Claystone, 70%; remainder as above; slight increase in pyrite; trace of siderite; some rounded quartz nodules.
- 4420- 4430 Claystone, 75%; increased siltstone; decrease in shale; increased Pyrite, 5%; reduced siderite; some rounded quartz nodules.
- 4430- 4440 Claystone, 75%; Siltstone: gray, argillaceous, with a minor amount brownish-gray, argillaceous; trace of Sandstone: "salt and pepper", in part, glauconitic; trace of Shale: dark gray, silty; small amount of pyrite; trace of siderite; some rounded quartz nodules.
- 4440- 4450 As above; siltstone is less argillaceous; small amount of mudstone.
- 4450- 4460 Claystone, 70%; Siltstone: gray to dark gray, more argillaceous, 20%; Shale: gray to dark gray, in part, silty; small amount of mudstone; trace of sandstone; reduced pyrite; trace of siderite; reduced quartz nodules.
- 4460- 4470 As above; trace of dark gray, carbonaceous shale.
- 4470- 4480 Claystone, 65%; Siltstone: gray and brownish-gray, argillaceous; Sandstone: "salt and pepper", quartz and chert grains; fine grained, subangular, well sorted, fairly friable, no shows, 5%; Shale: gray and brownish-gray to dark gray, rough texture, irregular fracture, in part, silty, 5%; trace of pyrite, siderite, and sideritic siltstone; rare quartz nodules.
- 4480- 4490 Claystone, 65%; siltstone and Shale: as above; Sandstone: as above, in part, friable; small amount of pyrite and marcasite; slight increase in siderite; some loose, rounded quartz nodules.
- 4490- 4500 Claystone, 65%; Siltstone: as above; Shale, 10%; reduced sandstone; increased pyrite and Marcasite, 10%; small amount of siderite and sideritic siltstone; rare quartz nodules, in part, subangular.
- 4500- 4510 Claystone, 70%; siltstone and silty Shale: as above; Sandstone: as above, more friable; pyrite and Marcasite, 5%; small amount of siderite; trace of bentonite; slight increase in rounded quartz nodules.

- 4510- 4520 Claystone, 50%; siltstone, shale and Mudstone: as above, but more brownish-gray; trace of pyrite, and bentonite.
- 4520- 4530 Claystone, 70%; Siltstone: as above; trace of Sandstone: less argillaceous than the siltstone; slightly friable; Shale: as above, 5%; trace of pyrite, siderite, sideritic siltstone, and bentonite.
- 4530- 4540 Claystone, 45%; Siltstone: gray to dark gray, argillaceous, "salt and pepper"; small amount of Shale: gray to dark gray, rough texture, irregular fracture, in part, silty; trace of argillaceous sandstone; pyrite and Marcasite, 10%; trace of siderite, sideritic siltstone, and rounded quartz nodules, clear to frosted.
- 4540- 4550 Claystone, 40%; Siltstone: gray, "salt and pepper", argillaceous; small amount of shale; trace of sandstone; small amount of pyrite; trace of siderite; trace of Limestone: brownish-gray, in part, mottled, cryptocrystalline; trace of coal, black, high luster.
- 4550- 4560 Claystone, 25%; Siltstone: as above; small amount of Sandstone: in part, slightly friable with some silty material in the matrix, rare weathered glauconite grains; small amount of shale, grading to a mudstone; small amount of pyrite and marcasite; trace of siderite, and coal.
- 4560- 4570 Claystone, 10%; Siltstone: as above, but, in general, more argillaceous; increased Sandstone: in part, argillaceous, 5%; silty shale is platy in part; small amount of pyrite; trace of sideritic siltstone and siderite.
- 4570- 4580 Claystone, 10%; Siltstone: as above, mainly brownish-gray with minor gray to dark gray, very argillaceous; increased Shale: gray to brownish-gray, fairly smooth texture, platy; trace of Sandstone: "salt and pepper", fine grained, subangular, well sorted, calcareous; trace of finely crystalline pyrite, marcasite, siderite, sideritic siltstone, and coal; reduced quartz nodules, in general, smaller.
- 4580- 4590 Reduced Claystone, 5%; Siltstone: as above, argillaceous, 85%; Shale: as above, in part, silty; small amount of Sandstone: argillaceous; trace of pyrite, and loose quartz nodules.
- 4590- 4600 Trace of claystone; reduced Siltstone and increased Shale, 50-50%; Sandstone: as above, 5%; trace of pyrite, siderite, and sideritic siltstone; some quartz nodules.

- 4600- 4610 Claystone, 20%; Siltstone: as above; increased shale, in part, silty; small amount of sandstone, in part, glauconitic, in part, cleaner than above; trace of pyrite and siderite.
- 4610- 4620 Claystone, 10%; Siltstone: as above, but softer, 45%; Shale: soft, almost a claystone; small amount of Sandstone: more argillaceous; siltstone, shale and sandstone are slightly calcareous, in part, carbonaceous; trace of pyrite, coal, siderite, and quartz nodules.
- 4620- 4630 Trace of claystone; siltstone; increased Shale, 45%; increased Sandstone: in part, nonargillaceous, 10%; trace of pyrite and siderite.
- 4630- 4640 Trace of claystone; remainder as above, but, in general, more silty; trace of pyrite and siderite.
- 4640- 4650 As above; slight increase in pyrite and marcasite; traces of bentonite, brownish-gray, cryptocrystalline limestone, and quartz nodules.
- 4650- 4660 Trace of claystone; argillaceous siltstone; silty shale; the sandstone is slightly less argillaceous; trace of pyrite.
- 4660- 4670 As above, but with an increase in Sandstone: more silty; slight increase in siderite.
- 4670- 4680 As above.
- 4680- 4690 As above, but with less sandstone.
- 4690- 4700 Claystone, 5%; Siltstone: as above, very argillaceous; Shale: as above, in part, silty; trace of light gray Shale: bentonitic, in part, silty; trace of pyrite and pyritized worm casts; trace of siderite; some quartz nodules, in part, with pink inclusions; trace of dark gray chert pebbles with some pyrite in minute fractures.
- 4700- 4710 Claystone, 5%; shale and Siltstone: as above; minor argillaceous sandstone; trace of pyrite and siderite; some quartz nodules.
- 4710- 4720 Claystone, 25%; Siltstone: as above, mainly dark gray, argillaceous; Shale: as above, almost a mudstone, in part, silty, in part, lighter gray and bentonitic, with a smoother texture; trace of pyrite and siderite.
- 4720- 4730 Claystone, 30%; remainder as above, but with increased Sandstone: argillaceous, in part, glauconitic, 15%.

- 4730- 4740 Claystone, 30%; Shale: gray to brownish-gray, fairly smooth texture, platy to fissile, 40%; siltstone; small amount of sandstone; trace of pyrite and siderite.
- 4740- 4750 Claystone, 30%; Shale: as above, but, in general, more silty; Siltstone: as above; small amount of Sandstone: in part, argillaceous, in part, cleaner and glauconitic; trace of marcasite, bentonite, and calcite.
- 4750- 4760 Claystone, 30%; remainder as above; trace of light gray, bentonitic shale.
- 4760- 4770 Claystone, 30%; Shale: gray and brownish-gray, with minor light gray; Siltstone: gray and with some brownish-gray, very argillaceous; trace of marcasite.
- 4770- 4780 Trace of claystone; shale and Siltstone: as above; reduced Sandstone: more argillaceous; trace of siderite and marcasite; trace of Limestone: light brownish-gray, cryptocrystalline; trace of quartz nodules.
- 4780- 4790 Shale: as above; Siltstone: as above; Sandstone: "salt and pepper"; quartz and chert with rare glauconite grains, very fine grained, poorly sorted, well consolidated, calcareous matrix, less argillaceous; trace of marcasite.
- 4790- 4800 As above, with decreased Sandstone: clean; more Siltstone, 50%.
- 4800- 4810 As above; shale is more silty; Siltstone: gray, very argillaceous; reduced sandstone; trace of marcasite and siderite.
- 4810- 4820 Claystone, 30%; Shale: as above, but, in part, darker, smoother textured; siltstone and Sandstone: as above; increased marcasite and Pyrite, 3%.
- 4820- 4830 Claystone, 30%; shale and Siltstone: as above; reduced Sandstone: more argillaceous and silty, 3%; trace of marcasite, pyrite, and siderite.
- 4830- 4840 Claystone, 10%; remainder as above; increased quartz nodules.
- 4840- 4850 Claystone, 10%; shale and Siltstone: as above, mainly light brownish-gray; small amount of sandstone; trace of pyrite, marcasite, and siderite.
- 4850- 4860 Shale and Siltstone, 50-50%; increased Sandstone: "salt and pepper", argillaceous, in part, glauconitic; trace of limestone, marcasite, and siderite.

- 4860- 4870 As above.
- 4870- 4880 Shale and Siltstone: as above; sandstone, in part, clean, glauconitic, with rare siderite grains.
- 4880- 4890 Shale and Siltstone; trace of argillaceous sandstone; trace of pyrite and pyritized worm casts.
- 4890- 4900 Siltstone: gray, argillaceous, and Shale: gray, in part, silty; traces of sandstone, pyrite, and siderite.
- 4900- 4910 As above, in general, more silty; slight increase in Sandstone: more friable, argillaceous; traces of pyrite, siderite, altered lignitic and pyritized wood, and quartz nodules.
- 4910- 4920 As above, but with increased Siltstone, 50%; trace of sandstone; increased pyrite and marcasite; trace of siderite and frosted, rounded quartz nodules.
- 4920- 4930 As above; siltstone and shale are more brownish-gray than gray.
- 4930- 4940 Siltstone, 50%; Shale: as above; Sandstone: gray and greenish-gray, 10%; trace of marcasite; very rare quartz nodules.
- 4940- 4950 As above; silty shale and Siltstone: brownish-gray, soft; Sandstone, 5%; trace of limestone.
- 4950- 4960 Siltstone and Shale: as above; increase in Sandstone: "salt and pepper"; quartz and scattered chert grains, fine grained, subangular, well sorted, well consolidated, calcareous matrix, tight, in part slightly argillaceous; trace of pyrite and siderite; very rare quartz nodules.
- 4960- 4970 Siltstone and Shale: brownish-gray to gray; small amount of sandstone, in part, glauconitic; trace of pyrite.
- 4970- 4980 Shale: light gray to gray and brownish-gray, less silty than above, mainly platy, 60%; Siltstone: as above, very argillaceous, harder; trace of sandstone, pyrite, and quartz nodules.
- 4980- 4990 As above.
- 4990- 5000 As above, but sandstone increased to 10%; light gray to gray, fine grained, subangular, well consolidated, calcareous matrix, tight, no shows.
- 5000- 5010 Shale and Siltstone: as above; sandstone increased to 15%; trace of pyrite and sideritic siltstone.

- 5010- 5020 As above.
- 5020- 5030 Shale: light brownish-gray to gray, fairly smooth texture, in part, platy, in part, slightly silty, 40%; Siltstone: light brownish-gray to gray and dark gray, very argillaceous; Sandstone: "salt and pepper", gray, in part, argillaceous, in part, slightly friable; trace of siderite.
- 5030- 5040 Shale, 40%, Siltstone, 30%, Sandstone, 30%; trace of pyrite.
- 5040- 5050 As above; sandstone is slightly argillaceous, slightly friable.
- 5050- 5060 Siltstone: as above, 40%; Sandstone, 30%; Shale: as above; trace of pyrite.
- 5060- 5070 As above; reduced Sandstone, 20%; siltstone and shale; trace of siderite and calcite.
- 5070- 5080 As above; in general, the shale is more silty; sandstone is less argillaceous, in part, slightly friable.
- 5080- 5090 Siltstone: gray to brownish-gray, argillaceous, 50%; Shale, 30%; Sandstone, 20%; trace of pyrite, siderite, and marcasite.
- 5090- 5100 Shale: gray to dark gray, in part, with a brownish tinge, platy to fissile, in part, silty, 70%; Siltstone: gray to dark gray, argillaceous; small amount of sandstone; trace of pyrite.
- 5100- 5110 Shale: as above, in general, more blocky; Siltstone: as above; increased Sandstone: as above, gray, "salt and pepper"; quartz and chert grains, fine grained, subangular, well sorted, fairly well consolidated, slightly calcareous; trace of pyrite.
- 5110- 5120 Shale: as above, light brownish-gray to gray, blocky to platy, in part, silty; Siltstone: as above; slight reduction in sandstone, in part, with rare siderite grains; trace of pyrite, sideritic claystone, and sericite in the sandstone.
- 5120- 5130 Reduced Shale: as above, 50%; slight reduction in sandstone, in general, more argillaceous; trace of siderite.
- 5130- 5140 As above; reduced sandstone, more argillaceous.

- 5140- 5150 Mainly Shale: gray to dark gray, mainly platy, in part, silty; Siltstone: gray to dark gray, argillaceous; Sandstone: as above, 5%.
- 5150- 5160 Increased siltstone; Shale, 20%; Sandstone, 10%; trace of pyrite and siderite.
- 5160- 5170 Siltstone and Shale: as above; increased Sandstone: in part, less argillaceous, 20%.
- 5170- 5180 Siltstone: as above, 60%; Shale, 20%; Sandstone, 20%.
- 5180- 5190 As above, but with reduced Sandstone: more argillaceous.
- 5190- 5200 Siltstone: gray, argillaceous; lesser shale and sandstone.
- 5200- 5210 As above.
- 5210- 5220 Siltstone and shale; small amount of sandstone; trace of pyrite.
- 5220- 5230 Shale: gray to light brownish-gray, blocky to platy, in part, silty, 40%; Siltstone: gray, argillaceous, 50%; Sandstone: less argillaceous, in part, glauconitic.
- 5230- 5240 Shale and Siltstone: as above; Sandstone: "salt and pepper", with rare glauconite grains, 15%; trace of marcasite.
- 5240- 5250 Siltstone: gray, argillaceous, 40%; Shale: gray to light brownish-gray, in part, silty, 30%; Sandstone: as above, less argillaceous, 30%; trace of pyrite and siderite.
- 5250- 5260 Siltstone: gray to dark gray, argillaceous; Sandstone: as above, light gray to white, "salt and pepper"; quartz and chert grains, fine grained, subangular, well sorted, well consolidated, calcareous, tight, 20%; Shale: gray, in part, silty, blocky, 30%.
- 5260- 5270 Siltstone: as above; increased Shale, 35%; in part, the dark gray shale is carbonaceous; Sandstone: as above, but more argillaceous, 20%.
- 5270- 5280 As above, but increased Sandstone: with rare, carbonaceous streaks, 25%.
- 5280- 5290 Siltstone, 40%; Shale, 30%; Sandstone, 20%; trace of pyrite.
- 5290- 5300 Siltstone and Shale, 50-50%; sandstone, in part, glauconitic, 30%; trace of pyrite.

- 5300- 5310 As above; trace of pyrite.
- 5310- 5320 Sandstone: "salt and pepper"; quartz and chert; fine grained, subangular, well sorted, well consolidated, calcareous matrix, argillaceous, 40%; siltstone and Shale: as above; trace of marcasite and siderite.
- 5320- 5330 As above.
- 5330- 5340 Sandstone: "salt and pepper", in part, more friable, with scattered carbonaceous streaks; traces of sericite in the Sandstone, 40%; Siltstone, 40%; Shale: as above, and some mudstone, 20%; trace of light brownish-gray limestone, cryptocrystalline.
- 5340- 5350 Sandstone: as above, argillaceous, 50%; Siltstone: gray, argillaceous, 40%; Shale, 10%; trace of siderite.
- 5350- 5360 Sandstone: as above, 55%; slight reduction in shale; Siltstone: as above; trace of siderite.
- 5360- 5370 Sandstone, 60%; trace of glauconitic sandstone; traces of scattered carbonaceous material in the sandstone; Siltstone, 25%; Shale, 15%; trace of siderite.
- 5370- 5380 Sandstone: as above, 70%; argillaceous Siltstone, 30%.
- 5380- 5390 Slight reduction in sandstone, in part, with scattered siderite grains; Siltstone: as above; Shale: dark gray to gray, in part, silty, 10%; trace of pyrite.
- 5390- 5400 Sandstone: as above, in part, friable, 60%; Siltstone: as above; Shale, 5%.
- 5400- 5410 Sandstone: as above, 55%; siltstone; silty Shale has a brownish tinge in part, 10%.
- 5410- 5420 Sandstone: as above, 65%; Siltstone: gray to dark gray, "salt and pepper", argillaceous; Shale: gray to light brownish-gray, smooth texture, platy to blocky, in part, silty, 5%.
- 5420- 5430 Sandstone, 50%; siltstone; Shale, 10%.
- 5430- 5440 As above.
- 5440- 5450 Sandstone: light gray, "salt and pepper"; quartz and chert with scattered siderite grains, fine grained, subangular, poorly sorted, well consolidated, with a calcareous and sideritic matrix, and with rare carbonaceous streaks, tight, 60%; Siltstone: gray, soft, argillaceous; Shale: gray to brownish-gray, fairly smooth texture, in part, silty, 10%.

- 5450- 5460 Sandstone: as above, slightly argillaceous, 55%; Siltstone: as above, argillaceous; Shale, 15%; trace of pyrite.
- 5460- 5470 Claystone, 10%; Sandstone: "salt and pepper", with a trace of sideritic material in the matrix, 60%; Siltstone: as above; Shale: gray to light brownish-gray, mainly platy, in part, silty; trace of siderite.
- 5470- 5480 Shale: gray, in part, silty, 50%; siltstone, 45%; sandstone, 5%.
- 5480- 5490 Shale: gray, soft, fairly smooth texture, in part, silty, grading to a Claystone, 60%; Siltstone: gray, argillaceous; small amount of Sandstone: as above, in part, friable.
- 5490- 5500 Shale, siltstone and Sandstone: as above; sandstone has scattered siderite grains.
- 5500- 5510 Shale, 60%; Siltstone: gray, in part, sandy; small amount of sandstone; trace of siderite.
- 5510- 5520 Shale, 45%; Siltstone: as above, with rare, scattered carbonaceous streaks and specks; Sandstone: as above, 15%.
- 5520- 5530 Shale, 45%; some light gray, bentonitic shale; Siltstone: as above; Sandstone, 20%; trace of finely crystalline pyrite.
- 5530- 5540 As above; in part, the shale is light brownish-gray; reduced Sandstone, 15%; trace of calcite; trace of Limestone: light brownish-gray, mottled, cryptocrystalline.
- 5540- 5550 As above.
- 5550- 5560 Shale, 40%; Siltstone, 30%; Sandstone, 30%.
- 5560- 5570 Sandstone, 50%; Siltstone, 30%; Shale, 20%.
- 5570- 5580 Sandstone: as above, with scattered siderite grains, 40%; Siltstone: gray, argillaceous; Shale: gray to brownish-gray, 25%; trace of pyrite.
- 5580- 5590 Sandstone: as above, but, in general, finer and darker, more argillaceous, 40%; siltstone; Shale, 20%; trace of pyrite.

- 5590- 5600 Sandstone: as above, 40%; Shale: as above, with increased dark gray Shale: in part, carbonaceous, 35%; Siltstone: gray, argillaceous; trace of pyrite, calcite, and Inoceramus prisms.
- 5600- 5610 Shale: as above, 40%; Sandstone: as above; Siltstone, 30%; trace of pyrite; trace of glauconite in the sandstone.
- 5610- 5620 Sandstone: as above, with rare carbonaceous streaks, 35%; Siltstone: as above; Shale: as above, with a trace of very light brownish-gray, platy shale; trace of siderite.
- 5620- 5630 Sandstone: as above, in part, glauconitic, 40%; Siltstone: as above; Shale: as above, 20%; trace of pyrite.
- 5630- 5640 Siltstone: as above, 40%; Shale, 40%; trace of pyrite, marcasite, and coal.
- 5640- 5650 As above; some very glauconitic sandstone; trace of pyrite.
- 5650- 5660 Siltstone, 40%; Shale, 50%; Sandstone, 10%; trace of pyrite.
- 5660- 5670 Siltstone, shale and Sandstone: as above; trace of pyrite.
- 5670- 5680 Shale: as above, 60%; Siltstone, 40%; small amount of sandstone; trace of pyrite.
- 5680- 5690 Siltstone: gray, argillaceous, less calcareous than above, 55%; Shale, 40%; Sandstone, 5%.
- 5690- 5700 Siltstone, shale, and Sandstone: as above; the shale is brownish-gray in part.
- 5700- 5710 Siltstone, 70%; Shale: as above; Sandstone: with some carbonaceous streaks, 5%.
- 5710- 5720 As above; small amount of sandstone; trace of pyrite.
- 5720- 5730 Shale: gray to dark gray, with a tinge of brown, smooth texture, platy; in part, the dark gray shale is carboniferous, 50%; Siltstone: gray, fairly soft, argillaceous; Sandstone: gray, "salt and pepper", argillaceous, 5%.
- 5730- 5740 Siltstone, shale and Sandstone: as above; sandstone is finer grained, more argillaceous.

- 5740- 5750 Shale, 50%; Siltstone, 40%; Sandstone, mostly fine to very fine grained, 10%; trace of siderite.
- 5750- 5760 Siltstone, 70%; Shale: as above; sandstone, 20%.
- 5760- 5770 Siltstone, 50%; Shale, 30%; sandstone; trace of pyrite and calcite.
- 5770- 5780 Siltstone, 45%; Shale, 35%; Sandstone: as above, with some carbonaceous streaks; trace of marcasite.
- 5780- 5790 Siltstone, 70%; Shale: as above, 30%; the dark gray shale is carbonaceous in part, platy; trace of argillaceous sandstone and siderite.
- 5790- 5800 As above.
- 5800- 5810 Siltstone, 45%; Shale, 40%; sandstone; trace of bentonite and pyrite.
- 5810- 5820 Siltstone, 50%; Shale, 30%; sandstone; trace of pyrite.
- 5820- 5830 Siltstone, 70%; Shale, 20%; sandstone.
- 5830- 5840 Siltstone: gray, argillaceous, 50%; Sandstone, 30%; shale.
- 5840- 5850 Siltstone, 70%; Shale, 20%; sandstone; trace of calcite and siderite.
- 5850- 5860 Increased Siltstone, 90%; Shale, 10%; trace of sandstone.
- 5860- 5870 Siltstone, 85%; Shale, 10%; in part, the dark gray shale is carbonaceous; shale has some carbonaceous streaks and specks; Sandstone, 5%; trace of pyrite and siderite.
- 5870- 5880 Siltstone, 70%; Shale: in general, darker, more carbonaceous, 20%; sandstone; trace of pyrite.
- 5880- 5890 Siltstone, 70%; Shale, 30%; trace of sandstone, in part, very light gray, mainly quartz grains, very fine grained, subangular, well sorted, poorly consolidated, possible bentonitic matrix, very slightly calcareous, with a trace of phlogopite and calcite.
- 5890- 5900 Siltstone: as above; Shale: as above, in part, fissile, 30%; Sandstone: as above, in general, lighter, less argillaceous, 10%; trace of calcite and pyrite.
- 5900- 5910 Siltstone, 70%; Shale: in part, dark gray, fissile, 30%; trace of Sandstone: as above.

- 5910- 5920 Siltstone: gray to dark gray, argillaceous, 70%; Shale: gray to brownish-gray, in part, with carbonaceous streaks, 30%; trace of Sandstone: light gray, "salt and pepper"; traces of light gray, bentonitic shale, siderite, and calcite.
- 5920- 5930 As above.
- 5930- 5940 Siltstone: as above, 70%; Shale: gray to dark gray, in part, platy to fissile, 30%; traces of light gray sandstone, and light gray, bentonitic shale.
- 5940- 5950 Siltstone, 55%; Shale, 45%; trace of sandstone; trace of marcasite; in part, the siltstone is lighter gray, less argillaceous.
- 5950- 5960 Siltstone: light gray to dark gray, 50%; Shale: light gray to dark gray, in part, fissile, 50%; trace of very fine grained sandstone; trace of marcasite.
- 5960- 5970 Siltstone: as above, 70%; Shale: as above, 30%; traces of sandstone, bentonite, and marcasite.
- 5970- 5980 Siltstone: as above, 55%; Shale, 45%; trace of sandstone and siderite.
- 5980- 5990 As above.
- 5990- 6000 Siltstone: as above; Shale: gray to dark gray, platy to fissile, less silty, in part, carbonaceous; trace of Sandstone: as above; trace of Sandstone: light brown, quartz grains, with a silty, sideritic matrix.
- 6000- 6010 Shale: mainly dark gray, 30%; Siltstone: as above, 70%; trace of Sandstone: as above, with rare, heavy, dead residual oil; very faint fluorescence when cut with chloroethane; trace of marcasite.
- 6010- 6020 Siltstone: light gray to gray, "salt and pepper", argillaceous, 70%; Shale: mainly dark gray and fissile, 30%; trace of "salt and pepper" sandstone, no shows; trace of marcasite.
- 6020- 6030 Siltstone: increasingly light gray, 60%; Shale: as above, mainly dark gray, fissile, 35%; Sandstone: light gray, "salt and pepper", quartz and chert grains, fine grained, subangular, well consolidated, calcareous matrix, tight.
- 6030- 6040 Siltstone: as above, 60%; Shale: as above, gray to dark gray, platy, in part, slightly silty; Sandstone: "salt and pepper", quartz and chert, 10%.

- 6040- 6050 Siltstone: as above; shale, 25%; increased sandstone, 15%; trace of pyrite.
- 6050- 6060 Sandstone: "salt and pepper"; quartz and chert, fine grained, subangular, well sorted, well consolidated, very slightly calcareous, occurring in thin beds; Siltstone: gray to dark gray, argillaceous; Shale: light gray to dark gray, in general, with a smooth texture, platy, in part, slightly silty, 45%; trace of pyrite.
- 6060- 6070 Shale: as above, but blocky to platy, 50%; Siltstone: as above, 30%; Sandstone: as above, in general, more argillaceous; increased pyrite; trace of marcasite, and white, crystalline calcite.
- 6070- 6080 Siltstone: as above, 50%; Shale, 40%; Sandstone: as above, light gray, very fine to fine grained, with carbonaceous streaks and a trace of heavy, residual oil; pale yellow cut fluorescence.
- 6080- 6090 Shale, 60%; Siltstone, 40%; trace of sandstone; trace of marcasite and bentonite.
- 6090- 6100 Shale, 60%; Siltstone, 40%; Sandstone: as above; trace of bentonite and marcasite.
- 6100- 6110 Shale, 60%; Siltstone, 40%; trace of calcite; shale is more splintery.
- 6110- 6120 Shale: as above, 50%; Siltstone, 45%; Sandstone: in part, darker, more argillaceous.
- 6120- 6130 Shale: as above, in part, lighter, in part more silty, 50%; Siltstone: as above; small amount of Sandstone: in part, with rare siderite grains, tight, no shows; trace of bentonite and pyritized worm casts.
- 6130- 6140 Shale: as above, slightly less fissile, 45%; Siltstone: gray, argillaceous, 40%; Sandstone: as above, in part, lighter gray, in part, gray.
- 6140- 6150 Shale: as above, brownish-gray, in part, slightly silty, 30%; Siltstone: brownish-gray, in part, argillaceous, 60%; Sandstone: as above, with scattered siderite grains, calcareous; trace of marcasite.
- 6150- 6160 Siltstone: gray, argillaceous, 60%; Shale: as above, in part, brownish-gray; trace of light gray, bentonitic shale; Sandstone: as above, in part, argillaceous, 10%.

- 6160- 6170 As above; shale is more blocky in general; trace of marcasite and siderite.
- 6170- 6180 Siltstone, 70%; Shale: as above, but in general, more silty; Sandstone: in general, more argillaceous, 10%; no visible porosity in the sandstone; trace of marcasite.
- 6180- 6190 Siltstone: as above, light gray to gray, in part, argillaceous, 80%; Shale: as above, 15%; reduced Sandstone: finer grained, 5%; trace of marcasite.
- 6190- 6200 Shale and siltstone; trace of sandstone and marcasite.
- 6200- 6210 Siltstone: light gray to gray, 75%; Shale: as above, mainly dark gray, platy, 15%; Sandstone: as above; trace of marcasite, siderite, and calcite.
- 6210- 6220 Siltstone, 60%; Shale: as above, blocky to platy, 35%; Sandstone: as above; trace of pyrite and marcasite.
- 6220- 6230 Siltstone: light to dark gray, argillaceous, 70%; Shale: as above; trace of light gray, bentonitic shale; sandstone, 10%; trace of marcasite.
- 6230- 6240 Siltstone: as above, 60%; Shale: mainly dark gray, platy, 40%; trace of Sandstone: fine grained, argillaceous; trace of calcite.
- 6240- 6250 Shale: mainly dark gray, with some gray, platy to fissile, less silty, 60%; Siltstone: mainly lighter gray, less argillaceous than above, 40%; trace of sandstone.
- 6250- 6260 Shale and Siltstone: as above; trace of sandstone.
- 6260- 6270 Shale: gray to dark gray, mainly platy, in part, slightly silty, 60%; Siltstone: mainly gray, with some dark gray, argillaceous, 40%; trace of Sandstone: "salt and pepper", quartz and chert grains, fine grained, subangular, well sorted, well consolidated, tight.
- 6270- 6280 Siltstone: as above, 50%; Shale: mainly dark gray, in part, fissile, 40%; Sandstone: as above, 10%; trace of marcasite.
- 6280- 6290 Siltstone: gray, argillaceous, 80%; Shale: dark gray, platy to fissile, 20%; trace of sandstone and pyrite.
- 6290- 6300 Siltstone: as above, 70%; Shale, 20%; Sandstone, 10%.
- 6300- 6310 Siltstone and Shale: as above; trace of sandstone and marcasite.

- 6310- 6320 Siltstone: gray, argillaceous, 50%; Shale: gray to dark gray, platy, 40%; Sandstone: in general, lighter, less argillaceous, fine grained, 10%.
- 6320- 6330 Siltstone: as above, 70%; Shale: mainly dark gray, 25%; sandstone, 5%; trace of Inoceramus prisms.
- 6330- 6340 Siltstone: as above, less argillaceous, 90%; Shale: as above; small amount of sandstone; trace of calcite.
- 6340- 6350 Siltstone: as above, gray to darker gray, 90%; Shale, 10%; trace of Sandstone: "salt and pepper"; trace of calcite.
- 6350- 6360 Siltstone: as above, mainly gray, slightly argillaceous, 80%; Shale: mainly dark gray, platy; small amount of Sandstone: light gray, "salt and pepper"; quartz and chert grains, fine grained, subangular, well sorted, well consolidated, calcareous matrix.
- 6360- 6370 Siltstone: as above, but more argillaceous, 90%; shale; small amount of sandstone.
- 6370- 6380 Siltstone, 70%; increased Shale: in part, silty, 20%; Sandstone: as above, 10%.
- 6380- 6390 Siltstone, 70%; Shale: gray to dark gray, blocky to platy; Sandstone: "salt and pepper", 10%.
- 6390- 6400 Siltstone, 75%; Shale, 25%; trace of Sandstone: in part, friable; trace of calcite and Inoceramus prisms.
- 6400- 6410 Siltstone, 60%; Shale: dark gray, platy to fissile, 30%; trace of sandstone.
- 6410- 6420 Siltstone, 55%; Shale: mainly dark gray, with some light gray, platy to fissile, 45%; trace of Sandstone: "salt and pepper"; quartz and chert grains, fine grained, subangular.
- 6420- 6430 Siltstone, 60%; shale; increased Sandstone, more friable, 50%.
- 6430- 6440 Siltstone: as above, 50%; Shale: platy, 40%; increased Sandstone, 10%.
- 6440- 6450 As above.
- 6450- 6460 Siltstone: gray, slightly argillaceous, 60%; Shale: gray to dark gray, mainly platy, 25%; Sandstone: "salt and pepper"; quartz and chert grains, fine grained,

subangular, well sorted, well consolidated, calcareous, in part, with rare scattered carbonaceous material and scattered, finely crystalline pyrite in the matrix; trace of pyrite, marcasite, and calcite.

- 6460- 6470 Siltstone: gray to dark gray, argillaceous, 30%; Shale: mainly dark gray, 40%; Sandstone: as above, 10%.
- 6470- 6480 Increased Shale: mainly dark gray, rough texture, irregular fracture, blocky to platy, in part, silty, 70%; Siltstone: as above, 30%; trace of sandstone.
- 6480- 6490 Shale: as above, platy to fissile, 60%; Sandstone: as above, 10%.
- 6490- 6500 Shale: as above, 60%; siltstone; Sandstone: as above, 10%.
- 6500- 6510 Shale: as above, 70%; Siltstone: gray, argillaceous; Sandstone, 10%.
- 6510- 6520 Shale, 50%; increased Siltstone, 40%; Sandstone: as above, with rare traces of heavy, residual oil, very faint yellow cut fluorescence.
- 6520- 6530 Shale, 60%; siltstone; trace of Sandstone: with very rare carbonaceous streaks and rare siderite grains.
- 6530- 6540 Shale, 50%; Siltstone: as above; increased Sandstone, 20%.
- 6540- 6550 Shale: as above, but with increasing lighter gray, 40%; Siltstone: as above; Sandstone: as above, in general, argillaceous, in part, slightly friable, 20%.
- 6550- 6560 Siltstone: as above, 40%; Shale, 30%; Sandstone, 30%; some phlogopite in the sandstone.
- 6560- 6570 Siltstone: gray, argillaceous, 50%; Shale: mainly dark gray, blocky, 30%; Sandstone: "salt and pepper"; quartz and chert grains, occurring as thin, even bands in the siltstone and shale.
- 6570- 6580 Siltstone: as above, 40%; Shale: as above, gray to dark gray, blocky to platy, 40%; Sandstone: "salt and pepper"; quartz and chert, with rare, scattered siderite grains, in part slightly friable.
- 6580- 6590 Siltstone: light gray to dark gray, in part, argillaceous, 40%; Shale: as above, 30%; Sandstone: as above, in general, harder, 30%.

- 6590- 6600 Siltstone: mainly gray, hard, 60%; Shale: as above, 20%; Sandstone: "salt and pepper"; quartz and chert grains, fine grained, subangular, fairly well sorted, well consolidated, 20%.
- 6600- 6610 Shale: dark gray, platy to fissile, 70%; Siltstone: light gray to gray, hard, in part, slightly argillaceous, 20%; Sandstone: light gray to gray, "salt and pepper"; quartz and chert grains, fine grained, subangular, well sorted, well consolidated, calcareous matrix, tight, 10%; trace of pyrite and siderite.
- 6610- 6620 Shale: gray to dark gray, platy to fissile, 60%; Siltstone, 20%; Sandstone, 20%.
- 6620- 6630 Siltstone: light gray to gray, in part, slightly argillaceous, 60%; Shale: as above, but more fissile, 40%; trace of Sandstone: in part, with carbonaceous streaks.
- 6630- 6640 Siltstone, 55%; Shale: gray, platy, and Shale: dark gray, blocky to platy, 35%; Sandstone: as above, 10%.
- 6640- 6650 Siltstone: as above, 45%; Shale: in part, brownish-gray, in part, slightly silty; Sandstone: poorly sorted, 10%.
- 6650- 6660 Increase in blocky, dark gray shale, 50%; Siltstone: as above; decrease in Sandstone: in general, finer grained, more argillaceous, 3%.
- 6660- 6670 Siltstone: light gray to gray, "salt and pepper", in part, slightly argillaceous, 50%; shale; small amount of sandstone; trace of marcasite.
- 6670- 6680 Siltstone: as above; Shale: as above, but, in part, brownish-gray, blocky to fissile; trace of sandstone and marcasite.
- 6680- 6690 Shale, 50%; Siltstone, 50%; trace of Sandstone: in part, with rare glauconite grains.
- 6690- 6700 Shale, 50%; Siltstone, 50%; trace of sandstone.
- 6700- 6710 Siltstone, 60%; Shale, 40%; trace of sandstone.
- 6710- 6720 Shale: mainly dark gray, rougher texture, irregular fracture, in part, slightly silty, 60%; Siltstone: as above; trace of "salt and pepper" sandstone; trace of light gray, bentonitic shale, and pyrite.

- 6720- 6730 Shale and Siltstone: as above; one piece shows very fine, even banding of shale and siltstone; trace of Sandstone: as above; trace of pyrite pods along a contact; trace of calcite.
- 6730- 6740 Siltstone, 55%; Shale, 45%; trace of Sandstone: in part, gray; quartz and chert with scattered siderite grains, some mafic materials and rare pyrite in the matrix, tight; trace of pyrite.
- 6740- 6750 Siltstone, 50%: light gray to gray; Shale: as above; trace of Sandstone: as above, occurring in thin, even sheets in the shale.
- 6750- 6760 As above.
- 6760- 6770 Shale: dark gray, tough texture, platy to fissile, 60%; Siltstone: light gray to gray, in part, argillaceous; Sandstone: as above, light gray to gray; quartz and chert grains, fine grained, subangular, well sorted, well consolidated, calcareous matrix, occurring as thin (± 2 mm), even beds in the shale; trace of marcasite and siderite.
- 6770- 6780 Siltstone: as above, 60%; Shale: as above; trace of Sandstone: in part, darker, with rare mafic minerals; one piece was bleeding very minute gas bubbles.
- 6780- 6790 As above; slight increase in darker Sandstone: with scattered mafic minerals.
- 6790- 6800 Shale: dark gray, platy to fissile, 50%; Siltstone: light gray to gray, in part argillaceous, in part, with carbonaceous streaks and specks, 50%; trace of Sandstone: fine to medium grained; quartz and chert; the medium grained sandstone is more friable.
- 6800- 6810 Shale: as above, 60%; Siltstone: gray, in part, with carbonaceous streaks; trace of Sandstone: "salt and pepper"; quartz and chert grains, fine to medium grained, subangular, poorly sorted; in part, the coarser sandstone is friable.
- 6810- 6820 Shale and Sandstone: as above; Sandstone: in general, coarser, more friable, with some mafic minerals; trace of phlogopite in the sandstone.
- 6820- 6830 Shale: dark gray, fissile, 50%; Siltstone: as above; Sandstone: in general, more argillaceous and with some mafic minerals, coarser, more friable, 10%.

- 6830- 6840 Shale: as above, but with a rougher texture, more silty, 50%; Siltstone: as above; Sandstone: as above, with some carbonaceous streaks; faint yellow cut fluorescence.
- 6840- 6850 Shale: as above, but more brownish-gray, 50%; Siltstone: as above; Sandstone: as above, 20%.
- 6850- 6860 Shale: as above, gray to brownish-gray, with very faint yellowish-white fluorescence when cut with chloroethane, 40%; Siltstone: gray, argillaceous, with scattered carbonaceous specks; increased Sandstone: as above, but darker gray, fine to medium grained, subangular, slightly carbonaceous, poorly sorted, calcareous, friable, 15%.
- 6860- 6870 Shale: gray to brownish-gray, platy to fissile, with faint cut fluorescence, 40%; Siltstone: as above, more argillaceous; Sandstone: as above, more argillaceous and silty, 15%.
- 6870- 6880 Shale: as above, 40%; Siltstone: as above; Sandstone, 25%; both the shale and the sandstone exhibit a faint yellowish-white cut fluorescence.
- 6880- 6890 Siltstone: gray, argillaceous, 40%; Shale: gray, in part, silty, 30%; Sandstone: as above; faint cut fluorescence; trace of bentonitic shale, with a bright yellow fluorescence.
- 6890- 6900 As above; Sandstone: more friable, but poor porosity, with some carbonaceous streaks and rare scattered blebs of dead oil, 35%; Siltstone, 35%; Shale: in part, brownish, 30%; faint cut fluorescence; trace of bentonitic shale with bright yellow cut fluorescence; appears to be a mineral fluorescence.
- 6900- 6910 Reduced Sandstone: in part, more argillaceous, 30%; trace of light green, glauconitic sandstone, with a silty matrix; Siltstone, 40%; Shale: as above, in part, silty, 30%; faint cut fluorescence; trace of light brownish-gray, bentonitic Shale: as above.
- 6910- 6920 Shale: as above, blocky to platy, 50%; Siltstone: as above, 30%; trace of light green siltstone; reduced Sandstone: as above, in general, finer, 20%; trace of bentonitic shale with a bright yellow and orange fluorescence.
- 6920- 6930 Siltstone: as above, light gray to gray, in part, argillaceous, 50%; Shale: dark gray, in part, with a brownish tinge, platy, 30%; reduced Sandstone: less

- argillaceous; faint yellow fluorescence when cut with chloroethane; trace of light brownish-gray, bentonitic shale, with a bright yellow and orange fluorescence.
- 6930- 6940 Siltstone: gray, in part, argillaceous, 40%; Shale: gray to dark gray, rough texture, hackly fracture, blocky to platy, with a faint yellow cut fluorescence, 35%; Sandstone: as above, finer grained, more uniform, less argillaceous, 25%; faint yellowish-white cut fluorescence; trace of light brownish-gray, bentonitic shale.
- 6940- 6950 Siltstone: as above, 45%; Shale: as above, with some brownish-gray, subbituminous, 35%; shale shows a faint, yellowish-white cut fluorescence; Sandstone: as above; trace of siderite.
- 6950- 6960 Siltstone, 45%; Shale: as above, 30%; increased Sandstone: cleaner, with a faint yellowish-white cut fluorescence.
- 6960- 6970 Shale: brownish-gray, rough texture, light brown streak, in part, platy, with a whitish-yellow cut fluorescence, 50%; Siltstone: light gray to gray, in part, argillaceous, 30%; Sandstone: "salt and pepper"; quartz and chert, with some scattered siderite grains, fine grained, subangular, in part, argillaceous.
- 6970- 6980 Shale: subbituminous, as above, 60%; Siltstone: light gray, 30%; Sandstone: as above, more uniform, 10%; trace of bentonitic clay, with bright yellow and orange fluorescence.
- 6980- 6990 Shale: as above, brownish-gray to dark brownish-gray, light brown streak, rough texture, in part, slightly silty, 70%; Siltstone: light gray; reduced Sandstone, 30%; trace of bentonitic shale.
- 6990- 7000 Shale: as above, 80%; siltstone, 20%; trace of sandstone, light gray, bentonitic shale, and siderite.
- 7000- 7010 Shale, siltstone and Sandstone: as above; trace of light green shale, marcasite, and calcite.
- 7010- 7020 Subbituminous Shale: as above, 90%; Siltstone, 10%; trace of sandstone and calcite.
- 7020- 7030 As above.
- 7030- 7040 Shale: as above, 90%; trace of sandstone; trace of light green shale; trace of orange-brown calcite filling fractures.

- 7040- 7050 Shale: as above, 90%; Siltstone, 10%; trace of sandstone, with carbonaceous streaks; trace of light green, bentonitic shale, and siderite.
- 7050- 7060 Shale: dark brownish-gray, subbituminous, light brown streak, in part, silty, with a faint yellow cut fluorescence; trace of Sandstone: as above; trace of light green shale and siderite.
- 7060- 7070 As above.
- 7070- 7080 Shale: as above, 95%; Siltstone, 5%; trace of sandstone.
- 7080- 7090 Shale: as above; small amount of siderite; trace of sandstone, pyritized worm casts, calcite, sideritic siltstone, and chert nodules.
- 7090- 7100 As above; still bright fluorescence from bentonitic clays and shales.
- 7100- 7110 Shale: dark brownish-gray, rough texture, hackly fracture, light brown streak, subbituminous, with a light whitish-yellow cut fluorescence; trace of Siltstone: light gray, soft, argillaceous; trace of light gray shale, bentonitic shale, and finely crystalline pyrite.
- 7110- 7120 Shale: as above; trace of light gray, bentonitic shale; trace of siltstone; trace of Sandstone: light gray, soft, argillaceous, with a light yellow cut fluorescence; trace of marcasite; trace of Limestone: light brownish-gray, brecciated.
- 7120- 7130 Shale: subbituminous, as above; Sandstone: "salt and pepper"; quartz with scattered chert grains and darker sandstone, with considerable Chert, 20%; Siltstone: gray, argillaceous, and Siltstone: light brownish-gray, argillaceous, 5%; trace of light gray, bentonitic shale.
- 7130- 7140 Shale: dark brownish-gray, subbituminous, 70%; Shale: light gray to gray, smoother texture; Sandstone: white to light gray, mainly quartz, calcareous, fine grained, subangular, 30%; trace of Sandstone: brown, mainly quartz grains, yellowish-white cut fluorescence, with a trace of epidote grains; trace of coarser sandstone, with rounded, clear quartz and rounded, black chert grains; trace of Limestone: light brownish-gray and light gray, cryptocrystalline, brecciated; trace of siltstone, chert nodules, and pyrite.
- 7140- 7150 Shale: subbituminous, as above, 50%; Siltstone: gray to dark gray, argillaceous; Sandstone, mainly quartz grains,

- 25%; trace of brown sandstone, with yellowish-white cut fluorescence; trace of smoky chert; trace of rounded, clear quartz grains in black matrix.
- 7150- 7160 Shale: subbituminous, 50%; Sandstone: mainly white, with a trace of brown sandstone, 25%; Siltstone: gray to dark gray, 25%; trace of light gray shale with a smooth texture; trace of marcasite; trace of Limestone: cryptocrystalline, brecciated.
- 7160- 7170 Shale: dark brownish-gray, rough texture, irregular fracture, subbituminous, 60%; Sandstone: as above, clean, white to light gray, with increased brown; Siltstone: as above, 20%; small amount of pyrite and marcasite; trace of Limestone: brown, subtranslucent, brecciated.
- 7170- 7180 Shale: dark brownish-gray, subbituminous, as above; small amount of dark gray Shale: smooth texture, platy; small amount of light gray, bentonitic shale; Siltstone: light gray to gray, in part, argillaceous, 20%; reduced Sandstone: white to brown, 15%; in part, the sandstone is indurated, with indistinct grain boundaries; trace of marcasite.
- 7180- 7190 Shale: gray to dark gray, smoother texture, blocky; Siltstone: gray to dark gray, 10%; small amount of subbituminous Shale; Sandstone: mainly quartz, fine grained, subangular, well sorted, indurated, slightly calcareous; some brown sandstone; trace of finely crystalline pyrite.
- 7190- 7200 Subbituminous shale, 35%; Shale: gray to dark gray, 30%; Sandstone: as above, with less brown staining, 30%; Siltstone; trace of light gray, bentonitic shale, and pyrite.
- 7200- 7210 Shale: dark brownish-gray, subbituminous, 30%; Shale: gray to dark gray, blocky, smoother texture, 25%; Siltstone, 20%; Sandstone: as above, 25%; some bright green grains in brown sandstone, possibly epidote; trace of pyrite; trace of light gray, bentonitic shale, smooth texture, in part, platy.
- 7210- 7220 Shale: subbituminous, 30%; Shale: gray to dark gray, blocky, 30%; increase in brown sandstone, very fine to fine grained, argillaceous, yellowish-white fluorescence when cut with chloroethane; lesser amount of hard, white sandstone; Sandstone, 30%; Siltstone, 10%; trace of pyritized worm casts.

- 7220- 7230 As above; increased brown siltstone, grading to a fine grained sandstone; slight increase in light gray, bentonitic shale; trace of pyrite and calcite.
- 7230- 7240 Shale: subbituminous, 25%; Shale: gray to dark gray, blocky, 35%; Sandstone: mainly white to very light gray, indurated, 30%; Siltstone, 10%; trace of pyrite and black chert nodules.
- 7240- 7250 As above; slight increase in dark gray Shale: carbonaceous; trace of marcasite; trace of light gray, bentonitic shale, with a slight bluish tinge; trace of bright, emerald green grains in the brown sandstone.
- 7250- 7260 Reduced subbituminous shale; some of the dark gray shale is platy; total shale, 55%; increased sandstone, mainly white to light gray; quartz grains, fine grained, subangular, well sorted, indurated; trace of pyrite; trace of large, angular quartz fragments.
- 7260- 7270 Shale: gray to dark gray and brownish-gray, in part, platy; reduced Shale: dark brownish-gray; Sandstone: mainly quartz, 20%; Siltstone: brown, argillaceous, 15%; small amount of Siltstone: light gray to gray, argillaceous; trace of pyrite and marcasite.
- 7270- 7280 As above; increased brown siltstone, grading to a very fine Sandstone: light yellowish-white cut fluorescence, 30%; Sandstone: light gray, 20%; Shale: as above, 50%; trace of marcasite.
- 7280- 7290 Shale: mainly gray and brown to dark gray, smooth texture, in part, platy; Siltstone: brown with fluorescent cut, 40%; clean Sandstone, 10%; trace of marcasite.
- 7290- 7300 Shale: subbituminous; Shale: gray to dark gray, blocky to platy; Sandstone: white to light gray, indurated, 20%; trace of brown Sandstone: very fine to fine grained, as above; small amount of Siltstone: gray to brownish-gray; some light gray, bentonitic shale; trace of marcasite and pyrite.
- 7300- 7310 Shale: gray to dark gray and brown, relatively smooth texture, blocky to platy, with a minor part slightly silty, 90%; Siltstone: brown, firm, argillaceous, 10%; trace of Sandstone: white, mainly quartz, fine grained, subangular, well sorted, well consolidated, slightly calcareous, indurated, tight; trace of light green epidote in the sandstone; trace of marcasite and pyrite.

- 7310- 7320 Shale: as above, 80%; Siltstone: brown, 20%; sandstone; trace of marcasite, and pyrite.
- 7320- 7330 Shale: gray to dark gray and brown, blocky to platy, 90%; Siltstone: brown, and lesser Siltstone: gray to dark gray, with some carbonaceous streaks; total siltstone, 10%; trace of Sandstone: white to light gray; trace of pyrite.
- 7330- 7340 Shale: as above, 60%; increase in Siltstone: brown and light gray to gray, argillaceous, 40%; trace of sandstone, pyrite, and pyritized worm casts.
- 7340- 7350 Siltstone: as above, mostly brown to brownish-gray, 60%; Shale: as above, light gray to dark gray, blocky to platy; small amount of Sandstone: white, indurated; trace of siderite and sideritic siltstone; trace of Limestone: brownish-gray, micro to finely crystalline; trace of Inoceramus prisms.
- 7350- 7360 Siltstone: brownish-gray to dark brownish-gray, soft, argillaceous, with a moderate yellowish-white cut fluorescence, 90%; Shale: gray to dark gray and brownish-gray, blocky; trace of light gray, bentonitic shale, and marcasite.
- 7360- 7370 Siltstone: as above, 90%; shale; trace of sandstone; small amount of pyrite and marcasite.
- 7370- 7380 Siltstone: as above, mainly brown; small amount of Shale: gray to dark gray, smooth texture, platy; trace of pyrite and marcasite; trace of bentonite and Inoceramus prisms.
- 7380- 7390 As above; shale is gray to dark gray, with some light gray, bentonitic shale; trace of pyrite.
- 7390- 7400 Siltstone: as above, mainly brown; increased shale, in part, silty, 5%; trace of marcasite, pyrite, pyritized worm casts, and calcite.
- 7400- 7410 Siltstone: as above, with increased gray Siltstone, 90%; Shale: as above, in part, more fissile, 10%; trace of bentonite and marcasite.
- 7410- 7420 Reduced Siltstone, 70%; Shale: gray and dark gray, as above, but much more fissile; trace of siderite.
- 7420- 7430 Shale: mostly dark gray, with some gray, smooth texture, fissile to blocky, 20%; Siltstone: as above; trace of siderite, and light gray, bentonitic shale.

- 7430- 7440 Siltstone: as above, brown, argillaceous, 95%; Shale: as above, blocky to platy, 5%.
- 7440- 7450 Siltstone: brown, argillaceous; trace of Shale: gray to dark gray, smooth texture, platy; trace of finely crystalline pyrite.
- 7450- 7460 As above; in part, the shale is fissile; trace of pyrite.
- 7460- 7470 Siltstone: brownish-gray to dark brownish-gray.
- 7470- 7480 Increased Shale: gray to dark gray, blocky, 40%; Siltstone: as above; trace of light gray, bentonitic shale.
- 7480- 7490 Siltstone: as above, with cut fluorescence, 65%; Shale: as above, but more platy to fissile; trace of sandstone, mainly quartz, white, fine grained, subangular, well sorted, well consolidated, calcareous, tight.
- 7490- 7500 Siltstone: as above, 70%; Shale: blocky to platy; trace of light gray, bentonitic shale, and siderite.
- 7500- 7510 Siltstone: dark brownish-gray, argillaceous, 50%; Shale: light gray, bentonitic to dark gray, carbonaceous, blocky to platy, 50%.
- 7510- 7520 Reduced brown siltstone; Siltstone: light gray to dark gray; Shale: light gray to dark gray, blocky, 20%; trace of white sandstone; trace of Limestone: white to light brown, mottled, cryptocrystalline, brecciated and recemented.
- 7520- 7530 Siltstone: mostly dark brownish-gray, with a yellowish-white fluorescence, 50%; Shale: as above, but more blocky; trace of light gray, bentonitic shale, with a bright orange fluorescence.
- 7530- 7540 Shale: gray to dark gray, with some light gray, blocky to fissile, 60%; Siltstone: as above; trace of marcasite.
- 7540- 7550 Shale: brownish-gray and gray to dark gray, mostly platy, 70%; Siltstone: dark brownish-gray, 30%; siltstone is fairly soft; trace of hard coal, subconchoidal fracture.
- 7550- 7560 Siltstone: as above, 75%; Shale: as above; the dark gray shale is carbonaceous; trace of pyrite.
- 7560- 7570 Shale: as above, in part, carbonaceous, in part, silty, 80%; Siltstone: as above; trace of sandstone.

- 7570- 7580 Shale: as above, in part, carbonaceous, 90%; Siltstone: mostly dark gray, 10%; trace of white sandstone.
- 7580- 7590 Shale: as above, in part, fissile, 90%; Siltstone: as above, with less brown; trace of sandstone, mainly quartz grains, fine grained, subangular, poorly sorted, tight.
- 7590- 7600 Shale: as above, 80%; Siltstone, 20%; trace of Limestone: light brownish-gray, dolomitic, with visible rhombs, rare fractures.
- 7600- 7610 Shale: as above, 80%; Siltstone, 20%; trace of sandstone and pyrite.
- 7610- 7620 Shale: gray to dark gray and brownish-gray, blocky to fissile, in part, silty, 90%; Siltstone: gray to dark gray, argillaceous, no shows; trace of pyrite; trace of calcite, a fracture filler.
- 7620- 7630 Slight increase in Shale: as above; Siltstone: brownish-gray, gray and dark gray; the dark gray shale is carbonaceous in part.
- 7630- 7640 Shale: as above, with some evidence of fracturing in the shale; small amount of siltstone; trace of marcasite.
- 7640- 7650 Shale: as above, but more blocky, in part, silty, 70%; increased Siltstone: in part, brown, with a cut fluorescence; trace of light gray, bentonitic shale, and pyrite.
- 7650- 7660 Shale: as above, 70%; Siltstone, 30%; trace of sandstone and pyrite.
- 7660- 7670 Shale: gray to dark gray, with a brownish tinge, blocky to fissile, 90%; Siltstone: as above, 10%; trace of quartz sandstone and pyrite.
- 7670- 7680 Shale: as above, in part, dark brown, mainly platy, 80%; Siltstone: as above, 20%; the brown siltstone has a faint whitish cut fluorescence.
- 7680- 7690 Shale: as above, light gray to dark gray and brownish-gray, mainly platy, 95%; Siltstone: as above, with a minor amount of brown; trace of pyrite.
- 7690- 7700 Shale: as above, gray to dark gray, blocky to platy, in part, silty, 90%; Siltstone: brown, gray and dark gray, 10%; trace of glauconitic sandstone.

- 7700- 7710 Shale: as above, in general, darker, platy to fissile, 90%; the lighter shale is micromicaceous; Siltstone: as above; trace of Sandstone: in part, dark, argillaceous; trace of pyrite and coal.
- 7710- 7720 Shale and Siltstone: as above; trace of sandstone.
- 7720- 7730 Shale: as above, but, in general, more silty; Siltstone: light gray to dark gray, in part, micromicaceous, in part, argillaceous; trace of quartz sandstone.
- 7730- 7740 Shale: brownish-gray to dark gray, platy, silty; Siltstone: as above, 10%; trace of pyrite; trace of Limestone: gray, cryptocrystalline, finely brecciated and recemented.
- 7740- 7750 As above; shale is silty in part; trace of pyrite, calcite, and siderite.
- 7750- 7760 Shale: dark gray and dark brownish-gray, rough texture, irregular fracture, blocky to fissile; trace of Siltstone: mostly dark gray, argillaceous; trace of pyrite.
- 7760- 7770 As above.
- 7770- 7780 Shale: as above, blockier, siltier; small amount of gray siltstone; trace of marcasite.
- 7780- 7790 Shale and Siltstone: as above.
- 7790- 7800 Shale: as above, mainly brownish-gray, mainly platy, silty; trace of Siltstone: gray, argillaceous; trace of pyrite.
- 7800- 7810 Shale: brownish-gray, with some dark gray, mainly platy; trace of Siltstone: gray, argillaceous; trace of pyrite.
- 7810- 7820 Shale: as above, but more fissile; trace of Siltstone: mainly dark gray.
- 7820- 7830 Shale: as above, mostly brownish-gray; rare carbonaceous streaks in the shale; trace of siltstone, pyrite, and bentonite.
- 7830- 7840 Shale: brown, rougher texture, irregular fracture, mainly silty; increased marcasite and pyritized worm casts.

- 7840- 7850 Shale: more blocky, silty, 90%; Siltstone, 10%; trace of marcasite; trace of Limestone: brownish-gray, cryptocrystalline, brecciated.
- 7850- 7860 Shale and Siltstone: as above; trace of Sandstone: medium grained, argillaceous; trace of marcasite; minute fractures healed with calcite.
- 7860- 7870 Shale: as above, platy, silty; the gray shale is micromicaceous; Siltstone: as above; trace of pyrite.
- 7870- 7880 As above; some pyrite along partings in the shale; reduced siltstone; trace of pyrite and calcite.
- 7880- 7890 Shale: gray and brownish-gray to dark gray, blocky to platy, mostly silty; Siltstone: gray to brownish-gray, with minor dark gray, argillaceous, 10%; trace of pyrite.
- 7890- 7900 Shale: mainly dark gray and dark brownish-gray, platy; small amount of Siltstone: as above; trace of pyrite; lighter gray shale is micromicaceous.
- 7900- 7910 Shale: as above, gray to dark gray and brownish-gray, platy to fissile, less silty; trace of gray, "salt and pepper" siltstone; trace of light gray, bentonitic shale.
- 7910- 7920 Shale: as above, but blocky and slightly siltier, 90%; Siltstone: as above, dark gray, argillaceous; trace of finely crystalline pyrite.
- 7920- 7930 Shale: gray to dark gray and brownish-gray, blocky, in part, finely laminated, in part, slightly silty; Siltstone: gray to dark gray, argillaceous; trace of sandstone; the dark gray shale is carbonaceous.
- 7930- 7940 Shale: as above, mostly dark gray, mostly blocky, in part, silty; Siltstone: mostly dark gray, argillaceous, 10%; trace of Sandstone: "salt and pepper", argillaceous; trace of pyrite.
- 7940- 7950 Shale: brownish-gray to dark gray and gray, blocky to platy, in part, silty, with carbonaceous streaks and specks; Siltstone: dark gray, argillaceous; trace of sandstone and pyrite.
- 7950- 7960 Shale: dark brownish-gray to dark gray, platy to fissile; trace of siltstone and pyrite.
- 7960- 7970 As above.

- 7970- 7980 Shale: gray to brownish-gray, rough texture, irregular fracture, in part, silty; lesser Shale: dark gray, smooth texture, fissile; Siltstone: dark gray, 5%; trace of Sandstone: gray, "salt and pepper", with carbonaceous streaks; small amount of pyrite and pyritized worm casts; trace of marcasite.
- 7980- 7990 Shale: gray, blocky to platy, silty, and Shale: dark gray, smoother, fissile; trace of siltstone and pyrite.
- 7990- 8000 Shale: as above; Siltstone: brownish-gray and gray, argillaceous, 10%; trace of pyrite.
- 8000- 8010 Shale: as above; Siltstone: as above, 20%; trace of Sandstone: light gray, "salt and pepper", very fine grained; trace of marcasite.
- 8010- 8020 Shale: as above; increased dark gray, fissile Shale; Siltstone: as above, mostly brownish-gray, 20%; increased pyrite and marcasite; trace of Sandstone: "salt and pepper", argillaceous.
- 8020- 8030 Shale: brownish-gray, silty, in part, pyritic; Shale: dark gray, blocky to platy; Siltstone: brownish-gray to gray, argillaceous, 10%; trace of finely crystalline pyrite.
- 8030- 8040 Shale: as above, with increased dark gray, blocky Shale; the lighter, silty shale has a greenish cast; Siltstone: greenish-gray, argillaceous, 30%; trace of Sandstone: darker gray, argillaceous.
- 8040- 8050 Shale: dark gray, blocky to platy; Siltstone: brownish-gray, with a slight greenish cast, argillaceous, 4%; trace of limestone.
- 8050- 8060 Shale and Siltstone: as above, 50-50%; some of the silty shale is pyritic; trace of pyrite.
- 8060- 8070 Shale: gray to dark gray and brown, in part, silty, 50%; Siltstone: brownish-gray, argillaceous, 50%; trace of sandstone.
- 8070- 8080 Shale: gray, silty, 40%. Siltstone: brownish-gray, argillaceous, in part, pyritic, 60%; trace of dark, argillaceous sandstone; some fissile, dark gray shale cavings.
- 8080- 8090 Shale: brownish-gray, smooth texture, blocky, and Shale: dark gray, rough texture, irregular fracture; total Shale, 75%; Siltstone: gray to brownish-gray, argillaceous, very slightly calcareous; trace of pyrite and marcasite.

- 8090- 8100 Shale: dark brownish-gray and dark gray, mainly platy; Siltstone: as above, 10%; trace of pyrite and pyritized worm casts.
- 8100- 8110 Shale: as above, less brownish-gray, mostly silty, blocky to platy; Siltstone: as above, argillaceous, in part, pyritized.
- 8110- 8120 Blocky Shale: as above; Siltstone, 30%; trace of marcasite.
- 8120- 8130 Shale: as above, 50%; Siltstone, 50%; trace of pyrite.
- 8130- 8140 Shale: gray and brownish-gray to dark gray, 50%; the dark gray shale is carbonaceous, 40%; Siltstone: as above, in part, pyritized.
- 8140- 8150 Siltstone: mostly brownish-gray, very slightly calcareous, argillaceous, 70%; Shale: as above, mostly silty; small amount of dark gray, carbonaceous shale; trace of light green, bentonitic shale; trace of finely crystalline pyrite and pyritized worm casts.
- 8150- 8160 Siltstone: as above, 70%; faint yellowish-white cut fluorescence; Shale: as above, 30%; trace of light gray, bentonitic shale; trace of Sandstone: light gray, "salt and pepper"; trace of sandstone, with a sideritic matrix; trace of pyrite.
- 8160- 8170 Siltstone: as above, 60%; Shale, 40%; trace of Sandstone: "salt and pepper", very fine grained, argillaceous, with a very faint cut fluorescence.
- 8170- 8180 Siltstone: as above, coarser, argillaceous, grading into a very fine grained sandstone, 90%; no fluorescence; Shale: brownish-gray to dark gray, blocky to platy, in part, silty.
- 8180- 8190 Siltstone: as above, grading to a very fine grained, "salt and pepper" sandstone, no shows; trace of shale; trace of finely crystalline pyrite.
- 8190- 8200 Siltstone: as above, grading to a fine grained Sandstone: more friable; trace of shale.
- 8200- 8210 Siltstone: as above, grading to a very fine grained sandstone, mainly quartz; fine grained, subangular, well sorted, fairly well consolidated, but friable in part, very argillaceous, very faint cut fluorescence; small amount of Shale: dark gray, blocky.

- 8210- 8220 Siltstone: grading to a very fine grained Sandstone: as above, 90%; Shale: brown to dark gray, blocky, smooth texture.
- 8220- 8230 Siltstone to fine grained Sandstone: as above; Shale: as above, with some carbonaceous streaks, 20%; trace of green, bentonitic shale; trace of finely crystalline pyrite and pyritized worm casts.
- 8230- 8240 Sandy siltstone; Shale: brownish-gray and gray to dark gray, blocky to platy; trace of pyrite.
- 8240- 8250 Siltstone: as above, finer grained, mostly brownish-gray, very slightly calcareous, argillaceous; Shale: as above, 20%; trace of marcasite.
- 8250- 8260 Siltstone: as above, slightly less argillaceous; Shale: as above, platy to fissile, 40%; trace of pyrite.
- 8260- 8270 Siltstone: as above, lighter brownish-gray, argillaceous, 50%; Shale: dark brownish-gray, smooth texture, platy to fissile; trace of pyrite and pyritized worm casts.
- 8270- 8280 Shale: as above, 55%; in part, may be cavings; Siltstone: as above, with some lighter gray, slightly argillaceous siltstone.
- 8280- 8290 Shale: as above, with less brownish-gray, blocky to platy, 60%; Siltstone: light gray to dark gray, argillaceous.
- 8290- 8300 Shale: as above, smooth texture, 60%; Siltstone: more uniform, harder, slightly calcareous.
- 8300- 8310 As above.
- 8310- 8320 Increased siltstone, 60%.
- 8320- 8330 Shale: gray and brownish-gray to dark gray, smooth texture, blocky to platy; Siltstone: gray to dark gray, argillaceous; trace of finely crystalline pyrite and Inoceramus prisms.
- 8330- 8340 As above.
- 8340- 8350 Mainly cement; trace of Siltstone: dark gray, hard, argillaceous.
- 8350- 8360 Cement; quartz nodules, mainly frosted, with a trace of granitic nodules, 10%; trace of Siltstone: in part, carbonaceous.

- 8360- 8370 Cement: as above, 55%; Siltstone: brownish-gray to dark gray, in part, platy, argillaceous, 40%; quartz nodules, as above, 5%; trace of pyrite.
- 8370- 8380 Cement, 35%; Siltstone: as above, 30%; Shale: gray to dark gray, blocky to platy, in part, carbonaceous, 30%; quartz nodules, as above, 5%; trace of Sandstone: light green, "salt and pepper"; quartz and chert with scattered glauconite grains, fine grained, subangular, well sorted, well consolidated; trace of finely crystalline pyrite.
- 8380- 8390 Cement, 40%; Shale: dark gray, very silty, fissile; trace of Siltstone: dark gray, argillaceous.
- 8390- 8400 Cement, 40%; Siltstone: gray to dark gray, argillaceous; trace of shale.
- 8400- 8410 Reduced cement; Shale: brown to dark brown, blocky, in part, slightly silty; Siltstone: as above.
- 8410- 8420 Shale: gray to dark gray, micromicaceous, carbonaceous, platy to fissile, in part, slightly silty, with thin, even bands of pyrite; trace of Siltstone: brownish-gray, argillaceous; trace of pyrite.
- 8420- 8430 Shale: gray to dark gray, as above, slightly more fissile, 90%; Siltstone: as above, 10%; trace of Sandstone: dark gray, "salt and pepper"; quartz and chert, with scattered dark inclusions of a mafic mineral, fine grained, subangular, poorly sorted, well consolidated, tight; trace of finely crystalline pyrite and siderite.
- 8430- 8440 Shale: as above, more brownish-gray and dark brownish-gray, carbonaceous, 90%; Siltstone: brownish-gray to dark gray, argillaceous, 10%; trace of siderite.
- 8440- 8450 Siltstone: brownish-gray to dark gray, hard, argillaceous, 60%; Shale: dark brownish-gray to dark gray, blocky to platy, in part, silty, rougher texture than above, in part, with a varve effect; trace of finely crystalline pyrite.
- 8450- 8460 Siltstone: brownish-gray with minor dark gray, 50%; Shale: as above, in part, with very fine laminations and some pyritic laminae; trace of Sandstone: "salt and pepper", fine to medium grained, poorly sorted.

- 8460- 8470 Siltstone: as above, but with less brownish-gray, 60%; Shale: as above, but with increased dark gray, more fissile; trace of finely crystalline pyrite.
- 8470- 8480 Siltstone and Shale: as above, increased brownish-gray, 50-50%.
- 8480- 8490 Siltstone: gray to dark gray, with some brownish-gray, argillaceous, 70%; Shale: gray to dark gray and brownish-gray, rough texture, irregular fracture, micromicaceous, blocky to platy.
- 8490- 8500 Shale: as above, platy to fissile, micromicaceous, 60%; the dried shale has almost a schistose appearance; Siltstone: as above, 40%.
- 8500- 8510 Shale: gray to dark gray, in part, with a brownish tinge, micromicaceous, rough texture, mainly platy, in part, silty; Siltstone: gray to dark gray, argillaceous, 10%.
- 8510- 8520 Shale: gray to dark gray and dark brownish-gray, rough texture, platy to fissile, micromicaceous, carbonaceous, in part, silty; Siltstone: gray to dark gray, with rare lighter gray, argillaceous; trace of Shale: light brownish-gray, bentonitic, platy.
- 8520- 8530 Shale: as above, in part, with a smoother texture, platy to fissile; Siltstone: as above, 10%; trace of Claystone: light brown, sideritic, platy; dark gray shale is carbonaceous.
- 8530- 8540 Siltstone: as above, 10%; Shale: as above, 60%; Sandstone: dark gray, "salt and pepper"; quartz and chert with some mafic minerals, fairly well sorted, well consolidated, calcareous matrix, in part, showing light and dark, fine banding, 30%.
- 8540- 8550 Shale: gray to dark gray and brownish-gray, platy to fissile, 80%; Siltstone: as above, argillaceous, slightly calcareous.
- 8550- 8560 Siltstone: gray to dark gray and brownish-gray, calcareous, argillaceous, 60%; Shale: gray to dark gray and brownish-gray, platy to fissile, in part, silty, micromicaceous; small amount of Sandstone: light gray, bentonitic, silty.
- 8560- 8570 Sandstone: light gray, hard, mainly quartz; fine grained, subangular, poorly sorted, well consolidated, very slightly calcareous matrix, no shows; Shale: dark gray, fairly smooth texture, fissile, 20%.

- 8570- 8580 Sandstone: as above, light gray to gray, very fine to fine grained, with irregular argillaceous patches, probably due to turbidity currents; Shale: as above; trace of crystalline calcite occurring as infilling in minute fractures.
- 8580- 8590 Sandstone: as above, with very rare, small glauconite grains, mainly noncalcareous; sandstone is tight; trace of Shale: as above, dark brownish-gray to dark gray; some calcareous pieces with possible kaolinite infilling.
- 8590- 8600 Sandstone: as above, hard, mainly noncalcareous; very rare, tight, irregular fractures outlined by darker mineralization; trace of shale.
- 8600- 8610 Sandstone: as above, in general, lighter gray; some very thin, irregular dark lines in the lighter sandstone; some of the dark minerals appear to be hornblende; trace of shale; trace of amorphous material, with an oolitic appearance associated with kaolinite, noncalcareous.
- 8610- 8620 Sandstone: as above, slightly darker; the dark material follows thin, irregular lines, possibly fractures; some light green, weathered glauconite grains in the darker sandstone.
- 8620- 8630 Sandstone: as above; slight increase in mafic minerals.
- 8630- 8640 Sandstone: as above, in general, darker; matrix is dolomitic; Shale: brownish-gray to dark gray, smooth texture, blocky to fissile, dolomitic, 20%; the lighter shale is micromicaceous.
- 8640- 8650 Sandstone: as above, in general, darker; Siltstone, 20%; Shale: rougher texture, mainly dark gray, in part, silty, 10%; shale is calcareous.
- 8650- 8660 Sandstone: as above, mostly darker gray, in part, silty, 50%; Siltstone, 40%; Shale, 10%.
- 8660- 8670 Reduced Sandstone: as above, in general, darker, 30%; Siltstone: mainly dark gray, 40%; Shale: dark gray, fissile, 30%.
- 8670- 8680 Shale: as above, dark brownish-gray to dark gray, blocky to fissile, in part, silty, 50%; Siltstone: dolomitic, 30%; Sandstone: as above, 20%.
- 8680- 8690 Siltstone: mainly dark gray, 50%; Sandstone: as above, 30%; Shale, 20%.

- 8690- 8700 Siltstone: as above, dolomitic, 70%; Shale: as above, 30%; small amount of Sandstone: very calcareous; trace of Limestone: brownish-gray to dark gray, in part, subtranslucent, cryptocrystalline, finely brecciated and recemented, a calcarenite, very argillaceous in part, with some crystalline calcite along small fractures.
- 8700- 8710 Shale: gray to dark gray, fissile, in part, silty, in part, calcareous and dolomitic, 80%; the lighter shale is micromicaceous; Siltstone: gray to dark gray, calcareous, argillaceous; trace of heavy, dark, residual, dead oil with yellowish-green cut fluorescence in some of the siltstone; small amount of calcareous sandstone; trace of limestone; some Ostracods; trace of Monotis sp.; trace of a Crinoid stem.
- 8710- 8720 Increased Siltstone: with some brownish-gray, in part, sandy; Shale, 20%; Limestone: as above, and Limestone: gray, dense, massive, in part, fossiliferous, 10%; trace of finely crystalline calcite.
- 8720- 8730 As above.
- 8730- 8740 Limestone: white to dark gray, mottled, cryptocrystalline, finely brecciated and recemented, a Calcarenite, argillaceous, 80%; Shale: brownish-gray to dark gray, platy to fissile, in part, dolomitic, 20%; trace of Siltstone: brownish-gray to dark gray, argillaceous.
- 8740- 8750 Limestone: as above, mottled, in part, soft, chalky, in part, argillaceous; limestone is a calcilutite, grading to a calcarenite; considerable fossil impressions; Shale: dark gray, smooth texture, platy to fissile, 20%.
- 8750- 8760 Limestone: as above, with considerable soft, chalky limestone, and some dark Lutites, 70%; Shale: as above, calcareous, micromicaceous.
- 8760- 8770 Limestone: as above, 85%; Shale: as above, mainly silty, 15%; trace of Pecten.
- 8770- 8780 Limestone: brownish-gray to dark gray, cryptocrystalline, very silty, argillaceous, 70%; Shale: dark gray, smooth texture, blocky to fissile, slightly dolomitic, 30%; trace of Ostracods.
- 8780- 8790 Limestone: as above, grading to a calcareous Siltstone, 60%; shale, 40%; very faint, yellowish-white, cut fluorescence.
- 8790- 8800 Very silty limestone, 55%; Shale: platy to fissile, 45%.

- 8800- 8810 Silty Limestone: brownish-gray to dark gray, with some light gray, grading to a calcareous siltstone; Shale: as above, 40%.
- 8810- 8820 Limestone: very cherty, consisting of subangular lithoclasts in a white, chalky matrix, 90%; Shale: dark gray, blocky to platy; trace of very small Pelecypods.
- 8820- 8830 Siltstone: as above, mainly dark gray, very calcareous; Limestone: cherty, as above, 5%; Shale: dark gray, blocky to platy, 5%.
- 8830- 8840 Siltstone: as above, very calcareous, 40%; Limestone: argillaceous, silty, 30%; Shale: gray to dark gray, platy to fissile, micromicaceous, 30%.
- 8840- 8850 Siltstone: calcareous, and Limestone: very silty; Shale: as above, 30%; some phosphatic pellets.
- 8850- 8860 Siltstone: brownish-gray to dark gray, argillaceous, dolomitic, 60%; Limestone: mainly light gray, with some dark lithoclasts, in part, rounded, argillaceous, 25%; Shale: as above; rare coarse quartz grains, subangular, clear to frosted in the siltstone; trace of quartz and pyrite breccia in a dark gray, dolomitic matrix.
- 8860- 8870 Limestone: light brown to dark gray, silty to sandy; some inclusions appear to be mafic, 80%; Shale: dark brown to dark gray, mainly fissile, 20%; trace of Sandstone: "salt and pepper", medium grained, subangular, poorly sorted, calcareous matrix.
- 8870- 8880 Limestone: light to dark gray, in part, finely brecciated and recemented, in part, silty to sandy, 50%; Siltstone: as above, dolomitic, 25%; Shale: as above, 25%.
- 8880- 8890 Siltstone: gray to dark gray and brownish-gray, argillaceous, calcareous and dolomitic, in part, sandy, 70%; Limestone: as above, silty to sandy, 20%; Shale: as above, 10%; in part, the shale is almost a claystone.
- 8890- 8900 Siltstone: as above, dolomitic, in general, less argillaceous, in part, sandy; Limestone: silty to sandy, argillaceous, 10%; Shale, 10%.
- 8900- 8910 Siltstone: gray to dark gray, dolomitic, 85%; Shale: as above, slightly dolomitic, mainly platy; trace of silty limestone.
- 8910- 8920 Siltstone: light gray to gray, with some dark gray, argillaceous, dolomitic matrix, 60%; Shale: dark brownish-gray to dark gray, platy to fissile, in part, silty.

- 8920- 8930 Shale: as above, 60%; Siltstone: as above, 40%; trace of Sandstone: white to light gray.
- 8930- 8940 Mostly Shale: gray to dark gray, in part, with a brownish tinge, platy to fissile, in part, silty; trace of siltstone, grading to a fine grained sandstone.
- 8940- 8950 Shale: as above; lighter gray shale is micromicaceous and silty, 60%; Siltstone: as above, 30%; Sandstone: light gray to gray, hard, mainly quartz grains, fine grained, subangular, well sorted, well consolidated, matrix mainly siliceous, but slightly dolomitic, tight, no shows.
- 8950- 8960 Sandstone: light gray, mainly quartz grains, very fine to fine grained, subangular, poorly sorted, indurated, dolomitic matrix, tight, no show; traces of chert and phlogopite in the sandstone; trace of Shale: brownish-gray to dark gray, platy; trace of Limestone: white, chalky.
- 8960- 8970 Sample mostly nutplug and mica (lost circulation material); Sandstone: as above; trace of sandstone, with 50% glauconite grains; trace of shale, chalky limestone, and quartz nodules, clear, loose, subangular to angular.
- 8970- 8980 Sandstone: as above, light gray to gray, indurated, tight; increased shale, 10%; some clear quartz nodules.
- 8980- 8990 Sandstone: as above, but, in general, darker, with some scattered chert grains and with some mafic minerals, possibly hornblende; no apparent micas; some pieces show a sideritic, silty matrix; some white pieces consisting of compressed silica flour; trace of shale, rare, clear quartz nodules, and finely crystalline pyrite.
- 8990- 9000 Quartz Sandstone: as above, with considerable kaolinitic infilling, hard, tight; Shale: brownish-gray to dark gray, platy to fissile, 30%; trace of pyrite.
- 9000- 9010 Sandstone: as above, but with some coarser grained sandstone exhibiting a fused appearance, with indistinct grain boundaries; Shale: as above, 10%; trace of white, hard material, with a dull luster.
- 9010- 9020 Sandstone: as above, hard, tight; small amount of Shale: dark gray, fissile, very calcareous; trace of finely disseminated pyrite in the sandstone; some of the sandstone is almost an orthoquartzite.

- 9020- 9030 Mainly shale and siltstone; Sandstone: as above, hard, slightly dolomitic; trace of Bentonite: light greenish-gray, slightly calcareous; trace of light gray, bentonitic shale.
- 9030- 9040 Sandstone: as above, almost an orthoquartzite; rare traces of sericite in the sandstone; some argillaceous patches in the sandstone; trace of dark gray shale, with traces of fine pyrite cubes included.
- 9040- 9050 Sandstone: as above; some kaolinitic infilling; some phlogopite in the sandstone; trace of kaolinite; some white, compressed silica flour.
- 9050- 9060 Sandstone: as above, with slightly siliceous cement, 45%; Shale: gray, rough texture, silty, blocky, and Shale: dark gray, smoother texture, platy to fissile, 55%; trace of light gray, bentonitic shale and pyrite.
- 9060- 9070 Sandstone: as above, in general, finer grained, with rare iron staining; trace of arkosic sandstone, with rare pink feldspars, probably orthoclase; trace of light brown sericite in the sandstone; Shale: brownish-gray to dark gray, 50%; in part, the dark gray shale is fissile; trace of kaolinite; both shale and sandstone are slightly dolomitic.
- 9070- 9080 Sandstone: light gray, mainly quartz, with scattered phlogopite, sericite and chert grains, fine grained, subangular, fairly well sorted, indurated, very slightly dolomitic, but with the matrix mostly siliceous; quartz grains are clear, frosted and smoky; trace of arkosic sandstone, with rare feldspars; Shale: brownish-gray to dark gray, in part, fissile, 60%; trace of light gray, bentonitic shale; trace of Dolomite: cream, in part, with a slight pinkish tinge, dense, massive, crypto to microcrystalline; trace of gray siltstone; trace of calcite.
- 9080- 9090 Shale: gray to dark gray, smoother texture, platy to fissile, 80%; Sandstone: as above, with rare arkosic sandstone; trace of pyrite.
- 9090- 9100 Sandstone: mainly quartz grains, fine grained, subangular, well sorted, indurated, siliceous matrix, and rare arkosic sandstone, with scattered feldspars and a trace of mica; Shale: brownish-gray to dark gray, rough texture, irregular fracture, blocky to platy, in part, silty, 30%; trace of Limestone: light brown, very silty.
- 9100- 9110 Sandstone: in general, cleaner, mainly clear quartz grains, with more pink orthoclase; trace of brownish-gray

- sandstone with considerable glauconite grains; Shale: brownish-gray to dark brownish-gray and dark gray, 70%.
- 9110- 9120 Sandstone: as above, with some pinkish iron staining; some of the grains are clear, but covered with a rusty film; matrix is dolomitic; trace of feldspars in the sandstone; Shale: as above, 30%.
- 9120- 9130 Sandstone: as above, 60%; Shale, 40%.
- 9130- 9140 Sandstone: as above, nondolomitic, in part, with kaolinitic infilling, in part, with light iron staining; trace of phlogopite in the sandstone; rare, euhedral hornblende crystals; trace of light tan, lithographic limestone occurring in thin plates.
- 9140- 9150 Sandstone: white to gray, "salt and pepper", mainly quartz with scattered chert and some mafic minerals; some hornblende, phlogopite and pyrite in the sandstone; Shale: gray to dark gray, with some brownish-gray, in part, with a smooth texture, blocky to platy, 30%; trace of light gray, bentonitic shale and lignite, with some finely disseminated pyrite.
- 9150- 9160 Sandstone: slightly coarser grained, poorly sorted, not quite as hard; reduced feldspars and iron staining; small amount of shale; trace of light brownish-gray, bentonitic shale.
- 9160- 9170 Sandstone: as above, 30%; Shale: as above; small amount of very light gray shale, with a very slight mauve tinge; Siltstone: brick-red, lateritic, containing some scattered quartz grains, 40%.
- 9170- 9180 Sandstone: as above, but fine to coarse grained, poorly sorted, with reduced siliceous cement; more mafic minerals in the sandstone; reduced lateritic siltstone.
- 9180- 9190 Sandstone: as above, fine to coarse grained, mainly clear quartz, with some frosted grains and rare chert grains; in general, coarser grained, with increased mafic minerals, hornblende and biotite; some of these are confined to the matrix; Shale: as above, 10%; trace of light gray, bentonitic shale.
- 9190- 9200 Sandstone: as above, in part, slightly friable; slight increase in shale; sandstone and shale are slightly dolomitic; trace of light gray limestone.
- 9200- 9210 Sandstone: as above, with less mafic material; Shale: brown to dark gray, in part, silty; trace of light gray and light brownish-gray, bentonitic shale.

- 9210- 9220 Sandstone: as above; shale, 50%; trace of light gray Shale: as above.
- 9220- 9230 Sandstone: as above; Shale: as above, 40%; trace of micaceous, schistose shale, lateritic siltstone, and limestone.
- 9230- 9240 Sandstone: as above, fine to coarse grained, kaolinitic; Shale: brownish-gray to dark gray, platy to fissile; trace of lateritic, silty shale.
- 9240- 9250 Sandstone: light gray, in part, with a slight greenish tinge, mainly quartz; fine to medium grained, subangular, poorly sorted, indurated, with a very slightly dolomitic matrix, 30%; Shale: gray and brownish-gray to dark gray, 70%; small amount of light brownish-gray shale; trace of light green shale, with a rough texture, slightly silty; trace of very micaceous Shale: schistose; small amount of brick-red, lateritic shale; small amount of brownish-gray siltstone.
- 9250- 9260 Sandstone: white to light gray, with a trace of pink staining, mainly quartz, with scattered light gray chert, a trace of glauconite and very rare mafic minerals, fine to medium grained, subangular to subrounded, with less kaolinitic infilling, 50%; Shale: as above; small amount of light brownish-gray shale, with a slight purplish cast; trace of brick-red, silty, lateritic shale, light green siltstone, finely crystalline pyrite, quartz nodules, and Pelecypod imprints.
- 9260- 9270 Sandstone: as above; Shale: brownish-gray to dark gray, platy to fissile, 70%; increased siltstone, with a light green tinge, grading to a silty shale; trace of light gray, bentonitic shale; small amount of lateritic shale.
- 9270- 9280 Sandstone: as above, white to light gray, mainly with a very light green tinge; trace of sandstone, with a pinkish tinge; Shale: gray and brownish-gray to dark gray, platy to fissile, 60%; small amount of light brownish-gray shale.
- 9280- 9290 Shale: brownish-gray to dark gray, rough texture, irregular fracture, in part, silty; trace of light green shale; small amount of Sandstone: as above, in part, very light apple green; trace of light green siltstone and brick-red, shaly, lateritic siltstone.
- 9290- 9300 Shale: as above, 95%; Sandstone: as above, in part, with pink patches; sandstone is fine to medium grained, subangular, poorly sorted, well consolidated.

- 9300- 9310 Shale: brownish-gray, finely laminated, and Shale: dark gray, silty, blocky; Sandstone: as above, in part, with a faint green tinge; trace of light gray, bentonitic shale; trace of brick-red, lateritic, shaly siltstone and micaceous shale.
- 9310- 9320 Shale: as above, brownish-gray to dark gray, blocky to platy, in part, silty, 60%; Sandstone: as above, light pink to light green and white; trace of brick-red, silty, lateritic shale; trace of silver-gray, micaceous shale and light brownish-gray, bentonitic shale.
- 9320- 9330 As above; sandstone has rare, scattered chert grains, 50%; Shale: as above.
- 9330- 9340 As above; sandstone breaks up more readily and has increased darker constituents; Shale: as above, 40%.
- 9340- 9350 Sandstone: as above, in general, more friable; scattered feldspars in the sandstone; Shale: as above; small amount of brick-red, lateritic, silty shale; trace of light brownish-gray, bentonitic shale.
- 9350- 9360 Sandstone: as above, light gray, siliceous matrix, very slightly argillaceous; Shale: as above, 20%; trace of brick-red, lateritic shale and light brownish-gray, bentonitic shale.
- 9360- 9370 Sandstone: light gray, mainly quartz with scattered hornblende and chert grains, fine to medium grained, subangular, poorly sorted, well consolidated, dolomitic matrix; some kaolinitic infilling; Shale: as above; trace of lateritic shale and very micaceous shale.
- 9370- 9380 Sandstone: as above, with increased dark minerals; trace of coarse grained sandstone, clear quartz grains, angular to subangular.
- 9380- 9390 Sandstone: as above, more friable; Shale: mainly dark gray, blocky, 5%; trace of light brownish-gray, bentonitic shale; trace of brick-red, lateritic, silty shale; trace of Shale: silver-gray, very micaceous.
- 9390- 9400 Sandstone: gray, "salt and pepper"; trace of glauconitic sandstone; trace of Shale: as above.
- 9400- 9410 Sandstone: "salt and pepper", as above; trace of Shale: brownish-gray to dark gray, blocky to platy; trace of lateritic shale; trace of light brownish-gray, bentonitic shale.

- 9410- 9420 Sandstone: as above, light gray to gray, in general, finer grained, more argillaceous; Shale: as above, 5%.
- 9420- 9430 Sandstone: as above, but darker gray and finer grained, grading to a gray, argillaceous siltstone; small amount of brick-red lateritic shale; trace of dark gray, blocky shale.
- 9430- 9440 Increased siltstone, 30%; some sandstone, with a kaolinitic matrix; trace of Shale: as above.
- 9440- 9450 Sandstone: as above, grading to a siltstone; trace of clear, coarse grained quartz sandstone; small amount of lateritic shale; trace of light, brownish-gray shale.
- 9450- 9460 Siltstone: light gray to gray, argillaceous, 40%; Sandstone: "salt and pepper", mainly quartz, with scattered chert grains, tight, no shows, 30%; Shale: light gray to dark gray and light brownish-gray, platy to fissile, 30%.
- 9460- 9470 Increased Shale: with more light brownish-gray, in general, more fissile, 35%; Siltstone, 35%; Sandstone: as above; slight increase in brick-red, lateritic, silty shale; trace of dark gray limestone, with some shell fragments.
- 9470- 9480 Shale: as above, in part, silty, 50%; Siltstone, 40%; Sandstone: as above; some sandstone, mainly quartz, with rare hornblende, coarse grained, angular, fairly well sorted, well consolidated; trace of black material in the matrix; very faint yellow cut fluorescence; trace of dark gray, silty, argillaceous limestone.
- 9480- 9490 As above; Sandstone: dark gray, argillaceous, 40%; reduced coarse grained sandstone; Siltstone, 30%; Shale, 30%.
- 9490- 9510 Shale: dark gray, smooth texture, platy to fissile, 40%; Shale: brick-red, lateritic, silty, grading to a shaly siltstone, 35%; Shale: gray, silty, 10%; Shale: brownish-gray to light brownish-gray, 10%; sandstone, mainly quartz grains, fine grained, subangular, siliceous matrix, indurated, grading to finer grained, more argillaceous sandstone, with increased mafic material.
- 9510- 9520 As above, with increased Sandstone: dark gray, fine to very fine grained, grading to an argillaceous siltstone; Sandstone, 25%; Siltstone, 35%; Shale: dark gray, 20%; Shale: brick-red, lateritic, 10%; Shale: lighter gray to light brownish-gray, in part bentonitic, 10%.

- 9520- 9530 Shale: gray to dark gray, and light brownish-gray to brownish-gray, blocky to platy, 60%; Siltstone: gray, "salt and pepper", argillaceous, 40%; trace of sandstone, mainly quartz, with some darker minerals, indurated.
- 9530- 9540 Siltstone: gray, argillaceous; Sandstone: white; quartz grains, fine grained, subangular, well sorted, well consolidated, 5%; Shale: mostly gray to dark gray, with lesser brownish-gray, platy, 40%.
- 9540- 9550 Siltstone: as above, 55%, mostly gray, "salt and pepper", uniform; Shale: as above, in part, softer; small amount of Sandstone: white, fine to medium grained, poorly sorted.
- 9550- 9560 As above; slight decrease in siltstone; trace of sandstone.
- 9560- 9570 As above; Shale: mostly brownish-gray with some gray, platy to fissile, in part, silty, 60%; Siltstone: gray, "salt and pepper"; small amount of sandstone; some light gray, bentonitic shale; trace of dark gray, carbonaceous shale.
- 9570- 9580 Shale and Siltstone: as above; rare quartz nodules in a dark, hard siltstone; trace of dark gray limestone, a calcilutite.
- 9580- 9590 Siltstone: gray to darker gray, "salt and pepper", argillaceous, 60%; Shale: light brownish-gray, gray and dark gray, platy to fissile; Sandstone: white, mainly quartz grains, hard, and some finer grained Sandstone: gray to dark gray, with considerable mafic minerals; trace of quartz nodules.
- 9590- 9600 Shale: as above, 55%; Siltstone, 45%; trace of Sandstone: as above; trace of light green and light gray, bentonitic shale.
- 9600- 9610 Shale: as above, 70%; the gray shale is more fissile; Siltstone: as above; small amount of Sandstone: white; quartz grains, fine grained, subangular, well sorted; trace of light green, bentonitic shale, and carbonaceous shale.
- 9610- 9620 Shale: as above, 70%; Siltstone: as above; trace of sandstone; slight increase in carbonaceous shale.
- 9620- 9625 Sandstone: gray to dark gray, "salt and pepper", clear quartz and dark chert grains, with considerable mafic minerals, including hornblende, fine grained, mainly

- subangular with some angular, poorly sorted, well consolidated, slightly dolomitic matrix, tight, no shows; in part, exhibits light, fine, subrounded to angular lithoclasts, in a dark matrix; some pieces contain 50%, 59%, 75% of glauconite grains; Sandstone, 40%; shale and Siltstone: as above.
- 9625- 9630 Sandstone: as above, 90%; the sandstone is indurated with indistinct grain boundaries, an orthoquartzite; Shale, 10%.
- 9630- 9635 Sandstone: as above, in part, light gray and, in part, dark gray, with reduced quartz; and with some glauconitic sandstone; small amount of Shale: mostly light brownish-gray, platy to fissile.
- 9635- 9640 Sandstone: as above, with increased scattered glauconite; small amount of Shale: light brownish-gray, platy to fissile, 5%.
- 9640- 9650 As above; some finely crystalline pyrite, including pyritohedrons; some light green to blue mineral, appearing amorphous, in part, and crystalline; trace of a copper colored mineral, with a tarnished surface.
- 9650- 9655 As above.
- 9655- 9660 Dolomite: light gray, in part, massive, in part, finely brecciated, crypto to finely crystalline, in part, a dolarenite, grading to a dolilitite; some intercrystalline and fracture porosity; trace of drusy vugs lined with calcite crystals; traces of dead oil between fragments and along minute, irregular fractures; scattered yellowish-gold fluorescence, no visible cut fluorescence; some fragments of dolomite rhombohedrons; rare, finely disseminated pyrite crystals in the dolomite; rare crystalline quartz; trace of gray to dark gray shale.
- 9660- 9665 Dolomite: as above, but more argillaceous, more brecciated, a dolarenite; reduced porosity; trace of pyrite; trace of gray to dark gray shale.
- 9665- 9670 Dolomite: as above, 20%; Limestone: white, cryptocrystalline, finely brecciated and recemented, a calcarenite; some mottled, dark gray and white calcite; no visible porosity, no shows; small amount of Shale: gray to dark gray, blocky to platy, in part, slightly silty.
- 9670- 9675 Limestone: as above, white to light gray, crypto to finely crystalline, in part, brecciated and recemented, a calcarenite, in part, argillaceous; Limestone: mottled

white and dark gray, 10%; trace of buff Limestone: softer, almost chalky in part; Shale: as above, 10%; the darker gray limestone is dolomitic.

- 9675- 9680 Limestone: as above, but very fossiliferous; numerous Stachyodes and Amphipora; some brecciated Limestone: with dark gray fragments adjacent to clean white fragments; some laminites, layers of nonskeletal grains in a calcitic matrix; the matrix containing the fossils appears to be a micrite; this sample suggests a lagoonal environment.
- 9680- 9685 Limestone: light brownish-gray, mottled, cryptocrystalline, finely brecciated and recemented, a calcarenite, with very rare calcite rhombs; fossiliferous, with some Amphipora; trace of shale.
- 9685- 9690 As above; very rare, dead oil staining.
- 9690- 9695 Limestone: white to gray, in part, subtranslucent, crypto to microcrystalline, in part, finely brecciated and recemented, in part, argillaceous, with scattered chert pieces; grades from a calcilutite to a calcarenite; fossiliferous, mainly Amphipora with some Stachyodes; in one piece, the replacement mineral for the Stachyodes is blue; some light and dark laminite structure; trace of Shale: light gray to gray, smooth texture, platy to fissile; trace of clear calcite.
- 9695- 9700 Limestone: as above; some chalky limestone, with a duller luster.
- 9700- 9705 Limestone: as above, but lighter, with increased dark gray Amphipora and some white Stachyodes; some light and dark laminite structure.
- 9705- 9710 As above, but the limestone is darker gray and more argillaceous; reduced fossils; some cream limestone.
- 9710- 9715 Limestone: as above, white to light gray, a calcilutite grading to a calcarenite, in part argillaceous; greatly reduced fossils; trace of white dolomite, with a high luster; trace of shale.
- 9715- 9720 Limestone: as above, white to gray, in part, subtranslucent, crypto to microcrystalline, mostly a calcilutite, less fossiliferous; some white Limestone: chalky, with a duller luster.
- 9720- 9725 Limestone: as above, but with considerable dark gray Amphipora in a white matrix.

- 9725- 9730 Limestone: as above, with increased white Stachyodes; rare Amphipora; some lateritic material, probably cavings from above; some angular, nonskeletal intraclasts in a slightly darker matrix; trace of dark gray shale; trace of light green, bentonitic shale.
- 9730- 9735 Limestone: white to gray, in part, subtranslucent, cryptocrystalline, in part, argillaceous; fossiliferous, as above, with increased Amphipora; small amount of Shale: gray to dark gray, blocky, slightly dolomitic.
- 9735- 9740 As above; in part, the limestone is more argillaceous; reduced fossils.
- 9740- 9745 Limestone: as above, crypto to microcrystalline, mainly a calcarenite, with numerous Amphipora in a white matrix; Shale: gray to dark gray, 10%.
- 9745- 9750 Limestone: as above, with very few fossils.
- 9750- 9755 Limestone: as above, white to gray, in part, subtranslucent, mainly cryptocrystalline, a calcilutite; rare fossils; trace of low amplitude stylolites.
- 9755- 9760 As above, but more mottled white and gray.
- 9760- 9765 Limestone: as above, but darker, more mottled, crypto to microcrystalline, with some finely crystalline, fossiliferous limestone; fossils have been subject to movement and abrasion; trace of cream colored limestone; Shale: gray to dark gray, blocky, 10%; trace of chert with a blue, translucent appearance.
- 9765- 9770 Limestone: as above, in part, mottled, in part, subtranslucent; less fossiliferous; trace of cream limestone.
- 9770- 9775 Limestone: white to gray and brownish-gray, in part, subtranslucent, cryptocrystalline; trace of stylolitic partings forming an anastomosing network; some light colored lutites; the limestone appears to have been deposited in a quiet water environment with a low energy level.
- 9775- 9780 Limestone: as above, but more fossiliferous, mostly Stachyodes in a light colored lutite; trace of shale; trace of smoky chert.
- 9780- 9790 As above, but more mottled; skeletal intraclasts in a micritic matrix, cryptocrystalline, mostly a calcilutite; trace of chert.

- 9790- 9795 Limestone: as above, in part, more argillaceous, cryptocrystalline, mostly a calcilutite with some calcarenite; fewer fossils, more broken up.
- 9795- 9800 Limestone: as above, more brecciated than above; some calcite rhombs in the limestone; trace of chert; trace of Shale: brownish-gray to dark gray, in part, cherty and dolomitic.
- 9800- 9810 Limestone: as above, more mottled, and brecciated; fossiliferous, with scattered Amphipora; some Stachyodes, trace of septate corals and Stromatoporoid detritus, chalky limestone, dark gray, carbonaceous shale, with a rougher texture, and milky chert.
- 9810- 9820 Limestone: white to gray, a calcilutite, with a high silica content; some softer Limestone, with a duller luster; trace of tripolite and a white, hard, microcrystalline mineral.
- 9820- 9830 Limestone: white to brownish-gray, in part, subtranslucent, a calcilutite; scattered Amphipora.
- 9830- 9840 Limestone: as above, in general, darker, more argillaceous; some white Limestone, with a duller luster, softer; trace of bluish-gray, translucent chert.
- 9840- 9850 Limestone: as above, but more mottled and more brecciated; some dead oil staining along minute fractures; some light green fragments in the brecciated limestone; increased fossils; some Stachyodes; increased chert, 5%.
- 9850- 9860 Limestone: as above, containing rare fossils, badly altered; increased chert, opalescent, 10%; trace of shale.
- 9860- 9870 Limestone: white to light gray, mottled and brecciated, consisting of darker skeletal intraclasts in a lighter matrix; the altered fossils look like Stachyodes; trace of Shale: gray, rough texture, irregular fracture.
- 9870- 9880 Limestone: white to gray, in part, mottled, brecciated and recemented, a calcarenite; skeletal intraclasts; trace of shale and chert.
- 9880- 9890 Limestone: as above, light brownish-gray, in part, more argillaceous; trace of chert.
- 9890- 9900 Limestone: as above, in general, darker, more mottled, brecciated and recemented; trace of subtranslucent chert.

- 9900- 9910 Limestone: light brownish-gray, cryptocrystalline to microcrystalline, a calcilutite; consists, in part, of fine, clear nonskeletal intraclasts in a beige matrix; in part, there seems to be a filler of either sparry calcite or a recrystallized Micrite; possible Algae growths; small amount of white chert, with rudistics resembling sponge spicules.
- 9910- 9920 Limestone: white to gray, mottled, cryptocrystalline, a calcarenite; clear to subtranslucent intraclasts in a more opaque matrix; reduced chert.
- 9920- 9930 Limestone: white to light gray, with some buff, cryptocrystalline, a calcilutite; Shale: dark gray, platy, carbonaceous; Shale: brownish-gray, blocky; trace of Chert: as above.
- 9930- 9940 Skeletal intraclasts, as above; some white, finely crystalline limestone.
- 9940- 9950 Limestone: white to gray, mottled, a calcarenite; skeletal intraclasts in a micritic matrix; skeletal intraclasts in a micritic matrix.
- 9950- 9960 Limestone: white to gray, mottled, cryptocrystalline; skeletal intraclasts in a micritic matrix; trace of smoky chert.
- 9960- 9970 Limestone: brownish-gray, in part, subtranslucent, cryptocrystalline, a dark calcilutite, with a fairly high luster, high silica content; trace of Limestone: white, with a dull luster, almost chalky; Chert: dark brownish-gray, smoky, 20%.
- 9970- 9980 Limestone: as above, and Limestone: light gray to gray, mottled, with some Stachyodes; trace of Stromatoporoids, probably dendritic.
- 9980- 9990 Limestone: white to gray, cryptocrystalline, in part, finely brecciated, in part, consists of skeletal intraclasts in a micritic matrix; some Stachyodes; the lighter limestone has a slight beige tinge and is not chalky, a light lutite; trace of light and dark laminations; slight reduction in chert.
- 9990-10,000 Limestone: very light brownish-gray to dark gray, cryptocrystalline, in part, finely brecciated and recemented; fossiliferous; skeletal intraclasts in a micritic matrix; angular chert fragments, opalescent, 20%.

- 10,000-10,010 Limestone: white, and Limestone: very light gray to gray, mottled, cryptocrystalline, bioclastic; reduced fossils, but traces of Stachyodes and Amphipora; reduced chert, with some rudistics, 3%.
- 10,010-10,020 Limestone: white to gray, in part, mottled, cryptocrystalline, with some skeletal and some nonskeletal intraclasts, in part, finely brecciated and recemented; increased angular Chert fragments: milky to smoky, 10%.
- 10,020-10,030 Limestone: white to gray, mottled, cryptocrystalline; fossiliferous, with mostly Amphipora; trace of some dentritic Stromatoporoids; trace of smoky chert.
- 10,030-10,040 Limestone: gray, with numerous Amphipora; small amount of white Limestone: duller luster; trace of Shale: dark gray, platy to fissile.
- 10,040-10,050 Limestone: gray, as above, with Amphipora; Limestone: white, dull luster, microcrystalline, massive, in part, almost chalky, 40%; trace of shale and chert.
- 10,050-10,060 Limestone: as above, with fewer fossils and increased white limestone; trace of shale and chert.
- 10,060-10,070 Limestone: light gray to dark gray, in part, finely brecciated and recemented; a few skeletal intraclasts and some nonskeletal intraclasts; trace of light and dark Amphipora; trace of chert and dark gray shale.
- 10,070-10,080 Limestone: white to gray, in part, mottled, in part, finely brecciated and recemented; grades from a calcilutite to a calcarenite; some nonskeletal intraclasts in a micritic matrix; rare Amphipora; small amount of chert, milky to smoky; trace of dark gray, silty shale.
- 10,080-10,090 Limestone: light gray to dark gray, in part, mottled, in part, finely brecciated and recemented; small amount of Amphipora; trace of dark gray shale.
- 10,090-10,100 Limestone: as above, in part, finely brecciated and recemented, a calcilutite grading to a calcarenite; a slight greenish tinge in some of the limestone; trace of Amphipora.
- 10,100-10,110 Limestone: as above, but with increased Amphipora; some sparry calcite or recrystallized micrite surrounding the fossils; trace of light brown, smoky chert.
- 10,110-10,120 Limestone: white to gray, in part, subtranslucent, in part, finely brecciated, a calcilutite grading to a calcarenite, fossiliferous; trace of chert.

- 10,120-10,130 Limestone: white to gray, in part, subtranslucent, cryptocrystalline, a calcilutite; trace of Amphipora and smoky chert.
- 10,130-10,140 Limestone: white to gray, more brecciated and recemented than before, a calcarenite; fewer fossils; trace of chert; trace of low amplitude stylolitic partings.
- 10,140-10,150 Limestone: white to gray, in part, mottled, crypto to microcrystalline, rare finely crystalline, a calcarenite, with rare skeletal intraclasts.
- 10,150-10,160 Limestone: as above, in part, argillaceous; some of the lighter limestone has a creamy color; trace of Shale: brownish-gray, rough texture, irregular fracture; trace of smoky chert, and chert with a pearly luster; trace of stylolitic partings.
- 10,160-10,170 Limestone: as above, with increased light gray, a calcarenite; trace of Stachyodes; trace of smoky chert.
- 10,170-10,180 Limestone: as above, light gray to gray, in part, finely brecciated and recemented; some skeletal intraclasts in a crystallized calcite matrix; trace of light brownish-gray Limestone: in part, subtranslucent; trace of Shale: brownish-gray to dark gray.
- 10,180-10,190 Limestone: mainly brownish-gray, with some light brownish-gray, in part, subtranslucent, cryptocrystalline, platy, a calcilutite.
- 10,190-10,200 Limestone: white to gray, in part, mottled, cryptocrystalline, bioclastic, consisting of numerous fossils, mainly light brown to dark Amphipora; trace of brownish-gray lutite.
- 10,200-10,210 Limestone: white and light brown to gray, with minor dark gray, crypto to microcrystalline, in part, brecciated, a calcilutite grading to a calcarenite; trace of calcite rhombs in the limestone; minor light brown Amphipora; trace of Ostracods; badly altered trace of Pecten; slight increase in dark gray shale.
- 10,210-10,220 Limestone: white to gray, in part, with a brownish tinge, cryptocrystalline; numerous dark Amphipora; trace of chert; slight reduction in shale; trace of Ostracods.
- 10,220-10,230 Limestone: as above, white to gray, cryptocrystalline; trace of Limestone: white, with a higher luster, massive; some Amphipora and rare Stachyodes; increased Shale: dark gray, fissile, 5%.

- 10,230-10,240 Limestone: as above, in part, mottled, with reduced Amphipora and some Stachyodes; trace of Ostracods; Limestone: brownish-gray, in part, subtranslucent, with a higher luster, cryptocrystalline, a calcilutite, 30%; trace of chert; small amount of Limestone: as above.
- 10,240-10,250 Limestone: white to gray, uniform, a Calcilutite, 40%; Limestone: white to gray, in part, mottled, cryptocrystalline, in part, finely brecciated and recemented; some nonskeletal intraclasts in a micritic matrix; a few Amphipora; trace of chert; a few coarse dolomite rhombs in a dark limestone matrix.
- 10,250-10,260 Limestone: white to gray, in part, mottled, cryptocrystalline; some Stachyodes and lesser Amphipora; small amount of Limestone: white, microcrystalline, with a dull luster.
- 10,260-10,270 Amphipora: mainly dark, with some lighter brown, micritic matrix; trace of low amplitude, stylolitic partings.
- 10,270-10,280 As above, with some nonskeletal intraclasts in a micritic matrix; trace of dark lutite.
- 10,280-10,290 Limestone: light gray, with minor dark gray Limestone: cryptocrystalline, finely brecciated and recemented, a calcarenite; minor fossils; some dark brownish-gray Amphipora and some Stachyodes; small amount of Shale: dark gray and dark brownish-gray, blocky to platy.
- 10,290-10,300 Limestone: light gray to dark gray, with increased dark gray, cryptocrystalline, a calcilutite, with some dark brownish-gray Amphipora and some light brown Amphipora; small amount of dark gray shale.
- 10,300-10,310 Limestone: as above, very fossiliferous; dark and light brown Amphipora in a micritic matrix; trace of chert; trace of dark gray shale.
- 10,310-10,320 Limestone: as above, but not as dark or as fossiliferous; some green Siltstone: brick-red lateritic siltstone and some dark gray siltstone from above, 5%; some Amphipora in a crystalline calcite matrix.
- 10,320-10,330 Limestone: as above, but much more fossiliferous; Amphipora, mostly light brown in a micritic matrix; trace of light green, silty shale.
- 10,330-10,340 Limestone: white to gray, in part, mottled, cryptocrystalline, finely brecciated; nonskeletal lithoclasts in a lighter matrix; reduced Amphipora; trace of light

- green siltstone; trace of finely crystalline limestone; trace of brownish-gray lutite, in part, subtranslucent; small amount of shale.
- 10,340-10,350 As above, with increased dark gray shale, 10%; considerable dark Amphipora.
- 10,350-10,360 Limestone: white to dark gray, in part, mottled, cryptocrystalline, in part, finely brecciated; considerable dark Amphipora and rare Stachyodes; some nonskeletal intraclasts in a micritic matrix; trace of finely crystalline limestone, no visible porosity or shows; traces of dark brown, subtranslucent lutite, stylolitic partings, with a low amplitude, small amount of shale, and Ostracods.
- 10,360-10,380 As above.
- 10,380-10,390 Limestone: as above; increase in dark Amphipora; a portion of the matrix is crystallized calcite; some skeletal intraclasts in a micritic matrix; small amount of light gray, microcrystalline, silty limestone; trace of brownish-gray, subtranslucent calcilutite.
- 10,390-10,400 Limestone: light brownish-gray to gray, cryptocrystalline; some skeletal and nonskeletal intraclasts in a micritic matrix; Siltstone: gray, in part, very calcareous, in part, dolomitic; trace of brownish-gray, subtranslucent limestone.
- 10,400-10,410 Limestone: as above; few amphipora; some dark lithoclasts in a dark matrix; Limestone: light gray, cryptocrystalline, finely brecciated and recemented, a calcarenite; small amount of Siltstone: as above; traces of chert, with some rudistics, brownish-gray lutite, soft, chalky limestone, Shale: dark gray, slightly micromicaceous, and stylolitic partings.
- 10,410-10,420 Limestone: as above; reduced fossils; Amphipora are smaller; trace of Stachyodes; Limestone: light gray, as above, in part, slightly darker; one piece of limestone has minor inclusions of glauconite; trace of Siltstone: as above, chert, with rudistics, stylolitic partings, and dark gray shale.
- 10,420-10,430 Limestone: light gray to dark gray, cryptocrystalline, finely brecciated and recemented, a calcarenite; reduced Amphipora; trace of shale and chert.
- 10,430-10,440 Limestone: buff to light gray, cryptocrystalline, finely brecciated and recemented, a calcarenite; small amount of Amphipora; trace of shale.

- 10,440-10,450 Limestone: as above, but more brecciated; a few fossils; trace of green Shale: very calcareous, in part, silty; trace of limestone, with minute scarlet inclusions, appears to be orthoclase; trace of Ostracods.
- 10,450-10,460 Limestone: as above; skeletal intraclasts in a micritic matrix; fossils are badly altered; trace of green, very calcareous, silty shale; trace of clear quartz in the limestone, with some scarlet orthoclase; trace of chert, and light green, bentonitic shale.
- 10,460-10,470 Limestone: light gray to gray, cryptocrystalline, finely brecciated and recemented, a calcarenite; trace of Amphipora; trace of light green to green, very calcareous siltstone; trace of quartz in the limestone, with traces of orthoclase; trace of finely crystalline pyrite in the light limestone; trace of iron staining surrounding fragments in the brecciated limestone; trace of glauconite.
- 10,470-10,480 Limestone: light gray to dark gray, in part, mottled, cryptocrystalline, finely brecciated and recemented, in part, silty, in part, argillaceous; trace of Amphipora; small amount of Chert: light brown to light blue, subtranslucent, subconchoidal fracture; trace of green siltstone, and white, very fine quartzite.
- 10,480-10,490 Limestone: as above; increased subtranslucent chert, in part, opalescent, 20%; trace of dolomitic siltstone; some skeletal intraclasts.
- 10,490-10,500 Limestone: as above, mainly dark intraclasts in a micritic matrix; increase in brownish-gray lutite; reduction in chert, 15%; trace of light green, bentonitic, slightly calcareous shale; trace of dark gray, silty shale; trace of brick-red, lateritic siltstone.
- 10,500-10,510 Limestone: as above, brecciated, in part, silty; some chert.
- 10,510-10,520 Limestone: as above, light gray to gray, cryptocrystalline, finely brecciated and recemented; some nonskeletal and skeletal intraclasts in a micritic matrix; some Amphipora; trace of chert with some rudistics.
- 10,520-10,530 Limestone: as above; rare fossils; increased light gray limestone; trace of Shale: dark gray, micromicaceous.
- 10,530-10,540 As above; trace of light green, silty shale; trace of dark gray shale.

- 10,540-10,550 Limestone: mainly very light gray and very light brown with minor darker gray, crypto to microcrystalline, in part, silty, finely brecciated and recemented, a calcarenite; trace of Siltstone: light green, shaly, calcareous; trace of light green, bentonitic shale; trace of Sandstone: white to gray, in part, with a slight greenish tinge, fine grained, subangular to subrounded, well sorted, well consolidated, very calcareous, in part, argillaceous; trace of Shale: brownish-gray to dark gray, mostly with a rough texture and irregular fracture.
- 10,550-10,560 Limestone: as above, with increased subtranslucent limestone; trace of Sandstone: as above, in part, with rare glauconite; trace of lateritic siltstone; Chert: subtranslucent, 10%; Shale: as above.
- 10,560-10,570 Limestone: as above, in general, with more darker gray, finely brecciated and recemented, cryptocrystalline, a calcarenite; some light green fragments; in part, silty; very rare fossils; reduced Chert, 5%; reduced shale; trace of chalky limestone.
- 10,570-10,580 Limestone: very light gray to gray, very silty, in part, finely brecciated and recemented, a calcarenite; trace of chert; trace of shale.
- 10,580-10,590 Limestone: white to gray, in general, less argillaceous, finely brecciated and recemented, a Calcarenite: silty; trace of brownish-gray, subtranslucent limestone; trace of tripolite.
- 10,590-10,600 Limestone: as above, in general, more argillaceous, silty to sandy, finely brecciated and recemented; Siltstone: grading to a fine sandstone, mainly quartz grains, subangular to subrounded, well sorted, well consolidated, very calcareous, tight, no shows, 5%; trace of sandstone, consisting of glauconite grains in a dark matrix.
- 10,600-10,664 Granite: consisting of roughly equal amounts of quartz and plagioclase feldspar, with minor amounts of biotite; quartz fragments are angular with distinct crystal contacts with the feldspars; crystal size varies from 0.1 mm to 2 mm or more.

NATIONAL PETROLEUM RESERVE ALASKA
345 Middlefield Road
Menlo Park, California 94025

March 14, 1977

Memorandum

To: George Gryc, Chief, ONPRA
From: Ken Bird, Branch of Oil and Gas Resources
Subject: Granitic basement in Husky NPR East Teshekpuk Lake #1

Sample examination suggests that the Husky NPR East Teshekpuk Lake well (1-14N-4W) bottomed in granitic basement and not in conglomeratic sandstone as previously reported by well loggers.

Drilling of the subject well was halted at 10,664 ft. when about 40 ft. of "conglomeratic sandstone" was penetrated beneath nearly 1,000 ft. of Lisburne Group carbonates. During routine examination of cuttings and thin sections I discovered the presence of granitic rock chips in samples from 10,630 ft. to 10,664 ft. Because granitic rock or granitic debris (conglomerate) has not previously been reported from the subsurface a closer look at this part of the well was undertaken. Samples from the interval 10,600 ft. to 10,664 ft. were examined; their quality is judged to be good with only minor amounts of 'uphole' contamination.

Samples from 10,600 ft. to 10,630 ft. consist of fossiliferous, calcareous sandstone and sandy limestone with minor amounts of chert (see photo-micrograph). The sandstone consists of fine to very fine, subrounded grains of quartz and chert in a ratio of about 60/40, respectively. Feldspar was specifically searched for but none was found. The age of these sandy carbonates is reported to be Late Mississippian-Early Pennsylvanian (foraminiferal zones 18-20) by Anderson, Warren, and Associates. My own studies of this well are in progress but are not yet completed.

Granitic rock predominates in samples from 10,630 ft. to 10,664 ft. This rock consists of roughly equal amounts of quartz and plagioclase feldspar with about 1 percent to 5 percent biotite. Crystal size varies from 0.1 mm to 2 mm or more (see photomicrograph). All minerals are relatively unaltered and show an interlocking or intergrown fabric characteristic of an igneous origin. Additional study of this rock including detailed petrographic examination and staining for K-feldspar is currently underway. Because of the previous description of a conglomeratic sandstone a special effort was made to determine if the cuttings came from granitic pebbles or from an igneous basement. Features indicative of a detrital origin that can be observed in cuttings include 1) chips with one or more smooth or rounded edges, 2) chips with a weathered rind on one edge, 3) rounded, granule-or-sand-size granitic fragments, and 4) chips showing sand or clayey matrix adhering to the edge of a larger fragment.

None of these features were observed. Therefore it is concluded that these chips came from a mass of granitic rock and not from clasts in a sedimentary deposit. The contact between the Lisburne and the granitic rock may be represented on the electric log by a prominent resistivity low and positive SP deflection at about 10,625 ft. (see attached graphic summary). A sidewall core sample at 10,624 ft., just above the postulated contact, is described as a sandstone. Examination of recently obtained pieces of this sidewall core sample shows that it is also granitic like the cuttings below and not sandstone like the cuttings above.

The evidence presented above suggests that the Lisburne Group is resting on granitic basement. The lack of thermal alteration or unusual mineralization in the Lisburne indicates that the granitic rock is pre-Lisburne in age. The exact nature of the contact is unknown. It could be depositional with Lisburne overlapping a granitic basement high; alternatively, it could be a fault juxtaposing the two units. In either case it appears that there is a granitic body of pre-Lisburne age present in the basement complex in this area.

Gravity data may show the areal extent of this granitic mass. The well is located on the edge of a Bouger gravity low shown on the most recent Alaska gravity map (Barnes, 1976, USGS open file report 76-70). A known granite in the Brooks Range (Mount Michelson) is characterized by a prominent gravity low. If the granitic body at East Teshekpuk Lake #1 provides a similar gravity response then its outline may be described by the gravity low shown on the map (see attachment). It is interesting to note that this gravity low also corresponds nicely to a seismic high as mapped by Tetra Tech.

Ken Bird

cc: Husky NPR (2)
Dir, RF
File
Mast
Bird

NOTE: Plates accompanying original letter
have not been reproduced for report.