

JOHN D. PRUIT

Petroleum Geology

P.O. Box 1268
Ranchos de Taos, NM 87557-1268
(505) 751-0115

GEOLOGIC REPORT
ENSIGN OPERATING COMPANY, INC.
#2-20 Boaldin
(NWNE) SECTION 20-T35S-R43W
MORTON COUNTY, KANSAS

OPERATOR: Ensign Operating Company, Inc.
WELL NAME: #2-20 Boaldin
LOCATION: 475' FSL. 1980' FWL
 (NWNE) Section 20-T35S-R43W
 Morton County, Kansas
FIELD: Okan
TOTAL DEPTH: 4730' Driller, 4736' Logger, 4736.12' Strap
SPUD DATE: November 6, 1993
COMPLETION DATE: November 17, 1993
ELEVATION: 3683' G.L., 3696' K.B.
SURFACE CASING: Set 32 joints 8 5/8" 24# casing at 1393' K.B. with 575
 sacks lite. 2% cc, 1/4# flocele + 150 sacks Class C, 3%
 cc. Plug down 11:30 a.m., November 8, 1993.
CONTRACTOR: Gabbert & Jones, Rig 8
WELLSITE GEOLOGIST: John D. Pruitt
MUD: Cimarron Drilling Fluids, Inc., Liberal, Kansas
 Jim Reed, Engineer
GAS DETECTION: Unmanned unit from Holmes Gas Detectors, Inc.
 Liberal, Kansas
DRILL STEM TEST: Western Testers, Pratt, Kansas
 Rod Tript, Tester
LOGS: BPB Logging Services, Liberal, Kansas: Dual Induction
 Log, Compensated Density Neutron Log; Microlog
RESULT: Ran casing to production test Keyes, Morrow, and Atoka.

WELL HISTORY:

<u>Date</u>	<u>Depth</u>	<u>Formation</u>	<u>Operation</u>
11-06-93	0'	Surface	Spud 10:15 a.m.
11-07-93	685'	---	Drilling. Made 685' in 20 3/4 hrs. VIS 32, MW 9.1, LCM 4# WOB 15-20, RPM 120, PP 900, SPM 60
11-08-93	1393'	---	Running Casing. Made 708' in 24 hrs. VIS 33, MW 9.2, LCM 4# WOB 20, RPM 120, PP 900, SPM 60

WELL HISTORY: (Continued)

<u>Date</u>	<u>Depth</u>	<u>Formation</u>	<u>Operation</u>
11-09-93	1700'	---	Drilling. Made 307' in 24 hrs. VIS 30. MW 8.9, LCM 0 WOB 30-35, RPM 75, PP 1150. SPM 60
11-10-93	2640'	---	Drilling. Made 940' in 24 hrs. VIS 31. MW 9.0, CI 600, PV 2. YP 2 pH 8.0, WL NA, LCM 4#, CA 100 WOB 35-38, RPM 75, PP 1150. SPM 60
11-11-93	3175'	Heebner	Drilling. Made 535' in 24 hrs. VIS 31. MW 9.1, CI 600. PV 9. YP 4. GS 1/6 pH 8.5. WL 13.2. LCM 2#. CA 60 WOB 35-38, RPM 75, PP 1150. SPM 60
11-12-93	3590'	Marmaton	Drilling. Made 415' in 24 hrs. VIS 36. MW 9.0, CI 600, PV 11, YP 5. GS 2/5 pH 8.5. WL 11.2. LCM 4#, CA 40 WOB 35-38, RPM 75, PP 1150. SPM 60
11-13-93	4005'	Atoka	Drilling. Made 415' in 24 hrs. VIS 51. MW 9.0, CI 950, PV 18, YP 14. GS 4/11 pH 9.5, WL 8.8. LCM 2#. CA 40 WOB 38-40, RPM 75, PP 1150. SPM 40
11-14-93	4055'	Atoka	Drilling. Made 50' in 24 hrs. VIS 38. MW 8.6, CI 300, PV 15, YP 10. GS 4/10 pH 9.5, WL 10.0, LCM 8#. CA TRACE WOB 38-40, RPM 75, PP 1150. SPM 60
11-15-93	4242'	Morrow	Drilling. Made 86' in 24 hrs. VIS 46. MW 8.7, CI 800, PV 16, YP 11. GS 3/9 pH 9.0, WL 9.2, LCM 10#. CA 40 WOB 38-40. RPM 75, PP 850-1150. SPM 60 Lost circulation at 4156', 17 hours.
11-16-93	4560'	Morrow	Drilling. Made 318' in 24 hrs. VIS 42. MW 9.0. CI 800. PV 14, YP 11. GS 6/9 pH 8.5, WL 9.4, LCM 8#. CA 40 WOB 38-40. RPM 75, PP 1150. SPM 60
11-17-93	4730' DTD 4736' LTD 4736.12' STD	Mississippian	Running Casing. Made 170' in 24 hrs.

FORMATION TOPS:

<u>Formation</u>	<u>Sample</u>	<u>Datum</u>	<u>E. Log</u>	<u>Datum</u>
Waubunsee	2701'	(+ 995')	2699'	(+ 997')
Topeka	2876'	(+ 820')	2878'	(+ 818')
Greenwood	3113'	(+ 583')	3116'	(+ 580')
Heebner	3172'	(+ 524')	3177'	(+ 517')
Lansing	3290'	(+ 406')	3292'	(+ 404')
Marmaton	3526'	(+ 170')	3533'	(+ 163')
Cherokee	3816'	(- 120')	3821'	(- 125')
Atoka	3910'	(- 214')	3912'	(- 216')
Morrow	4184'	(- 488')	4182'	(- 486')
Upper Morrow Sand	4294'	(- 598')	4288'	(- 592')
2nd Upper Morrow Sand	4319'	(- 623')	4324'	(- 628')
Keyes	4579'	(- 883')	4584'	(- 888')
Mississippian	4676'	(- 980')	4677'	(- 981')

DRILL STEM TEST RECORD:

DST #1 3908'-4055' (Atoka)

30-60-60-120

1st open: bottom of bucket in 30 seconds

gas to surface: 3 minutes--965 MCFD
 10 minutes--1379 MCFD
 20 minutes--1813 MCFD
 30 minutes--1856 MCFD

2nd open: gas to surface--1949 MCFD for 60 minutes

Recovery: 195' Gassy Mud (20% gas, 80% mud)

FP: 697-676 697-697

SIP: 835-825

HP: 2027-1920

BHT: 118°F

Sampler: 983 cu ft gas at 820 psig

SHOW DESCRIPTION:

<u>Formation</u>	<u>Interval</u>	<u>Description</u>
Lansing	3329'-3332'	Dolomite, white-buff, microcrystalline, tight-fair vuggy porosity, bright white fluorescence, very pale milky cut, fair ring. FAIR SHOW.

SHOW DESCRIPTION: (continued)

<u>Formation</u>	<u>Interval</u>	<u>Description</u>
Marmaton	3627'-3630'	Sandstone, white, very fine grained, calcareous, micaceous in part, tight-poor visible porosity, spotty gold fluorescence, instant streaming cut, fair ring. POOR SHOW.
Marmaton	3636'-3641'	Sandstone, white-light gray, very fine grained-silty, calcareous, micaceous, tight, tight-fair visible porosity, trace spotty light brown oil stain, dull gold fluorescence, no cut, fair ring. POOR SHOW.
Marmaton	3780'-3790'	Sandstone, light gray, very fine-fine grained, subangular-subrounded, calcareous, siliceous in part, tight-good visible porosity, spotty-solid bright gold fluorescence, instant streaming cut, fair ring. FAIR SHOW.
Atoka	3944'-3954'	Sandstone, light gray-light brown, very fine-coarse grained, trace subrounded loose quartz granules, very siliceous in part, very calcareous, glauconite, no visible porosity, spotty bright gold fluorescence, no cut, strong ring. POOR SHOW.
Atoka	3965'-3970'	Sandstone, clear-light gray, very fine-medium grained, subangular, poorly sorted, very siliceous, calcareous in part, dark lithic grains, tight-trace poor visible porosity, 20% sand in sample, 10 to 20% loose grains, spotty gold fluorescence, pale cut, weak ring. POOR SHOW.
Atoka	4040'-4046'	Limestone, light brown, packstone, very fine-fine grained, micritic matrix, dolomitic oolites, no visible porosity, bright white gold fluorescence, instant streaming cut, fair ring. POOR SHOW.
Upper Morrow Sand	4294'-4309'	Sandstone, clear-light gray, very fine grained-granules, subangular-subrounded, poorly sorted, very calcareous, siliceous in part, no visible porosity, 20% sand in samples, 20% loose grains, gold fluorescence, slow streaming cut, fair ring. POOR-FAIR SHOW.

SHOW DESCRIPTION: (continued)

<u>Formation</u>	<u>Interval</u>	<u>Description</u>
2nd Upper Morrow Sand	4319'-4348'	Sandstone, clear, very fine grained-granules, average grain size, increase with depth, subangular-subrounded, moderately-poorly sorted, siliceous, calcareous in part, trace dark gray lithic grains, trace pyrite, tight-fair visible porosity, 30-50% sand in samples, 50-90% loose grains, spotty brown soil stain, bright white-gold fluorescence, slow-instant streaming cut, fair ring. GOOD SHOW.
Keyes	4579'-4676'	Sandstone, clear, very fine grained-granules, subangular-subrounded, poorly-moderately sorted, calcareous in part, siliceous in part, glauconitic in part, pyritic, 10-90% sand in samples, 30-90% loose grains, tight-good visible porosity, light brown-brown oil stain, dull-faint gold fluorescence, pale-very pale streaming cut, weak-faint ring. POOR-GOOD SHOW.

DEVIATION RECORD:

<u>Depth</u>	<u>Deviation</u>	<u>Depth</u>	<u>Deviation</u>	<u>Depth</u>	<u>Deviation</u>
638'	1/4°	2485'	3/4°	4055'	1 1/8°
924'	1/2°	3041'	1°	4547'	1°
1393'	1/2°	3646'	1°	4730'	1 1/4°
1897'	3/4°				

BIT RECORD:

<u>No.</u>	<u>Size</u>	<u>Make</u>	<u>Type</u>	<u>Depth Out</u>	<u>Feet</u>	<u>Hours</u>
1	12 1/4	HTC	X3A	924'	924	18
2	12 1/4	HTC	X3A	139'	469	12 3/4
3	7 7/8	SEC	S88CF	4730'	3337	143

SAMPLE DESCRIPTION:

10 foot samples were caught from 2600' to total depth at 4730'. 1 foot drill time was saved from 2600' to total depth. Sample examination commenced at 2600' and continued to total depth. One dry cut was prepared and shipped to Kansas Geological Survey, Wichita, Kansas for storage. Samples were caught

by crews and lagged by geologist. Sample depths reported herein are lagged depths.

- 2600'-2610' Limestone, gray, mudstone, micritic, shell fragments, very argillaceous, tight, no stain, fluorescence, or cut.
Limestone, brown-dark brown, mudstone-micritic, shell fragments, argillaceous in part, dark gray shale laminae in part, tight, no stain, fluorescence, or cut.
Chert, brown-dark brown, opaque.
- 2610'-2620' Siltstone, gray, very argillaceous, very calcareous, microfossils in part, tight, no stain, fluorescence, or cut.
- 2620'-2630' Limestone, tan, packstone-grainstone, very fine grain-medium grain, micritic matrix, shell fragments, microfossils, tight-good intergranular porosity, no stain, fluorescence, or cut.
Limestone, tan-light brown, mudstone-wackestone, micritic, microfossils, tight, no stain, fluorescence, or cut.
- 2630'-2640' Limestone, tan-light brown, wackestone-packstone, very fine grain-fine grain, micritic matrix, microfossils, trace shell fragments, tight-good intergranular porosity, no stain, fluorescence, or cut.
- 2640'-2650' Limestone, tan-light brown, wackestone-packstone, very fine grain-fine grain, micritic matrix, microfossils, trace shell fragments, tight-good intergranular porosity, no stain, fluorescence, or cut.
Shale, gray, platy-blocky, slightly-very calcareous, silty.
- 2650'-2660' Shale, gray-dark gray, platy-blocky, slightly-very calcareous, silty, micaceous in part.
Limestone, light brown-gray, wackestone, micritic, very argillaceous in part, shell fragments, tight, no stain, fluorescence, or cut.
- 2660'-2670' Limestone, light brown-gray, wackestone-packstone, very fine grain-coarse grain, micritic matrix, very argillaceous in part, shell fragments, corals, brachiopods, dark gray shale laminate and fragments in part, tight, no stain, fluorescence, or cut.
- 2670'-2680' Limestone, light brown-gray, wackestone-packstone, very fine grain-coarse grain, micritic matrix, very argillaceous in part, shell fragments, corals, brachiopods, dark gray shale laminate and fragments in part, tight, no stain, fluorescence, or cut.
Shale, gray, platy-blocky, waxy in part, slightly calcareous and silty in part.

- 2680'-2690' Shale, gray, platy-blocky, waxy in part, slightly calcareous and silty in part.
Limestone, light brown, wackestone-packstone, very fine grain-coarse grain, micritic matrix, microfossils, oolites, shell fragments, no visible porosity, no stain, fluorescence, or cut.
- 2690'-2700' Trace dolomite brown, microsugrosic, tight, no stain, fluorescence, or cut.
Limestone, light brown-brown, wackestone-packstone, dark gray shale laminae in part, very fine grain-coarse grain, micritic matrix, microfossils, oolites, shell fragments, no visible porosity, no stain, fluorescence, or cut.
Shale, gray-dark gray, splintery-blocky.

Top Waubunsee 2701' (+995')

- 2700'-2710' Shale, gray-dark gray, splintery-blocky.
Limestone, light brown-brown, wackestone-packstone, dark gray shale laminae in part, very fine grain-coarse grain, micritic matrix, microfossils, oolites, shell fragments, no visible porosity, no stain, fluorescence, or cut.
Limestone, light brown-light gray-mauve, mudstone-wackestone, micritic, microfossils, tight, no stain, fluorescence, or cut.
- 2710'-2720' Limestone, light brown-light gray-mauve, mudstone-wackestone, micritic, microfossils, tight, no stain, fluorescence, or cut.
Dolomite, buff, microcrystalline, abundant microfossils, tight-fair intergranular porosity, no stain, fluorescence, or cut.
Sandstone, buff, very fine grain-silty, very calcareous, argillaceous, no visible porosity, no stain, fluorescence, or cut.
- 2720'-2730' Limestone, light brown-light gray-mauve, mudstone-wackestone, micritic, trace dark gray oolites, microfossils, tight, no stain, fluorescence, or cut.
Limestone, light gray-light brown, mudstone, micritic, argillaceous in part, tight, no stain, fluorescence, or cut.
- 2730'-2740' Limestone, light gray-light brown, mudstone, micritic, argillaceous in part, tight, no stain, fluorescence, or cut.
Limestone, buff-brown, packstone, very fine grain-coarse grain, micritic-microcrystalline matrix, shell fragments, corals, tight-fair vuggy porosity, no stain, fluorescence, or cut.

- 2740'-2750' Sandstone, light brown, very fine grain, very calcareous, silty micaceous, argillaceous, no visible porosity, no stain, fluorescence, or cut.
Limestone, buff-light brown, wackestone-packstone, very fine grain-medium grain, micritic matrix, slightly-very dolomitic, shell fragments, no visible porosity, no stain, fluorescence, or cut.
- 2750'-2760' Limestone, buff-light brown, wackestone-packstone, very fine grain-medium grain, micritic matrix, slightly-very dolomitic, shell fragments, tight-fair vuggy porosity, no stain, fluorescence, or cut.
- 2760'-2770' Limestone, buff-light brown, wackestone-packstone, very fine grain-medium grain, micritic matrix, slightly-very dolomitic, shell fragments, no visible porosity, no stain, fluorescence, or cut.
Shale, gray-dark gray, platy, calcareous in part, silty in part.
- 2770'-2780' Shale, gray-dark gray, platy, calcareous in part, silty in part.
Limestone, light brown, wackestone-packstone, micritic matrix, fine grain-medium grain, oolites, trace shell fragments, tight, no stain, fluorescence, or cut.
- 2780'-2790' Limestone, light brown-mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 2790'-2800' Limestone, light brown-light gray, variegated in part, mudstone-wackestone, micritic, argillaceous in part, shell fragments, tight, no stain, fluorescence, or cut.
- 2800'-2810' Shale, dark gray, platy-blocky, very calcareous in part, micaceous in part, pyritic.
Limestone, light brown-light gray, mudstone-wackestone, micritic, microfossils, tight, no stain, fluorescence, or cut.
Dolomite, buff-light gray, microcrystalline, microsucrosic, micaceous in part, no visible porosity, no stain, fluorescence, or cut.
- 2810'-2820' Dolomite, buff-light gray, microcrystalline, microsucrosic, micaceous in part, no visible porosity, no stain, fluorescence, or cut.
Limestone, light brown-light gray-gray, mudstone-wackestone, micritic, very argillaceous in part, oolites, shell fragments, dark gray shale laminae in part, tight, no stain, fluorescence, or cut.

- 2820'-2830' Limestone, light brown-light gray-gray, mudstone-wackestone, micritic, very argillaceous in part, oolites, shell fragments, dark gray shale laminae in part, tight, no stain, fluorescence, or cut.
Limestone, light gray, mudstone-wackestone, micritic, dolomitic, slightly argillaceous, microfossils, tight, no stain, fluorescence, or cut.
Limestone, light brown, packstone, very fine grain-fine grain, micritic matrix, slightly dolomitic, shell fragments, tight-fair vuggy porosity, no stain, fluorescence, or cut.
- 2830'-2840' Limestone, light brown, packstone, very fine grain-fine grain, micritic matrix, slightly dolomitic, shell fragments, tight-fair vuggy porosity, no stain, fluorescence, or cut.
Limestone, light gray-grayish brown, mudstone, micritic-microcrystalline, slightly argillaceous, microfossils, tight, no stain, fluorescence, or cut.
- 2840'-2850' Dolomite, tan-trace white, microcrystalline-microsugrosic, limy in part, sandy in part, tight-poor pinpoint vuggy porosity, no stain, fluorescence, or cut.
Limestone, light brown-brown-gray, mudstone, micritic-microcrystalline, trace shell fragments, argillaceous in part, tight, no stain, fluorescence, or cut.
- 2850'-2860' Limestone, light brown-brown-gray, mudstone, micritic-microcrystalline, trace shell fragments, argillaceous in part, tight, no stain, fluorescence, or cut.
- 2860'-2870' Limestone, tan, packstone, very fine grain-fine grain, micritic matrix, very dolomitic in part, oolites, shell fragments, tight-fair vuggy porosity, trace tarry black oil stain, no stain, fluorescence, or cut.
- 2870'-2880' Limestone, buff-gray-light gray, mudstone, micritic, slightly dolomitic in part, tight, no stain, fluorescence, or cut.
Shale, dark gray, platy-blocky.

Top Topeka 2876' (+820')

- 2880'-2890' Limestone, light brown-brown-trace gray, mudstone, micritic-microcrystalline, trace argillaceous, tight, no stain, fluorescence, or cut.
- 2890'-2900' Limestone, light brown-brown-trace gray, mudstone, micritic-microcrystalline, trace argillaceous, tight, no stain, fluorescence, or cut.
Anhydrite, clear-white, crystalline, red shale laminae.

- 2900'-2910' Limestone, brown, packstone, fine grain-coarse grain, micritic matrix, anhydritic, subangular-subrounded clasts red shale and oolites, trace shell fragments, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, splintery-platy, calcareous in part.
- 2910'-2920' Limestone, light brown, packstone, very fine grain-fine grain, micritic matrix, slightly-completely dolomitized, oolites, shell fragments, tight-fair oomoldic and good intercrystalline porosity, no stain, fluorescence, or cut.
- 2920'-2930' Limestone, light brown-light gray, mudstone-wackestone, micritic matrix, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 2930'-2940' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, dolomitic in part, sandy in part, argillaceous in part, tight, no stain, fluorescence, or cut.
Sandstone, white, very fine grain-fine grain, silty in part, trace dark lithic grains, very calcareous, no visible porosity, no stain, fluorescence, or cut.
- 2940'-2950' Limestone, gray-brownish gray, mudstone-wackestone, micritic, shell fragments, shale chips, tight, no stain, fluorescence, or cut.
Shale, dark gray, splintery, micaceous.
- 2950'-2960' Limestone, light brown-grayish brown, mudstone, micritic matrix, tight, no stain, fluorescence, or cut.
Dolomite, light brown-white, microsucrosic-microcrystalline, limy in part, oolites, no visible porosity, no stain, fluorescence, or cut.
- 2960'-2970' Dolomite, light brown-white, microsucrosic-microcrystalline, limy in part, oolites, no visible porosity, no stain, fluorescence, or cut.
Limestone, light brown-brown-light gray, mudstone, micritic, shell fragments in part, oolites in part, trace pyrite, tight, no stain, fluorescence, or cut.
- 2970'-2980' Limestone, light brown, mudstone-packstone, fine grain, micritic-microcrystalline matrix, dolomitic, oolites, no visible porosity, no stain, fluorescence, or cut.
Dolomite, white-buff, microcrystalline, oolites, chalky in part, no visible porosity, no stain, fluorescence, or cut.

- 2980'-2990' Limestone, buff, mudstone, micritic, shell fragments, tight, no stain, fluorescence, or cut.
Limestone, buff, packstone, very fine grain-fine grain, micritic matrix, slightly dolomitic, oolites, shell fragments, tight-poor intergranular porosity, no stain, fluorescence, or cut.
- 2990'-3000' Limestone, buff, mudstone, micritic, slightly-very dolomitic, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 3000'-3010' Limestone, buff, mudstone, micritic, slightly-very dolomitic, oolites, shell fragments, mudstone-wackestone, microfossils in part, tight, no stain, fluorescence, or cut.
Chert, light brown, opaque.
- 3010'-3020' Limestone, buff, mudstone, micritic, slightly-very dolomitic, oolites, shell fragments, mudstone-wackestone, microfossils in part, tight, no stain, fluorescence, or cut.
Shale, dark gray, splintery-platy.
Limestone, buff-white, sandy texture, very fine grain-silty quartz sand in micritic, chalky matrix, tight, no stain, fluorescence, or cut.
- 3020'-3030' Sandstone, light gray-white, very fine grain-silty, subangular, well sorted, trace dark lithic grains, calcareous in part, tight-fair visible porosity, no stain, fluorescence, or cut.
- 3030'-3040' Limestone, light brown-gray, mudstone, micritic, shell fragments in part, slightly dolomitic in part, tight, no stain, fluorescence, or cut.
Shale, dark gray, splintery, waxy in part.
- 3040'-3050' Shale, dark gray, splintery, waxy in part.
Siltstone, light gray, argillaceous, very calcareous in part, tight, no stain, fluorescence, or cut.
- 3050'-3060' Siltstone, light gray, argillaceous, very calcareous in part, tight, no stain, fluorescence, or cut.
- 3060'-3070' Limestone, buff, mudstone, micritic, anhydritic in part, tight, no stain, fluorescence, or cut.
- 3070'-3080' Siltstone, light gray-white, argillaceous in part, very calcareous, micaceous in part, trace pyrite, tight, no stain, fluorescence, or cut.

- 3080'-3090' Siltstone, light gray-white, argillaceous in part, very calcareous, micaceous in part, trace pyrite, tight, no stain, fluorescence, or cut.
Limestone, gray, mudstone, micritic, very argillaceous, silty in part, tight, no stain, fluorescence, or cut.
- 3090'-3100' Limestone, gray, mudstone, micritic, very argillaceous, silty in part, tight, no stain, fluorescence, or cut.
Limestone, light gray-gray, silty texture, very argillaceous, tight, no stain, fluorescence, or cut.
- 3100'-3110' Limestone, light gray-gray, silty texture, very argillaceous, tight, no stain, fluorescence, or cut.
Shale, gray, platy, micaceous.
Shale, dark gray, splintery-blocky, calcareous, micaceous.
Limestone, light brown-dark brown, mudstone-wackestone, micritic, shell fragments, tight, no stain, fluorescence, or cut.

Top Greenwood 3113' (+583')

- 3110'-3120' Shale, dark gray, splintery-blocky, calcareous, micaceous.
Limestone, dark brownish gray, mudstone, microcrystalline, argillaceous, tight, no stain, fluorescence, or cut.
- 3120'-3130' Limestone, dark brownish gray, mudstone, microcrystalline, argillaceous, tight, no stain, fluorescence, or cut.
Dolomite, buff-light brown, microcrystalline, chalky, oolites, microfossils, shell fragments, limy in part, tight, no stain, fluorescence, or cut.
Limestone, light brown-light gray, mudstone, micritic, tight, no stain, fluorescence, or cut.
- 3130'-3140' Limestone, light brown-light gray, slightly-very dolomitic in part, mudstone, micritic, tight, no stain, fluorescence, or cut.
Dolomite, buff-white, microcrystalline, very limy in part, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 3140'-3150' Dolomite, buff-white, microcrystalline, very limy in part, oolites, chalky in part, shell fragments, tight, no stain, fluorescence, or cut.
Limestone, light gray, mudstone, micritic, tight, no stain, fluorescence, or cut.

3150'-3160' Limestone, light brown-gray, variegated in part, mudstone, micritic, shell fragments, microfossils in part, dark gray shale laminae, argillaceous in part, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, splintery-platy, very calcareous in part.

3160'-3170' Limestone, light brown-grayish brown, mudstone-wackestone, micritic, shell fragments, dolomitic in part, bioturbated, tight, no stain, fluorescence, or cut.

Top Heebner 3172' (+524')

3170'-3180' Limestone, light brown-grayish brown, mudstone-wackestone, micritic, shell fragments, dolomitic in part, bioturbated, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, platy-blocky, fissile in part.
Dolomite, buff, microcrystalline-trace microsucrosic, chalky in part, shell fragments, tight-fair vuggy porosity, no stain, fluorescence, or cut.

3180'-3190' Dolomite, buff, microcrystalline-trace microsucrosic, chalky in part, shell fragments, tight-fair vuggy porosity, no stain, fluorescence, or cut.
Limestone, buff-light brown, mudstone-wackestone, slightly-very dolomitic, shell fragments, tight, no stain, fluorescence, or cut.

3190'-3200' Limestone, buff-light brown, mudstone-wackestone, slightly-very dolomitic, shell fragments, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, blocky, calcareous.
Limestone, light brown, wackestone-packstone, fine grain, micritic matrix, completely dolomitized in part, oolites, tight-good oomoldic and fair vuggy porosity, no stain, fluorescence, or cut.

3200'-3210' Limestone, light brown, wackestone-packstone, fine grain, micritic matrix, completely dolomitized in part, oolites, tight-good oomoldic and fair vuggy porosity, no stain, fluorescence, or cut.
Shale, dark gray-black, platy.
Limestone, light brown, mudstone-wackestone, micritic, oolites, tight, no stain, fluorescence, or cut.

- 3210'-3220' Limestone, grayish brown-gray-dark gray, mudstone, micritic, very argillaceous in part, pyritic in part, tight, no stain, fluorescence, or cut.
Limestone, light brown, packstone, micritic matrix, fine grain, dolomitic, oolites, tight-poor vuggy porosity, no stain, fluorescence, or cut.
- 3220'-3230' Limestone, light brown, mudstone-packstone, fine grain, micritic matrix, dolomitic in part, oolites, tight-poor vuggy porosity, no stain, fluorescence, or cut.
- 3230'-3240' Limestone, light brown-grayish brown, mudstone, micritic, dolomitic in part, tight, no stain, fluorescence, or cut.
- 3240'-3250' Limestone, light brown-grayish brown, mudstone-wackestone, micritic, oolites, dolomitic in part, tight, no stain, fluorescence, or cut.
- 3250'-3260' Limestone, light brown-grayish brown, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
Shale, gray, splintery, micaceous in part.
- 3260'-3270' Shale, gray, splintery, micaceous in part.
Limestone, light gray-gray, silty-sandy texture, very argillaceous in part, tight, no stain, fluorescence, or cut.
- 3270'-3280' Limestone, light gray-gray, silty-sandy texture, very argillaceous in part, tight, no stain, fluorescence, or cut.
Limestone, buff-grayish brown, mudstone, micritic, microfossils, shell fragments, tight, no stain, fluorescence, or cut.
- 3280'-3290' Limestone, buff-grayish brown, mudstone, micritic, microfossils, shell fragments, tight, no stain, fluorescence, or cut.

Top Lansing 3290' (+406')

- 3290'-3300' Limestone, light brown, mudstone, micritic, tight, no stain, fluorescence, or cut.
Limestone, buff-light brown, packstone, very fine grain-fine grain, micritic matrix, dolomitic, tight-good oomoldic porosity, no stain, fluorescence, or cut.
- 3300'-3310' Limestone, buff-light brown, packstone, very fine grain-fine grain, micritic matrix, dolomitic, tight-good oomoldic porosity, no stain, fluorescence, or cut.
Limestone, light brown-grayish brown, mudstone-wackestone, micritic, oolites, bioturbated, tight, no stain, fluorescence, or cut.

- 3310'-3320' Limestone, light brown-grayish brown, mudstone-wackestone, micritic, oolites, bioturbated, tight, no stain, fluorescence, or cut.
Limestone, light brown, packstone, very fine grain-fine grain, micritic matrix, completely dolomitized in part, oolites, tight-fair oomoldic porosity, no stain, fluorescence, or cut.
- 3320'-3330' Limestone, buff-light grayish brown, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3330'-3340' Dolomite, buff, microcrystalline, tight-fair vuggy porosity, bright white fluorescence, very pale milky cut, fair ring.
Limestone, light brown-buff, mudstone, micritic, dolomitic in part, tight, no stain, fluorescence, or cut.
- 3340'-3350' Limestone, light brown-buff, mudstone, micritic, dolomitic in part, tight, no stain, fluorescence, or cut.
Sandstone, light gray, very fine grain, 10% dark lithic grains, micaceous, argillaceous in part, calcareous in part, fair visible porosity, no stain, fluorescence, or cut.
Shale, gray-dark gray, splintery-platy.
- 3350'-3360' Limestone, buff-grayish brown, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3360'-3370' Limestone, buff-light brown, shell fragments, oolites in part, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3370'-3380' Limestone, buff-light brown, shell fragments, oolites in part, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3380'-3390' Limestone, grayish brown-dark gray, variegated, packstone-wackestone, very fine grain, micritic matrix, dark gray oolites, no visible porosity, no stain, fluorescence, or cut.
- 3390'-3400' Limestone, light brown-brown-gray, wackestone, micritic, shell fragments, oolites, argillaceous in part, tight, no stain, fluorescence, or cut.
- 3400'-3410' Limestone, light brown-brown-gray, wackestone, micritic, shell fragments, oolites, argillaceous in part, tight, no stain, fluorescence, or cut.
Siltstone, gray, argillaceous, calcareous, micaceous, tight, no stain, fluorescence, or cut.
Limestone, buff, mudstone, micritic, microfossils, tight, no stain, fluorescence, or cut.

- 3410'-3420' Shale, gray, splintery, waxy in part, silty in part.
Limestone, buff-light gray with trace brown, mudstone,
micritic, chalky in part, shell fragments, tight, no stain,
fluorescence, or cut.
- 3420'-3430' Trace limestone, grayish brown, packstone, fine grain, micritic
matrix, dark brown-dark gray oolites, tight, no stain,
fluorescence, or cut.
Siltstone, light gray-gray, very calcareous, argillaceous,
micaceous, tight, no stain, fluorescence, or cut.
Shale, gray, trace dark gray, platy-blocky, waxy in part.
- 3430'-3440' Siltstone, light gray-gray, very calcareous, very argillaceous,
micaceous, sandy in part, tight, no stain, fluorescence, or
cut.
Shale, gray-dark gray, splintery-platy, micaceous.
- 3440'-3450' Limestone, grayish brown, mudstone, micritic, tight, no stain,
fluorescence, or cut.
Shale, gray-dark gray, very silty, very calcareous, blocky-
platy.
- 3450'-3460' Limestone, grayish brown, mudstone, micritic, crinoids, tight,
no stain, fluorescence, or cut.
- 3460'-3470' Limestone, grayish brown, mudstone, micritic, crinoids, tight,
no stain, fluorescence, or cut.
Shale, gray, platy-blocky, very calcareous in part, very silty
in part.
- 3470'-3480' Limestone, buff, mudstone, micritic, microfossils, tight, no
stain, fluorescence, or cut.
- 3480'-3490' Dolomite, white-buff, microsugrosic, shell fragments, very fine
grain-medium grain angular buff limestone grains, silty in
part, micaceous in part, no visible porosity, no stain,
fluorescence, or cut.
Shale, gray-dark gray, splintery, shell fragments in part.
- 3490'-3500' Dolomite, white-buff, microsugrosic, shell fragments, very fine
grain-medium grain angular buff limestone grains, silty in
part, micaceous in part, no visible porosity, no stain,
fluorescence, or cut.
- 3500'-3510' Shale, light gray-gray, splintery-platy, waxy in part, very
calcareous in part.
- 3510'-3520' Shale, light gray-gray, splintery-platy, waxy in part,
micaceous in part, very calcareous in part.

Top Marmaton 3526' (+170')

- 3520'-3530' Shale, light gray-gray, splintery-platy, waxy in part, micaceous in part, very calcareous in part.
Siltstone, gray, very argillaceous, calcareous, tight, no stain, fluorescence, or cut.
Limestone, light brown, mudstone-packstone, micritic matrix, very fine grain, oolites, tight, no stain, fluorescence, or cut.
- 3530'-3540' Limestone, light brown, mudstone-packstone, micritic matrix, very fine grain-medium grain, oolites, tight, no stain, fluorescence, or cut.
Limestone, light brown-light gray, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3540'-3550' Limestone, light brown-light gray, mudstone, micritic-microcrystalline, tight, no stain, fluorescence, or cut.
- 3550'-3560' Shale, gray, blocky, calcareous, silty.
Limestone, gray, mudstone, micritic, argillaceous, tight, no stain, fluorescence, or cut.
- 3560'-3570' Limestone, gray-brown, variegated in part, mudstone-wackestone, micritic, argillaceous in part, oolites, tight, no stain, fluorescence, or cut.
- 3570'-3580' Limestone, buff-light brown, packstone, very fine grain, micritic matrix, dolomitic in part, oolites, trace black tarry residue along fractures, tight-good oomoldic porosity, no stain, fluorescence, or cut.
- 3580'-3590' Limestone, buff-gray, mudstone, micritic, tight, no stain, fluorescence, or cut.
- 3590'-3600' Shale, gray-dark gray, splintery-blocky, calcareous in part, silty in part, trace pyrite.
- 3600'-3610' Limestone, buff-light brown-brown, mudstone-wackestone, sandy texture, shell fragments, fine grain-coarse grain brown limestone clasts in sandy texture, dolomitic in part, micritic, chalky in part, no visible porosity, no stain, fluorescence, or cut.
- 3610'-3620' Limestone, buff-light brown-brown, mudstone-wackestone, sandy texture, shell fragments, fine grain-coarse grain brown limestone clasts in sandy texture, dolomitic in part, micritic, chalky in part, no visible porosity, no stain, fluorescence, or cut.

- 3620'-3630' Limestone, buff-light brown-brown, mudstone-wackestone, sandy texture, shell fragments, trace loose subrounded coarse grain quartz grains, fine grain-coarse grain brown limestone clasts in sandy texture, dolomitic in part, micritic, chalky in part, no visible porosity, no stain, fluorescence, or cut. Sandstone, white, very fine grain, calcareous, micaceous in part, tight-poor visible porosity, spotty gold fluorescence, instant streaming cut, fair ring.
- 3630'-3640' Limestone, brown, mudstone-wackestone, micritic, shell fragments, tight, no stain, fluorescence, or cut. Sandstone, white-light gray, very fine grain, silty in part, calcareous, micaceous, tight-fair visible porosity, trace spotty light brown oil stain, dull gold fluorescence, no cut, fair ring.
- 3640'-3650' Limestone, buff-white with trace brown and gray sandy texture, micaceous, no visible porosity, no stain, fluorescence, or cut.
- 3650'-3660' Sandstone, white, very fine grain-fine grain, calcareous, micaceous, tight-trace fair visible porosity, no stain, fluorescence, or cut.
- 3660'-3670' Limestone, gray-brown, mudstone-packstone, fine grain, micritic matrix, oolites, sandy in part, argillaceous in part, trace pyrite, tight, no stain, fluorescence, or cut.
- 3670'-3680' Dolomite, buff-white, microcrystalline, very chalky, limy in part, no visible porosity, no stain, fluorescence, or cut. Limestone, brown, mudstone-wackestone, micritic, microfossils, oolites, tight, no stain, fluorescence, or cut.
- 3680'-3690' Limestone, brown, mudstone-wackestone, micritic, microfossils, oolites, tight, no stain, fluorescence, or cut.
- 3690'-3700' Limestone, light brown-brown, mudstone, micritic, shell fragments in part, tight, no stain, fluorescence, or cut.
- 3700'-3710' Limestone, light brown, wackestone-packstone, very fine grain-coarse grain, micritic matrix, oolites, crinoids, shell fragments, tight, no stain, fluorescence, or cut. Siltstone, gray, very argillaceous, very calcareous, micaceous, tight, no stain, fluorescence, or cut.
- 3710'-3720' Siltstone, gray, very argillaceous, very calcareous, micaceous, tight, no stain, fluorescence, or cut.

- 3720'-3730' Siltstone, light gray-gray, very argillaceous, trace black lithic grains, trace angular limestone fragments, calcareous, micaceous, sandy in part, tight, no stain, fluorescence, or cut.
- 3730'-3740' Siltstone, light gray-gray, very argillaceous, trace black lithic grains, trace angular limestone fragments, calcareous, micaceous, sandy in part, tight, no stain, fluorescence, or cut.
Limestone, light brown-brown, mudstone-wackestone, micritic, oolites, shell fragments, sandy in part, tight, no stain, fluorescence, or cut.
- 3740'-3750' Limestone, light brown-brown, mudstone-wackestone, micritic, oolites, shell fragments, sandy in part, tight, no stain, fluorescence, or cut.
Shale, dark gray, platy-blocky, calcareous in part, waxy in part.
- 3750'-3760' Shale, dark gray-black, platy-blocky, calcareous in part, waxy in part.
Limestone, light grayish brown-light brown, mudstone-wackestone, micritic, oolites, shell fragments, sandy in part, tight, no stain, fluorescence, or cut.
- 3760'-3770' Limestone, light brown-buff, mudstone-wackestone, micritic, oolites, shell fragments, sandy in part, tight, no stain, fluorescence, or cut.
- 3770'-3780' Dolomite, white, microsucrosic, shell fragments, no visible porosity, no stain, fluorescence, or cut.
Limestone, buff-brown, mudstone-wackestone, micritic matrix, oolites, tight, trace bright white fluorescence, no cut, no ring.
- 3780'-3790' Sandstone, light gray, very fine grain-fine grain, subangular-subrounded, calcareous, siliceous in part, tight-good visible porosity, spotty-solid bright gold fluorescence, instant streaming cut, fair ring.
- 3790'-3800' Limestone, light brown, mudstone-wackestone, micritic, oolites, sandy in part, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, platy, blocky, slightly-very calcareous in part, very silty-sandy in part.
- 3800'-3810' Shale, gray-dark gray, platy, blocky, slightly-very calcareous in part, trace pyrite, very silty-sandy in part.

Top Cherokee 3816' (-120')

- 3810'-3820' Shale, dark gray, splintery-platy, micaceous.
Limestone, light gray, salt and pepper, sandy texture, micritic matrix, very fine grain quartz and dark lithic grains, tight, no stain, fluorescence, or cut.
Limestone, gray-light brown, mudstone, micritic, sandy, tight, no stain, fluorescence, or cut.
- 3820'-3830' Limestone, gray-light brown, mudstone, micritic, sandy, tight, no stain, fluorescence, or cut.
Limestone, brown-gray, wackestone-packstone, very fine grain-fine grain, micritic matrix, trace glauconite, argillaceous, oolites, tight, no stain, fluorescence, or cut.
- 3830'-3840' Limestone, brown-gray, wackestone-packstone, very fine grain-fine grain, micritic matrix, trace glauconite, argillaceous, oolites, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, platy-blocky, very calcareous, sandy in part.
Limestone, light brown-gray, mudstone-wackestone, micritic-microcrystalline, oolites, sandy in part, tight, no stain, fluorescence, or cut.
- 3840'-3850' Limestone, light brown-gray, mudstone-wackestone, micritic-microcrystalline, oolites, sandy in part, tight, no stain, fluorescence, or cut.
Limestone, light gray-light brown, mudstone, micritic, argillaceous in part, dolomitic in part, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 3850'-3860' Limestone, light gray-light brown, mudstone, micritic, argillaceous in part, dolomitic in part, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 3860'-3870' Limestone, light gray-light brown, mudstone, micritic, argillaceous in part, micaceous in part, dolomitic in part, oolites, shell fragments, tight, no stain, fluorescence, or cut.
Shale, dark gray, chippy-splintery, micaceous, trace pyrite.
- 3870'-3880' Shale, dark gray, chippy-splintery, micaceous, trace sandy, trace pyrite.
- 3880'-3890' Shale, dark gray, chippy-splintery, micaceous, trace sandy, trace pyrite.
- 3890'-3900' Shale, dark gray, chippy-splintery, micaceous, trace sandy, trace pyrite.

3900'-3910' Shale, dark gray-black, splintery-platy, micaceous.
Limestone, gray, mudstone, micritic, very argillaceous, tight,
no stain, fluorescence, or cut.

Top Atoka 3910' (-214')

3910'-3920' Sandstone, light gray-white, very fine grain-silty, calcareous,
trace glauconite, 2-5% dark lithic gains, tight-trace poor
visible porosity, no stain, fluorescence, or cut.

3920'-3930' Limestone, light brown, mudstone-wackestone, micritic, shell
fragments, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, blocky, very calcareous in part,
micaceous in part.

3930'-3940' Shale, gray-dark gray, blocky, very calcareous in part, silty
in part, micaceous in part.
Dolomite, buff, microcrystalline, limy, very fine grain
oolites, shell fragments, sandy in part, no visible porosity,
no stain, fluorescence, or cut.

3940'-3950' Limestone, light brown, packstone, very fine grain-coarse
grain, micritic matrix, shell fragments, glauconitic, sandy,
tight, no stain, fluorescence, or cut.
Sandstone, light gray-light brown, very fine grain-coarse grain
with trace subrounded loose quartz granules, very calcareous,
glauconite, no visible porosity, spotty bright gold
fluorescence, no cut, good crush cut, strong ring, very
siliceous in part.

3950'-3960' Sandstone, light gray-light brown, very fine grain-coarse grain
with trace subrounded loose quartz granules, very calcareous,
glauconite, no visible porosity, spotty bright gold
fluorescence, no cut, good crush cut, strong ring, very
siliceous in part.
Limestone, buff-light brown, mudstone-wackestone, micritic,
oolites, shell fragments, sandy in part, tight, no stain,
fluorescence, or cut.

3960'-3970' Limestone, buff-light brown, mudstone-wackestone, micritic,
oolites, shell fragments, very sandy, tight, no stain,
fluorescence, or cut.
Sandstone, clear-light gray, very fine grain-medium grain,
subangular, poorly sorted, very siliceous, calcareous in part,
dark lithic grains, tight-trace poor visible porosity, 20% sand
in sample, 10-20% loose grains, spotty gold fluorescence, pale
cut, weak ring.

- 3970'-3980' Dolomite, gray, microsucrosic, very argillaceous, tight, no stain, fluorescence, or cut.
Limestone, buff-brown, mudstone-wackestone, micritic, very dolomitic in part, oolites, shell fragments, tight, no stain, fluorescence, or cut.
- 3980'-3990' Limestone, buff-light gray, trace light brown, mudstone-wackestone, dolomitic in part, oolites, tight, no stain, fluorescence, or cut.
- 3990'-4000' Limestone, buff-light brown, trace light brown, mudstone-wackestone, dolomitic in part, oolites, tight, no stain, fluorescence, or cut.
- 4000'-4010' Limestone, buff-light brown, trace light brown, mudstone-wackestone, dolomitic in part, oolites, tight, no stain, fluorescence, or cut.
- 4010'-4020' Limestone, buff-light brown, trace light brown, mudstone-wackestone, dolomitic in part, oolites, tight, no stain, fluorescence, or cut.
Sandstone, light gray-white, very fine grain-silty-medium grain, very calcareous, dark gray subrounded lithic fragments in part, carbonaceous laminae in part, no visible porosity, no stain, fluorescence, or cut.
- 4020'-4030' Limestone, buff, sandy texture, micritic matrix, tight, no stain, fluorescence, or cut.
Dolomite, buff, microcrystalline, silty-sandy in part, shell fragments in part, limy in part, no visible porosity, no stain, fluorescence, or cut.
- 4030'-4040' Limestone, buff-light gray, mudstone, micritic, tight, no stain, fluorescence, or cut.
Dolomite, buff, microcrystalline, silty-sandy, tight, no stain, fluorescence, or cut.
Chert, light brown-brown-buff, translucent-opaque.
- 4040'-4050' Limestone, light brown, packstone, very fine grain-fine grain, micritic matrix, dolomitic, oolites, no visible porosity, bright white gold fluorescence, instant streaming cut, fair ring.
Shale, gray-dark gray, platy-blocky, calcareous in part.
- 4050'-4060' Shale, gray-dark gray, platy-blocky, calcareous in part.
Limestone, gray-grayish brown, mudstone, micritic, argillaceous, shell fragments, tight, no stain, fluorescence, or cut.

- 4060'-4070' Limestone, grayish brown-brown, trace gray, mudstone-wackestone, micritic, dolomitic, oolites, shell fragments, no visible porosity, no stain, fluorescence, or cut.
- 4070'-4080' Limestone, grayish brown-brown, trace gray, mudstone-wackestone, micritic, dolomitic, oolites, shell fragments, no visible porosity, no stain, fluorescence, or cut.
Limestone, gray-dark gray, mudstone, micritic, very argillaceous, tight, no stain, fluorescence, or cut.
- 4080'-4090' Limestone, dark gray-grayish brown, mudstone, micritic, very argillaceous in part, tight, no stain, fluorescence, or cut.
- 4090'-4100' Limestone, dark gray-grayish brown, mudstone, micritic, very argillaceous in part, tight, no stain, fluorescence, or cut.
Shale, black, platy, shell fragments in part.
Shale, light grayish brown-dark gray, mudstone, micritic, very argillaceous in part, tight, no stain, fluorescence, or cut.
- 4100'-4110' Dolomite, light gray, microcrystalline, argillaceous, tight, no stain, fluorescence, or cut.
Limestone, tan-light grayish brown, mudstone, micritic, shell fragments, tight, no stain, fluorescence, or cut.
- 4110'-4120' Limestone, tan-light grayish brown, mudstone, micritic, shell fragments, tight, no stain, fluorescence, or cut.
Shale, black, platy.
- 4120'-4130' Shale, black, platy.
Limestone, tan-light grayish brown, mudstone, micritic, shell fragments, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, platy-blocky, very calcareous in part.
Limestone, dark gray, mudstone, micritic, argillaceous, tight, no stain, fluorescence, or cut.
- 4130'-4140' Limestone, dark gray, mudstone, micritic, argillaceous, tight, no stain, fluorescence, or cut.
Shale, dark gray, splintery-blocky, very calcareous in part.
- 4140'-4150' No sample 4140'-4156' lag depth.
Lost circulation at 4156'.

- 4150'-4160' No sample 4140'-4156' lag depth.
Lost circulation at 4156'.
Limestone, gray-dark gray, mudstone, micritic, sandy in part,
very argillaceous, tight, no stain, fluorescence, or cut.
- 4160'-4170' Shale, dark gray-black, splintery-platy.
Dolomite, gray, microcrystalline, very argillaceous, tight, no
stain, fluorescence, or cut.
- 4170'-4180' Dolomite, gray, microcrystalline, very argillaceous, tight, no
stain, fluorescence, or cut.
Limestone, gray-dark gray, mudstone, micritic, sandy in part,
very argillaceous, tight, no stain, fluorescence, or cut.
Shale, dark gray, splintery.

Top Morrow 4184' (-488')

- 4180'-4190' Limestone, gray-dark gray, mudstone, micritic, sandy in part,
very argillaceous, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, splintery-blocky, silty in part,
calcareous in part, trace pyrite.
- 4190'-4200' Shale, dark gray-black, splintery-blocky, silty in part,
calcareous in part, trace pyrite.
- 4200'-4210' Shale, dark gray, splintery-platy, micaceous in part.
- 4210'-4220' Shale, dark gray, splintery-platy, micaceous in part.
- 4220'-4230' Shale, dark gray, very calcareous in part, pyritic in part,
splintery-platy, trace shell fragments, micaceous in part.
- 4230'-4240' Shale, dark gray, very calcareous in part, pyritic in part,
splintery-platy, trace shell fragments, micaceous in part.
Limestone, light brown, mudstone, micritic, glauconite, tight,
no stain, fluorescence, or cut.
- 4240'-4250' Shale, dark gray-black, splintery-platy, waxy in part.
- 4250'-4260' Limestone, brown-light brown, mudstone, micritic, dolomitic in
part, tight, no stain, fluorescence, or cut.
Shale, greenish gray, platy-blocky, waxy in part, very
calcareous in part.

- 4260'-4270' Shale, greenish gray, platy-blocky, waxy in part, very calcareous in part, sandy.
Sandstone, clear, very fine grain-coarse grain, calcareous, 5% sand in sample, 100% loose grains, no stain, fluorescence, or cut.
Limestone, dark brownish gray, mudstone, micritic, sandy in part, tight, no stain, fluorescence, or cut.
- 4270'-4280' Limestone, dark brownish gray, mudstone, micritic, sandy in part, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, splintery-platy.
- 4280'-4290' Shale, dark gray-black, splintery-platy.
Shale, greenish gray-dark greenish gray, splintery-blocky, waxy, sandy in part, pyritic in part.

Top Upper Morrow Sand 4294' (-598')

- 4290'-4300' Shale, greenish gray-dark greenish gray, splintery-blocky, waxy, sandy in part, pyritic in part.
Sandstone, clear-light gray, very fine grain-granules, subangular-subrounded, poorly sorted, very calcareous, siliceous in part, no visible porosity, 20% sand in sample, 20% loose grains, gold fluorescence, slow streaming cut, fair ring.
- 4300'-4310' Sandstone, clear-light gray, very fine grain-granules, subangular-subrounded, poorly sorted, very calcareous, siliceous in part, no visible porosity, 20% sand in sample, 20% loose grains, gold fluorescence, slow streaming cut, fair ring.
- 4310'-4320' Shale, pale greenish gray-dark gray, platy-blocky, trace sandy.

2nd Upper Morrow Sand 4319' (-623')

- 4320'-4330' Sandstone, clear, very fine grain-granules, average grain size increases with depth, subangular-subrounded, moderately-poorly sorted, siliceous, calcareous in part, trace dark gray lithic grains, trace pyrite, tight-fair porosity, 30-50% sand in samples, 50-90% loose grains, pyritic in part, spotty brown oil stain, bright white-gold fluorescence, slow streaming cut, fair ring.
- 4330'-4340' Sandstone, clear, very fine grain-granules, average grain size increases with depth, subangular-subrounded, moderately-poorly sorted, siliceous, calcareous in part, trace dark gray lithic grains, trace pyrite, tight-fair porosity, 30-50% sand in samples, 50-90% loose grains, pyritic in part, spotty brown oil stain, bright white-gold fluorescence, slow streaming cut, fair ring.

- 4340'-4350' Sandstone, clear, very fine grain-granules, average grain size increases with depth, subangular-subrounded, moderately-poorly sorted, siliceous, calcareous in part, trace dark gray lithic grains, trace pyrite, tight-fair porosity, 30-50% sand in samples, 50-90% loose grains, pyritic in part, spotty brown oil stain, bright white-gold fluorescence, slow streaming cut, fair ring.
- 4350'-4360' Shale, dark gray, splintery-platy, sandy in part, trace pyrite.
- 4360'-4370' Shale, dark gray, splintery-platy, very sandy in part.
- 4370'-4380' Shale, dark gray, very calcareous in part, trace pyrite, splintery-platy, very sandy in part.
- 4380'-4390' Shale, dark gray, very calcareous in part, trace pyrite, splintery-platy, very sandy in part.
- 4390'-4400' Shale, dark gray, very calcareous in part, trace pyrite, splintery-platy, very sandy in part.
Limestone, dark gray, mudstone, micritic, argillaceous, tight, no stain, fluorescence, or cut.
Shale, gray-dark gray, splintery-blocky, waxy in part.
- 4400'-4410' Limestone, gray-dark gray, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
- 4410'-4420' Limestone, gray-dark gray, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
Sandstone, light brown-light gray, very fine grain-granules, very calcareous, glauconitic, brown calcareous matrix, trace pyrite, tight, no stain, fluorescence, or cut.
- 4420'-4430' Limestone, gray-dark gray, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
Sandstone, brown-dark gray, very fine grain-fine grain with trace granules, very calcareous, very argillaceous, glauconitic, tight, no stain, fluorescence, or cut.
- 4430'-4440' Shale, black, blocky, waxy.
Shale, greenish gray-gray, platy-blocky, waxy in part.
Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
- 4440'-4450' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
- 4450'-4460' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.

- 4460'-4470' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
- 4470'-4480' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, splintery-blocky, fissile in part.
- 4480'-4490' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
- 4490'-4500' Limestone, gray-dark gray, mudstone, micritic-microcrystalline, very argillaceous, tight, no stain, fluorescence, or cut.
Shale, dark gray-black, splintery-blocky, calcareous in part, fissile in part.
Limestone, brown-dark gray, sandy texture, very fine grain-coarse grain quartz grains, glauconitic, tight, no stain, fluorescence, or cut.
- 4500'-4510' Limestone, brown-dark gray, sandy texture, very fine grain-coarse grain quartz grains, glauconitic, tight, no stain, fluorescence, or cut.
Shale, dark gray, platy-blocky, very sandy, calcareous.
- 4510'-4520' Limestone, brown-dark gray, sandy texture, very fine grain-coarse grain quartz grains, glauconitic, tight, no stain, fluorescence, or cut.
Limestone, gray, mudstone, micritic, very argillaceous, pyritic, tight, no stain, fluorescence, or cut.
- 4520'-4530' Shale, gray-dark gray, splintery-platy, micaceous.
- 4530'-4540' Shale, gray-dark gray, splintery-platy, micaceous.
- 4540'-4550' Shale, gray-dark gray, splintery-blocky, calcareous in part, sandy in part, micaceous in part.
- 4550'-4560' Shale, gray-dark gray, splintery-blocky, calcareous in part, sandy in part, micaceous in part.
Limestone, dark gray, mudstone, micritic, very argillaceous, tight, no stain, fluorescence, or cut.
- 4560'-4570' Shale, trace pyrite, gray-dark gray, splintery-blocky, calcareous in part, sandy in part, micaceous in part.
- 4570'-4580' Shale, gray-dark gray, splintery, very sandy in part.

Top Keyes 4579' (-883')

- 4580'-4590' Sandstone, clear, very fine grain-coarse grain, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace pyrite, 10-20% sand in sample, 60-90% loose grains, tight-trace fair visible porosity, trace light brown oil stain, dull gold fluorescence, pale streaming cut, fair ring.
- 4590'-4600' Sandstone, clear, very fine grain-coarse grain, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace pyrite, 10-20% sand in sample, 60-90% loose grains, tight-trace fair visible porosity, trace light brown oil stain, dull gold fluorescence, pale streaming cut, fair ring.
- 4600'-4610' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace pyrite, 50-70% sand in sample, 90% loose grains, no visible porosity, dark brown oil stain in part, dull gold fluorescence, pale streaming cut, fair ring.
- 4610'-4620' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 50-70% sand in sample, 90% loose grains, no visible porosity, dark brown oil stain in part, dull gold fluorescence, pale streaming cut, fair ring.
- 4620'-4630' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 50-70% loose grains, trace poor visible porosity, light brown oil stain in part, dull gold fluorescence, pale streaming cut, fair ring.
- 4630'-4640' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 50-70% loose grains, no visible porosity, light brown oil stain in part, dull gold fluorescence, pale streaming cut, fair ring.
- 4640'-4650' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 30-50% loose grains, abundant pyrite, tight-fair visible porosity, light brown oil stain in part, dull gold fluorescence, pale streaming cut, fair ring.

4650'-4660' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 60-90% loose grains, abundant pyrite, tight-good visible porosity, light brown oil stain in part, faint gold fluorescence, very pale cut, faint ring.

4660'-4670' Sandstone, clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 60-90% loose grains, abundant pyrite, tight-good visible porosity, light brown oil stain in part, faint gold fluorescence, very pale cut, faint ring.

Top Mississippian 4676' (-980')

4670'-4680' Sandstone; clear, very fine grain-granules, subangular-subrounded, poorly sorted, calcareous in part, siliceous in part, trace glauconite, trace pyrite, 80-90% sand in sample, 60-90% loose grains, abundant pyrite, tight-good visible porosity, light brown oil stain in part, faint gold fluorescence, very pale cut, faint ring.
Shale, mauve-red-pink-pale green, very calcareous in part, silty in part.

4680'-4690' Shale, mauve-red-pink-pale green, very calcareous in part, silty in part.
Siltstone, pink-red, very argillaceous, calcareous, tight, no stain, fluorescence, or cut.

4690'-4700' Siltstone, pink-red, very argillaceous, calcareous, tight, no stain, fluorescence, or cut.
Limestone, mauve, silty texture, micritic matrix, tight, no stain, fluorescence, or cut.

4700'-4710' Siltstone, red-grayish red, calcareous in part, tight, no stain, fluorescence, or cut.

4710'-4720' Siltstone, red-grayish red, calcareous in part, tight, no stain, fluorescence, or cut.
Limestone, gray-maroon, micritic, very silty in part, tight, no stain, fluorescence, or cut.

4720'-4730' Siltstone, red-grayish red, calcareous in part, tight, no stain, fluorescence, or cut.
Limestone, gray-light brown, mudstone, micritic, very silty in part, trace pyrite, tight, no stain, fluorescence, or cut.

Ensign Operating Company, Inc.
#2-20 Boaldin
Page 30

REMARKS AND RECOMMENDATIONS:

Based on drill stem test results from the Atoka and on log and sample analysis from the Keyes and Morrow sands, I recommend that casing be run for production test.

Respectfully submitted,

John D. Pruitt/sln

John D. Pruitt

JDP:sln