

Cuttings Description

Corehole #4

2940' FNL x 2320' FEL  
Sec.3, T6S, R97W  
Garfield County, Colorado

Ground Elev. 8497'  
Kelly Bushing 8507'

## CH #4

From	To	Description
10'	15'	Sandstone, medium brown, 70%, shale, gray, 30%.
15'	20'	Sandstone, medium brown, micaceous, 60%, shale, gray, 40%.
20'	25'	Sandstone, medium brown, micaceous, 100%.
25'	30'	Sandstone, medium brown, micaceous, 100%.
30'	35'	Sandstone, medium brown, micaceous, 40%, shale, gray, 40%, siltstone, medium brown, 20%.
35'	40'	Sandstone, medium brown, 40%, shale, gray, 60%.
40'	45'	Sandstone, medium brown, 60%, shale, gray, 40%.
45'	50'	Sandstone, medium brown, 60%, shale, gray, 30%, siltstone, medium to dark brown, 10%.
50'	55'	Shale, gray, 60%, sandstone, medium brown, 30%, siltstone, grayish brown, 10%.
55'	60'	Shale, gray, 80%, sandstone, medium brown, 20%.
60'	100'	Missing. Missing interval caused by lost circulation.
100'	105'	Sandstone, medium brown, dark inclusions, 60%, shale, gray, 40%. Sample badly contaminated by casing cement.
105'	110'	Sandstone, gray with dark carbonaceous inclusions, 60%, shale, dark gray 40%.
110'	115'	Siltstone, grayish brown, 50%, shale, dark gray, 50%.
115'	120'	Siltstone, gray brown, 70%, marlstone, medium brown, 30%.
120'	125'	Siltstone, dark gray, 100%.
125'	130'	Siltstone, dark gray, dark carbonaceous inclusions, slightly calcareous, 100%.
130'	135'	As above.
135'	140'	As above.
140'	145'	As above.

From	To	Description
145'	150'	As above.
150'	155'	Siltstone, grayish brown, 60%, siltstone, dark gray brown, 40%.
155'	160'	As above.
160'	165'	As above.
165'	170'	As above.
170'	175'	Siltstone, gray, 95%, oil shale, dark brown, platy 5%.
175'	180'	Siltstone, medium gray brown, 85%, oil shale, dark brown, platy, 15%.
180'	185'	As above.
185'	190'	As above.
195'	200'	Siltstone, medium gray brown, 100%.
200'	205'	Siltstone, as above with trace of dark brown oil shale, 100%.
205'	210'	Siltstone, brownish gray, 100%.
210'	215'	Siltstone, medium brown, 100%.
215'	220'	Missing.
220'	225'	Siltstone, medium brown, calcareous, 100%.
225'	230'	Oil shale, dark brown to medium green brown, varved, calcareous, 85%, marlstone, light to medium brown, varved, 15%.
230'	235'	As above.
235'	240'	Siltstone, light greenish brown, 70%, marlstone, light brown to medium brown, 15%, oil shale, dark brown, 15%.
240'	245'	As above.
245'	250'	Siltstone, light brown to medium brown, 50%, marlstone, slightly varved, light brown to medium brown, 40%, oil shale dark brown, 10%.

From	To	Description
250'	255'	Oil shale, dark brown slightly varved, calcareous, 80%, tuff, light brown, 20%.
255'	260'	Siltstone, light to medium brown, 85%, marlstone, light brown, 10%, oil shale, dark brown, 5%.
260'	265'	Siltstone, light gray, 70%, oil shale, dark brown, 30%.
265'	270'	Siltstone, light brown, 90%, marlstone, light brown, slightly varved, 10%.
270'	275'	Siltstone, grayish brown, 100%.
275'	280'	As above.
280'	285'	As above.
285'	290'	Siltstone, light brown, 90%, oil shale, dark brown, 10%.
290'	292'	Siltstone, light brown, 40%, marlstone, light brown to medium brown, varved, 40%, oil shale, dark brown, varved, calcareous, 20%.
1000'	1005'	Oil shale, light brown to medium brown, slightly calcareous, 60%, siltstone, light brown 40%.
1005'	1010'	As above.
1010'	1015'	Missing.
1015'	1020'	Marlstone, light brown, slightly varved, 40%, oil shale, light brown, slightly varved, calcareous, 40%, siltstone, light gray, 20%.
1020'	1025'	Marlstone, dark brown, 50%, siltstone, light brown to gray brown, 50%.
1025'	1030'	Siltstone, light gray brown, 80%, marlstone, light brown, 20%.
1030'	1035'	Marlstone, light brown to medium brown, slightly varved, 60%, siltstone, light brown, 20%, oil shale, medium brown to dark brown, 20%.
1035'	1040'	As above.
1040'	1045'	Marlstone, light green brown to medium brown, slightly varved, 80%, siltstone, light brown, 20%.

From	To	Description
1045'	1050'	As above.
1050'	1055'	Siltstone, light gray, 80%, marlstone, light brown, slightly varved, 20%.
1055'	1060'	Marlstone, light brown to medium brown, slightly varved, 50%, siltstone, light gray, 50%.
1060'	1065'	As above.
1065'	1070'	Siltstone, light gray, 90%, marlstone, light brown, 10%.
1070'	1075'	Siltstone, light gray, 70%, marlstone, light brown, slightly varved, 20%, oil shale, dark brown, 10%.
1075'	1080'	As above.
1080'	1085'	As above.
1085'	1090'	Siltstone, light gray, 80%, marlstone, light brown, 10%, siltstone, very light brown, 10%.
1090'	1095'	Missing.
1095'	1100'	Marlstone, light brown, slightly varved, 60%, oil shale, dark brown, slightly varved, calcareous, 40%.
1100'	1105'	Marlstone, light brown, slightly varved, 60%, oil shale, dark brown, calcareous, 40%.
1105'	1110'	As above.
1110'	1115'	As above.
1115'	1120'	As above.
1120'	1125'	As above.
1125'	1130'	Siltstone, light gray, 40%, marlstone, light brown, 40%, oil shale, dark brown, 20%.
1130'	1135'	Siltstone, light brown, 50%, oil shale, dark brown, 50%.
1135'	1140'	Siltstone, light brown, 60%, oil shale, dark brown, 40%.
1140'	1145'	As above.
1145'	1150'	As above.

From	To	Description
1150'	1155'	Marlstone, light brown, slightly varved, 50%, oil shale, dark brown, calcareous, 50%.
1155'	1160'	As above.
1160'	1165'	Oil shale, dark brown, slightly varved, calcareous, 60%, marlstone, light brown, 40%.
1165'	1170'	Oil shale, dark brown, slightly varved, calcareous, 60%, siltstone, light brown, 20%, marlstone, light brown, 20%.
1170'	1175'	As above.
1175'	1180'	Oil shale, dark brown to medium brown, slightly varved, calcareous, 60%, marlstone, light brown, 40%.
1180'	1185'	As above.
1185'	1190'	Missing.
1190'	1195'	Marlstone, light brown, 50%, siltstone, light gray, 40%, oil shale, dark brown, 10%.
1195'	1200'	Oil shale, dark brown, 40%, siltstone, light gray, 40%, marlstone, light brown, 20%.
1200'	1205'	As above.
1205'	1210'	Oil shale, dark brown, slightly varved, calcareous, 40%, marlstone, light brown, slightly varved, 40%, siltstone, light brown to gray, 20%.
1210'	1215'	As above.
1215'	1220'	As above.
1220'	1225'	Marlstone, light brown, slightly varved, 60%, oil shale, dark brown, slightly varved, calcareous, 20%, siltstone, light brown, 20%.
1225'	1230'	As above.
1230'	1235'	Oil shale, dark brown, slightly varved, calcareous, 60%, marlstone, light brown, 20%, siltstone, light gray, 20%.
1235'	1240'	As above.

From	To	Description
1240'	1245'	As above.
1245'	1250'	Siltstone, light gray, slightly varved, 60%, marlstone, light brown, 20%, oil shale dark brown, 20%.
1250'	1255'	Oil shale, dark brown, slightly varved, calcareous, 40%, marlstone, light brown, 40%, siltstone, light brown, 20%.
1255'	1260'	Oil shale, dark brown to medium brown, 40%, marlstone, light brown, 40%, siltstone, gray, 20%.
1260'	1265'	As above.
1265'	1270'	Siltstone, light gray, 60%, marlstone, light brown, 20%, oil shale, dark brown, 20%.
1270'	1275'	As above.
1275'	1280'	As above.
1280'	1285'	Siltstone, gray, 40%, marlstone, light brown, 40%, oil shale dark brown, 20%.
1285'	1290'	Marlstone, 40%, light brown, oil shale, dark brown, 40%, siltstone, gray, 20%.
1290'	1295'	Siltstone, light gray, 50%, marlstone, brown, 50%.
1295'	1300'	Marlstone, light brown, 60%, oil shale, dark brown, 40%.
1300'	1305'	As above.
1305'	1310'	Marlstone, light green to medium brown, 40%, siltstone, light gray, 40%, oil shale, dark brown, 20%.

Core Description

Corehole #4

360' FSL X 430" FEL  
Sec. 8, T6S, R97W  
Garfield County, Colorado  
Ground Elevation 8412  
Kelly Bushing 8422

Corehole 4

From	To	Description
Core #1	292.0' to 308.1'	Cored 16.1' Recovered 11.7' Recovery 93%
292.0'	294.0'	Siltstone light to medium brown slightly varved, some slight bedding truncation, some collapse structures with hydro carbon stain; occasional top of unit marked by thin white tuff, pyritized
294.0'	297.6'	Oil shale varved medium brown to dark brown, calcareous unit very blebby with distorted bedding; thin irregular bedded tuff with hydrocarbon staining at 294.3.
297.6'	303.6'	Claystone, light brown, slightly varved, slightly calcareous, verticle fractures, with crimson red coating, siderite, 0.2' thick white siltstone (after tuff) at 299.5'
303.6'	308.1'	Missing
Core #2	308.1' to 328.1'	Core 20.0' Recovered 20.0' Recovery 100%
308.1'	309.8'	Marlstone, varved light brown, some slump structures with anhydrite.
309.8'	310.8'	Oil shale, varved dark brown to dark green brown, blebby, calcareous very small segregate crystals of calcite, blebs and irregular, thin beds of tuff.
310.8'	328.1'	Marlstone and siltstone slightly varved light brown; badly fractured vuggy in places, with collapsed solution structured with hydrocarbon stain, also pyrite; some solution structures such as one at 320.5' have an hydrite.
Core #3	Core 328.1' to 351.4'	Cored 23.3' Recovered 22.9' Recovery 98%
328.1'	329.1'	Oil shale, varved brown to light brown calcareous with interbedded greenish gray claystone and gray siltstone 2 beds of tuff at 328.6 less than 1/2" showing some degree of pyritization, vuggy.

Corehole 4

From	To	Description
329.1'	331.8'	Oil shale, dark brown, massive, dolomitic with blebs of pyritic tuff; siderite coating in vugs; oil shale exhibits reddish brown resonous luster.
331.8'	339.1'	Oil shale, varved light brown to dark brown dolomitic, contains inclusions of carbonaceous material to 336.0 ft, occasional blebs of tuff. Tuff; brown to reddish brown 10" thick at 338.3'.
339.1'	351.1'	Marlstone, brown to light brown interbedded siltstone, claystone and oil shale; anhydrite, 1/2 " thick at 240.0' and 342.0'; from 340.6' to 341.6' vertical fractures with brownish anhydrite coating; at 342.4' vuggy zone with white anhydrite coating; from 343.1' to 346.2' vertical fracture; from 346.2' to bottom, core is broken up; at 348 fracture, of gilsonite on fracture surfaces, probably lost .2' in this zone fracture surfaces have a light coating of anhydrite and pyrite.
Core #4	351.1' to 405.3'	Core 54.2' Recovered 53.65' Recovery 99%
351.1'	357.2'	Oil shale, varved light brown to brown exhibits some looped and truncated bedding; at 352.6' large vug containing anhydrite, probably 3 feet missing from this zone at 353 vuggy containing some bladed residual clay structure; at 353.3' large vug 3" in diameter, bladed containing clay with some gilsonite coating; at 354, tuff, unaltered 3/4 "thick, irregularly bedded; on interval 359.0' to 359.6' siltstone, gray with vertical fracturing exhibiting anhydrite on fracture surface; at 356.2' vug 2" in diameter, with very fine residual clay structure, some anhydrite.
357.2'	365.0'	Siltstone, gray with interbedded light brown claystone, calcareous; vertical fracturing exhibits pyrite on fracture surface, finely crystalline; the interval from 461.0' to 461.8' is heavily fractured; from 364.2' to 365.0' gray claystone with minor oil shale banding.

Corehole 4

From	To	Description
365.0'	369.4'	Oil shale, varved light brown to brown, with interbedded siltstone, gray and claystone, gray, calcareous; at 368.7' tuff 3/4" thick, white.
369.4'	373.8'	Oil shale, varved dark brown to light brown, dolomitic with looped and truncated bedding.
373.8'	376.9'	Siltstone, light to dark gray with some vertical fractures, coated with pyrite.
376.9'	379.6'	Siltstone, gray, banded with gray claystone and brownish oil shale, calcareous.
379.6'	388.6'	Oil shale, varved brown to light brown with some interbedded gray siltstone, calcareous; bleb 1"X2" of unaltered tuff at 380.2'; at 380.9 veinlet of anhydrite 1/4" thick, white, very fine crystalline; at 387.3' tuff, brown 1" thick, irregularly bedded.
388.6'	389.7'	Siltstone, pinkish gray with organic fragments.
389.7'	405.3'	Oil shale, varved brown to light brown, dolomitic, with irregularly bedded and blebs of tuff scattered throughout; some of these are anacitized; residual bladed clay structure at 399.0'; from 401.8 to 405.0, heavily fractured, with anhydrite coating on fractured surfaces and trace of gilsonite.
Core #5	405.3 - 419.8'	Cored 14.5 Recovery 12.0' Recovery 83%
405.3'	408.7'	Marlstone, gray to brown, containing interbedded oil shale, claystone, siltstone, from 407.0' to 408.7', vertical fracture coated with gilsonite and calcite; the interval 408.4 to 408.7 is vuggy.
408.7'	409.6'	Heavily broken zone, with residual bladed clay structure showing crystals of calcite.

## Corehole 4

From	To	Description
409.6'	412.1'	Siltstone, gray with some dark gray claystone banding, calcareous; vug at 411, with bladed clay structure and nahcolite.
412.1'	417.3'	Heavily broken zone, consisting of gray to light brown marlstone; at 415.2 vertical fracture coated with pyrite; oil shale on interval 415.2-417.2' with some interbedded siltstone.
417.3'	419.8'	Missing.
Core #6	419.3' - 439.45'	Cored 19.65' Recovered 19.65' Recovery 100%
419.8'	423.2'	Interbedded gray claystone, gray siltstone with some brown oil shale, dolomitic, irregularly bedded, flow structure; at 422.8' vug with residual bladed clay structure.
423.2'	424.9'	Oil shale, dark brown, massive, dolomitic with occasional blebs of tuff.
424.9'	425.3'	Siltstone, dark brown, irregularly bedded.
425.3'	427.0'	Oil shale, dark brown, dolomitic, massive, with blebs of tuff; on interval 426.3 to 426.7 vugs containing free hydrocarbon and anhydrite
427.0'	427.4'	Tuff, dark brown, irregularly bedded, contains trace of gilsonite, minor vugs containing free hydrocarbon, collapse structures.
427.4'	429.3'	Oil shale, medium brown, calcareous, collapse structures and breccia common, vugs and cavity at 429.4'.
429.3'	430.4'	Siltstone, light brown, slightly varved, calcareous.
430.4'	439.45'	Oil shale, medium brown to dark brown, calcareous vuggy; solution structures and collapse structures with gilsonite, calcite around cavities; irregular bedded tuffs at 431.0, 431.4', 431.8', 432.2' 438.3'

Corehole 4

From	To	Description
Core #7	Core 439.45' to 462.7'	Cored 23.25 Recovered 19.8' Recovery 85%
439.45'	445.5'	Oil shale, dark brown to medium brown, calcareous, varved to massive, unit badly broken and fractured; vugs and solution cavities common; tuff, 0.3" thick, with hydrocarbon stain at 441.1'; irregular bedded tuffs, at 443.2', 444.0', 444.2', 444.9'.
445.5'	448.4'	Oil shale, dark green brown to black, calcareous, blebby with light brown claystone, relatively low density.
448.4'	456.0'	Oil shale, varved light to medium brown, varved to dark brown, calcareous; thin irregular beds of analcitized tuff rare; looped and truncated bedding in most of unit.
456.0'	456.9'	Marlstone, dark green brown, carbonaceous frag. calcareous, badly broken and fractured.
456.9'	459.3'	Oil shale, varved medium to dark brown, calcareous, some loop and truncated bedding; unit badly broken.
459.3'	462.7'	Missing.
Core #8	Core 462.7' to 495.7'	Cored 33.0' Recovered 19.35' Recovery 59%
462.7'	465.8'	Oil shale, varved light to dark brown, calcareous blebs of claystone common, looped and truncated bedding very common; vertical fracture running entire length of unit.
465.8'	474.8'	Oil shale, varved dark brown to black, with occasional lighter zones, calcareous, with thin bedded tuff at 471.25, some looped and truncated bedding.
474.8'	482.0'	Oil shale, medium to dark brown, some zones very vuggy, most of unit is badly broken with orientation difficult to ascertain; calcite mineralization around collapse structure; irregular bedded thin tuff at 477.4'.

Corehole 4

From	To	Description
482.0'	495.7'	Missing.
Core #9	Core 495.7' to 510.0'	Core 14.3' Recovered 13.6' Recovery 95%
495.7'	500.4'	Oil shale, varved medium to dark brown, calcareous, unit badly fractured, looped and truncated structures; tuffs, thin, irregularly bedded, rare toward bottom of unit.
500.4'	501.0'	Oil shale, brown, numerous small vugs (has pumice like texture), badly broken - rubble.
501.0'	501.7'	Missing.
501.7'	505.5'	Oil shale, varved light to medium brown, calcareous, looped and truncated bedding; unit badly broken; thin streaks of tuffs rare; collapse structure at 503.3'
505.5'	510.0'	Oil shale, varved dark brown to black, calcareous, unit more competent than above core; possibly coming out of "leached zone"; irregular bedded tuff of unknown thickness at very bottom of unit.
Core #10	510.0' to 569.0'	Core 59.0' Recovered 59.0' Recovery 100%
510.0'	513.7'	Oil shale, massive, dark brown, calcareous to 513.7 after which it becomes varved light brown to brown and dolomitic, from 510.0' to 510.1' tuff partially altered, white to light brown.
513.7'	514.8'	Oil shale, varved light brown to dark brown, looped and truncated bedding, dolomitic at 514.2 irregularly bedded tuff 1.4' thick with heavy hydrocarbons; pinches out.
514.8'	520.7'	Oil shale, varved brown to dark brown, calcareous interbedded with lean oil shale, light brown to brown, with minor amounts of interbedded siltstone at 519.9 tuff, irregularly bedded, anacitized; at 520.7, fractured zone, probably 1/8" wide secondary finely crystalline calcite, hydrocarbon staining.

Corehole 4

From	To	Description
520.7'	525.2'	Oil shale, brown to dark brown, massive, calcareous, occasional varving within interval.
525.2'	527.1'	Oil shale, varved brown to dark brown, calcareous; occasional blebs of anacitized tuff.
527.1'	543.5'	Oil shale, varved brown to dark brown, calcareous; on interval 528 to 530.5, interbedded siltstones 1/4" thick occasionally exhibits looped and truncated structure; at 533.2 and 533.5, 533.2 tuff 2" thick, brown to light brown hydrocarbon staining; at 536.0 bleb, 1/2" x 1", of anacitized tuff; at 543.4 discontinous bed of tuff 1/2" thick, brown to light brown, hydrocarbon stained.
543.5'	545.0'	Oil shale, varved dark brown to black, calcareous.
545.0'	558.0'	Oil shale, varved brown to dark brown, calcareous; at 546.2, tuff, white to brown, irregular bedded with hydrocarbon staining; at 550.0' tuff, white to brown with secondary calcite and hydrocarbon saturation; at 550.8', tuff, 1/4" thick, light blue to white, analcitized; at 552.2, tuff, white to brown, heavy hydrocarbon saturation; at 556.2, tuff, discontinously bedded, saturated with heavy hydrocarbons.
558.0'	558.9'	Oil shale, dark brown to black, calcareous with very fine crystals of calcite.
558.9'	563.5'	Oil shale, brown to dark brown, calcareous, looped and truncated bedding.
563.5'	564.3'	Oil shale, varved very dark brown to black, calcareous; at 563.5', tuff, brown, 1/8" thick.
564.3'	568.8'	Oil shale, varved light brown to dark brown with small stringers of gray claystone.
568.8'	569.0'	Siltstone with small interbeded claystone, gray to light brown.

Corehole 4

From	To	Description
Core #11	569.0 - 628.8'	Cored 59.8' Recovered 59.8' Recovery 100%
569.0'	585.2'	Oil shale, varved brown to dark brown, calcareous with some interbedded light gray claystone, very finely crystalline calcite throughout; At 569.2, tuff, brown to light blue and white, partially anacitized 1/2" thick; at 569.4, tuff 1/4" thick, white to light brown; at 570.2' tuff, 1 1/8" thick, brown to white, at 570.9, tuff 1/4" thick, light brown; at 516.8, vertical fracture, coated with gilsonite and fine crystalline siderite; at 578.8, tuff, 1/4" thick, white to gray anacitized; at 578.4, tuff, vuggy, irregularly bedded, saturated with hydrocarbon, tuff, small stringers less than 1/8" thick occasional throughout interval.
585.2'	587.5'	Oil shale, varved light brown to brownish gray, calcareous to dolomitic; small interbedded siltstones from 586.7 to 587.5'
587.5'	589.4'	Oil shale, varved brown to dark brown, calcareous looped and truncated bedding with occasional blebs of brownish tuff, also occasional small regularly bedded brownish tuff, approximately 1/8" thick.
589.4'	595.4'	Oil shale, varved brown to dark brown calcareous, with occasional carbonaceous inclusions, some very small blebs of gray claystone throughout; at 541.0, tuff 2" thick light brown to blue gray anacitized bottom contact irregular, 2" vuggy appearance; occasional blebs of tuff, gray to blue gray, anacitized.
595.4'	596.0'	Oil shale, varved brown to dark brown varved, calcareous with looped bedding.
596.6'	598.3'	Oil shale, varved brown to light brown, with some interbedded gray claystone, occasional carbonaceous inclusions

## Corehole 4

From	To	Description
598.3'	602.4'	Oil shale, varved brown to light brown occasionally massive, interbedded with some 1/4" gray siltstone 1/4" thick.
602.4'	604.2'	Oil shale, varved brown to dark brown, calcareous with looped and truncated bedding; heavy banding in interval 602.4-603.1' due to black oil shale.
604.2'	607.7'	Marlstone, varved light brown to gray, dolomitic with interbedded small siltstones 1/4" thick.
607.7'	610.1'	Oil shale, varved to dark brown exhibits truncated bedding, at 608.4', tuff 1" thick white to light brown irregularly bedded some hydrocarbon saturation.
610.1'	615.4'	Oil shale varved light brown to brown, calcareous with some interbedded gray claystones.
615.4'	619.0'	Oil shale, varved brown to dark brown, calcareous at 615.9, tuff, 1/2" thick, light brown irregularly bedded, vuggy at 616.4, tuff 1/2" thick, light brown irregularly and discontinuously bedded at 615.6' tuff, steel gray irregularly bedded anacitized, minor vugs.
619.0'	622.8'	Oil shale, varved light brown to brown, calcareous at 619.8, tuff, 2" thick, gray, irregularly bedded, anacitized. at 619.5', tuff, 3/4" thick steel gray, irregularly bedded anacitized.. At 620.3' tuff, 1" thick gray, irregularly bedded, analcitized vuggy, less than 1 " at 620.6' tuff, 2 " thick brown, irregularly bedded, vuggy, at 620.8' tuff, 1/2" thick steel gray, irregularly bedded, analcitized.
622.8'	625.1'	Oil shale, varved brown to dark brown, calcareous occasional looped and truncated bedding; at 624.6' tuff, 1/2" thick light brown, irregularly bedded, vuggy, at 624.8', tuff 2" thick light brown irregular bedded with inclusions of oil shale, vuggy.
625.1'	627.5'	Oil shale varved, light brown to brown, calcareous, exhibits some looped and truncated bedding, calcareous.

Corehole 4

From	To	Description
627.5'	628.8'	Marlstone, gray to light gray very finely crystalline with some interbedded gray claystones.
Core #12	628.8' 668.0'	Cored 59.2' Recovered 59.2' Recovery 100%
628.8'	633.5'	Oil shale, varved dark brown, calcareous, reddish brown, resinous luster, irregularly bedded thin tuffs at 629.5, 629.9, and 631.6' contorted as well as looped and truncated bedding, very dark zone from 629.1' - 629.4'
633.5'	642.9'	Oil shale, varved medium brown to medium green brown, some loop and truncated bedding tuffs thin to 0.4' at 633.5, 633.7', 635.5' 635.7', 635.9', 636.3' 636.4' 636.6' 639.3' 639.7', 642.3', all with hydrocarbon stain.
642.9'	644.9'	Oil shale, varved dark brown, calcareous, reddish resinous luster looped, contorted bedding near bottom of unit streaks of tuff at 644.2', blebby tuffs at 644.5-644.6'.
644.9'	647.5'	Oil shale, varved medium brown to green brown calcareous, upper part of unit has zones of irregular blebby bedded tuffs saturated with hydrocarbon, tuff zones are at 644.9-645.2' 645.3-645.5, 645.7'-646.25'.
647.5'	666.6'	Oil shale, slightly varved medium green brown to dark brown, calcareous, darker zones have more resinous type lustre; tuffs, irregularly bedded at 651.9, 654.1'. 654.5' 656.0', 658.5, 660.4', 660.6 and 664.3, thickness of tuffs range from 1/4" to 2 1/2" thick.
66.6'	668.0'	Oil shale, varved light to medium brown calcareous truncation of bedding rare irregular bedded tuffs at 666.7 and 667.6.
668.0'	669.5'	Oil shale, lean light brown calcareous, interbedded with light brown siltstone and marlstone.
669.5'	678.6'	Oil shale, varved medium to dark brown, calcareous, truncated bedding with rarer loop bedding thin irregular bedded tuffs at 673.3 677.0, 678.4 and 678.5 very thin dolomitic zone at 675.9.

Corehole 4

From	To	Description
678.6'	680.3'	Tuff, pink partially analcitized with interbedded varved, green brown oil shale, zone of oil shale from 679.1' - 679.5 is with truncated bedding, traces of bleeding hydrocarbon.
680.2'	688.0'	Oil shale, varved dark green brown, calcareous, reddish resinous lustre loop and truncated bedding common rare streaks and blebs of analcitized tuffs.
Core #13	Core 688.0 to 747.0	Cored 59.0 Recovered 51.4' Recovery 88%
688.0'	694.9'	Oil shale, slightly varved, dark brown to black, calcareous, reddish resinous lustre.
694.9'	703.3	Oil shale, varved light brown to medium brown, dolomitic looped and truncated bedding, thin irregularly bedded analcitized tuff at 700.9.
703.3'	706.05'	Oil shale, varved medium green brown, to dark brown, calcareous reddish resinous luster, looped truncated bedding.
706.05'	709.1'	Oil shale, varved light brown to medium brown, banded toward top of unit, calcareous, looped and truncated bedding structures common.
709.1'	710.6'	Oil shale, varved dark green brown, calcareous looped and truncated bedding structures, dark reddish resinous lustre.
710.6'	721.6'	Oil shale, varved light brown to medium green brown, rarer to dark brown, calcareous, irregularly bedded tuffs at 717.4, 718.2 and 719.8' looped and truncated bedding common.
721.6'	728.0'	Siltstone, light brown, interbedded with lean oil shale; light brown slightly varved; oil shale in calcareous siltstone only slightly disrupture bedding at 724.3' solution, cavity with clay at 724.5'.
728.0'	731.1'	Siltstone, slightly varved light brown, badly broken ("A" Groove).
731.1'	734.4'	Oil shale, varved dark brown to black, dolomitic some loop and truncated bedding.

Corehole 4

From	To	Description
734.4'	738.8'	Oil shale, varved light brown to darker greenish brown, dolomitic, looped and truncated bedding common irregular bedded tuffs at 735.1', 735.6', 737.15', 737.4', 737.6' and 738.35, tuff at 738.35 is 2 1/2" thick, tuffs in this unit have hydrocarbon stain.
738.8'	739.05'	Tuff, medium brown to light pinkish brown, with irregular contacts.
739.05'	739.4'	Oil shale, varved medium green brown to dark green brown.
739.4'	747.0'	Missing.
Core #14	Core 747.0 - 799.0'	Cored 52.0' Recovered 55.5' Recovered 100%
744.0'	747.0'	Broken and crushed zone recovered from previous core, Oil shale, varved brown to very dark brown and black, calcareous with some very small irregularly bedded tuffs, steel gray analcitized, pyritized at 746 a tuff 1/2" thick, gray pyritic discontinuously bedded.
747.0'	749.8'	Oil shale, varved brown to light brown, with occasionally interbedded 1/2" thick gray siltstone at 749.5' tuff, 1/4" thick white to light blue irregular and discontinuously bedded microfaulted.
749.8'	750.0'	Tuff, white to light blue gray and light brown irregularly bedded, vuggy analcitized, saturated with hydrocarbon; vugs contain both hydrocarbon and calcite. (Mahogany Marker)
750.0'	753.3'	Oil shale, varved light brown to brown, calcareous with occasional interbedded siltstone 1/2" thick, gray at 753.0' tuff 1" thick, white to blue, analcitized, vuggy hydrocarbon and calcite in vugs.
753.3'	754.2'	Oil shale, varved dark brown to brown, dolomitic
754.2'	757.1'	Oil shale, varved brown to light brown, calcareous exhibits minor amount of looped and truncated bedding; some interbedded gray siltstone, 3/4" thick in interval 756.0' to 757.0' at 755.3 tuff, light brown, irregular and discontinuously bedded.

Corehole 4

From	To	Description
757.1'	758.0'	Oil shale, varved brown to dark brown, calcareous exhibitites looped and truncated bedding at 757.9 tuff 1 1/2" thick light brown irregularly bedded, vuggy with some oil shale inclusions.
758.0'	758.9'	Oil shale, varved brown to dark brown, dolomitic exhibits looped bedding.
758.9'	767.1'	Oil shale, varved brown to dark brown, calcareous looped and truncated bedding very pronounced; fractured at 30° to vertical filled with medium crystalline white to clear nahcolite interbedded siltstones at 766.8 tuff 1 1/2" thick white to gray partially analcitized with hydrocarbon saturation.
767.1'	769.9'	Oil shale, varved brown to light brown calcareous occasional looped bedding structure.
769.9'	770.9'	Oil shale, varved brown to dark brown, calcareous looped and truncated bedding common.
770.9'	773.9'	Oil shale, varved light brown to brown, calcareous with some interbedded siltstones 1/2" thick, gray at 773.0, occasional looped bedding.
773.9'	774.9'	Oil shale, varved brown to dark brown, dolomitic with looped and truncated bedding.
774.9'	777.4'	Oil shale, varved light brown to dark brown dolomitic, blebs of pyritized tuff occasional looped and truncated bedding occasional at 775.5 2 tuff, 1/4" thick and 1/2" thick, white to gray analcitized separated by 1/2" oil shale, irregularly bedded.
777.4'	783.4'	Oil shale, varved light brown to brown, calcareous locally hydrocarbon banding due to brown very dark oil shale, vertical fracture from 777.4 to 778.6.
783.4'	784.7'	Nahcolite, very coarsely crystalline, clear, to brown, light blue earthy luster on oil shale inclusions, blade like boxwork structure.
784.7'	789.1'	Interbedded, brown to light brown oil shales and gray siltstones calcareous from 784.6 to 785.0' tuff, 1 1/2" thick white to light brown irregularly bedded partially analcitized, saturated with hydrocarbons.

Corehole 4

From	To	Description
789.1'	796.5'	Oil shale, varved brown to light brown, calcareous with locally heavy banding due to brown very dark brown oil shale, occasionally looped and truncated bedding.
796.9'	799.1'	Oil shale, varved light brown to brown, calcareous.
Core #15	799.0' to 858.0'	Cored 69.1' Recovered 59.1' Recovery 100%
799.0'	801.0'	Oil shale, light brown, massive, calcareous minor varving locally within interval, from 799.6 to 799.8' vuggy zone containing nahcolite white to clear, vugs max size 1/8" X 1/2" from 800.4 to 800.8 2 beds of tuff both are gray irregularly bedded, vuggy, anacitized and pyritized.
801.0'	804.1'	Oil shale varved light brown to brown with calcareous interbedded gray to light brown siltstone,
804.1'	810.3'	Oil shale, varved brown to light brown, varved upper half of interval is dolomitic lower half is calcareous, with some locally banding due to brown to very dark brown varved oil shale, occasional looped and truncated bedding, at 804.2 tuff, 1/8" thick, blue to gray, anacitized pyritic at 805.9' tuff 1/4" thick blue to gray anacitized pyritic at 806.5 tuff 2" thick gray to blueish gray anacitized and pyritic between 806.7 and 806.9, 3 beds of altered tuff discontinuously bedded.
810.3	811.5	Oil shale, varved light brown to brown dolomitic with some interbedded gray siltstones and blebs of pyritic tuff; minor amounts of loop bedding.
811.5	812.5	Oil shale, varved light brown to brown, varved, calcareous, looped and truncated bedding very prevalent at 811.7, Tuff, 1/8" thick, gray to blue gray, pyritic & altered; at 811.8 tuff 1/2" thick light brown, unaltered, light brown regularly bedded, scattered tuffs 1/8" thick or less in rest of interval.
812.5	813.4	Oil shale, varved brown th dark brown, dolomitic occasional thin tuffs.

Corehole 4

From	To	Description
813.4	815.1	Oil shale, varved light brown to brown, calcareous occasional thin tuffs.
815.1	816.4	Marlstone, varved light brown to gray, with interbedded gray siltstone; at 815.8, tuff 1/2" thick gray, wavy bedded, analcitized.
816.4	818.2	Oil shale, varved dark brown to brown, calcareous with some looped and truncated bedding calcareous at 814.4, tuff 1 1/2" thick dark brown, vuggy irregularly bedded some hydrocarbon saturation.
818.2	821.2	Tuff, irregularly bedded, showing flow structure intermingled with light brown to dark brown oil shale, inclusions, pyritic and analcitized, some hydrocarbon saturation.
821.2	825.0	Oil shale, varved light brown to brown, calcareous with occasional siltstone, occasional loop bedding; at 821.5 tuff, gray to light brown, irregularly bedded, pyritic; at 821.8 tuff, 1/2" thick gray to light brown pyritic.
825.0	828.9	Oil shale, varved light brown to brown, with some interbedded gray siltstones, minor amount of loop bedding; some gray blebs shown with finely chrystalline pyrite.
828.9	835.1	Interbedded sequence of brown to light brown, calcareous, oil shale and gray siltstone; at 833.5, tuff, 1/2" thick gray to blue gray, regularly bedded analcitized and pyritic; at 832.4, tuff, 1/2" thick, bluish gray, irregularly bedded.
835.1	836.1	Marlstone, light gray to gray, with interbedded gray siltstones occasional pyritic bleb
836.1	842.0	Siltstone, gray massive, with some interbedded gray to light gray marlstones calcareous, containing vuggy zones. ("B" Groove)
842.0	844.5	Vuggy zone, consisting of gray to light gray marlstone with some interbedded gray clay stone and siltstone, entire zone is partially pyritic and dolomitic to calcareous with some calcite in vugs both the upper and lower

## Corehole 4

From	To	Description
842.0	844.5 (Con't)	contact are irregular; at 844.4 irregularly bedded vuggy zone with pyritic on contacts and separated from the zone above.
844.5	849.9	Interbedded gray to dark gray and light brown marlstones, dolomitic, and gray siltstone, pyritic blebs or common throughout, discontinuous and irregularly bedded zones of pyritic material also common; from at 846.0 to 846.1 pyritic zone, irregular, vuggy, at 849.9 solution breccia, calcareous, contains appreciable amount of pyrite.
849.9	853.0	Oil shale, varved brown to dark brown, varved, some disturbed bedding, from at 849.9 to 850.1, solution breccia, composed of marlstone, occasional blebs of tuff and pyritic material. At 850.7' solution breccia marlstone vuggy, vugs coated with gilsonite.
853.0'	855.4'	Marlstone, varved light gray to light brown calcareous with occasional blebs of pyritic material.
855.4'	857.0'	Oil shale, varved brown to dark brown, calcareous looped bedding common at 855.5 tuff 2" thick, bluish gray, irregularly bedded analcitized.
857.0'	858.1'	Marlstone, gray to light brown, calcareous interbedded with some siltstone 1" thick at 858.0 tuff, gray to blue gray, analcitized vuggy; blebs of pyritic material common.
Core #16 858.1' 913.3 Cored 59.0 Recovered 55.2' Recovery 94%		
Lost Bottom 3.7 feet of core- fell back into hole during trip out.		
858.1'	861.4'	Marlstone, varved gray to light brown, calcareous with occasional interbedded siltstone at 859.1 tuff, 1/4" thick pyritic tuff less than 1/4 occasional blebs of pyritic tuff throughout at 859.1 siltstone, 2" thick light gray with band of pyritic material through middle speckled with pyritic material regular contact.

## Corehole 4

From	To	Description
861.4'	867.6'	Marlstone varved light gray to light brown calcareous with interbedded lean oil shale and gray siltstone, blebs and streaks of pyritic material parallel to bedding at 862.7' tuff 2" thick gray, anacitized and pyritic, upper contact regular, lower contact irregular at 865.0' tuff 1/2" thick gray, pyritic discontinuously bedded
867.6'	869.7'	Oil shale, varved brown to dark brown, calcareous, at 868.9' tuff 1/4" thick gray irregular bedded, pyritic oil shale shows disturbed bedding around tuff.
869.2'	872.4'	Marlstone, gray to light brown, dolomitic with interbedded gray siltstones and light brown oil shale. Oil shale predominant on interval, 870.7 to 872.4' pyritic blebs common throughout; at 871.4' tuff 1/2" thick light brown, regularly bedded.
872.4'	874.7'	Siltstone, gray with interbedded lean oil shale, varved light brown to brown, calcareous, pyritic streaks and blebs common.
874.7'	876.2'	Oil shale, varved brown to dark brown, dolomitic in upper half, calcareous in lower half, looped bedding in lower 1/2; at 875.3' tuff 2 1/2" thick gray to blue gray, pyritic and anacitized lower contact irregular.
876.2'	878.7'	Marlstone, varved light gray to light brown, calcareous pyritic streaks common through out some interbedded gray siltstones and light brown oil shale, at 877.5' tuff 1/4" thick blue gray to gray anacitized pyritic.
878.7'	880.3'	Oil shale, varved brown to dark brown, calcareous blebs of tuff, altered and unaltered, common some microfracturing at 878.7'.
880.3'	881.2'	Marlstone, gray to light brown with minor amounts of brown to dark brown oil shale dolomitic.

## Corehole 4

From	To	Description
881.2'	882.0'	Oil shale, varved light brown to dark brown, varved predominately dolomitic, locally calcareous, looped and truncated bedding are uncommon; at 882.0 tuff 3/4" thick gray to blue gray, anacitized and pyritic, irregularly bedded.
882.0'	883.9'	Marlstone, light brown to light gray, dolomitic vertical gratured from 882.6' to 883.0', minor amounts of residual hydrocarbon coating on fracture surface; at 883.1' tuff 1/2" thick gray to blue gray, anacitized.
883.9'	888.3'	Oil shale, varved brown to dark brown, local banding due to very dark brown, black oilshale, blebs of tuff occasional, streaks of altered tuff, less than or equal to 1/4" thick occasional at 886.1' disturbed bedding around inclusion of tuff 1 1/2" thick gray, pyritic showing flow structure and slumpage some occasional microstructure evident.
888.3'	892.2'	Oil shale varved brown to light brown, with dolomitic interbedded gray claystone, heavy microstructure in lower 2 feet showing, microfolding and faulting some interbedded siltstones around 890.1' very small beds of altered tuff, occasional throughout.
892.2'	896.8'	Marlstone, varved light gray to light brown, dolomitic with interbedded gray claystones and some gray siltstones; fractured (vertical) 892.2 to 893.0, coated with hydrocarbon residue and pyrite microstructure common due to slumpage; minor amounts of brown oil shale interval.
896.8'	898.1'	Oil shale, varved dark brown to light brown, dolomitic slumpage structure on interval from 897.0 to 898.0 occasional truncated bedding.
898.1'	899.2'	Marlstone and Oil shale, varved gray to light brown and brown, dolomitic occasional microfaulting and looped bedding.

Corehole 4

From	To	Description
899.2'	899.7'	Oil shale, varved brown to very dark brown dolomitic, looped bedding.
899.7'	906.5'	Siltstone, Marlstone and occasional oil shale (lean) gray to light brown, upper 1 1/2 feet sequence of interbedded oil shale and siltstone, oil shale siltstone sequence streaks and blebs of pyrite material common, lower part of unit 901-906.5 predominantly siltstone with some marlstone, dolomitic.
906.5'	908.7'	Oil shale, varved brown to dark brown, dolomitic, locally calcareous at 908.0 tuff 1 1/2" thick blue gray, analcitized at 908.2 tuff blue gray, analcitized, irregularly bedded; gray siltstone, and interbedded marlstone, on interval 907.6 to 908.0.
908.7'	913.3'	Siltstone, gray with some interbedded gray to light gray marlstone and light brown lean oil shales flow structure evident in some marlstones at 908.9 tuff, white to light brown vuggy, whitish material parbably anhydrite sugury texture.
913.3'	917.0'	Missing (fell out of barrel)
Core #17 917.0'	941.0	Cored 27.7 Recovered 0.0 Recovery 0%
917.0'	941.0'	Missing.

End of Core