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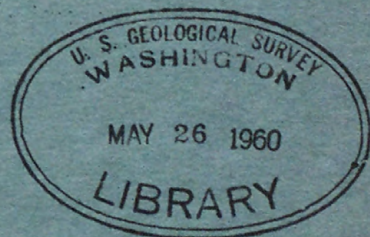
U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska



Report No. 18

STRATIGRAPHY AND STRUCTURE OF THE AREA OF THE
UTUKOK RIVER WITH NOTES ON THE CORWIN-CAPE BEAUFORT REGION, ALASKA

1948

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Report No. 13

STRATIGRAPHY AND STRUCTURE OF THE AREA OF THE
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By

W. I. Barksdale

and

R. M. Thompson

1948

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STRATIGRAPHY AND STRUCTURE OF THE AREA OF THE
UTUKOK RIVER WITH NOTES ON THE CORWIN-CAPE BEAUFORT REGION, ALASKA

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INTRODUCTION

U. S. Geological Survey Party No. 3 studied the geology of the Utukok River area from its headwaters in the DeLong Mountains to its mouth and conducted a short reconnaissance of the Corwin-Cape Beaufort region during the period May 12 to August 31, 1947. The upper part of the river was examined for several miles on either side, while the lower, or coastal plain portion, was necessarily limited to the few outcrops along the river. This report is a compilation of the field data and the results of office and laboratory work on rock specimens, fossils, and aerial photographs.

During the study, the major emphasis was placed upon the petroleum possibilities of Upper Cretaceous rocks. All macrofossils found, and samples for porosity, heavy mineral, and microfossil determinations were collected.

Nine sections of Upper Cretaceous rocks were measured by plane table and by Brunton compass between Meat Mountain and Klusive Creek (See map, fig. 2). A detailed description of these sections is given in Appendix A. The geology was plotted on photographs in the field where adequate coverage was available. The 1:500,000-scale map (Fig. 1) was prepared in the fall, since no accurate, more detailed map of the area was available. During the winter months the geology was replotted on a new base of 1:96,000 prepared by the Geological Survey from trimetrogon photographs taken in 1947 (See Fig. 2).

A triangulation net was established by theodolite from Camp 1 to the mouth of Carbon Creek. The Survey started and ended on measured base lines, and stations were selected, insofar as possible, on points that could be pin-pricked on aerial photographs. Vertical differences were computed from an elevation of 2,000 at Camp 1 based upon two different airplane altimeter readings.

Most of the country is too rough for landing with a plane on wheels, with the exception of the large gravel bars in the river between Camp 6 and the coast. Pontoon landings with a Cub plane can be made at most places along the river.

Driftwood, Adventure, Disappointment, Carbon, and Elusive Creeks are the main tributaries of the Utukok. At several localities, terrace gravels are common on divides of these streams. There appears to be several terrace levels. At Camp 1 a gravel-capped dissected bench lies 50-60 feet above the present channel; an older one lies about 200 feet above the river. The gravel appears identical with that in the present river channel. A high terrace north of Driftwood Creek and about 10 miles east of Camp No. 2 is covered with a deposit of gravel 30 feet or more thick and is spread over an irregular area about $1\frac{1}{2}$ miles in a north-south direction and one mile in an east-west direction. A tundra cover, believed to be thin, obscures an area to the east which is probably a much larger continuation of the gravel deposit. With favorable conditions plane landings could be made, and it is believed that with relatively little work a commercial-size airfield could be constructed.

STRATIGRAPHY

Mississippian

Very little time was available for studying the rocks of this age. Just north of the divide of the DeLong Mountains is about 500-750 feet of blue gray, cherty, coarsely crystalline, crinoidal limestone of the Lisburne formation. Sandstones and conglomerates of the older Noatak formation are well exposed in the area. This formation was only noted near its contact with the limestone. It is believed, however, that it is much thicker than the Lisburne formation. The limestone forms a prominent light-colored trace on the aerial photographs. The darker-colored Noatak formation weathers into conical hills much like those formed by the Triassic cherts near the mountain front.

Triassic-Lower Cretaceous (?)

North of the Lisburne limestone and extending a distance of about six miles to the chert which is well exposed in prominent outcrops at Camp 1 is a complexly folded and faulted area mapped as the Triassic-Lower Cretaceous complex zone. These rocks consist of steeply dipping, dark gray sandstones, black shale, and varicolored cherts.

At Camp 1 a chert bed approximately 200 feet thick has been mapped as the top of the Triassic, because it marks the uppermost observed occurrence of Triassic fossils and because there is a lithologic break. The change is from a section of black shale, dark sandstones and chert to an overlying thick section of greenish-gray sandstones, conglomerates, and shales. The chert is dominantly dark bluish-gray on a fresh surface, weathering to light yellow-brown, tan and light yellow-red. The chert contains abundant pelecypods of which the predominant form is Monotis subcircularis.

Although the chert is mainly massive, there are partings of oil shale which occur sporadically. Concretionary nodules of black chert in a thin zone within the chert have a pronounced petroleum odor on a fresh surface.

Underlying the chert bed at Camp 1 is several thousand feet of dark gray, medium to coarse-grained, argillaceous sandstone interbedded in about equal amounts with black shale. The section was mapped as Triassic-Lower Cretaceous and differs from the basal Lower Cretaceous in color, presence of black shale, and the absence of conglomerate. Beneath this sequence several ridge-forming chert beds of Triassic age crop out to the south and may or may not be correlative with each other. The age of this sandstone and black shale sequence which is tightly enfolded with the known Triassic is undetermined and, although mapped as part of the Triassic-Lower Cretaceous sequence, may be in part Jurassic.

Lower Cretaceous

Two units of Lower Cretaceous rocks were recognized on the Utukok, a lower greenish member and an upper black shale. The lower member, overlying the chert bed at Camp 1, is estimated to be about 5,000 feet thick, although no measurements were made. This unit has been mapped as the greenish member and consists of gray-green and gray sandstones, conglomerates, and shales. The sandstones are coarse to fine-grained, very argillaceous, and generally at low porosity. Four samples, which are Ba 2, 5, 6, and 8, gave porosities of 13.9, 7.5, 10.6, and 12.9, respectively. In the lower half of the formation several very coarse-grained sandstones and conglomerates are present. In the upper half there is an absence of conglomerate, and the sandstones are finer grained. There appears to be an equal amount of sandstone and shale. Most of the shales in the unit contain an abundance of finely-divided colorless mica. Quartz crystals up to one inch in length occur with calcite crystals along some of the sandstone-shale contacts.

The upper black shale unit is well exposed on the Utukok but could nowhere be measured due to scarcity of outcrops and complex structure. The rocks of this unit are largely siltshales, and weather into characteristic blocks with a tension crack pattern. Upon slight compression these blocks break down into many small, hard, angular pieces. The siltshale contains colorless mica in lesser amount than the underlying green zone. Most exposures contain nodular members. Finely cross-bedded gray siltstone and very fine-grained sandstone in beds a few inches to three feet thick are interbedded within the shale. They weather light cream. The amount of the well indurated, dark gray sandstone and siltstone increases in the upper half of the shale formation.

Areas underlain by the black shale are typically lowlands in marked contrast to the cuestas and mesas of Upper Cretaceous rocks. Wherever the river has cut into the shales it is braided and has a wide floodplain in contrast to the meandering single channel through Upper Cretaceous rocks.

Upper Cretaceous

Approximately 7,700 feet of Upper Cretaceous rock was measured in the Utukok River area. It is predominantly a sandstone shale sequence, becoming coaly in the upper two-thirds. Two units of Upper Cretaceous rocks were mapped, and they are in general correlative with Zones A and D of the Umiat area. Five sections were measured and are designated by the letters A through J and are shown on the map (Fig. 2) and the stratigraphic chart (Fig. 3). Each section was begun at the assumed top of the Lower Cretaceous black shale. This contact was never exposed, and the abrupt change in slope was considered the base of Zone A. A detailed description of each section is found in Appendix A.

Zone A: The lower marine sandstone and shale series, designated as Zone A, is approximately 2,500 feet thick. It apparently thins to the north, for it is only 2,100 feet thick in the vicinity of Elusive Creek, 28 miles north of Camp No. 5. The rocks are chiefly fine to very fine grained sandstones and siltshales. The sandstones are generally thick, bluff-colored, argillaceous, slightly calcareous, of low porosity, cross-bedded, ripple marked and contain carbonized fragments. There is an increase to the north in the amount of shale and siltstone in the basal portion of Zone A. A non-marine member with thin coal beds occurs in Zone A as shown by Section I (See Fig. 3). It is probably of very limited areal extent, and is exposed along the axis of a syncline near Camp 8. The sandstone beds range from 10 to 50 feet in thickness and form conspicuous ledges which are easily traced on aerial photographs. A joint system striking northwest and perpendicular to the bedding was noted throughout the formation.

Sections A through E and G through I are entirely confined to Unit A and indicate shallow marine, near-shore or lagoonal type of sedimentation. The contact with Zone D is not too well defined since it lies in a covered interval.

Macrofossil determination was made by George Gryc of the Geological Survey. All of the macrofossils collected are pelecypods, excepting one Ammonite which comes from Section I, and the collections are restricted to Zone A. Three or more species of Pecten were noted, and this fossil is the most common for this area. According to Gryc, the collections resemble Faunal Zone 1 from the Colville but differ from Faunal Zone I of the upper Chandler and Kurupa Rivers. The index fossil for the Umiat area, Inoceramus, was not found on the Utukok.

The following fossils are present:

- Pecten cf. orbicularis.
- Pecten (camptonectes) sp.
- Pecten sp.
- Tellina sp.
- Veniella sp.
- Modiola sp.
- Ammonite, undet.

Zone D: There is no clear contact between rocks of Zone of Zone D. The rocks of Zone D are sandstone and shale with interbedded conglomerate, ironstone, and coal. As compared to the sandstones of Zone A, the sandstones are coarser, and the porosity generally is greater. The cliff-forming nature of the rocks of Zone A is not present in D, and Zone D sandstones and shales weather yellow-red. Zone D is about 5,200 feet thick as shown on Section J.

At Camp 12 a medium to coarse-grained, dark brown sandstone with conglomerate lenses composed largely of white quartz pebbles marks the upper exposures of the area. The conglomerate, though not developed over the entire area, lies in a sequence of beds which can be correlated with reasonable certainty from Camp 12 for 40 miles downriver. Below this sandstone a coal bed about three feet thick contains a two-inch layer of bentonitic claystone with tiny, rounded, vitreous fragments. This claystone within the coal, was observed at several localities along 40 miles of river.

Porosity: Results of porosity tests on 72 sandstone samples taken throughout the area are tabulated below and are shown on the columnar chart (Fig. 3). Many of the sandstones of obviously low porosity were not sampled.

Sample Number	Measured section	Zone	For details see Appendix page number	Porosity in percent
Tm 3 (Bed 5)	A	A	2a	12
Tm 3 (Bed 7)	A	A	2a	17.1
Tm 3 (Bed 18)	A	A	1a	8.3
Ba 16	C	A	5a	13.5
Ba 18	C	A	5a	11.5
Ba 21	C	A	5a	18.2
Ba 24	C	A	5a	4.2
Ba 26	C	A	4a	11.9
Ba 33	D	A	6a	8.2
Ba 35	D	A	6a	11.
Ba 36	D	A	6a	18.4
Ba 37	D	A	6a	6.4
Ba 41	D	A	6a	22.4
Tm 9 (Bed 2)	E	A	8a	8.8
Tm 9 (Bed 9)	E	A	7a	8.4
Tm 9 (Bed 12)	E	A	7a	14.6
Tm 10 (Bed 2)	F	A	15a	9.2
Tm 10 (Bed 9)	F	A	14a	6.
Tm 10 (Bed 13)	F	A	14a	12.3
Tm 10 (Bed 15)	F	A	14a	12.8
Tm 10 (Bed 16)	F	A	13a	11.
Tm 10 (Bed 18)	F	A	13a	8.2
Tm 10 (Bed 20)	F	A	13a	14.3 and 17.9

Sample number	Measured section	Zone	For details see Appendix page number	Porosity in percent
Tm 10 (Bed 22)	F	A	12a	8.6
Tm 10 (Bed 28)	F	D	12a	11.
(Upper half)				
Tm 10 (Bed 28)	F	D	12a	6.4
(Lower half)				
Tm 10 (Bed 30a)	F	D	11a	9.9
(Middle)				
Tm 10 (Bed 30a)	F	D	11a	7.1
(Lower 15')				
Tm 10 (Bed 35)	F	D	10a	13.4
Tm 10 (Bed 37)	F	D	10a	7.2
Tm 10 (Bed 42)	F	D	10a	9.9
Tm 10 (Bed 44)	F	D	9a	11.8
Tm 10 (Bed 48)	F	D	9a	7.7
Tm 10 (Bed 50)	F	D	9a	8.2
Ba 43	F	A	14a	11.7
Ba 55	F	D	11a	13.8
Ba 56	F	D	11a	10.5
Tm 13 (Bed 4)	G	A	17a	15.6
Tm 13 (Bed 8)	G	A	16a	14.7
Ba 64		A	16a	13.9
Ba 66		A	16a	13.4
Ba 68	H	A	19a	13.2
Ba 69	H	A	19a	12.6
Ba 70	H	A	19a	13.3
Ba 72	H	A	18a	20.8
Ba 75	H	A	18a	11.6
Ba 76	H	A	18a	11.7
Tm 15 (Bed 5)	I	A	22a	12.1
Tm 15 (Bed 7)	I	A	22a	10.6
Tm 15 (Bed 12)	I	A	22a	13.1
Tm 15 (Bed 14)	I	A	22a	14.1
Tm 15 (Bed 16)	I	A	21a	7.8
Ba 80	I	A	20a	13.4
Ba 84	I	A	21a	16.8
Ba 86	I	A	21a	14.9
Ba 87	I	A	21a	14.9
Tm 19 (Bed 29)	I	A	20a	13.5
Tm 19 (Bed 40)	I	A	19a	13.2
Tm 23 (Bed 4)	J	A	26a	16.2
Tm 24 (Bed 6)	J	A	26a	8.9
Tm 24 (Bed 10)	J	A	26a	16.3
Tm 24 (Bed 12)	J	A	26a	15.8
Tm 24 (Bed 18)	J	D	25a	8.2
Tm 24 (Bed 23)	J	D	25a	18.9
Tm 24 (Bed 24)	J	D	24a	8.0
Tm 30	J	D	23a	14.8
Tm 31	J	D	23a	16.2
Tm 32	J	D	23a	18.1-18.8

Microfossils: The stratigraphic positions of samples containing microfossils are shown on the columnar chart (Fig. 3). Identifications, which were made by H. N. Loeblich, are also shown on this chart.

Coal analyses: The following moisture-free analyses of Upper Cretaceous coal samples, all from Zone D, were made by the U. S. Bureau of Mines:

Specimen number.	Volatile matter. (Percent)	Fixed carbon. (Percent)	Ash. (Percent)	Total. (Percent)	Sulphur. (Percent)	B. T. U.	Thickness of bed.	Latitude.	Longitude.
Tm 19	30.5	50.6	18.9	100.0	.8	11,200	3-4"	69°17'N.	159°48'W.
Tm 24	39.5	57.3	3.2	100.0	.2	12,400	5'	69°25'N.	160°00'W.
Tm 24	36.0	50.2	13.8	100.0	.9	12,330	5'	69°25'N.	160°00'W.
Tm 25	45.7	50.4	3.9	100.0	.1	12,890	Unknown	69°25'N.	160°00'W.
Tm 29	38.6	59.1	2.3	100.0	.6	13,870	Unknown	69°35'N.	160°00'W.
Tm 30	34.2	62.4	3.4	100.0	.2	13,450	Unknown	69°35'N.	160°05'W.
Tm 31	38.7	59.0	2.3	100.0	.6	13,720	Unknown	69°35'N.	160°05'W.
Tm 34	33.8	62.3	3.9	100.0	.2	13,920	6'	69°35'N.	160°15'W.
Tm 40	37.9	54.1	8.0	100.0	.2	—	8'	69°40'N.	160°35'W.

STRUCTURE

Mississippian

A reconnaissance near the divide of the DeLong Range reveals 500 to 750 feet of overturned Lisburne limestone, overlain by steeply dipping overturned Noatak sandstone and conglomerate. This sequence has been thrust faulted to the north and overlies a Triassic-Lower Cretaceous complex zone. The Lisburne limestone has apparently been thinned on outcrop by the thrusting.

Triassic-Lower Cretaceous(?)

A highly folded, truncated complex of Triassic rocks and possibly of infolded Lower Cretaceous and Jurassic(?) rocks occupies the area between the Lisburne limestone and Camp 1. Several ridges of chert crop out, striking about N. 80° E., and may be the same chert that is exposed so well at Camp 1.

Lower Cretaceous

Several excellent exposures of Lower Cretaceous rocks were found along the river cuts and on many of the drainages. This group of rocks is generally steeply dipping to complexly folded and faulted. They apparently were truncated to a gentle slope with little relief before Upper Cretaceous deposition.

The contact with the Triassic is probably a normal fault as suggested by drag dips near Camp 1. Displacement could not be determined.

Sandstone similar to the green member crops out in an interesting anticline at Camp 2. On the west side of the river this asymmetrical structure plunges to the west. On the east side of the river the north limb of this anticline is overturned. The part of the anticline on the east can be traced south of Meat Mountain where it disappears under terrace gravels on the divide between the Colville and Utukok Rivers. It is likely that the three areas of the green member appearing on the map (See map Fig. 1) are correlative.

The black shale member, being the uppermost unit of Lower Cretaceous, almost certainly underlies the Upper Cretaceous in angular unconformity. This relationship is quite pronounced from Camps 3 to 4, decreases from Camp 6 to a few miles south of Carbon Creek, and then becomes strongly evident at the last exposure at Carbon Creek. At Camp 3 a fairly competent series of Lower Cretaceous siltstones, sandstones and shale dip 35° to the north and are overlain by a synclinal butte of Upper Cretaceous dipping 7° to the north. From Camps 6 to 7 the black shale is gently dipping and appears nearly conformable with the Upper Cretaceous, although the details are obscured by a shale on shale contact.

Upper Cretaceous

From Meat Mountain to Carbon Creek the remnants of deeply eroded synclines form a striking topography. The intervening anticlines are completely breached by headward erosion of lateral drainage. The anticline north of Camp 6 plunges gently to the west and has a very thin remnant of Upper Cretaceous in the western portion.

In the vicinity of Camp 8 it appears that the structures are arranged in an en echelon manner in which anticlinal axes can be connected diagonally between basins. This gives more persistence to the anticlinal axes, leaving the basins as isolated structures. It probably is an indication of lobes of unequal folding during or after Upper Cretaceous time. Other evidence of unequal compression is shown by the previously described anticline at Camp 2.

From Carbon Creek westward a breached anticline reveals beds near the base of Zone A dipping from 50° to vertical on the structural axis. The beds on the north limb of this anticline flatten progressively until they reverse into a syncline two miles north of Elusive Creek.

About $3\frac{1}{2}$ miles north of Elusive Creek a small anticline with closure on the east, dips 4° south and 5° north. West closure may be present but is not exposed. Closure, if present, would be about 100 feet, increasing in amount with possible increase of dip lower in the section. The surface bed of this anticline is stratigraphically 6,000 to 6,500 feet above the Lower Cretaceous.

The next anticline about 8 miles north of Elusive Creek is not well defined and was not observed too close at either end due to poor exposures. For many miles north of this anticline the dip is regionally northward, with possible minor wrinkling, up to the fault zone near Camp 13.

Exposures in the fault zone reveal steeply dipping beds often in anomalous relationship to each other. Step normal faulting is common, displacement probably not exceeding a few hundred feet. Some minor thrust faulting and reverse faulting were also noted.

Between the fault zone and the anticline south of Camp 15 dips are regionally southward, suggesting a large syncline with small structures on the limbs. The major axis would probably pass through the fault zone.

Beyond Camp 15 numerous anticlines and synclines are indicated, always with the surface bed equivalent to the top of Section J--the coal, conglomerate, bentonite, and bentonitic mudstone sequence.

CONCLUSIONS

The following conclusions can be drawn regarding the Utukok River area:

1. No Upper Cretaceous rocks in the mapped area south of Carbon Creek have petroleum possibilities because the structures are breached to the Lower Cretaceous shales.
2. Some of the sandstone in Zone A may have high enough porosity to warrant testing on structures where closure and depth appear favorable. However, high porosity of a single surface sample is no indication that the same bed will have high porosity in other localities.
3. The area from Elusive Creek to Camp 12 appears to be the most favorable structurally of the region studied. A detailed investigation of this area, by a weasel party, from the Kokolik River eastward to the Ketik River or beyond may discover closed structures.
4. The uppermost sandstone of the Utukok area, exposed intermittently from Camp 12 to near the river mouth, averaging about 25 feet in thickness, would be worthy of testing on a closed structure, if one were found in Zone E or higher. This sandstone appears to have high porosity everywhere that it was observed. If this condition persists to the east, it may be potential reservoir rock.
5. Oil possibilities in the area studied appear very limited. No economically important discoveries were made.

NOTES ON THE CORWIN-CAPE BEAUFORT REGION

A week at the end of the season was spent along the coast line between Esok and Cape Beaufort during which the Upper Cretaceous rocks were sampled for porosity, heavy mineral, and microfossil determinations.

Good exposures occur almost continuously along sheer cliffs and narrow beaches from Esok to Thetis Creek. From Thetis Creek to Cape Beaufort the exposures are intermittent and often highly covered, with Upper Cretaceous Zone A rocks probably the only age remaining.

The sequence from Esok to Thetis Creek is estimated to be around 13,000 feet thick and is represented by four separable lithologic units. General descriptions of these units are as follows:

1. Basal unit exposed from Thetis Creek between sample locality C-50 and C-44 is about 1,400 feet thick. The rocks are thin interbedded sandstones and thick shales. The sandstone is very fine, dark brown, weathering to red and is thin bedded. The shale is dark gray to black, probably silty, and contains little or no clay.
2. Between sample locality C-43 and C-20, which is located a few hundred feet east of Corwin Creek, some 5,500 feet of sandstone, conglomerate, coal, and bentonitic shale is exposed. The conglomerates are composed principally of dark chert, white quartz, and some yellow quartzite, ranging from granule to cobble in size. Porosity on the conglomerate runs 13.6% to 14%. The sandstone generally appears to be of moderate porosity. Shale beds are thick and very bentonitic with abundant ironstone nodules. Two coal beds about 14 feet thick are exposed in the lower part and numerous 2 to 4 foot beds occur throughout.
3. From Arrow Creek east to sample locality C-19 about 4,200 feet of predominantly marine rocks with non-marine members are exposed. Thick beds of bentonitic, black shale is interbedded with massive, very fine, indurated, tan colored sandstone. There are several thin coal beds and one two-foot bed of clean, cream colored bentonite.
4. From Esok to Arrow Creek about 1,900 feet of section has been estimated, but it is not too reliable. From Arrow Creek westward a gradual distortion takes place, gaining in amplitude until the thick incompetent shales are complexly folded and faulted. These black marine shales are hackly and contain numerous beds of thin siltstone and fine-grained sandstone. They resemble Lower Cretaceous rocks but appear to lie conformably upon the unquestioned Upper Cretaceous. A pecten was found in the sequence near Esok and appears identical with the Zone A pecten of the Utukok area.

The very thick section of Upper Cretaceous rocks, so well exposed along the coast line warrants a season of detailed study. Several sandstone beds up to 40 feet thick in Unit 2 appear to have favorable porosity, indicated up to 14% by the few determinations which are available. Structures in the area are large and likely contain Unit 2 rocks at depth. The area also is very favorable for a tectonic study. Therefore it appears that a detailed study of the coast line and the inland structures should be made. Such a study could best be made by using a seaworthy boat, such as an Eskimo skin boat, and a weasel. During the relatively few days calm enough to study the rocks from the sea, the boat could be used. Unfavorable days for shoreline work could be spent inland.

APPENDIX A

Section A

Stratigraphic section on Meat Mountain measured by Brunton. Section starts along west side of main drainage flowing out the south side of the syncline. Lat. = 68° 55' - 56' N, Long. = 160°. Collections are numbered A 47 Tm 3.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
24	56	Sandstone, like unit 22.
23	2	Shale, black to brownish, hackly, largely covered.
22	88	Sandstone, fine to medium, hard, low porosity, salt and pepper, weathers into small thin pieces, contains wood fragments; lower 5'-10' forms partial cliff. A local outcrop at the base has some tan, thin bedded, very calcareous siltstone that weathers to an ochre yellow, contains some wood fragments. Some units are intensely ripple marked with large to small symmetrical ripples.
21	64	Covered, light colored soils probably derived from silt shale.
20	66	Sandstone, like unit 18. This unit is a prominent cliff throughout the syncline.
19	230	Covered, upper 20' appears to be shaly.
18	36	Sandstone, fine, buff to light gray, low porosity, slightly calcareous in part, splits into large $\frac{1}{4}$ " slabs near top, more blocky at base, gives a prominent sheer cliff. Red lichen grows on it giving it a "rusty bed" appearance.
17	150	Covered, upper 30' may be shale.
16	85	Sandstone, fine, thin bedded, moderately calcareous, low porosity, weathers buff, angular salt and pepper grains, lower 40' ridge forming, quartz crystal facets.
15	65	Covered, appears to be sandstone like unit 16 but contains some sticky shales.
14	10	Sandstone, very fine, like unit 11, ridge forming thin black shale at base makes a characteristic break in slope.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
13	98	Largely covered, rubble indicates thin bedded slabby sandstone with some silt shale interbedded.
12	43	Covered.
11	70	Sandstone, fine to very fine, tan, slightly calcareous, low porosity, weathers to $\frac{1}{2}$ " slabs, with some beds of salt and pepper sandstone containing carbonized wood fragments. Some beds are hard dark gray, very dense, containing numerous well formed worm trails with characteristic chevron markings. Prominent ridge.
10	100	Sandstone, like unit 9 but with considerable silty shale which forms sticky spots in the poorly exposed material.
9	225	Sandstone, buff, fine to medium grained, carbonaceous, slabby, ripple marked, contains worm borings. Material poorly exposed.
8	40	Covered.
7	15	Sandstone, very fine grained, buff, medium porosity, moderately calcareous, non-carbonaceous, thin bedded, weathers deeply, forms thin flat, finely cross-bedded slabs.
6	130	Covered, lower part and upper part seem to be thin bedded fissile sandstone.
5	60	Sandstone, fine to medium grained, slabby to blocky, very thin bedded in upper third; hard, ripple marked, forms prominent ledge; thin bands of dark tan sand run through forming bands, green and black specks are abundant, moderately calcareous, medium porosity. The upper half is much more fissile and tends to cover more readily. The middle sandstone has many carbonaceous fragments in it.
4	120	Covered, probably all slabby sandstone.
3	5	Sandstone, like unit 1, lighter colored, more slabby, small carbonaceous fragments, moderately calcareous, some hard quartzitic layers, blue.
2	30	Covered zone, appears like unit 1.

<u>Unit</u>	<u>Thickness</u>	<u>Description</u>
<u>Top of Section</u>	<u>In Feet</u>	
1	100 + —	Sandstone, tan to brown, hard, very fine grained, low porosity, quartz crystal type, weathers to large slabby thin blocks. This zone forms a prominent talus slope and largely obscures bedding. The sandstone is greenish on fresh surfaces and appears rather dirty, slightly calcareous.

About 200' - 300' stratigraphically below unit 1 a ten foot exposure of fine grained buff sandstone is visible in the stream bed.

Section B

Lower Cretaceous section as exposed at first river cut north of Camp #3. Measured by Brunton. Samples labeled A 47 Tm 8.

14	200 + —	Sandstone, fine to medium grained, angular, slabby to fissile, dark brown. <u>Upper Cretaceous</u> -----Angular Unconformity-----
13	100 + —	Covered slope (shale and sandstone).
12	20	Sandstone, fine grained, tan, hard, massive beds 1'-3' thick separated by black shale beds about 3' thick in lower half and 6" thick in upper half.
11	30	Shale, black with 2"-3" beds of fine sandstone 6"-12" apart.
10	4	Sandstone and shale, like unit 1.
9	8	Shale, black to dark gray, very much like unit 3.
8	10	Sandstone, very fine grained, tan, like unit 2 but weathers into thicker blocks. This bed makes a prominent bedding trace around the Camp #3 butte. It has a few minor, nodular shale layers ranging from 1"-6" thick.
7	30	Shale, black with some thin siltstone beds in lower third and a 1' sandstone bed in middle.
6	5	Sandstone, very fine grained, gray, thinly interbedded with black shale and gray siltstone.
5	18	Shale, black with some very thin siltstone layers.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
4	5	Sandstone, like unit 2, but entirely massive, very hard.
3	7	Shale, gray weathering, black when fresh, silty, has rather a conchoidal fracture.
2	10	Sandstone, very fine grained, tan to yellow-brown on weathered surfaces, dark on fresh, very delicately and finely cross-bedded in deltaic fashion as shown on fractures which are perpendicular to bedding. Many of the fine bands are formed by a thin layer of fine, dark mica on bedding planes. (Forsets inclined 8°-10°, Topsets = Bottomsets 1"-2") The sandstone has tiny quartz crystal facets that reflect sunlight. It is very glauconitic and sideritic (?). Many of the bedding planes are black due to an abundance of paper thin, carbonaceous plant remains. The sandstone beds range from 1" to 1' in thickness and are separated by thin gray to black shale beds and nodular siltstone layers.
1	5 +	Shale, black. Talus and tundra.

Section C

This section was measured on the syncline about one mile west of Camp 3. Macrofossils are labeled A 47 Tm 7, all other samples labeled A 47 Ba 16 to 29A.

14	108	Sandstone, medium, tan, very thin-bedded, weathers into $\frac{1}{2}$ " - 1" slabs, marked cross-bedding, pronounced dip slope. Black shale in 5' - 10' bed is exposed about 20' from top of unit 14.
13	90	Sandstone, fine to medium, thin cross-bedded, wood fragments common, dark gray.
12	25	Sandstone, very fine grained, weathers to purple flagstone, mostly covered.
11	232	Sandstone, medium grained, tan, ledge former, thin cross-bedded, wood fragments, perpendicular joints, rusty color on weathering, supports red lichen.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
10	154	Sandstone, medium grained, tan, weathers into angular blocks and flagstones about $\frac{1}{2}$ '-1' in size and reddish color, poorly exposed.
9	146	Sandstone, very fine to coarse, well indurated to friable in coarse beds, wood fragments, ripple marks, poor fossil imprints.
8	75	Sandstone, medium to fine grained, gray-buff, salt and pepper, weathers dark tan, cross-bedded.
7	70	Sandstone and siltshale, mostly covered, center third contains the siltshale and forms light colored soil.
6	32	Sandstone, medium tan, forms reddish to gray sub-angular blocks on weathering, not greater than 1'-upper $\frac{1}{4}$ covered.
5	16	Sandstone, very fine grained, very thin bedded $\frac{1}{4}$ "- $\frac{1}{16}$ ", dark rusty color, forms dip slope.
4	27	Sandstone, medium to fine, faint salt and pepper appearance, wood fragments common, cross-bedded. Basal 10' massive, upper part flaggy and thin bedded, forms first definite ledge; joint system perpendicular to bedding.
3	248	Covered, believed to be thin bedded sandstone, friable (some slabs in the talus of the upper half of this unit, or slumped from higher in the section, contain poorly preserved fossils)
2	38	Sandstone, very fine grained, bluish on fresh surface, weathers tan, highly indurated, quartzitic.
1	162	Sandstone, medium grained, tan-gray, upper and lower $\frac{1}{4}$ very thin-bedded and friable, fine salt and pepper cast, weathers light brown, angular weathering of various size. This member is in contact with the L.K. black shales in the stream valley, it is not a ledge former. Unit is 75% covered.

Section D

Stratigraphic section on syncline 10 miles southwest of Camp #4. Measuring done by Brunton methods starting at the approximate base of the Upper Cretaceous. Lat. $69^{\circ} 03'$, Long. $160^{\circ} 38'$. Collections numbered A 47 Ba 33 - 41.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
11	10	Sandstone, medium to coarse, salt and pepper, friable, medium to high porosity.
10	10	Sandstone, medium-fine, tan, argillaceous, cross bedded, contains poor fossil impressions.
9	30	Sandstone, fine, tan, weathers to a brilliant rust color. This unit forms the main ledge and is mapped as a structure trace on the 1:48,000 base map. Thin bedded and cross bedded. On weathering forms thin rectangular blocks and dip slopes.
8	75	Sandstone, very fine, light gray, forms blocky blue gray talus, beds 1"-2" thick, rippled marked, unit poorly exposed.
7	50	Sandstone, medium-coarse, containing large amounts of carbonaceous matter, weathers from tan to rust color. Upper one-third is covered.
6	176	Sandstone, medium, tan to light gray, salt and pepper, friable, forms a pronounced ledge and flagstone talus slope, talus weathers blue gray to rust. A few siltstone beds occur within this unit.
5	56	Covered.
4	22	Sandstone, fine, tan, contain bands of a dark mineral or carbonaceous material. Ledge former.
3	56	Covered- Pecten-like fossil found as float and believed to occur in this unit.
2	100	Divided from unit 1 by break in topography and sandstone ledges. Sandstone, medium-fine, tan, argillaceous, containing carbonized fragments 6" long and 2" wide. Sandstones contain fossil imprints. Unit contains dark gray siltshale but percent is not known. Joint system perpendicular to the bedding planes. Very fine cross bedding noted. Both talus and bluffs weather light tan. Beds do not exceed 2" in thickness-flaggy. Possible thin bed of black shale.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>
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Description

1 275

This unit is a steep talus slope which forms the abrupt break in topography. The talus is blue gray to tan flagstone.

Tightly folded Lower Cretaceous black shale exposed in the valley one mile from the base of unit 1. Unit 1 within 100 feet+ of the black shale.

Section E

Stratigraphic section measured by Brunton on the broad warp starting about 5 miles west of Camp #4 and continuing upward and westward toward the Kokolik for about 3 miles. Collections labeled A 47 Th 9.

13 600

Estimated covered zone to highest part of section.

12 5

Sandstone, like unit 10, forms the highest prominent ledge between the two drainages. Other units occur stratigraphically above this one but they are so poorly exposed that dips cannot be determined. The unit apparently flattens out and changes dip before reaching the Kokolik. There is perhaps another 500 to 600 feet of sediments.

11 110

Covered, intermittent exposures of rubble indicate a gray fucoidal, worm-tracked siltstone with some dark gray shale.

10 90

Sandstone, like sandstone in unit 9, basal 3' forms prominent cuesta. From 30' to 44' above base a poorly exposed zone indicates interbedded dark gray shale and buff siltstone. At 44' a sandstone ledge, just like the basal one, about 2' thick is well exposed, then unit is largely covered again but rubble indicates only sandstone.

9 44

Sandstone, fine grained, medium gray, argillaceous, low porosity, thin bedded, weathers into big blocks, iron stained on surface, symmetrical ripple marks, 1" amplitude, 3"-4" wave length, probable N-S current direction (corrected for structure) crests sub-rounded, no apparent grain sorting. Unit is also gently cross-bedded. Largely covered in upper part, but it apparently has an interbedded dark gray shale 3' thick about 5' above base, and occasional thinner shale units all the way up. Ironstones in very thin layers are also common. Composite shale sample for microfossils.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
8	26	Siltstone, dark gray, hackly, with considerable interbedded black shale, worm trails, rain marks (?) occur sporadically. Unit is peculiar in that basal part forms a steep little cuesta due to the hard siltstone beds.
7	5	Sandstone, very fine, gray to yellow, slightly calcareous, medium porosity, slight ferruginous content, very thin bedding weathering into 1/8" - 1" curved slabs which reflect a gentle but broad type of cross-bedding. Unit largely covered.
6	15	Shale, black, very fissile with considerable thin beds of siltstone and silt shale, gray, in which fine trails are common. Unit is largely covered. From 8' up, the thin siltstone beds are much more abundant, increasing upward until the shale makes up only about 25% of the unit. At about 11' a 1'-2' sandstone bed appears. It is fine to medium grained, greenish-gray, argillaceous, and ferruginous cemented, low porosity.
5	13	Siltshale, gray, weathering into a prominent light gray band, contains thin paper-like siltstone beds. The unit is poorly exposed but appears to contain a few very thin fine to medium sandstone layers. In a block of this sandstone, one pelecypod outline was collected. One 1/2" black chert pebble was seen in the sandstone, which may not be in this unit.
4	15	Sandstone, very fine to fine, buff to gray, slightly argillaceous, low porosity, weathers into 1/4" to 1" slabs up to 1' across, but averaging 6", thin bedded and cross-bedded.
3	10 +	Covered, rubble indicates a possible continuation of unit 2.
2	10	Sandstone, very fine to fine, tan to yellow-brown on fresh surface, gray to dark brown on weathering, thin bedded 1/2" to 1 1/2" which can be lifted apart slab by slab, broadly cross-bedded, lower part ferruginous with low porosity, upper part less ferruginous with medium porosity, moderately calcareous.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
1	560	Sandstone, fine to very fine, gray to tan and light brown, slightly calcareous, low porosity, with some interbedded black shale, as indicated by the rubble which forms 4 small ledges. Some siltstone beds. From 50' - 100' below the top of this highly covered unit several fossils were found.
		<u>Lower Cretaceous</u> Shale, black and sandstone, very fine to fine grained, interbedded, Lower Cretaceous type, gentle tundra covered hills. Break in topography at top, tundra largely disappears, Upper Cretaceous sandstone forms rubble covered traces and terraces above. Contact within 100' - of unit 1.

Section F

Stratigraphic section from Camp 4 butte, northward across river to highest visible outcrop. Plane table control. Calculated thicknesses underlined, Brunton measured not underlined. Collections labeled A 47 Tm 10.

50	10	Sandstone, fine to medium, light gray, weathers tan, medium porosity, cross-bedded, very thin bedded in center with a 2" zone of interbedded coal and sandstone in about 1/32" layers. This bed is the highest point exposed on the axis of the syncline and the sandstone forms a prominent "chimney rock" on the skyline.
49	23	Sandstone, poorly exposed with thin carbonaceous shale in middle and near base.
48	20	Sandstone, light to dark gray, fine to very fine, slightly calcareous, becomes darker and increasingly argillaceous upward, poorly exposed in upper part.
47	1	Shale, carbonaceous, with sub-bituminous coal partings.
46	2	Siltstone, light gray, well indurated, massive.
45	32	Covered, probably like unit 23, some thin coaly beds present.
44	8	Sandstone, fine grained, light tan, low porosity, yellowish banded streaks, micaceous, argillaceous, thin bedded, poorly exposed.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
43	35	Covered, some carbonaceous shale exposed in center.
42	22	Sandstone, fine to medium grained, medium porosity, light gray, non-calcareous, sub-angular grains, ledgy in upper 1/3, poorly exposed.
41	5	Shale, about a 1' zone at the base of this poorly exposed unit contains an abundance of bituminous (?) coal fragments with carbonaceous shale and a brownish fissile shale.
40	23	Covered, probably sandstone.
39	6	Covered, probably black carbonaceous shale.
38	20	Covered, probably sandstone.
37	5	Sandstone, fine, light gray, low porosity, carbonaceous, argillaceous, thin bedded, ledge forming.
36	70	Covered, probably sandstone, fine, thin bedded, and siltstone.
35	38	Sandstone, highly covered, lower part is light gray, argillaceous, slightly calcareous, medium grained, angular; while upper part is fine grained, dark gray, highly argillaceous, calcareous, very carbonaceous, low porosity.
34	70	Covered, probably shale and thin interbedded sandstone. Top of unit is top of 20'± bedding trace.
33	16	Sandstone, fine, light gray to blue gray, moderately argillaceous, slightly calcareous, some beds are very dirty looking, highly argillaceous and carbonaceous, medium grained, poorly exposed; small pieces of fossil wood occur near top.
32	30	Shale, black, and clay shale, very fissile, highly covered, abundant small fossil wood fragments occur on the surface but probably weather out of the shale; upper part poorly exposed, contains some 1" red ironstone nodules.
31	26	Covered, trace at base indicates sandstone, isolated outcrop indicates sandstone, very fine to fine grained, light gray, argillaceous, very fissile, thin partings of carbonaceous material (coal?).

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
30A	49	Sandstone, tan, fine to medium grained in lower third, medium grained in upper, argillaceous, slightly calcareous, low to medium porosity, very carbonaceous wood fragments, lower half massive and has a slight petroliferous odor on fresh surface. Upper part thin bedded $\frac{1}{4}$ "-2", cross-bedded and weathers to rusty and ochre colors, moderately ferruginous. Lower part has a few clay pebble (?) impressions. Upper third badly covered, probably shaly at top.
29H	16	Covered, base contains thin dark gray siltstone beds that weather to a yellow orange, red ironstone nodules up to 2" are also common, some of these are filled with wood fragments.
29G	10	Shale, black, fissile and clay shale, contains shiny particles of sub-bituminous (?) coal, tiny cubes and plates of prismatic structure disseminated through shale probably as thin lenses.
29F	20	Covered.
29E	5	Rubble trace, sandstone, very fine.
29D	27	Shale, black, fissile, with thin interbedded very fine gray sandstone, poorly exposed, some small sub-bituminous coal particles noted on surface.
29C	5	Sandstone, gray, fine to very fine, calcareous, low porosity, very fissile, poorly exposed.
29B	33	Covered.
29A	10	Rubble trace; sandstone, fine with dark gray siltstone, weathering in thin orange-yellow slabs, current ripple marks.
29	810	Covered; various traces of sandstone, fine to medium grained. Somewhere, well down in this unit are some exposures in the river cut to the northeast. Photo reveals that it is probably from 50' to 100' above unit 28 conglomerate bed. Interbedded shale, sandstone, and siltstone about 60' + well exposed, underlain and overlain by poorly exposed black shale. Sandstone, very fine, dark gray, cross-bedded, ripple marked, wave length from $\frac{1}{2}$ " - 6", asymmetrical, crests roughly N-S indicated current from

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
		east. Sandstone is intricately worm tracked and ramous masses of "fucoids?" are abundant, several reeds, highly carbonized, up to 2" wide and 3' long were noted. A fossil collection was made and the forms, all pelecypods, are like those of unit 16, the same pecten form, etc. Scattered at random through the sandstone are dark chert pebbles up to 1", while occasional lenses of pebble-granule conglomerate may be present locally. Shale is dark gray-black, nodular in some beds, fissile in others, and develops marked columnar jointing in some beds. (Upper few feet of this unit is black shale.)
28	32	Sandstone, fine to medium, dark gray, moderately to highly calcareous, medium porosity, contains random chert pebbles up to $\frac{1}{2}$ " throughout unit; massive in lower half, to thin bedded in upper part (2"-1") and very fissile at top $1/16$ " slabs; entire unit broadly cross-bedded, assymetrical ripple marks with rounded crests, wave length from $\frac{1}{2}$ " - 4", amplitude $1/4$ " - $3/4$ ". 8' above the base and 12' above the base + are two conglomerate lenses. The upper one is about 200' long and the lower one at least that long (talus obscuring).
27	<u>82</u>	Shale, dark gray to black, darker and more fissile at top. Hackly and containing red and brown iron-stone concretions in a thin zone near base. Composite sample.
26	<u>100</u>	Sandstone, very fine, almost siltstone, dark gray, very calcareous, slightly argillaceous, low porosity, thin bedded, blocky 1"-4", occasional thin beds of orange siltstone $1/16$ "- $1/4$ " thick, ripple marked.
25	<u>130</u>	Shale, black to dark gray, slightly silty in upper part and very fissile, almost paper-like, more massive, nodular, and hackly in lower part, except for some thin beds of fissile, carbonaceous clay shale; numerous thin 1"-6" sandstone beds in lower part, very fine, brown to gray, argillaceous.
24	<u>98</u>	Sandstone, very fine, brown, argillaceous, slightly calcareous, very fissile, poorly exposed.
23	20	Shale, black to gray, hackly, poorly exposed.
22	20	Sandstone, very fine, dark gray to tan, thin yellow limonitic (?) streaks, medium porosity, 2" to 4" blocky bedding, symmetrical ripple marks with round crests, 3"-6" wave length, $\frac{1}{2}$ " amplitude, axes orient E-W.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
21	<u>510</u>	Covered.
20	28	Sandstone, fine to medium, dark gray to blue gray, lower half is massive to blocky in 4" beds while upper part is thin bedded 1"-5" and possibly more medium grained sandstone, entire unit broadly cross-bedded. About 1' above the base is a 6" bed of carbonaceous clay shale with macerated carbonaceous wood fragments and interbedded silt. At one locality about 1' of brownish silty shale, slightly carbonaceous, is present at base of sandstone.
19	<u>142</u>	Covered; appears to be shale and clay shale. In lower part there is some interbedded, very fine grained sandstone, brown, very fissile. Upper 1' is brown shale, silty, slightly carbonaceous.
18	8	Sandstone, fine to medium, dark gray, medium porosity to low porosity, slightly calcareous, ledgy, broadly cross-bedded, stream channel type of jumbled ripple marks, occasional thin bed of carbonized wood fragments and some sandstone beds with poorly preserved pelecypod outlines, zone near middle contains thin ($\frac{1}{2}$ ") intraformational conglomerate lense of sandstone and shale pebbles up to $\frac{1}{2}$ ".
17	<u>132</u>	Covered.
16	26 + —	Sandstone, fine to very fine, gray, with occasional lenses of medium grained sandstone of medium porosity, remainder of low porosity, fine grained sandstone in hard bluish quartzitic layers which pop off in conchoidal masses and large blocks up to 8" thick. These blocks which are moderately calcareous contain an abundance of Pecten-like fossils with extremely fine concentric banding. These fossils are difficult to find in place but are common in the talus below the cliff. Many other pelecypods including one <u>Inoceramus</u> sp.? were also found, some in place. Flattened pieces of carbonized wood from tiny fragments to 12" reed-like masses occur with the fossils and on random bedding planes throughout the bed. An intra-formational conglomerate lens of shale and sandstone pebbles up to $\frac{3}{4}$ " was seen near the middle of the unit. The unit is topographically the highest ridge above Camp 4 on the north. The entire unit is ripple marked and broadly

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
		cross-bedded. These ripples are characterized by the toppled crest. Some planes have ball shaped hollows associated with asymmetrical ripple marks, which, however, are not of the "toppled crest" variety. An occasional random lense of intraformational conglomerate of $\frac{1}{2}$ " sandstone pebbles occurs, worm trails common. Cliff forming, certain fresh slides exhibit a tan-yellow color that can be distinguished from long distances. Near the center black shale in a thin lense in contact with a bed of pelecypod outlines occurs locally.
15	<u>84</u>	Sandstone, very fine, lower part, light gray to dark gray, very fissile, thin bedded $1/8$ " to $1/2$ " slabs, some of them very shaly and argillaceous, low porosity, macerated carbonaceous plant remains, moderately to highly calcareous, interbedded in about equal amounts with gray siltstone and minor black shale partings. Highly covered.
14	90	Mostly covered; lower 10' <u>+</u> appears to be very fissile, medium grained sandstone, dark greenish, low porosity, worm tracks, then shale crops out in 4 equally spaced bedding traces with thin fissile fine grained sandstone.
13	16	Sandstone, very fine to medium, dark gray, low to medium porosity, slightly argillaceous, non-calcareous, thin bedded 1"-6" thick, but very massive, cliff forming, cross-bedded; sandstone is rounded, glauconitic (?).
12	<u>214</u>	Covered; bedding trace in middle indicates siltstone and very fine grained sandstone.
11	<u>45</u>	Covered; light soil and abundance of thin very fine grained sandstone slabs and siltstone indicated interbedded with shale. This top forms another bedding trace.
10	6	Shale, black, fissile, non-calcareous, micaceous, largely covered.
9	4	Sandstone, silty, very fine, dark gray, argillaceous, slightly calcareous, low porosity, hard, intensely ripple marked, same type as in bed #7, highly worm tracked, 2"-4" beds with shale partings and some shale pellets within bedding, forms semi-ridge.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
8	70	Covered; probably mainly sandstone, some siltstone.
7	5	Sandstone, very fine grained, dark gray-buff, slightly calcareous, low porosity, hard, thin-bedded 1"-4", finely cross-bedded and ripple marked, troughs run E-W, 3"-5" wave length, $\frac{1}{2}$ " amplitude, round crests, no apparent grain sorting, worm tracks, tiny carbonized wood fragments.
6	<u>70</u>	Covered; this unit is a rubble heap of sandstone blocks very similar to the rubble in which the fossils were collected on the section to the west. By following bedding traces and correcting for structure it appears to lie about midway in the 560' covered interval of the measured section to the west.
5	<u>140</u>	Covered; but unit contains thin 1"-3" interbedded siltstones, gray-green, worm tracked, with black shale. Apparently the siltstone increases upward being capped by a 6' shale bed. This shale is black, highly nodular, micaceous, and contains fucoidal masses.
4	20	Shale, black, fissile, non-calcareous, weathering dark gray, tiny fucoidal remains in thin, silt shale layers.
3	<u>49</u>	Covered; but like unit 1.
2	4	Sandstone, very fine, hard, yellow buff to dark gray, low porosity, moderately calcareous, slightly argillaceous, small yellowish bands of limonite ?, ridge forming, platy in large blocks 1" to 1' thick, predominantly thin bedded and cross-bedded, occasional random slabs will be pockmarked with many pelecypod outlines too poorly preserved to collect. Ripple marks are contorted and asymmetrical with occasional cross ripples.
1	16	Covered, rounded, steep facing slope of 1st bedding trace north of Camp 4. This slope is a neutral gray with soil of very fine grained sandstone to siltstone.
		Lower Cretaceous within a few hundred feet of #1 bed.

Section G

Stratigraphic section on south limb of syncline one mile west of Camp 6. Collections labeled A 47 Tm 13.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
14	50	Covered, possible addition to section to axis of syncline - same sandstone as No. 13.
13	20	Sandstone, dark gray - weathers light brown, very fine, well indurated, very thin bedded, very calcareous, low porosity - upper part slightly more massive with symmetrical ripple marks, wave length of 3"-4", amplitude $\frac{1}{2}$ " - crests aligned N-S. Small pelecypod collection made - occasional, random chert pebbles up to 1".
12	4	Siltshale, duplicate of unit No. 6. Apparently has some thin interbedded, very fine grained sandstones.
11	28	Covered - probably interbedded siltshale and sandstone.
10	88	Sandstone, fine-medium, low porosity, slightly calcareous, slightly ferruginous, and slightly argillaceous, rounded to sub-angular grains, very loosely cemented, very thin bedded, forms rounded hills of light tan sandy soil - occasional thin ledges of brown sandstone cap these little hills. From 40-60' above base of this unit there appears to be an interbedded siltshale, and fine fissile sandstone.
9	73	Covered - probably like unit No. 10 with some interbedded siltshale.
8	65	Sandstone, lower 40 feet inferred by steep rubble covered slope - upper 25 feet is fine, gray to brown, massive and blocky, slightly ferruginous, low to medium porosity, angular grains, covered with black lichen forming contrast with the upper yellow-tan weathering beds.
7	35	Covered.
6	11	Siltshale, dark gray, weathers black, micaceous - worm tracks.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
5	250	Covered - upper 50 feet is a steep slope, indicating possibly a sandstone bed.
4	48	Sandstone - very fine, thin bedded in upper 10 feet and lower 10 feet. Middle is fine-medium grained, medium porosity, non-calcareous, slightly ferruginous, rounded to sub-angular grains, light gray. Upper part is dark brown rusty, highly ferruginous, low porosity, broadly but gently cross-bedded, thin bedded 1/8"-1/2". Unit forms prominent ledges and bedding trace.
3	146	Covered - lower part appears to be like unit No. 2 only very thin-bedded and fissile. From 30 to 40 feet above the base the rubble is composed of a sandstone similar to unit No. 2 but containing abundant pelecypod outlines too poorly preserved even for generic determinations. These are the same type as those which have been collected at the base of the Upper Cretaceous section over the entire outcrop belt.
2	16	Sandstone, very fine, brown, slightly ferruginous, non-calcareous, slightly argillaceous, low porosity, thin bedded - 1/4"-1" slabs, gently cross-bedded. Upper part becomes much more fissile and less durable. Unit forms first prominent ledge and bedding trace over much of the strike of the south limb of the Camp 6 syncline.
1	98	Covered, steep slope composed mainly of sandstone, fine, brown, thin-bedded; and black shale. Shale, black, forms blocks with polygonal cracks that have been seen in most of the Lower Cretaceous exposures. These blocks look quite sturdy but a slight compression breaks them into many hackly, angular fragments. This shale is well exposed in the river bank at Camp 6. It is folded into rather gentle anticlines and synclines with a maximum dip of 40°.

Section H

Stratigraphic section on north limb of syncline about one-half mile north of Camp 6. Collections labeled A 47 Ba 67 to 75.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
14	65	Sandstone, very fine, tan. Weathers light buff, ferruginous, thin-bedded, cross-bedded, moderately to very calcareous, 1/16"-1/32" beds at top weather to brown. Rim rock.
13	5	Sandstone, fine, light gray, slightly calcareous, ledge former.
12	76	Sandstone, very fine, dark dirty brown to brown to light gray, argillaceous, non-calcareous. Symmetrical ripple marks, sharp crested, wave length 2".
11	49	Sandstone, medium-fine, light gray salt and pepper texture, thin ferruginous bands common, medium porosity, slightly calcareous, cross-bedded.
10	27	Shale, black at base of unit and interbedded sandstone, very fine, light gray, argillaceous, containing wood fragments.
9	103	General sequence of sandstone, shale and siltshale: Sandstone, fine-very fine, light gray to dark gray, carbonaceous wood fragments, fossil imprints (pelecypods), moderately calcareous, low porosity. Sandstone, gray-brown, salt and pepper, slightly calcareous, medium porosity. These sandstone beds are ripple marked, symmetrical, wave length 8", amplitude 3/4". Siltshales dirty tan, poorly exposed. Shale black, up to 10' thick. (An interbedded series - no individual thicknesses given.)
8	10	Covered. Lower 5 feet sandstone, fine grained, thin bedded calcareous, ferruginous; upper 5 feet shale (?).
7	17	Sandstone, fine, gray, argillaceous, low porosity - poorly exposed.
6	11	Covered. Black shale and clay (?) ironstone seen in rubble.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
5	86	Sandstones, medium-fine, light gray and light brown, medium grained, salt and pepper, sub-angular to angular, non-calcareous, distinct talus.
4	22	Silty to sandy shale. Very fine grained, black to light tan, poorly exposed.
3	43	Sandstone, medium, light gray, clean, medium porosity, salt and pepper, non-calcareous, ledge former, sub-angular grained, small black chert fragments.
2	75	Partly covered; sandstone and interbedded black shale comprise bulk of unit. Sandstone, medium grained, salt and pepper, medium porosity, slightly argillaceous, contain small wood fragments, friable, weathers tan, forms bluish talus.
1	64	Shale, lower 30'; Sandstone to siltstone, very fine, dark gray, argillaceous, interbedded with black shale.

Section I

Stratigraphic section east of Camp 7 going up the exposures forming the west side of the V's to Disappointment Creek. Collections labeled A 47 Tm 19 from units 40 to 27A; A 47 Ba 80 to Ba 87 for units 27 to 18; A 47 Tm 15 for units 17 to 1.

40	25	Sandstone, medium-fine, light red-brown to light gray, salt and pepper texture, medium porosity, thin bedded to blocky, interbedded sandstone in center is fine, rusty and quite calcareous, slabby, sandstone is slightly argillaceous and contains random black chert pebbles up to $\frac{1}{2}$ ".
39	200	Covered.
38	110	Covered - lithology of this unit on basis of rubble is gray siltstone with deep yellow weathering with 2" ironstone concretions followed by very fine sandstone, dirty gray to light gray, with wood fragments. This followed by shale sequence with a thin coal bed, all capped by very fine sandstone with shaly partings.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
37	2	Siltstone, dark gray weathering light gray to yellow-brown, very massive, filled with reeds and wood fragments.
36	5	Shale, blue gray, fissile, soft, with thin 3" siltstone beds.
35	2	Siltstone to very fine sandstone, medium gray, hard, macerated carbonized plant remains.
34	2	Shale - like unit 32.
33	3"-4"	Coal, bituminous, very clean, prismatic structure, some traces of pyrite.
32	2	Shale, dark gray to black, weathers blue gray, thin bedded, hackly.
31	1	Siltstone, medium to dark gray, very hard, ledgy forms small waterfall in creek bottom.
30	8	Covered - undoubtedly shale.
29	6	Sandstone, coarse to very coarse, conglomeratic lenses of granule-pebble type - chert pebbles up to 1", angular. Some white clayey particles, medium porosity, non-calcareous, slightly argillaceous; thin bedded, fine sandstone lenses occur within unit and form the "second red zone" - this sandstone is moderately calcareous, highly ferruginous; upper 1' of unit is a fine-medium, non-calcareous, non-argillaceous, medium porosity, blocky sandstone that forms black lichen covered talus.
28	40	Covered.
27A	50 +	Estimated addition to bed 27 - covered; some sandstone, fine, brown, slabby, weathers into circular patches of orange-red ferruginous and calcareous outcrops. Occasional spherical nodules of sandstone 1"-12" in diameter occur in the sandstone and appear to be syngenetic.
27	90	Sandstone lower part highly covered by talus - fine, gray, non-argillaceous, non-calcareous, low-medium porosity, forms pronounced ledge and dip

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
26	78	slope which crops out near mouth of Disappointment Creek, sands within unit have varying amounts of ferruginous material - about 30' from bottom a thin siltshale may occur.
25	95	Covered - probably mostly shale.
24	28	Sandstone, medium-fine, medium porosity, buff, salt and pepper, may be calcareous in lower part (?), upper 1/2 is a blocky talus slope of fine-medium grained, non-calcareous, non-argillaceous, medium porosity, weathers bluish.
23	10	Covered, probably interbedded siltshale and very fine grained sandstone.
22	140	Sandstone, medium-fine, tan, salt and pepper, very calcareous, thin rusty bands, medium porosity, light tan on weathered surface.
21	71	Covered, forms saddle between ridges, rubble indicates siltshale, siltstone, and very fine grained sandstone, rocks are argillaceous and moderately calcareous.
20	17	Covered, shale (?).
19	8	Sandstone, very fine, slightly argillaceous, iron stain, forms rubble trace.
18	20	Sandstone, very fine, gray - largely covered, rubble indicates possible silt shale.
17	12	Sandstone, fine, tan, clean, medium porosity, weathers brown to rusty, ferruginous, thin-bedded 1/16"-1 1/2", cross-bedded (10°-30° angles), forms "chimney rocks" and prominent skyline ridge.
16	26	Sandstone, fine, tan, very fissile, thin bedded, interbedded with siltshale - poorly exposed. (Unit 14 of Camp 6 syncline fits about unit 17 by mapping traces.)
15	31	Sandstone, fine-medium (dark gray with yellowish streaks), salt and pepper type, slightly calcareous, medium porosity, thinner bedded and ferruginous near top.
14		Covered, probably all siltshale and interbedded fine-medium, very fissile sandstone.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
14	52	Sandstone, lower 2/3 very fine, dark gray, moderately argillaceous, moderately calcareous, low porosity, thick bedded, highly indurated, upper 1/3 medium gray, fine-medium grained, moderately argillaceous, moderately calcareous, low porosity. Symmetrical ripple marks, 3" wave length, 1/4" amplitude, occasional poorly preserved pelecypod outline and an occasional tiny black chert pebble.
13	48	Covered, probably siltshale with sandstone, brown, very fine, thinly interbedded.
12	58	Sandstone - poorly exposed, lower 2/3 thin bedded, very fine to siltstone, dark gray, moderately calcareous, low porosity, upper 1/3 medium gray, medium-grained, sub-rounded, non-calcareous, medium porosity, blocky, fairly thick bedded. Slope weathers to light gray.
11	62	Shale, and siltshale, dark gray to black fissile, micaceous - poorly exposed, probably contains interbedded sandstone in lower half.
10	15	Covered - probably all sandstone, fine-medium, light gray medium porosity.
9	52	Covered - probably all siltshale with thin fissile interbedded sandstone, forms very steep talus slope that weathers light gray to light tan.
8	20	Covered - probably same as unit 7, very fissile, thin bedded.
7	30	Sandstone, medium-fine, medium gray, slightly calcareous, medium porosity, thin-bedded - poorly exposed - weathers to light gray slope.
6	57	Shale, and siltshale, like unit 4, poorly exposed.
5	15	Sandstone, lower half dark gray, fine-very fine, moderately calcareous, argillaceous, contains abundant fragments of carbonized wood, thin bedded 1/4"-1" slightly cross-bedded; Upper half yellow brown, fine grained, sub-rounded grain, medium porosity, thin bedded 1"-2", cross-bedded.
4	165	Shale and interbedded siltshale and siltstone, dark gray, weathers black to brown.
3	100	Covered - probably shale.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
2	4	Sandstone, fine, dark gray, weathers brown, thin bedded, argillaceous, shaly, slightly calcareous, low porosity. Poorly exposed.
1	40	Shale, few thin sandstone layers interbedded. Almost entirely covered.
		Lower Cretaceous. Probably present at break in topography, 150' plus below unit 1.

Section J

Composite section from Elusive Creek to 3 miles south, with intermittent exposures to Camp 12. Collections labeled: A 47 Tm 32 for uppermost units; A 47 Tm 31 for next units below; A 47 Tm 24 for units 1 to 24; A 47 Ba 88 to Ba 100 for units Ba 5 to Ba 26; A 47 Tm 23 for units 1A to 4A.

8	Sandstone, very fine, dark gray, weathers dark brown to rusty, well indurated, massive.
60	Poorly exposed shale, bentonitic and carbonaceous with about a 2' coal bed near the base.
15 +	Conglomerate, locally developed for about 40 miles, 50% or more white quartz; ironstone and dark chert pebbles up to 2" in diameter, some bedding planes contain thin horizons of only white quartz pebbles dispersed in the sandstone matrix. Sandstone is medium to coarse, dark brown to dark gray, medium to high porosity.
10	Poorly exposed coal and shale. One 3½' coal bed has a 2" layer of bentonitic claystone, observed in several places over 40 miles. This claystone contains rounded vitreous "grain-like" fragments.
470	Covered.
6	Sandstone, fine to medium, dark buff, poorly exposed.
4	Coal.
15	Sandstone, coarse, light to medium gray, medium-low porosity, carbonaceous, salt and pepper type, slightly calcareous, moderately argillaceous, massive, ledgy contains many round ironstone concretions, basal part is locally siltstone, very ferruginous.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
	30	Siltshale and clay shale, highly covered, carbonaceous partings, several thin coal beds and iron-claystone beds.
	1	Coal.
	5	Sandstone, very fine, dark gray, low porosity, very carbonaceous.
	480	Covered.
	10	Sandstone.
	215	Covered.
27D	3	Sandstone, very fine, light gray, hard, many carbonized wood fragments.
27C	14	Claystone in lower half with massive fossil logs up to 2' in diameter, grading upward into clay shale - unit contains 1" to 2" very fine sandstone beds.
27B	1 - 2	Coal.
27A	6	Sandstone, very fine-fine, light to medium gray, massive, medium porosity, irregularly bedded, 2" clay-ironstone at top.
	50	Covered - thicknesses estimated.
27	30	Sandstone - very fine-fine, brown, very thin bedded, moderately calcareous, highly ferruginous, many carbonized wood remains - low porosity, poorly exposed, some fossil wood noted. (Units 24-27 form north bank of Elusive Creek).
26	4	Coal and shale rubble.
25	98	Covered - indicated shale, coal, and thin-bedded, fine sandstone.
24	52	Sandstone, fine, brown to yellow-brown, moderately calcareous, moderately ferruginous, slightly argillaceous, low-medium porosity, lower 14' cliff forming, thin bedded 1"-3", upper part very fine-fine and very thin bedded - entire unit weathers to red.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
23	65	Sandstone, forms break in slope, good trace, but very poorly exposed. Fine-grained, yellow-brown to dark brown, moderately calcareous, highly ferruginous, slightly argillaceous, low-medium porosity, upper 40' of rubble has numerous lignitic particles which indicate several thin coal beds, 2-foot one at top.
22	4	Poorly exposed shale and interbedded coal.
21	370	Covered, rubble indicates mainly fine-grained sandstone, medium gray from 250' up. At 100' above base a little shale and coal was noted.
20	92	Highly covered, appears to be brown to medium gray fine-grained sandstone with some very thin coal seams.
19	230	Covered - from 50-90' above base there is apparently a sandstone unit like unit 18. From 210' to 230' above base there is a thin coal and shale sequence.
18	62	Sandstone, lower 2' and upper 2' massive to thin bedded 4"-6", ledge forming, medium gray, fine grained, moderately argillaceous, slightly calcareous, low porosity, moderately ferruginous - center very loose, thin-bedded, fine-medium grained with interbedded yellow siltstone. Entire unit weathers orange-red and has occasional zones of red ironstone concretions up to $\frac{1}{2}$ " - some thin sand lenses near center seem more porous - laterally this unit might become a high porosity sand (?).
17	172	Covered - upper 30' more or less appears to be mainly fine grained thin bedded sandstone.
16	20	Sandstone, fine-medium, medium-gray, medium-low porosity, slightly calcareous, slightly argillaceous, moderately ferruginous, very thin bedded, 1/4"-1", cross-bedded, middle 10' forms rounded ridge - trace weathers to light orange red.
15	44	Covered - lower 5' appears to be shale, then a coal bed about 2' thick, overlain by 8' of shale and another coal bed 2-3' thick, then shale.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
14	34	Sandstone, lower 18' cliff forming, coarse-medium, low-medium porosity, salt and pepper type, slightly calcareous, moderately argillaceous, moderately ferruginous, cross-bedded and thin-bedded 2-4" - upper 16' fine medium with very fine beds, highly ferruginous forming red trace, very thin bedded (1/16"-1"), fissile, finely cross-bedded.
13	44	Sandstone, coarse-medium, light rusty color, like unit 10, very thin bedded, loosely cemented, forming soil cover, quite ferruginous.
12	184	Covered but steep slope - several faint traces with sandstone like unit No. 10, probably with interbedded shale - highly covered.
11	33	Covered - probably sandstone and shale.
10	23	Sandstone, brown, coarse-medium with very coarse lenses, salt and pepper type, slightly calcareous, moderately argillaceous, slightly ferruginous, medium-low porosity, sub-angular grains - poorly exposed, rubble trace.
9	170	Covered - lower 3 or 4 feet probably dark gray shale with thin sub-bituminous partings; entire unit probably predominantly shale.
8	5	Sandstone, fine-very fine, quartzitic, slightly calcareous, low porosity, dark gray, weathers rusty red. Massive irregular bedding.
7	1 - 4	Siltstone, dark gray, very hard almost quartzite, weathers to bright orange, lensing.
6	6	Sandstone, fine-very fine, dark gray, slightly calcareous, highly carbonaceous, low-medium porosity.
5	10	Siltstone, dark gray, highly ferruginous weathering to orange colored beds, numerous red ironstone concretions.
4	14	Siltshale with 6"-1' interbedded dark gray siltstone beds containing abundant carbonized wood fragments.
3	3	Siltstone, dark gray, irregularly bedded, massive, indurated, weathers to orange.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
2	5	Lignite to sub-bituminous coal - upper 1' clayey - top and bottom root well-exposed.
1	893	Covered - sandstone crops out at 190' and 470'.
Ba 26	17	Sandstone, basal 5' conglomeratic, pebbles up to 1", medium grained, salt and pepper sandstone, upper part carbonaceous, medium porosity (?).
Ba 25	112	Covered. About 78' above base of unit a carbonaceous shale and coal is indicated.
Ba 24	32	Sandstone, fine-medium, tan to bright tan, salt and pepper texture, trace and rubble heap, slightly friable sandstone and medium porosity (?). Ironstained bands common.
Ba 23	98	Covered.
Ba 22	10	Sandstone, fine, friable, and sandstone, very fine, well indurated, highly ferruginous, salt and pepper, orange stain.
Ba 21	184	Covered.
Ba 20	10	Sandstone, fine, light gray, poorly exposed, weathers bright orange.
Ba 19	273	Covered.
Ba 18	6	Sandstone, same as unit 15, probably more ferruginous.
Ba 16	223	Covered.
Ba 15	18	Sandstone, very fine, dark tan, very ferruginous, rubble.
Ba 14	594	Covered.
Ba 13	58	Sandstone, fine-medium, light brownish gray, salt and pepper texture, medium porosity.
Ba 12	112	Shale, black, interbedded with sandstone, very fine, and siltstones. Unit well indurated, ripple marked; 3/4 of unit is black shale.
Ba 11	180	Sandstone, fine-medium, light brown to gray, salt and pepper texture, pelecypod outlines noted.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
Ba 10	18	Sandstone, very fine, well indurated, interbedded with black shale in 1" to 2" beds, ripple marked, worm trails and mud lumps.
Ba 9	80	Sandstone, medium, light gray, salt and pepper texture, clean, sub-angular grains, finely cross-bedded, ripple marked, weathers into light gray angular blocks, ledgy, some parts very carbonaceous, pelecypod molds, poorly preserved near top.
Ba 8	515	Shale, black, and interbedded sandstone, very fine, in minor amounts. Sandstone grades into siltshale similar to unit 7. This is typical of lower part of unit. Upper part of unit is sandstone, very fine, gray, micaceous, finely cross-bedded, thin bedded - 1"-4", interbedded in equal amounts with black, slightly ferruginous shale. About 385' above base of unit the marine fossil zone represented in the Camp 4 section, appears. The fossils are macerated but a few specimens were collected. In the upper 85' of the unit, sandstone, very fine, and siltshale predominates. This sandstone contains large reed-like impressions 1" wide and up to 6" long, ripple marked, numerous worm borings and mud lumps.
Ba 7	75	Sandstone, very fine, dominantly dull gray brown, weathers from dull purple to tan, low porosity, ledge forming, most beds are carbonaceous, crested assymetrical ripple marks.
Ba 6	50	Shale, sandy, black, light to dark gray on fresh surface, banded appearance.
Ba 5	785	Covered - poorly exposed near top indicating sandstone, very fine, some fossil cavities, carbonaceous, finely cross-bedded, thin bedded, slightly ferruginous; interbedded black shale.
4 a	22	Sandstone, fine-very fine, medium gray, weathering to deep yellow-brown - slightly ferruginous, slightly calcareous, medium porosity, some beds are medium grain, thin bedded in 1"-6" beds with occasional beds of silt shale 3"-6" thick, lensing laterally.
3 a	32	Shale, black, hackly, thin dark gray siltstone beds crop out near center - some very fine sandstone beds, some shale units are nodular near the top.

<u>Unit</u> <u>Top of Section</u>	<u>Thickness</u> <u>In Feet</u>	<u>Description</u>
2 a	5	Sandstone, very fine, tan, slightly calcareous, low porosity, worm tracked, 2" asymmetrical ripple marks, surfaces covered with black, carbonaceous material.
1 a	16	Shale, black, ferruginous near top, well bedded to finely hackly - at 4' a thin bedded dark gray siltstone comes in.
		Lower Cretaceous - Within 200' more or less of contact.

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