The analysis of geologic data collected in 1947 has resulted in some revision in the stratigraphic picture of the Upper Cretaceous and early-Tertiary sequences of rocks. In connection with this revision it has become advisable to drop the use of the term "formation" as the time-rock unit designations A through I and instead to use the term "zone." Use of the term "formation" will be more appropriate in a more detailed tongue-member classification of the Upper Cretaceous rocks.

In these 1947 preliminary reports the time-rock units formerly called Formations E, F, G, H, and I are now called Zones E, F, G, H, and I. However, some changes in vertical limits have been made. These are discussed in the reports concerned.

As the term is used in the October 1947 reports, Zone A is, in general, the sequence of rocks formerly called Formation A. Exceptions are on the Oolamnagavik and Kurupa Rivers where Zone A is equivalent to Formations A, B, and C. Zone A is dominantly a marine section of thick sandstone members separated by siltstone and shale. The thickness is fairly consistent, ranging from about 2,000 feet to about 2,500 feet as measured along streams from the Sagavanirktok to the Utukok Rivers. Zone A has proved to be a very persistent unit laterally. It has been recognized in the field on the Utukok, Colville, Kurupa, Oolamnagavik, Killik, Chandler, Anaktuvuk, Nanushuk, and Sagavanirktok Rivers.

All rocks between the top of Zone A and the bottom of Zone E are now classified as Zone D. This sequence of rocks thickens from east to west, ranging from about 2,500 feet on the Nanushuk to about 5,000 feet on the Utukok River. On the Nanushuk River it is mainly a marine shale section which becomes sandy and contains some coal near the top. Although marine tongues are present in the sections that have been studied to the west, deltaic-coastal, and terrestrial facies form a large part of the section. The units into which Zone D can be divided differ from river to river and are called d-1, d-2, etc. These divisions apply only to a particular river or area and are not to be considered correlative.
Preliminary Report on the Stratigraphy and Structure of the Area of the Colville River North of Umiat, Alaska

By

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Introduction

The stratigraphy and structure of the area of the Colville north of Umiat was studied by U. S. Geological Survey Party No. 1 during the period of May 31 to July 19, 1947. The party, consisting of two geologists, a cook, and a "weasel" mechanic, left Umiat in two "weasels". The weasels were used to transport the party and equipment from camp to camp, and also made it possible for the geologists to work as far as 15 to 20 miles out from a camp in one day. A ten-foot canvas boat was carried along. During most of the month of June even the smaller tributaries to the Kogohokruk carried enough melt and run-off water to make them navigable in the 10-foot boat. The party returned to Umiat on June 23, after traversing both the Kikikdrorak and the Kogohokruk Rivers, and several smaller tributaries to the Kogohokruk.

On June 26 the party left Umiat in three boats and traversed the Colville River down to Ocean Point. The "weasel" mechanic remained in Umiat and Mr. Zumberge, geologist, joined the party. The party returned to Umiat on July 19.

No horizontal or vertical control was established, but all outcrops were located on aerial photographs of the area, as well as on 1:48,000 planimetric base maps. The preliminary geologic map, accompanying this report, shows the locations of all geologic stations where stratigraphic or structural data was obtained. No composite stratigraphic column has as yet been drafted, but descriptions of the major stratigraphic sections are appended to the report. The number prefixed to each section refers to the geologic station shown on the map (Fig.1).

Stratigraphy

All rocks exposed in this area appear to be Tertiary or younger in age except near Umiat where rocks of Zones F, G, and H are exposed. Along the Kikikdrorak, the Kogohokruk, and their tributaries, the outcrops are generally poor, and the thickness of strata exposed is not great. A composite section of all outcrop data has not been attempted because of lack of persistent, traceable, lithologic units, and because of lack of reliable structural control. The section along the Colville, however, is continuous from Sta. 65 north to Ocean Point, and should include all lithologic units mapped on the streams to the west of the Colville.
The rocks of the bluff upriver from Sta. 65 was studied in 1946* and are considered to be Upper Cretaceous (Zone H) in age. The section at Sta. 65 directly overlies these rocks, and the contact is, as far as could be determined, conformable and gradational. There is, however, considerable change in lithology between the rocks of Zone H and those exposed at Sta. 65 and further downriver (stratigraphically higher). There is also a distinct color break between rocks of Zone H and those stratigraphically higher. The bluffs of Zone H are almost uniformly very light gray, whereas the bluffs downriver are banded—alternating buff, yellowish, yellow-red, pink.

Mrs. Loeblich reports** that definite post-Cretaceous foraminifera occurred as deep as 764-765 feet in the Sentinel Hill Core Test. The samples below this depth contain mainly long-range genera. However, as they seem to be the same species as those higher in the well, the entire section is regarded as being early Tertiary. This conclusion is in keeping with field studies. As shown in outcrops to the south, stratigraphically, from the color of Sentinel Hill Core Test, the section is lithologically unbroken down to the base of Sta. 65. The stratigraphically lowest rocks at Sta. 65 are therefore considered to be the basal Tertiary rocks in this area. It therefore appears that there was no break in deposition between the Upper Cretaceous and the Tertiary. The contact is conformable and gradational.

Zone H (Upper Cretaceous) is predominantly a sandy section with some shale, and considerable amounts of bentonite. Coal is extremely rare. The rocks, generally, are fairly well consolidated.

Zone I (Early Tertiary) is a poorly consolidated section of clay, silt, and shale with abundant coal (bony) and tuff, and is very bentonitic throughout. Ironstone lenses and nodules are common, especially in sandstone members. The few sandstone members that occur in this section are generally of two types: (1) Thin beds (up to 1-5 feet thick), usually fairly well consolidated, slaty, fine to medium grained, gray in color, silty. The thicker beds of sandstone are usually loosely consolidated, light gray, fine to medium grained, friable, non-bedded to massive, or cross-bedded, and usually bentonitic. Conglomeratic sands do not occur, with one notable exception. This is the 15-foot conglomeratic sand on which the structure contour map of the "Gubic Anticline" was drawn. (For detailed descriptions of lithology, see appendix)

The rocks of Zone I are exposed in the bluffs of the Colville from Sta. 65 north to Ocean Point. A composite section, aggregating about 2300 feet of these rocks was mapped. Fossils were found at only two localities. These collections have not yet been examined by paleontologists.

* Stafansson, Karl and Whittington, C. L., Stratigraphy and structure of the Unait anticline, 1946.

** Progress of Microfossil Investigations, M.P.R. No.4, Alaska, pp. 7 and 8.
Zone I is capped by a densely consolidated, extremely cross-beded, yellowish or buff-colored sand, that is considered to be Late Tertiary or Quaternary in age. This sand is exposed in some of the bluff of the Lower Colville, but is especially well exposed along the Kogohokruk and the Kikiakrorak and their tributaries. Generally, the basal 10 feet of this sand is conglomeratic, with angular to sub-angular pebbles, cobbles and boulders of chert, tuff, sandstone, shale, silt, and ironstone. Some exposures show the basal 1-2 feet to be a grayish sand. This basal section usually contains fossils. These have not been examined by paleontologists as yet. In places a bluish plastic clay underlies the sand. Higher in the sand, peat beds, up to 4 feet thick, are found. The maximum thickness of this sand seen in this area is about 150 feet. This section is at Station 7.

In smaller outcrops the bluish sand appears to lie conformably on Zone I rocks. Along the Colville, however, in the long bluffs, it is quite evident that the contact is unconformable. The angular unconformity is very low, however, and probably does not exceed 1 or 2 degrees. In the cutbanks of the Kogohokruk and the Kikiakrorak are found numerous evidences of stream-channeling of Zone I rocks, with bluish sand deposited in the channels. In one place the bluish sand was seen overlying Zone I rocks in which a minor fault occurred. The relations were such as to leave no doubt, that the faulting was prior to the deposition of the sand.

STRUCTURE

The over-all impression of the structure of the area was of a very low regional dip to the north, with a few minor flexures. Generally, the dips are 1 degree or less. At only few localities were dips of over 1 degree observed. These low dips, together with lensing and cross-bedding of the sediments, make it impossible in most places to determine accurately the strike of the bedding. At the better exposures, it is possible to determine the general dip-component, that is, whether the rocks dip towards north, south, northeast, etc. On the accompanying map (Fig. 1) most strikes and dips have been left out, because at most localities only the general dip-component could be determined. However, by plotting the dip components at all geologic stations, a few minor flexures were delineated. Thus on the upper Kogohokruk and two tributaries to that river, the reversal in dip-components show a very gentle syncline whose axis must lie between geologic stations 204 and 205, 49 and 50, and 217 and 218. Similarly, about 3 miles further north, an anticlinal axis is outlined between stations 33 and 35, and 40 and 41. North of this anticlinal exposures of rock along the Kogohokruk and the Kikiakrorak show the bedding to be very nearly flat, or with a very low north dip-component.

The geologic traverse along the lower Colville was begun at Sta. 65. The strata here strike approximately H60°W and dip 4 degrees NE. The dip flattens to north, and near Sta. 67 a narrow syncline was observed. North of this syncline an anticline was noted, the north limb of which dips 5 degrees NE at Sta. 68. These two flexures were mapped in detail.
(Fig. 2) with plane table and alidade. Structure contours were drawn on a persistent 15-foot conglomeratic sandstone member (See sections at Sta. 57 and 63) that is stratigraphically about 3000 feet above the No. 1 Oil Zone in Unit No. 1, and approximately 1500 feet below the collar of Sentinel Hill Core test. The structure-contour map (Fig. 2) shows that the anticline has a west plunge, and a closure of at least 40 feet, and probably considerably more. How far this anticline extends towards the east, or whether it has an east plunge can not be determined from surface geology. To the east lies a flat marshy tundra. However, studies made by the U. S. Geological Survey along the Aqaktuvuk River in 1945 show that an anticline, which may be the eastern part of the anticline discussed above, was mapped where it crosses the river. The geographic positions and trends of the two axes are such as to suggest that they are parts of the same major anticlinal axis.

North from Sta. 63 the dips of the strata flatten to two degrees at Sta. 70, and to 1 degree at Sta. 71. From here on north to Ocean Point, the strata dip very gently, probably about 0°30'; to a maximum dip of 1 degree. There is a general regional dip to the north, but several reversals were noted. The structures formed appear to be minor ones, at least on the surface. They are gentle warps that would go unnoticed in smaller outcrops. Along the Colville, however, many of the strata can be traced in the bluffs for several miles, and over such distances a dip of only 1/2 degree becomes apparent. At Sta. 72 one such anticlinal warp was noted, and less than 1/2 mile south there is a minor synclinal warp. Similarly, at Sta. 227 a minor anticline and syncline were seen. At Sta. 73 there is another minor anticline. Theoretically there should be a syncline somewhere between Sta. 227 and 73. The axis of such a syncline was not seen. At Sta. 73 and 74 minor anticlines were seen, with a syncline in between. From Sta. 74 north to Ocean Point, no structures were seen. The strata appear to be practically flat lying, or have a very low (less than 1 degree) north dip-component. There are no outcrops north of Ocean Point.

Along the entire length of the Colville bluffs, from Sta. 65 north to Ocean Point individual strata show considerable minor folding. That is, one bed may be considerably folded, but the overlying and underlying strata are not. This was particularly noticeable at Sta. 75 where a 20-30 foot sequence of coal, clay and bentonite was tightly folded into three anticlinal folds, but the overlying and underlying beds were practically flat lying, and undisturbed.

Several minor thrust faults were seen. The maximum displacement on any one fault was 6 feet. Practically all these faults were thrust from the south.
DESCRIPTI07 (*) or STATIC I .

ZONE I ALONG COVILLE RIVER

Station 65:

Top of section
30.0 ft. - Clay, sandy, carbonaceous, tuffaceous. Some pure tuff. Exposure weathers out in "needles". Weathered surfaces noticeably medium yellow to yellow-red. Top of this unit same as bottom Section 66.
1.0 ft. - Bentonite, light yellow.
15.0 ft. - Clay, medium to dark gray.
0.2 ft. - Clay, bentonitic. Weathers white.
10.0 ft. - Clay, dark gray.
0.1 ft. - Bentonite, brown.
9.0 ft. - Clay, dark gray.
0.1 ft. - Bentonite, tan.
7.0 ft. - Clay shale, dark, very thinly laminated.
0.1 ft. - Bentonite, yellow.
8.0 ft. - Clay shale, dark gray.
0.2 ft. - Bentonite, brown.
5.0 ft. - Clay, dark gray.
6.0 ft. - Clay, interbedded with several 2-3" beds of bentonite. Large ironstone concretions present.
12.0 ft. - Covered, probably similar lithology to the preceding 6 ft.
1.3 ft. - Bentonite, yellow-brown.
0.2 ft. - Clay, light gray, bentonitic.
1.5 ft. - Bentonite, light gray at base to yellow-green. Grades into clay above.
30.0 ft. - Pyroclastic section. Interbeds, 1'-1' thick, tuff, volcanic ash, bentonite, and clay.
2.5 ft. - Tuff, friable.
11.0 ft. - Clay, shale at base.
7.0 ft. - Silt and shale, carbonaceous, dark gray.
160.2 ft.

Station 66:

Top of section
7.0 ft. - Sandstone, fine-grained, friable, bentonitic. Weathers yellow. Top of this sandstone same as bottom of Section 67.
0.5 ft. - Conglomerate.
13.0 ft. - Coal zone. Coal is bony. A lens, 3.5-6 ft thick, of carbonaceous, fine-grained sandstone lies in middle of zone. A few thin yellow-brown beds of bentonite in the coal.
25.0 ft. - Largely covered. Fine-grained, medium gray, carbonaceous sandstone present.
2.0 ft. - Coal and clay interbeds, in 2-5' ft layers.
5.0 ft. - Covered
2.0 ft. - Clay, medium gray, bentonitic.
15.0 ft. - Sandstone, fine-grained, light gray, cross-bedded.
25.0 ft. - Tuff, stratified, bluff-forming. Bentonite at base.
20.0 ft. - Clay, shaly, somewhat bentonitic.
80.0 ft. - Clay, very silty, some shaly, minor interbeds of thin bentonite, several ironstone lenses. Cliff-forming, weathers red-brown.
80.0 ft. - Clay, similar to above 80 feet, less silty and more shaly.
Interbeds of bentonite, and lenses of ironstone.
277.5 ft.

Station 67:

Top of section
10.0 ft. - Sandstone, very bentonitic, largely covered. Bottom of this sandstone same as bottom of 25-foot sandstone at top of Section 68.
10.0 ft. - Covered, probably clay, bentonitic.
20.0 ft. - Sandstone, lt-med. gray to wk. ygy, fine to medium grained, friable, cross-bedded, massive. Abundant ironstone nodules, up to 8" diam., also 2 ironstone lenses 2-3" thick.
15.0 ft. - Partly covered. Clay, bony coal, and bentonite. Upper 10 feet appears to be mostly bony coal with thin interbeds of bentonite.
10.0 ft. - Sandstone, light gray, medium grained, bentonitic.
20.0 ft. - Partly covered. Dark colored material, probably clay and shale, somewhat bentonitic.

15.0 ft. - Sandstone, conglomeratic. Cliff-forming. Sand is coarse-grained, somewhat friable, light to medium gray. Extreme cross-bedding. Conglomeratic layers up to 2 ft thick, with pebbles, cobbles and boulders of chert (greenish and bluish black) and quartz. Pebbles 1-3" most abundant. Conglomerate layers lens and split. Carbonaceous plants and tree fragments present.
5.0 ft. - Covered, probably shale or clay.
4.0 ft. - Sandstone, hard, massive, fine-grained, light to medium gray, with a few pebbles of black chert near top.
117.0 ft.

* Marker horizon used in delineating the "gubic" structure. See also section at Station 68. This section (at 68) better exposed than at Station 67.

Station 68:

Top of section
25.0 ft. - Sandstone, friable, fine-grained, bentonitic, medium gray. Top of this sandstone same as bottom of Section 69.
15.0 ft. - Clay and silt shale, bentonitic, and with some coal. Top 3 feet is largely bony coal, or highly carbonaceous shale.
20.0 ft. - Sandstone, medium-grained, medium gray, friable, and with considerable amounts of ironstone nodules and lenses.

15.0 ft. - Clay and silt shale, some bentonite layers. One layer of pure yellow swelling bentonite.

8.0 ft. - Sandstone, cliff-forming. Light to medium gray, medium grained, fairly well indurated, with scattered pebbles of chert and quartz. Massive, but some extreme cross-bedding present, especially where laminae of carbonaceous material occur. A few lenses of ironstone, up to 3-4" thick, are present.

25.0 ft. - Partly covered. Probably silt or clay shale. May contain lenses or beds of bentonite and bony coal.

*15.0 ft. - Conglomeratic sandstone. Light to medium gray, medium grained, extremely cross-bedded. Contains conglomeratic layers of pebbles, cobbles and boulders (chert, quartz, and some tuff). These layers lense and split, maximum thickness 3 feet. Some carbonaceous plant and tree fragments are present.

123.0 ft.

* Marker horizon -- see Station 67.

Station 69:

Top of section

8.0 ft. - Sandstone, fine-grained, light gray, cross-bedded, slabby, cliff-forming. Lenses and nodules of ironstone. Weathered red-brown. Top of this sandstone same as bottom of Section 70.

60.0 ft. - Claystone, dark-colored. Weathered medium gray. Soft and very crumbly. Indications of shell-fragments, but rock too crumbly to permit collecting of fossils.

3.0 ft. - Sandstone, medium-grained, gray, slabby, scattered pebbles of black chert. Shell fragments present.

20.0 ft. - Covered, probably clay similar to following 15 feet.

15.0 ft. - Clay shale, brownish.

6.0 ft. - Clay shale, gray colored, bluff-forming.

20.0 ft. - Clay shale, brown, finely laminated. Some thin interbeds of bentonite, and carbonaceous streaks.

20.0 ft. - Covered by bentonite. Appears to be very bentonitic clay shale and clay. Some ironstone lenses are present. One fairly resistant shale horizon, 3 feet thick, gray in color, occurs near top. Interbeds of bentonite.

1.0 ft. - Bentonite, bright yellow.

20.0 ft. - Clay shale, thinly laminated, dark brown to black in color.

4.0 ft. - Shale, silty. One layer of bony coal, 0.4 ft thick, near base. Occasional thin ironstone lenses, and thin interbeds of bentonite.

36.0 ft. - Shale, clayey, very thinly laminated, some carbonaceous layers.

12.0 ft. - Clay, dark gray, bentonitic.

1.0 ft. - Coal, bony.

1.5 ft. - Bentonite, yellow.
5.0 ft. - Coal zone, bony, with thin clay and bentonite interbeds.
0.5 ft. - Bentonite, brown and yellow.
15.0 ft. - Clay, bentonitic, with some shaly and silty lenses and bentonite interbeds.
5.0 ft. - Shale, carbonaceous. One 12 ft layer bony coal in middle, topped by 0.1 ft of carbonaceous shale overlain by 0.1 ft white ash layer.
25.0 ft. - Partly covered. Clay, bentonitic, with some ironstone lenses. Appears more shaly and silty toward top.
6.0 ft. - Shale, carbonaceous, some clay and bentonite interbeds.
4.0 ft. - Coal, bony, with thin interbeds of bentonite.
16.0 ft. - Clay, bentonitic. Some sandy lenses.
30.0 ft.

Station 70: (Composite section)

Top of section
15.0 ft. - Clay and silt interbeds, bentonitic. Top of this unit same as bottom of Section 71.
10.0 ft. - Clay and interbeds of tuff and bentonite.
6.0 ft. - Coal, bony, with laminae of carbonaceous shale.
30.0 ft. - Silt, and sandy clay.
2.5 ft. - Ironstone.
1.5 ft. - Coal, bony.
16.0 ft. - Silts and clays interbedded.
4.0 ft. - Coal, bony.
4.0 ft. - Silt.
2.0 ft. - Coal, bony.
150.0 ft. - Covered. Traces of interbedded silt and clay, some ironstone.
5.0 ft. - Clay and silt. Strong stratification.
1.0 ft. - Ironstone.
6.0 ft. - Coal, bony, interbedded with carbonaceous clay. Layers 6" to 1 ft.
30.0 ft. - Sandstone, fine-grained with interbeds of silt. Ironstone lenses up to 3 ft thick present.
45.0 ft. - Sand, light gray, very bentonitic, high silt content. Considerable amounts of ironstone.
18.0 ft. - Clay, interbedded with bony coal, sand bentonite. One thin bed ironstone 2 ft. up from base.
50.0 ft. - Clay and sandy silt, with interbeds of bony coal, thin beds about 20 feet up from base. Strong cross-bedding, and facies change northward, from sandy to more clayey.
20.0 ft. - Siltstone, sandy (or silty sandstone), thinly laminated and minutely cross-bedded.
15.0 ft. - Pyroclastic section, interbeds of tuff, carbonaceous tuff, bentonite (hard) a few thin layers of bony coal, clay and silt.
2.0 ft. - Claystone.
1.0 ft. - Coal, bony.
12.0 ft. - Clay and sandy siltstone, some ironstone. Section much iron stained, even-bedded in about 2" layers.
6.0 ft. - Shale, carbonaceous, some bony coal. Lensing pronounced.
75.0 ft. - Largely covered. Basal 30 feet probably a series of carbonaceous shale interbedded with clays. May be same to top.

10.0 ft. - Sand, fine-grained, very loosely consolidated, fossiliferous. Fossils in top 1 foot, also in some ironstone and ironstained sandstone blocks that apparently overly this section.

60.0 ft. - Covered.
1.0 ft. - Coal, bony.
10.0 ft. - Clay.
2.0 ft. - Coal, bony.
30.0 ft. - Covered. Some clay shale in section.
5.0 ft. - Sandstone, unconsolidated, very bentonitic.
25.0 ft. - Covered by bentonite slides.

610.0 ft.

Station 71: (Generalized)

Top of section

150.0 ft. - Interbedded clay, shale, silt, and ironstone. Top of this unit same as bottom of Section 227.

1.0 ft. - Coal, bony.
20.0 ft. - Sandstone, fine to medium grained, medium gray, silty.
2.0 ft. - Carbonaceous shale, bony coal.
50.0 ft. - Sandstone, fine-grained, gray, silty, with ironstone lenses.
5.0 ft. - Shale, carbonaceous, with interbeds of silt.
25.0 ft. - Sandstone, silty, and bentonitic.
15.0 ft. - Shale, carbonaceous, with clay interbeds and some bentonite.
50.0 ft. - Clay, silt, and some sandy silt, interbedded.

318.0 ft.

Station 227:

Top of section

30.0 ft. - Clay and silt, sandy. Top this unit same as bottom of Section 79.

2.0 ft. - Coal, low grade.
40.0 ft. - Clay and silt, bentonitic.
15.0 ft. - Sandstone, bentonitic, fine to medium grained, light to medium neutral, poorly cemented, very friable. A wet sample is unconsolidated. Contains laminations of carbonaceous material.

0.5 ft. - Coal.
2.0 ft. - Clay.
1.0 ft. - None.
15.0 ft. - Clay and silt.
2.0 ft. - Coal, low grade thin.
40.0 ft. - Silt and clay, thin layers of carbonaceous material. 5 feet in the middle is laminated sandstone and silt shale.

1477.5 ft.
Station 79:

Top of section
Gypseous sand.
5.0 ft. - Silt and sandstone, interbedded. Top of this unit same as bottom of Section 231.
0.5 ft. - Shale, carbonaceous.
5.0 ft. - Clay, gray.
5.0 ft. - Sandstone, medium gray, medium-grained, fairly well consolidated, slabby, cross-bedded.
2.0 ft. - Coal, bony, and carbonaceous shale.
27.5 ft.

Station 231:

Top of section
Sandstone, poorly consolidated, has minor layers of silt. At the base is thin conglomerate up to 3-inch cobble size, containing chert and quartz. The sandstone is medium to fine grained, moderately porous, light green-gray. Top of this sandstone is same as bottom of Section 232.
30.0 ft. - Interbedded silt and clay.
10.0 ft. - Sandstone, as described above. Contains several conglomerate layers, with silty ironstone pebbles and white quartz.
4.0 ft. - Coal and bone.
2.0 ft. - Brown sandy silt, bentonitic.
71.0 ft.

Station 232:

Top of section
10.0 ft. - Clay and silt. Top of this unit is same as bottom of Section 63.
0.5 ft. - Bentonite.
0.5 ft. - Bone.
3.0 ft. - Sandy silt.
0.5 ft. - Bone.
3.0 ft. - Silt.
0.5 ft. - Bone.
25.0 ft. - Silt and clay.
20.0 ft. - Sandstone. Basal part is dark green, on a wet surface. Central part is light green, very fine-grained, moderately porous. Top is laminated with interbeds of carbonaceous material. The 20-foot unit contains a few crossbeds. It has some silty layers.
20.0 ft. - Bone and carbonaceous silt, bentonitic.
10.0 ft. - Bone.
10.0 ft. - Bentonite, yellow.
1.0 ft. - Bentonitic silt.
8.0 ft. - Bentonite, gray, silty.
8.0 ft. - Bone and clay. Three distinct bone layers 1 foot thick. The clay is bentonitic.
62.0 ft. - Poorly exposed. Thickness approximate. Primarily silt and clay.
162.0 ft.
Station 83:
Gubic sand
30.0 ft. - Clay and silt, interbedded, bentonitic near top.
1.0 ft. - Tuff (thickness varies, up to maximum of 4 ft.)
19.0 ft. - Silt and clay, interbedded. Includes 3 layers (thin) of bony coal and carbonaceous shale. Also some thin tuff layers. Section slightly bentonitic.
20.0 ft. - Silt and clay interbeds.
70.0 ft.

DESCRIPTIONS OF STRATIGRAPHIC SECTIONS MEASURED ALONG THE KILIKILPIK AND KOGHOKRAK RIVERS

Station 13:
Top of section
2.0 ft. - Coal, bony, or carbonaceous shale.
5.0 ft. - Sandstone, with interbeds of silt.
3.0 ft. - Coal, bony, with layers of carbonaceous shale.
10.0 ft. - Silt, sandy.
3.0 ft. - Coal, bony.
15.0 ft. - Silt, sandy, bentonitic at base.
2.0 ft. - Bentonite.
15.0 ft. - Sandstone, silty and bentonitic.
3.0 ft. - Silt, carbonaceous, with siltstone layers 1 to 3" thick.
2.0 ft. - Clay, bentonitic, with ironstone lenses 6-10" thick, 4 ft. long.
2.0 ft. - Shale, carbonaceous.
3.0 ft. - Sandstone, fine to medium grained, medium gray, stratified 1-2".
15.0 ft. - Silt and pyroclastics interbedded, with one 6" coal bed in middle.
60.0 ft.

Station 16:
Top of section
1.0 ft. - Coal, impure.
10.0 ft. - Sand, medium gray, medium grained, bentonitic.
5.0 ft. - Clay, bentonitic, with ironstone lenses (thin).
5.0 ft. - Zone of interbedded coal - layer, 6-8" thick, with bentonitic sand.
5.0 ft. - Sand, gray, bentonitic.
1.0 ft. - Silt, brown, bentonitic.
1.0 ft. - Tuff, whitish.
5.0 ft. - Sand, interbedded with silt layers and ironstone.
0.5 ft. - Bentonite, brown.
1.5 ft. - Coal, bony.
0.5 ft. - Clay, dark brown, bentonitic.
30.0 ft. - Sandstone, medium gray, medium grained, friable, cross-bedded.
Contains some layers of ironstone.
65.5 ft.
Station 20:

Top of section
15.0 ft. - Cubic sand
1.0 ft. - Sand, bentonitic.
0.5 ft. - Shale, carbonaceous.
5.0 ft. - Sand, silty, bentonitic.
2.0 ft. - Shale, carbonaceous, or bony coal.
30.0 ft. - Sand, brownish-gray, and silt. Minor ironstone lenses.
3.0 ft. - Coal, bony, and carbonaceous shale, with interbeds of clay.
20.0 ft. - Sand and silt, interbedded, layering 1-2". Loosely consolidated, friable, medium gray. Some layers very shaly.
Sharp, minor cross-bedding. Ironstone lenses, 3-5" thick.
1.0 ft. - Coal, bony, shaly.
2.0 ft. - Clay.
82.5 ft.

Station 24:

Top of section
5.0 ft. - Sandy clay and ironstone interbeds. Bentonitic.
2.0 ft. - Ironstone.
1.0 ft. - Clay, bentonitic.
1.0 ft. - Coal, bony.
15.0 ft. - Sandstone, fine-medium grained, gray, cross-beded, with 1-3" ironstone.
1.0 ft. - Ironstone.
2.0 ft. - Coal, bony, with thin interbeds of clay.
12.0 ft. - Sandstone, gray, fine-medium grained, cross-beded, bentonitic. Also ironstone, about 1/4 of section.
0.5 ft. - Coal.
3.0 ft. - Clay, bentonitic.
1.0 ft. - Coal, bony, chunky.
43.5 ft.

Station 26:

Top of section
7.0 ft. - Sand and clay interbeds, bentonitic.
0.3 ft. - Bentonite, tan.
0.2 ft. - Clay, dark gray.
0.5 ft. - Bentonite, tan.
3.0 ft. - Sand, brownish, bentonitic.
1.0 ft. - Coal, bony.
0.5 ft. - Bentonite, tan.
1.5 ft. - Coal, bony.
20.0 ft. - Sandstone, loosely consolidated, light yellow gray, medium grained, very clayey, bentonitic. Weathers brownish.
30.0 ft. - Sandstone, similar to preceding 20 ft., same color and grain size. Somewhat better consolidated (still poor), very friable, fairly well stratified. Base clayey.
0.1 ft. - Bentonite, yellow.
3.0 ft. - Coal, bony.
6.0 ft. - Clay shale, and very indurated clay-stone, much fractured. Some ironstone. Shaly layers thin, about 0.5 inches.
0.3 ft. - Bentonite, light tan, topped by 2 carbonate layers, 1/4" thick each.
1.0 ft. - Silt, shaly, carbonaceous, yellow-weathering stringers throughout bed.
2.0 ft. - Coal, bony, with thin layers (up to 1/2") of carbonaceous shale.
6.0 ft. - Clay, brown, bentonitic, with some sandy layers.
1.5 ft. - Sandstone, light gray, fine-medium grained, layered 2-3", minor cross-bedding.
1.5 ft. - Sand, light gray, bentonitic, unconsolidated.
0.7 ft. - Bentonite, light yellow.
3.0 ft. - Tuff, carbonaceous, thinly laminated.
1.0 ft. - Tuff, grayish, weathered reddish.
3.0 ft. - Coal, bony. Coal layers 5-10" separated by clay 1-2" thick. Galls abundant on surface.
2.0 ft. - Ironstone, with some silty clay, slightly bentonitic.
6.0 ft. - Clay, gray, silty, slightly bentonitic.
0.5 ft. - Coal, bony.
6.0 ft. - Partly covered, probably silt and sand.
107.6 ft.

Station 29:

Cubic Sand

15.0 ft. - Clay, silt, sand, interbedded, well stratified.
5.0 ft. - Clay and silt.
5.0 ft. - Sandstone, gray, medium grained, bentonitic.
0.2 ft. - Bentonite, whitish.
0.5 ft. - Shale, carbonaceous.
5.0 ft. - Silt, brown weathering, with lenses of ironstone.
2.0 ft. - Silt, carbonaceous, with some bony coal.
10.0 ft. - Sandstone, medium gray, medium grained.
42.7 ft.

Station 32:

Top of section

15.0 ft. - Bentonitic sands with lenses and beds of ironstone, and thin layers of carbonaceous material.
1.0 ft. - Silt, carbonaceous.
3.0 ft. - Clay, bentonitic, and ironstone lenses.
1.0 ft. - Clay, carbonaceous.
1.0 ft. - Sand, bentonitic.
0.5 ft. - Clay, carbonaceous.
1.5 ft. - Clay and ironstone.
0.5 ft. - Coal, bony.
2.0 ft. - Clay and ironstone.
0.5 ft. - Clay, carbonaceous.
3.0 ft. - Sands, bentonitic, unconsolidated.
0.5 ft. - Clay, carbonaceous.
5.0 ft. - Silty clay and ironstone.
2.0 ft. - Clay, carbonaceous.
6.0 ft. - Silt and clay, interbeds of ironstone.
0.4 ft. - Shale, carbonaceous, to bony coal.
6.0 ft. - Sandstone, bentonitic, loosely consolidated.
3.0 ft. - Coal, bony, shaly.
53.9 ft.

Station 35:

Gubic Sand
8.0 ft. - Sandstone, light gray to greenish, fine to medium grained, poorly consolidated friable, cross-beded.
0.5 ft. - Conglomerate, well-rounded pebbles up to 2" blue, green, red, and white chert. Sandy matrix.
3.0 ft. - Coal. One 5" bentonite bed, tan-yellow within coal, one 1/4 inch bentonite at top.
6.0 ft. - Covered.
25.0 ft. - Pyroclastics, tuff, ash, some bentonite, banded, 2-3" layers.
42.5 ft.

Station 44:

Gubic Sand
8.0 ft. - Sandstone, gray, fine-grained, bentonitic.
2.0 ft. - Bentonite, sandy gray.
7.0 ft. - Coal zone, with 4 interbeds (thin) of gray bentonite.
1.0 ft. - Bentonite, sandy.
0.5 ft. - Shale, carbonaceous.
1.5 ft. - Sand, gray, bentonitic.
0.2 ft. - Bentonite, red-brown.
1.0 ft. - Clay, brown, shaly in part.
0.4 ft. - Bentonite, sandy, yellow.
9.0 ft. - Shale, carbonaceous, with interbeds of silt and sand, some ironstone lenses up to 3" thick. Sand mainly in center, top and bottom shallier.
0.2 ft. - Bentonite, yellow.
3.0 ft. - Shale, carbonaceous, with one 1.5 inch layer of brown bentonite near base. Sandier near top.
0.4 ft. - Bentonite, brown.
1.0 ft. - Coal.
1.0 ft. - Shale and silt interbeds. Sandy at top. Ironstone lenses up to 1" thick.
1.5 ft. - Shale, silty and carbonaceous.
2.5 ft. - Sandstone, medium gray, fine-grained, friable, bentonitic; with nodules and lenses of ironstone up to 1" thick. Top is ironstone lens 2" thick.
43.2 ft.
Station 64:

Top of section
2.0 ft. - Coal.
25.0 ft. - Covered.
10.0 ft. - Sandstone, gray, fine-grained.
2.5 ft. - Coal zone.
15.0 ft. - Sandstone, light gray, fine-grained, bentonitic.
15.0 ft. - Clay, dark gray, carbonaceous, somewhat sandy.
3.0 ft. - Sand, yellowish, medium grained.
4.0 ft. - Sand, light gray, fine-grained, bentonitic.
20.0 ft. - Sand, silt, interbedded, yellow-brown weathering.

96.5 ft.

Station 30:

Top of section
10.0 ft. - Cubic sand.
25.0 ft. - Partly covered, probably clay section.
4.0 ft. - Clay, with thin interbeds of bony coal.
4.0 ft. - Coal, bony, with thin interbeds of clay, and one 1 ft. bed of tuff in middle.
30.0 ft. - Interbeds of clay and silt, with some carbonaceous shale.
Bentonitic.
4.0 ft. - Sand, silty at bottom, getting more clayey towards top.
6.0 ft. - Partly covered. Zone of bony coal with interbeds of clay.

83.0 ft.

Station 82:

Top of section
25.0 ft. - Cubic sand. Yellow-buff sand, unconsolidated, with layers of gray sand. Conglomeratic sporadically for 10 feet from base. Peat interbeds.
20.0 ft. - Sands, gray, unconsolidated, conglomeratic, fine-grained, cross-bedded, fossiliferous. Probably the basal Cubic sand.
6.0 ft. - Coal zone, bony, with interbeds of carbonaceous shale and clay.
25.0 ft. - Clay, medium gray, slightly bentonitic, with few interbeds of sands, silts, and carbonaceous shale.
30.0 ft. - Sandstone, salt and pepper, fine-grained, loosely consolidated, with layers and nodules of clay, and ironstone lenses. Grades into above 251.

106.0 ft.

Station 203:

20.0 ft. - Cubic sand
8.0 ft. - Bone and ash(?).
1.0 ft. - Bentonite, yellow.
20.0 ft. - Interbedded clay and silt.
10.0 ft. - Sandstone, bentonitic, light to medium gray. Contains 2-foot lenses of ironstone.
4.0 ft. - Coal, in 6 to 12 inch beds with clayshale interbeds. The coal varies in quality from low-grade to bone.
2.0 ft. - Bentonitic clay.
1.0 ft. - Coal and ash(?), tuff.
1.0 ft. - Bentonite, yellow.
5.0 ft. - Coal, in 6 to 10 inch layers, with 3 to 4 inch interbeds of tuff.
0.5 ft. - Tuff, gray.
1.0 ft. - Tuff, light neutral.
2.0 ft. - Coal in 3 to 6 inch layers with 1 to 2 inch interbeds of tuff.
1.0 ft. - Clayshale.
1.5 ft. - Bentonite, yellow.
1.0 ft. - Bone.
5.0 ft. - Gray bentonitic clay.
34.0 ft.