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United States

Department of the Interior

U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

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By

Robert M. Chapman and Edward G. Sable

April 1950

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STRATIGRAPHY AND STRUCTURE OF THE KOKOLIK AND KUKPOWRUK RIVERS AREA, ALASKA

By

Robert M. Chapman and Edward G. Sable

INTRODUCTION

Party and Logistics

U. S. Geological Survey Party 6 traversed the area of the Kukpowruk and Kokolik Rivers, northwestern Alaska, during the field season of 1949. The party consisted of Robert M. Chapman, geologist and party chief, Edward G. Sable, geologist, Dale A. Hauck, field assistant, Gordon W. Herreid, field assistant, Paul H. Shannon, cook, and Ralph Solecki, Smithsonian Institution archaeologist who was attached to the party through an arrangement with the Office of Naval Research. With the excellent assistance and cooperation of all the temporary employees, it was possible to complete the geological work in this large area in the time available. Special commendation is due Mr. Solecki, who not only carried on his own investigations but also aided at all times the progress of the geological work.

The party assembled at Umiat in mid-May, and three men and equipment were flown by bush plane on May 17 to the initial field camp on the Kukpowruk River, about 16 miles from the headwaters. Owing to inclement weather and a forced landing of the plane, the other three men and equipment did not reach camp until May 27. At this time sufficient snow remained in the area for safe bush landings. The downriver travel was begun on June 13 in three 18-foot folding canvas boats. Food and some equipment had previously been landed by bush plane during April and early May at the initial camp, at six caches along the Kukpowruk, and at six caches along the Kokolik. All of the food was cached in metal drums, and everything was found intact.

Owing to unseasonable weather during June, the work was delayed and the party did not reach the mouth of the Kukpowruk until July 30. At this point the hospitality of the U. S. Coast and Geodetic Survey camp near Point Lay was enjoyed until the party could be moved, in three bush-plane loads, to the large lake on the Kokolik River about 16 miles below the headwaters. Work was begun at this point on August 2, and the traverse completed to the mouth of the Kokolik on September 3. The party was transported to Barrow in three bush-plane loads between September 3 and 6, and returned to Umiat and Fairbanks.

Work Accomplished

During the season detailed geologic studies were made of the river-bluff exposures, and of outcrops and traces as far east and west of the rivers as the time and geology warranted. A total of about 225 air-line miles along the rivers was covered. Triangulation nets and elevations were carried by theodolite from the initial camp to the mouth of the Kukpowruk River, where a tie to U. S. Coast and Geodetic Survey stations was made, and from the lake on the Kokolik River to a point about 40 miles above the mouth of this river. Insofar as possible, stations for this net were located on points of geological interest, and additional shots were taken to provide control for geological and aerial-photo computations. These data were augmented by barometer traverses.

It is believed that all the significant exposures of rock that can be reached by a party traveling in boats were examined. If further work is contemplated in this or contiguous areas, weasel transportation will be necessary in order to gather a significant amount of additional data.

Most of the vertical and trimetrogen aerial photographs of the area have been examined by the authors and/or photogeologists of the Navy Oil Unit. Insofar as possible the formation and zone contacts, the fold axes, and attitudes of beds have been interpreted and from the photographs in areas not reached in the fields, and the geologic coverage shown on figure 1, therefore, includes the area between the Kokolik and Kukpowruk Rivers, and also areas to the east and west beyond these rivers. Additional detailed photogeologic work still remains to be done, particularly in the southern and western parts of the region although all the major features have been delineated.

Previous Work in the Area

Several earlier surveying and geological traverses have been made in parts of this area. In 1923 W. T. Foran and party ascended the Kukpowruk River for a distance of about 45 miles from the coast and the Kokolik River for a distance of about 40 miles in connection with the earlier Geological Survey investigations of Naval Petroleum Reserve No. 4. In 1926 P. S. Smith and party crossed part of the headwaters area of the Kukpowruk River on a dog-sled trip from Kivalina to the Kokolik River 1/. Smith's party descended the Kokolik River by canoe from a point a few miles north of Poko Mountain to the coast 2/. A U. S. Bureau of Mines party, investigating coal deposits, ascended the Kukpowruk River in 1946 and covered about the same area that was examined by Foran in 1923 3/.

1/ Paige, Sidney, Foran, W. T., and Gilluly, James Reconnaissance of the Point Barrow region, Alaska: U. S. Geol. Survey Bull. 772, 1925.

2/ Smith, P. S., and Mertie, J. B. Jr., Geology and mineral resources of northwestern Alaska: U. S. Geol. Survey Bull. 815, 1930.

3/ Toenges, A. L., and Jolley, T. R., Investigation of coal deposits for local use in the Arctic regions of Alaska and proposed mine development: U. S. Bur. Mines, R. I. 4150, December 1947.

Recommendations for additional work

If additional information is desired on Lower Cretaceous and older rocks in the southwestern part of N.P.R. No. 4, the headwaters region of the Utukok, Kokolik, and Kukpowruk Rivers contains considerable accessible geology that was beyond the reach of Party 6. As a result of an airplane reconnaissance with R. L. Miller in the headwaters of the Kokolik, Kuguruok, and Kelly Rivers, of an examination of aerial photographs, and of binocular examination in the field, it is apparent that there are numerous workable outcrops and rubble traces in the Southern Foothills province, in the De Long Mountains, and in the foothills on the south side of the mountains.

Exposures of Lower Cretaceous, Triassic, Lisburne, and Noatak rocks were identified with reasonable assurance. In the opinion of the authors, practically all these exposures could be reached by weasel parties and could not be worked effectively by any other method.

It is apparent that marked changes in facies and in thickness occur in rocks of the Nanushuk group between the Utukok River and the coast. If this problem is of future interest, detailed examinations by a weasel-borne field party in the Northern Foothills section would be necessary to map these rocks properly.

Terrain

Parts of the Coastal Plain and Arctic Foothills provinces are included in this area. The Coastal Plain is characterized by relief of less than 300 feet, many lakes and swamps, poorly defined drainage, and scattered, poorly exposed outcrops that are confined to the cut banks of the major rivers. The Northern Foothills section of the Arctic Foothills Province is a roughly east-trending belt of rolling terrain 40-50 miles wide that is marked by prominent cuesta ridges and mesas which reflect the underlying synclinal and basin structures. River-bluff outcrops are excellent, and many additional rock exposures occur along tributary creeks and on the ridges where the vegetal cover is thin to nonexistent. The drainage is good and lakes are rare and very small. The local relief is from 300 to 2,200 feet, and averages about 600 feet. The Southern Foothills section of the Arctic Foothills Province lies between the Northern Foothills and the De Long Mountains, the name applied to the western part of the Brooks Range. It is a region of scattered high hills, featureless flats with a few lakes, most of which are small in size, and high, rugged hills and ridges adjacent to the mountains. Drainage is mostly good, streams are small and shallow, and many of the smaller creeks are sharply incised with very little level valley floor. Outcrops are located chiefly on the rivers and small tributaries, and most of the ridges are talus-covered and barren of of vegetal cover. The local relief is from 500 to 2,500 feet and averages approximately 800 feet.

No serious difficulties in weasel, boat, or foot travel are encountered in the Coastal Plain province and Northern Foothills section. In the Southern Foothills section travel on foot presents no more than usual difficulties. The The streams, except at flood stage, are too small and shallow to be practical for boat travel. Weasel travel is feasible nearly everywhere, if care is exercised in choosing routes.

Station Ch-116-117 . Syncline 3, north limb; zones B-C.

Top of section

4 ft.	-(Top Ch-117) Siltstone, medium gray to dull yellow, carbonaceous fragments and laminae, iron staining, chunky fracture, moderately indurated, non calcareous, irregular bedding.
2 ft.	-(Base Ch-117) Siltstone, medium gray, hard, thin bedded.
100 ft.	-Covered
3 ft.	-(Top Ch-116) Sandstone, fine to very fine-grained, light gray to pale yellow, non-calcareous, carbonaceous fragments and laminae, moderately to well indurated, beds 1-2 " thick.
5 ft.	-Siltstone, weak yellow to dark gray, non calcareous, moderately indurated, gnarled surfaces, chunky fracture, abundant carbonaceous plant impressions, some silt shale interbedded.
65 ft.	-Covered; some carbonaceous and coaly shale, limy ironstone concretions, and highly calcareous siltstone in talus.
48 ft.	-Siltstone, medium gray, moderately calcareous, abundant carbonaceous plant fragments, well indurated, beds 1-7 " thick, ripple marks; some interbedded mud shale, weak yellow to dark gray, soft, chunky fracture; a few massive cross bedded siltstone layers, 2-3 ft. thick .
25 ft.	-Covered.
3 ft.	-Siltstone, similar to 48 ft. above
255 ft.	

Station Ch-139,141. Syncline 6, Kukpowruk River, south limb; zones B-C.

Top of section

25 ft. -(Top Ch-141) Sandstone, very fine-grained to silty, light gray, shaly cross bedded, carbonaceous fragments and laminae, beds 2-5 " thick, heavy iron stain.

9 ft. -Sandstone, very fine-grained, silty, light gray, salt and pepper type, non-calcareous, carbonaceous and coaly fragments and laminae, moderately to well indurated, low porosity, ripple marks, beds 3-12 " thick.

5 ft. -(Base Ch-144) Siltstone, thin to shaly bedded, medium gray, nodular, gnarled appearance, iron nodules, ripple marks.

744 ft. -Covered.

? (Top Ch-139) Siltstone, weak yellow to medium gray, thin bedded to platy 1/2-4 ", carbonaceous, cross bedded, ripple marked.

4 ft. -Siltstone, weak yellow to light gray, well indurated, platy to massive.

? Mostly talus; silt shale

? Talus; siltstone, silt shale, clay shale, same as above.

92 ft. -Covered

12 ft. -Silt shale, similar to below.

5 ft. -Siltstone and silt shale, similar to 25 ft. layer below.

3-5 ft. -Siltstone, lenticular, similar to 2 ft. bed below.

5 ft. -Siltstone and silt shale, similar to 25 ft. unit below

2 ft. -Siltstone, massive, similar to 3-5 ft. bed above

25 ft. -Silt shale and some clay shale, weak to dull yellow, chunky to fissile; a few thin siltstone beds, nodular, gnarled appearance, lensing-irregular.

3 ft. -Siltstone, weak yellow to light gray, well indurated, slightly calcareous, sandy in part, platy 2-14 " thick to massive beds, irregular and lensing, some iron stain.

3 ft. -Siltstone, shaly weak yellow, non-calcareous, poorly consolidated, carbonaceous fragments.

50 ft. -Covered

? Fault, displacement unknown, probably small.

30 ft. -Sandstone and sandy siltstone, lgith gray, slightly to moderately calcareous, well indurated, beds 1-6 ft. thick, platy to massive, a few ironstone nodules and clay galls, low to moderate porosity varying with lensing and gradations within layers, very little carbonaceous material.

110 ft. -Partly covered; mostly fissile silt shale, some clay shale; nodular iron-stained shale layers; occasional siltstone beds 2-8 " thick and lenses 3-12 " thick, hard; several nodular silicified ironstone layers 2-4 " thick near top of section.

22 ft. -Siltstone, sandy, weak yellow, slightly calcareous, well indurated, minute cross bedding with carbonaceous laminae, micaceous, thin bedded; some silt shale.

2-3 ft. -Sandstone, very fine-grained, light gray to pale yellow, similar to 4 ft. below but with carbonaceous cross bedded laminae. Gradational to 22 ft. above.

15 ft. -Covered, mostly silt shale and clay shale.

Station Ch-139-141

Top of section

4 ft.	-Sandstone, very fine-grained, light gray, well indurated, massive, carbonaceous fragments, iron stained patches, slightly calcareous, low porosity, ripple marked.
10 ft.	-Covered; probably silt shale
4 ft.	-Siltstone, weak yellow, highly calcareous, massive, well indurated, slightly iron stained.
50 ft.	-Mostly covered; talus is weak yellow to dark gray, thin bedded siltstone and dark gray silt shale and mud shale; some medium gray sandy siltstone, coaly fragments.
3-4 ft.	-Sandstone, silty, very fine-grained, carbonaceous layers abundant, similar to 2-4 ft. sandstone below.
10 ft.	-Covered; probably same as 16 ft. siltstone below.
15½ ft.	-Same as 16 ft. siltstone below.
4 ft.	-Same as 16 ft. siltstone below.
20 ft.	-Covered; probably silt shale and clay shale.
2-4 ft.	-Sandstone, silty, very fine-grained, low porosity, well indurated, carbonaceous, micaceous, slightly calcareous, weathered light gray to pale iron stained, massive, lenticular.
16 ft.	-Siltstone, weak yellow, slightly calcareous, moderately indurated, carbonaceous and micaceous laminae, beds irregular 1-12 " thick; interbedded silt shale and mud shale, similar to siltstone, in beds 4-12 " thick.
90 ft.	-(Base Ch-139) Covered; siltstone, silt shale and clay shale. Poorly preserved pelecynods in talus.
1115 ft.	(Approximate)

Station Ch-145. Syncline 6, Kukpowruk River, south limb; zones B-C.

Top of section

? (Ch-145) Clay shale, weak to dull yellow, moderately calcareous, soft, chunky, nodular. A few interbedded siltstone, medium gray, highly calcareous, ripple marked, minutely cross bedded, beds 1/4-1 " thick.

5 ft. -Siltstone, light gray to pale yellow, sandy moderately calcareous, moderately indurated, platy 1-3 " thick, abundant ripple and mud marks, worm trails, some very fine-grained sandy facies, with mica, carbonaceous fragments, clay galls, and iron stain; beds 5-15 ft. thick.

4 ft. -Sandstone, very fine-grained, light gray, moderately calcareous, low porosity, carbonaceous plant fragments, ripple marked, iron stained.

40-50 ft. -Siltstone, medium gray to weak yellow, moderately to poorly indurated, gnarled appearance, carbonaceous fragments, thin bedded; interbedded weak to dull yellow claystone and clay shale, chunky, partly silty.

? Sandstone, very fine to fine-grained, similar to 4 ft. above. Interbedded sandstone, similar to above, ripple marked, beds 2-4 ft. thick, grading in part to sandy silt and siltstone, carbonaceous fragments, iron concretions and nodules, clay galls, cross bedded, poorly preserved pelecypods and 1 starfish; and silt shale, weak yellow. Clay shale and silt shale, with a few siltstone layers; pelecypods, partly pyritized, some pyritic nodules.

3 ft. -Siltstone, light gray, moderately calcareous, hard platy to massive.

10-20 ft. -Silt shale and siltstone, gnarled, nodular, weak to dull yellow, slightly calcareous, carbonaceous fragments.

15 ft. -Sandy siltstone, ripple marked, moderately calcareous, cross bedded, carbonaceous laminae, well indurated, beds 2-8 " thick, and irregular, light iron stain. Some 3-6 " shaly interbeds, sandstone very fine-grained, part shaly, carbonaceous laminae, mostly 2-6 " thick.

? Partly covered; siltstone, silt shale, clay shale

4 ft. -Sandstone, silty, very fine-grained, light gray, cross bedded, 1-2 " layers, non to slightly calcareous, poorly preserved pelecypods.

25 ft. -Shale

20 ft. -Siltstone, weak to dull yellow, poor to moderately indurated, thin bedded, non calcareous, carbonaceous fragments, irregular beds, some shaly.

15 ft. -Sandstone, silty, fine-very fine-grained, light to medium gray, low porosity, cross bedded, platy.

? 1-4 " covered.

2-3 ft. -Sandstone, silty, very fine-grained pelecypod in place, clay galls, iron concretions, slickensided calcite, similar to 15 ft. above.

20 ft. -Covered, probably silt shale and clay shale.

1-2 ft. -Siltstone, weak yellow to light gray, thin platy, similar to above.

? Valley, covered.

? Silt shale and thin siltstone, 1-3 " thick, nodular, and some clay shale, clay galls, worm trails, mud marks, a few poorly preserved small pelecypods.

Station Ch-145

Top of section

?	(Highly folded and slickensided) siltstone and shaly siltstone.
?	Covered.
1-2 ft.	-Siltstone, sandy, light gray, moderately indurated, non-calcareous, cross bedded, platy, beds 1-2 " thick, ripple marks, some interbedded silt shale.
7 ft.	-Silt shale and clay shale, medium gray to weak yellow.
1-2 ft.	-Siltstone, same as 1-2 ft. above
20 ft.	-Clay-silt shale, same as 7 ft. above.
?	Covered
35 ft.	-Interbedded shales and siltstone, similar to above. Several staffish fossils in one siltstone bed, also worm trails and ripple marks.
5 ft.	-Siltstone, same as above, with abundant fragmental pelecypods in a 1" layer.
25 ft.	-Covered; mostly shale.
22 ft.	-Siltstone, as above, and 1-2 ft. of silt shale interbedded.
40 ft.	-Covered; siltstone and silt shale
10 ft.	-Sandstone, silty, very fine-grained, light gray, moderately calcareous, thin platy beds 1-3 " thick, low porosity, irregular mud markings and ripple marks.
?	Covered and slumped; interbedded siltstone and silt-clay shale, similar to above.
?	Talus; silty sandstone, very fine-grained similar to 10 ft. above, with poorly preserved pelecypods.
3250 ft.	(approximate)

Station Ch-146. Syncline 6, Kukpowruk River, south limb; zones B-C.

Top of section

65 ft.	-Siltstone and silt shale, as below
6 ft.	-Siltstone
200 ft.	-Silt shale, clay shale, and rubble of siltstone and sandstone.
7 ft.	-Sandstone, very fine-grained, light gray
35 ft.	-Similar to 30 ft. below but more shaly
30 ft.	-Silt shale and clay shale in 2-3 ft. beds; sandstone in 3-4 ft beds; siltstone nodular, 3-5 ft. beds; all similar to below.
20 ft.	-Silt shale and clay shale
10 ft.	-Siltstone and sandstone, similar to 30 ft. above
60 ft.	-Silt shale and clay shale with small amount of interbedded siltstone, similar to below
30 ft.	-Sandstone, very fine to fine-grained, silty, light gray, carbonaceous fragments and laminae, some iron stain, non-calcareous, cross bedded, lenticular beds, platy 1-4 " thick, some shaly beds, abundant iron nodules 2-6 " diameter in 3-6 " beds.
36 ft.	-Siltstone, medium gray to weak yellow, chunky, non-calcareous, moderately indurated, nodular, highly fractured and jointed, carbonaceous fragments, nearly shaly. Gradational to 10 ft. below.
10 ft.	-Interbedded sandstone, silty, very fine-grained and sandy siltstone bedded 1-4 ft. thick, iron stained and nodular moderately indurated, chunky siltstone and silt shale.

Station Ch-146, continued.

Top of section

8-9 ft. -Sandstone, very fine-grained, light gray, minute cross bedding, platy to massive, a few ironstone nodule lenses and a 1-3 " thick bed.

50 ft. -Silt shale and clay shale, with a few thin siltstone beds and 3 sandstone to sandy siltstone beds, 1-18 " thick.

3 ft. -Sandstone, very fine-grained, light gray, a few pelecypods.

50 ft. -Silt shale and clay shale, nodular

30 ft. -Interbedded siltstone or silty sandstone light to medium gray, platy to massive, 3-6 ft. beds, a small amount of ironstone; silt shale and clay shale 2-3 ft. beds; silt shale with carbonaceous fragments and ripple marks abundant, 2-3 ft. thick.

200 ft. -Silt shale and clay shale, some thin beds siltstone, similar to below.

12 ft. -Sandstone, very fine-grained, silty, medium gray to weak yellow, platy to shaly, minute cross bedding, carbonaceous laminae.

22 ft. -Silt shale and clay shale, similar to 30 ft below.

6 ft. -Siltstone grading to silt shale, medium gray, soft to moderately indurated, carbonaceous and mica flecks abundant.

20 ft. -Silt shale, medium gray; some clay shale.

30 ft. -Clay shale and silt shale with a few thin siltstone layers, dark gray to dull yellow, fissile, soft, chunky in parts.

18-20 ft. -Sandstone, very fine-grained, light gray, similar to 9 ft. sandstone bed below but with lesser amount of white grains; included 3 ft. of silt shale and clay shale, and 3 ft. siltstone, light gray, massive, similar to sandstone and shale below, abundant ripple and mud marks, poorly preserved pelecypods in one 8 ft. thick sandy siltstone layer, internal casts poorly preserved; carbonaceous and mica flecks, clay galls, iron nodules, one 1/2 " layer of pelecypods and chert pebbles.

3 ft. -Silt shale and clay shale

9 ft. -Siltstone, similar to 4 ft. bed below; 2 ft. of silt shale and clay shale interbedded.

10 ft. -Silt shale and clay shale, interbedded 2-4 " beds of about siltstone types.

4 ft. -Siltstone, weak yellow, thin to massive bedded, minute cross bedding, carbonaceous and mica laminae, non-calcareous, heavy iron staining.

4 ft. -Silt shale, gradational to 4 ft. bed above.

9 ft. -Sandstone, very fine to fine-grained, light gray, salt and pepper type, abundant non-calcareous white grains, slightly calcareous, massive to platy beds 1-3 " thick, carbonaceous and mica flakes, moderately indurated, low to moderate porosity.

12-15 ft. -Shaly section similar to 20 ft. below.

5 ft. -Sandstone, very fine-grained, silty, light gray, non-calcareous, well indurated, iron nodule layers 1-2 " thick, weathered light to pale yellow, massive to 1/2 " and shaly beds, carbonaceous laminae, cross bedded, low porosity.

20 ft. -Silt and clay shale and siltstone, thin bedded, similar to below.

Station Ch-146, continued.

Top of section

5 ft.	-Siltstone, light gray to weak yellow, shaly to 10" thick irregular beds, slightly calcareous, moderately indurated, carbonaceous laminae, ripple marked.
100 ft.	-Siltstone, thin beds with some 6-12" thick light to medium gray, hard, iron stained, 20-25 percent of section; interbedded silt shale and clay shale, mostly silty, 75-80 percent of section.
30 ft.	-Sandstone, 3 beds, with interbedded thin siltstone and silt shale, medium gray to weak yellow.
75 ft.	-Covered;
10-12 ft.	-Sandstone, same as above 30 ft.
175 ft.	-Covered; shaly, silty beds
5-10 ft.	-Sandstone, very fine-grained, light gray, same as 30 ft. above
50 ft.	-Covered; shaly
1-3 ft.	-Siltstone, sandy, similar to above
200 ft.	-Covered
450 ft.	-Interbedded sandstone, very fine-grained; siltstone; silt shale; clay shale. Pelecypods in the talus.
2150 ft.	(approximate)

Station Ch-147. Syncline 6, Kukpowruk River, south limb; zones B-C top.

Top of section

300 ft. -Sandstone, very fine-grained, weathered light to bright yellow-red-yellow, silty shaly to massive beds, micaceous, low porosity, cross bedded, ripple marks, some carbonaceous laminae, iron nodules, clay galls, rare poorly preserved pelecypod impressions. Interbedded siltstone and sandy siltstone of above type, carbonaceous fragments, light to medium gray and weak yellow, and silt and clay shale, thin bedded to shaly. Sandstone and siltstone beds are 10-20 ft. thick with 20-50 ft. of silt and clay shale interbedded.

80 ft. -Clay shale and minor amount of intermixed silt shale, dark gray to black, fissile, soft.

620 ft. -Sandstone very fine-grained some fine-grained, hard similar to above 300 ft. unit, mostly highly calcareous, siltstone and sandy siltstone, abundant nodular surfaced, both in beds 1-30+ ft. thick, well jointed, weathered light to bright yellow-red-yellow. Interbedded shaley types and silt-clay shale in beds 15-70 ft. thick. Abundant carbonaceous plant fragments. Two beds of carbonaceous shale, fissile, with coaly lenses 1/8-1/4 " thick, first of this rock seen in Ch-145-146-147 section.

1000 ft.

Station Ch-148. Syncline 6, Kukpowruk River, south limb; zones D-E.

Top of section Note: This section is more reddish-yellow than most previous sections on Kukpowruk River, and also is more carbonaceous and coaly.

5 ft. -Siltstone, sandy light gray, shaly to massive, similar to 20 ft. bed below.

75 ft. -Covered; coaly and carbonaceous shale, limy ironstone containing wood fragments.

20 ft. -Siltstone and silt shale, weak yellow, carbonaceous fragments, moderate to poorly indurated, gnarled irregular beds, carbonaceous plant impressions.

75 ft. -Covered; partly coal, carbonaceous shale, iron concretions and nodules.

16 ft. -Sandstone, very fine to fine-grained, light gray, salt and pepper type, carbonaceous, mica and clay fragments, low porosity, highly calcareous, well indurated, partially iron stained, platy to massive beds 1-20 " thick and very irregular.

120 ft. -Covered; two traces of carbonaceous shale with coaly vugs.

8 ft. -Sandstone, very fine-grained, and sandy siltstone, slightly calcareous, light gray, similar to above, shaly to massive, weathered various shades of yellow-red-yellow and red-yellow.

100 ft. -Covered; ironstone with slickensided calcite, thin siltstone beds.

65 ft. -Partly covered; 3 siltstone and silty sandstone layers 3-6 ft. thick, similar to 18 ft. below; some clay and silt shale with iron nodules and calcite crystals.

90 ft. -Covered; abundant ironstone talus.

18 ft. -Siltstone, sandy, a few intergraded very fine to fine-grained sandstone layers, weak yellow, carbonaceous fragments, highly calcareous, weathered yellow-red-yellow iron nodules, ripple marks, cross bedded, shaly to 12 " thick beds.

Station Ch-148, continued.

Top of section

12 ft.	-Covered.
2 ft.	-Carbonaceous shale, slightly coaly
30 ft.	-Siltstone and silt shale, sandy, weak yellow, minutely cross bedded, carbonaceous fragments and laminae moderately to poorly indurated, ripple marked, non to slightly calcareous, bedded 1/2-4 " becoming shaly in top 25 ft.
75 ft.	-Covered; ironstone, shale, siltstone
4 ft.	-Sandstone same as 5 ft. below
15 ft.	-Covered
5 ft.	-Sandstone, silty very fine to fine-grained, salt and pepper type, light gray to yellow-red-yellow weathering, moderately indurated, carbonaceous micaceous laminae, cross bedded, low porosity, highly calcareous, ripple marked, beds 3-8 " thick.
3 ft.	-Covered.
3 ft.	-Sandstone, limy, medium to dark gray, plant fragments, gnarled surfaces, yellowish-white weathering, some slickensided calcite.
5 ft.	-Silt shale and clay shale, weak yellow, similar to 4 ft. siltstone below.
4 ft.	-Siltstone, sandy, light gray to pale yellow, highly calcareous, very hard, ripple marked, abundant iron concretions and nodules, carbonaceous-micaceous laminae, weathered light to bright yellow-red-yellow, beds 4 " thick to massive.
750 ft.	

Station Ch-149, Syncline 6, Kukpowruk River, south limb; zones B-E.

Top of section

70 ft.	-Sandstone, very fine to fine-grained, and some medium grained. Some iron nodules and chert iron cobble thin layer near bottom.
3 ft.	-Clay
5 ft.	-Bituminous coal
10 ft.	-Clay and clay shale, some carbonaceous shale and 1/2 " coal lenses and iron nodules
0.5 ft.	-Ironstone
2 ft.	-Same as 10 ft. above, shale and coal
0.5 ft.	-Ironstone
3 ft.	-Shale and coal, same as 10 ft. above
5 ft.	-Siltstone, sandy iron nodules
80 ft.	-Covered and slumped
12 ft.	-Siltstone and sandstone silty very fine-grained.
20 ft.	-Interbedded clay shale and silt shale, some siltstone, ironstone nodules.
100 ft.	-Covered.
20 ft.	-Interbedded clay shale, slaystone, some thin siltstone, ironstone nodules.
12-13 ft.	-Coal, excellent
344 ft.	

Station Ch-150 . Syncline 6, Kukpowruk River, north limb; zones D-E.

Top of section

20 ft.	-Covered.
15 ft.	-Siltstone, thin beds 2-6 " thick, moderately indurated, and interbedded clay shale in 2-6 " beds. Massive hard siltstone lens in upper part varying from 6" to 3 ft. thick.
2 ft.	-Siltstone, weak yellow to light gray, gnarled irregular surfaces, soft to moderately indurated, slightly calcareous, light to bright yellow-red-yellow weathered stain.
27 ft.	-Covered.
10 ft.	-Siltstone, weak yellow to medium gray, chunky fracture, some ironstone nodules, thin irregular beds 1-6 " thick, soft to moderately indurated, carbonaceous fragments, grades laterally to a very fine-grained silty sandstone.
47 ft.	-Covered.
7 ft.	-Siltstone, sandy, light to medium gray, hard, some interbedded silt shale.
20 ft.	-Covered, clay, bone, siltstone in talus.
4 ft.	-Siltstone, light to medium gray, hard, very slightly calcareous, beds 2-3 " thick to massive, iron stained in part, some ironstone nodules.
13 ft.	-Siltstone and clay shale with ironstone concretions, similar to above.
0.5 ft.	-Bone and coaly shale.
14 ft.	-Siltstone, gnarled type, similar to 2 ft. bed above
27 ft.	-Covered; probably clay shale
6 ft.	-Siltstone, sandy, hard, light gray, ironstone beds 3-12 " thick, abundant plant impressions.
15 ft.	-Siltstone, light gray, hard, non calcareous, carbonaceous, beds 2-5 " thick, and interbedded clay shale with ironstone nodules, beds 2-4 " thick.
3-5 ft.	-Siltstone, similar to above
21 ft.	-Covered; probably clay shale
2.5 ft.	-Siltstone, similar to above, light gray.
16 ft.	-Coaly shale, clay shale, and ironstone lenses.
1-2 ft.	-Coaly and carbonaceous shale
23 ft.	-Covered
15.5 ft.	-Coaly shale; coal in 1-3 " beds; ironstone nodules and lenses; carbonaceous shale, fissile; and petrified logs 1 1-1/2 ft. in diameter, iron stained and coaly.
5 ft.	-Clay shale, medium to dark gray, fissile, papery, ironstone lenses 1-3 " thick, non calcareous, nodular septarian ironstone concretions 4-12 " in diameter with calcite veinlets.
4-5 ft.	-Siltstone, similar to 10 ft. below.
11 ft.	-Covered; mostly clay shale
3 ft.	-Coaly shale, soft.
10 ft.	-Siltstone, light to medium gray, slightly calcareous, poor to moderately indurated, beds irregular and gnarled 2-6 " thick, abundant carbonaceous plant fragments and coaly laminae, ironstone nodules and tabular lenses, cross bedded, abundant mica flecks.
346.5 ft.	

Station Ch-153 , Syncline 6, Kukpowruk River, south limb; zones D-E.

Top of section

2 ft.	-Siltstone, light to medium gray, hard, cross bedded carbonaceous laminae, heavy iron stain.
0.5 ft.	-Bituminous coal
1 ft.	-Clay shale, soft, fissile
3 ft.	-Siltstone, medium gray, soft to moderately indurated, nodular, thin bedded, blocky fracture, carbonaceous and micaceous fragments abundant.
0.1 ft.	-Bituminous coal, shiny
2.5 ft.	-Siltstone, light to medium gray, hard, slightly calcareous lenticular, and interbedded mud shale in 6-12 " beds.
6 ft.	-Clay shale, weak yellow, fissile, gradational in upper 2 ft. to chunky, nodular mudstone.
5 ft.	-Clay shale, weak yellow, fissile, soft, and interbedded carbonaceous and coaly shale and 1/2-1 " layers of shiny coal; gradational to the 6 ft. above.
5-6 ft.	-Limy siltstone, medium gray, dense, irregular bedding, light to pale yellow iron stain.
7 ft.	-Clay shale and claystone, weak to dull yellow.
14 ft.	-Sandstone, salt and pepper type, light gray to pale yellow, fine to medium grained, hard, irregular, platy to thin bedded (1-6 "), non-calcareous, low porosity, abundant carbonaceous plant remains, weathered pale yellow; includes a 2-3 ft. dark gray clay shale layer.
18 ft.	-Partly covered; clay shale, fissile, and silt shale, carbonaceous laminae, iron nodules.
10 ft.	-Siltstone and silt shale, medium gray, moderately indurated, iron nodules, thin bedded to massive.
7-8 ft.	-Clay shale, weak to dull yellow, soft, chunky to fissile, mostly slumped.
5-6 ft.	-Bituminous coal, shiny, hard, blocky.
8 ft.	-Siltstone, light to medium gray, moderately indurated, slightly calcareous, thin bedded (2-4 "); ironstone nodules and lenses, carbonaceous fragments; some interbedded clay shale in 1-2 ft. beds.
59.3 ft.	

Station Ch-154. Syncline 6, Kukpowruk River, north limb; zones D-E and B-C.

Top of section

44 ft. -Covered

3 ft. -Siltstone, medium gray to weak yellow, moderately to well indurated, slightly calcareous, carbonaceous-mica laminae, cross bedded, irregular beds 1-6 " thick, light to moderate yellow-red-yellow weathering.

29 ft. -Covered.

10 ft. -Clay shale, weak to dull yellow, soft, chunky to fissile, non calcareous, beds up to 1/2 " thick and interbedded silt shale and thin bedded siltstone, weak yellow to medium gray, soft to moderately indurated; one 2 " layers of bituminous coal near top of unit

80 ft. -Covered; probably same as 10 ft. above with ironstone nodules.

7 ft. -Siltstone, same as 3 ft. bed above.

3 ft. -Ironstone and siltstone, gnarled type, medium gray, thin bedded to shaly, moderately indurated.

2 ft. -Clay shale, weak yellow to dark gray, chunky to fissile.

20 ft. -Covered; some carbonaceous shale talus.

8 ft. -Interbedded thin siltstone, silt shale, and clay shale, as above.

1 ft. -Bituminous coal, hard, blocky, shiny

12 ft. -Sandy siltstone, light gray, moderately indurated, moderately calcareous, carbonaceous and mica laminae, irregular to platy beds 1-4 " thick; a 1-2 ft. lens of sandstone, fine to medium grained, moderately porous, with ironstone nodules.

366 ft. -Covered.

15 ft. -Siltstone, similar to 12 ft. above

10 ft. -Coaly and carbonaceous shale, soft, fissile, with 1/4 " thick shiny coal lenses.

41 ft. -Covered

10 ft. -Sandstone, silty, very fine to fine-grained, pale to weak yellow, carbonaceous fragments and laminae, abundant, low porosity, non calcareous, soft to moderately indurated, gnarled irregular beds, small amount interbedded clayshale.

4 ft. -Clay shale, medium to dark gray, fissile, with 1-2 " lenses of pyritic, carbonaceous material, hard concretions.

2 ft. -Coal, bone, carbonaceous shale, and wood fragments.

34 ft. -Covered

10 ft. -Siltstone, hard, light to medium gray.

35 ft. -Covered.

12 ft. -Siltstone, same as 10 ft. above, with good plant fossils and ironstone nodules.

20 ft. -Siltstone, medium gray, soft to moderately indurated, nodular, with some small ironstone concretions and layers.

52 ft. -Interbedded sandy siltstone, thin, hard, beds 6-12 " thick, clay shale, and carbonaceous shale with ironstone concretions.

14 ft. -Siltstone, weak yellow to medium gray, carbonaceous mica laminae, hard, thin bedded; one 3 ft. lenticular siltstone bed.

3 ft. -Clay silt shale, soft.

1-1 1/2ft. -Bituminous coal, hard, shiny.

1 ft. -Carbonaceous shale, fissile.

5 ft. -Siltstone sandy, light to medium gray, hard, beds 2-6 " thick, carbonaceous wood and plant remains.

Station Ch-154, continued

Top of section

10 ft. -Interbedded siltstone, ironstone lenses and clay shale

6-8 ft. -Interbedded carbonaceous shale, coaly shale, and clay shale; one 6" bituminous coal bed, and some limy ironstone.

20 ft. -Covered.

6 ft. -Siltstone, medium gray, moderately to poorly indurated, ironstone nodules.

20 ft. -Covered

3 ft. -Siltstone, same as 6 ft. above

2-3 ft. -Coal and coaly shale.

4 ft. -Siltstone and ironstone, similar to 6 ft. above

2 ft. -Carbonaceous and coaly shale, paverty, with coal lenses

3-4 ft. -Mud shale, weak yellow, abundant carbonaceous fragments, and nodular ironstone lenses.

1.5 ft. -Siltstone, hard, similar to 6 ft. above

1 ft. -Clay to carbonaceous shale, dark gray.

8 ft. -Clay shale, silt shale, and thin siltstone stringers.

25 ft. -Interbedded siltstone, same as above, 1-3 ft. thick bed, and clay shale, 3-6 ft. thick beds, some clay shale and thin carbonaceous shale. Siltstone and ironstone lenses.

12 ft. -Clay and carbonaceous shale with 1 ft. bituminous coal and 2 lenses of nodular ironstone 6-24" thick.

22 ft. -Siltstone, hard, light gray to weak yellow, thin beds, and some shaly parts.

2 ft. -Carbonaceous and coaly shale.

25 ft. -Ironstone, siltstone, and silt clay shale interbedded.

65 ft. -Covered

42 ft. -Partly covered; interbedded siltstone and clay silt shale, similar to above; first appearance of ripple marks in this section.

90 ft. -Clay shale, carbonaceous shale, 10-25 ft. of gnarled type siltstone, ironstone nodules, all interbedded.

3 ft. -Silstone, light to medium gray, hard, slightly calcareous, massive, lensing, heavily iron stained, abundant carbonaceous laminae.

15 ft. -Siltstone, silt shale, and clay shale interbedded.

3 ft. -Siltstone, same as 3 ft. above.

2 ft. -Clay shale, as above

11 ft. -Sandstone or sandy siltstone, light gray to weak yellow, carbonaceous fragments and laminae irregular bedding.

124 ft. -Covered and talus: siltstone, coaly shale, clay shale, and sandstone, fine-grained.

3 ft. -Sandstone, similar to 11 ft. above

10 ft. -Sandstone, same as 3 ft. above, and interbedded silt shale

83 ft. -Covered and talus; clay shale, silt shale, and sandy siltstone.

3 ft. -Sandy siltstone, shaly to thin bedded, carbonaceous laminae, moderately to highly calcareous, small ripple marks.

10 ft. -Covered; clay shale and carbonaceous shale.

Station Ch-154, continued.

Top of section

41 ft.	-Covered; siltstone, silt shale, and clay shale in talus
55 ft.	-Siltstone, similar to 3 ft. above, in 3 ft. beds; interbedded 1-5 ft. beds of clay shale, and some thin siltstone lenses, ripple marked.
0.5 ft.	-Bone
71 ft.	-Interbedded sandy siltstone and clay silt shale, similar to above
316 ft.	-Covered; talus is sandstone medium and fine-grained, light yellow with reddish tinge, platy to blocky, carbonaceous wood and plant fragments, slightly calcareous, moderate porosity, moderately to well indurated, and a few clay and ironstone nodule layers.
8 ft.	-Siltstone, weak yellow to medium gray, shaly to thin bedded
266 ft.	-Covered; talus sandstone same as 216 ft. above.
2146 ft.	

Station Ch-156 . Syncline 7, south limb; zones D-E.

Top of section

1-2 ft. -Bituminous coal, medium grade
53 ft. -Mostly covered; some siltstone, light to medium gray, hard, heavily iron stained
7 ft. -Coal and bone, soft, low-grade
35 ft. -Party covered; coal; carb naceous shale; ironstone nodules; and sandy silt shale.
2 ft. -Sandstone, silty, very fine-grained, pale yellow to light gray, moderately calcareous, platy to thin bedded (1-4"), moderate yellow-red-yellow weathering.
44 ft. -Covered.
4-5 ft. -Bituminous coal, good grade
61 ft. -Covered.
3 ft. -Siltstone, medium gray, dense, slightly calcareous, heavily iron stained, similar to 1 ft. below.
78 ft. -Covered, some siltstone, silt shale, and carbonaceous shale talus.
1 ft. -Siltstone, same as 1 ft. below
2 ft. -Limy siltstone, medium gray, weathered light yellow
2 ft. -Siltstone, same as 1 ft. below
68 ft. -Covered
2 ft. -Coal and coaly shale
1 ft. -Sandy siltstone, light gray, hard, abundant
26 ft. -Covered.
4 ft. -Bituminous coal, grading up into carbonaceous shale.
2 ft. -Siltstone same as 3 ft. below
34 ft. -Covered.
3-5 ft. -Siltstone, same as 3 ft. below
41 ft. -Covered
3 ft. -Siltstone, light gray, heavily iron stained.
31 ft. -Covered and talus; some silt shale and ark red ironstone concretions containing abundant plant fragments.
14 ft. -Siltstone, gnarled type similar to 5 ft. below, and interbedded sandy siltstone, light gray, hard, 3-8 " beds, with small amount of clay shale and ironstone.
25 ft. -Covered
15 ft. -Partly covered; silt shale; ironstone nodules, bituminous coal; and carbonaceous shale.
3 ft. -Siltstone, light gray, dense, highly calcareous, lenticular beds 3-6 " thick, weathered light to bright yellow-red-yellow.
5 ft. -Sandy siltstone, weak yellow, slightly calcareous, carbonaceous and mica laminae, irregular gnarled beds.
90 ft. -Covered; some sandy shale; ironstone nodules; and carb-naceous shale.
10 ft. -Similar to 17 ft. below but grading to shaly sandstone, siltshale and hard calcareous ironstone nodules.
17 ft. -Sandstone, similar to 18 ft. below with a few interbedded siltstone layers 3-6 " thick.
36 ft. -Covered.

Station Ch-156, continued.

Top of section

9 ft. -Interbedded siltstone, clay shale, silt shale and some carbonaceous shale.

43 ft. -Mostly covered; some ironstone; one 6" coal bed and one 2 ft. bed of coaly and carbonaceous shale.

18 ft. -Sandstone, shaly, very fine to fine-grained, weak yellow to light gray, carbonaceous and micaceous material ironstone nodules, moderately indurated, bedding shaly to 3" thick.

18 ft. -Covered

7 ft. -Bituminous coal with several 1-2" coaly shale partings.

46 ft. -Interbedded shales, ironstone nodules, 2 beds of hard siltstone, 1-3 ft. thick, and 2 beds of carbonaceous shale, 6-12 " thick.

6 ft. -Siltstone, light gray, non-calcareous, dense, weathered light to bright yellow-red-yellow, beds lenticular 2" thick to massive.

44 ft. -Mostly covered; similar to 8 ft. below, with a 6 " coal bed.

8 ft. -Interbedded silt shale, thin-bedded siltstone, and clay shale.

0.9 ft. -Biruminous coal

0.9 ft. -Coaly and carbonaceous shale

5 ft. -Siltstone, similar to 3 ft. below

20 ft. -Mostly covered; siltstone, iron stained, and clay silt shale with iron nodules; one 6" coal bed near top of section

3 ft. -Siltstone, sandy and shaly, weak yellow to light gray, moderately indurated, abundant carbonaceous material, massive bedded.

60 ft. -Covered and talus; shale; iron nodules; and siltstone similar to below.

22 ft. -Sandstone, silty, very fine-grained, salt and pepper type, non-calcareous, low porosity, moderately to well indurated, carbonaceous laminae and plant impressions, beds 1-6 " thick, a few iron nodules.

15 ft. -Interbedded clay shale and silt shale, cross bedded, medium gray, iron stained

3 ft. -Clay shale, weak yellow, non-calcareous

6 ft. -Same as 11 ft. below.

27 ft. -Covered

4 ft. -Bituminous coal with about 2 ft. of coaly and carbonaceous shale interbedded.

11 ft. -Siltstone, sandy, light gray, coaly and ironstone nodules and fragments, carbonaceous plant remains, similar to below.

18 ft. -Interbedded siltstone, thin 1-3 " beds, similar to below, and siltshale with tabular ironstone concretions.

25 ft. -Covered

10 ft. -Interbedded siltstone and clay shale

3 ft. -Sandy siltstone, shaly, fissile in parts, light gray to weak yellow, slightly calcareous, moderately indurated, beds irregular.

92 ft. -Covered, similar to 106 ft. below.

1 ft. -Coal and coaly shale interbedded.

106 ft. -Partly covered; some silt shale in 5-8 ft. beds; siltstone, medium gray to weak yellow, moderately indurated, cross bedded, and irregular beds, carbonaceous laminae; and siltstone, hard, massive, heavily iron stained, abundant carbonaceous fragments.

Station Ch-156, continued.

Top of section

14 ft. -Interbedded silty sandstone, very fine grained, light gray, beds 1-2 ft. thick, similar to sandstone below; and silt shale and siltstone with ironstone nodules, beds 1-1/2 ft. thick.

71 ft. -Covered; some carbonaceous shale talus.

2 Ft. -Siltstone and sandstone, very fine-grained with a few fine to medium grained lenses, medium gray, thin layers of clay pellets and dark chert pebbles, carbonaceous plant fragments and coaly vugs, weathered light to moderate yellow-red-yellow, ironstone nodules, massive layers.

141 ft. -Covered and talus; shaly siltstone, weak yellow to medium gray, carbonaceous and mica laminae, non-calcareous; some bituminous coal, hard and shiny; and ironstone nodules, hard, dark reddish stained, carbonaceous and coaly flecks.

5 ft. -Sandstone, very fine to fine-grained, light gray, iron stained thin-bedded, similar to 10 ft. below.

71 ft. -Covered

10 ft. -Sandstone, very fine-grained, silty, shaly , slightly to moderately calcareous, moderately indurated, iron stained, carbonaceous fragments, undulating irregular bedding.

134 ft. -Covered

71 ft. -Partly covered; siltstone and silty sandstone very fine-grained, weak yellow to medium gray, carbonaceous laminae and fragments, moderately indurated, alternating shaly and thin beds.

424 ft. -Covered and talus; sandstone, fine-grained, silty, pale yellow to light gray, thin to platy, low porosity, non-calcareous, carbonaceous plant remains; and siltstone, with iron nodules in parts.

2292 ft.

Station Ch-157. Syncline 7, south limb; zones D-E.

Top of section

10 ft. -Interbedded siltstone, medium gray, slightly calcareous, moderately indurated, some lensing sandy beds, and shaly sandstone, silty very fine-grained, moderately indurated, carbonaceous and mica laminae, slightly iron stained.

49 ft. -Covered

3 ft. -Siltstone, medium gray, hard, heavily iron stained similar to 10 ft. above.

65 ft. -Covered

10 ft. -Sandstone, silty, very fine-grained, medium gray, slightly calcareous, hard, low porosity, weathered light yellow, irregular lensing beds 1-6 " thick, cross bedded, small amount of carbonaceous gragments.

12 ft. -Siltstone, thin bedded 1/2-1 1/2 ", similar to 10 ft. above.

68 ft. -Covered

1 ft. -Bituminous coal and interbedded bone.

1 ft. -Silt shale, sandy pale yellow to light gray, carbonaceous and mica laminae, slightly calcareous, moderately indurated, slightly iron stained.

Station Oh-157, continued.

Top of section

14 ft. -Covered

3 ft. -Siltstone, similar to above

236 ft.

Station Oh-159. Syncline 7, north limb; zones D-E.

Top of section

8 ft. -Sandstone, very fine to medium grained, silty, light gray, weak to moderate yellow, and moderate yellow-red-yellow, well weathered in parts, soft to moderately indurated, slightly calcareous, moderate to high porosity, lensing irregular beds, shaly to 1 " thick, cross bedded; interbedded soft to unconsolidated, medium grained sandstone, with abundant carbonaceous layers and rounded coaly fragments 1/2 - 1" in diameter; a few small iron nodules. Carbonaceous fragments throughout. Marked change in color, induration, and lithology from outcrops farther upstream.

30 ft. ? -Covered interval.

3 ft. -Siltstone, light gray to pale yellow, and silt shale in beds 1-3" thick, moderately indurated, cross bedded laminae of carbonaceous and mica fragments, slightly iron stained. Carbonaceous plant remains and some ironstone in thin layers and nodules.

? Covered and talus; abundant dark red weathered ironstone nodules and concretions 1/2-6 " in diameter, also layered 1/8-1/4 " with carbonaceous plants remains, original color is medium gray; sticky clay, light to very light gray; limy siltstone, medium gray, weathered light yellow, some of these pieces are septarian-like concretions; coal is rare.

5 ft. -Sandstone, very fine-grained, silty, light gray to pale yellow, soft to moderately indurated, poorly cemented, slightly calcareous, carbonaceous laminae, cross bedded in layers 1-3 " thick, low porosity.

15 ft. -Sandstone similar to above, but very fine to medium grained in some layers, ironstone concretion layers, 1-3 " thick, moderate porosity, some coal conglomerate in ironstone layers.

10-15 ft. -Sandstone, similar to 15 ft. but massive in 6-18 " layers, shaly cross beds and laminae, fine to medium grained, good porosity.

76 ft.

Station Oh-160. Syncline 7, north limb at next anticline; zones D-E.

Top of section

? Talus; bituminous coal; light gray clay; ironstone; sandstone, of grained, light gray, moderately to highly calcareous, well indurated, shaly to platy abundant carbonaceous-micaceous laminae, plant impressions, minutely cross bedded, small amount of siltstone, light-medium gray, hard, platy, moderately calcareous, heavily iron stained, carbonaceous fragments.

Station Ch-160, continued.

Top of section
36 ft. -Covered
5 ft. -Siltstone, medium gray, soft to moderately indurated, moderately calcareous, carbonaceous and mica fragments, shaly to 1-2" beds, irregular, a few ironstone nodules.
0.3 ft. -Ironstone, hard, layered to nodular.
0.4 ft. -Limy siltstone, medium gray, hard, slightly pitted surface, blocky, calcite veined, weathered light yellow.
26 ft. -Covered. Carbonaceous shale, ironstone concretions and nodules, limy mud shale, and siltstone, soft.
1 ft. -Siltstone, same as 5 ft. layer above
13 ft. -Covered
10 ft. -Siltstone, light gray, slightly calcareous, moderately indurated, carbonaceous fragments, bedded 1-2" thick, and interbedded ironstone, silty, hard, beds 1-3" thick, light to moderate yellow-red-yellow stain, nodular in part.
49 ft. -Covered and talus; coaly and carbonaceous shale; some coal; light gray clay; and hard iron stained platy siltstone.
2 ft. -Siltstone, medium gray, hard, slightly calcareous, carbonaceous plant remains, blocky, pitted surfaces, light to moderate yellow-red-yellow weathered stain.
40 ft. -Covered and talus; coal; sandy siltstone, shaly; and silty sandstone, very fine-grained, pale yellow to light gray.
1.5 ft. -Carbonaceous shale
10 ft. -Covered; mostly shale
2 ft. -Sandstone, very fine-grained, silty, pale yellow to light gray, carbonaceous and mica fragments, plant impressions, moderately indurated, low porosity.
49 ft. -Covered; siltstone; sandstone; ironstone, talus.
0.5 ft. -Coaly shale
45 ft. -Covered and talus; siltstone; clay; and 2 thin sandstone beds, very fine-grained.
2 ft. -Siltstone, hard iron stained, same as above
34 ft. -Covered
7 ft. -Bituminous coal, hard, well weathered surface, and slumped.
1-2 ft. -Siltstone, shaly, similar to above.
24 ft. -Covered and talus; some sandstone, very fine-grained, silty, similar to above.
2.5 ft. -Bituminous coal, medium grade.
2 ft. -Siltstone, medium gray, moderately indurated, abundantly carbonaceous.
72 ft. -Covered and talus; siltstone; ironstone; and sandstone, fine, grained, shaly, moderately indurated.
2 ft. -Sandstone, very fine and fine-grained, platy, similar to above.
2 ft. -Siltstone, light gray, sandy, minutely cross bedded, beds 3-8 " thick, slightly calcareous, hard.
21 ft. -Covered; bituminous coal and ironstone talus.
1 ft. -Siltstone, medium gray, hard, similar to above
30 ft. -Covered; clay shale and silt shale
2 ft. - Siltstone, medium gray, hard, massive, heavily iron stained, grades to a sandstone, very fine-grained.

Station Ch-160, continued.

Top of section

17 ft.	-Covered and talus; coaly shale and ironstone.
3 ft.	-Siltstone, light gray to pale yellow, moderately to well indurated, slightly calcareous, bedding shaly to irregular, 1-3 " thick cross bedded, light iron stain.
15 ft.	-Covered
25 ft.	-Same as 3 ft. above, more sandy.
8 ft.	-Covered, clayey talus
7-8 ft.	-Bituminous coal, medium grade.
21 ft.	-Covered.
1-3 ft.	-Siltstone, medium gray, hard, iron stained.
42 ft.	-Covered and talus, carbonaceous shale; iron nodules; limy siltstone with light yellow stain.
911 ft.	

Station Ch-166-170 and Sa-145-146 Poko Mountain

Top of section

? Small amount of siltstone section probably present on slightly higher point 1/4 miles southwest.

? (Top Ch-169) Topmost talus; sandstone, silts, very fine-grained, some fine-grained, medium gray to weak yellow, shaly, fissile, similar to 20 ft. bed below.

20 ft. -Sandstone to sandy siltstone, very fine-grained, pale to weak yellow, slightly to moderately calcareous, well indurated, low porosity. Carbonaceous and micaceous laminae, beds 1/4-4 " thick with a few massive beds 1-2 ft. thick, irregular and cross bedded, some siltstone.

40 ft. -Siltstone and sandy siltstone, platy to shaly, cross bedded, slightly to moderately calcareous, moderately to well indurated, moderate iron stain, low porosity.

3 ft. -Siltstone, weak yellow to medium gray, slightly calcareous, similar to 20 ft. bed below, abundant oscillation ripple marks.

? Talus; silt shale and clay shale, similar to fossiliferous zone; some limy ironstone, and siltstone, thin bedded, weak yellow, ripple marked, worm trails; some sandy gradation of above types.

? Talus; sandstone, silty, very fine-grained, pale to weak yellow, heavy iron weathering stain, dark reddish in part, carbonaceous plant fragments, shaly to thin bedded, poor to moderate indurated; moderately to highly calcareous, low porosity, ripple marked.

? Slumped and weathered beds; silt shale and clay shale, fissile, dull yellow, poorly indurated, slightly calcareous, carbonaceous plant fragments, mica flakes, and interbedded sandstone, very fine-grained, micaceous, highly calcareous, carbonaceous fragments, ripple marked. Abundant thick-shelled pelecypods, all in broken fragments.

? Talus; siltstone, sandy, weak yellow to medium gray, highly calcareous, platy bedding, mica flecks, light yellow-red-yellow weathering, and thin bed limy siltstone or ironstone, medium gray, well indurated, shaly, ripple marked, weathered light to moderate yellow.

? Talus covered bed; silt shale and clay shale, medium to dark gray, poorly indurated, chunky weathering, carbonaceous plant fragments, abundant yellow and red ironstone concretions, oval 1-4 " in diameter.

35 ft. -(Base Ch-169) siltstone, thin bedded to shaly, similar to 20 ft. and bed below.

? Talus; sandstone, very fine-grained, silty, pale yellow green-yellow to light gray, slightly calcareous, moderately indurated, low porosity, platy to angular blocky fragments, and sandy silt shale, weak yellow, carbonaceous flecks and laminae, highly calcareous, moderately indurated.

Station Ch-166-170 and Sa-145-146 Peko Mountain, continued.

Top of section

20 ft. -(Ch-168) Siltstone, medium gray to weak yellow, thin to platy beds 1/2-2 " thick, moderately calcareous, well indurated, weathered iron stain, cross bedded, ripple marked, mud lumps, worm tubes and trails, weathered out clay galls, a few carbonaceous wood impressions, and carbonaceous and mica flakes.

25 ft. -(Top Sa-145) Siltstone and sandstone, very fine to fine-grained, medium gray to pale yellow brown, moderately calcareous, massive to platy, contains wood fragments and ascillation ripple marks. Sandstone, very fine-grained to conglomeratic, bluish-gray. Contains single shells and fragments of pelecypods associated with scattered well-rounded pebbles of ironstone and chert. Shale, medium dark gray.

? (Base Sa-145) Rubble and talus; siltstone and shale, medium dark gray to olive gray, slightly calcareous, platy, weathers yellow brown to red-orange. Contains carbonized wood fragments and shale pebbles.

? (Ch-167) Rubble and talus; siltstone, medium gray to weak yellow, weathered light yellow to yellow-red-yellow thin platy beds 1/4-1/2 " thick, moderately to highly calcareous, moderately indurated, fine mica flecks; some shaly siltstone, medium to dark gray, similar to siltstone. Both types have minute cross bedding, undulatory bedding, some oscillation ripple marks, fucoidal and mud markings, ironstone nodules are rare.

10 ft. -(Ch-170) Interbedded siltstone, medium gray to weak yellow, well indurated, beds 2-6 " thick, highly calcareous, weathered yellow-red-yellow iron stain, and mud shale to mudstone, medium gray to dull yellow, slightly to non-calcareous, moderately indurated, beds 1/4-2 " thick, contains carbonaceous fragments, slightly iron stained.

5 ft. -(Top Sa-146) Siltshale as below, contains 6 " bed of massive siltstone at top.

6 ft. -Siltstone, similar to below. Some interbedded silt shale.

30 ft. -Silt shale, medium dark gray, blocky to fissile, with few thin (1-3 ") beds of siltstone. Non-calcareous.

13 ft. -Shale and siltstone similar to below. Shale more abundant. Siltstone well indurated.

0.3 ft. -Siltstone, medium dark gray, weathers light brown, contains small shale pebbles.

11 ft. -(Base Sa-146) Interbedded siltstone (60 percent) and silt shale (40 percent). Siltstone is olive gray to dark yellow brown, slightly calcareous, blocky partings 1-3 " thick. Silt shale medium dark gray, weathers in blocky fragments.

? Talus; (Ch-166) weathered gravel (from conglomerate?), black, gray, greenish chert, a few reddish and white quartz, minor amounts of quartzite with white quartz veins, and schistose rock types, 1/4-2 " diameter gravel, subangular. More likely this is terrace gravel.

1135 ft. (approximate)

Station Ch-193 . Syncline 2, Kokolak River, north limb; zones B-C.

Top of section

5 ft. -Siltstone, medium gray slightly calcareous, well indurated minutely laminated, beds 1 1/2-2 ft. thick, slightly lenticular, weathered moderate yellow-red-yellow. 6" shaly layer in middle, well jointed.

15 ft. -Interbedded siltstone same as above, in 3-6" thick lenses and 1-2" beds, and clay silt shale, 1/2-10" thick beds, medium gray to dull yellow, slightly calcareous, soft, siffile to chunky, gradational to claystone, mud markings, clay pellets, carbonaceous fragments.

20 ft.

Station Ch-196 . Syncline 8, south limb; zones B-C basal.

Top of section

18 ft. -Sandy siltstone grading to sandstone, very fine-grained, similar to 12 ft. below, platy, irregular beds, slightly shaly, heavily iron stained, light yellow to yellow-red-yellow.

20 ft. -Covered

12 ft. -Siltstone, similar to 30 ft. unit below

96 ft. -Slumped and covered; largely clay and silt shale, with 2-4 ft. of siltstone interbedded.

10 ft. -Siltstone, similar to 30 ft. below, beds 1-4" thick, ten percent interbedded siltshale, gnarled surfaces, some iron stone concretions.

11 ft. -Slumped; mostly shale.

13 ft. -Siltstone, similar to 30 ft. below, 20 percent interbedded silt shale.

25 ft. -Covered; probably shale.

5 ft. -Siltstone, prominent ripple marks, similar to 30 ft. below.

10 ft. -Clay shale and silt shale, soft, weak yellow to medium gray, fissile.

30 ft. -Siltstone, medium gray, moderately to slightly calcareous, well indurated, irregular and undulatory beds 2-4" thick, cross-bedded, abundant carbonaceous-mica laminae, many carbonaceous plant impressions. Interbedded softer shaly siltstone, heavy to moderate yellow-red-yellow iron stain, small current ripple marks. Coaly rugs and lenses 1/4" thick in several layers.

250 ft.

Station Ch-198 . Syncline 4, south limb; zones B-C basal.

Top of section

6 ft. -Clay shale and silt shale, weak and dull yellow to dark gray, chunky to fissile, gradational to 1-2" thick beds in parts.

10 ft. -Siltstone, hard, medium gray, laminated in parts, abundant carbonaceous and woody material, some parts are nodular gnarled apparently caused by flowage and shallow water disturbance before consolidation took place, 30 percent interbedded clay shale, jointing prominent throughout.

Station Ch-198, continued.

Top of section

19 ft. -Interbedded siltstone, nodular siltstone, and clay silt shale, similar to above.

1 1/2-3 ft. -Siltstone, medium gray, hard, abundant carbonaceous plant fragments, weathered light yellow-red-yellow, lenticular, blocky to platy.

27 ft. -Interbedded claystone, 1-2" beds, and siltstone, soft to moderately indurated, gradational to shale in parts, weak yellow and medium to dark gray, rounded to nodular weathered surface; about 20 percent siltstone medium gray, hard, in beds 2-3" thick.

1/2 ft. -Siltstone, medium gray, carbonaceous-mica laminae, platy, prominent resistant bed.

37 ft. -Interbedded siltstone and clay silt shale, shaly rock about 65 percent of unit, similar to above types. Siltstone beds 1-3" thick lensing to 1 ft. thick. Worm trails and sand filled worm tubes.

3 ft. -Siltstone, medium gray, very hard, abundant carbonaceous flecks bedding massive, weathered moderate yellow-red-yellow.

40 ft. -Interbedded silt shale, clay shale, and thin bedded siltstone similar to above.

145 1/2 ft.

Station Ch-204-209. Syncline 5, east end; zones D-E and B-C.

Top of section

1900 ft.+ -Zones D-E(?)

Interbedded clay silt shale, medium to dark gray and weak yellow, soft, to moderately indurated; clay ironstone, shaly to thin bedded and concretionary, hard, weathered bright yellow-red-yellow to dark yellow-red; siltstone, medium gray to weak yellow, moderately indurated, moderately calcareous, carbonaceous-mica laminae, shaly to thin bedded 1-2" thick, heavily iron stained; and some carbonaceous shale, soft, thin bedded, fissile, coaly.

3500 ft.± -Zones B-C

Interbedded siltstone, some sandy beds, pale-weak yellow, slightly calcareous, moderately indurated, scattered tiny carbonaceous fragments, some ripple marks, minutely laminated, platy 1/2-3" thick, shaly to thin bedded; silt shale and some clay shale, medium gray, soft to moderately indurated, mud markings, slightly to non-calcareous, partly fissile; sandstone, very fine and some fine-grained, silty, shaly to thin bedded, 1/2-3" thick, pale yellow to light gray, moderately indurated, cross bedded, non-calcareous, low porosity, carbonaceous fragments, very slight iron staining, rare ironstone concretions and coaly vugs.

5400 ft.±

Station Ch-223. Syncline 6, Kokolik River, north limb; zones D-E.

Top of section

14 ft. -Clay to mud shale, dark gray, carbonaceous, soft, fissile to chunky, non-calcareous, coaly; limy ironstone nodules and lenses, medium gray to weak yellow, abundant carbonaceous plant fragments.

18 ft. -Siltstone, sandy pale-weak yellow, and interbedded silt shale, carbonaceous-mica laminae, plant fragments, cross-bedded, slightly calcareous, moderately indurated, weathered moderate-bright yellow-red-yellow, shaly to 1 ft. thick beds. A few lenses and nodules of ironstone, and lenticular sandstones, very fine to medium grained, gradational from siltstone.

32 ft.

Station Ch-224-225. Syncline 6, Kokolik River, north limb; zones B-C.

Top of section

35 ft. -Covered; up to Zone D contact

20 ft. -Silt-mud shale, weak to dull yellow, chunky to fissile, gradational to thin bedded silt-mudstone 3-4" thick, interbedded ironstone, dull yellow-red-yellow, nodules and lenses, abundant carbonaceous fragments, non-calcareous, layers and lenses 3-6" thick. Top part is a thin coaly shale bed in the talus.

26 ft. -Siltstone and silt shale, weak to dull yellow, soft, non-calcareous, abundant carbonaceous fragments, weathered to chunky talus; some claystone and clay shale layers, contain a few small ironstone concretions parallel to the bedding.

3 ft. -Siltstone, weak yellow to medium gray, very slightly calcareous, moderately indurated, abundant carbonaceous fragments and carbonaceous-mica laminae, lensing, cross bedded within massive beds, weathered weak to dull yellow-red-yellow, slightly shaly and gradational to 26 ft. above.

4 ft. -Mud-claystone and shale, dark gray, similar to above, lenses laterally within 50-100 ft.

2-4 ft. -Siltstone, same as 3 ft. above, lenses laterally.

25 ft. -Interbedded silt shale and siltstone, beds 1-1/2 ft. thick, some silt-mud shale, similar to section above.

10 ft. -Sandstone, fine-grained, some very fine-grained light gray to pale yellow, very slightly calcareous, slightly silty, well indurated, low to moderate porosity, lensing, layered 1-6" thick, laminated within layers, slightly stained with moderate to pale yellow-red-yellow. Lateral gradation to shaly sandstone, with carbonaceous and micaceous laminae, and some medium to coarse grained, soft, sandy lenses.

Station Ch-224-225, continued.

Top of section

758 ft. -Mostly covered. (Ch-225) Some traces of sandstone, very fine to fine-grained, shaly to thin bedded, silty, pale yellow to light gray, moderately to slightly calcareous, carbonaceous and mica flecks; siltstone, medium gray, thin bedded to shaly, hard, moderately calcareous; slight iron stain; silt shale weak yellow to dark gray, carbonaceous fragments, cross bedded, partly fissile, probably forms over half of the section.

1225 ft. -Covered, to contact with Torok formation

2200 ft.

Station Ch-226, Syncline 9, Kokolik River, south limb; zones D-E.

Top of section

5 ft. -Interbedded carbonaceous and coaly shale, soft, and 1-4" layers of bituminous coal, a few clay shale beds, weak yellow, 2-3" thick. Grades laterally within 10 ft. to a 1 ft. coal bed.

5 ft. -Bituminous coal, hard, shiny, blocky, with a 1" clay parting 3 ft. above bottom of the bed.

1 ft. -Clay, light gray, plastic

1/2 ft. -Siltstone, medium gray, lenticular, minutely cross bedded, abundant carbonaceous fragments, sand filled worm tubes (?), a few coaly streaks, weathered light iron stain.

26 ft. -Siltstone and mudstone, medium gray, moderately indurated, non-calcareous, iron stained in part, slightly carbonaceous, nodular weathering, beds 4-7" thick grading to shaly, numerous ironstone lenses 6-18" thick, medium gray, weathered light yellow, slightly limy.

7 ft. -Silt shale and clay shale, interbedded, medium gray, moderately indurated, fissile, non-calcareous, carbonaceous fragments and laminae, yellowish red weathering, some iron-stone concretions.

10 ft. -Siltstone and silt shale, similar to 7 ft. above, sandy in parts, beds 2-10" thick, some ironstone lenses up to 1 ft. thick, a few coaly streaks, carbonaceous-mica laminae abundant.

49 ft. -Covered. Probably shaly.

3 1/4 ft. -Bituminous coal, hard, blocky, good quality.

37 ft. -Mostly covered, clay and silt shale, medium gray, heavy iron stain, ironstone concretions up to 2 ft. diameter, average 6-10".

5 ft. -Silt shale and some thin siltstone, similar to 7 ft. above.

10 ft. -Siltstone and interbedded silt shale, tabular ironstone concretions, same as 7 ft. above.

8 ft. -Covered.

3 ft. -Bituminous coal, shiny, moderately hard, well jointed, good quality.

49 ft. -Slumped and covered, siltstone, silt shale, clay shale, and some ironstone.

220 ft.

Station Ch-227-232 . Syncline 9, north limb; zones D-E.

Top of section

20 ft. -Slumped (Ch-227). Siltstone, slightly sandy in parts, light gray to weak yellow, slightly calcareous, moderately to well indurated, carbonaceous and coaly plant fragments, slightly iron-stained, 3" to massive beds, lenticular; some ironstone concretions, coal, carbonaceous shale, mudstone, limy ironstone weathered light yellow, in the talus.

640 ft. -Covered (includes Sa-180).

2 ft. -Slumped (Ch-228). Sandy siltstone, light gray, slightly calcareous, heavily iron-stained, platy, cross-bedded, similar to Ch-227 above.

20 ft. -Covered.

4 ft. -Sandstone, very fine to fine grained, slightly silty, light gray-pale yellow, salt-pepper type, slightly calcareous, moderately indurated, low to moderate porosity, platy, 1-3" beds, ironstone and clay pellets, and carbonaceous laminae.

12-15 ft. -Talus below-coal, ironstone concretions and clay.

3 ft. -Siltstone similar to above. Underlying talus of sandstone, fine to medium-grained with some coarse to very coarse grained layers, and some siltstone, coal, and ironstone same as above.

390 ft. -Covered

6 ft. -Sandstone, fine-medium grained with some coarse grained facies, pale yellow to light gray, slightly calcareous, moderately indurated, low to moderated porosity, silty, carbonaceous flecks and laminae, irregular thin beds 1/2-2". Underlying talus probably 100 ft. of sandstone, similar to above, bedded ironstone, and septarian ironstone concretions, mudstone, siltstone, coal, and coaly shale. Abundant carbonaceous plant impressions in the sandstone.

352 ft. -Covered (includes Sa-181).

7 ft. -(Ch-230). Sandstone, fine grained, light gray, cross-bedded, ironstained, with ironstone concretions, similar to sandstone above.

1 ft. -Shaly sandstone, similar to above, soft.

12 ft. -Covered

5-5 1/2 ft. -Bituminous coal, good quality, hard, blocky.

680 ft. -Covered

12 ft. -(Ch-231) Sandstone, medium-fine grained, light gray, salt and pepper type, non-calcareous, moderately indurated, medium porosity, cross-bedded, thin layered 1-2", moderate yellow-red stained, ironstone concretions, a few gray-black chert pebbles (1/2" diameter), and some carbonaceous and coaly lenses.

1 ft. -(base covered) Bane and low grade coal with some soft carbonaceous shale and clay, poorly consolidated.

100 ft. -Covered, (includes Sa-182).

50 ft. -Talus (Ch-232) coaly and carbonaceous shale, sandstone, medium-fine grained, soft to moderately indurated, moderate porosity, abundant carbonaceous fragments, all similar to Ch-231 above.

2325 Ft.

(All Sable stations described from top to bottom of section.)

Station Sa 13-14 (Lisburne limestone)

Top of section

?	(Sa-14) Rubble of limestone and chert. Limestone is medium dark gray, finely crystalline, weathers light grayish-pink. Contains nodules and angular fragments of black chert.
?	Covered.
25 ft.	-(Top Sa-13) Interbedded limestone and shale, dark gray to black. Limestone predominant, very dense. Some thin layers extremely fossiliferous, containing bryozoa, crinoid remains, and shell fragments of Spirifer-type brachiopods (49ASa-17f).
2 ft.	-Limestone, medium gray, unfossiliferous.
7 ft.	-Limestone, dark gray, in part fossiliferous and with "oolitic" texture.
18 ft.	-Chert, black, evenly bedded with few thin interbeds of black shale.
15 ft.	-Interbedded shale, limestone, and chert. Limestone is predominant and is similar to 25 ft. unit above. Black chert appears as small lenses in limestone.
15 ft.	-Black chert, with few interbeds of black shale in upper 5 ft. Some chert fractures in prismatic fragments and appears to contain minute organic remains.
5 ft.	-Limestone, dark gray to black, finely crystalline dense, with petroliferous odor.
20 ft.	-Black chert and silicified (?) limestone. Calcite veining common.
3 ft.	-Limestone, medium gray, uniform, weathers light gray.
40 ft.	-Black chert with thin interbeds of black shale. Chert is massive to blocky, in part finely banded.
35 ft.	-Talus of black chert. Includes some silicified limestone breccia.
10 ft.	-Silty limestone and black shale.
8 ft.	-Interbedded dark gray to black limestone and black shale. Limestone contains minute fauna of brachiopod fragments and tiny organisms (49 ASa-15f).
20 ft.	-Interbedded black limestone and shale. Limestone fissile to blocky, contains chert nodules to 2 " length associated with tiny organisms. Shale extremely fissile.
9 ft.	-Fissile black limestone and shale.
17 ft.	-Limestone, black, finely crystalline, blocky, very dense. Contains 4 ft. black shale in center of unit.
8 ft.	-Talus of limestone similar to unit 2. 1 ft. black shale at top of unit.
12 ft.	-Limestone, dark gray to black, finely crystalline, with fissile parting and petroliferous odor on fresh surfaces. Minor amounts of black shale near top.
60 ft.	-Talus of dark gray to black limestone, petroliferous odor on fresh surfaces, uniform in appearances. Weathers light gray in platy to blocky fragments. Minor amounts of interbedded black shale.
6 ft.	-Interbedded black chert, shale, and limestone. Beds less than 6 " thick.
?	Talus covered. Shale, limestone, chert. Shale predominant.
335 ft.	

General note: Nearly all limestone, exhibited petroliferous odor on fresh surfaces.

Station Sa 82 (North limb of Syncline 2 Zones B-C)

Top of section

8 ft. -Sandstone, very fine-fine grained slightly calcareous, cross-bedded. Carbonaceous matter producing laminated effect. Weathers in platy to blocky fragments.

? Covered

3 ft. -Sandstone, very fine-fine grained, light tan, clean appearing, massive. Low porosity. Underlain by silt shale.

? Covered. Heavings of silt shale.

6 ft. -Siltstone. Medium gray, massive, cross-bedded. Weathers rust color. Shaly layers in upper 3 feet.

20+ Covered

15 ft. -Siltstone and few interbeeded sandstone beds to 8 inches thick. Dark gray to gray-brown color. Abundant wood remains, irregular surfaces. Contains ironstone nodules.

? Rubble of sandstone, siltstone, and shale similar to Unit 2. Siltstone ripple-marked and surfaces covered thinly by mud-cracked (?) black shale. Shale pebbles in sandstone and siltstone. A few poorly preserved pelecypods in sandstone.

? Talus similar to unit 2.

6 ft. Sandstone similar to unit 2, but lighter in color. Moderately calcareous. Irregular surfaces and small scale ripple-marking trending North-South. Massive.

? Talus of dark gray silt shale and siltstone with minor amounts of sandstone

Station Sa 119 (South limb of syncline 6 Zones D-E)

Top of section

6 ft. -Sandstone, medium-grained, pale yellow brown, non-calcareous. Somewhat friable, moderate porosity, blocky and much fractured.

10 ft. -Covered. Conglomerate in float, containing pebbles of ironstone, chert, and quartz.

1 ft. -Coal and coaly shale. Fissile to prismatic parting.

4 ft. -Covered. Clay shale and ironstone float.

10 ft. -Siltstone, light olive, slightly calcareous. Massive with irregular bedding surfaces containing clay ironstone. Six inches coaly shale near base.

4 ft. -Covered

6 ft. -Sandy siltstone, medium gray, slightly clacareous, massive to platy. Abundant ironstone, carbonaceous fragments, and plant roots perpendicular to bedding surfaces are present. Unit lenses to 10'feet thickness within 100 lateral feet.

10 ft. -Siltstone as in unit 4.

13 ft. -Covered.

17 ft. -Siltstone and ironstone as in unit 4

28 ft. -Covered.

5 ft.? -Coal and ironstone rubble

40 ft. -Covered.

11 ft. -Sandstone, conglomeratic sandstone, and conglomerate. Fine grained, moderate porosity. Conglomerate occurs as lenses to 3 inches thick.

3 ft. -Silt shale, moderate yellow-brown.

2 ft. -Coal and coaly shale.

8 ft. -Siltstone, medium dark gray, blocky to platy, with carbonaceous fragments and ironstone nodules.

34 ft. - Covered.

6 ft. -Siltstone, medium dark gray, non-calcareous.

15 ft. -Covered.

15 ft. -Siltstone, medium dark gray platy to fissils contains thin beds of carbonaceous shale.

4 ft. -Covered.

27 ft. -Sandstone, fine to medium grained, medium gray, massive to platy. Contains thin beds of carbonaceous shales, ironstone nodules, coal wood fragments, thin layers of pebble conglomerate (ironstone, white quartz, and chert). Cross-bedded with angle of foreset beds to 25°. Moderate porosity.

9 ft. -Siltstone, medium dark gray, blocky to platy, with abundant plant impressions and tree trunks perpendicular to bedding.

50+ ft. -Covered.

5 ft. -Sandstone, very fine grained, pale yellow-brown, platy, non-calcareous.

50-80 ft. -Covered.

8 ft. -Siltstone, platy to shaly. Contains one 3 inch coal bed and abundant coaly fragments.

29 ft. -Covered.

7 ft. -Siltstone as above

1 ft. -Carbonaceous shale and coal

8 ft. -Siltstone, olive gray. Appears to underlie 1 ft. coal unconformably.

10 ft. - Covered.

Station Sa 119 (South limb of syncline 6 Zones D-E) cont.

Top of section

3 ft.	-Siltstone with abundant plant fragments and some coaly shale. Weather yellow-orange.
8 ft.	-Covered.
3 ft.	-Siltstone, medium-dark gray, well indurated, micaceous. Platy to shaly
13 ft.	-Covered.
5 ft.	-Siltstone, dark yellow-brown, micaceous, abundant carbonaceous fragments.
120½ ft.	-Covered.
4 ft.	-Siltstone, ironstone nodules, and coaly shale.
75½ ft.	-Covered.
3 ft.	-Sandstone, very fine grained.
4 ft.	-Siltstone, poorly exposed.
114 ft.	-Covered.
11 ft.	-Sandstone, very fine grained, medium light gray, massive to platy, highly calcareous.
550 ft.	-Covered.
10 ft.	-Sandstone and siltstone, dark yellow-brown, massive to platy, micaceous, cross-bedded.

Calcite veining is common throughout above section

1040½ ft.

Station Sa 134 (South limb of Syncline 7 - Zones B-C and D-E)

Top of section

18 ft. -Siltstone and very fine-grained sandstone, poorly exposed. Light yellow-brown, slightly calcareous, fractures blocky. Equivalent to bottom of Ch 156 section.

253 ft. -Mostly covered. Some siltstone, shale, and carbonaceous shale float.

6 ft. -Sandstone, very fine grained, medium gray, slightly calcareous Massive to platy.

126 ft. -Mostly covered. Scattered exposures of siltstone. Carbonaceous shale heaving near top.

193 ft. -Poorly exposed. Siltstone and shale. Coaly shale near base.

84 ft. -Interbedded shale and siltstone. Shale in 5 to 8 foot units, siltstone in 2 to 3 foot beds. A medium gray calcareous claystone, weathering dusky yellow, occurs. Coaly shale near top.

133 ft. -Interbedded shale and siltstone as in unit 36. Abundant clay ironstone nodules.

6 ft. -Siltstone and very fine-grained sandstone. Moderately calcareous, massive to platy.

67 ft. -Siltstone and shale as above. Siltstone predominant. Contains mud lumps and worm trails.

22 ft. -Sandstone, very fine grained, medium light gray, moderately calcareous, contains wood fragments.

16 ft. - Sandstone and siltstone.

120 ft. -Poorly exposed. Siltstone, silt shale, clayshale, interbedded. Siltstone in beds 2 to 3 feet thick.

41 ft. -Conglomeratic sandstone, fine-grained, friable, moderate porosity, Yellow discoloration of fresh surfaces. Noncalcareous. Contains scattered chert and ironstone pebbles.

110 ft. -Mostly covered. Siltstone and silt shale in lower third. Shale and siltstone float in upper part.

12 ft. -Silty sandstone, blocky to fissile, blocky parting. Contains oscillation ripple marks trending N60°E.

170 ft. -Interbedded siltstone, silt shale, and clayshale, medium dark gray to dark yellow-brown. Siltstone weathers dark yellow-orange.

5 ft. -Silt shale and clay shale, light olive-gray, highly calcareous, fissile to blocky, weathers dusky yellow.

51 ft. -Sandstone and silt shale. Sandstone well indurated, one 20 foot bed at top of unit. Contains wood fragments, mud lumps.

76 ft. -Clayshale (lower 10 feet), siltstone, sandstone, single-shelled pelecypods associated with mud lumps and worm trails.

150 ft. -Sandy siltstone and sandstone with thin interbeds of silt shale. Yellowish discoloration in sandstone, which is medium gray and makes up top 50 feet of unit.

230 ft. -Poorly exposed silt shale and clay shale in lower 100 feet. Interbedded sandy siltstone and shale in upper part. Minor amount of carbonaceous shale.

57 ft. -Sandstone and siltstone, medium gray, slightly friable, platy to blocky, slightly calcareous. Scattered ironstone pebbles.

Station Sa 134 (South limb of Syncline 7 - Zones B-C and D-E) cont.

Top of section

89 ft.	-Interbedded siltstone and shale. Clayshale predominant.
7 ft.	-Sandstone, fine-grained, medium gray, moderately friable, blocky. Contains poorly-preserved pelecypod impressions.
26 ft.	-Interbedded silstone, clayshale, and silt shale. Shale dominant.
5 ft.	-Silty sandstone, medium gray. Pelecypod impressions and shells of Pecten sp. associated with mud lumps and shale pebbles.
81 ft.	-Siltstone, silt shale, and clayshale. Siltstone in 1 to 2 foot beds, contains oscillation ripple marks in float. Shale 70% of unit.
64 ft.	-Covered. Shale and siltstone talus.
40 ft.	-Siltstone and very fine-grained sandstone. 20 foot sandstone bed at top with yellowish coloration, contains shale pebbles, is moderately friable.
78 ft.	-Covered. Some siltstone and silt shale.
60-65 ft.	-Sandstone, fine grained, medium-dark gray, non-calcareous, salt and pepper type. Scattered shale and ironstone pebbles. Uniform.
10 ft.	Covered
16 ft.	-Sandy siltstone. Carbonaceous partings, shale pebbles.
30 ft.	-Covered
12 ft.	-Siltstone and silt shale. Poorly exposed.
30 ft.	-Covered.
25-30 ft.	-Sandstone, fine-grained, medium gray, moderately friable, wood fragments.
130 ft.	-Sandstone and clayshale heavings.
4 ft.	-Sandstone as in unit 10 but darker gray in color and well indurated.
43 ft.	-Clayshale and silt shale heavings.
4 ft.	-Siltstone.
55 ft.	-Covered.
10 ft.	-Siltstone and sandstone as above.
31 ft.	-Clayshale and siltshale heavings
3 ft.	-Sandstone as in unit 5.
56 ft.	-Siltstone and shale heavings.
15 ft.	-Sandstone, fine grained, moderate yellow-brown, platy non-calcareous.
500 ft.	Covered to anticline axis.
1700 ft.	To assumed Torok fm.-Zones B-C contact.
5065 ft.	

Station Sa 135 (South limb of Syncline 7 - zones D-E)

1,000 ft.+	-Scattered exposures of siltstone, sandstone, ironstone, carbonaceous shale, and coal. Sandstones are fine- to medium grained, medium gray, friable, to 6 ft. thick. Coal is associated with medium light gray "underclay."
165 ft.	-Covered.
3-5 ft.	-Coal and coaly shale. Appears to be of poor grade.
6 ft.	-Covered
11 ft.	-Sandstone, fine-grained, medium dark gray, very friable. Weathers light gray. Dull sound when struck with hammer.
13 ft.	-Covered.
16 ft.	-Sandstone, fine- to medium grained, medium to dark gray, well indurated to friable, massively cross bedded. Moderate porosity.
5 ft.	-Coaly shale and coal.
52 ft.	-Covered. Heavings of ironstone, siltstone, carbonaceous shale and gray clay.
7 ft.	-Interbedded ironstone (3 feet), siltstone, and sandstone.
62 ft.	-Covered. Few heavings of coaly shale and clay.
4 ft.	-Coal and coaly shale.
4 ft.	-Siltstone.
5 ft.	-Light gray clay heavings, bentonitic(?).
3 ft.	-Siltstone and coaly shale associated with gray clay.
1,358 ft.	

Station Sa 157 (South of Syncline 8 - zones B-C and D-E)

460 ft.± -Heavings and poor exposures of ironstone, very fine-grained sandstone, coaly shale, coal, and calcareous claystone.
12 ft. -Sandstone, very fine-grained, well-indurated to moderately friable. Lensing and nodular beds. Associated with float of ironstone and carbonaceous shale.
60 ft.± -Covered.
15 ft. -Sandstone, very fine-grained, massive, lensing beds to 5 feet thick, contains wood fragments. Overlain by coaly shale.
260 ft.± -Scattered outcrops of sandstone 5 to 10 feet thick.
8 ft. -Interbedded sandstone, siltstone, and orange-weathering calcareous claystone. Contains abundant plant fragments.
170 ft.± -Covered.
4 ft. -Sandy siltstone, medium gray, moderate calcareous, iron stained, with platy partings.
1 ft. -Coaly shale and coal.
15 ft.± -Clayshale, olive gray, with platy partings 1/8 to 1/2 inches. Contains layers of ironstone.
3 ft. -Sandstone, very fine-grained, massive, well-indurated.
150 ft.± -Scattered sandstone traces. Orange weathering color predominant.
10 ft. -Sandstone similar to unit 18. Weathers grayish-orange. Ironstone in float at base of unit.
270 ft.± -Covered.
15 ft. -Sandstone, very fine-grained, medium gray, iron stained. Ironstone in float at top of unit, platy, containing small oscillation ripple marks.
24 ft. -Sandstone, very fine-grained, medium gray, slightly calcareous, uniform
70 ft.± -Covered.
9 ft. -Silty sandstone, slightly calcareous.
320 ft.± -Covered.
35 ft. -Sandstone, very fine- to fine-grained, medium grained, salt and pepper type, slightly calcareous. Contains carbonized wood fragments and scattered pebbles and cobbles to 7 inch diameter of black chert and white quartz.
770 ft.± -Mostly covered. Two 5-foot beds of sandy siltstone exposed.
9 ft. -Siltstone.
435 ft. -Mostly covered. Some sandstone and siltstone rubble.
24 ft. -Sandy siltstone, poorly exposed.
710 ft. -Mostly covered. Thirty feet poorly exposed siltstone and shale in central part.
40 ft. -Sandy siltstone.
280 ft. -Covered.
25 ft. -Silty sandstone, poorly exposed.
85 ft. -Covered.
21 ft. -Sandstone, very fine-grained, medium gray, weathers pale yellow-brown, contains calcareous ironstone nodules and shale pebbles.

Station Sa 157 (cont'd)

70 ft.	-Covered.
6 ft.	-Sandy siltstone, moderately calcareous.
100 ft.	-Covered.
12 ft.	-Siltstone.
35 ft.	-Covered.
5 ft.	-Siltstone, medium dark gray, massive, well-indurated.
50 ft.	-Covered.
10 ft.	-Siltstone.
100 ft.	-Covered.
50 ft.	-Silty sandstone.
75 ft.	-Covered.
15 ft.	-Siltstone and shale, medium gray partings, ½ to 6 inches.
45 ft.±	-Covered.
35 ft.	-Sandstone. Shale pebbles are concentrically laminated. A few wood fragments scattered throughout.
270 ft.	-Covered. Some sandstone and shale heavings.
53 ft.	-Sandstone, very fine-grained, medium light gray, moderately calcareous, contains ironstone nodules and shale pebbles. Weathers pale yellow-brown.
420 ft.	-Covered. Torok-Nanushuk contact at base.
20 ft.	-Siltstone and siltshale, dark gray, blocky to nodular. Shale approximately 80 percent of unit.
5,840 ft.±	

South limb of syncline 9 - zones B-C and D-E

400 ft.± to axis of syncline. Heavings of siltstone, ironstone, coaly shale, coal.

Station Sa 177

6 ft.	-Siltshale and siltstone, medium gray, nodular to blocky. Contains ironstone nodules.
4 ft.	-Covered.
4 ft.	-Siltstone, light gray, massive, moderately calcareous, contains coaly plant roots to 1/8 inch thick perpendicular to bedding.
4 ft.	-Coal, good quality.
7 ft.	-Siltstone, medium gray, weathers dusky yellow.
275 ft.	-Covered.
35-40 ft.	-Conglomeratic sandstone, very fine to fine-grained, moderately calcareous, massive, well-indurated. Pebbles and cobbles of chert, argillite, and quartzite.
150 ft.	-Covered. Some coaly float.
10 ft.	-Sandstone, very fine-grained, medium gray, moderately calcareous.
525 ft.	-Mostly covered. Heavings of sandstone, ironstone, coaly shale and small amount of coal.
3 ft.	-Siltstone.
1 ft.	-Gray clay and carbonaceous shale.
4 ft.	-Coal, iron stained.
5 ft.	-Siltstone.
15 ft.	-Covered.
13 ft.	-Siltstone and very fine-grained sandstone. Medium gray, cross bedded, weathers pale yellow-brown, contains ironstone nodules.
150 ft.	-Mostly covered. Some poor exposures of siltstone, yellow-orange weathering ironstone, and coaly shale. Wood fragments common.
5 ft.	-Siltstone associated with ironstone and carbonaceous shale.
350 ft.	-Covered. Some coaly shale float.
5 ft.	-Siltstone and sandstone. Sandstone coarse-grained to granule size.
75 ft.	-Covered.
4 ft.	-Siltstone with ironstone nodules.
100 ft.	-Covered.
3 ft.	-Sandstone, very fine to fine-grained.
125 ft.	-Mostly covered. Sandstone, siltstone, and carbonaceous shale heavings.
12 ft.	-Sandstone, very fine-grained, medium gray, moderately calcareous. Massive lensing present.
100 ft.	-Mostly covered. Coal and coaly shale heavings.
?	-Rubble of sandstone and siltstone. Altered by nearby combustion of coal to reddish brown color and burnt appearance.
150 ft.	-Mostly covered. Coal heavings.
3 ft.	-Siltstone.
100 ft.	-Covered.

220 ft. Station Chapman 226.

40 ft. -Covered.

Station Sa 176

25 ft. -Siltstone and siltshale, poorly exposed. Medium dark gray, noncalcareous, contains well-preserved reed fragments.

1 ft. -Shaly coal associated with massive ironstone concretions to 8 inches diameter containing numerous reed and wood fragments.

5 ft. -Covered.

18 ft. -Siltstone, siltshale, clayshale, and thin (2 to 4 inches) coaly shale lenses. Ironstone nodules throughout.

14 ft. -Sandstone and ironstone. Sandstone fine-grained, medium gray, contains abundant coaly fragments. Two and a half feet of ironstone at top.

480 ft. -Mostly covered. Heavings of siltstone, calcareous ironstone, coal associated with gray clay. Weathering colors are light brown to dark yellow-orange.

16 ft. -Sandstone, siltstone, and ironstone.

315 ft. -Mostly covered. Thin beds of (1 to 2 feet) calcareous and silty ironstone. Wood fragments.

9 ft. -Siltstone, olive gray, massive lensing.

400 ft. -Covered. One 5-foot bed of fine-grained sandstone. Weathers dark yellow-orange.

10 ft. -Conglomeratic sandstone, very fine to fine-grained, medium gray, massively cross bedded. Pebbles and cobbles of chert and ironstone.

300 ft. -Mostly covered. Heavings of carbonaceous shale and coal in upper part.

Zones B-C -- zones D-E contact in above interval.

9 ft. -Sandstone, fine-grained, medium gray, platy. Contains lensing ironstone and a few chert and ironstone pebbles.

100 ft. -Mostly covered. Sandstone traces and small amounts of carbonaceous shale and ironstone.

11 ft. -Silty sandstone, medium gray, moderately calcareous. Weathers pale yellow-brown.

175 ft. -Covered.

10 ft. -Silty to very fine-grained sandstone, medium gray, weathers pale yellow-brown.

50 ft. -Covered.

3 ft. -Sandstone

75 ft. -Covered.

10 ft. -Sandstone, as above. Contains coaly fragments.

75 ft. -Covered.

10 ft. -Rubble of sandstone, moderately friable.

1,500 ft.± -Mostly covered. Numerous rubble traces of medium gray, very fine-grained sandstone and siltstone.

Break in slope is assumed zones B-C -- Torok formation contact.

6,500 ft. ±