United States

Department of the Interior

U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Preliminary Report No. 23

PRELIMINARY REPORTS ON THE CARBON CREEK ANTICLINE AND ON THE UPPER MEADE RIVER, ALASKA

1949

United States

Department of the Interior

U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Preliminary Report No. 23

PRELIMINARY REPORTS ON THE CARBON CREEK ANTICLINE AND ON THE UPPER MEADE RIVER, ALASKA

By

Charles L. Whittington and Samuel A. Keller

November 1949

CONTENTS

CONTENTS (CONT'D)

ILLUSTRATIONS

PRELIMINARY REPORTS ON THE CARBON CREEK ANTICLINE AND ON THE UPPER MEADE RIVER, ALASKA

By

Charles L. Whittington and Samuel A. Keller

STRATIGRAPHY AND STRUCTURE OF A PART OF THE CARBON CREEK ANTICLINE, ALASKA

INTRODUCTION

From June 9 to July 27, 1949, U. S. Geological Survey Party No. 2 made a survey of a part of the Carbon Creek anticline. The objectives of the party were twofold: (1) to find and delineate structural highs; and (2) to carry on such supplementary stratigraphic studies as time permitted. Field work began with several reconnaissance traverses. The dip-strike pattern plotted from this work gave no conclusive closure data. Because of poor surface expression along considerable parts of the anticline, it became obvious that even precise surveys would not be conclusive enough to indicate small reversals that might be present.

The largest part of the area surveyed lies in quadrangle J-18. It is about 150 miles south of Barrow and 150 miles west of Umiat.

The maximum relief in the area surveyed is about 1,100 feet. This change of altitude occurs over a distance of about 10 miles in the western part of the area between Lookout Ridge and Carbon Creek. The "axial" valley, which corresponds to the Zone A pattern (figure 1), is $3\frac{1}{2}$ to $4\frac{1}{2}$ miles wide in most of the area, but becomes narrower to the west as the anticline plunges. On the structural low at longitude 159°00'W the valley is less than 1 mile wide. Except for moderate dissection in the Carbon Creek drainage basin, this "axial" valley has low relief, and elevations remain fairly constant throughout. On both the north and south the valley is flanked by hills of the resistant Tuktu sandstone. To the north, the relief between the valley and the hills is about 300 feet, to the south, 400 feet.

Most of the area covered by this report lies in the headward parts of two drainage basins. The eastern part is in the basin of the Awuna River, a tributary of the Colville River. The western part is drained by Carbon Creek which flows into the Utukok River. The gradient of

Carbon Creek is about three to four times that of the Awuna River. This difference in stream gradients has resulted in much better exposures in the western part of the area as compared with the eastern. A continuing process of stream piracy is underway, in which Carbon Creek is progressively capturing one after another of the streams at the head of the Awuna drainage. That part of the area south of Lookout Ridge is drained by small streams which flow into the Colville River.

The only previous field work in the area covered by this report was that of W. R. Smith 1/ in the exploratory survey of 1925. No specific observations on this area are included in the text of U.S.G.S. Bulletin 815. The general trend of the anticline was outlined in 1946 by photo interpretation and aerial reconnaissance. Study of aerial photographs prior to the 1949 field season indicated that the stratigraphy on this part of the anticline would be correlative with that studied on the Utukok River in 1947. 2/

STRATIGRAPHY OF THE NANUSHUK GROUP (CRETACEOUS)

Beds exposed range from the Zone A shale sequence along the center of the anticline, through the Zone B-C sandstone section along the flanks, into the Zone D coal-bearing sequence in the basin at about longitude 158°55'W and latitude 69°14'N. Fossils are rare, and those collected have not been identified. In the field no diagnostic fossils were recognized.

Zone A (Torok Shale)

Rocks of Zone A occur along the axial portion of the Carbon Creek anticline in a lowland area 3½ to 4½ miles wide. Zone A beds are probably also present in the lowland area south of Lookout Ridge, inasmuch as the lithology in this area is similar to Zone A lithology on Carbon Creek.

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

2/ Barksdale, W. L., and Thompson, R. M., Stratigraphy and structure of the Utukok River with notes on the Corwin-Cape Beaufort region, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 18, March 1948.

In the area of Carbon Creek drainage, outcrops of this zone are confined to cutbanks along the streams. No outcrops and only minor occurrences of sandstone rubble were found in the Awuna drainage. On the basis of the exposures seen along Carbon Creek and its tributaries, the predominant rocks in Zone A are silt shales and clay shales. Color of the shales ranges from medium gray and greenish gray to dark gray. Sandstone in beds one to several inches thick is interbedded with the shales in some exposures. In the interstream areas sandstones also form a number of rubble areas and structure traces. From the indefinite character of these structure traces it would appear that these sandstone beds are at most only a few feet thick. The sandstones are uniformly light to medium gray, very fine grained, and tight. The ratio of sandstone to shale is not more than one to twenty.

Because of limited exposures, complicated structure, and the general absence of traceable beds, it is impossible to make a reliable estimate of the stratigraphic thickness of Zone A. Locally the dip varies from horizontal in one exposure to vertical in another a few hundred feet away. There are a number of exposures in which the dip varies 30° to 40°. It is estimated that the axial lowland represents a stratigraphic section 2,500 to 3,000 feet thick.

Zone B (Tuktu Sandstone) and Zone C, Undifferentiated

Overlying Zone A, beds of Zones B and C form the hills on both flanks of the anticline and extend into the synclines on either side. Total thickness of this stratigraphic unit is 2,000 feet, but the upper portion is missing in most places. In the Lookout Ridge syncline the thickness ranges from 1,300 feet at longitude 158°20'W to 1,800 feet at longitude 159°00'W. In the syncline north of the anticline a section of 1,600 feet is exposed at longitude 158°42'W. In the basin 5 miles to the west the complete 2,000 feet is present and is overlain by approximately 1,000 feet of Zone D sediments. Outcrops are small and are generally limited to structure traces in the interstream areas. Only a few minor outcrops occur along the streams.

The rocks of Zone B-C are almost entirely sandstone and shale. Ironstone (clay ironstone and hard ferruginous shale) is fairly common in thin beds. Thin beds of coal occur in a few places. In the lower 1,000 feet, the ratio of sandstone to shale is not less than 1:1, but the sandstone-shale ratio for the upper 1,000 feet is considerably less.

The sandstones are prevalently light gray, slightly to moderately argillaceous, and noncalcareous to moderately calcareous. Those which are darker in color are somewhat harder, moderately to highly argillaceous and generally calcareous. Although porosity is moderate to high locally, it is characteristically low. Many of the sandstones contain conglomeratic layers 1 to 3 inches thick. The pebbles comprising these layers are predominantly dark chert, although light chert and white quartz are also present. Oscillation ripple marks, carbonized plant fragments, and shale pebbles (clay galls) are common. (Stratigraphic sections in Zones B-C, based on plane-table traverses in the western part of the area, are depicted in figure 2).

Zone D

Exposures of this unit were found only in the basin north of the anticline, which centers at latitude 69°14'N. and longitude 158°55'W. A thickness of approximately 1,000 feet of these beds is present in this synclinal basin. This zone is characterized by the occurrence of coal and ironstone, which is generally expressed as coal blossoms and ironstone rubble. A 4-foot coal seam was exposed at one outcrop. A high content of inorganic constituents has a tendency to impart a shaly aspect to the coal. Where exposed in place, the coal is associated with clay ironstone, medium-gray claystone, clay shale, silt shale, light-gray siltstone, and light-gray, very fine grained, highly argillaceous sandstone. The rocks of this zone commonly weather to a reddish-yellow hue, so distinguishable that they can be readily identified at considerable distances. The proportion of sandstone in this section is about the same as that in the upper 1,000 feet of Zone B-C.

BASIS FOR CORRELATION

The stratigraphy on the Carbon Creek anticline corresponds closely to that exposed on the Utukok River in the vicinity of Carbon Creek, and to that exposed on the Awuna anticline. The lowland (Zone A), flanked on either side by hills bearing prominent structure traces (lower part of Zone B-C), may be traced on aerial photographs from this area to the Utukok River. In this report, that unit depicted as Zone A, Torok Shale, corresponds to the Lower Cretaceous black shales referred to in the report

on the Utukok area 1/ and to that designated as Zone Sub-A in the Awuna report. 2/ Zone E-C in this area corresponds to that described as Zone A in both previous reports. The classification of Zone D remains unchanged.

STRUCTURE

The outstanding structural feature in the area is the Carbon Creek anticline (figure 1). This anticline continues into the Utukok area to the west beyond the limits of figure 1, and also can be traced east to the vicinity of the Colville River. The convergence of strikes on the flanks of the anticline indicates a marked west plunge. Computed stratigraphic thicknesses, one at longitude 158°42'W, and one at longitude 158°56'W, indicate that minimum plunge within these limits is 1,000 feet. A further reversal occurs at longitude 159°00'W, and may indicate eastward plunge of structure in the area to the west. Although several strikes appear to converge slightly at longitude 158°19'W, thus indicating a structural high, evidence is not conclusive, and the high, if present, would be very minor. The effects of bends in the anticlinal axial trend upon the occurrence of possible highs is unknown. No conclusive evidence of plunge is indicated in the eastern section of the area surveyed.

The Lookout Ridge syncline (figure 1) can be traced across the entire southern area. Minor west plunge is indicated at longitude 158°10'W. Steep west plunge is indicated on the synclinal structure that centers at longitude 158°50'W and latitude 69°14'N. East plunge on this structure is indicated at longitude 158°58'W.

1/ Barksdale, W. L., and Thompson, R. M., Stratigraphy and structure of the Utukok River, with notes on the Corwin-Cape Beaufort region, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 18, 1948.

2/ Whittington, C. L., and Troyer, M. L., Stratigraphy and structure of the area of the Kigalik and Awuna Rivers, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 17, 1948.

As shown by dips on the flanks in the Zone B sandstone, the Carbon Creek anticline is not quite symmetrical. Dips on the north flank are generally a few degrees steeper than those on the south flank. Along the axial portion of the structure, within the area designated as Zone A (figure 1), structural data is limited. In the Carbon Creek drainage area, scattered outcrops indicate that dips in Zone A are steeper than those in Zone B, and that they increase in magnitude toward the axis. The dips, however, vary greatly within short distances normal to the strike. Vertical and very steep dips occur well out from the Zone B contact, that is, near the axis. The exact position of the axis is uncertain. The structure may be analagous to that of the Umiat anticline, with the vertical dips indicating a monoclinal flexure, possibly faulted, a short distance north of the axis. In the Awuna drainage area, outcrops in Zone A are absent, and the character of the axial portion of the fold can only be inferred from observations in the Carbon Creek area.

On the south flank of the structure, north-trending faults offset the sandstone traces in the lower part of Zone B (see figure 1). From the regularity of the features associated with the faults, it is logical to assume that the fault planes are steeply dipping. In most cases, examination of photographs and field studies indicate a likely correlation between the traces on opposite sides of each offset. Thus, the apparent horizontal displacement is indicated for each fault. However, the faults cannot be traced very far into the syncline to the south, but appear to die out rapidly. With this abrupt disappearance of the faults, it seems more logical to assume that the relative movement along them is essentially vertical. For dips of the order encountered in the area in question the vertical movement necessary to produce a given horizontal displacement is much less than the horizontal movement necessary to produce the same offset. For bedding dipping 11°, an apparent horizontal offset of 1,000 feet would be produced by a vertical movement of 200 feet; for a 22° dip the 1,000-foot offset would result from a vertical movement of 400 feet.

Several good exposures of the top part of Zone A sediments along Carbon Creek exhibit the same phenomenon. This condition is manifested in pinchouts, indicating considerable bedding-plane slippage. In a few places, fault planes cut bedding at large angles. Strike and dip of these fault planes are essentially parallel to the bedding. Drag, where observed, indicated that movement was such that the top beds moved toward the anticlinal axis relative to the bottom beds. Accompanying some of these faults are considerable changes in dip and strike, which, if noted in a poor exposure, might be erroneously considered manifestations of an angular unconformity.

POSSIBILITY OF AN UNCONFORMITY BETWEEN ZONE A AND ZONE B

An unconformity between the shale sequence of Zone A and sandstone sequence of Zone B-C was reported to be present on the Utukok River in the vicinity of Carbon Creek. 1/ This unconformity is not evident on the Carbon Creek anticline. The steeper dips and more complex structure which are present in Zone A, as compared to the younger beds, may be explained more logically as due to greater deformation of incompetent beds rather than by an angular unconformity. The considerable changes in dip which accompany the faulting in the Carbon Creek outcrops may have been interpreted in more poorly exposed sections as an unconformity.

PETROLEUM POSSIBILITIES

Determinations of porosity and permeability have been made on samples from two sandstones which appeared to have favorable reservoir characteristics. These sandstones are part of the Zone B-C sequence in the eastern part of the area. In an attempt to obtain a representative measure of porosity and permeability, these samples were taken from large rubble blocks, but probably have been affected to some extent by weathering. Both sandstones are light gray, fine-grained, and noncalcareous. Pertinent data are as follows:

Sample 49A Wh 55

Locality:	south flank of the Carbon Creek anticline at longitude 158°17'W
Stratigraphic position:	approximately 1,200 feet above the base of Zone B-C
Effective porosity:	14.0 percent
Air permeability:	5 millidarcies

Sample 49A Wh 66

Locality:	north flank of the Carbon Creek anticline at longitude 157°52'W
Stratigraphic position:	approximately 400 feet above the base of Zone B-C
Effective porosity:	14.5 percent
Air permeability:	8 millidarcies

Although these statistics are not inspiring, the sands may be considered to possess the minimum requirements for a potential reservoir rock.

1/ Barksdale, W. L., and Thompson, K. M., Stratigraphy and structure of the area of the Utukok River with notes on the Corwin-Cape Beaufort region, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 18, p. 8, 1948.

Possible reservoir beds on this structure are limited to those older than the Torok shale, that is, Killik group, Shublik formation, and Lisburne limestone. The character of the outcropping sandstones of the Namushuk group is entirely unfavorable west of longitude 158°30'W. East of this point beds of fair porosity in Zones B-C crop out, and these become somewhat more favorable to the east.

SUMMARY

1. Sediments aggregating a maximum thickness of 6,000 feet are present in the area studied. Zone A comprises 3,000 feet, Zone B-C undifferentiated, 2,000 feet, and Zone D, 1,000 feet.

2. No closure is indicated, but minor closures may be present in the eastern half of the area. The effect of bends in the anticlinal axial trend upon the occurrence of possible highs is unknown. In the western portion of the area, west plunge becomes progressively steeper, but suddenly reverses at longitude 159°00'W.

3. Possible reservoir beds are limited to rocks older than Zone A (Torok shale).

4. Outcropping sandstones of Zone B-C are considered to be unfavorable as potential reservoirs in the western part of the area, but become increasingly favorable to the east.

STRATIGRAPHY AND STRUCTURE OF THE UPPER MEADE RIVER AREA, ALASKA

INTRODUCTION

Detailed geologic studies of structure and stratigraphy in the area of the upper Meade River were made by U. S. Geological Survey Party No. 2 during August 1949. Most of the area surveyed (figure 3) lies in the western two-thirds of quadrangles H-17 and I-17. The area extends from 69°28'N to 69°34'N and from 157°20'W to 158°10'W. In addition to detailed work in the area depicted on figure 3, several geologic traverses were extended northward to Shaningarok Creek. The nature of the area to the north, however, is such that little information of geologic significance could be obtained.

The upper Meade River area lies in the northern part of the Arctic Foothills Province. Physiographic expression in the district consists of gently-rounded ridges and widely-flaring V-shaped valleys. Maximum relief is approximately 300 feet. The major drainage is the Meade River. Its banks are generally steep, and a discontinuous flood plain is developed approximately 10 feet above low-water level. The flood plain, in most localities, is only 100 to 200 feet wide, but in the vicinity of abandoned meanders, it is considerably more extensive. Locally, these old meanders have been preserved as lakes. For some distance away from the main river, secondary streams have steep banks 3 to 4 feet high, and relatively narrow channels.

During the field season of 1946, E. J. Webber 1/ traversed the Meade, encompassing in his final report geologic information on the upper Meade River and Shaningarok Creek areas. Supplementary information in the vicinity of Shaningarok Creek was added by E. J. Webber 2/ during the 1947 field season. For the purpose of extending Webber's observations in this district into a better integrated areal picture, vertical aerial photographs

---

1/ Webber, E. J., Stratigraphy and structure of the area of the Meade and Kuk Rivers and Point Barrow, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 6, 1947.

2/ Webber, E. J., Stratigraphy and structure of the area of the Titaluk River and the upper part of the Ikpikpuk River, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 16, 1948.

were utilized in two separate projects. Both projects, one by W. A. English 1/ and one by W. A. Fischer 2/, included the area in question. Party 15 of the United Geophysical Co. Inc. initiated their 1949 seismograph survey in this area (see figure 3).

STRATIGRAPHY OF THE NANUSHUK GROUP (CRETACEOUS)

Exposures in this district are limited to scattered and, for the most part, poorly exposed outcrops along the Meade River proper. In addition, sandstone rubble traces are present in interstream areas, and are best developed near the ridge tops. An estimated maximum of 10 percent of the total thickness of stratigraphic section in the area is thus exposed by outcrops and structure traces.

Paleontologic evidence and the aspect of the gross lithology indicate that the exposed sediments range in age from Zone D to Zone D of the Nanushuk group. The general lack of bentonite corroborates this hypothesis, inasmuch as the occurrence of bentonite is believed to be associated largely with sediments younger than those of Zone D. In addition, the fossil Cleoniceras, found at station K-161, and Inoceramus fragments, found at W-174 (figure 3), attest to sediments of Zone B-C age.

Zone B-C (undifferentiated)

Because of limited exposures, and inasmuch as the total thickness of Zones B and C are not present in the area, it is not feasible to consider these zones other than as a unit. The Zone B-C beds crop out, except in isolated areas, in a band limited on the north by the southern boundary of the zone of reverse faults (figure 3), and extends into the syncline to the south. A maximum of from 700 to 1,200 feet of this unit is represented in the western part of this area. Necessitated by the swing in strike of the over-all structure, and a lessening of dip to the east, approximately 500 to 700 feet of this unit progressively disappears against the fault zone in the eastern sector (figure 3).

The lithology in this unit closely resembles that in the same stratigraphic range at the Carbon Creek anticline. In general, the rocks exposed consist of very fine to fine-grained, poorly sorted, noncalcareous to very slightly calcareous sandstone. Where found unweathered, these units are light gray. Where weathered, they show typical yellow-red-yellow surfaces, and color banding. The poor sorting, absence of glauconite, and the

---

1/ English, W. A., Personal communication, 1949.

2/ Fischer, W. A., Interpretation from aerial photographs of geologic structures of the central Colville River area, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 30, April 1949.

argillaceous content of the sandstone attest to at least a moderately rapid rate of deposition. Porosity in these sands varies from low to medium, and the permeability throughout is low. Porosity and permeability determinations made on several samples in the Fairbanks laboratory of the Geological Survey indicate porosity as high as 15 percent and permeability from 5 to 10 millidarcies. Throughout the area, these sandstones are nondistinctive. The monotony of their appearance is offset locally, however, with oscillation ripple marks, worm trails, depositional markings, and shale-pebble inclusions (clay galls). Cross bedding was observed at a few exposures. Carbonaceous material occurs sporadically increasing to some extent in the beds higher in the stratigraphic section.

Although shale is probably the predominant rock in the total thickness of section, exposures are few, and limited in occurrence to outcrops along the Meade River. Where exposed, it is predominantly clay shale, light to medium gray, with a greenish cast locally, thinly bedded, noncalcareous, and with a semi-conchoidal fracture.

The remainder of the exposed section, includes combinations of the above rock types, and minor amounts of silt shale, ironstone in lenses and nodules, thin coal seams, and several black chert-pebble layers.

At station W-177 cyclic sedimentation is suggested by minor erosional breaks and repetition of rock types in definite sequence. A more pronounced, but still minor, erosional break is present in the outcrop at K-122. It seems probable that minor diastems occur throughout the Zone B-C sequence in this area. Oscillation ripple marks attest to relatively shallow water deposition. Indications are that the Zone B-C sediments were deposited as near-shore marine units, becoming marginal deposits higher in the stratigraphic column.

Zone D

The preponderance of coal seams, clay ironstone, sideritic calcareous claystone, leaf imprints, carbonized wood, and weathered nonmarine sandstones bear witness to the presence of Zone D sediments in this area. This unit manifests itself, except in isolated places, as a band bounded on the south by the northern limit of the faulted zone (figure 3), and it extends north at least to Shaningarok Creek. Because dips in the area north of the fault zone are extremely low, the beds exposed probably represent a stratigraphic sequence of not more than 500 feet.

A close similarity exists between the lithology of the Zone D sequence exposed in this area and the 1,000 feet of Zone D sediments exposed in the Carbon Creek area. The sandstone units in this zone are predominantly very fine to fine-grained, noncalcareous to slightly calcareous, and are generally highly weathered to a limonitic hue. In addition to this type, a sandstone bed believed to be Zone D in age is present within the zone of faulting at stations K-145 and K-205, and in the vicinity of K-196. This rock is a medium- to coarse-grained sandstone, light gray in color, and can be identified in the field by the characteristic occurrence of gray lichens on its exposed surfaces. On first appraisal, this sandstone appears to be a highly favorable potential reservoir sand; however, an analysis made at the Fairbanks laboratory indicates that although the porosity of this sand is 15 percent, the permeability is low.

Other than the rock types discussed above, a minor amount of siltstone is also exposed, and at two localities conglomerate is present. The conglomerate consists of pebbles and an occasional cobble, predominantly light-gray to black chert, with a lesser amount of white quartz. At station W-140, one of the chert pebbles contained crinoid stems. A few pebbles of black argillite also occur at the same locality.

Stratigraphy within the zone of Faulting

In the preceding discussion, it was noted that both Zone B-C and Zone D sediments manifest themselves in wide bands except in isolated places. The isolated outcrops of both B-C and D sediments occur within the complex zone of faulting shown on figure 3. Owing to the number of offsets in the area, the units exposed range widely in position in the stratigraphic column.

STRUCTURE

Faulting

The paramount feature of structural importance in this area is the zone of reverse faulting delineated on figure 3. An analysis of the area indicates no clear-cut, single fault line, but a faulted zone, extending as a band approximately three-fourths of a mile wide, along the Meade River. Its limits in an east-west direction were not ascertained beyond the area shown on figure 3. Within this band of faulting, many isolated faults contribute to the major pattern. The more important of these faults are summarized below:

Stations W-144 and W-145 (Meade River at longitude 157°46'W)

At station W-144, a 5-foot exposure of very fine sandstone strikes N. 40° E., and dips 35° to the northwest. About 100 feet to the north,

at station W-145, a 6-foot exposure of similar-appearing sandstone strikes N.60°W. and dips 12° to the southwest. These strikes and dips are anomalous when compared to those immediately to the south. In addition, considerable coal is present below W-145, and considerable coal float may be seen north of this station. No coal float is present south of W-144. A fault is therefore postulated immediately south of station W-144. Lithology south of this postulated fault line suggests sediments of Zone B-C age, that to the north, Zone D age. Coupling this postulation with the strong northwest dips at W-144, which may be interpreted as drag, relative apparent movement is south-side up, north-side down.

Station K-161 (Meade River at longitude 157°59'W)

At this locality three sandstone traces dip steeply south. In sandstone on the northernmost trace (stratigraphically lowest), Cleoniceras and pelecypods were found. The trace bordering this to the north consists primarily of steep south-dipping (35°-65°) coal beds. The outcrops for the next hundred yards to the north are highly contorted. Sandstone and coal beds have vertical attitudes; in places the less competent beds have been overridden and overturned. Slickensiding, calcite-filled fractures, and mullion structure attest to considerable slippage. Farther to the north, the beds have a low north dip. A high-angle thrust has thus been postulated between the sandstone containing the fossils (Zone B-C), and the coal-bearing section (Zone D); relative apparent movement, south-side up, north-side down.

Station W-163 (latitude 69°32'N, longitude 158°02'W)

At this locality, fine-grained sandstone beds strike N.60°W, and dip 70°-90° to the southwest. Ten feet to the north, thin-bedded sandstone dips southwest about 10°. Fifty feet south of this point, sandstone rubble traces dip southwest approximately 25°. Rapid variations in dip, plus the magnitude of these dips in an area of otherwise low-dipping sediments, are suggestive of faulting.

Stations K-145,205,184 and 196(eastern end of fault zone, fig. 3)

As the same phenomenon exists at all four of these stations, these will be discussed as a unit. Anomalous conditions exist at each one of these stations. These conditions arise as a result of decided changes in strike in relatively short distances, although no dip reversals are noted. The alignment of these anomalous conditions in a band wherein faulting has already been proved to the west, strongly suggests that the faulting is continuous, at least to station K-196.

at station W-145, a 6-foot exposure of similar-appearing sandstone strikes N.60°W. and dips 12° to the southwest. These strikes and dips are anomalous when compared to those immediately to the south. In addition, considerable coal is present below W-145, and considerable coal float may be seen north of this station. No coal float is present south of W-144. A fault is therefore postulated immediately south of station W-144. Lithology south of this postulated fault line suggests sediments of Zone B-C age, that to the north, Zone D age. Coupling this postulation with the strong northwest dips at W-144, which may be interpreted as drag, relative apparent movement is south-side up, north-side down.

Station K-161 (Meade River at longitude 157°59'W)

At this locality three sandstone traces dip steeply south. In sandstone on the northernmost trace (stratigraphically lowest), Cleoniceras and pelecypods were found. The trace bordering this to the north consists primarily of steep south-dipping (35°-65°) coal beds. The outcrops for the next hundred yards to the north are highly contorted. Sandstone and coal beds have vertical attitudes; in places the less competent beds have been overridden and overturned. Slickensiding, calcite-filled fractures, and mullion structure attest to considerable slippage. Farther to the north, the beds have a low north dip. A high-angle thrust has thus been postulated between the sandstone containing the fossils (Zone B-C), and the coal-bearing section (Zone D); relative apparent movement, south-side up, north-side down.

Station W-163 (latitude 69°32'N, longitude 158°02'W)

At this locality, fine-grained sandstone beds strike N.60°W, and dip 70°-90° to the southwest. Ten feet to the north, thin-bedded sandstone dips southwest about 10°. Fifty feet south of this point, sandstone rubble traces dip southwest approximately 25°. Rapid variations in dip, plus the magnitude of these dips in an area of otherwise low-dipping sediments, are suggestive of faulting.

Stations K-145,205,184 and 196(eastern end of fault zone, fig. 3)

As the same phenomenon exists at all four of these stations, these will be discussed as a unit. Anomalous conditions exist at each one of these stations. These conditions arise as a result of decided changes in strike in relatively short distances, although no dip reversals are noted. The alignment of these anomalous conditions in a band wherein faulting has already been proved to the west, strongly suggests that the faulting is continuous, at least to station K-196.

As it is difficult to definitely ascertain the position in the stratigraphic column of the units north and south of the fault zone, it is not possible to accurately compute the amount of displacement of the fault. However, generalities may be drawn. As has been previously noted under the discussion on stratigraphy, from 700 to 1,200 feet of Zone B-C is exposed in the western area of figure 3. Owing to the swing in strike of the structure, and to the lessening magnitude of dip, as much as 700 feet of B-C sediments may disappear in the eastern sector. Within Zone D no such loss of section is known to take place along the northern limit of the fault zone. Assuming that Zone B-C is 2,000 feet thick and Zone D is also 2,000 feet thick, maximum displacement in the western section of the fault may be computed as 3,500 feet (from the bottom of Zone B-C to 500 feet below the top of Zone D). Minimum displacement in the western sector may be estimated as 700 to 1,200 feet (from 700 to 1,200 feet below the top of Zone B-C to the bottom of Zone D). In the eastern sector of the fault maximum displacement may be as high as 2,800 feet (from 700 feet above the bottom of Zone B-C to 500 feet below the top of Zone D), and minimum displacement from 0-500 feet (0-500 feet below the top of Zone B-C to the base of Zone D).

Folding

The anticlinal fold delineated in the western sector of the area (figure 3) can be traced a short distance only. Dips on the flanks are extremely low, and the origin of the fold is considered to be a direct result of the faulting.

The syncline to the south can be traced across the entire area. Dips are extremely low. An eastward plunge of approximately 500 feet occurs between longitudes 158°05'W and 157°50'W.

The anticlinal fold, designated as the Meade River segment of the Titaluk anticline, also shows low dips. Owing to the poor surface manifestations, it is impossible to determine whether plunge is present along the anticline. The fold apparently dies out to the west, in the complex zone of faulting. It can, however, be traced eastward beyond the area surveyed. The dips along its flanks as it crosses the Meade are extremely low. The Meade River segment has been designated as the western segment of the far-reaching Titaluk trend. 1/

1/ Fischer, W. A., Interpretations of aerial photographs of geologic structures of the central Colville River area, Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Report No. 30, April 1949.

PAHRON GAS SEEP

The Pahron gas seepage occurs at the lake about a quarter of a mile north of the Meade River, at longitude 157°36'W. The main seepage centers about 100 feet off the west shore of the lake, along a 50-foot line that trends N.75°E. The main concentration of the seep is present at the extremities of this line. Two small centers of escape are present 50 feet from shore, and approximately 50 feet apart, one on either side of the projection of the main line. Manifestations of the seepage occurs in the form of continuous bubbling at the surface when the lake waters are calm.

In addition to this seepage, gas was also encountered in shot holes No. 4 and No. 6, along Line 1-49 of the seismograph survey. 1/

PETROLEUM POSSIBILITIES

The statistics cited in connection with the sandstone units in this area, discussed in the section on stratigraphy, although not inspiring, indicate that these sands possess the minimum requirements for reservoir beds. A greater thickness of these sands is present in Zones B-C than in Zone D.

Should closure be proved on the Meade River segment of the Titaluk anticline, oil possibilities may be considered in the Zone B beds (Tuktu sandstone). Because of the nature of the area, however, definitely proving closure is considered to be beyond the scope of a geological surface party. Traps may also occur associated with the zone of reverse faulting.

SUMMARY

1. A three-quarter mile band of reverse faults extends along the Meade River for the total length of the area surveyed.

2. Maximum displacement on this fault approximates 3,500 feet in the western area, and 2,800 feet in the eastern area.

Minimum displacement is computed as 700 feet in the western area, and from 0-500 feet in the eastern area.

3. Closure on the Meade River segment of the Titaluk anticline can not be definitely proved by surface geological methods.

4. Seventeen hundred feet of section (not continuous) is represented in this area. Twelve hundred feet of continuous Zone B-C sediments are present south of the fault zone. An estimated 500 feet of continuous Zone D sediments are present north of the fault zone, extending to Shardngarok Creek.

1/ Palenske, A., Party 45, Report for month of March 1949, United Geophysical Co., Inc., plate 3.

5. Sands which fulfill the minimum requirements for potential reservoir beds are present within Zone B-C and Zone D; and a somewhat greater total thickness of sands is represented in Zone B-C than in Zone D.

6. Structural traps may occur adjacent to the zone of reverse faulting.