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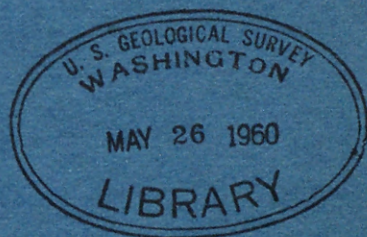
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Washington



Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Report No. 4

STRATIGRAPHY AND STRUCTURE OF THE AREA OF MAYBE CREEK

1947

Previous reports on investigations by the Geological Survey
in Naval Petroleum Reserve No. 4, Alaska

- No. 1 Stratigraphy and structure of the area of the Killik,
Chandler, Anaktuvuk, and Colville Rivers, (1946)
- No. 2 Magnetic survey of part of Naval Petroleum Reserve No. 4
by airborne magnetometer, (1946)
- No. 3 Stratigraphy and structure of the Umiat anticline, (1947)

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STRATIGRAPHY AND STRUCTURE OF THE AREA OF MAYBE CREEK

By

Richard G. Ray

and

William A. Fischer

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STRATIGRAPHY AND STRUCTURE OF THE AREA OF MAYBE CREEK

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INTRODUCTION

During the summer of 1946 the United States Geological Survey continued its program of stratigraphic and structural investigations in Naval Petroleum Reserve No. 4, northern Alaska. This report summarizes the results of work in the area of Maybe Creek (see inset, fig. 1). The area studied is southwest of Umiat and includes about 500 square miles lying generally between the headwaters and mouth of Maybe Creek. Structural data covering approximately 250 square miles of this area has been compiled from aerial photographic studies. The area is bordered generally on the north by the lake country and on the west by the Ikpiuk River. Most of the area is north of Maybe Creek except for that part extending for 6 miles south of Maybe Creek between longitudes $153^{\circ} 30' W.$ and $154^{\circ} 20' W.$ The latitude of Maybe Creek is about $69^{\circ} 15' N.$ The stream flows generally westward and at longitude $154^{\circ} 40' W.$ unites with the eastward-flowing Kigalik River to form the Ikpiuk River, which has a northerly course across the Arctic Slope to the ocean.

Prior to 1945 geologic investigations in Naval Petroleum Reserve No. 4 were largely limited to reconnaissance studies. The only work done up to that time in the area of Maybe Creek was by Mertie 1/ in 1924. Detailed studies were first undertaken by Navy Party 3 2/ in 1945.

Geological Survey Party 2 was assigned to carry out detailed structural and stratigraphic investigations in the area of Maybe Creek during the summer of 1946. From an initial field camp 26 airline miles N. $83^{\circ} W.$ of Umiat a main traverse route more than 100 miles in length was covered by weasel during the period May 26 to September 4.

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

2/ Navy Geological Party 3, Geological reconnaissance of Maybe Creek-Ikpiuk-Colville River area, U. S. Naval Petroleum Reserve No. 4, 1945.

Rock exposures are scarce along Maybe Creek, and only a few scattered outcrops are found on the hillslopes away from the stream. Great difficulty was encountered in obtaining adequate strike and dip data for structural interpretations by direct observation with Brunton compass. Although outcrops are scarce, structure traces are common in the area of Maybe Creek. These are surface expressions of structure in the form of rubble horizons of certain rock types, breaks in topography, and changes in vegetation. Considerable structural data were obtained by mapping structure traces in detail. The positions and elevations of three or more points on a ridge were carefully determined with plane table and alidade, and the strike and dip computed. Where direct observations were made by Brunton compass, the dips recorded are, for the most part, noticeably greater than dips determined by plane table and alidade in the same area. Dips recorded by the Navy field party in 1945 and by Mertie in 1924 also are much steeper than those determined by plane table and alidade in 1946. Careful surveying is the best method for obtaining dependable structural information from surface studies in areas where dips are generally low. This method largely eliminates errors in attitude determinations caused by local slumping, frost heaving, and cross-bedding, which are common in the area of Maybe Creek.

Ground control was obtained with plane table and alidade. In some areas small triangulation nets were set up, but in most areas control was established by carrying stadia traverses.

Detailed field studies were confined to an area east of longitude 153° W., except for one stadia traverse west along Maybe Creek to its junction with the Kigalik River. Considerable structural data in the area west of longitude 153° W. were obtained from a thorough study of vertical aerial photographs taken during the summer of 1946. Ground control in this area was not as complete as desired, and structural data obtained from photographic interpretation are less reliable than those determined by detailed ground studies in areas to the east. There is little doubt, however, that the broader structural interpretations in the area west of longitude 153° W. are correct.

The accuracy of structural data determined by interpretation of aerial photographs is roughly proportional to the accuracy of ground control established in the field. By use of a stereo-comparograph elevations can theoretically be determined from aerial photographs with as little as 2 feet of error. It is therefore possible by photographic methods to determine elevations of 3 or more points on a structure trace and to compute the strike and dip. Results of aerial photograph studies of the Maybe Creek area probably include errors in elevation averaging 10 feet or more. Such errors, however, do not significantly affect the strike and dip determinations. These errors in elevation are minimized as the horizontal distance between the two points chosen is increased. Two other factors do significantly affect the strike and dip determinations, namely, tip and tilt in the photographs, and distance away from ground control. A few

erratic strike and dip determinations north of Maybe Creek may be due to tip and tilt in the photographs. The only ground control west of longitude 154° W. is the stadia traverse along Maybe Creek, and structural data becomes less accurate to the north. No photographic interpretations were made of the area south of Maybe Creek.

Stratigraphic and structural data were plotted in the field on 1:24,000 trimetrogon aerial photographs taken in 1945 and on 1:20,000 vertical photographs taken in 1946. Planimetric base maps on a scale of 1:48,000 were available after July 1, 1946. Air reconnaissance was of considerable value in planning detailed ground studies.

TERRAIN CONDITIONS

The terrain is similar to that encountered in the Umiat region away from the flood plain of the Colville River. The topography is rolling, and the hills have rather gentle slopes which, in general, are less than 10°-15°. Steep slopes are found in some of the deeper tributary valleys of Maybe Creek and in places along the north side of Maybe Creek itself. In some parts of the area relief is as great as 800 feet, but, in general, it is less than 500 feet.

The thickness of soil cover is 1 to 3 feet on the hills, but in the valleys it probably exceeds 25 feet in places.

In summer the permafrost level ranges in depth from approximately 3 feet on the south slopes to 1 foot on the north slopes and in the narrow valleys.

Several ridge tops in the area are suitable for runway construction. Gravel is not abundant, but it could be obtained in sufficient quantities for surfacing from Maybe Creek, Wolf Creek, or perhaps from nearby weathered conglomerate exposures.

Lakes located at the headwaters of Prince Creek are large and deep enough to accommodate any single-engine float plane.

A year-round water supply would not be available at most localities. A permanently thawed zone is known to exist between the permafrost level and the zone of winter freezing beneath the beds of the large rivers that traverse the Arctic Slope. It is not known whether or not this condition also applies to the beds of Maybe Creek and Wolf Creek. Most of the oxbow lakes in these valleys are probably deep enough to furnish a large supply of water. The actual depths of the lakes are not known but are believed to be greater than 5 feet. The lakes ordinarily do not freeze below a depth of 5-7 feet. In the eastern part of the area a large supply of water could be obtained from the deep lakes at the head of Prince Creek.

Ridges in the area of Maybe Creek are generally connected and form relatively solid, dry routes for tracked vehicles. During the summer months the larger streams ordinarily will not hinder cat and weasel movements, but two or more days of steady rain will cause these streams to become raging torrents under which conditions crossing is impossible. The small, narrow tributary streams commonly have deep incised channels which are an effective block to crossing in weasels. Such stream areas can usually be by-passed with little difficulty.

It should be noted that the old Barrow trail following the ridge along the south flank of the Umiat anticline crosses the northeast corner of the Maybe Creek area and forms an excellent "highway" from the Umiat Test No. 1 rig site. The ridge is capped by the Umiat sandstone which is covered by only a few inches of soil and vegetation throughout most of the distance.

STRATIGRAPHY

Formations E, F, G, and part of H, all of upper Cretaceous age, are found in the area of Maybe Creek. Approximately 4,500 feet of stratigraphic section, including Faunal Zones 2 and 3, are represented.

The stratigraphic column is based on data gathered from several scattered outcrops. The relative position in the column of most of these outcrops is only approximate.

Area south of Maybe Creek

Outcrops south of Maybe Creek, all part of Formation E, are generally light gray to buff colored, fine- to very fine-grained sandstones which are calcareous in part. Some coarse sandstones and pebble conglomerates occur in the area, and just west of longitude 154° W. at about latitude 69° 12' N. pebble conglomerates form prominent bluffs. The conglomerates are composed largely of well-rounded chert, milky quartz, and quartzite pebbles. Coal seams as much as 8 inches thick were found in the vicinity of camp no. 6, and coal float was seen on some slopes and in many small streams. Silver-gray bentonite is present in a few places.

The pelecypods Mytilus sp. and the linguiform Inoceramus n. sp. (group Inoceramus crippsi) were found in fine- to very fine-grained, calcareous sandstone 1.6 miles northwest of camp no. 6 (fig. 1). These pelecypods are characteristic of Faunal Zone 2, and on the basis of previous work the rocks in this area are correlated with the base of Formation E. A quarter of a mile east of camp no. 6 thin siltstone bands in fine-grained sandstone contain the pelecypod Unio sp. The pelecypods Mytilus sp., Unio sp., and the linguiform Inoceramus n. sp. were found in sandstone lenses in pebble conglomerate 2 miles northwest of camp no. 5, indicating that these rocks are in the lower part of Formation E.

Area along Maybe Creek

Some sandstone and shale sections were seen along Maybe Creek, but outcrops are generally scarce. Calcareous zones in a clay shale exposure 4 miles west of camp no. 7 contain well-preserved fossils of Faunal Zone 3 (fig. 1), including a small distinctive cephalopod Watinoceras sp., the pelecypods Inoceramus cf. I. fragilis and Inoceramus cf. I. labiatus?, and the cephalopods Scaphites spp. This shale section is equivalent to the black shale member of Formation F at Umiat mountain about 40 miles to the east. On the north side of Maybe Creek 8 miles west of camp no. 4, specimens of the pelecypod Inoceramus cf. I. fragilis were found in very fine-grained calcareous sandstone bands in a clay shale exposure. These rocks are in the upper part of Formation F and are believed to be approximately equivalent stratigraphically to the fossiliferous shale zone on Maybe Creek west of camp no. 7 where the fossils of Faunal Zone 3 occur.

Area north of Maybe Creek

Sandstones of Formation G exposed in scattered outcrops north of Maybe Creek are generally medium grained and noticeably coarser than those of Formation E to the south. In places they contain fragments of fossil wood and carbonized plant remains. About 4 miles north of Maybe Creek, at longitude 153° 43' W., an 8-foot coal bed crops out. This coal bed is believed to be in the lower part of Formation G. It is stratigraphically only a few hundred feet above the fossiliferous shale section of Formation F on Maybe Creek.

Vicinity of Wolf Creek

In the northeastern part of the Maybe Creek area shales predominate. Some float of coal from Formation G is found on the slopes northeast of Wolf Creek. Thin stringers of coal have been found in place in a medium- to fine-grained, gray-green sandstone 2 miles south of camp no. 3. This sandstone also contains clay-ironstone nodules ranging in longest dimension from 1 to 8 inches.

Microfossils have been separated from several of the shale samples from Formation F collected in the vicinity of Wolf Creek. Several species of arenaceous foraminifera were found that also occur in Umiat Test No. 1, in two zones centering at about 500 feet and 1,600 feet below the collar of the hole. One species suggests a correlation with the lower of these two zones, but data are insufficient at this time to permit a conclusive statement in this regard. On the basis of detailed structural and stratigraphic investigations in the Umiat area during 1946, it seems much more likely that the fossiliferous zone in the area of Wolf Creek is correlative with the upper microfossil zone in Umiat Test No. 1. A stratigraphic interval of approximately 1,775 feet separates this fossiliferous shale zone from the base of the

Umiat sandstone in the area of Wolf Creek. In the vicinity of Umiat the stratigraphic interval between the base of the Umiat sandstone and the upper microfossil zone in Umiat Test No. 1 is approximately 2,100 feet.

Three resistant pebble conglomerate beds of Formation G, each about 25 feet thick, stand out as distinct ridges northeast of Wolf Creek. The conglomerates are similar to others in the area and are composed largely of well-rounded black chert, milky quartz, and quartzite pebbles. In places fragments of fossil wood are present. The pebbles average one-half inch in longest dimension, but locally they are of granule size. The lowest of these three beds crops out over a distance of 6 miles. The stratigraphic section immediately overlying the uppermost conglomerate bed is poorly exposed, but in the vicinity of camp no. 1 it consists of a medium- to fine-grained, limonitic brown sandstone. This sandstone, believed to represent the base of Formation H as defined in the Umiat area, is a persistent ridge marker and can be traced eastward for 30 miles into the Umiat sandstone along the south flank of the Umiat anticline. In the vicinity of camp no. 1 this sandstone is underlain largely by black, carbonaceous, mud shale which contains a few thin coal seams. In places, chalky white volcanic material, probably silicified tuff, is interbedded with the carbonaceous shale. Bentonites were also seen at this locality. This carbonaceous shale and associated rocks probably represent the top of Formation G.

In the vicinity of Wolf Creek Formation G is estimated to be approximately 1,375 feet thick. This compares favorably with a thickness of 1,300 feet for Formation G as determined in the Umiat area in 1946 but is approximately 1,000 feet greater than indicated by studies made in the Umiat area by the Navy parties in 1944 and 1945.

Porosity of sandstone samples

Eight sandstone specimens from Formations E and G in the area of Maybe Creek were submitted to the Fairbanks laboratory of the Geological Survey for porosity tests. Results are as follows:

<u>Specimen No.</u>	<u>Formation</u>	<u>Porosity (%)</u>
46A Fi 27	E	17.7
46A Ry 98	E	14.9
46A Ry 99	E	5.3
46A Ry 107	E	12.
46A Fi 2	G	3.2
46A Ry 40	G	11.
46A Fi 62	G	14.2
46A Ry 133	G	6.4

STRUCTURE

The westerly regional structural trend which dominates most of Naval Petroleum Reserve No. 4 also persists in the area of Maybe Creek. The folds are broad and open, measuring about 5 to 7 miles from crest to crest. Dips are mostly less than 5° . In general, the north limbs of the folds dip more steeply than do the south limbs. This feature is common to many folds in other areas in the Arctic Plateau.

Field studies supplemented by aerial photographic interpretation indicate a broad downwarp in the westerly-trending structures at about longitude 153° W. The axis of this downwarp probably trends about N. 15° E. From this downwarp westward along the anticline north of Maybe Creek the beds again rise to a major structural "high" in the vicinity of longitude $153^{\circ} 30'$ W. and then reverse dip towards the Ikpikpuk River.

A structure contour overlay (fig. 4) has been prepared to show more clearly the structural features in the area of Maybe Creek. Structural data used in compiling the overlay were based in large part on interpretation of vertical aerial photographs, and it should be noted that results here presented are necessarily generalized except those pertaining to the Maybe Creek dome.

The structure of the top of the fossiliferous shale zone in the upper part of Formation F was contoured at a 100-foot interval, except on the Maybe Creek dome where detailed field studies were made and a 50-foot contour interval was used. This fossiliferous shale zone is correlative with the black paper shale in the Umiat area. No accurate elevation above sea level was known, and figures shown are only approximate.

Maybe Creek Anticline

The crest of the Maybe Creek anticline, $2\frac{1}{2}$ miles south of Maybe Creek, trends N. 80° - 85° E. This structure is about 6 to 8 miles in width, but the length is not known. Structural data are not sufficient for conclusive interpretations as to plunge. The western end of the structure appears to plunge westward at longitude 154° W., but few outcrops and structure traces are found in this area. To the east surface data are entirely lacking.

The north flank of the Maybe Creek anticline is more steeply dipping than is the south flank. Dips determined on the south flank by detailed surveying with plane table and alidade rarely exceed 5° , but those on the north flank are as much as 19° although the average is about 12° .

Sandstone in a stream cut 1.6 miles northwest of camp no. 6 ranges in dip from 20° - 45° N. Its position near the axis and approximately 600 feet below the crest of the anticline suggests that folding in the Maybe Creek anticline may be more pronounced at depth. Exposures in this same stream cut contain fossils of Faunal Zone 2 which, on the basis of previous work, indicate that rocks exposed at the surface on the Maybe Creek anticline represent the lower 600 feet of Formation E.

From the crest of the Maybe Creek anticline southward to the Colville River the strata dip generally southward, but $2\frac{1}{2}$ miles south of the anticlinal axis a minor syncline is believed present. It trends N. 80° - 85° E. and plunges to the west at about longitude $153^{\circ} 57'$ W. This synclinal structure could not be traced eastward. One mile farther south a minor anticlinal flexure trending parallel to the major structure may be present.

The north flank of the Maybe Creek anticline is probably cut by a westerly-trending fault of large displacement. The displacement is believed to decrease from east to west. Evidence for this fault is largely paleontological. Faunal fragments identified as the linguiform Inoceramus n. sp. were discovered in slickensided sandstone blocks $1\frac{1}{2}$ miles southeast of camp no. 7 (fig. 1). If these fossils are equivalent to Faunal Zone 2 at the base of Formation E, then a stratigraphic thickness of 4,000-4,500 feet, representing part of Formation E and all of Formation F, is missing, inasmuch as sandstones near the base of Formation G occur only a few hundred feet northwest of the outcrop containing the Inoceramus fossils. If, however, the linguiform Inoceramus, which to date has been reported from only the basal part of Formation E, occurs higher in Formation E in this area, the displacement along the fault may be considerably less than 4,000 feet.

The fault probably extends several miles to the west, and in the vicinity of longitude $153^{\circ} 50'$ W. the displacement is inferred to be not greater than 2,000 feet and may be less if Formations E and F thin to the west from Umiat.

Maybe Creek Dome

The structural dome $4\frac{1}{2}$ miles north of Maybe Creek is about 5 miles wide and represents a "high" on a major anticlinal structure trending about N. 65° W. At longitude $153^{\circ} 40'$ W. this structure trends more nearly west. Dips on the structure rarely exceed $2\frac{1}{2}^{\circ}$, and many are less than 1° . Vertical closure of the dome is estimated to be about 150 feet. This dome is a nearly symmetrical structure. The base of Formation G and probably the top of Formation F are represented.

A second structural "high" occurs on the same anticlinal trend at approximate longitude $153^{\circ} 55'$ W. The rocks exposed at the surface are probably in the lower part of Formation G. No detailed field studies were made in this area.

Information obtained by the interpretation of aerial photographs indicates a third structural "high" on this anticline at longitude $154^{\circ} 30'$ W. The upper part of Formation F probably underlies this area. No field studies were made in this vicinity.

Wolf Creek Anticline

The Wolf Creek anticline is not as well defined as the Maybe Creek anticline or the dome just north of Maybe Creek. A stratigraphic thickness of about 1,800 feet is represented on the north flank, where exposures are better than on the south flank, but outcrops are scarce. Structure traces, although abundant, are generally straight-line traces and are unfavorable for structural interpretation.

The small amount of surface data available indicates that the north flank of the Wolf Creek anticline dips more steeply than the south flank, and in this respect the structure is similar to the Maybe Creek anticline. Dips as great as 10° were observed on the north limb of the structure, but on the south limb no dips greater than 5° were noted.

Air reconnaissance and studies of aerial photographs strongly suggest that the Wolf Creek anticline is a closed structure 8-9 miles long and as much as 6 miles wide.

SUMMARY AND CONCLUSIONS

During the summer of 1946 three anticlinal structures in the area of Maybe Creek were studied in detail. The ground control established with plane table and alidade was later used in interpretation of vertical aerial photographs taken during the 1946 field season.

The anticline south of Maybe Creek is probably the largest single structure studied in detail. Unfortunately surface data are meager, and it was not possible to map closure on this anticline.

North of Maybe Creek is a major anticlinal structure trending N. 65° W. Three areas of closure occur along this structure within the area of Maybe Creek, but detailed field studies were made on only the most easterly closed structure. Here the strata have been folded into a nearly symmetrical dome about 5 miles wide. The dome has a vertical closure of nearly 150 feet. Rocks exposed at the surface represent the base of Formation G. It is estimated that 1,600-1,800 feet of sediments would have to be penetrated to reach a zone correlative with the oil zone in Umiat Core Test No. 1. Nearby creeks would furnish sufficient water for drilling during the summer season, but, if a year-round drilling program were planned, it would be necessary to haul water 6-7 miles, probably from the lakes at the head of Prince Creek.

A somewhat larger anticlinal structure occurs along the southwest side of Wolf Creek. There is little doubt that this is a closed structure, but the evidence is not conclusive. Two or three additional weeks of ground studies may prove to be of considerable value. The structure is a potential oil trap and is favorably located stratigraphically in relation to known oil horizons in the Umiat area. Surface beds on the Wolf Creek anticline are in

the top of Formation F, and it is estimated that approximately 1,600 feet of sediments would have to be penetrated to reach a zone correlative with the oil zone in Umiat Core Test No. 1. Wolf Creek and oxbow lakes along its course would furnish an adequate supply of water for a summer drilling program. A year-round supply of water would be available in the deep lakes at the head of Prince Creek 5-6 miles to the south. Travel along the ridge tops to these lakes is good.

Aerial photograph studies show a structural "high" on the anticline north of Maybe Creek at about longitude 154° 30' W. This appears to be a larger structure than any yet studied in the area of Maybe Creek. Structure traces are numerous, and detailed ground studies would adequately delimit the closure.