United States

Department of the Interior

U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Preliminary Report No. 33

PRELIMINARY REPORT ON THE STRATIGRAPHY AND STRUCTURE OF PART OF THE CARBON CREEK AND KETIK ANTICLINES

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November 1950

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PRELIMINARY REPORT ON THE STRATIGRAPHY AND STRUCTURE OR PARTS OF THE CARBON CREEK AND KETIK ANTICLINES

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INTRODUCTION

U. S. Geological Survey Party No. 4 mapped the stratigraphy and structure of parts of the Carbon Creek and Ketik anticlines during the summer of 1950. The area, which lies in quadrangles I-19 and I-20 is shown in figure 1. Large-scale maps, compiled from plane-table surveys, give a more detailed picture of two parts of the area, the west plunge of the Carbon Creek anticline (fig. 2) and a segment near the middle of the Ketik anticline (fig. 3).

STRATIGRAPHY

The rocks of the area, entirely sedimentary, consist of the Torok formation and the Nanushuk group (Zones B, C, and D) of Lower Cretaceous age and alluvial deposits of Cenozoic age. The zonation of the Lower Cretaceous rocks is somewhat arbitrary, being subject to change from later studies. In general it agrees with that used in the earlier report on the Utukok River 1/. It is not necessarily in agreement with the zonation used for the eastern part of the Carbon Creek anticline in 1949 2/.

Outcrops in the area are rare. However, considerable parts of zones B and C are exposed on the north flank of the Carbon Creek anticline at the Utukok River (fig. 4). For the most part the area was mapped on bedding traces (rubble horizons, scarps, and small outcroppings) formed by weathered sandstones.

Torok Formation

The Torok formation, the oldest stratigraphic unit recognized in the area, occupies the axial lowland of the Carbon Creek anticline. Small portions of the formation are exposed in a few outcrops, and, in a few places, sandstone rubble forms poorly defined structure traces. The rocks of the formation are predominantly silt and clay shales, with some interbedded siltstone and dirty, fine- to very fine-grained sandstone of the graywacke type. Except for the absence of thick relatively clean sandstone beds, the rocks of the Torok formation in this area are not distinguishable from those

1/ Barksdale, W. L. and Thompson, R. M., Stratigraphy and structure of the Utukok River with notes on the Corwin-Cape Beaufort region, Alaska: U. S. Geological Survey Navy Oil Unit Report No. 18, Section J, pp 31-37 and fig. 3, 1948.

2/ Whittington, C. L. and Keller, A. S., Preliminary report on the Carbon Creek anticline and on the upper Meade River, Alaska: U. S. Geological Survey Navy Oil Unit Preliminary Report No. 23, 1949.

in zones B and C of the Nanushuk group. The contact between the Torok formation and zone B is placed at the lowest persistent sandstone trace. The contact appears to be gradational. South of Eskimo Hill, that part of the Torok formation present at the surface may be as much as 4,000 feet thick. Westward the thickness of exposed beds probably decreases so that at the western margin of the mapped area it may not exceed 1,500 feet. Because of erratic dips in the few scattered outcrops these figures are not reliable.

Zone B

Zone B of the Nanushuk group occupies the inward-facing hill slopes on either side of the axial lowland along the Carbon Creek anticline. The unit is predominantly shale with a few siltstone and sandstone beds. On the north flank of the fold the thickest sandstone, and the only relatively clean one, occurs at the base of the unit (fig. 4). On the south flank, where, in places, two or three bedding traces are present in the lower part of the unit, the sandstones are evidently thicker than on the north side. The zone is approximately 1,000 feet thick.

Zone C

Zone C overlies zone B and caps the hills on either flank of the Carbon Creek anticline. The unit contains the thickest and most persistent sandstone beds in the area. About two thirds of the unit, however, is shale. The thicker sandstones are comparatively clean but they do not appear to be favorable as reservoirs. Samples taken at two localities where the sandstones appear to be especially porous, were tested in the Fairbanks Laboratory of the U. S. Geological Survey, with results as follows:

Sample No.	Locality	Effective porosity	Air Permeability
50AWh 2	see fig. 3	13.54 percent	Less than 1 md.
50AWh 7	see fig. 2	10.74 percent	Impermeable

The thinner sandstones are generally similar to those in the Torok formation in that they are poorly sorted, hard, rather thin-bedded and commonly show ripple mark and worm (?) trails on the bedding surfaces. In most of the area the upper part of the zone was not mapped. At present the thickness is arbitrarily set at 1,000 feet.

Zone D

Overlying zone C, zone D occurs on the north flank of the Carbon Creek anticline and makes up the country rock of an extensive area north of the fold. At the axis of the Harris syncline (fig. 3) zone D rocks are 2,400 feet thick. At the axis of the Ketik anticline not less than 1,200 feet of the lower part of the zone is present, providing possible northward thinning is ignored. Zone D rocks also occur on the south flank of the Carbon Creek anticline in the western part of the area.

The unit consists of silt and clay shale, sandstone in part conglomeratic, coal, and ironstone. The sandstones are considerably less persistent than those in the lower zones. No one bed can be traced for more than 2 miles. The sandstones vary from rather hard, dirty, and generally fine grained to rather clean, medium- and coarse-grained salt and pepper sandstones, some of which are conglomeratic in part. In the clean sandstones the ratio of chert to quartz varies considerably, but the variation appears to be erratic and of no significance for correlation. In the dirty sandstones the grains are masked by clayey material so estimate of the chert-quartz ratio is impossible. The most distinctive characteristics of this zone are the relatively abundant ironstone and coal, and the distinctive reddish weathering seen on the structure traces. The upper part of the zone may be the equivalent of zone E, but no criteria have been recognized that would substantiate such a conclusion.

STRUCTURE

The major structures of the area are east- to southeast-trending folds with amplitudes of several miles. Anticlinal crests are sharper than synclinal troughs. In places reverse faults coincide with or parallel the anticlinal axes.

The Carbon Creek Anticline

The Carbon Creek anticline is an asymmetric fold, the north flank in most places being considerably steeper than the south flank. The fold is well outlined by the flanking beds of zones B and C, but the axial lowland developed on the Torok formation is an almost featureless valley in which geologic data are so sparse that the nature of the fold near the axis cannot be ascertained.

Because of convergence of the flanks and narrowing of the axial lowland, that part of the fold studied this year, from Eskimo Hill northwest for 16 miles, appears to be plunging to the northwest. However, most of this convergence results from a flexure on the south flank 6 miles west of Eskimo Hill. In the flexure the strike of the beds swings about 30° to the north from the general northwest strike. The nature of the flexure is not understood.

Along the anticlinal axis in the vicinity of Eskimo Hill low hills mark the probable structural high. It is believed that these hills, one 3 miles west of Eskimo Hill and the other east of the Utukok River 2 miles southeast of Eskimo Hill, stand above the general level of the valley because they are composed of more resistant rocks, i.e., thicker and more numerous sandstone beds. In this setting such a stratigraphic sequence must, therefore, be older than the rest of the Torok formation present in this area. Where the effect of topography can be ignored, as in this case, the outcrop area of the oldest stratigraphic unit is obviously the structural high.

Possible thrust faulting may be the cause of the local erratic dips near the fold axis. In the vicinity of Eskimo Hill dips of beds are erratic and not in agreement with dips in the Nanushuk group. Ten miles to the northwest on Omicron Hill dips of beds also seem erratic and here are associated with small faults with apparent displacements of 10 to 200 feet.

Ketik Anticline

The Ketik anticline is a low symmetrical fold with some thrust faults on the south flank. Because of the lenticular nature of the sandstone units and of the poor exposures in the area it has been impossible to contour the structure. There is no indication of plunge in the area mapped.

In the western part of the area a thrust fault with a maximum south dip of 13° has been mapped (fig. 3). In this vicinity, about 3/4 mile south of the axis of the Ketik anticline, the south flank is modified by a small syncline. About 1,000 feet farther south, an anticlinal dip reversal parallels the small syncline. Although some beds can be traced through the syncline no beds can be traced across the anticlinal dip reversal immediately south of it. At one place where a bedding trace appeared to be continuous the lithology was found to change abruptly. The anticlinal dip reversal, therefore, is interpreted as a thrust fault, with the small syncline resulting from drag in the lower plate. The amount of displacement is unknown. This fault may be a westward continuation of the thrust faults on the south flank of this fold as shown on Photogeologic Map I-19 (June, 1950).

PETROLEUM POSSIBILITIES

Some sandstones in the area of the Carbon Creek anticline contain petroleum residues, but because of low permeability they are not considered likely reservoirs. The Fairbanks Laboratory of the U. S. Geological Survey ran petroleum tests on four samples from the area with the following results:

Sample Number	Locality	Cut	Residue
50 ASv 12	see fig. 2	very pale straw	pale yellow.
50 AWh 2	see fig. 3	none	none.
50 AWh 7	see fig. 2	very pale straw	pale yellow.
50 AWh 11	see fig. 2	black (possibly carbonaceous matter)	brownish black.

Sample 50 AWh 11 was collected on Omicron Hill from a sandstone bed cut by one of the small faults. Adjacent to the fault this sandstone is moderately dark-brownish gray, but in about 100 feet on either side of the fault the dark color disappears. A portion of the same sample was submitted to the Branch of Geochemistry and Petrology of the U. S. Geological Survey for determination of the nature of the intergranular

material. Anna Hietanen-Makela reported, "The dark material which fills the cavities between the mineral grains and the cracks in them appears brown under the microscope. It burns when heated and colors the chloroform brown. W. W. Brannock tested it chemically and found it to be asphalt." Although some of the sandstones of the lower part of the Nanushuk group have been found to contain petroleum residues, their permeability on outcrop, as reported in the section on stratigraphy, is low. Unless permeability is greater where these rocks occur beneath the surface, on the Ketik anticline for example, oil cannot be produced from them.

SUMMARY

The rocks of the area are of Lower Cretaceous age, the Torok formation, and zones B, C, and D of the Nanushuk group.

The Carbon Creek anticline appears to plunge to the northwest with a possible structural high on the Utukok River south of Eskimo Hill. Geologic data are largely lacking along the axial lowland of the Torok formation, but the erratic dips of beds north of the axis are suggestive of faulting.

The Ketik anticline is a low fold on which no plunge was detected. In places a mile or more south of the axis its south flank is modified by thrust faults.

Some sandstones in the Nanushuk group contain petroleum residues. However, permeability of the sandstones in outcrop is too low for potential reservoirs.

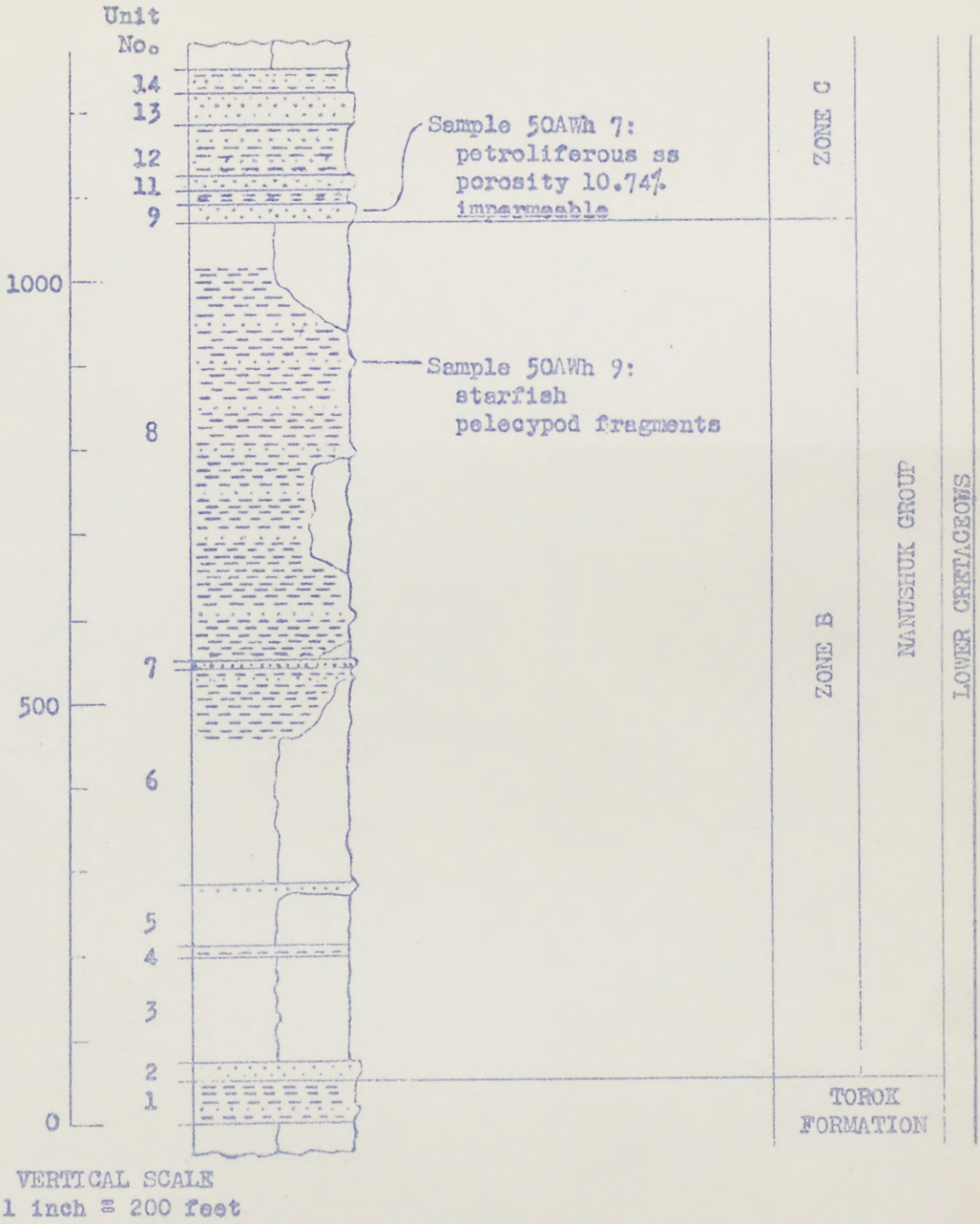

Figure 4. -- Preliminary stratigraphic column of outcropping rocks on the north flank of the Carbon Creek anticline.
(For localities, see figure 2.)