# PRELIMINARY REPORT ON THE STRATIGRAPHY AND STRUCTURE OF THE AREA OF THE UTUKOK RIVER WITH NOTES ON THE CORWIN-CAPE BEAUFORT REGION, ALASKA

By

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U.S. Geological Survey Party 3 studied the geology of the Utukok River area and conducted a short reconnaissance of the Corwin-Cape Beaufort Region during the period May 12 to August 31, 1947. The upper part of the Utukok River was examined for several miles on either side while the lower, or Coastal Plain portion, was necessarily limited to the few outcrops along the river.

During this study, the major emphasis was placed upon rocks of Upper Cretaceous age and their relationships to the underlying Lower Cretaceous rocks. All macrofossils, and numerous samples for porosity, heavy mineral, and microfossil determinations were collected.

A triangulation net was established by theodolite from Camp 1 near the headwaters of the river to the mouth of Carbon Creek. The survey started and ended on measured base lines, and stations were determined by intersection and resection. Stations were selected, insofar as possible, on points that could be pin pricked on aerial photographs where adequate coverage was available. Horizontal control was computed for cartographic purposes. Vertical differences were computed from an elevation at Camp 1 assumed at 2,000 feet above sea level based upon two different airplane altimeter readings.

Most of the country is too rough for wheel landings with the exception of several gravel bars in the river between Camp 6 and the coast. Pontoon landings with a Cub plane can be made at most places on the river.

Driftwood, Adventure, Disappointment, Carbon, and Elusive Creeks are the main tributaries to the Utukok. At various localities, terrace gravels are common on divides of these streams. A terrace north of Driftwood Creek and about ten miles east of Camp 2 is covered with a deposit of gravel which is apparently thick and is spread over an irregular area about two miles long and a half mile wide. A thin tundra cover obscures what is probably a much larger continuation of the gravel deposit. With favorable conditions plane landings could be made, but with a little construction work a commercial size airfield could be made.

## STRATIGRAPHY

### Mississippian

Very little time was available for studying the rocks of this age. About 500 feet of blue gray, coarsely crystalline, crinoidal limestone of the Lisburne formation is exposed near the divide of the DeLong Mountains. The older sandstones and conglomerates of the Noatak formation are exposed in greater thickness to the south. The limestone forms a prominent trace on the aerial photographs. The darker colored Noatak formation weathers into conical hills much like those formed in the Triassic cherts.

### Triassic

These rocks consist of steeply dipping, dark gray sandstone, black shale, and varicolored chert. The group is probably very thick, although no accurate determination could be made due to structural complexities.

At Camp 1 a chert bed approximately 200 feet thick has been tentatively defined as the top of the Triassic because it marks the uppermost observed occurrence of Triassic fossils and because there is a lithologic break. The chert is dominantly dark bluish gray on fresh surfaces weathering to light yellow brown, tan and light yellow red. The chert contains abundant pelecypods of which the predominant form, Monotis sub-circularis, has been recognized.

Shaly partings are common in the chert and some fragments of thin petroliferous (?) shale occur sporadically. Concretionary nodules of black chert in a thin zone within the main massive chert have a pronounced petroleum odor on fresh surfaces.

Underlying the chert bed at Camp 1 is several thousand feet of dark gray, medium to coarse, argillaceous sandstone interbedded in about equal amounts with black shale. Beneath this sequence several ridge forming chert beds crop out to the south and may or may not be correlative with each other. They are probably Triassic.

### Lower Cretaceous

Two units of Lower Cretaceous rocks were recognized on the Utukok--a lower greenish member and an upper black shale. The lower member, overlying the chert bed at Camp 1, is very thick and consists of gray-green and gray sandstone, conglomerate and shale. The sandstones are fine to coarse, very argillaceous, and generally of low porosity, although no determinations have yet been received. Quartz crystals up to one inch occur with calcite crystals along some of the sandstone-shale contacts. In the upper part of

the green unit are several beds of granule-pebble type conglomerate containing a large proportion of sub-angular black chert fragments. A few thin plates of burnable asphaltic (?) residue were noted in the conglomerate. Most of the shales in the unit contain an abundance of finely divided colorless mica, and little or no argillaceous material. The entire sequence indicates rapid local sedimentation in a brackish environment.

The upper black shale unit is also very thick but could nowhere be measured. The rocks of this unit are largely non-argillaceous siltshales which have little fissility, and weather into characteristic blocks with a tension (?) crack pattern. Upon a slight compression these blocks readily break down into many small hard, angular pieces. The siltshale contains colorless mica in lesser amount than the underlying green zone. Most exposures have nodular members probably due to a graduation to siltstone. Cross-bedded gray siltstone is also common and usually contains finely divided black mica along the bedding planes. Fine-grained, dark gray to blue-gray, very hard sandstone occurs in minor amounts particularly in the upper part.

Topography of the area is reflected by the black shale unit which forms flat lands in marked contrast to the Upper Cretaceous cuestas and buttes. Wherever the river has cut into the shales it is braided and has a large flood plain in contrast to the meandering single channels through Upper Cretaceous rocks.

## Upper Cretaceous

The lower marine sandstone and shale series has been designated as Zone A, while the thick, upper coal bearing series of the Utukok has been designated as Zone D. Formations B and C, as used on the Kurupa, do not appear to be valid on the Utukok. Non-marine members may occure in Zone A, and marine tongues may occur in Zone D and may or may not be correlative with other areas.

Nine sections of Upper Cretaceous rocks were measured by plane table and by Brunton, between Meat Mountain and Elusive Creek. Detailed descriptions of these sections are given in Appendix A. In general they show an increase northward in the amount of shale and siltstone in the basal portion of Zone A.

Sections A through E are entirely confined to Unit A and indicate shallow marine, or lagoonal type of sedimentation. Section F has exposures that range through Unit A and into D. The contact is not too well defined since it lies in a covered interval at about 2550 feet above the base of the Upper Cretaceous. Zone A apparently thins to the north for in Section J, about 28 miles to the northeast, the contact lies at 2100 feet above the base of the Upper Cretaceous.

In general the sandstone members of Unit D are coarser and more porous than the sandstones of Unit A, although not quite so massive. The only determinations available are from the conglomerate at the top of Section J. They range from 18% to 18.8% porosity. A sandstone about 10 feet thick within Bed No. 9 of Section H showed 20.8% porosity, and all other sandstone sampled in the section ranged from 11.6% to 13.9% porosity. Bed No. 6 of Section C shows 18.2% porosity. All other beds sampled in the section range from 4.2% to 11.9% porosity. No further porosity determinations are available at this time for the Utukok area.

Faunal determinations have not been made at present. All of the macrofossils collected are pelecypods, excepting one ammonite which comes from Section I. A very finely sculptured pecten ranges through Zone A but is predominant in the lower half. Microfossils are known to occur in Section H and likely will be shown in others when the studies have been completed. A few fossil leaves were collected from Zone D.

Section J is a composite giving the maximum determinable thickness on the Utukok. It is essentially continuous from the base about 4 miles south of Elusive Creek through 6,200 feet stratigraphically to the mouth of Elusive Creek. An additional 1,500 feet of section can be picked up from Elusive Creek to Camp 12, about 15 miles to the north, by correcting the gentle structures and tracing surface beds.

At Camp 12 a medium to coarse, dark brown sandstone with conglomerate lenses composed largely of white quartz pebbles marks the upper exposures of the area. The conglomerate, though not developed over the entire area, lies in a sequence of beds which can be followed over many miles, and correlated with reasonable certainty from Camp 12 for forty miles downriver. Below this sandstone a 3½-foot coal bed contains a two-inch layer of bentonitic claystone with tiny, rounded, vitreous fragments. This claystone within the coal, was observed at several localities along forty miles of river and is therefore a good marker bed. Bentonite, occurring only in the upper part of the section, is significant in that it indicates a sudden beginning of pyroclastic sedimentation. This may afford a means of correlation with Zone E in the area south of Umiat in which pyroclastics likewise make a sudden appearance.

Further comparison with the area south of Umiat reveals the following facts:

1. The Upper Cretaceous below Zone F is more terrestrial on the Utukok.
2. The Upper Cretaceous below Zone F is over three thousand feet thicker on the Utukok River than it is on the Nanushuk River and about 2,000 feet thicker than it is on the Chandler River.

A non-marine member with thin coal beds occurs in Zone A as shown by Section I. It is probably of very limited areal extent, being developed mostly in an east-west direction along the axis of a basin near Camp 8. There is a slight suggestion that the member may be present near Camp 4 where Section F contains a channel type conglomerate and some ironstone.

## STRUCTURE

### Mississippian

A reconnaissance near the divide of the DeLong Range reveals 500 feet or less of overturned Lisburne limestone, overlain by steeply dipping overturned Noatak sandstone and conglomerate. This sequence has been thrust faulted to the north and overlies a Triassic-Lower Cretaceous complex zone. The Lisburne limestone has apparently been thinned on outcrop by the thrusting.

### Triassic

A highly folded, truncated complex of Triassic rocks and possibly of infolded Lower Cretaceous rocks occupies the area between the Lisburne limestone and Camp 1. Several ridges of chert crop out, striking about N. 80° E., and may be the same chert that is exposed so well at Camp 1.

### Lower Cretaceous

Several excellent exposures of Lower Cretaceous rocks were found along the river cuts and on many of the drainages. This group of rocks is generally steeply dipping to complexly folded and faulted. They apparently were truncated to a gentle slope with little relief before Upper Cretaceous deposition.

The contact with the Triassic is probably a normal fault as suggested by drag dips near Camp 1. Displacement could not be determined.

Sandstone similar to the green member crops out in an interesting anticline at Camp 2. On the west side of the river an asymmetrical structure plunges gently to the west, under the Upper Cretaceous. This anticline on the east side of the river is overturned and probably is separated from the west side by a tear fault system passing along the present river channel. The part of the anticline on the east can be traced south of Meat Mountain where it disappears under terrace gravels on the divide between the Colville and Utukok Rivers. The last outcrop of the green member occurs about half-way between Camps 2 and 3 on the west side of the river. It is likely that the three areas of the green member appearing on the map are correlative on the basis of major folding.

The black shale member, being the uppermost unit of Lower Cretaceous, almost certainly underlies the Upper Cretaceous in angular unconformity. This relationship is quite pronounced from Camps 3 to 4, decreases from Camp 6 to a few miles south of Carbon Creek, and then becomes strongly evident at the last exposure at Carbon Creek. At Camp 3 a fairly competent series of Lower Cretaceous siltstones, sandstones and shale dip 35° to the north and are overlain by a synclinal butte of Upper Cretaceous dipping 7° to the north. From Camps 6 to 7 the black shale is gently dipping and

appears nearly conformable with the Upper Cretaceous, although the details are obscured by a shale on shale contact. Between Camps 3 and 4 the black shale is complexly folded and highly faulted.

## Upper Cretaceous

From Meat Mountain to Carbon Creek the remnants of deeply eroded synclines form a striking topography. The intervening anticlines are completely breached by headward erosion of lateral drainage. The anticline north of Camp 6 plunges gently to the west and has a very thin remnant of Upper Cretaceous in the western portion.

In the vicinity of Camp 8 it appears that the structures are arranged in an en echelon manner in which anticlinal axes can be connected diagonally between basins. This gives more persistence to the anticlinal axes, leaving the basins as isolated structures. It probably is an indication of lobes of unequal folding during or after Upper Cretaceous time. Other evidence of unequal compression is shown by the previously described anticline at Camp 2, and also by the warped area west of Camp 4. In the warped area, axes so prominent east of the river have lost their identity, and a single monoclinal series plunges gently westward.

From Carbon Creek westward a breached anticline reveals beds near the base of Zone A dipping from 50° to vertical on the structural axis. The beds on the north limb of this anticline flatten progressively until they reverse into a syncline two miles north of Elusive Creek.

About 3½ miles north of Elusive Creek a small anticline with closure on the east, dips 4° south and 5° north. West closure may be present but is not exposed. Closure, if present would be about 100 feet, increasing in amount with possible increase of dip lower in the section. The surface bed of this anticline is stratigraphically 6,000 to 6,500 feet above the Lower Cretaceous.

The next anticline about 8 miles north of Elusive Creek is not well defined and was not observed to close at either end due to poor exposures. For many miles north of this anticline the dip is regionally northward, with possible minor wrinkling, up to the fault zone near Camp 13.

Exposures in the fault zone reveal steeply dipping beds often in anomalous relationship to each other. Step normal faulting is common, displacement probably not exceeding a few hundred feet. Some minor thrust faulting and reverse faulting was also noted.

Between the fault zone and the anticline south of Camp 15 dips are regionally southward, suggesting a large syncline with small structures on the limbs. The major axis would probably pass through the fault zone.

Beyond Camp 15 numerous anticlines and synclines are indicated, always with the surface bed equivalent to the top of Section J--the coal, conglomerate, bentonite, and bentonitic mudstone sequence.

## CONCLUSIONS

The following conclusions can be drawn regarding the Utukok River area:

1. No Upper Cretaceous rocks in the mapped area south of Carbon Creek have petroleum possibilities because the structures are breached to the Lower Cretaceous shales.
2. Some of the sandstone in Zone A may have high enough porosity to warrant testing on structures where closure and depth appear favorable. However, high porosity of a single surface sample is no indication that the same bed will have high porosity in other localities.
3. The sandstones of Zone D generally appear more porous than those of Zone A, although the porosity determinations are not available at present.
4. The area from Elusive Creek to Camp 12 appears to be the most favorable structurally of the region studied. A detailed investigation of this area, by a weasel party, from the Kokolik River eastward to the Ketick River or beyond may discover closed structures.
5. The uppermost sandstone of the Utukok area, exposed intermittently from Camp 12 to near the river mouth, averaging about 25 feet in thickness, would be worthy of testing on a closed structure, if one were found in Zone E or higher. This sandstone appears to have high porosity everywhere that it was observed. If this condition persists to the east, it may be potential reservoir rock.
6. Oil possibilities in the area studied appear very limited. No economically important discoveries were made. Coal appears to be low rank.

## NOTES ON THE CORWIN-CAPE BEAUFORT REGION

A week at the end of the season was spent along the coast line between Esok and Cape Beaufort during which the Upper Cretaceous rocks were sampled for porosity, heavy mineral, and microfossil determinations.

Good exposures occur almost continuously along sheer cliffs and narrow beaches from Esok to Thetis Creek. From Thetis Creek to Cape Beaufort the exposures are intermittent and often highly covered, with Upper Cretaceous Zone A rocks probably the only age remaining.

The sequence from Esok to Thetis Creek is estimated to be around 13,000 feet thick and is represented by four separable lithologic units. General descriptions of these units are as follows:

1. Basal unit exposed from Thetis Creek between sample locality C-50 and C-44 is about 1,400 feet thick. The rocks are thin interbedded sandstones and thick shales. The sandstone is very fine, dark brown, weathering to red and is thin bedded. The shale is dark gray to black, probably silty, and contains little or no clay.

2. Between sample locality C-43 and C-20, which is located a few hundred feet east of Corwin Creek, some 5,500 feet of sandstone, conglomerate, coal, and bentonitic shale is exposed. The conglomerates are composed principally of dark chert, white quartz, and some yellow quartzite, ranging from granule to cobble in size. Porosity on the conglomerate runs 13.6% to 14%. The sandstone generally appears to be of moderate porosity. Shale beds are thick and very bentonitic with abundant ironstone nodules. Two coal beds about 14 feet thick are exposed in the lower part and numerous 2 to 4 foot beds occur throughout.

3. From Arrow Creek east to sample locality C-19 about 4,200 feet of predominantly marine rocks with non-marine members are exposed. Thick beds of bentonitic, black shale is interbedded with massive, very fine, indurated, tan colored sandstone. There are several thin coal beds and one two-foot bed of clean, cream colored bentonite.

4. From Esok to Arrow Creek about 1,900 feet of section has been estimated, but it is not too reliable. From Arrow Creek westward a gradual distortion takes place, gaining in amplitude until the thick incompetent shales are complexly folded and faulted. These black marine shales are hackly and contain numerous beds of thin siltstone and fine grained sandstone. They resemble Lower Cretaceous rocks but appear to lie conformably upon the unquestioned Upper Cretaceous. A pecten was found in the sequence near Esok and appears identical with the Zone A pecten of the Utukok area.

The very thick section of Upper Cretaceous rocks, so well exposed along the coast line warrants a season of detailed study. Several sandstone beds up to 40 feet thick in Unit 2 appear to have favorable porosity, indicated up to 14% by the few determinations which are available. Structures in the area are large and likely contain Unit 2 rocks at depth. The area also is very favorable for a tectonic study. Therefore it appears that a detailed study of the coast line and the inland structures should be made. Such a study could best be made by using a seaworthy boat, such as an Eskimo skin boat, and a weasel. During the relatively few days calm enough to study the rocks from the sea, the boat could be used. Unfavorable days for shoreline work could be spent inland.