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Naval Petroleum Reserve No. 4
Alaska

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### ILLUSTRATION

Geologic map of the area of the Avalik and Ketik Rivers, Alaska. (Separate)
INTRODUCTION

Scope of the investigation

U.S.G.S. Party 2 of the 1948 field program was assigned the task of investigating the stratigraphy and structure of Cretaceous and possibly Tertiary rocks exposed along the Avalik and Ketik Rivers, two of the main tributaries to the Kuk River, in the western part of Naval Petroleum Reserve No. 4. A traverse down the Ketik River, starting about 40 airline miles upriver from its confluence with the Avalik River, was planned and carried out, as was also a traverse down the Avalik River starting about 35 airline miles upriver from the junction of the two rivers. In addition, a geologic traverse down the Nigiaktuvik River, starting about 20 airline miles southwest of its confluence with the Meade River was completed.

Chronologic summary of operations

U.S.G.S. Party 2 arrived at its initial field camp on the Ketik River on May 31, 1948. The approximate position of this camp was latitude 69° 36' N., longitude 159° 12' W. On June 19 the Ketik River had broken and subsided to the extent that it was traversable by boat, and the party started downriver, reaching the junction of the Ketik and Avalik Rivers on June 22. Here the party waited until July 4 when a small float plane finally arrived from Umiat. The party was then flown up the Avalik River, and camp was established at a location about 35 miles upstream on the Avalik, near latitude 69° 54' 30" N., longitude 158° 15' W. The geologic traverse down the Avalik River was completed in three days. The party continued down the Kuk River and got within 8 miles of Wainwright on July 9. Here further travel by boat became impossible because of ice.

On July 10 the party was flown from the Kuk River to the Nigiaktuvik River, leaving boats and other equipment cached on the Kuk. Camp was made on the Nigiaktuvik River near latitude 70° 20' N., longitude 158° 06' W., approximately 20 airline miles southwest of its confluence with the Meade River. The Nigiaktuvik traverse was completed on July 12. A Bellanca on floats brought the party to Barrow the following day, and a few days later picked up the equipment that had been cached on the Kuk River and brought that to Barrow. The party and equipment arrived in Umiat on July 16, and was flown to Chandler Lake on July 25.
Cretaceous and Tertiary rocks on the Ketik and Avalik Rivers

Along the Ketik and Avalik Rivers outcrops of bedrock were seen in only a few places. These outcrops were small and poorly exposed. It must be kept in mind, however, that the geologic reconnaissance along these rivers was made shortly after the spring break-up, and that high water and steep snow-banks at that time probably covered some outcrops that normally would be exposed in late summer.

The authors believe that the rocks seen in cutbanks along the Ketik and Avalik Rivers represent Upper Cretaceous and Tertiary sediments. There is, however, no faunal evidence to support this division of the rocks seen into two groups of different ages. No megafossils were found, and the shale samples collected proved devoid of microfossils. The two-fold division of these rocks is, therefore, based entirely on their lithology and degree of induration, and on comparison of these rocks with other rocks whose stratigraphic position is fairly well known.

The rocks considered Upper Cretaceous in age crop out in the southern part of the area, and the Tertiary (?) rocks are exposed in the northern part (see geologic map). The outcrops are sparse and limited to cutbanks along the rivers. The maximum thickness of Upper Cretaceous rocks measured in any one outcrop was 25 feet, but most outcrops exposed a continuous section of only 6 or 8 feet. Many of the outcrops were slumped. The sparsity of outcrops, lack of continuous stratigraphic sections of any great thickness, and the lack of reliable structural data make it impossible to construct even a generalized stratigraphic column for the Upper Cretaceous rocks of this area. These rocks are gray, fine to medium-grained, thin to heavy-bedded sandstones, many of which are cross-bedded and iron-stained. Most of them are hard, but a few are friable. Ironstone lenses and nodules, carbonaceous laminae, and plant fragments are common. No coal was seen in place, but coal float was seen at many places along the river.

No fossils were found, and the structural data obtained is insufficient to permit definite correlation with parts of the stratigraphic sequence known elsewhere. Hence, the problem of assigning a definite age to the sandstones described above is one of lithologic comparison with rocks of known age in other areas. On the basis of such comparison, these sandstones appear to be part of the Upper Cretaceous sequence, and are tentatively assigned to Zones D or E.

The rocks considered here to be of Tertiary age are poorly exposed on the two rivers. The exposures indicate, however, that a composite section of about 80 feet of beds crops out in this area. The stratigraphically highest part of this section is a fine-grained, hard, thin-bedded, cross-bedded, highly ferruginous sandstone about
15 to 20 feet thick. This unit, more resistant to weathering than the underlying rocks, seems to "hold up" the very low, tundra-covered ridges in the interstream areas. Stratigraphically below this resistant sandstone is a section, about 40 feet thick, of gray, medium-grained, extremely friable, cross-bedded sandstone that weathers to a sand. The top 10 feet of this sandstone is somewhat ferruginous and better consolidated than the bottom 30 feet. The sand from this 40-foot unit covers the underlying section in most places, but the underlying beds are exposed in a few places. This unit is about 20 feet thick, and consists of bentonitic clay, with ironstone lenses and nodules common in the upper part, and coal layers in the bottom part. The coal is in thin layers, having a maximum thickness of 1.5 feet, which appear to form discontinuous beds and lens cut rapidly along the strike. The authors believe that the bentonitic shale is underlain by sandstone of unknown thickness and probably of Upper Cretaceous age, but this is by no means certain because bentonitic mud-flows invariably cover the slopes below the shale section.

The bentonitic shale seems to have a characteristic topographic expression. Wherever the shale is present in the river banks, the banks are cut by numerous small gullies, separated by well-rounded, partly overgrown knobs, or "bentonitic boils." This feature and the lithology of the section, both so strikingly similar to the Tertiary "bentonitic boils" seen on the Kogosukruk River northeast of Umiat, lead to the tentative conclusion that the bentonitic section and the overlying sands are Tertiary in age. No megafossils were found in these rocks, and shale samples that were tested for microfossils proved barren.

Gubik formation on the Nigiaktuvik River

No exposures of consolidated bedrock were seen along the entire length of the Nigiaktuvik River traverse. Numerous cutbanks along the river expose yellowish, medium-grained, somewhat cross-bedded, unconsolidated sands, with several interbeds of peat. No fossils were found in these beds, but the color, the lack of consolidation, and the presence of peat beds in the sand indicate that this may be the Gubik formation of late Tertiary age. However, the basal gray, pebbly, very fossiliferous sand, which is characteristic of the base of the Gubik in the eastern part of the Reserve, was not seen. This suggests that either the Nigiaktuvik River has not cut down to the basal sand and is entrenched in the upper part of the Gubik sand, or that the basal sand is absent in the Nigiaktuvik River area. The latter possibility seems to be the more logical because in a few places angular pieces of sandstone and ironstone were found as float along the river, probably denoting the presence of consolidated bedrock on which the river may have and there be flowing. Furthermore, E. J. Webber 1/, who flew over part of this area in 1946 at a time when the water in the river was at a low

1/ Webber, E. J., Oral communication.
stage, reports that there are outcrops of bedrock along the river channel. Webber examined two of these outcrops, which proved to be largely sandstone with some sub-lithographic limestone, coal and bentonite. No geologic map of the Niglaktuvik River area was made because no consolidated bedrock was seen by the 1948 party.

**STRUCTURE**

Only a few reliable strike and dip readings on bedding are obtainable along the Ketik and Avalik River traverses. These indicate that bedding in the Upper Cretaceous rocks trends approximately east, or a few degrees south of east. Dips up to 25 degrees were recorded. The Tertiary (?) sediments are very nearly flat.

There appear to be no outcrops of bedrock away from the river cutbanks, and aerial photographs show no mappable traces of bedding. It is therefore impossible to trace any structures in this area, at least by surface geologic work. The general south dip of the rocks northward from Camp 1 on the Ketik River (see map) to approximately latitude 69° 40' N., and the general north dip from latitude 69° 45' N. to latitude 69° 52' N., suggest the possibility of a major east-trending anticline whose axis would lie somewhere between latitude 69° 40' N. and 69° 45' N. Because positive evidence for the existence of this anticline is lacking, no axis has been plotted on the accompanying geologic map.

**PROBABLE UNCONFORMITY BETWEEN THE UPPER CRETACEOUS AND TERTIARY**

A probable unconformity between Upper Cretaceous and Tertiary sediments is indicated by the surface geologic studies along the Ketik and Avalik Rivers. If the presumed age determinations of the rocks exposed along the two rivers is correct—that is, if the sandstones along the upper parts of the rivers are correlative with rocks in Zones D or E, and if the bentonitic sequence is Tertiary—then a major unconformity exists between the Upper Cretaceous and the Tertiary sediments in this area, with the sediments of Zones F, G, and H absent. This possibility is further strengthened, and an angular unconformity is suggested, by the noticeably greater folding of the Upper Cretaceous sediments as contrasted with the nearly flat-lying Tertiary sediments. Along the Ketik River dips up to 25 degrees were noted in the Upper Cretaceous rocks, whereas the dips of the Tertiary sediments are almost everywhere less than 1 degree.

At the southernmost exposure of Tertiary sediments on the Ketik River near latitude 69° 52' N., the bedding strikes N75°E and dips 5°SE. But one mile due east of this place Upper Cretaceous rocks strike N75°W and dip 10°NE. This divergence of strike, and reversal of dip of the two rock units further emphasizes the possibility of an angular unconformity between them. Still another indication of an unconformity between the Upper Cretaceous and the Tertiary along the Ketik River was noted near the 69° 55' N. parallel. The bedding in two exposures of Upper Cretaceous rocks strikes approximately east, dips 25°N in one and 10°N in the other. North and south of these two exposures are flat-lying Tertiary sediments.