United States

Department of the Interior

U.S. Geological Survey

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Geological Investigations

Naval Petroleum Reserve No. 4

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Special Report No. 10

THE CARBON CREEK AND AWUNA ANTICLINES

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By

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INTRODUCTION

At the interim meeting of the Technical Committee in Fairbanks, Alaska, in September 1949, the Navy Oil Unit was requested to make photogeologic analyses of the Driftwood, Awuna, and Carbon Creek anticlines before the November meeting. A report on the photogeology of the Driftwood anticline, based on available air photos, has already been distributed. The present report considers the geology of the Carbon Creek and Awuna anticlines.

The central part of the Carbon Creek anticline was studied in the field by party No. 2 during the 1949 season. A geologic report on this part of the anticline, by C. L. Whittington and Samuel A. Keller, will be distributed at the November meeting. The present photogeologic report covers the part of the Carbon Creek anticline from the western end of Whittington and Keller's area westward to the point where the Carbon Creek anticline plunges and disappears. A photogeologic map (fig. 1) accompanies this report and incorporates all available data both from the aerial photographs and from earlier field geologic studies of a part of the anticline by Thompson and Barksdale.

The Awuna anticline has been mapped in the field by C. L. Whittington. A field geologic map of the anticline will be distributed at the November meeting. The discussion on the Awuna anticline in the present report is based in part on the field observations of Whittington and in part on a new study of the aerial photographs which had previously been studied by Whittington. In reading this section on the Awuna anticline, reference should be made to Whittington's geologic map, which will be available at the November meeting.

At the present time, only trimetrogon photography is available for study of the western part of Carbon Creek and the Awuna anticline areas. Hence quantitative analysis of the structures is not possible, although rough estimates of the amount of plunge and of closures can be made. Accurate calculations of closure and plunge by photogrammetric methods must await the arrival of the vertical photographs of the area.

THE CARBON CREEK ANTICLINE

The Carbon Creek anticline is an elongate structure with an overall length of a little more than 80 miles. This report covers only the western part of the anticline. The Utukok River flows across the structure approximately 10 miles east of the western end of the anticline.

Field Information

The Carbon Creek anticline was partially mapped by R. M. Thompson and W. L. Barksdale while traversing the Utukok River in 1947. 1/ The following pertinent statements were extracted from the field notebook of R. M. Thompson. Locations of camps referred to in these extracts may be obtained from the geologic map in Thompson and Barksdale's report (report No. 18). Clarifying comments in parentheses have been added where necessary.

Thompson, R. M., Field Notebook, Pg. 65

"On the move down river from camp 6 to camp 7 (approximately 10 miles south of Carbon Creek), various outcrops of the black shale were noted. . . . . These shales were gently folded often times at right angles to the U. K." (Tuktu sandstone).

Thompson, R. M., Field Notebook, Pg. 66

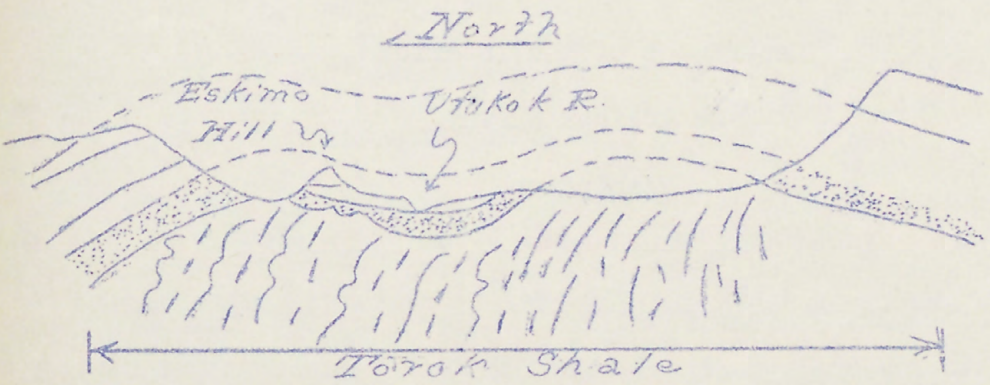
"From the vicinity of camp 4 to the north, the attitude of the folding in the Lower Cretaceous is much gentler--the tight folds have become broader and more symmetrical--faulting has changed from thrusting and reverse to normal with rare reverse faulting.

"From camp 4 southward there is almost certainly a marked angular unconformity between Lower Cretaceous and Upper Cretaceous (Torok shale and Tuktu sandstone). Competent beds at camp 2 are folded as complexly as the incompetent ones in the Lower Cretaceous (Torok) black shale sequence. While next to these complexities such gentle Upper Cretaceous (Tuktu) features as Meat Mountain exist.

"However, the folding in the black shale of the Lower Cretaceous (Torok shale) apparently decreases rapidly from camp 4 to the north, thereby establishing more and more conformity between the Lower Cretaceous and Upper Cretaceous (Torok and Tuktu). Any slight differences in attitude of the bedding can easily be accounted for by the incompetence of the Lower Cretaceous versus the Upper Cretaceous." (Torok shale vs. Tuktu sandstone.)

1/ Thompson, R. M., and Barksdale, W. L., 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, April 1948.

A cross section of the Carbon Creek anticline passing through Eskimo Hill would look like this.



Photogeologic data

The western part of the Carbon Creek anticline is a closed structure, with total closure of approximately 2000 feet. Stratigraphically the crest of the anticline lies at the approximate contact of the Tuktu sandstone and the Torok shale members of the Nanushuk group with the Torok shale exposed along and near the axis. The anticline is delineated by the competent and abundantly outcropping sandstones of the Tuktu which are exposed on the flanks of the fold. The incompetent and poorly exposed shales of the Torok along the crest do not necessarily reflect the anticlinal structure. South of this area a large angular unconformity is present between the Torok and the Tuktu. From photo studies and from what field information is available it does seem, however, that this angular difference has largely died out in the region of the Carbon Creek anticline. Therefore, angular discordances which may be present are probably local and have very little effect on the major structural configuration. Many small tear faults are evident along the flanks of the anticline but there is no evidence of any faulting of major importance.

In longitudinal section the western part of the Carbon Creek anticline is relatively flat-topped along much of its extent. There is no well-defined crest or high anywhere along the axis. At opposite ends of the long, flat-topped part of the anticline the fold drops off sharply and plunges to the west beneath younger unfolded sediments and to the east into a structural low at the junction between Whittington's area and the area considered in this report.

A field study of the stratigraphy exposed along the anticline and to the south would probably yield very little information of usable nature. This is due to the limited stratigraphic thickness available for study on the anticline itself and to the extreme structural complexity of the underlying Killik beds exposed to the south. The area appears to be unfavorable for determining the stratigraphic succession and thickness of the Killik

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group. Neither would field studies produce much additional structural information on the anticline. A better idea of the angular relationship between the Torok shale and the Tuktu sandstone probably could be secured, but there would still be the possibility of an angular break existing between the Torok shale and the underlying Killik sediments. The relationship of these units might be determined by seismic studies. Only by this means does it appear possible to predict whether the anticlinal structure delineated by the Tuktu sandstone at the surface persists downward into the Killik and older formations at depth. A thorough field study might produce a more accurate estimate of the amount of closure.

No accurate measurement of closure can be made by photogeologic or field methods because the anticline is breached throughout its length and the shales near the axis are badly contorted and poorly exposed. Plunge to the east begins at approximately 159° 15' west longitude and reversal of the direction of plunge is at approximately 159°. Plunge to the west may begin as far east as 159° 50' west longitude, and the beds flatten out and the anticline disappears at approximately 160° 30' west longitude.

THE AWUNA ANTICLINE

The Awuna anticline is a closed structure approximately 40 miles long running parallel to and just north of the Awuna River. Closure on this structure amounts to approximately 1000 feet. The structural high occurs at approximately 69° 10' north latitude, 156° 50' west longitude. At this point the axis is only about two miles north of the Awuna River.

The Awuna anticline occupies the same stratigraphic position as the Carbon Creek anticline. The flanks are marked by the Tuktu sandstone member. This immediately overlies the Torok shale which is exposed along the crest of the fold. These two members seem to be conformable in this area. However, as the shale is badly crumpled and contorted in its exposures near the axis the angular relationship is not definitely known. The Tuktu sandstone seems less massive in this area than in areas farther to the west. This tendency is noticeable even within the area of the Awuna anticline. Bedding traces at the west end of the anticline are much more pronounced than those that are exposed farther to the east. Accurate measurements of closure are again impossible because the structure is breached, leaving only poor exposures of badly crumpled shale near the axis.

Faulting seems more intense on the Awuna anticline than it is on the Carbon Creek structure. Tear faults along the flanks have a greater displacement. Whittington 1/ indicates that the eastern half of the anticline is cut by a fault running parallel to and just south of the axis.

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

Near the point of eastern plunge the apparent axis has moved northward from the shale member into the sandstone. This migration of the apparent axis out of the underlying shale can only be explained by inferring a fault with a throw of several hundred feet.

If other lines of evidence do not favor the Awuna anticline over the Carbon Creek as a drilling site, then the Carbon Creek anticline would be the more favorable structure for a test of the Killik and older sediments, because of the probability of greater faulting within the Awuna anticline and because of the easier accessibility of the Carbon Creek anticline.