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Alaska

Report No. 29

HEAVY MINERAL ZONATION OF CRETACEOUS AND TERTIARY ROCKS OF THE CENTRAL AREA OF NORTHERN ALASKA

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By

Ernest H. Lathram

April 1949

CONTENTS

ILLUSTRATIONS

K-29

HEAVY MINERAL ZONATION OF CRETACEOUS AND TERTIARY ROCKS OF THE CENTRAL AREA OF NORTHERN ALASKA

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INTRODUCTION

This report presents the general conclusions pertaining to the correlation of Cretaceous and Tertiary rocks in test wells and outcrops in the central area of northern Alaska (fig. 1) by means of heavy minerals. Approximately 1,000 drill and outcrop samples have been studied. In order to relate the material here presented to the regional geologic picture of the central area, the restored facies cross-sections A-A' and B-B' of T.G. Payne 1/ are used as a basis for the graphic presentation of the heavy mineral zonation. Section C-C' of Payne is not used because most of it lies outside the area treated in this report and because of new geological and geophysical interpretations in the Barrow area as the result of recent exploration. Instead, the heavy mineral zonation along a somewhat different section C-C' (see fig. 1) is discussed but not illustrated.

ZONATION BY OCCURRENCE OF MINERAL SPECIES

Zone 1 - Zone of rounded minerals

The zone of rounded minerals coincides with the zone of undifferentiated late Tertiary-Quaternary sediments, or Gubik formation. This heavy mineral zone is clearly defined, and is diagnostic of the Gubik formation. The distinguishing characteristics are the surbround to round shape of all grains, even including the most resistant minerals, and the abundance of hornblende and hypersthene. This zone has been recognized in the Simpson area in Core Holes 1 to 10, and in Simpson Test Well No. 1 where it is approximately 120 feet thick. In the Barrow area it is present to a depth of 39 feet in South Barrow Test Well No. 1 and to 85 feet in South Barrow Test Well No. 2. It has also been recognized in outcrop section along the lower Meade River. No samples were taken in this zone in the Oumalik Core Tests and Skull Cliff Core Test No. 1, but deeper samples from these tests contained contaminating grains that indicate the zone is present at the surface.

Zone 2 - Zone of non-resistant minerals

The zone of non-resistant minerals includes approximately Zones E through H of the Nanushuk group and the entire Colville group. In general, an assemblage of volcanic and metamorphic minerals, less resistant to weathering than tourmaline and zircon, characterizes this zone. This assemblage includes, in order of abundance, volcanic biotite,

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1/ Payne, T.G., Areal evaluation of petroleum possibilities of major stratigraphic units in northern Alaska: Geological Investigations Naval Petroleum Reserve No. 4, Report No. 24, November, 1948.

hornblende, hypersthene, chloritoid, glaucophane, staurolite, sillimanite, and kyanite. In addition, euhedral zircon crystals are present. Not all of these minerals occur in every sample, but several representatives of the group are usually present. The upper limit of the zone is placed at the base of the Gubik formation. The lower limit is placed at approximately the base of Zone E of the Nanushuk group in the southern part of the area. In the northern part of the area, there is no data for establishing the lower limit of the mineral zone except in South Barrow Test Well No. 2. Here there are indications that the lower limit of the zone may be at about 2,000 feet, which suggests that this may be the base of Zone E in the well.

Section A-A'.-- In Section A-A' (fig. 2) Zone 2 is recognized from about the "Big Bend" of the Chandler River to Sentinel Hill Core Test No. 1. No samples are available in the Fish Creek area. In general, the most prominent minerals of Zone 2 in this area are glaucophane and volcanic biotite, although these may be absent in some samples. A high concentration of glaucophane and volcanic biotite occurs in several of the sands of Zone G at Umiat. However, attempts to find sandstones with similar assemblages in Zone G in the Anaktuvuk-Chandler Rivers area have failed. The lower limit of Zone 2 is at the base of time Zone E in the area south of Umiat. North of Umiat all available samples come from the upper part of the zone, and hence the location of the base of the zone cannot be determined.

It is noteworthy that the glaucophane-bearing samples of Zone 2 occur in an area around Umiat roughly 60 miles in diameter(fig. 4). This area coincides approximately with the thickest part of the Upper Cretaceous section in the area studied. Since Zone 2 has also been recognized outside the area of glaucophane-bearing samples, as at Simpson, Barrow, Skull Cliff, and Maybe Creek, this localization of glaucophane would appear to be the result of limitations in the source area of the glaucophane.

Section B-B'.-- Zone 2 can be recognized along section B-B' (fig. 3) from about the Colville River to north of Maybe Creek and also in the Cape Simpson area. South of Maybe Creek, the lower limit of the zone appears to be approximately at the base of Zone E. The core tests in the Oumalik area are high in Zone D and probably penetrated rocks just below the lower limit of Zone 2. In the Simpson area the upper limit is placed at the base of the Gubik formation at a depth of 120 feet in Simpson Test Well No. 1 and the zone is recognized to a depth of 2,700 feet, which is just above the base of the Colville group. The lower limit of Zone 2 has not been defined because adequate sands for heavy mineral separations are not present in the Cretaceous section from 2,800 feet to 6,100 feet.

Section C-C'.-- Along the line C-C' (Index Map) Zone 2 is identified in only two places-- in Skull Cliff Core Test No. 1 and in the Barrow wells. Skull Cliff Core Test is almost entirely within this zone. The Gubik formation probably is present at the top of the well, but no samples were obtained from the Gubik. In the Barrow area the upper limit of

Zone 2 is the base of the Gubik formation which is at 39 feet and 85 feet in South Barrow Test Wells 1 and 2 respectively. The lower limit of the zone lies between 1,916 feet and 3,078 feet in Barrow No. 1 and between 1,299 feet and 2,023 feet in Barrow No. 2. No samples were available from Barrow No. 1 between 1906 and 3078 feet. A few grains of altered volcanic biotite were found in samples at 1,762 feet, 1,784 feet, and 1,999 feet in Barrow No. 2. These grains may indicate that the lower limit of Zone 2 is between 1,999 feet and 2,023 feet in this well.

Zone 3 - Zone of resistant minerals

This zone includes all Cretaceous rocks lying below Zone 2, with the exception of the rocks in the upper division of the Killik group that contain a high percentage of epidote (Zone 4). The characteristic of Zone 3 is the virtually complete absence of all but the most resistant minerals. Even garnet is normally rare to absent. The most common non-opaque minerals of this zone are tourmaline and zircon, with lesser amounts of rutile, garnet, and titanite. The zircons are all ovoid in shape; no euhedral grains are present. All other mineral grains are angular. In some areas picotite is present and is diagnostic of the zone. Chromite is also present, and is in general more abundant than in Zone 2. The upper limit of the zone is the previously described base of Zone 2.

Section A-A' (fig.2).-- Rocks containing the mineral assemblage of Zone 3 outcrop as far north as the "Big Bend" of the Chandler River. In this interval picotite is frequently present. Northward the zone has been recognized in several anticlines which expose rocks of Zones A through D and it is present in Umiat Test Well No. 1 from approximately 1,800 feet to the bottom. North of Umiat the zone has not been penetrated.

Section B-B' (fig. 3).-- Rocks of Zone 3 are present from the southern border of Cretaceous outcrops north to the Kigalik River. From this point to Simpson the zone has been penetrated only by the shallow core holes at Oumalik, which lie wholly within this zone. In Simpson Test Well No. 1 there are no Cretaceous sands from which heavy minerals samples could be obtained.

Section C-C'.-- Rocks outcropping from Ekakevik Mountain on the Ipnavik River north to the lower Meade River all are in this zone. It was not penetrated in Skull Cliff Core Test No. 1 but was found in both South Barrow Test Wells below Zone 2.

Zone 4 - Zone of epidote

A prominent zone of abundant epidote has been recognized in the southern part of the area studied (fig. 5). In samples of this zone epidote constitutes over 70 percent of the non-opaque minerals. The thickness and stratigraphic position of the zone are not certain, but the zone seems to be characteristic of the upper division of the Killik group where this division has been recognized. It is present in the Chandler, Killik, and Ipnavik River areas. The zone also includes the basal beds of Zone A of the Nanushuk group in the Chandler and Ipnavik River areas, and may also include these beds in the Killik River area.

This seems to indicate that the sediments of Zone A in these areas were derived by erosion of local epidote-rich Jurassic-Lower Cretaceous sediments. The mineral zone is not present in the Kurupa-Oclamnagavik Rivers area nor along the upper Colville River. It has not been recognized in the Anaktuvuk River area, but this may be due to the sparsity of outcrops of the Killik group in this region. The sediments below 2,328 feet in South Barrow Test Well No. 2 which are believed to belong in the Killik group, do not exhibit the high epidote zone.

ZONATION BY PERCENT OF ETCHED GARNETS

The phenomenon of etched garnets in Cretaceous and Tertiary rocks has been adequately discussed 1/. Three zones based on the percentage of etched garnet grains are recognized. These zones are not closely definable and can be used only tentatively as evidence of age. The zones with their approximate age limits are as follows:

Less than 40 percent of garnets etched - Base of Zone G of Nanushuk group to Recent.

From 0-100 percent of garnets etched - Base of Zone D to base of Zone G.

More than 60 percent of garnets etched - Below base of Zone D.

CONCLUSIONS

Although the heavy mineral suites of northern Alaskan samples show considerable variation both in number of mineral species and in percentage composition, attempts to use these variations for correlation of rock units succeed only when gross units are considered. Mineral ratios and varietal characteristics vary excessively, and distinctive zones can be recognized and traced for short distances only.

Forty-five samples from the Barrow wells and from Simpson Test Well No. 1 have been exhaustively studied. The results of this study have yielded no closer correlation of the rocks of the three wells than has the micropaleontology. There are indications in South Barrow Test Well No. 2 that the base of heavy mineral Zone 2 may be between 1,9999 feet and 2,023 feet. Since the base of Zone 2 in the southern part of the area is approximately at the base of Zone E, this suggests that the base of Zone E is at this depth in the well, which is approximately at the top of the pebble shale.

An interesting mineral feature was found in a sandstone at 2,330 feet in South Barrow Test Well No. 2. This sandstone immediately

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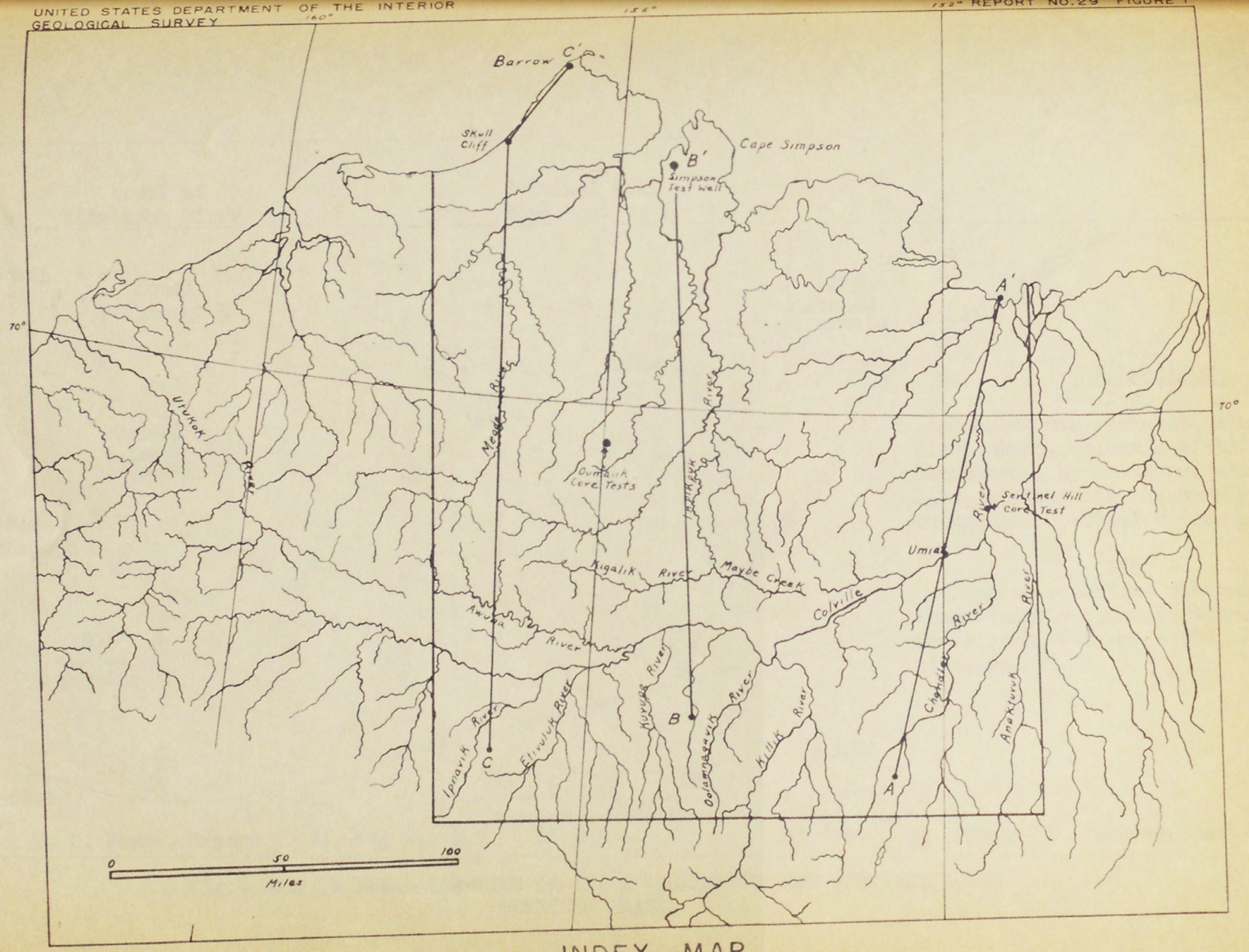
1/ Fellows, R. E., Significance and preliminary results of heavy mineral studies in northern Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Progress Report, November, 1946.

Lathram, E. H., Revision of report by Robert E. Fellows on significance and preliminary results of heavy mineral studies in northern Alaska: Geological Investigations, Naval Petroleum Reserve No. 4, Progress Report, November, 1947.

underlies the pebble conglomerate which is believed to be at the base of the Nanushuk group. It contains a high concentration of coarse, fresh garnet. A flood of fresh, coarse grains of one mineral has been used in other areas as a criterion of an unconformity. Hence, it here affords additional evidence for interpreting an unconformable contact between the Nanushuk and the Killik groups at the base of the pebble conglomerate at 2,328 feet in South Barrow Test Well No. 2.


160°
154°
Barrow
C'
Skull Cliff
Cape Simpson
B'
Simpson Test Well
A'
70°
Meade River
Ikpikpuk River
Ulviuk River
Oumalik Core Tests
Sentinel Hill Core Test
Umiat
Nigalik River
Maybe Creek
Colville River
Anuktuvuk River
Chandler River
Anaktuvuk River
Ipnavik River
Etivluk River
Kuyuktuvuk River
Dalamatuvuk River
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INDEX MAP

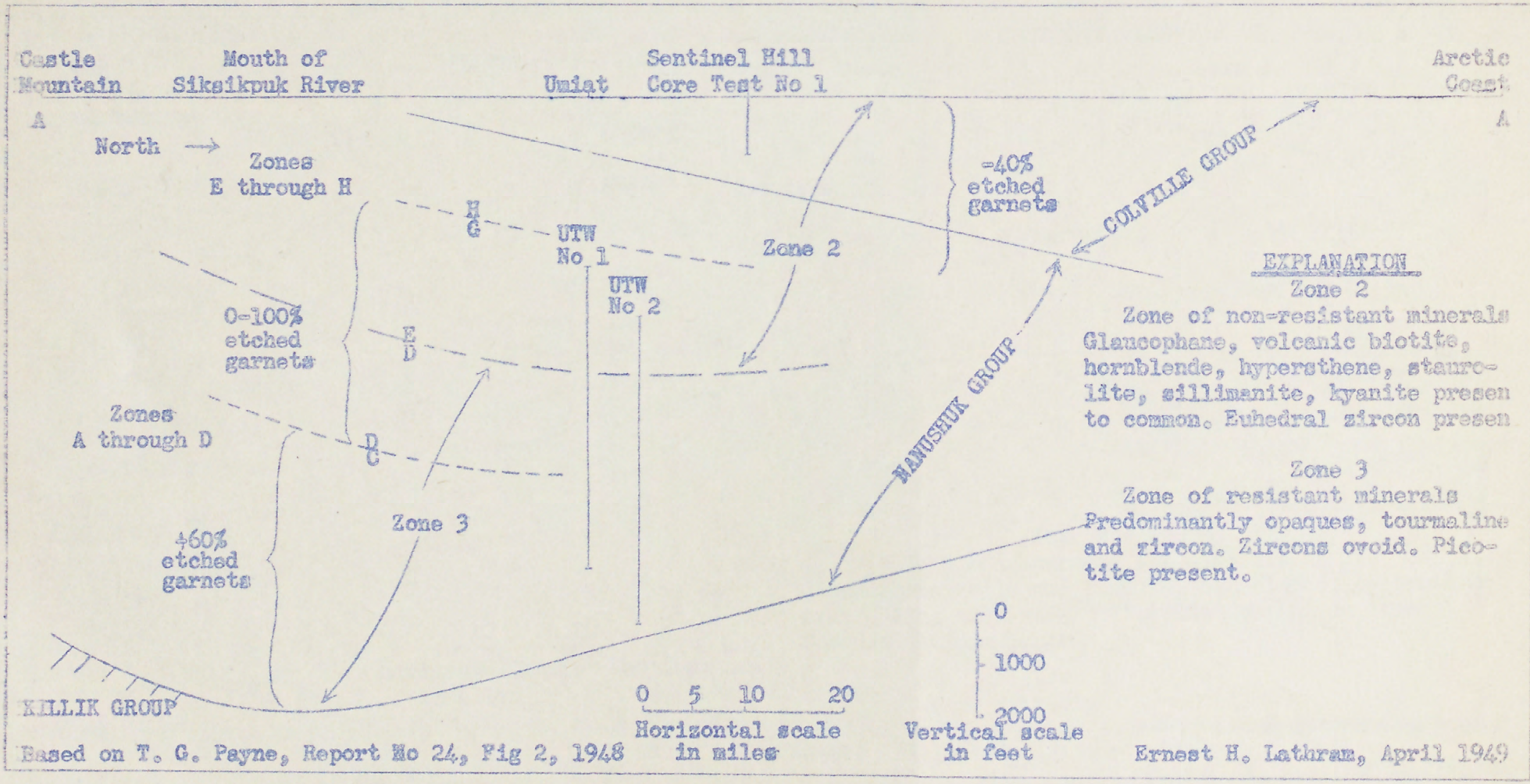
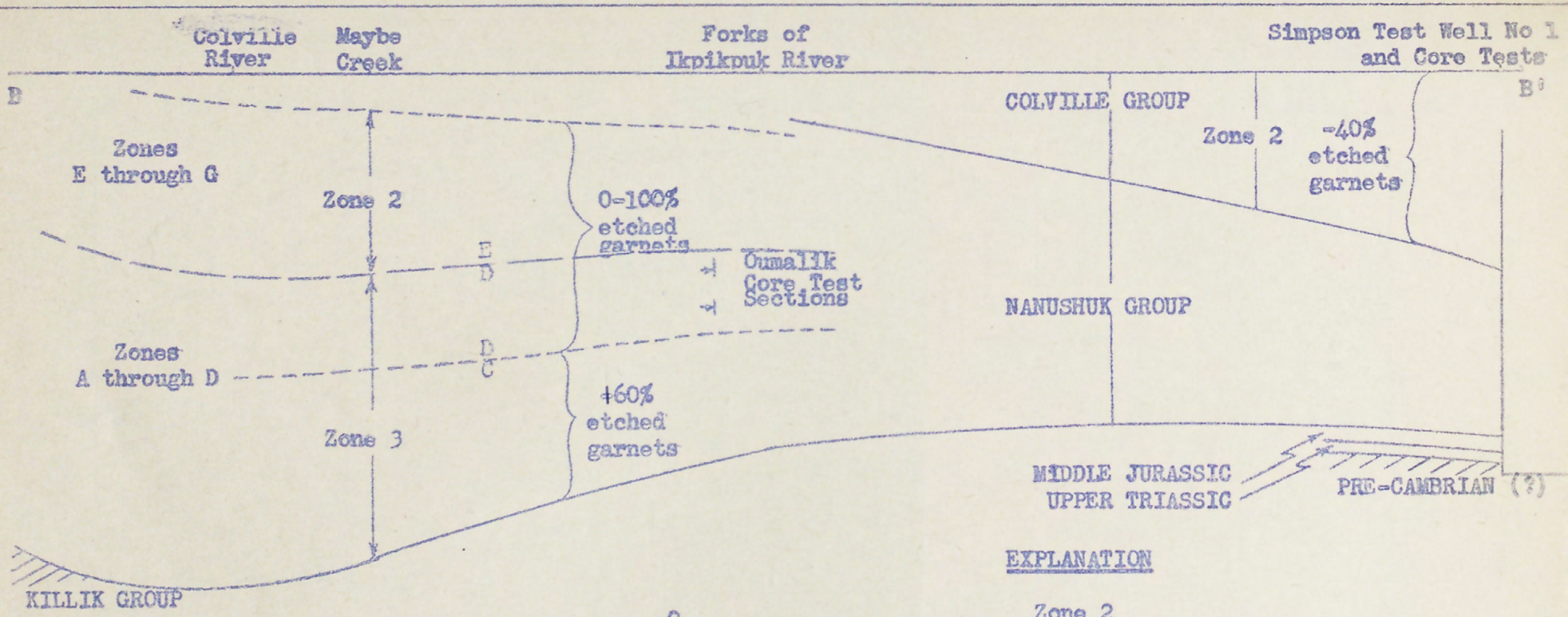


Fig. 2 HEAVY MINERAL ZONATION (A-A') OF CRETACEOUS AND TERTIARY ROCKS NORTHERN ALASKA



EXPLANATION

Zone 2

Zone of non-resistant minerals

Glaucophane, volcanic biotite, hornblende, hypersthene, staurolite, sillimanite, kyanite present to common. Euhedral zircon present

Zone 3

Zone of resistant minerals

Predominantly opaques, tourmaline and zircon. Zircons ovoid. Picotite present.

Based on T. G. Payne, Report No 24, Fig. 3, 1948

Ernest H. Lathram, April 1949

Fig. 3. HEAVY MINERAL ZONATION (B-B') OF CRETACEOUS AND TERTIARY ROCKS NORTHERN ALASKA

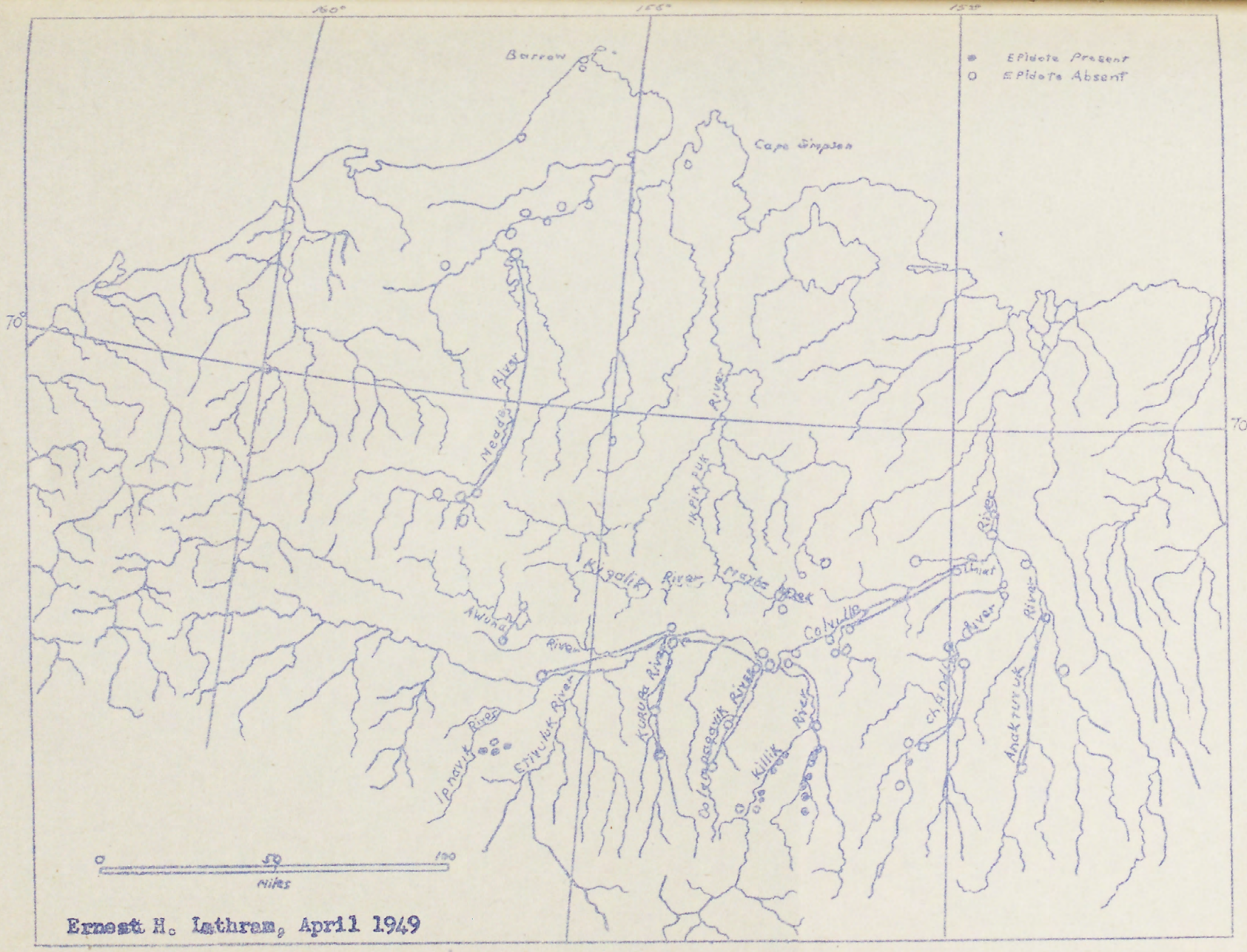
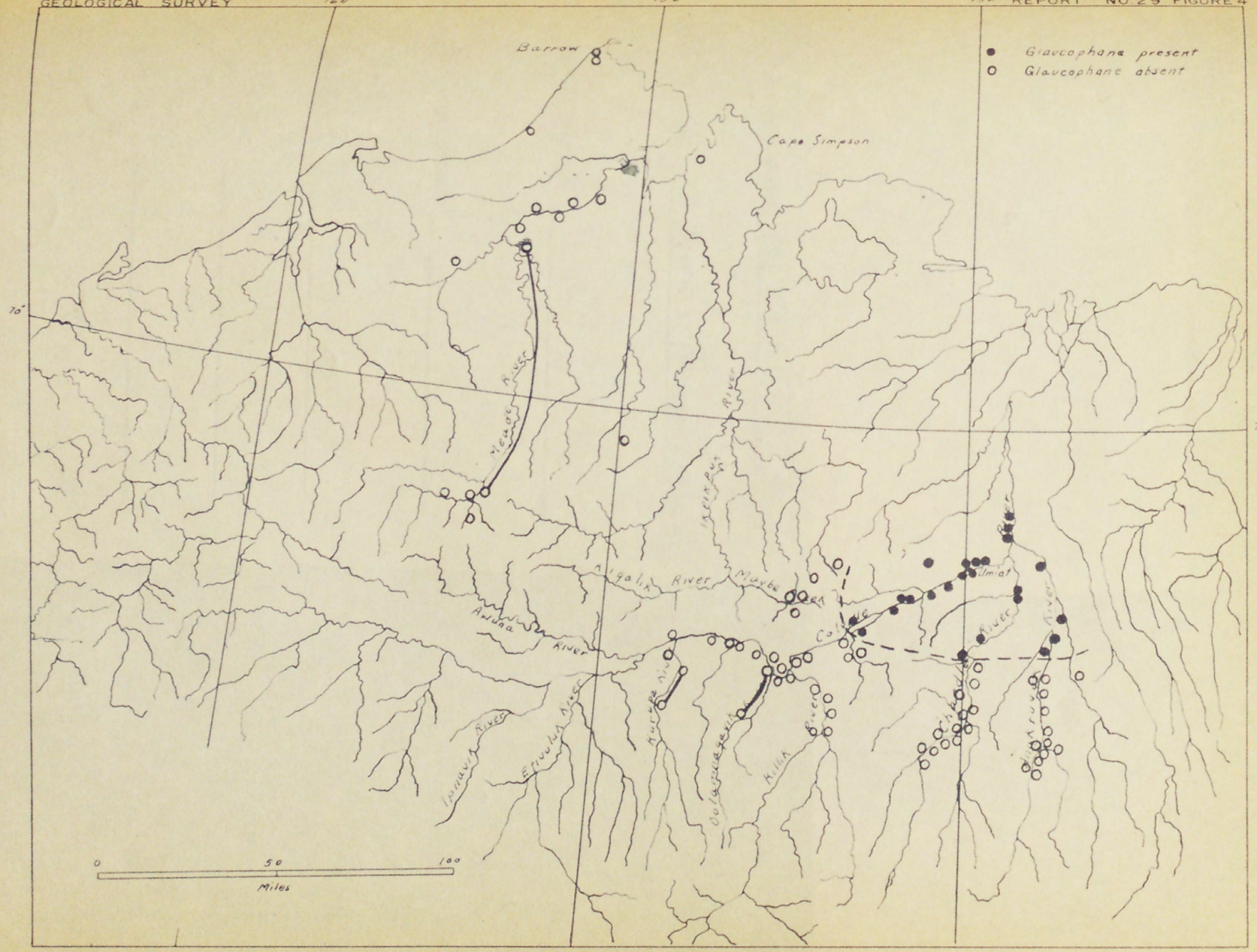


Fig. 5 DISTRIBUTION OF EPIDOTE BEARING SECTIONS
CENTRAL AREA OF NORTHERN ALASKA

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

REPORT NO. 29 FIGURE 4



DISTRIBUTION OF GLAUCOPHANE BEARING SECTIONS
CENTRAL AREA OF NORTHERN ALASKA

BY ERNEST H. LATHRAM
APRIL 1949