United States

Department of the Interior

U.S. Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Special Report 42

STRUCTURE OF THE DISCOVERY ANTICLINE

by

C. H. Marshall and A. B. Rosendale

1953

United States

Department of the Interior

U.S Geological Survey

Washington

Geological Investigations

Naval Petroleum Reserve No. 4

Alaska

Special Report 42

STRUCTURE OF THE DISCOVERY ANTICLINE

by

C. H. Marshall and A. B. Rosendale

May 1953

TABLE OF CONTENTS

ILLUSTRATIONS

STRUCTURE OF THE DISCOVERY ANTICLINE

by

C. H. Marshall and A. B. Rosendale

INTRODUCTION

Discovery anticline, named from Discovery Creek, is in the Northern Foothills section of the Arctic Foothills province. It is an east-trending structure that lies between the west end of Awuna syncline on the south and Sugar syncline on the north. No field work has been done in the vicinity of Discovery anticline, but reconnaissance photogeologic work 1/ indicated a structure that may be favorable for testing Cretaceous strata by drilling. The foothills bordering the coastal plain have low relief, and drainage is poorly developed; the ground is permanently frozen. In spite of the tundra cover and poor outcrops, it was felt that a detailed photogeologic study of the anticline would result in a sufficiently accurate structure-contour map for preliminary evaluation of the structure.

STRATIGRAPHY

The beds cropping out in the Discovery Creek area are in zones B-C (Lower Cretaceous) of the Nanushuk group. Approximately 1,600 feet of section is exposed in the area.

In the photogeologic study a continuous trace of a sandstone (?) bed was assumed to represent an approximate time line 2/; however, the sandstone (?) beds may actually transgress time lines and thus affect the structural interpretation. A persistent bed along the south flank was designated as x, and a persistent bed on the north flank was designated y. These could not be traced across the axis of the anticline, but bed y was estimated to be 200 feet stratigraphically lower in the section than bed x. This relationship was established by tracing each bed on each flank approximately 9 miles west to Wix anticline, where exposures are good and a fairly reliable correlation could be made.

STRUCTURE

The east-striking Discovery anticline is about 6 miles wide and 12 miles long. The structural high is at about lat. 69° 18' N. and long. 157°42'W. The anticline, in plan view, is asymmetrical in that the north flank is almost parallel to the axis, whereas the south flank is bowed southward. The structure-contour map (pl. 1) was compiled by the following procedure:

1/ Brosgé, W. P., Whittington, C. L., and Troyer, M. L., Preliminary map I-18: U. S. Geol. Survey Navy Oil Unit Compilation of photogeology and surface geology of NPR-4 and adjoining areas, Alaska, March 1952.

2/ Sable, Edward G., Shaling studies in the western part of NPR-4 and adjoining areas, Alaska: U. S. Geol. Survey Navy Oil Unit Spec. Rept. 37, 1952.

1. A base map showing the drainage of the area was compiled from aerial photographs oriented along the line of flight of the plane. (See fig. 1, step 1.)

2. Bedding traces, including the x and y beds, strike and dip of beds, faults, and anticlinal axes were marked on the aerial photographs and then transferred to the base map.

3. It was assumed that the beds of zones B-C are folded parallel to one another and that each bed is of constant thickness. A series of profiles across the anticline, approximately normal to the axis, was constructed in the following way:

a. The strikes of individual bedding traces were projected to intersect the nearest profile line.

b. Where the strike was not normal to the profile, the dip component in the plane of the line of profile was determined.

c. Each dip angle (or dip component) in the plane of the profile line was plotted at true horizontal and vertical scale (fig. 1, step 2). The dip of bed x was extended downward half the horizontal distance, a, and upward half the horizontal distance, b. Then the dip of bed 1 was plotted in the plane of bed x, and extended downward and upward half the horizontal distances b and c. The same procedure was followed for bed 2 and succeeding beds. By this method the attitude of the key bed was reconstructed.

4. By knowing the stratigraphic interval between the x and y beds and the altitude of the intersections of the two beds with the various structure profiles, the profiles could be tied together.

5. Using the structure profiles, structure contours at 100-foot intervals were drawn on beds x and y (fig. 1, steps 3 & 4). Inasmuch as beds x and y are eroded from the crest of the anticline, the contours were arbitrarily dropped 1,200 feet on the north flank and 1,400 feet on the south flank to make all the contours subsurface. This would place them within zone A, but they are intended to show the probable structure of zone B. The total topographic relief in the area is about 500 feet. Altitudes of bedding traces measured by stereocomparagraph, or estimated, are probably accurate within 100 ± feet. Error resulting from this procedure, therefore, would change the shape of the mapped structure by only one contour interval either way.

As shown on the contour map, a major fault is parallel to the western two-thirds of the axis on the south side to a point where the main axis reverses plunge and intersects the fault. East of the intersection of the axis and fault, and south of the main fault, the presence

of a second anticlinal nose that plunges east indicates either (1) offset from the main axis, or (2) two independent folds juxtaposed by faulting.

A northeast-striking system of faults oblique to the regional east-west structure appears to exist near the east end of Discovery anticline. The most prominent of these oblique faults is near Discovery Creek at the east end of Discovery anticline. It is at least 4 miles long. This fault is within a regional north-south zone of structural offset. East from this zone the Discovery anticline divides into two anticlinal structures. The axes of Sugar and Awuna synclines (which are adjacent to Discovery anticline) bend northward within this north-south zone of structural offset. (See Photogeologic preliminary map I-17 3/.) Bedding traces at the east end of Discovery anticline in this zone of structural offset are less well expressed and do not fit with the local structural picture.

As determined from the structure contours, the south flank closes against the fault within a crescent-shaped area, 10 miles long and 1.75 miles wide. The north flank closes against the fault within an area 10 miles long and 0.6 miles wide. The maximum amount of probable vertical or structural closure on the south flank is 1,300 feet and on the north flank, 500 feet. A longitudinal cross section (pl. 1, B-B') showing the position of the contoured bed on both flanks as it intersects the fault plane shows the variation in throw throughout the length of the fault. The shapes of the two traces on the fault plane are similar along the eastern two thirds of the fault, but along the western third, the south flank is offset progressively downward. Relatively little vertical displacement is indicated at the center of the structure. Horizontal displacement, however, is suggested by the similar shapes of the traces of the two flanks on the fault plane. Also, if there were much horizontal displacement, it might be postulated that the two folds described above are parts of one anticline.

PETROLEUM POSSIBILITIES

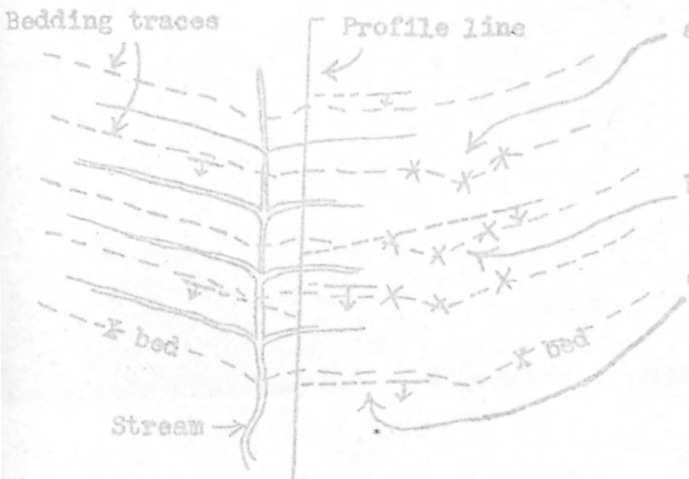
Sandstone (?) beds in the basal part of zones B-C may have favorable reservoir characteristics. The thickness of zones B-C is not known in this locality. Near the Chandler River, however, the total measured thickness of zones B-C is 2,100 feet, and the thickness of zone B is assumed to be 1,100 feet. Using these thicknesses in the Discovery Creek area and projecting the B-C contact over the axis of the structure indicates that the rocks of zone A (Torok formation) should be at or near the surface. As zone A is not exposed at the surface of the structure, zone B must be very thin over the crest.

3/ Brosgé, W. P., Whittington, C. L., and Troyer, M. L., Preliminary map I-18: U. S. Geol. Survey Navy Oil Unit Compilation of photogeology and surface geology of NPR-4 and adjoining areas, Alaska, March 1950.

Regional study indicates the presence of a large north-trending high that extends south from the Meade River area. Discovery anticline lies on the west flank of this high. This fact enhances the possibility of high structural position desirable for petroleum accumulation in the pre-Cretaceous formations.

Movement along the regional fault that extends through Discovery anticline from Discovery Creek west to Wix anticline may have started during deposition of the Torok formation and continued intermittently, and thus brought pre-Cretaceous rocks on the north side of the fault much nearer the surface. This would place them within reach of the drill. Zone A, typically shale, may contain enough sand in the upper part to be worth testing.

STEP 1. Plan View



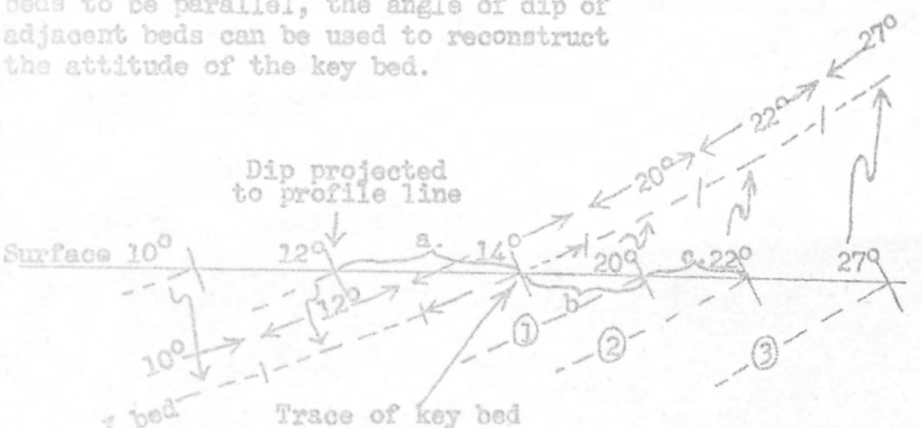
a. Three stereocomparagraph altitudes determined on bed where it vees down valley

b. Dip determined by three-point method.

c. Dip projected along the strike to line of section and dip corrected if strike is not normal to line of section.

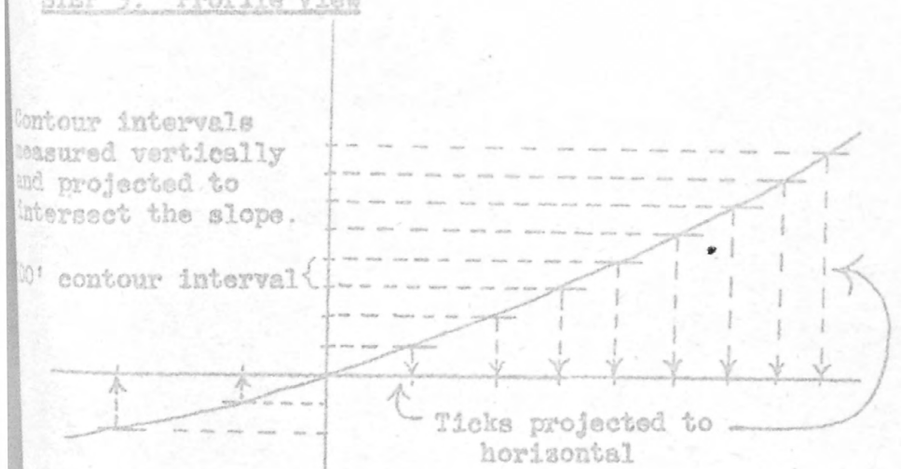
STEP 2. Profile View

After projecting corrected dips to line of profile the data is plotted at true horizontal and vertical scale. Assuming the beds to be parallel, the angle of dip of adjacent beds can be used to reconstruct the attitude of the key bed.



The dip of the key bed is extended half way to the adjacent dip and connected to it. Succeeding dips are likewise connected to form the slope.

STEP 3. Profile View



STEP 4. Plan View

If the key bedding trace crosses the adjacent line of profile at a different altitude, the contour ticks must be adjusted up or down the structure slope accordingly. If the key bed trace rises topographically between cross section lines, the contour tick must drop an equal vertical amount down the structure slope.

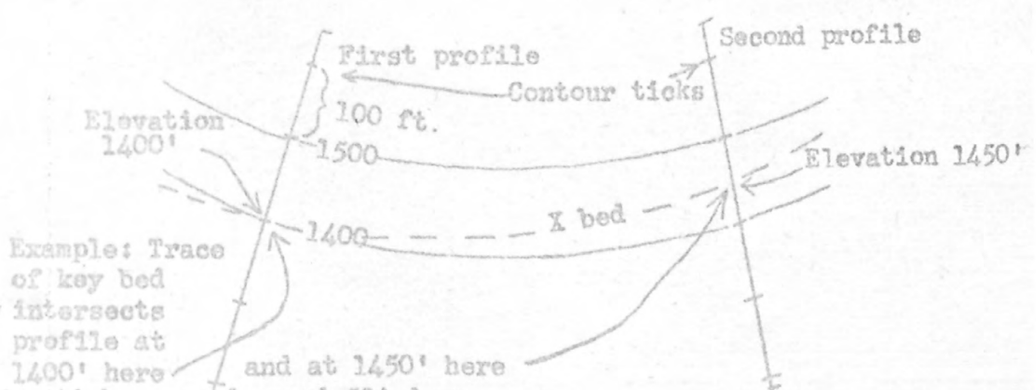


Figure 1. METHOD USED IN CONSTRUCTING STRUCTURE-CONTOUR MAPS ON DISCOVERY ANTICLINE, ALASKA