NORTH DAKOTA GEOLOGICAL SURVEY

REPORT OF INVESTIGATION NO. 37

MAPS OF THE FROBISHER-ALIDA INTERVAL, NORTH DAKOTA

BY

WILLIAM P. EASTWOOD

JANUARY, 1961

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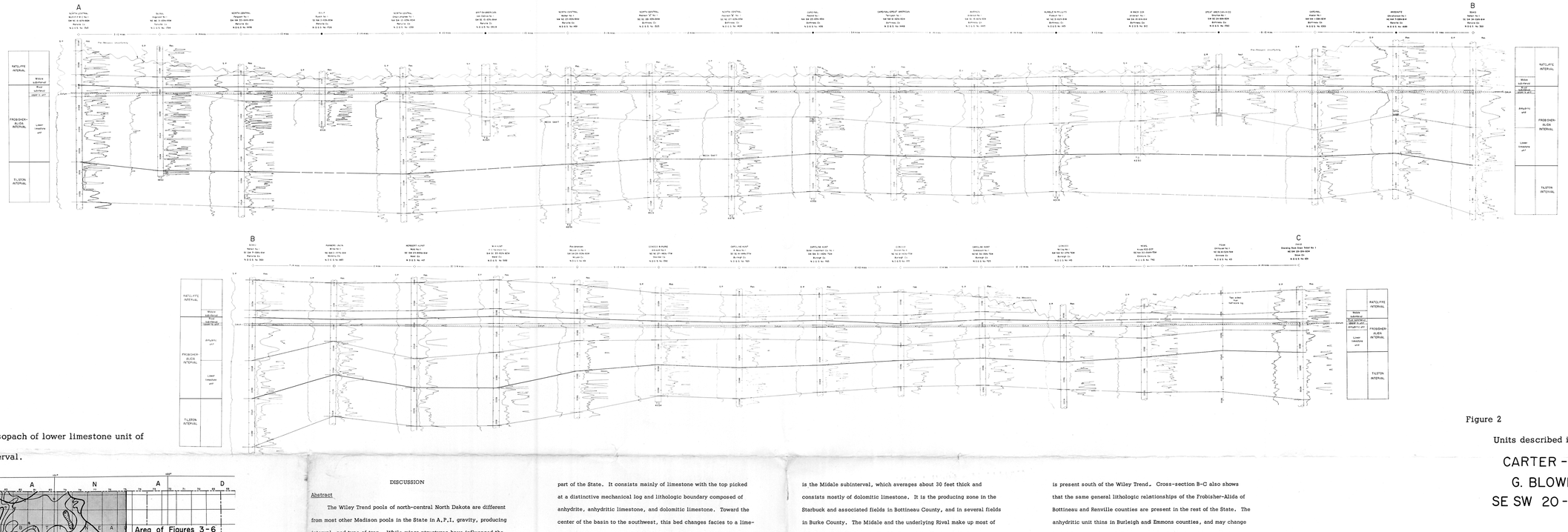

Figure 1

Location map and isopach of lower limestone unit of Frobisher-Alida interval.

Figure 2

Units described in this report.

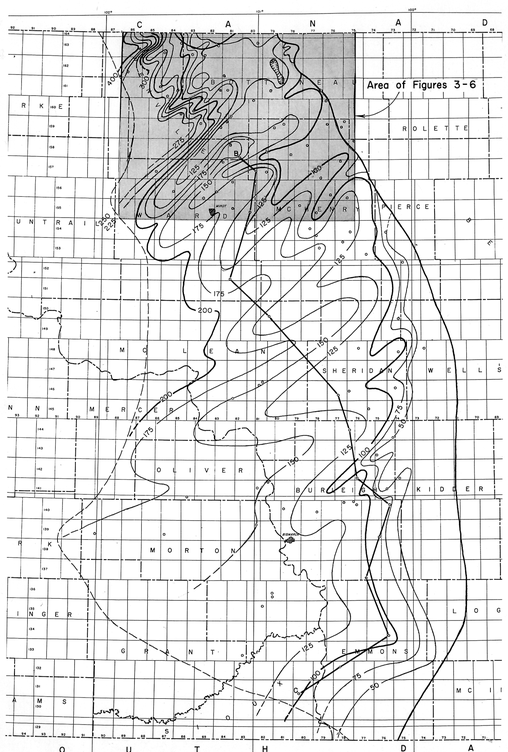

Plate 1 of 3

DISCUSSION

Abstract

The Wiley Trend pools of north-central North Dakota are different from most other Madison pools in the State in A.P.I. gravity, producing interval, and type of trap. While minor structures have influenced the exact location of some of the pools, the main reason for the accumulation and trapping of these pools is an updip facies change from porous carbonate to anhydrite in the lower part of the Frobisher-Alida interval. The same general stratigraphic conditions exist in the Frobisher-Alida south of the present Trend, and the producing area may be extended by the discovery of related pools.

Purpose of Study

Recent months have seen increased activity in connection with a group of related oil fields in the north-central part of North Dakota (see Figure 1). The nine fields are shown on Figures 3 - 6, and are here referred to as the Wiley Trend after the more centrally located field of the group. The purpose of this study is to show the lithologic and stratigraphic factors responsible for the formation of these oil pools and the possible presence of these same factors in other parts of the State. A short explanation of these factors in the Williston Basin was given by Fish and Kinard (1959).

Introduction

The pools of the Wiley Trend are similar in many respects. They produce oil of a lower gravity (about 28 degrees A.P.I.) than the other Madison pools of North Dakota. Seven of the pools produce oil from the top of the lower limestone unit of the Frobisher-Alida interval. The Bluell pool also produced from this unit, but is now abandoned. The North Haas pool produces from a quartzose sandstone bed which pinches out within the middle anhydritic unit of the Frobisher-Alida. This sandstone bed is probably equivalent to the Kisbey sand of Fuller (1956). In all of the pools, the method of trapping or accumulation seems to be related to a porosity pinchout against the middle anhydritic unit.

Four small pools in the eastern part of Bottineau County also produce from the lower limestone unit of the Frobisher-Alida, but the oil is of a higher gravity (36-38 degrees A.P.I.) and the accumulations are trapped against the pre-Mesozoic unconformity. Thus, these fields are different from those of the Wiley Trend, both in type of oil and kind of trap.

The names and units used in this report (see Figure 2) are those proposed by a committee, under the chairmanship of Smith (1960), of the North Dakota Geological Society.

Tilston Interval

The Tilston interval averages about 150 feet in thickness in this part of the State. It consists mainly of limestone with the top picked at a distinctive mechanical log and lithologic boundary composed of anhydrite, anhydritic limestone, and dolomitic limestone. Toward the center of the basin to the southwest, this bed changes facies to a limestone similar to the overlying and underlying beds and basinward from that change, the Tilston and Frobisher-Alida intervals cannot be separated at the present time. The Tilston interval produces oil in the North Souris field in eastern Bottineau County.

Frobisher-Alida Interval

The Frobisher-Alida interval overlies the Tilston interval. In the area of study, the thickness of a complete section of Frobisher-Alida ranges from about 220 feet in the east to a little over 400 feet in the west. In the eastern part of the area, the interval has been cut by the pre-Mesozoic unconformity, and in the western part, the boundary between the Frobisher-Alida and the underlying Tilston has not been determined accurately.

The basal unit of the Frobisher-Alida is a thick (100-400 feet) sequence of limestone, with the top portion consisting of oolitic and pseudo-oolitic limestone and containing tongues and lenses of anhydrite and shaly dolomitic limestone. Oil is produced from this unit in four of the unconformity trap pools in eastern Bottineau County, from the pools of the Wiley Trend, and from the Madison pools of Billings and Stark counties.

Above the lower limestone unit is a lithologic unit which is mostly anhydrite, but which also contains beds of dolomitic limestone, salt, and quartzose sandstone (the Kisbey sandstone of Fuller, 1956). This unit ranges in thickness from 0 to over 200 feet, and is thickest along a northwest-southeast trend through the central part of the area. From this trend, the unit thins slightly toward its subcrop in the east and pinches out toward the west (see Figure 4). West of the pinchout, lateral equivalents of the anhydritic unit consist of beds referred to the lower limestone unit.

Above the anhydrite unit, and above the lower limestone unit where the anhydrite is absent, is a thin (10-15 feet) bed of dolomitic limestone. Minor amounts of oil are obtained from this bed in a few scattered wells toward the west in Burke County.

The upper unit of the Frobisher-Alida is the Rival subinterval, which in this area consists of 25-30 feet of anhydrite and dolomitic limestone. In Burke County, the Rival changes facies to oolitic limestone and is productive in many of the fields of that area. It is also part of the main producing zone of the Madison pools along the Nesson anticline.

Ratcliffe Interval

Overlying the Frobisher-Alida is the Ratcliffe interval. This interval is about 200 feet thick, and in this area consists of alternating beds of dolomitic limestone, anhydrite, and shale. The basal unit of the Ratcliffe is the Midale subinterval, which averages about 30 feet thick and consists mostly of dolomitic limestone. It is the producing zone in the Starbuck and associated fields in Bottineau County, and in several fields in Burke County. The Midale and the underlying Rival make up most of the main producing zone in the Madison of the Nesson anticline area. Ratcliffe beds above the Midale are productive in the Newburg-South Westhope and associated fields in Bottineau County east of the Wiley Trend.

Description of Maps

Figure 3 is a structure map drawn on a prominent spontaneous potential log marker near the top of the Frobisher-Alida interval. This marker is the datum used for the two cross-sections. The map shows the regional northwest-southeast strike and southwest dip of the Madison beds in this part of the Williston Basin. Small anticlines are shown in the area of the Bluell and Sherwood fields and in the area of the Glenburn and Pratt fields. A slight structural anomaly is present around the Wayne field. The Wiley, Haas, and North Haas fields do not exhibit any structural pattern other than a slight nosing.

Figure 4 is an isopach of the middle anhydritic unit of the Frobisher-Alida. The Wiley Trend pools are seen to lie at or near the updip end of thin trends of the anhydrite and against an area of thick anhydrite.

Figure 5 is an isopach of the lower limestone unit of the Frobisher-Alida interval. The pattern shown is similar to that of Figure 4, except that the areas of thin anhydrite are represented by areas of thick limestone. The Wiley Trend fields lie near the updip ends of thick limestone trends and downdip from an area of thin limestone. Figures 4 and 5, together with the cross-section A-B, illustrate a facies relationship between the anhydrite and limestone units with the upper part of the limestone unit in the west shown to be time equivalent to the anhydritic unit to the east.

Figure 6 is a map of the structure on top of the lower limestone unit of the Frobisher-Alida interval. The same general pattern as Figure 3 is shown, but there are differences in detail which are caused by the changes in thickness of the limestone unit. The most important changes in the pattern are seen in the areas of the Glenburn and Wiley fields. On Figure 3, the Glenburn area shows only a southerly plunging anticline, and the Wiley area shows no distinctive structure. On Figure 6, good closure is shown in both areas.

Figure 1 is an isopach map of the lower limestone unit of the Frobisher-Alida of the central part of North Dakota. This unit cannot be mapped farther into the basin at present because the marker bed at the top of the underlying Tilston interval apparently disappears basinward. However, the same thickening and thinning shown in detail on Figure 5 is present south of the Wiley Trend. Cross-section B-C also shows that the same general lithologic relationships of the Frobisher-Alida of Bottineau and Renville counties are present in the rest of the State. The anhydritic unit thins in Burleigh and Emmons counties, and may change facies to a more porous lithology which would make it less effective in trapping oil.

Conclusions

The oil accumulations of the fields of the Wiley Trend are apparently caused by updip pinchouts of porous limestone against an overlying anhydrite. In the Sherwood, Glenburn, and Pratt field areas, the accumulations are localized by small anticlines. The Wiley field appears to be a stratigraphic trap with the oil being trapped in the limestone on the downdip side of an area of thick anhydrite and thin limestone. The other pools of the Wiley Trend are probably the result of porosity wedge-outs and small structures.

In general, the lithologic and stratigraphic relationships responsible for the formation of the Wiley Trend pools are present south of Bottineau and Renville counties. If small structures similar to the Glenburn and Sherwood fields exist, and if the anhydritic unit is an effective seal in the rest of the State, then the chances for the discovery of other pools related to the Wiley Trend are good.

References

Fish, A. R., and Kinard, J. C., 1959, Madison group stratigraphy and nomenclature in the northern Williston Basin: Program Ninth Annual Meeting, Rocky Mountain Sec. Am. Assoc. Petrol. Geol., Albuquerque, New Mexico, in Geological Record, Petroleum Information, Denver, Colorado, pp. 117-129.

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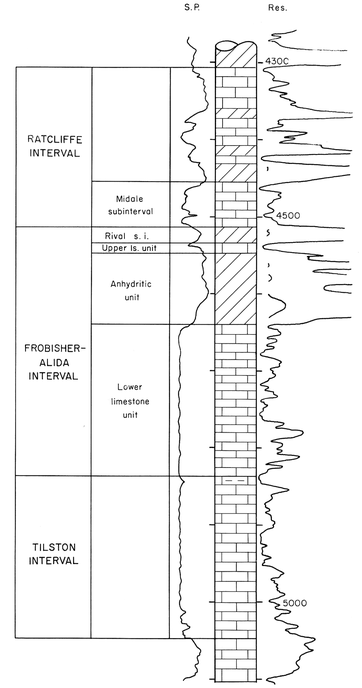
CARTER - PHILLIPS

G. BLOWER NO. 1

SE SW 20 - 160N - 83W



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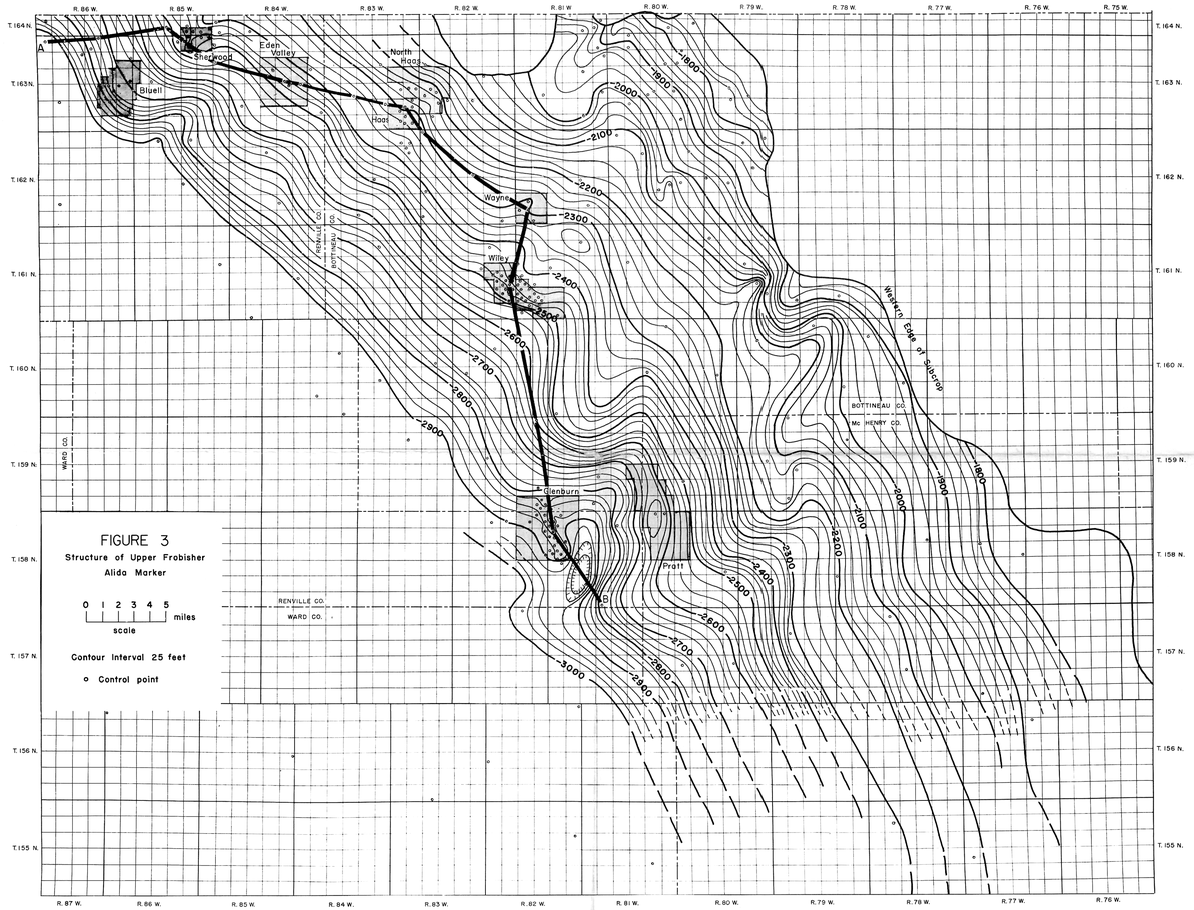

FIGURE 3

Structure of Upper Frobisher Alida Marker

0 1 2 3 4 5 miles

scale

Contour Interval 25 feet

o Control point

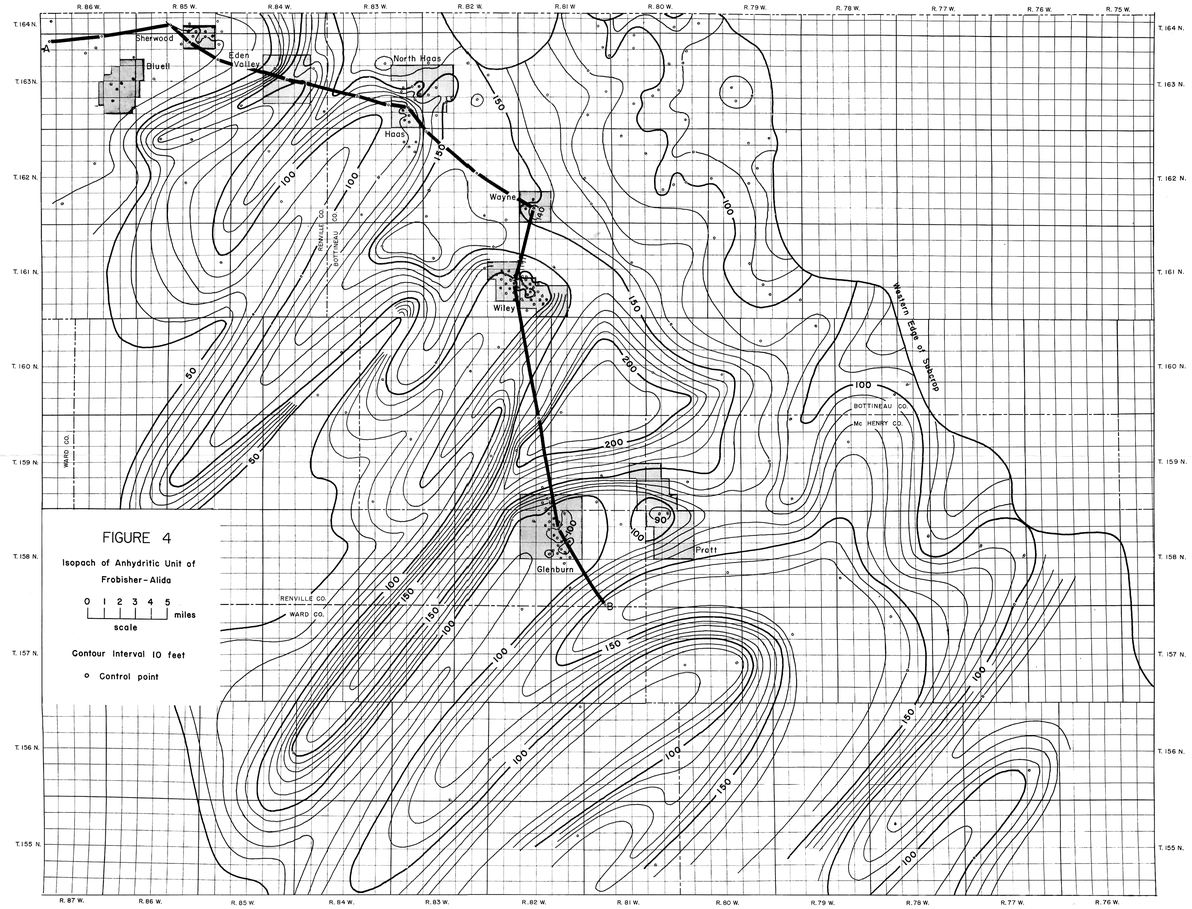

FIGURE 4

Isopach of Anhydritic Unit of Frobisher-Alida

0 1 2 3 4 5 miles

scale

Contour Interval 10 feet

o Control point

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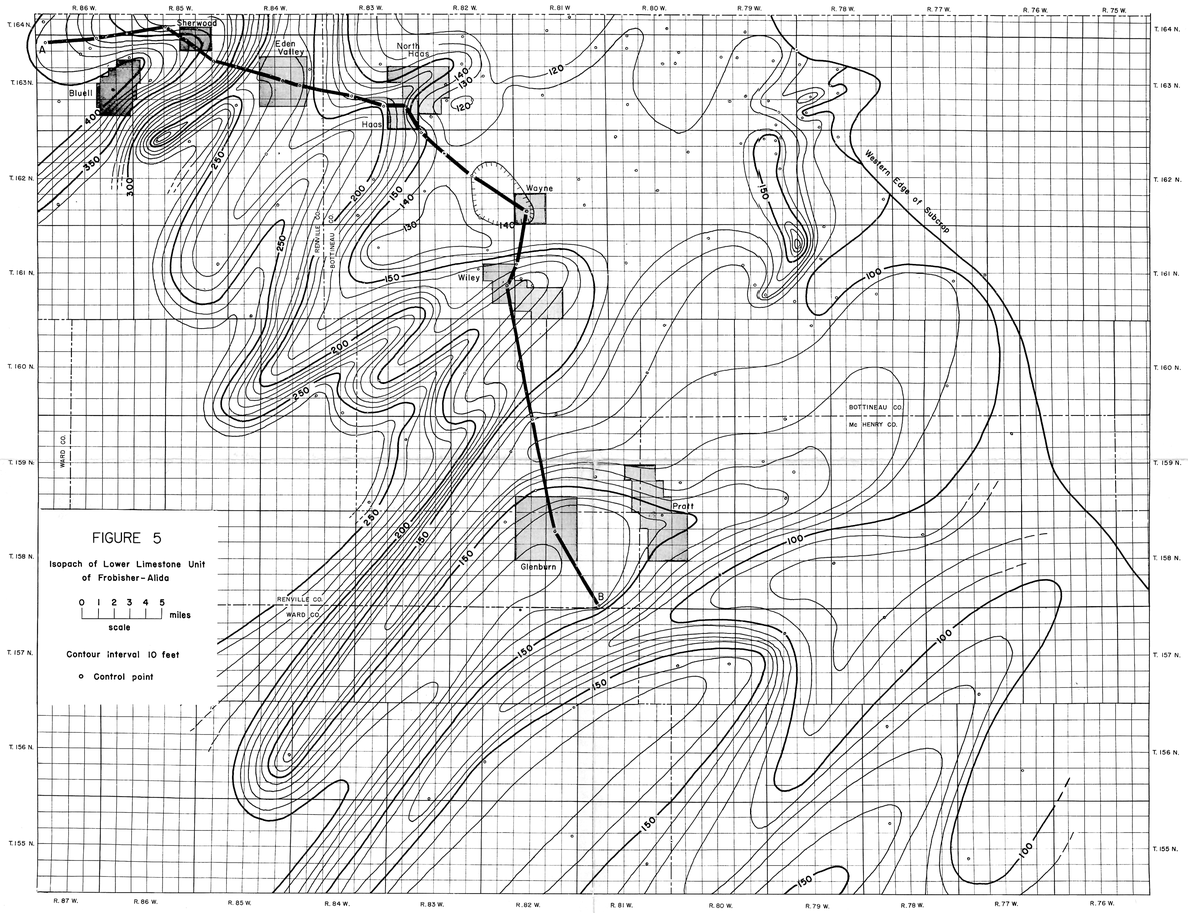

FIGURE 5

Isopach of Lower Limestone Unit of Frobisher–Alida

0 1 2 3 4 5 miles

scale

Contour interval 10 feet

o Control point

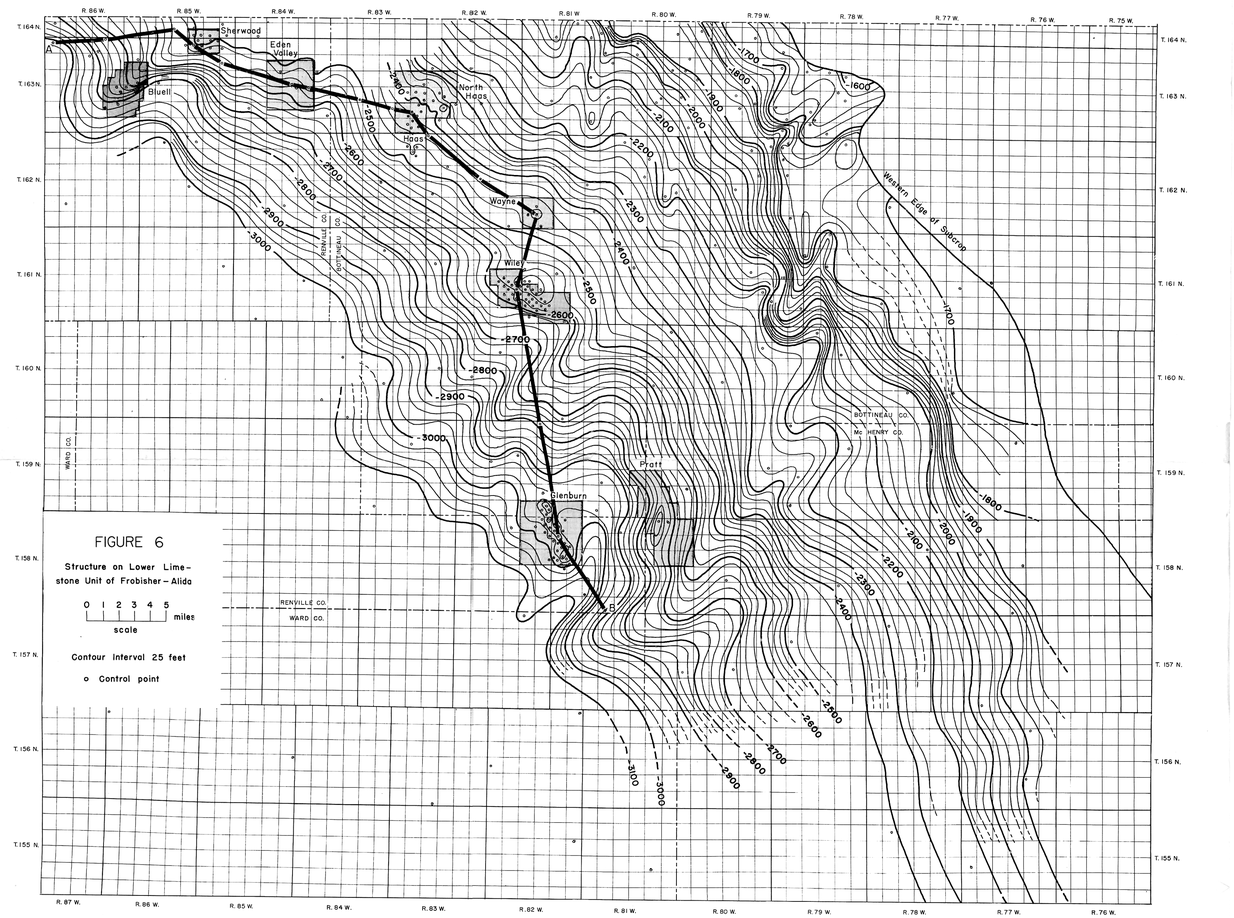

FIGURE 6

Structure on Lower Limestone Unit of Frobisher–Alida

0 1 2 3 4 5 miles

scale

Contour interval 25 feet

o Control point

Plate 3 of 3

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