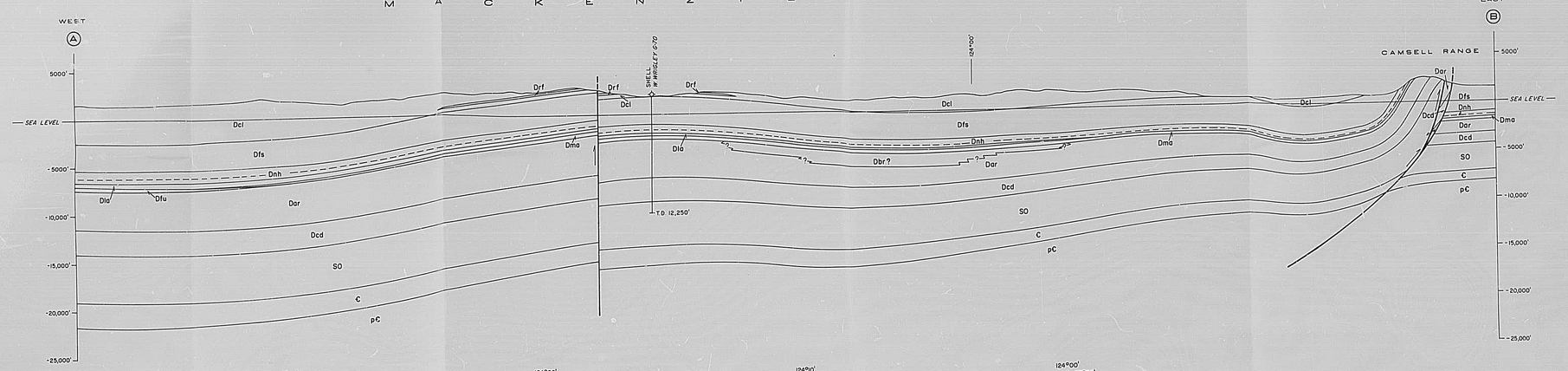
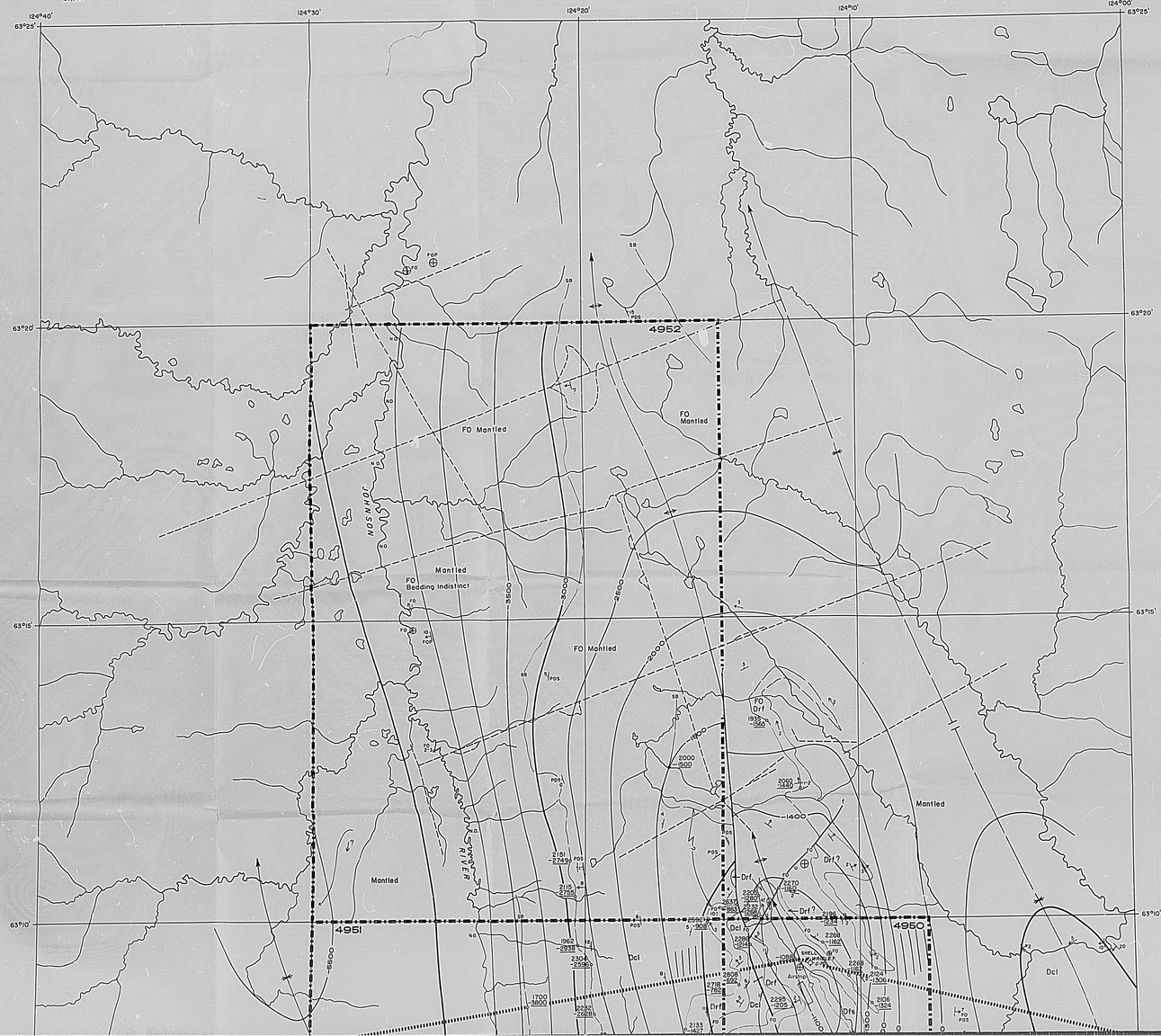
GEOLOGIC CROSS SECTION

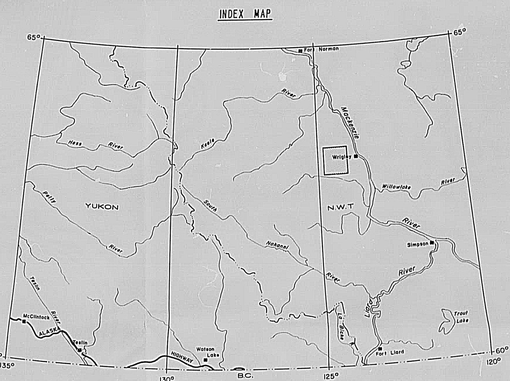
SCALE : 1 INCH TO 1 MILE

M A C K E N Z I E P L A I N





INDEX MAP



LEGEND

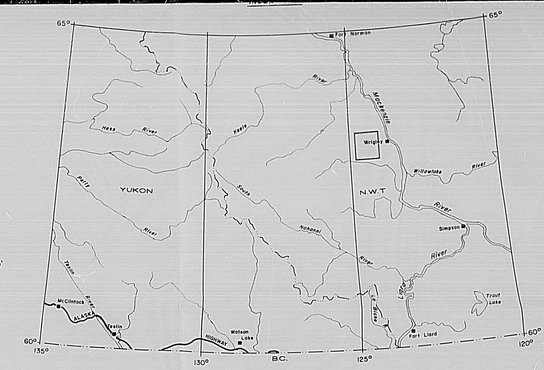
FORMATIONS

	Dcl	Unnamed clastic sequence. Sandstone, shale.
UPPER DEVONIAN	Drf	Unnamed reef limestones. Lies in lower part of Dcl.
	Dfs	Ft Simpson Shale. Includes Middle Devonian Horn River Formation.
	Dnh	Nahanni (Hume) Limestone. Headless. Argillaceous limestone.
	Dla	Landry, Limestone.
	Dfu	Funeral. Limestone, argillaceous.
MIDDLE DEVONIAN	Dma	Manetoe. Dolomite, porous.
	Dar	Arnica Limestone. Grades northeastward to Bear Rock.
	Dbr	Bear Rock. Dolomite and limestone; brecciated. Grades southwestward to Arnica. In upper part includes Landry, Funeral, and Manetoe where present.
LOWER DEVONIAN	Dcd	Camsell Dolomite, limestone; brecciated. Delorme Dolomite, anhydrite.
SILURIAN AND ORDOVICIAN	SO	Mt Kindle and Franklin Mountain. Reefal dolomite, dolomite, anhydrite.
CAMBRIAN	C	Saline River. Shale, gypsum. Mt Cap. Shale, siltstone, dolomite, limestone. Mt Clark. Sandstone, quartzite.
PRECAMBRIAN	pC	Lone Land in upper part. Sandstone, shale, siltstone, conglomerate, mudstone.

GEOLOGICAL SYMBOLS

- Bedding appears horizontal on photographs
- Dip and strike. Amount of dip cannot be measured.
- Dip component
- Field measured dip, V. Zay Smith Associates Ltd., 1969.
- Field observed published dip or component.
- Dip measured photogrammetrically
- Ground elevation and structure datum elevation (underlined) in feet relative to sea level. Measured with Multiplex photogrammetric plotter. Control points are projected to datum using quantitive information derived photogrammetrically.
- Structure contours on top of Middle Devonian carbonate (Nahanni Formation).
- Field observed information
- Field observed published information.
- Distinctive alignment, possible structural significance
- Fault; "U" denotes upthrown side.
- Anticline, arrow denotes plunge, diamond denotes approximate position of apex
- Syncline, arrow denotes plunge, break and cross bars denote approximate position of high point
- Glacial lineation indicating direction of ice movement
- Key bed, subtended letter or number indicates local correlation
- Stratigraphic break
- Indicates correlative beds or formations

1 of



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SILURIAN AND ORDOVICIAN	SO	Mt Kindle and Franklin Mountain Reefal dolomite, dolomite; anhydrite.
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PRECAMBRIAN	pC	Lone Land in upper part: Sandstone, shale, siltstone, conglomerate, mudstone.

GEOLOGICAL SYMBOLS

- Bedding appears horizontal on photographs
- Dip and strike. Amount of dip cannot be measured.
- Dip component
- Field measured dip, V Zay Smith Associates Ltd., 1969.
- Field observed published dip or component.
- Dip measured photogrammetrically.
- 2133 / 0-1427 — Ground elevation and structure datum elevation (underlined) in feet relative to sea level. Measured with Multiplex photogrammetric plotter. Control points are projected to datum using quantitive information derived photogrammetrically.
- 3000 / 1800 — Structure contours on top of Middle Devonian carbonate (Nahanni Formation).
- FO — Field observed information.
- FOP — Field observed published information.
- X — Outcrop
- N.O. — No outcrop
- Dry and abandoned test
- DA — Distinctive alignment, possible structural significance
- f — Fault; "U" denotes upthrown side.
- Anticline, arrow denotes plunge, diamond denotes approximate position of apex.
- Syncline, arrow denotes plunge, break and cross bars denote approximate position of high point.
- Glacial lineation indicating direction of ice movement
- Key bed; subtended letter or number indicates local correlation.
- SB — Stratigraphic break
- Indicates correlative beds or formations.
- A ——— B — Cross section
- Seismic line or trail.
- Permit Area

Cross section A-B extends easterly 10.4 miles beyond the map area across the northern end of the Camsell Range.

AREAL GEOLOGY AND STRUCTURAL INTERPRETATION MAP OF THE WEST WRIGLEY ANTICLINE AREA

NORTHWEST TERRITORIES

STRUCTURE CONTOURS ON TOP OF MIDDLE DEVONIAN NAHANNI FORMATION

CONTOUR INTERVAL: 100 AND 500 FEET

SCALE: 1 INCH TO 1 MILE

MILES 1/2 0 1 2 3 MILES

Prepared by

V. ZAY SMITH ASSOCIATES LTD.

CALGARY, ALBERTA

1969

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17-3-4-29

Areal Geology and Structural Interpretation of the West Wrigley Anticline, N.W.T.

AREAL GEOLOGY and STRUCTURAL INTERPRETATION

of the

WEST WRIGLEY ANTICLINE, NORTHWEST TERRITORIES

Prepared For

TEXACO EXPLORATION COMPANY

by

V. ZAY SMITH ASSOCIATES LTD.

1969

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ILLUSTRATIONS

AREAL GEOLOGY and STRUCTURAL INTERPRETATION

of the

WEST WRIGLEY ANTICLINE, NORTHWEST TERRITORIES

INTRODUCTION

A detailed areal geology and structural interpretation map of the West Wrigley anticline was compiled through the combined use of photogeologic and photogrammetric techniques. The resulting quantitative geologic map shows structure contours drawn on the top of the Middle Devonian Nahanni Formation. The work covers Exploratory Permits 4950, 4951 and 4952 held by Texaco Exploration Company, located 20 miles west of the settlement of Wrigley on the Mackenzie River between lat. 63° and 63° 25' N. and long. 124° and 124° 40' W.

A topographic profile showing the surface skim of geology was also constructed with a Multiplex plotter and used in the compilation of the geologic cross-section accompanying the report. The location of the western portion of the cross-section is indicated on the areal geology map and the eastern end of the section extends beyond the limits of the map to the northern end of the Camsell Range, over 10 miles to the east.

The geologic mapping covers an area of approximately 350 square miles and was restricted mainly to the three permits. Enough work was performed along the east edge of the permits to provide a complete structural picture of the West Wrigley anticline, the main portion of which is straddled by the permit acreage.

The areal geology map is drawn at the scale of 1 inch to 1 mile. The structure contour interval is mainly 500 feet although a 100-foot interval is used on the crestal area of the anticline.

PROCEDURES

The initial step in this work consisted of a detailed photo-geologic evaluation using vertical air photographs obtained from the Dominion government. The detailed geologic interpretation annotated on the airphotos was used as a guide for the quantitative Multiplex mapping. As mentioned earlier, the topographic profile and geologic surface detail used in the construction of the geologic cross-section were obtained using the Multiplex. The Multiplex projects an enlarged 3-dimensional image of the air photographs on a plotting table, allowing detailed and direct measurement of horizontal and vertical distances viewed within the image. Dips and strikes showing the attitude of bedding are measured in degrees and plotted on the surface map. Formational thicknesses are measured using standard trigonometric functions. Elevations of formational contacts are obtained by direct measurement.

Formation tops from Shell West Wrigley G-70 were used in the construction of the geologic cross-section. The thicknesses were integrated with regional isopach data and with observed formational contacts in the Camsell Range to the east to complete the necessary structural control for the geologic cross-section.,

Seismic trails as observed on the airphotos are indicated on the accompanying areal geology map and it should be noted that the photography covering the central portion of the West Wrigley anticline was flown one year prior to that on the north and to the south. Most of the seismic work performed in the area was completed after the photography was flown in the central area and prior to completion of photography on the north and south. Therefore, seismic trail detail is largely lacking in the area of earlier photography.

Photogeologic mapping was also completed along a strip beyond the eastern map area to provide control for the accompanying geologic cross-section.

GEOLOGY

STRATIGRAPHY

The stratigraphic correlation chart and the geologic cross-section show the lithologic character and lateral relationships of surface and subsurface formations in the permit area. The correlation chart relates the stratigraphy of the Wrigley-Dahadinni area to other nearby areas and also shows the relationship to northern Alberta stratigraphy.

Surface rocks in the West Wrigley anticline area are of Upper Devonian age. The oldest surface exposures include shales of the Upper Devonian Fort Simpson Formation in the core of the anticline. The geologic cross-section shows eastward thinning of the major stratigraphic units based on regional observations obtained from published information.

Around 2,000 feet of clastics including sandstone, quartzite, shale and perhaps gypsum and salt in the upper part probably constitute the Cambrian section in the subsurface of West Wrigley anticline. These are referred to, in ascending order, as the Mount Clark, Mount Cap, and Saline River Formations which rest unconformably upon the sandstones and shales of the Precambrian Lone Land Formation.

A succession of carbonates, probably exceeding 12,000 feet in thickness, and ranging in age from Silurian-Ordovician through Middle Devonian, offer the most promising reservoir potential.

The oldest of these carbonates are of Silurian-Ordovician age and are probably 4,000 to 5,000 feet thick. The dominant lithologies are dolomite and limestone, referred to in the Mackenzie Mountain region as the Sunblood and overlying Whittaker Formations. In the Franklin Mountains to the east, they are called the Franklin Mountain and overlying Mount Kindle Formations. Reefal buildups are reported in the Franklin Mountain Formation and in the Whittaker Formation to the west.

Formation tops reported in the Department of Indian Affairs and Northern Development schedule of wells 67 (Schedule No. 7) indicates that Shell West Wrigley G-70 penetrated 1,187 feet of the upper part of the Mount Kindle Formation including mainly dolomites and anhydrite.

These are overlain conformably by 2,433 feet of the Delorme Formation also comprised mainly of dolomite and anhydrite. The Delorme Formation is considered to be of late Silurian and/or Lower Devonian age. The map unit is designated Dcd on the cross-sections to denote the possible presence of dolomites of the Camsell Formation.

In Shell West Wrigley G-70 the Delorme Formation is overlain by 4,200 feet of dolomites and anhydrites of the Arnica Formation of Middle Devonian age.

The Arnica Formation grades northeasterly to brecciated dolomites and evaporites of the Bear Rock Formation and, because the position and character of the line of facies change is largely unknown, an inferred occurrence of Bear Rock Formation (Dbr) is shown on the geologic cross-section to call attention to the possible presence of Bear Rock in the subsurface.

The Arnica Formation is overlain by the Manetoe Formation consisting of 370 feet of dolomites which are often porous and vuggy in the Mackenzie Plain region.

A regional westward facies change from dolomites of the Manetoe Formation to argillaceous limestone of the Funeral Formation is known to exist in the area west of the West Wrigley anticline. Although the position of the facies front in the subsurface is indefinite, it is diagrammatically inferred in the western part of the geological cross-section. Under proper structural conditions this facies change is capable of providing effective stratigraphic traps.

Limestones and dolomites of the Landry Formation totalling 290 feet in thickness rest conformably on the Manetoe Formation. Landry beds appear to be absent in the Camsell Range to the east and increase in thickness to several hundred feet in the Mackenzie Mountains to the west.

The Landry, Manetoe, and Funeral Formations are approximately equivalent. Southwest of the permit area in the southern Dahadinni Range and northern Iverson Range the Geological Survey of Canada indicates the presence of around 300 feet of Landry Formation which is replaced northward by facies change to argillaceous limestones of the Funeral Formation.

The Headless Formation is comprised of shaly limestones totalling 285 feet in thickness in Shell West Wrigley G-70. The formation is quite persistent in the region, though often thin, and is commonly included with the overlying Hume Formation for purposes of mapping. The combined units are designated Dnh on the accompanying cross-section.

In West Wrigley G-70 the Hume Formation consists of 593 feet of limestones representing the uppermost of the Middle Devonian carbonates in the region. The top of the Hume Formation provides the structure datum on the accompanying geologic map.

A thick sequence consisting of shale, siltstone, mudstone and sandstone totalling around 2,900 feet in thickness rests conformably upon carbonates of the Hume Formation. This unit, known as the Fort Simpson Formation, is designated Dfs on the cross-section and map. It is mainly Upper Devonian in age although shales of the Horn River (Hare Indian) Formation included in the lower part of the map unit are of Middle Devonian age. The Horn River Formation typically includes black pyritic shales and occasionally contains fairly resistant siltstone and sandstone in the upper part.

A thick unnamed sequence of Upper Devonian clastics (Dcl) rests conformably upon the Fort Simpson. The formation contact is often poorly expressed. More than 5,000 feet of these Upper Devonian clastics are present west and north of the West Wrigley anticline. The Dcl map unit consisting mainly of sandstone, shale and siltstone, forms surface bedrock over 90% to 95% of the permit area.

A massive, reefal limestone unit 150 to 200 feet thick is mapped in the lower part of the Dcl map unit. This resistant unit is present on the north, west, and southwest flanks of West Wrigley anticline where it provides excellent structural control and dip definition. A similar reefal unit occurring at or near the base of the Upper Devonian clastic sequence is reported in other parts of the region also.

STRUCTURE

The accompanying areal geology and structural interpretation map shows structure contours on the top of the Middle Devonian Nahanni Formation.

The West Wrigley anticline is an oval shaped north-north-westerly trending closed anticline extending from the east-central part of Permit 4950 in the southeast to beyond the area of mapping in the north. The axis is mapped over a length of around 21 miles. A longitudinal fault parallels the main axis on the west flank at a distance of approximately 1 mile and exhibits a maximum displacement on the order of 800 feet upthrown to the west. The fault, is vertical or nearly vertical.

Overall independent closure of the West Wrigley anticline is on the order of 1,000 feet in the vicinity of Shell West Wrigley G-70. This overall area of closure is around 12-1/2 miles long and displays a maximum width of approximately 5-1/2 miles.

Although the area of independent closure was tested unsuccessfully by West Wrigley G-70 it should be noted that the longitudinal fault on the west flank of the feature provides structure datum elevations considerably higher than those encountered in the area of independent closure immediately to the east. The maximum structure datum elevation on the fault closure indicated on the map is around -400 ft. A datum elevation of this magnitude would provide an area of possible fault closure of around 600 or 700 feet over a length of 7 miles and a maximum width of roughly 1-1/4 miles.

Minimum structure datum elevations were encountered in the southwestern permit area where the Nahanni Formation lies at a depth of 5,500 feet or more below sea level on the axis of a north-northwesterly plunging syncline. Structural relief on the west flank of the anticline is around 5,000 feet in the permit area. Dips on the west flank reach a maximum of 12° and those on the east flank are considerably less, usually around 2° to 3°.

A northerly plunging anticlinal nose is mapped in the southern part of Permit 4950. The axis appears to terminate 2 miles north of the permit boundary forming an en echelon relationship to the southern end of West Wrigley anticline which lies 3-1/2 miles to the northeast. Minor folds may be present between the 2 axes.

CONCLUSIONS

The West Wrigley anticline exhibits an overall structural closure of at least 1,000 feet.

Although the main area of closure was unsuccessfully tested by Shell West Wrigley G-70, considerably higher structural elevations are encountered 1 mile west of the main axis where a longitudinal fault, trending north-northwesterly, is upthrown on the west side, provides a sizeable area of possible fault closure.

Respectfully submitted,

V. ZAY SMITH ASSOCIATES LTD.

George M. Collins, P. Geol.

William Brown, Senior Geologist

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