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FINAL

GEOLOGICAL REPORT

on

THE HEADWATERS OF VERMILLION, PROHIBITION AND NOTA CREEKS

N.W.T. (Canada)

IMPERIAL OIL LTD., CANOL PROJECT.

Assignment No. 27.

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Party Chief.
Assistant.

Date submitted: February 14, 1944.

Read and accepted by:

Herb. Thirkle

Date: Feb. 19 1944.

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Prohibition and Nota Creeks.

FINAL GEOLOGICAL REPORT

ON

"THE HEADWATERS OF THE NORMAN
PROBATION AND VERNON RIVERS"

N.W.T. (Canada)

A B S T R A C T

The area covered in this report flanks the Discovery Range twenty miles southeast of Norman Wells. Only a part of the Fort Creek shale formation, the Beavertail-Ramparts limestones and shales, and the Bear Rock brecciated dolomitic limestones were mapped in the field. Source, reservoir, and cap rock underlie that part of the area south of Discovery Range, but no structures warranting further investigation were found. The area is interesting structurally, for in it the Discovery Range makes an abrupt, almost right angle turn. Structures related to this change in trend probably occur in the area immediately to the south, but are not known because of lack of exposures. No further work is recommended in the area unless warranted by the test well located on the Vermillion Gorge Anticline.

Chapter I.

INTRODUCTION

The report area lies north of the Mackenzie River, twenty miles southeast of Norman Wells. It is roughly triangular in shape, the base of the triangle lies north of Vermillion Ridge, and the north and east sides lie along the flanks of the Discovery Range which makes a sharp swing in trend forming the apex of the triangle.

On June 20th, 1943, Party "G", consisting of D. C. Wetterberg and the writer made a reconnaissance flight over the area, and were landed on the Mackenzie River near the mouth of Vermillion Creek. From here the camp and equipment were packed along the road to the well location on Vermillion Gorge Anticline, where a base camp was established. The work was completed July 2nd, and the party returned to Norman Wells July 3rd, by canoe. The outcrops were located by the use of aerial photographs, and were plotted on a base map, scale one inch equals one mile.

T. A. Link (2) (5) mapped Vermillion Creek from its mouth to about one mile beyond the Vermillion Gorge Anticline in 1920, and ascended Prohibition Creek as far as the first exposure of Beavertail limestone. In November 1942 S. H. Houston (1) restudied these creeks. The area assigned to the writer commences where these previous surveys left off, and continues down in the section into the Bear Rock formation. It was not possible to cover the area in detail in the time available as continued packing retarded travel and work.

The writer is indebted to Mr. Wetterberg for his assistance and co-operation under the toilsome working conditions. Much benefit has been obtained by discussions with geologists who worked adjoining areas, especially C. R. Stelck (4). Fossil identifications were made by Stelck

assisted by K. F. Huff.

Accessibility - A winter road connects the Vermillion Gorge well location with the Mackenzie River and with the winter road from Norman Wells to Waterways, Alberta.

A preliminary report on Assignment No. 27, (Report No. 15), was submitted in July 1943. The original notes made on this assignment were lost in the accident on the Redstone River. For this reason the report will not be as complete as it might otherwise have been. The fossil collection was fortunately examined prior to the loss of the notes. According to Stelck (personal communication) a normal suite of specimens, correlatable with collections from the same formations in adjoining areas, is present.

TOPOGRAPHY

Discovery Range is the dominant topographic feature of the area. This is a mountainous range, composed mainly of Devonian and Silurian limestones and dolomites. It was formed by a major uplift affecting the greater part of the Mackenzie River Valley. The range trends southwesterly along the northern portion of the area, then it makes an abrupt swing to the south forming the east boundary of the area. In the western part of the report area, this range has a relief of approximately 1200 feet. The relief however, decreases progressing southwestwardly, and is only 500 to 600 feet where cut by Vermillion Creek.

Vermillion Ridge is a topographic feature of much smaller magnitude bordering most of the southern boundary of the area. It is in direct alignment with the Discovery Range west of the report area. Between this ridge and the Discovery Range is a wedge-shaped relatively flat, basin area. This basin has its greatest width where crossed by Vermillion Creek, coincident with the change in trend of the Discovery Range.

Glacial action has modified the topography of both the basin area and the Discovery Range, by scouring parallel to the major structural trends. Glacial morainic ridges and eskers have been deposited in the wedge-shaped basin area, and in the deeper glacial scours in the Discovery Range, particularly where underlain by the Ramparts shaley member.

STRATIGRAPHY

General

The stratigraphy was studied from the lower portion of the Fort Creek shales, through the Beavertail-Ramparts limestones and shale, down into the Bear Rock dolomitic limestone. These rocks are Devonian in age, except possibly the Bear Rock formation which may be Silurian. The top of the Franklin Mountain Formation (Silurian) was examined at only one locality.

Silurian

Franklin Mountain Formation. - This formation underlies the Bear Rock formation unconformably. Only one exposure of this formation was studied in the area (Plate 2). It is known from observations in the field and from aerial photographs to comprise the higher portions of the Discovery Range. The formation consists of finely crystalline, dense, light greenish-grey, well-bedded limestone. The formation lacks porosity, and has no apparent value as far as oil possibilities are concerned.

Devonian or Silurian

Bear Rock Formation - This formation underlies the Beavertail-Ramparts conformably. It consists of brown brecciated dolomitic limestone that weathers light tan to buff into characteristic "hoodoos" and rugged topography. The formation lacks noticeable bedding except near the top and bottom of the section, elsewhere the bedding has been distorted or destroyed by the brecciation. The Bear Rock formation usually exhibits more or less porosity, and commonly contains bitumen in the pores.

Middle Devonian

Beavertail-Ramparts Formation - The Beavertail-Ramparts beds overlie the

Bear Rock formation conformably, and are conformably overlain by the Fort Creek shales. Two lithological divisions are recognizable: a lower, bedded shale and limestone member, the Ramparts shaly member; overlain by massive Beavertail-Ramparts limestones.

Ramparts Shaly Member: - This section is poorly exposed as it is generally expressed as a topographic low. An exception to this occurs on the west branch of Prohibition Creek, where approximately 230 feet of dark, bedded limestones, shaly limestone, and thin shale beds are exposed. Fossil reefs composed predominantly of corals are common in this section.

The basal Actinoptera zone, the Schuchertella zone, and the Gyreceras zone, are all present. The suites of these zones were examined by Stelck, and they check with those established by him at Schooner and Oil Creeks, and at Bear Rock (4).

Beavertail Ramparts Limestone Member - These limestones form the front slopes of the Discovery Range, and are usually scarp-forming above the underlying Ramparts shale member. The limestones are dark grey to brownish, massive to rubbly, and the lower beds are gradational into the shale member. The top of the section usually emits a fetid or bituminous odor when freshly broken, and some bitumen was observed in local porosity in this zone.

The Cystiphyllum zone with associated fauna is present in the section. Where the center branch of Nota Creek emerges from the mountains, the upper part of the Beavertail appears to be more fossiliferous than elsewhere. This may be due to the fact that glacial action in this gap has grooved and polished the Beavertail section, causing the fossils to show up better. Stelck (4) however, indicates that the Beavertail fauna are more abundant in the Bear Rock area (just south of Nota

Creek) than elsewhere in the Discovery Range. Syringeops and associated fauna from the Beavertail at Nots Creek checks closely with the collection from this formation at Bear Rock.

Fort Creek Formation - The Fort Creek formation lies conformable upon the Beavertail-Ramparts. The section exposed in the area examined consists of dark grey to black, partly bituminous shale. At the forks of Prohibition Creek these shales have been burnt a brick red color. Sandy and limey beds appear near the base of the formation. The Tentaculites zone and associated fauna occur in these lower beds as at Bear Rock and elsewhere throughout the Discovery Range.

STRUCTURE

The area lies on the south flank (dip slope) of the Discovery Range, a major anticlinal uplift which forms the northwest boundary of the Long Reach - Carcajou Synclinorium. This range trends South 60 to 70 degrees East from Morrow Creek to Vermillion Creek where it swings abruptly southward, finally terminating at Bear Rock on the Mackenzie River.

Minor folds occur on the flank of this major uplift, and it is these which are of prime importance as potential oil reservoirs. The Vermillion Gorge Anticline south of the area studied is such a structure (1) (2) (3).

The trend of the Discovery Range in the report area is shown by the formation trends in Plate 2. Plate 3 is a fence diagram illustrating the areal structure in three dimensions. The base of the diagram is a plan projection of the surface distribution of the formations drawn to scale. On this plan a number of vertical sections or "fences" have been constructed, on an exaggerated scale. The plate includes the Vermillion Gorge Anticline, covering a somewhat greater area than was studied in the field.

The formations comprising the Discovery Range, along Prohibition Creek and its tributaries, strike approximately south 60 degrees east, and dip 10 to 20 degrees south. At the east end of the Beavertail-Ramparts limestone scarp in this part of the area (Plate 2), the strata and entire Discovery Range swing to the east, the beds become less steep, and the Range becomes lower. Where Vermillion Creek cuts through the Beavertail-Ramparts limestone, a zone of local folding gives a variety of dip and strike readings. The topography here is subdued coincident with the low

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dipping beds and the formations are exposed over a wider area than ordinarily. The characteristic of the central Discovery Range is as follows: the eastward trend of the Discovery Range continues to the Discovery east of the creek, and so southward projection of the range on the west side of the creek, this sharp swing, with a dip of about 10 degrees, maintains a south 10 degrees east trend with dips on the west, and about the remainder of the area. The other formations behave similarly.

The eastward and finally southward swing of the Discovery Range has developed a shallow syncline in the intervening wedge-shaped area (Section D-D', Plate 3), and has also produced a monoclinal flexure normal to the axis of the syncline.

No structures warranting further consideration at the present time, were found in the area. A small reverse of dip was observed on Vermillion Creek about one and a half miles above the Vermillion Gorge Anticline (Plate 2). It appears to trend parallel to the latter structure, but insufficient evidence is at hand to delineate its extent.

In all probability structures exist in the wedge-shaped area between the change in trend of the Discovery Range, but were not observed due to lack of exposures.

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Chapter V.

O I L P O S S I B I L I T I E S

No oil or gas seepages were observed in the area. The Fort Creek shales are partly bituminous and are a possible source rock for oil. The reservoir rock, Reef limestone, of the Norman Wells oil field is apparently not present in the area. Possible reservoir rocks are the Beavertail-Ramparts limestones, and the Bear Rock brecciated dolomitic limestone, both of which show some porosity and bitumen at their exposures.

That part of the area within the Discovery Range has the possible reservoir rocks exposed and eroded off, and unless tests of the pre-Silurian rocks are contemplated, may be disregarded as far as oil prospects are concerned. In the wedge area flanking the Range, the reservoir rocks are buried beneath an imperious covering of Fort Creek shales and any structures involving the formations at depth may be considered as potential oil traps.

The possibilities of the area can be judged better when the well on the Vermillion Gorge Anticline, south of the area, is completed.

Chapter VI.

C O N C L U S I O N S A N D R E C O M M E N D A T I O N S

Source rocks, reservoir rocks, and cap rocks occur in the area adjacent to the Discovery Range. Structures related to the development of this range probably exist in the "wedge" area below the swing of that range, but due to lack of exposures over much of this area the present structural picture is not complete. One small reversal in dip was found just north of the Vermillion Gorge Anticline but it warrants no further consideration at present.

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No further work in the area is recommended unless warranted
by the test on the Vermillion Gorge Anticline to the south.

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1. Houston, S. H. "Vermillion Gorge Anticline", Imperial Oil Limited, Canol Project, November 1942.
2. Link, T. A. "Fort Norman Area" N.W. To. Imperial Oil Limited, 1920.
3. Link, T. A. "Geological Report on the Fort Norman Area", Imperial Oil Limited, 1921.
4. Stelck, C.R. "The Bear Rock - Bluefish Creek Area" N. W. To. Canada. Imperial Oil Limited, Canol Project, Final Report, January 1944.

* * * * *

APPENDIX

January 4, 1944.

MEMORANDUM:

TO: Dr. T. A. Link.

RE: Fossil Identification

Attached is a tentative identification of fossils
collected by Mr. W. P. Hancock on Assignment No. 27 -
Headwaters Vermillion, Prohibition & Nota Creeks.

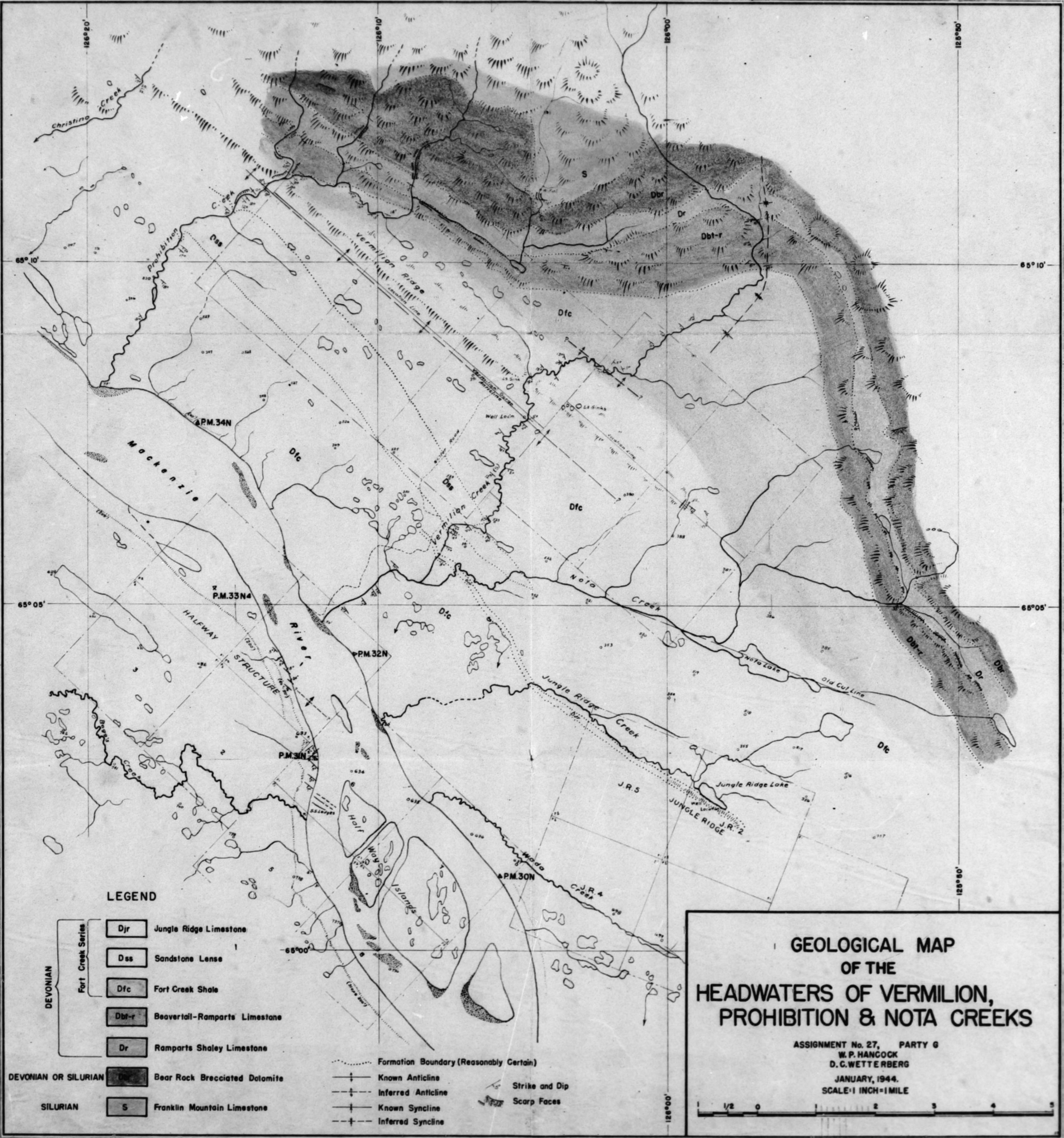
C. R. Stelck

KM/cm

FOSSIL IDENTIFICATION -- HEADWATERS VERMILLION,
PROHIBITION & NOTA CREEKS -- W. P. Hancock

<u>Suite No.</u>	<u>Location</u>	<u>Fossil</u>	<u>Accession No.</u>	<u>Age</u>
-----	Headwaters Vermillion and Nota Creeks	Prismatophyllum	42939	Ramparts.
"	"	Cyathophyllum	42940	"
"	"	Euomphalus	42941	"
"	"	Palaeocyclas	42942	"
-----	Headwaters Vermillion and Nota Creeks	Syringopora	42943	Beavertail
-----	Headwaters Vermillion and Nota Creeks	Paracyclas	42944	M. Devonian
-----	Headwaters Vermillion and Nota Creeks	Schuchertella	42945	Ramparts
-----	Headwaters Vermillion and Nota Creeks	Cladopora	42946	Ramparts - Beavertail
"	"	Helicophyllum	42947	"
"	"	Trilobite	42948	"
"	"	Atrypa	42949	"
"	"	Martinia	42950	"

* Suites badly mixed and impossible to sort out according to specific suites
and locations.



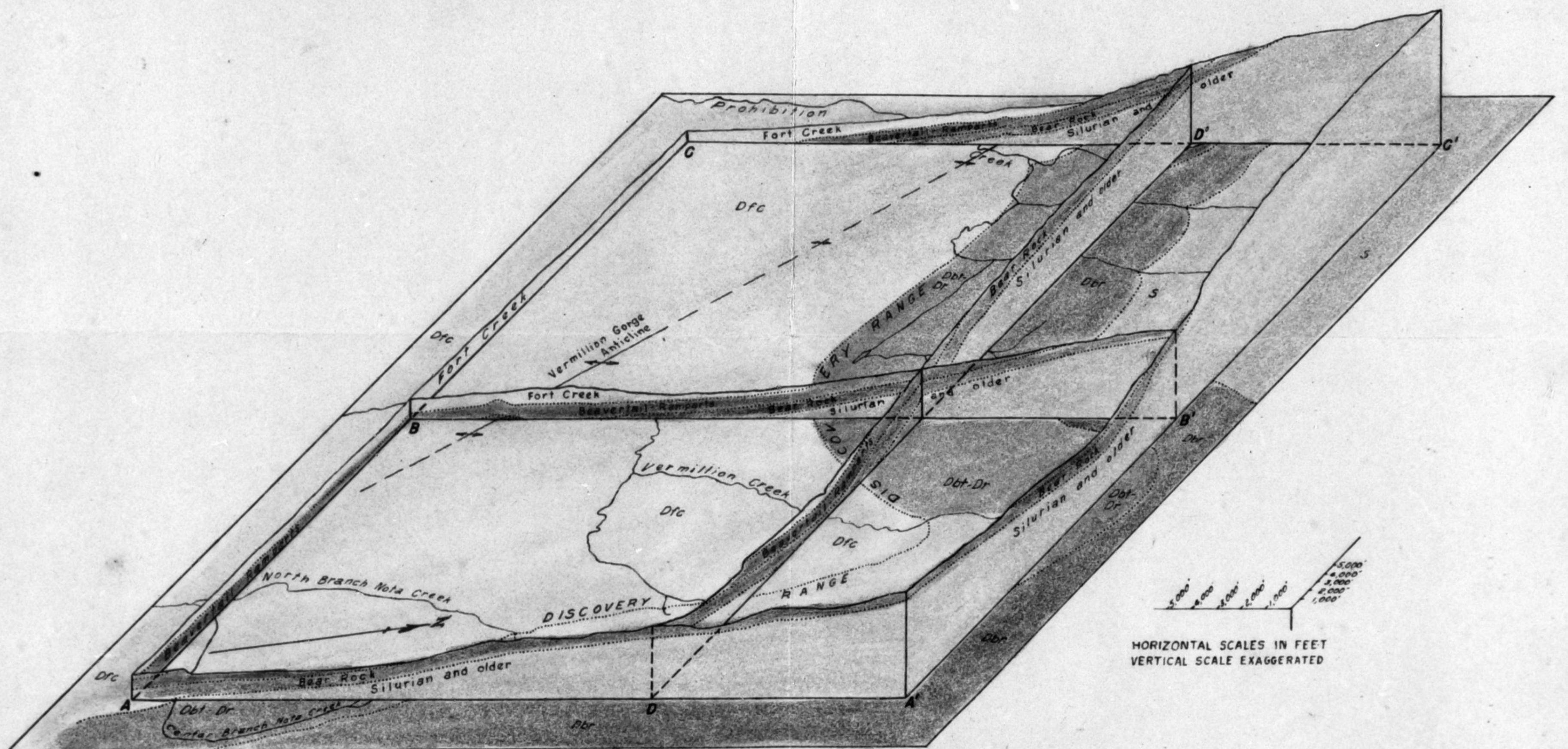
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PLATE 3

FENCE DIAGRAM SHOWING AREAL STRUCTURE
HEADWATERS VERMILLION, PROHIBITION & NOTA CREEKS

W. P. HANCOCK

ASSIGNMENT NO.27, JANUARY, 1944



HORIZONTAL SCALES IN FEET
VERTICAL SCALE EXAGGERATED

F-2.260