EVALUATION

FROM GEOPHYSICAL DATA

OF THE

LIARD RIVER AREA

OF

NORTHWEST TERRITORIES, CANADA

FOR

WESTERN DECALTA PETROLEUM LTD.

BY

A. E. PALLISTER CONSULTANTS LTD.

Calgary, Alberta, Canada

November, 1963

PROJECT NO. 461

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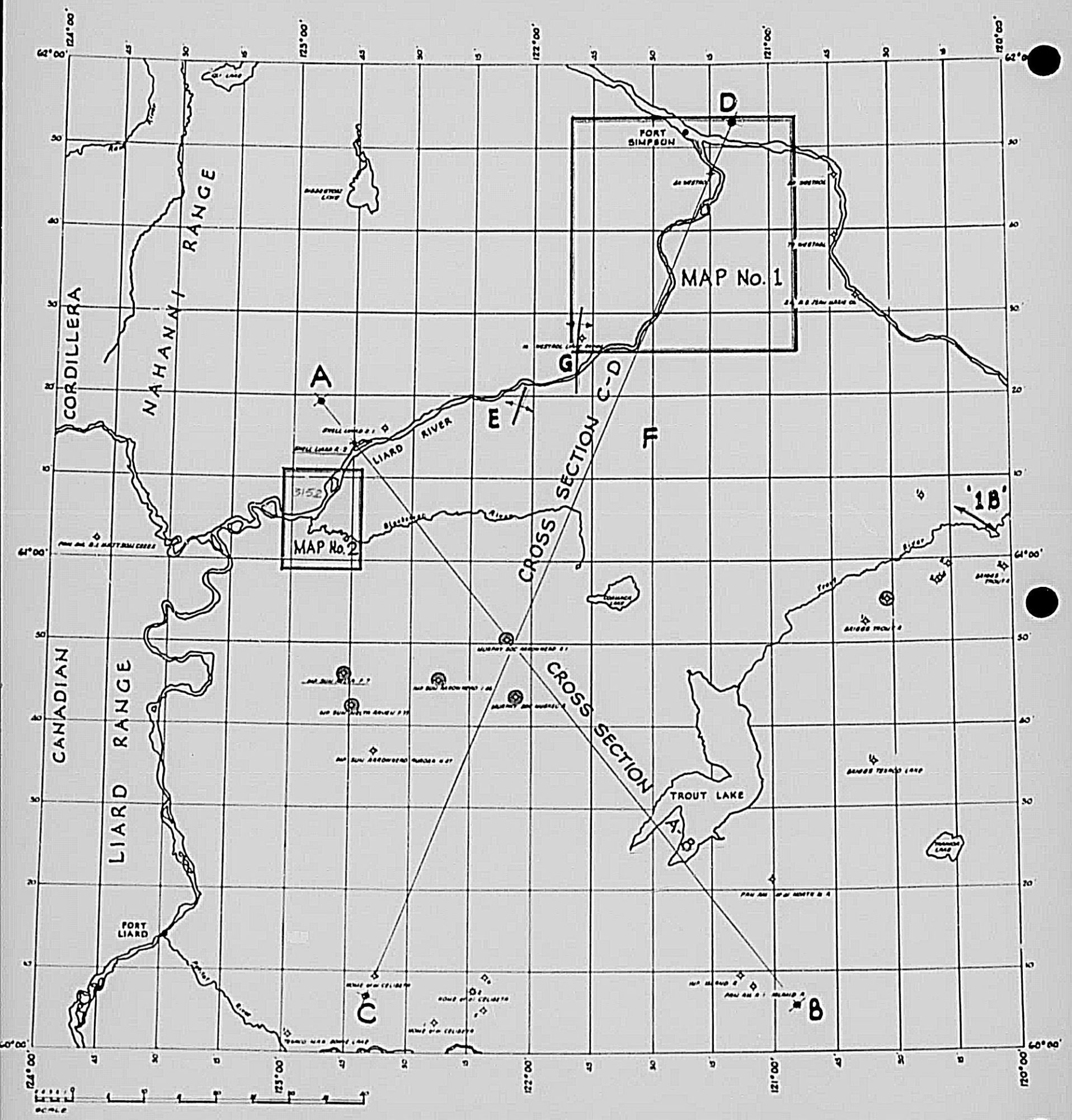

INDEX MAP OF LIARD RIVER REGION

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SONIC LOG WITH VELOCITY ANALYSIS
PERMIT No. 3152

SPARKER SURVEY

PART I

EVALUATION

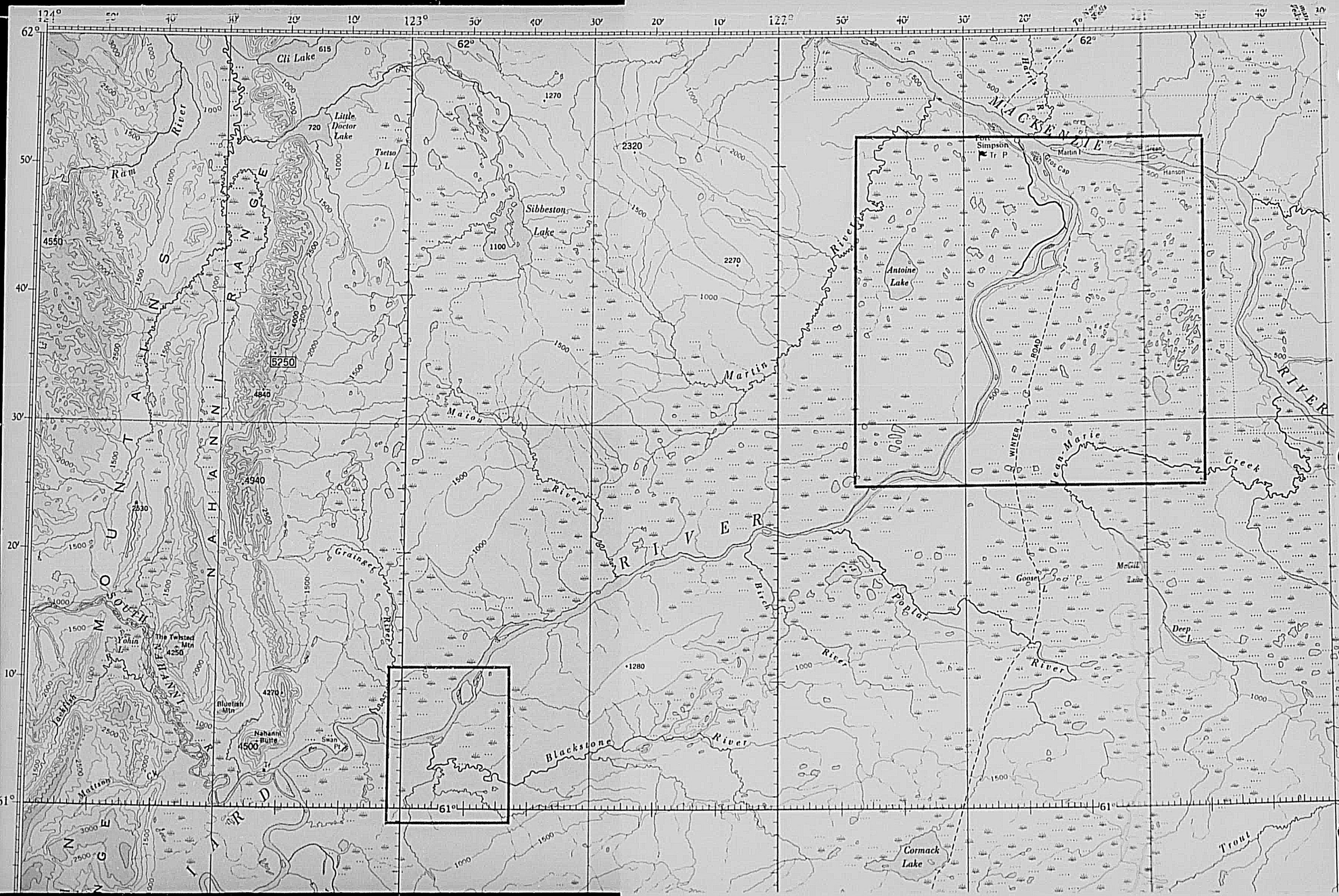
ABSTRACT

The Liard River prospect is located in the Canadian Northwest Territories, some 70 miles north of the British Columbia boundary. The area is of interest, since considerable structure is known to be present, and porosity and facies changes take place laterally within the Devonian carbonates. To date, little oil or gas has been encountered in these environs; however, well control is extremely sparse.

In order to evaluate a petroleum and natural gas permit, several types of geophysical data, which included continuous marine-borne sparker, correlation water-located seismic, and geophysical acoustical logs were analysed. These data were sufficient to locate major structural anomalies, by extrapolating Slave Point geologic contours into areas without well control.

From the sparker data, three anticlinal axes were shown near the mouth of the Liard River, while one major anticlinal axes was indicated within Permit No. 3152 from the seismic data. The control was not sufficient to postulate structural closure in these anomalous areas. The Regional Velocity Analysis indicated the lateral behavior of velocity/rock-units, from velocity, thickness and transit-time standpoints. The acoustical logs also served to indicate the location of numerous formational sub-crops.

The combination of results derived from these three sources provided maps which can guide future geophysical exploration.


124°
123°
122°
62°
61°
50'
40'
30'
20'
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Cli Lake
615
Little Doctor Lake
720
Tsetso L
Ram River
MOUNTAINS
RANGE
1270
2320
Sibbeston Lake
1100
2270
Martin River
Antoine Lake
Fort Simpson
Tr P
Martin I
Gros Cap
Hanson I
MACKENZIE
RIVER
ROAD
WINTER
Jean-Marie Creek
4550
5250
4840
4940
2530
Gratner River
Yohin L
The Twisted Mtn
4250
Jackfish
Bluefish Mtn
4270
Nahanni Butte
1500
Swan Pt
Mattson Ck
Blackstone River
1280
Birch River
Poplar River
Goose L
McGill Lake
Deep L
Cormack Lake
Trout

EXPLORATION PROGRAM

The prospect is located near the junction of the Liard and South Nahanni Rivers, some 70 miles up-stream from Fort Simpson, which is located at the junction of the Liard and Mackenzie Rivers. The permit is 300 miles south-southeast of Norman Wells, where oil production is being obtained from the limestone member of the Ramparts Formation (Kee Scarp Limestone) of the Upper Devonian.

The major potential reservoir for oil and gas production in this area is in the Middle Devonian-Slave Point Formation, where porosity can be present, sometimes from a reef facies. The area is the scene of structural folding, as illustrated by Shell-Liard River No. 2, 6 miles north of the permit. The structural attitude of the reservoir beds can be measured from seismograph and sparker data. As a means of providing reconnaissance structural control, seismic shotpoints were recorded in water bodies within Permit No. 3152, and sparker control was obtained in the navigable part of the Liard River, up to the Liard Rapids. These methods were used, since they provide a reduced cost reconnaissance-type control, utilizing water bodies, eliminating the need for a fully-equipped seismic crew.

CONCLUSIONS

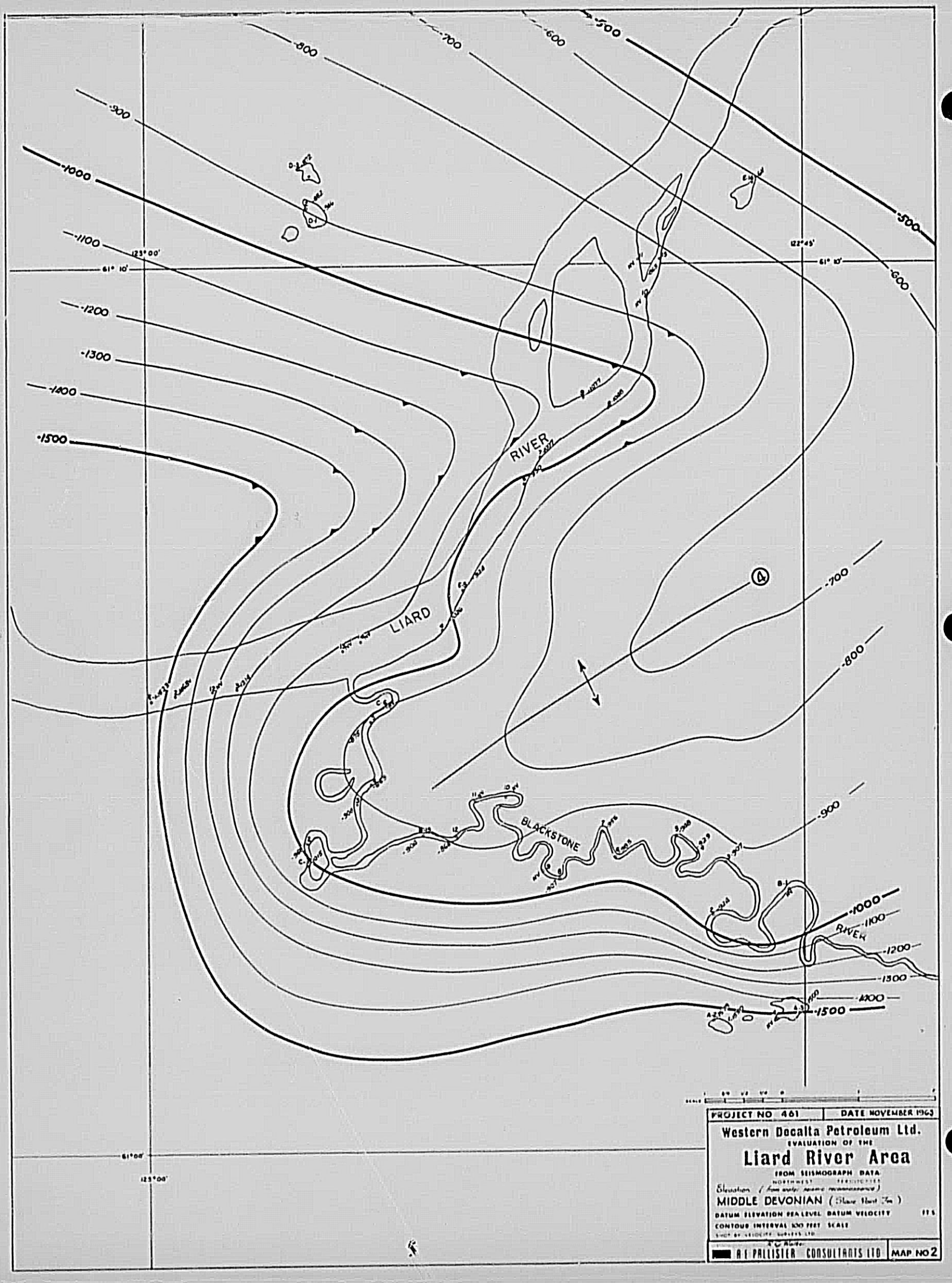
Four features of interest were mapped from the geophysical data. The first three, in the lower Liard River, are indicated to be anticlinal trends associated with the Simpson Arch to their northwest. The structural reversal flanking these trends is quite minor, with Feature Two showing the maximum reversal of some 80 feet - on the line of control.

Within the permit, Feature Four is indicated as a southwest-plunging anticlinal trend which may possess closure to the northeast. Additional control would be necessary to confirm this postulation. This anticline shows some 700 feet of relief on its flanks, and can be contoured as a southwestern extension of the anomaly encountered at Shell-Liard River No. 2, with the Slave Point indicated to be some 1,000 feet lower within the permit area than at the Shell test. Although this interpretation is subject to contour options, the most structurally interesting area is Feature Four.

The results of this evaluation should be used in eventual geophysical surveys, in the confirmation of these anomalies, and in the exploration for areas where closure is present.

Acoustical logs in nearby wells were studied from a geophysical viewpoint, in order to show regional velocity conditions in direct evaluation of the permit area, and in the determination of future geophysical methods compatible with all known geological and geophysical parameters.

An emphasis was placed on the mapping and assessment of the Slave Point, the prime objective. In the areas of geophysical control, very little sediments are preserved above the Slave Point.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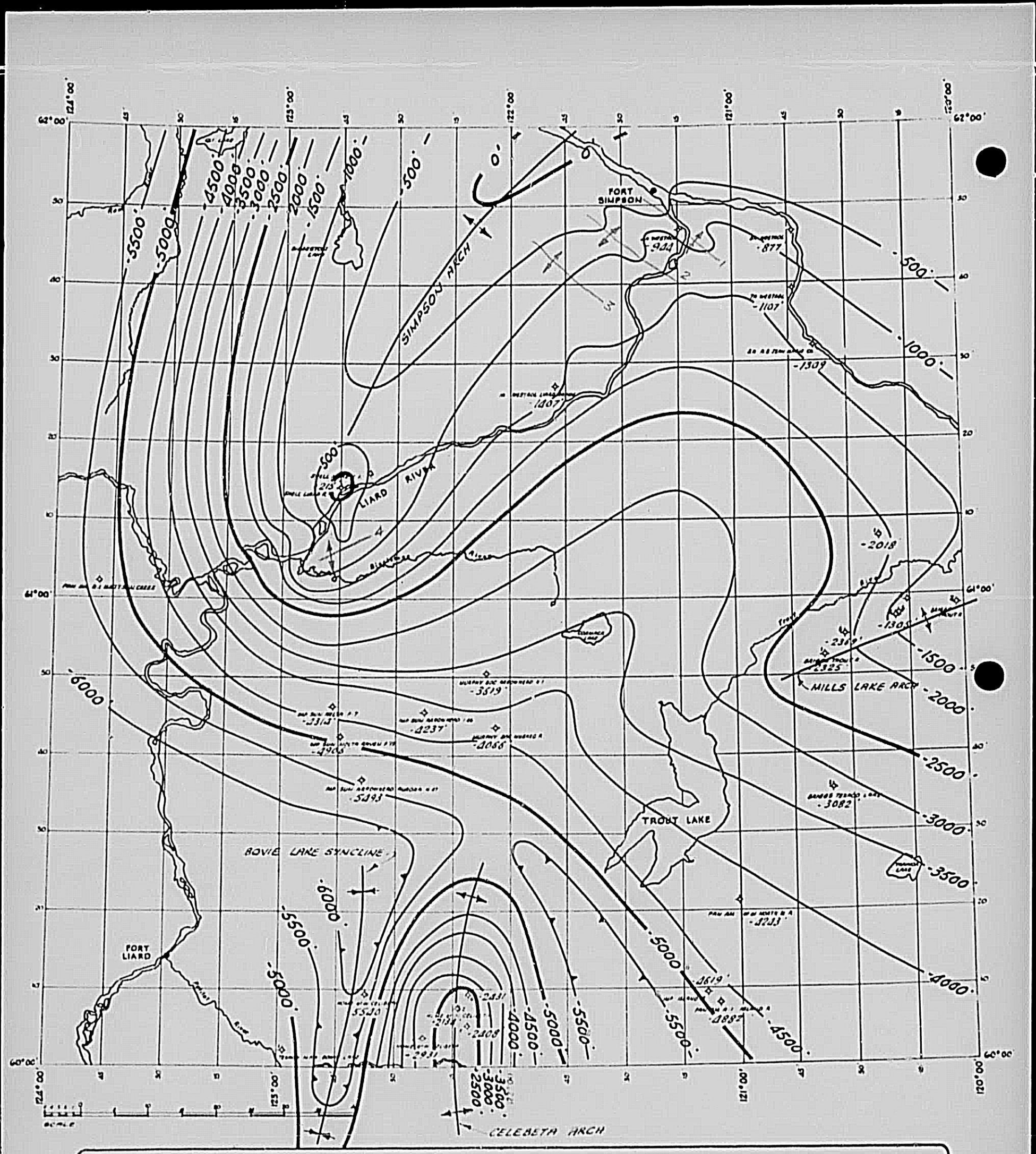
-1100
-1200
-1300
-1400
-1500
123° 00'
61° 10'
122° 45'
61° 15'
RIVER
LIARD
BLACKSTONE
RIVER
61°00'
125°00'
PROJECT NO 461
DATE NOVEMBER 1963
Western Decalta Petroleum Ltd.
EVALUATION OF THE
Liard River Area
FROM SEISMOGRAPH DATA
NORTHWEST TERRITORIES
Elevation
MIDDLE DEVONIAN
DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S
CONTOUR INTERVAL 100 FEET SCALE
SHOT BY VELOCITY SURVEYS LTD.
A.J. McPHAR GEOMETRICS LTD.
A.J. PRELISTER CONSULTANTS LTD
MAP NO 2

Detracting from the interpretation are:

(a) Limited reliability of conclusions from weak geophysical information, which cannot be expected to be as definitive as conventional (and more costly) seismic reflection shooting techniques.

(b) The position of the control leaves the seismologist with many options of contouring.

The conclusions derived from this reconnaissance analysis are restricted to a structural evaluation, and are subject to confirmation. Geologic considerations of facies characteristics and changes will be equally important in acreage assessment.



SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm)

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contour interval 500 feet MAP NO. 3A

RECOMMENDATIONS

The location of the anomalous areas, as indicated by this analysis, can be used in the guidance of land acquisition, and in the eventual positioning of other geophysical surveys, which should precede stratigraphic testing.

The information available to date is not sufficient to recommend a test location; however, this evaluation has resulted in providing a good basis from which to conduct future exploration.

Particular attention is drawn to the structural anomaly, Feature Four, located within Permit No. 3152.

Respectfully submitted,

A. E. Pallister, P. Geoph.
Principal Geophysicist.

INDEX MAP OF LIARD RIVER REGION

A·E·PALLISTER CONSULTANTS LTD.

SONIC LOG WITH VELOCITY ANALYSIS
PERMIT NO. 3152

SPARKER SURVEY

PART II

TECHNICAL DISCUSSION

GEOLOGIC CONTROL

The Liard River Area is located in the southwestern interior plains of the Northwest Territories, on the south side of the Liard River, about 70 miles southwest of Fort Simpson. The project lies on the east edge of the Canadian Cordillera at the south end of the Nahanni Range, and directly east of the Liard Range.

Five structural trends are superimposed on the Western Canada Sedimentary Basin within the regional map area:

1. Simpson Arch - The Simpson Arch enters the map area from the north and trends south-southwest.

2. Celibeta Arch - The Celibeta Arch enters from the south, east of the Home-et al-Celibeta No. 1 well, and trends north.

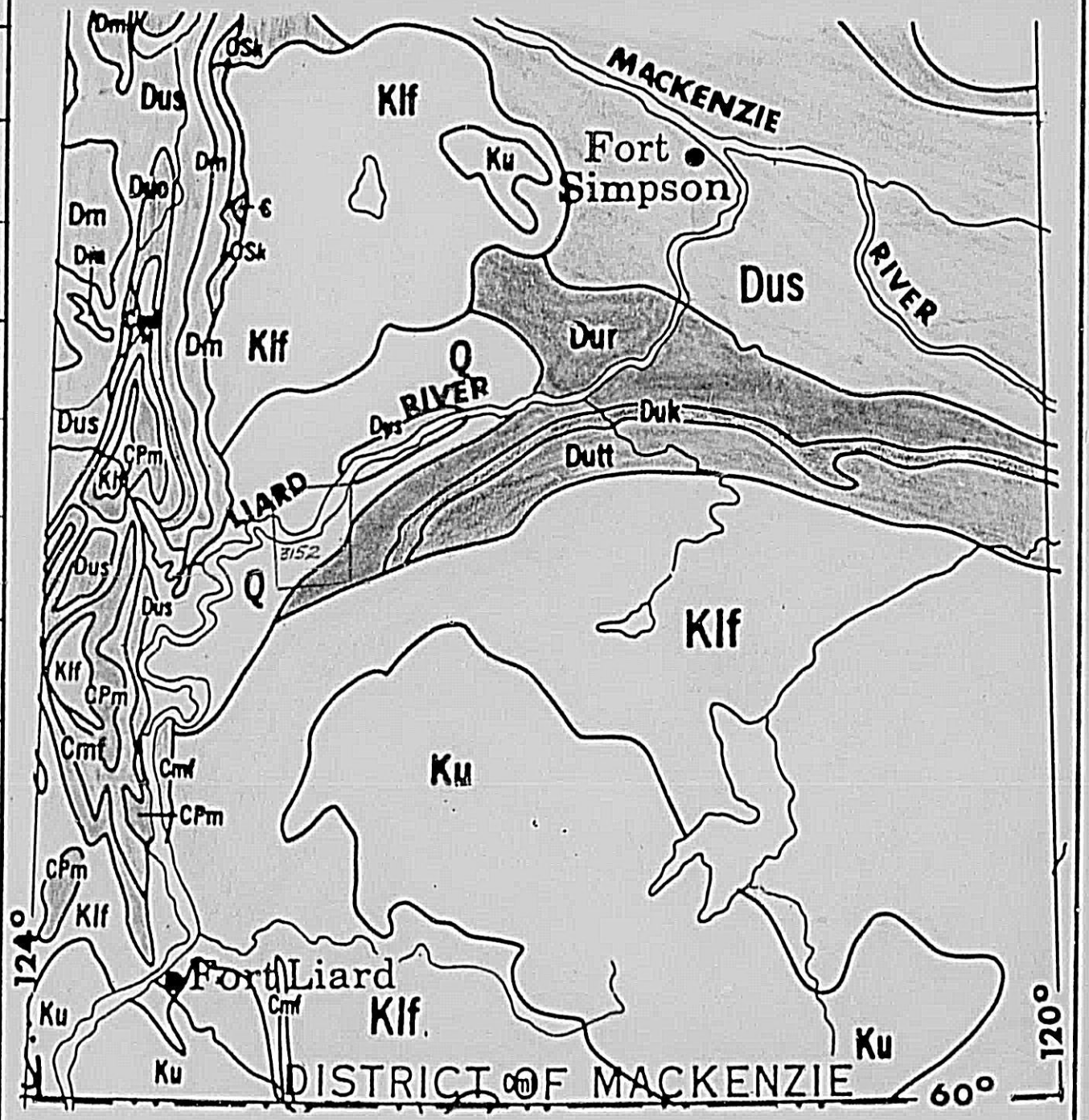
3. Bovie Lake Syncline - The Bovie Lake Syncline enters the map area from the south, west of Home-et al-Celibeta No. 7 well, and trends north.

4. Mills Lake Arch - Trends southwest, north of Briggs Tetcho Lake well.

5. Rocky Mountain Cordillera - The first thrust fault is present 15 miles west of the permit area. There are no indications of foothills in the zone east of the Rockies, such as those that exist further south.

From the accompanying Geologic Map, it can be seen that the outcrops, 45 miles along the Liard River from the Mackenzie River, are composed of Upper Devonian shales and limestones. Quaternary and Recent deposits are present along the rest of the Liard River, within the map area.

ERA	PERIOD	LEGEND OF GEOLOGY FOR LIARD RIVER REGION	
CENOZOIC	QUATERNARY AND RECENT	Q	SURFICIAL DEPOSITS
MESOZOIC	UPPER CRETACEOUS	Ku	FORT NELSON, KOTANEELEE, ETC.
		Klf	FORT ST. JOHN GROUP
PALEOZOIC	MISSISSIPPIAN	CPm	MATTSON, FANTASQUE
		Cmf	FLETT, CLAUSEN, YOHIN
		DC	SHALE, SLATE, SILTSTONE (Devonian & Mississippian)
	UPPER DEVONIAN	Dur	REDKNIFE
		Duo	OKSE BAY
		Dutt	TROUT RIVER, TETCHO
		Duk	KAKISA
		Dus	FORT SIMPSON (may include Middle Dev. Sh.)
	MIDDLE DEVONIAN	Dm	NAHANNI, BEAR ROCK, HUME
	ORDOVICIAN & SILURIAN	OSk	MOUNT KINDLE, FRANKLIN MOUNTAIN
	CAMBRIAN	€	SANDSTONE, SHALE



GEOLOGIC MAP OF THE LIARD RIVER REGION

taken from Geological Survey of Map No 30 - 1963

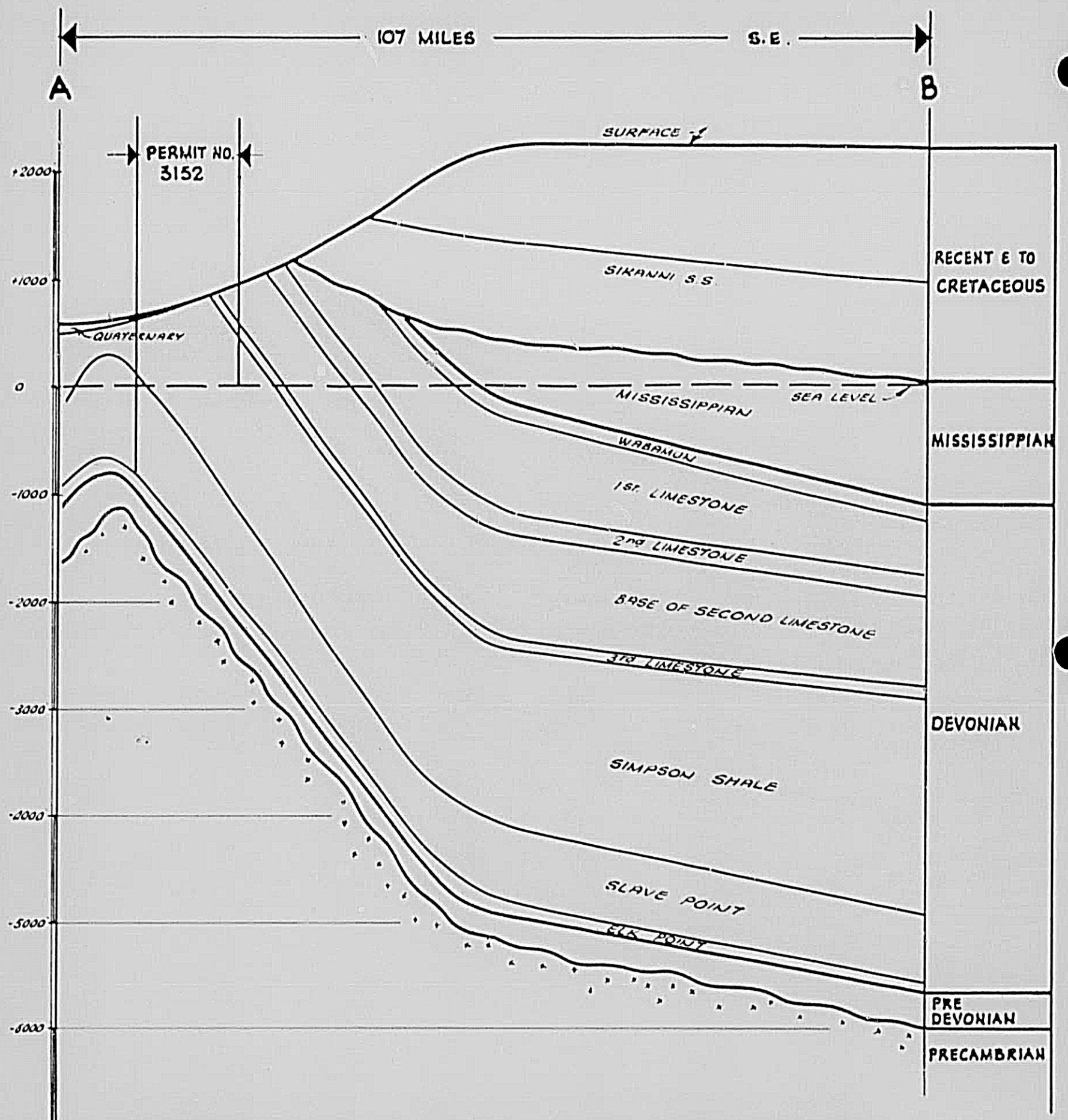
Seven wells have been drilled near Fort Simpson and along the Liard River; six other wells are located between Trout Lake and Liard River. All of these wells were dry and abandoned except for the Imperial-Sun-Netla No. F-7, which is a shut-in Slave Point gas well.

South of 61° north latitude, and west of 123° west longitude, the Slave Point Formation dips southwest at approximately 140 feet per mile. East of 122° west longitude, and north of 61° north latitude, the Slave Point horizon dips 30 feet per mile to the southwest, between 60° 00' and 60° 30' north latitude, and east of 123° west longitude, the Slave Point Formation dips north at 120 feet per mile. The Mesozoic erosional surface and formations above it have little dip.

GEOLOGIC SYSTEM	THICKNESS (Ft)
Recent and to Cretaceous	0 - 1700
Mississippian - erosional	0 - 2600
Devonian	1200 - 4700
Pre-Devonian	0 - 500 (estimate)
TOTAL	1200 - 9500

Average geologic column in the Liard River Area.

Devonian rocks outcrop on the north edge of the basin, which is developed in the Trout Lake region. Along the Liard River, the Simpson Shale is outcropping; thus, between the basin and the Liard River, approximately 8,000 feet of the above total section disappears.



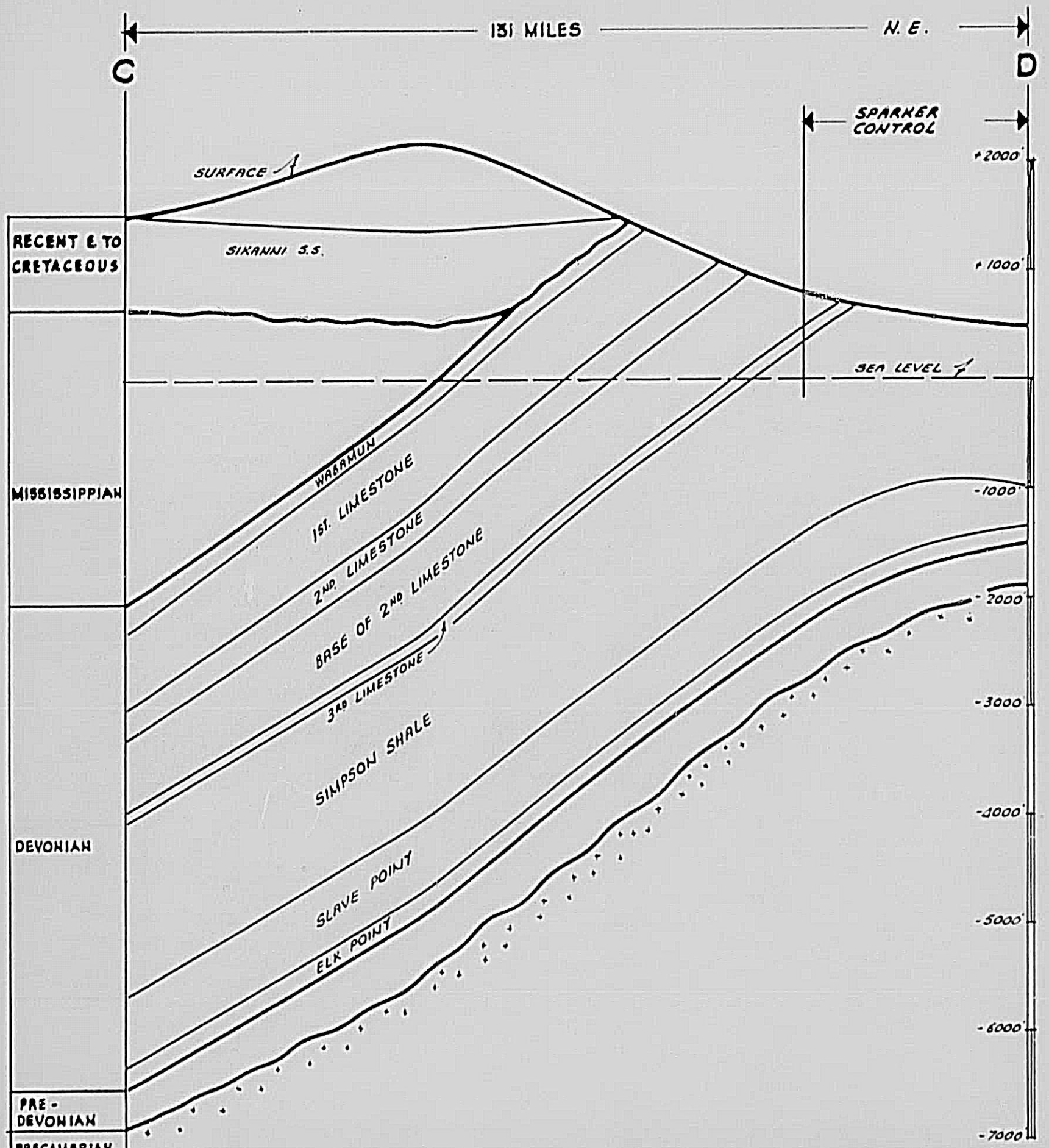
GENERALIZED N.W. - S.E. GEOLOGIC CROSS SECTION THROUGH THE LIARD RIVER AREA

Geologic reports available at the Department of Northern Affairs point out some interesting surface anomalies in the region. A report written, in 1952, by L. J. Martin for The British American Oil Company Limited, discusses the existence of domal structures along the Trout River. A location approximately 61° north latitude and 120° west longitude, Feature "IB" (see Index Map), appears as a domal structure three-quarters of a mile long with 3° dip up-stream, and 2° down-stream, possibly draping over a reef body in the Hay River Limestone (Base of Second Limestone?).

A report, by G. Dann, 1952, mentions the existence of small, sharp folds along the Matou River. Other features in the Hay River Formation, possibly associated with reef drape, also were described along Birch River (Feature E) and Poplar River (Feature F.)

A letter by C. Warren Hunt, November 2, 1953, contained in the Westerol 1A File (Department of Northern Affairs) outlined some of the preliminary thought that went into the drilling of the Westerol wells.

> "The Westerol 3A well found the thin sedimentary cover above the basement rocks that had been hoped for, Precambrian being encountered slightly above total depth of 2,422 feet. Unfortunately, the Devonian reef, which had been sought, was not developed and, while the well found small oil showings in the Middle Devonian, no substantial porosity was found.....
>
> "Three further wells were drilled during the summer, the Westerol 7A, Westerol 4A and B.A.-Hudson Bay-Trail Creek No. 1. These wells succeeded in establishing very definitely an east-west strike, and a south dip of some 35 feet per mile. Secondly, a showing of oil and some porosity was encountered in the Westerol 7A well in the Middle Devonian.....



GENERALIZED N.E.-S.W. GEOLOGIC CROSS SECTION THROUGH THE LIARD RIVER AREA

"Westerol Liard Rapids 1A was drilled basically as a stratigraphic test..... The well was located on the best known structure in the area, an anticline outcropping on the banks of the (Liard) River above the main rapids. The anticline has a northward dip of about 20° and gave evidence of having about 200 - 300 feet of amplitude on the river section. No closure could be proved northward or southward in the direction of the axis....."

VELOCITY ANALYSIS

Velocity information for the area was obtained by the integration of the sonic logs from the following wells:

Murphy-B.O.C.-Muskeg River No. 1	-	60° 43' 38" N 122° 3' 45" W
Imperial-Sun-Arrowhead I - 46	-	60° 45' 30" N 122° 23' W
Imperial-Sun-Netla-Raven F-73	-	60° 42' 30" N 122° 44' W
Imperial-Sun-Netla F-7	-	60° 46' 30" N 122° 45' 50" W
Murphy-B.O.C.-Arrowhead River No. 1	-	60° 50' 22" N 122° 5' 50" W
Briggs-Trout River No. 5	-	60° 55' 03" N 120° 31' 34" W

A total of 35,850 were integrated from the above wells.

No velocity information was available in the area of seismic control. Mean interval velocities and isopachs were calculated from control, which is located south of the project area.

The next step, after calculating the velocities and isopachs, was to project the calculated velocities into the area of seismic control. This was done by studying the geology of the prospect area; for example, Simpson-Shale outcrops along the Liard River. Since the horizon of interest in this report is the Slave Point Formation,

IMP. SUN NELTA P-7

IMP. SUN NELTA RAVEN P-78

IMP. SUN ARROWHEAD I-45

MURPHY BOC. ARROWHEAD RIVER I

MURPHY BOC. MUSKEG R.

BRIGGS TROUT R. I.

1 2 3 4 5 6

MISSISSIPPIAN

WABAMUN

1ST. LIMESTONE

2ND LIMESTONE

BASE OF 2ND LIMESTONE

3RD LIMESTONE

SIMPSON

SLAVE POINT

KEG RIVER

2ND LIMESTONE

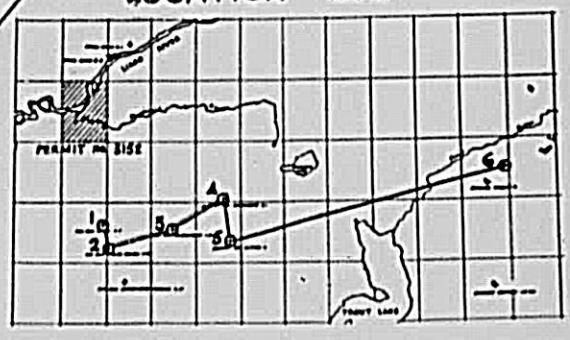
SEA LEVEL

BASE OF 2ND LIMESTONE

SIMPSON

SLAVE POINT

LOCATION MAP



SONIC LOG CROSS SECTION IN THE LIARD RIVER REGION

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the velocity down to it, along the Liard River, can be narrowed down to that of the Simpson Shale, plus the velocity of the low-velocity zone. In the case where the sparker seismic was used, this low-velocity layer would include the river, and the zone below the river. Since the depth of the water and the saturated zone is shallow, in comparison with the thickness of the Simpson Shale, the water and the saturated layer would not greatly alter the average velocity down to the Slave Point Formation.

VELOCITY/ROCK-UNIT	AVERAGE ISOPACH (Ft)	AVERAGE HALF-VELOCITY (Ft/0.001 sec)
K.B. - 1000 to Detrital Zone	706	4.5
Detrital Zone to Mississippian	61	4.1
Mississippian to Wabamun	323	4.6
Wabamun to First Limestone	193	5.2
First Limestone to Second Limestone	878	5.6
Second Limestone to Base of Second Limestone	348	7.5
Base of Second Limestone to Third Limestone	711	5.6
Third Limestone to Simpson Shale	137	8.7
Simpson Shale to Spence River	1672	5.7
Spence River to Slave Point	75	6.4
Slave Point to Keg River	765	9.6
Remainder of Section	Not Known	

Average isopachs and interval velocities in the Liard River Area.

In Permit No. 3152, the depth of the Slave Point Formation increases from about - 500 feet to - 1500 feet below sea level and, thus, a gradient velocity can be seen on the accompanying maps.

The changes in velocities are in a direct proportion to the depth of present day burial of the various formations. It can be seen on the generalized dip sections that the depth of burial increases rapidly southward from Permit No. 3152 and the Liard River.

The "Average velocity and average isopach" table was calculated from sonic logs, and should not be applied as such to any particular area without compensating for the depth of burial and lithologic changes. The variations in isopachs and velocities can be readily seen on the accompanying maps (Map Nos. 4A to 9C.)

If further seismic work is to be carried out in this area, reflections could be predicted to arrive from the following velocity interfaces:

Detrital/Mississippian

Wabamun/First Limestone

First Limestone/Second Limestone

Second Limestone/Base of Second Limestone

Base of Second Limestone/Third Limestone

Third Limestone/Slave Point Formation

Slave Point Formation/Keg River Formation

Interfaces expected to produce seismic reflections.

Due to the fact that the Slave Point Formation was located at a depth of 407 feet, in the Shell-Liard River No. 2 well, long off-set shooting would not be recommended. There is a very good possibility that, if long off-sets were used in the Shell-Liard River No. 2 area, refractions instead of reflections will be recorded.

GEOPHYSICAL APPRAISAL

A sparker survey of the Liard River was carried out by Accurate Exploration Ltd., on July 26th and 30th, 1959. Velocity Surveys Ltd. shot a reconnaissance water seismic survey of Permit No. 3152 on September 13th to 16th, 1961.

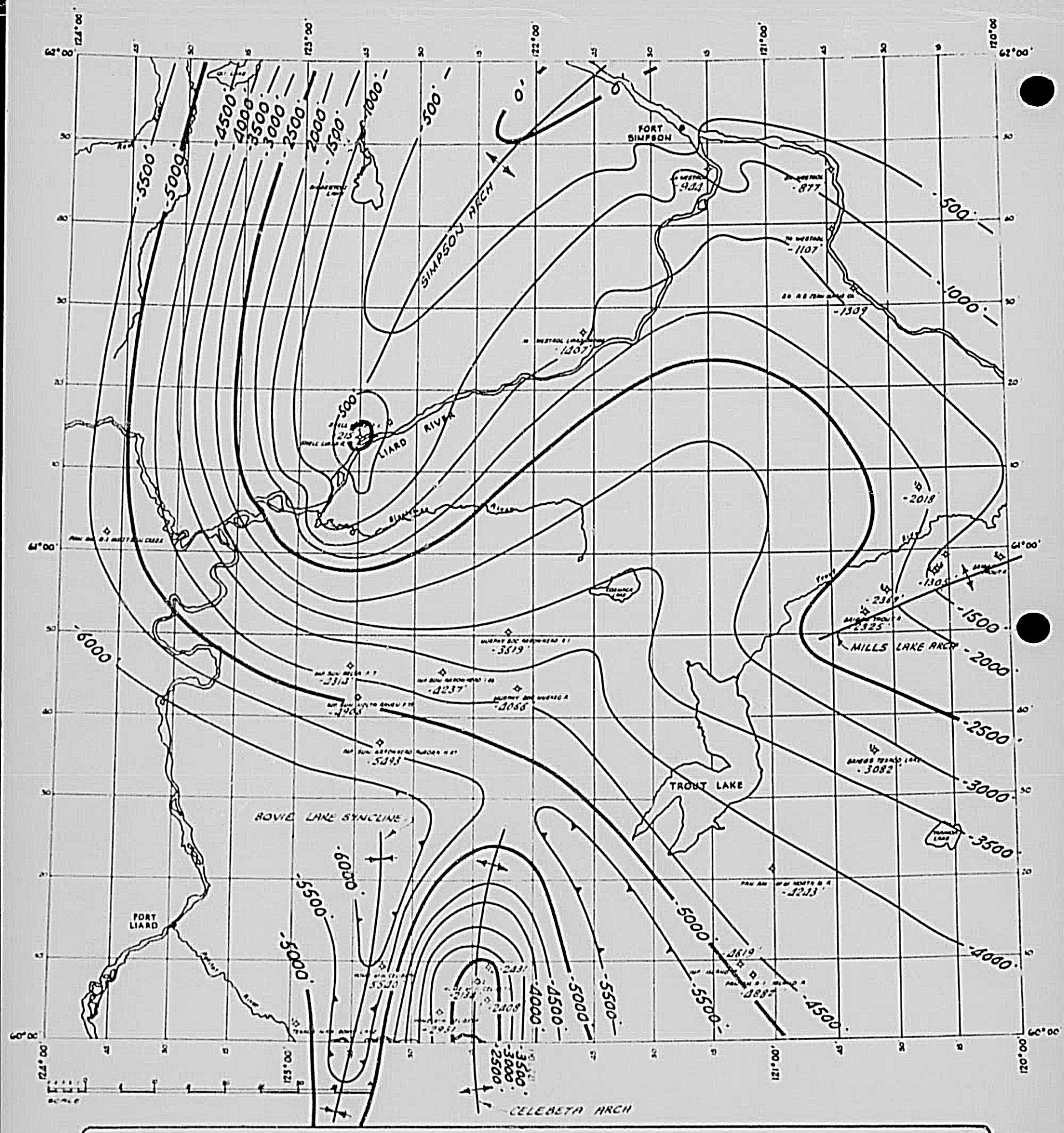
The sparker records for this survey were below par, due to high noise level caused by high boat speed down the river, and also vibration on the survey boat. The record quality of the water seismic was poor to fair.

Due to large off-sets on the water seismic, and the shallowness of the section, only one or two reflections were recorded. Jump correlations on these records were hampered by the fact that the reflection picked was located very close to the first breaks. Frequency and character changes also added to the correlation problem.

One phantom horizon was projected on the sparker records. Numerous multiples were apparent on the sparker data, but these did not interfere with the fictitious horizon picked. The sparker seismic was conducted as a single nearly straight-line traverse. This traverse makes it almost impossible for the interpreter to determine three dimensional geology.

The water seismic was shot with charges varying from 1¼ to 15 pounds, with a shot depth varying from 2 to 7 feet. The sparker records were recorded by towing an electrode 250 feet astern of the survey boat. This electrode is controlled to emit a spark of 10,000 volts every 2 to 4 seconds. This method provided a continuous section of the geologic structure beneath the survey boat.

The Regional Velocity Analysis served to indicate the behavior of velocity/rock-units laterally, from both a velocity and a thickness standpoint (see Map Nos. 4A to 9C.) The Velocity Analysis also helped to simplify the geologic correlation and will be useful for any further seismic interpretations in the area.



SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm)

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contour interval 500 feet MAP NO. 3A

GEOPHYSICAL - GEOLOGICAL INTEGRATION

The Slave Point Elevation Map was prepared from the Sparker Survey in the following manner:

An isochron was calculated for the interval from sea level to the Slave Point horizon at the Westerol 4A well. A half-velocity of 5.7 feet per millisecond was used to compute this isochron; this isochron then was marked on the sparker record adjacent to the 4A well. Reflection dips were picked on all records. A phantom horizon was projected, on the sparker records, from the tie point at the Westerol 4A well. The phantom horizon reached the limit of penetration of the sparker records as the depth of the section increased. A new phantom then had to be started at the top of the record. This phantom horizon was based on the deeper reflection dips.

At all points along the traverse, the isochrons were converted to depth, by using a half-velocity of 5.7 feet per millisecond.

It has been found, from well control, that the Middle Devonian drops 463 feet between the Westerol 4A well and the Westerol-Liard Rapids 1A well. Over this same interval, the fictitious horizon drops 930 feet. The Westerol-Liard Rapids 1A well is located 10 miles west and up-dip from the Liard River, thus accounting for the difference in the drop of the Middle Devonian over this interval.

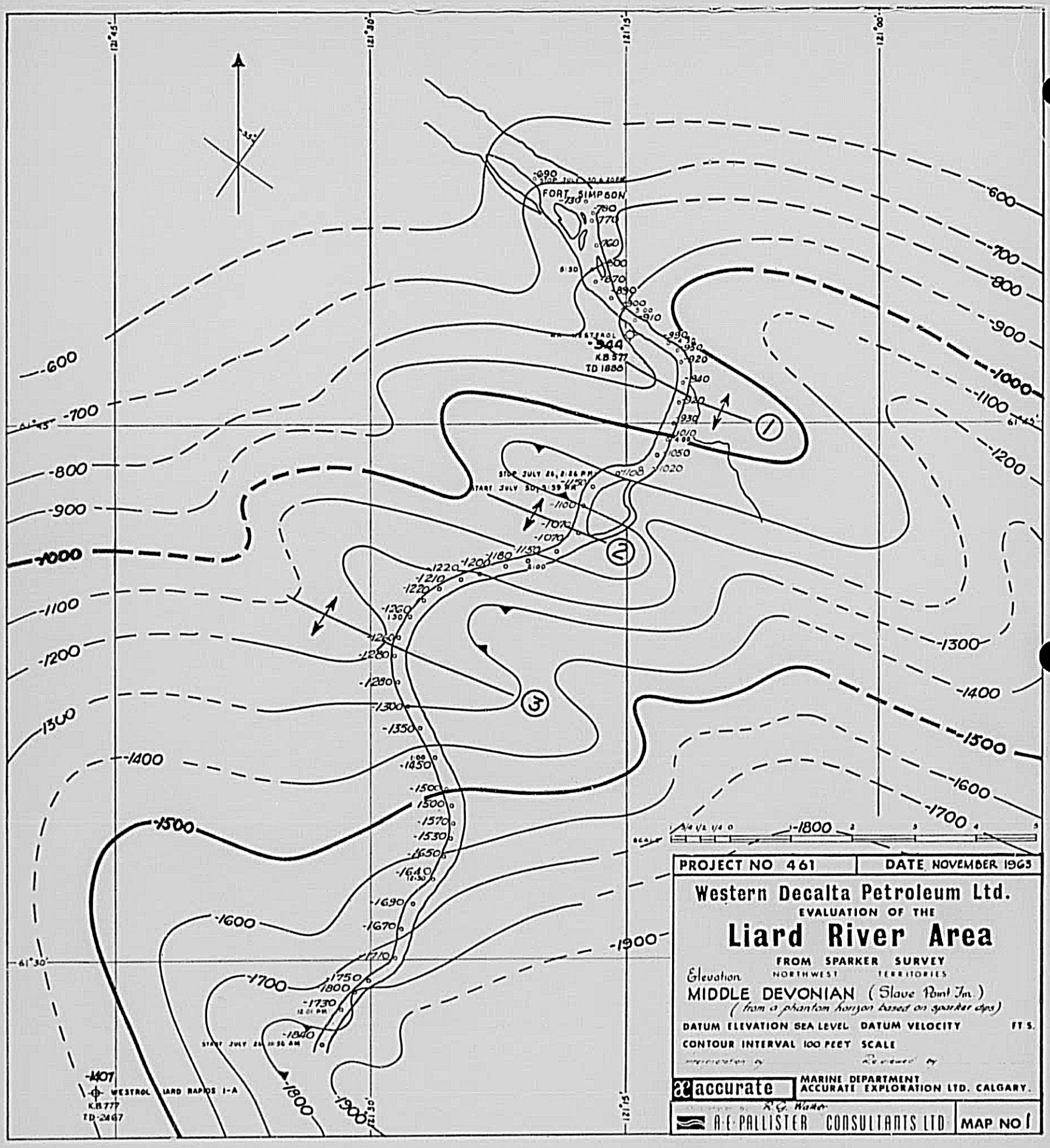
The Slave Point Elevation Map was prepared from the water seismic reconnaissance in the following manner:

All first breaks were checked to see if they gave velocities indicative of reflection or refraction energy. All records except a few (these are shown as N.V.) indicated velocities associated with reflections.

The closest well to Permit No. 3152 is the Shell-Liard River No. 2. Elevation of the Slave Point at this well is + 215. Regional dip then was projected to Shotpoint No. E-16, and an identification of the Slave Point Reflection was made, using a half-velocity of 5.7 feet per millisecond. This reflection was carried throughout the project area.

All reflection times were converted to depth, using a half-velocity of 5.7 feet per millisecond. The elevation of the shotpoints was subtracted from the depth conversions to give the elevation of Slave Point horizon. No computations were made to allow for low-velocity problems. The normal move-out for the off-set of the geophones was not calculated, and remains in the depths mapped.

TABLE OF MAPS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FORT SIMPSON
-344
K.B 377
T.D 1886
STOP JULY 26, 8:56 PM
START JULY 30, 3:39 A.M.
-1407
WESTROL LIARD RAPIDS I-A
K.B 777
T.D 2467
START JULY 28, 10:36 AM
-1730
12:01 PM
-1840
1
2
3
SCALE
PROJECT NO 461
DATE NOVEMBER 1963
Western Decalta Petroleum Ltd.
EVALUATION OF THE
Liard River Area
FROM SPARKER SURVEY
NORTHWEST TERRITORIES
Elevation
MIDDLE DEVONIAN (Slave Point Fm.)
(from a phantom horizon based on sparker dips)
DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.
CONTOUR INTERVAL 100 FEET SCALE
accurate
MARINE DEPARTMENT
ACCURATE EXPLORATION LTD. CALGARY.
A.E. PALLISTER CONSULTANTS LTD
MAP NO 1

MAP DISCUSSION

Maps No. 1, No. 2 and No. 3A Elevation and Seismogeological Regional Elevation - MIDDLE DEVONIAN (Slave Point Fm)

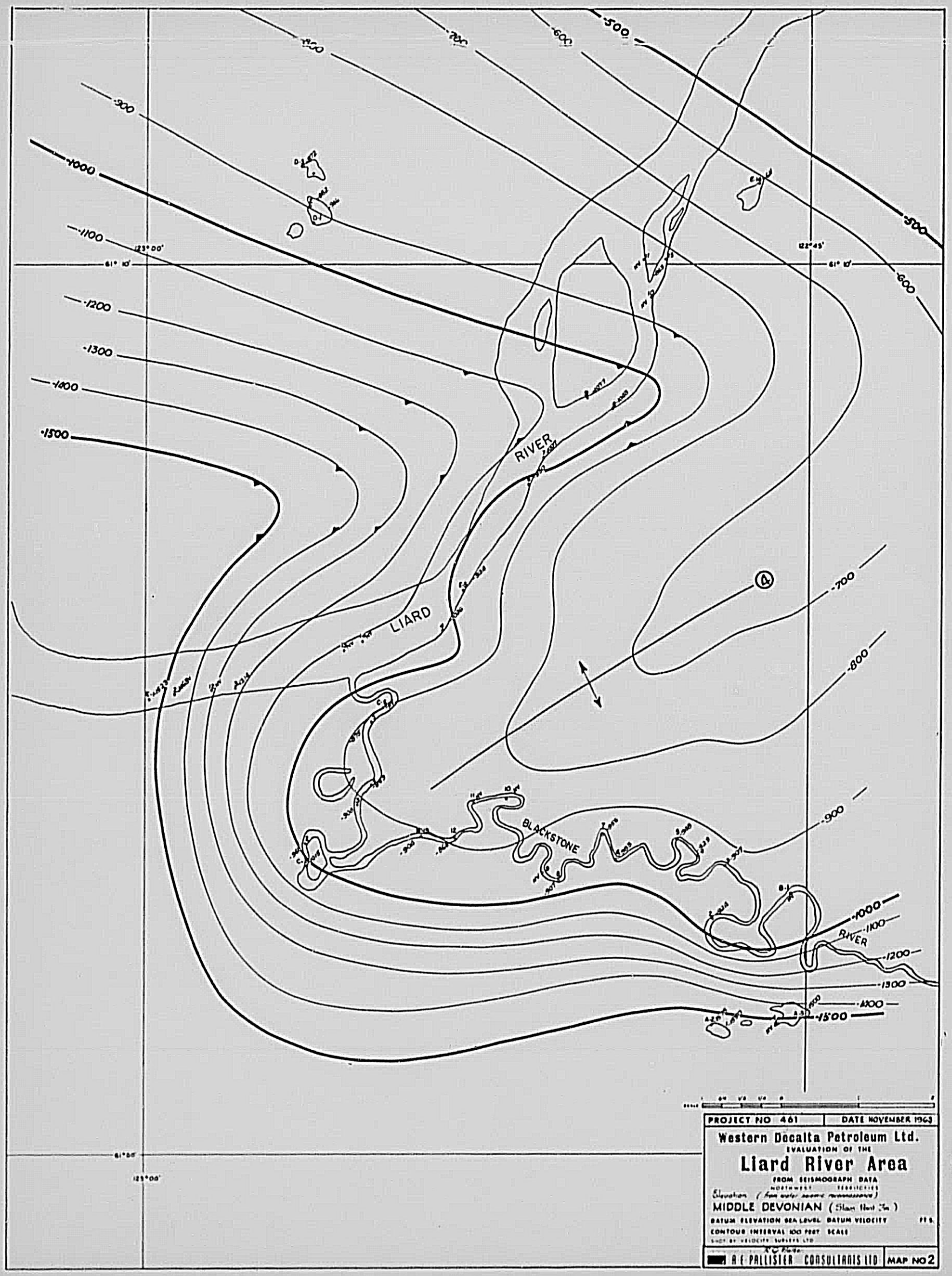
These maps were prepared in order to evaluate any structure on the Slave Point horizon. Porous Slave Point potential has been indicated at the shut-in gas well Imperial-Sun-Netla No. F-7, which is approximately 15 miles south of Permit No. 3152. Several indications of geologic structure, which could be the result of reef build-up, have been noted in geologic outcrops. These maps were contoured in harmony with the regional framework.

MAP NO. 1 - (Slave Point Formation from phantom horizon based on sparker dips)

Regionally, the map area is located on the southeast flank of the Simpson Arch. The Arch rises northwest of the map area at 60 feet per mile.

This map was prepared by picking a phantom horizon, utilizing reflection dips on the sparker records. These phantom values were then converted to depth by using a half-velocity of 5.7 feet per millisecond. The elevation of the river then was subtracted from the converted phantom values. A phantom horizon such as this is highly interpretive.

Three structural highs are noted on this map; no entrapments are indicated on these highs. The three features shown are compatible with trends indicated in outcrops along the Liard River. The series of tight folds indicated along the river in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-1200
-1300
-1400
-1500
123° 00'
122° 45'
61° 10'
61° 05'
RIVER
LIARD
BLACKSTONE
RIVER
PROJECT NO 461
DATE NOVEMBER 1963
Western Decalta Petroleum Ltd.
EVALUATION OF THE
Liard River Area
FROM SEISMOGRAPH DATA
NORTHWEST TERRITORIES
Elevation (from outer seismic measurements)
MIDDLE DEVONIAN (Slave Point Fm)
DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.
CONTOUR INTERVAL 100 FEET SCALE
SHOT BY VELOCITY SURVEYS LTD
A.E. PALLISTER CONSULTANTS LTD
MAP NO 2

outcrop appear to have north-south trending axes, while the structures on this map have northwest-southeast axes.

It is next to impossible to determine three dimensional geologic structure from a single nearly straight-line traverse. This traverse gave the interpreter several contour options. The contour option used for this map was one of trying to show any possible highs, which extend from the flank of the arch, and to show possible closure on these highs.

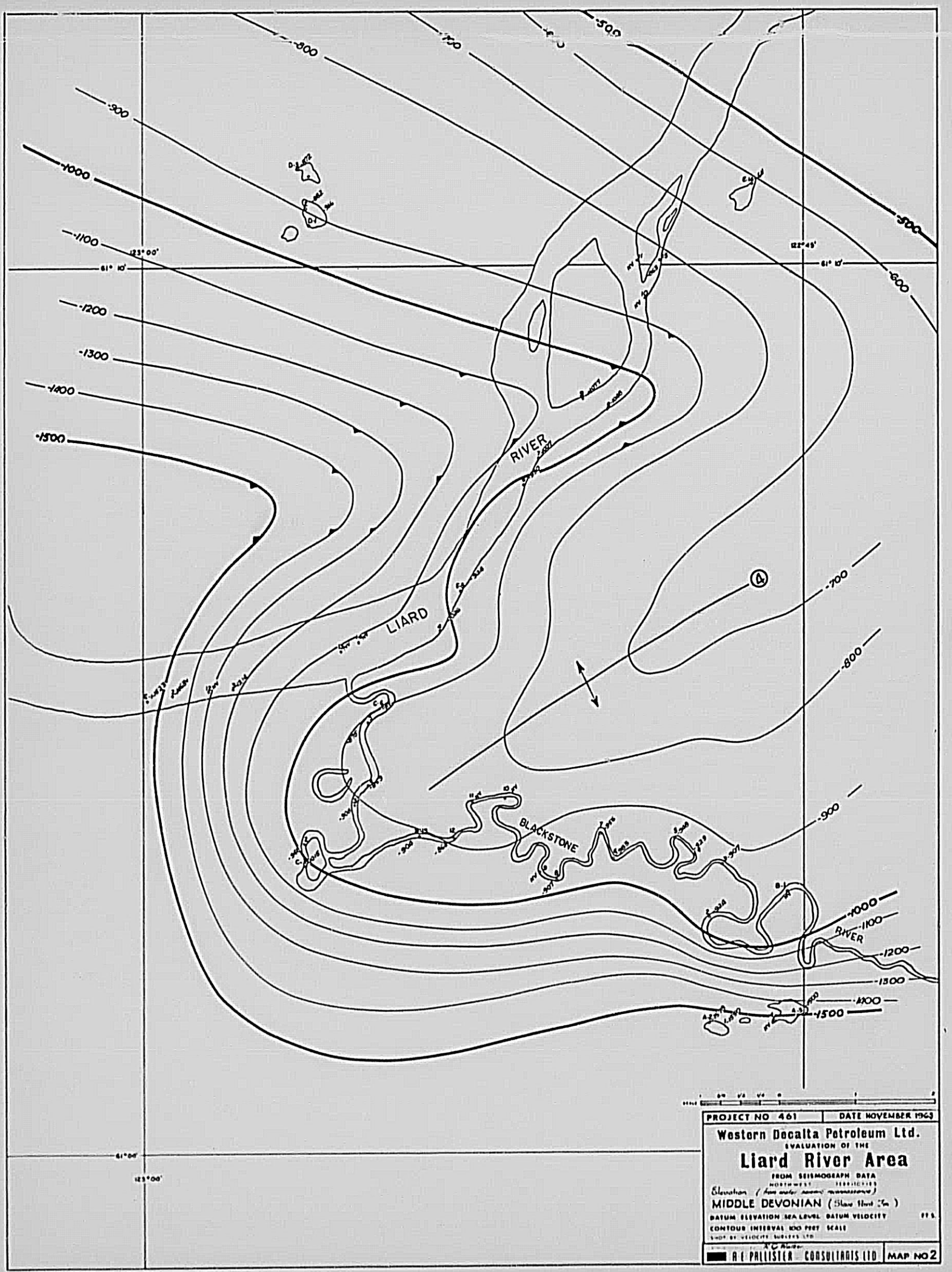
Any further evaluation of the highs shown would require additional conventional seismic control across and along these highs.

Porosity in the third limestone, which should pinch-out close to this area, could be of interest, along with the major play in the Slave Point Formation.

MAP NO. 2 - (Slave Point Formation from water seismic reconnaissance)

Regionally, this horizon portrays southwest dip of approximately 140 feet per mile. North of the Liard River the regional picture is very much distorted by the southwest trending Simpson Arch. This arch apparently cuts directly across the permit area. The Slave Point Formation was penetrated at +215 feet in the Shell-Liard River No. 2 well.

The Nose, Feature Four, could be considered a southwest extension of the anomaly on which the Shell-Liard well was drilled. Any closure on this feature, within the permit area, would have to be evaluated by further seismic control. It is suggested that, if future seismic work is to be done, a few lines should be shot across this nose and also along its axis.


-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
-1500
123°00'
122°45'
61° 10'
61°00'
RIVER
LIARD
BLACKSTONE
RIVER
PROJECT NO 461
DATE NOVEMBER 1963
Western Decalta Petroleum Ltd.
EVALUATION OF THE
Liard River Area
FROM SEISMOGRAPH DATA
NORTHWEST TERRITORIES
Elevation (from water bearing measurements)
MIDDLE DEVONIAN (Slave Point Fm.)
DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.
CONTOUR INTERVAL 100 FEET SCALE
SHOT BY VELOCITY SURVEYS LTD.
A.E. PALLISTER CONSULTANTS LTD
MAP NO 2

This map was prepared by making an identification of the Slave Point Reflection at Shotpoint No. E-16. This reflection then was carried throughout the prospect by jump correlations. The reflection times, used to convert to depth, were not corrected for normal move-out. Normal move-out was not calculated for the reason that the off-set distance was essentially constant at all shotpoints. The accuracy of the results, of course, are limited by three conditions: one, the difficulty in making correlations close to first breaks; secondly, by the use of jump correlations; and, thirdly, by the possibility that a velocity change could take place locally, so that the conversion velocity used would be incorrect through a portion of the area. A half-velocity of 5.7 feet per millisecond was used to convert to depth throughout the prospect.

Reliability of the jump correlations is dependent on the closeness of the reflection to the first breaks and the severity of frequency changes; thus, these correlations could not be considered completely reliable, and would only produce approximate results.

Here, again, a few contour options were available and the option taken was one to show a high extending from the Simpson Arch. Since the results are only approximate, there is a good possibility that closure could exist on the high shown as Feature Four.

In addition to Slave Point production possibilities, any porosity associated with the Second Limestone zero edge should not be overlooked. Facies changes and zero edge relationships associated with the First and the Second Limestone are also of interest (see Sonic Log Cross-Section and Geologic Cross-Sections.)

FORT SIMPSON

SIMPSON ARCH

LIARD RIVER

FORT LIARD

BOVIE LAKE SYNCLINE

MILLS LAKE ARCH

TROUT LAKE

CELEBETA ARCH

SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm).

A·E·PALLISTER CONSULTANTS LTD.

contour interval 500 feet

MAP NO. 3A

MAP NO. 3A - (Slave Point Seismogeological Regional Elevation)

This Seismogeological Map was prepared from elevations taken from well control. Its purpose is to show the regional structure on the Slave Point Formation. The contouring was done as smoothly as possible to retain the structure on this horizon.

This map portrays four strong features in this portion of the Western Canada Sedimentary Basin. The largest feature, and possibly the most important, is the Simpson Arch. The Simpson Arch enters the map area from the north, trending southwest and cutting across Permit No. 3152.

The second largest feature is the Celibeta Arch, which enters the map area from the south and trends north.

West of the Celibeta Arch lies the Bovie Lake Syncline. There is approximately 3,500 feet difference between the Bovie Lake Syncline and the Celibeta Arch.

The fourth major structure shown on this map is the Mills Lake Arch, which enters the map from the east and trends southwest.

This map summarizes the regional structure on the Slave Point Formation. The values from the sparker survey (Map No. 1) and water seismic (Map No. 2), were added to the regional picture to produce this seismogeological map. These values influence the regional contours only in the areas of geophysical control.

Maps No. 4A to No. 9C inclusive - Regional Velocity Analysis Maps

---

These maps were prepared to display regional isopachous, isochronal and interval-velocity variations within the region.

Isopach values were obtained from published and released well control. Only those geologic horizons which represented strong velocity changes were used. Several nomenclatural problems were experienced in these correlations.

Velocity information was gained from six acoustic type logs. The logs were integrated to obtain interval velocities and transit time values. The interval velocities show a general increase to the southwest, in response to the deepening of the basin. Distinct velocity log interfaces were of value in solving correlation problems.

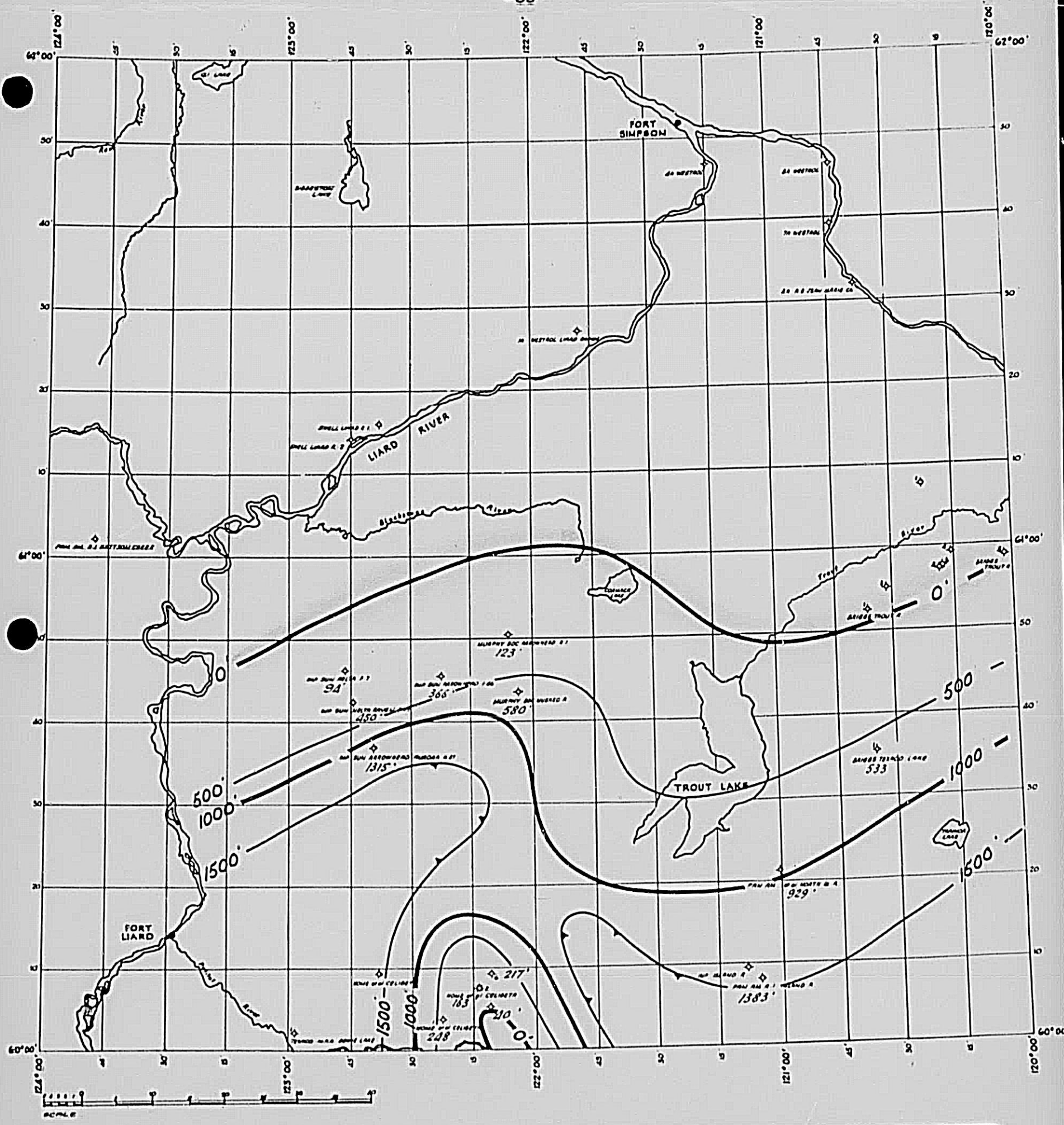
The regional velocity values may be used with confidence for any future seismic depth conversions in the area. However, as further acoustic log control becomes available, it should be included with this analysis. Nomenclatural problems may be resolved as further study is completed; however, this will alter little, the results of this R.V.A., since only obvious velocity breaks were correlated and, no doubt, will be associated with major sedimentary changes.

Isochronal values were computed from the known isopachs and average interval velocities.

This Regional Velocity Analysis will be of value for future seismic work that may be carried out in this area.

Respectfully submitted,

R. G. Walker,
Seismologist.

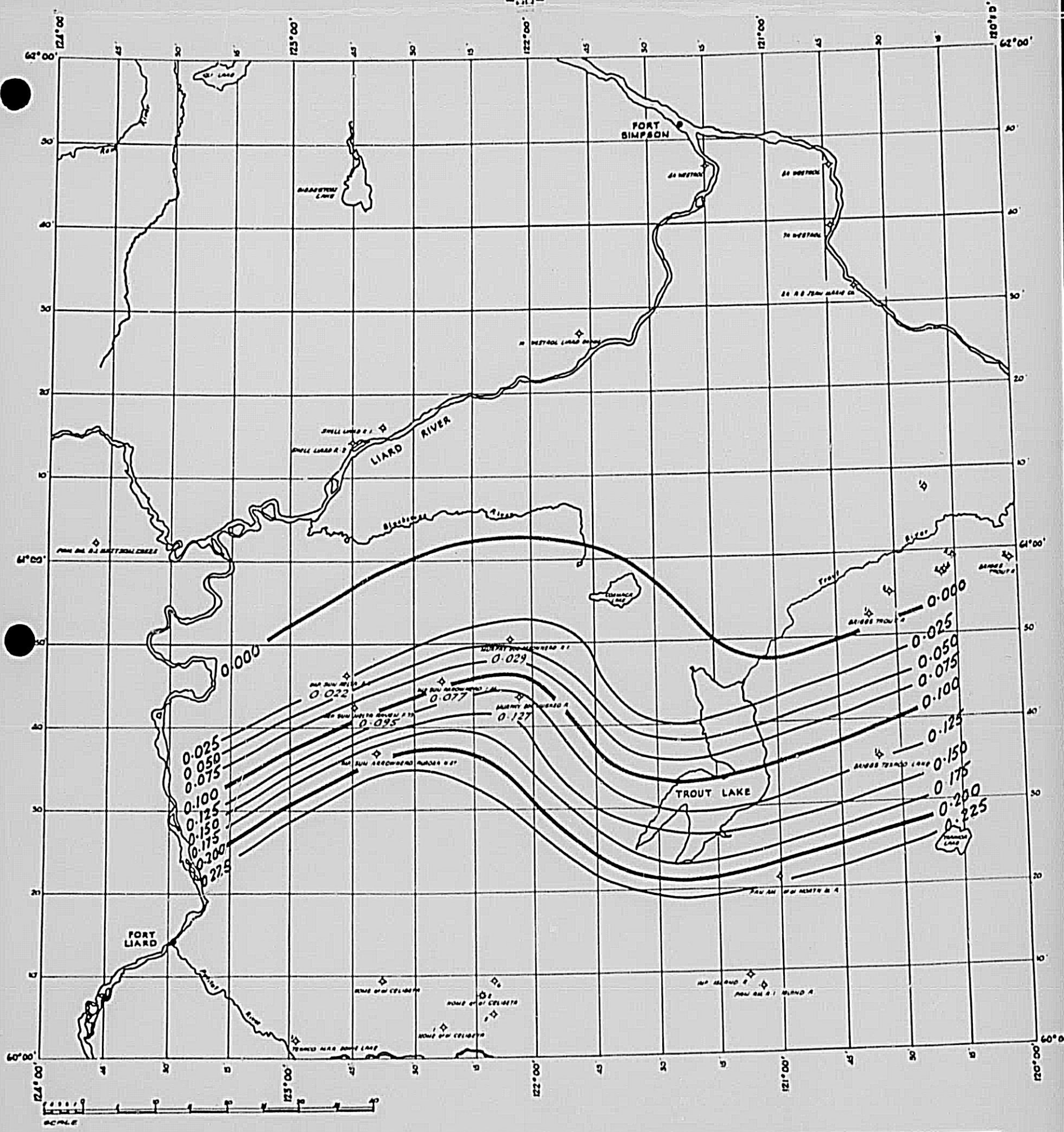


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN - erosional TO
UPPER DEVONIAN (Wabamun Gr)
contour interval 500 feet

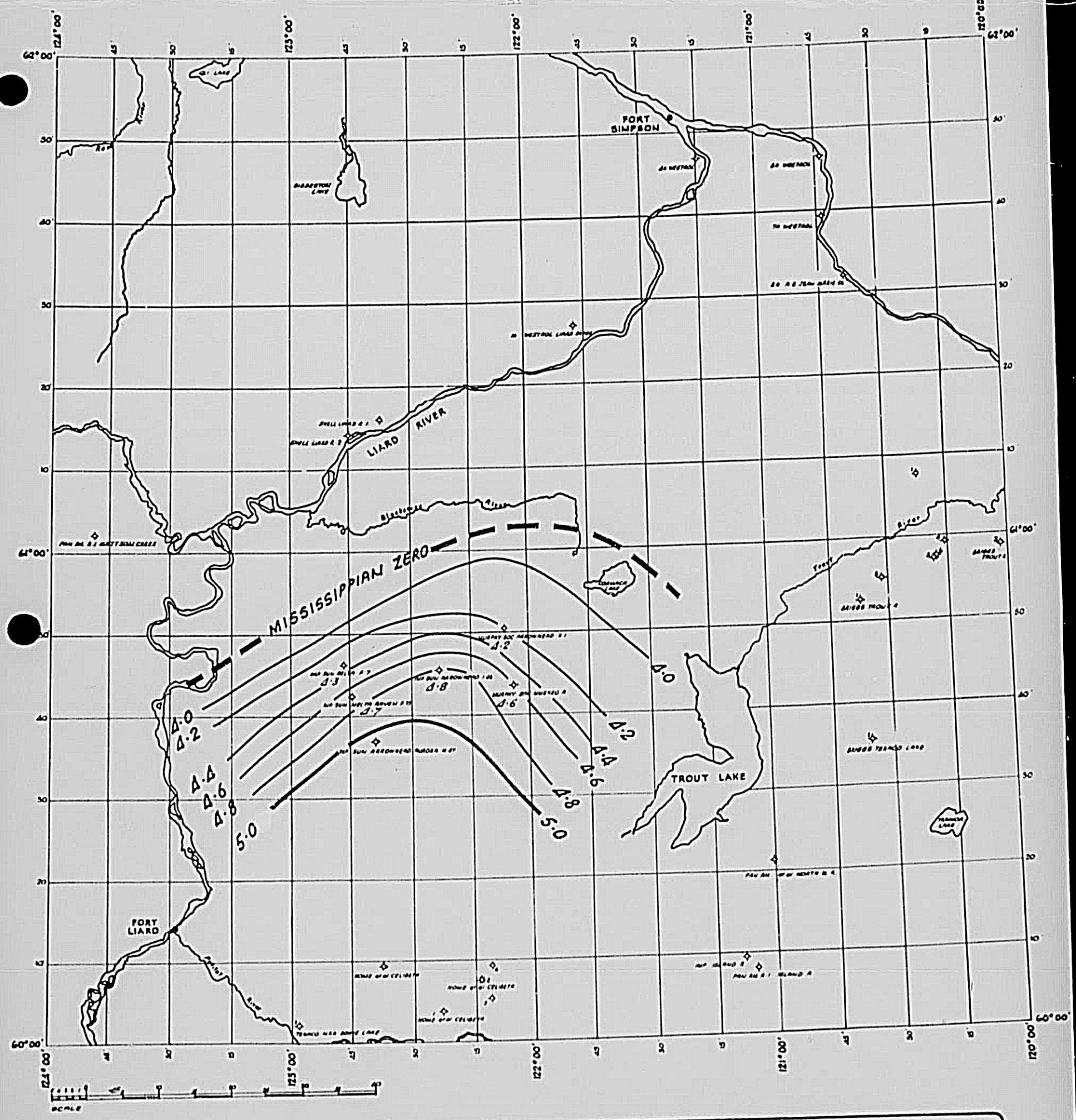
MAP NO. 4A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

MISSISSIPPIAN – erosional TO
UPPER DEVONIAN (Wabamun Gr)
contour interval 0.025 seconds MAP NO. 4B

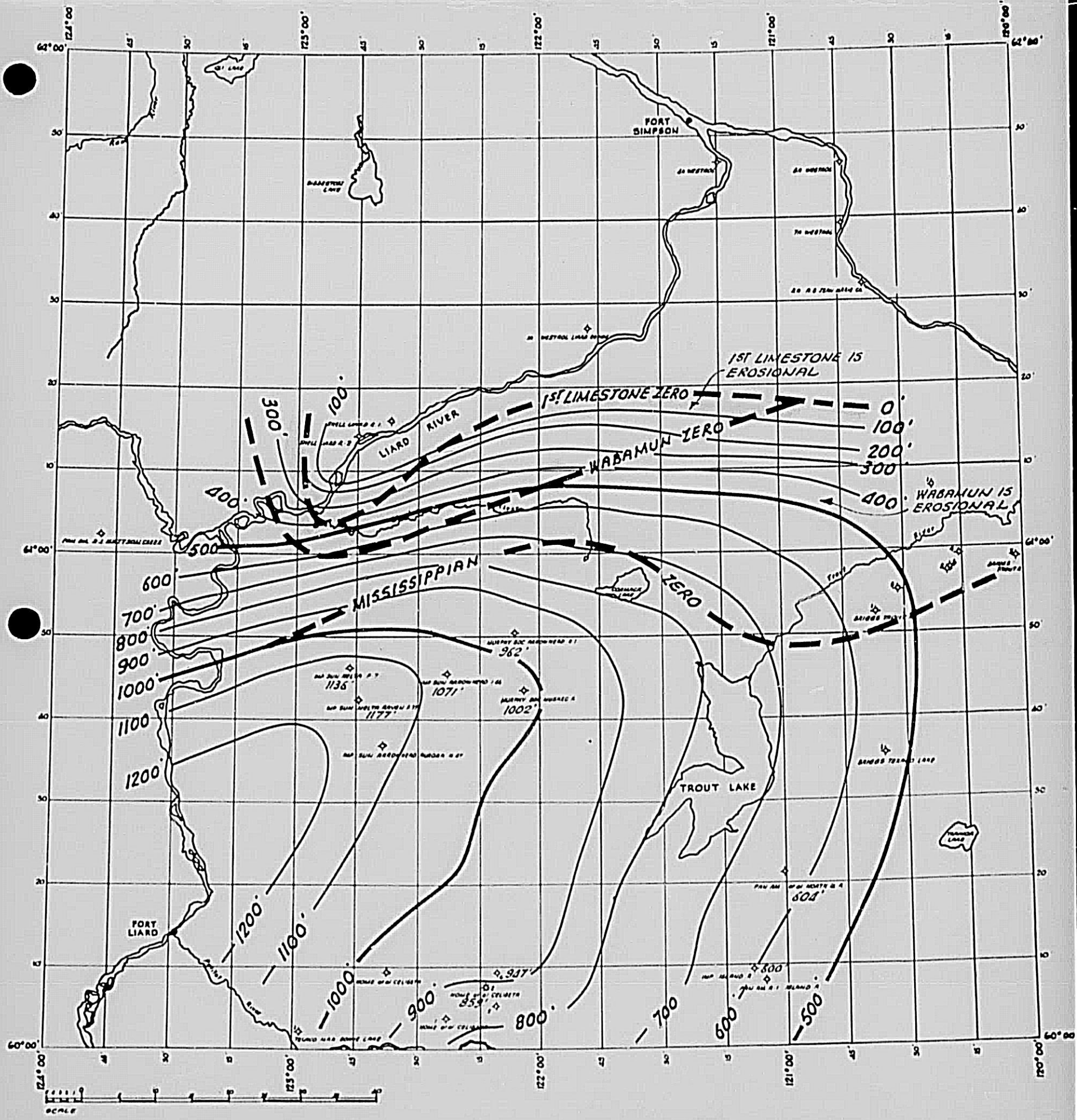


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN – erosional TO
UPPER DEVONIAN (Wabamun Gr)
contour interval 0.2 feet per millisecond

MAP NO. 4C

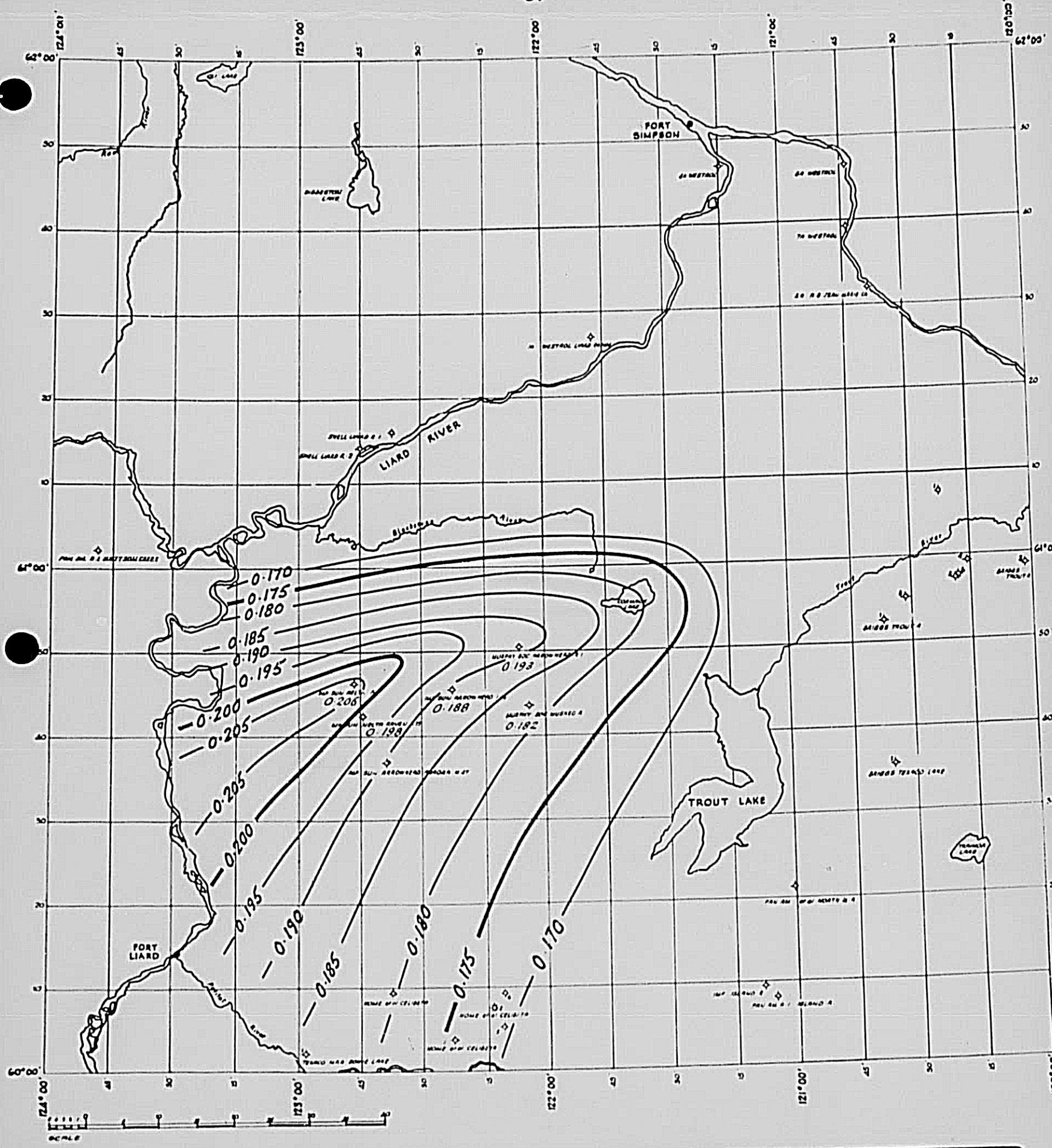


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Wabamun Gr.) TO
UPPER DEVONIAN (Second Limestone)
contour interval 100 feet

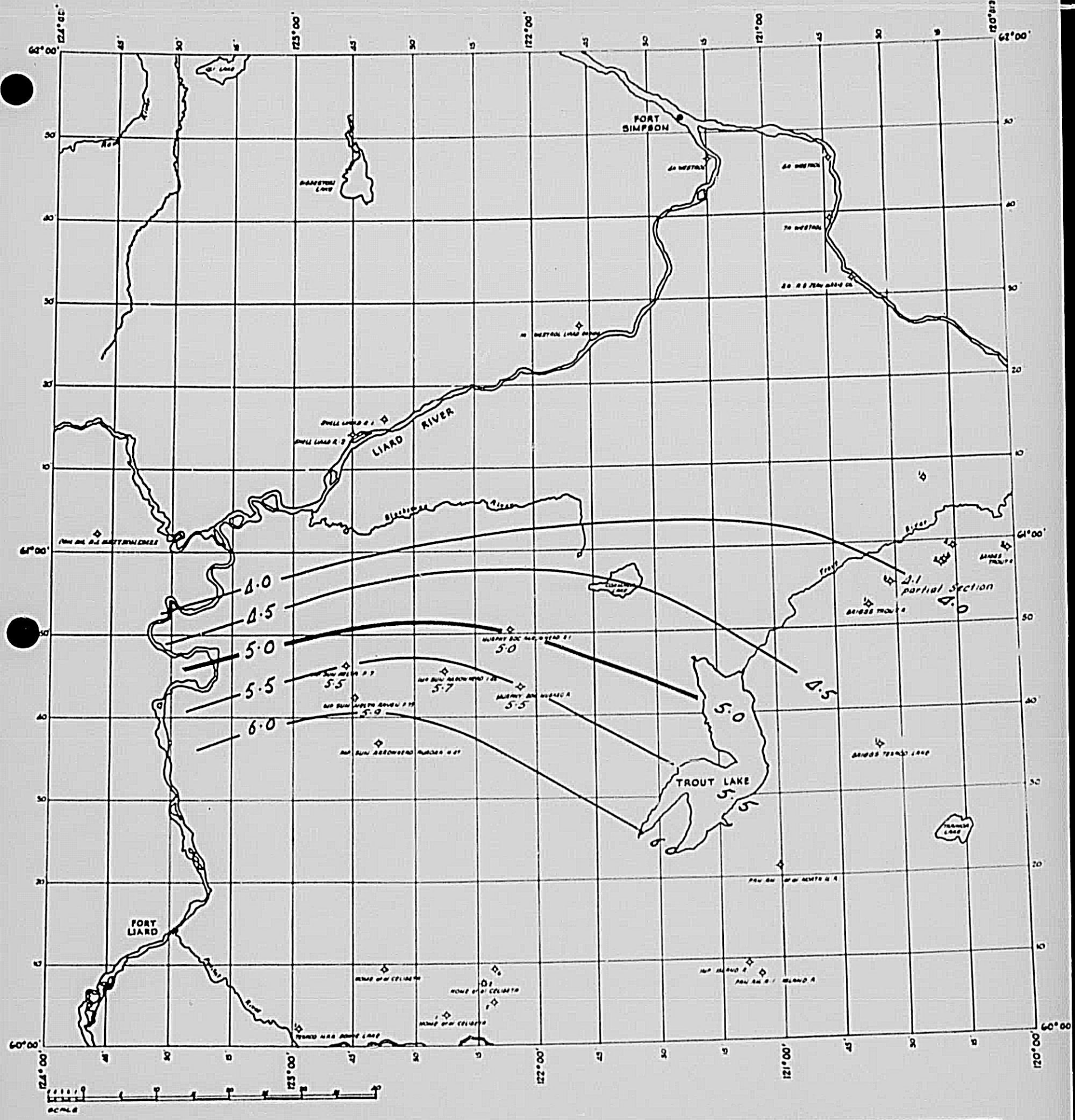
MAP NO. 5A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Wabamun Gr) TO
UPPER DEVONIAN (Second Limestone)
contour interval 0.005 seconds MAP NO. 5B

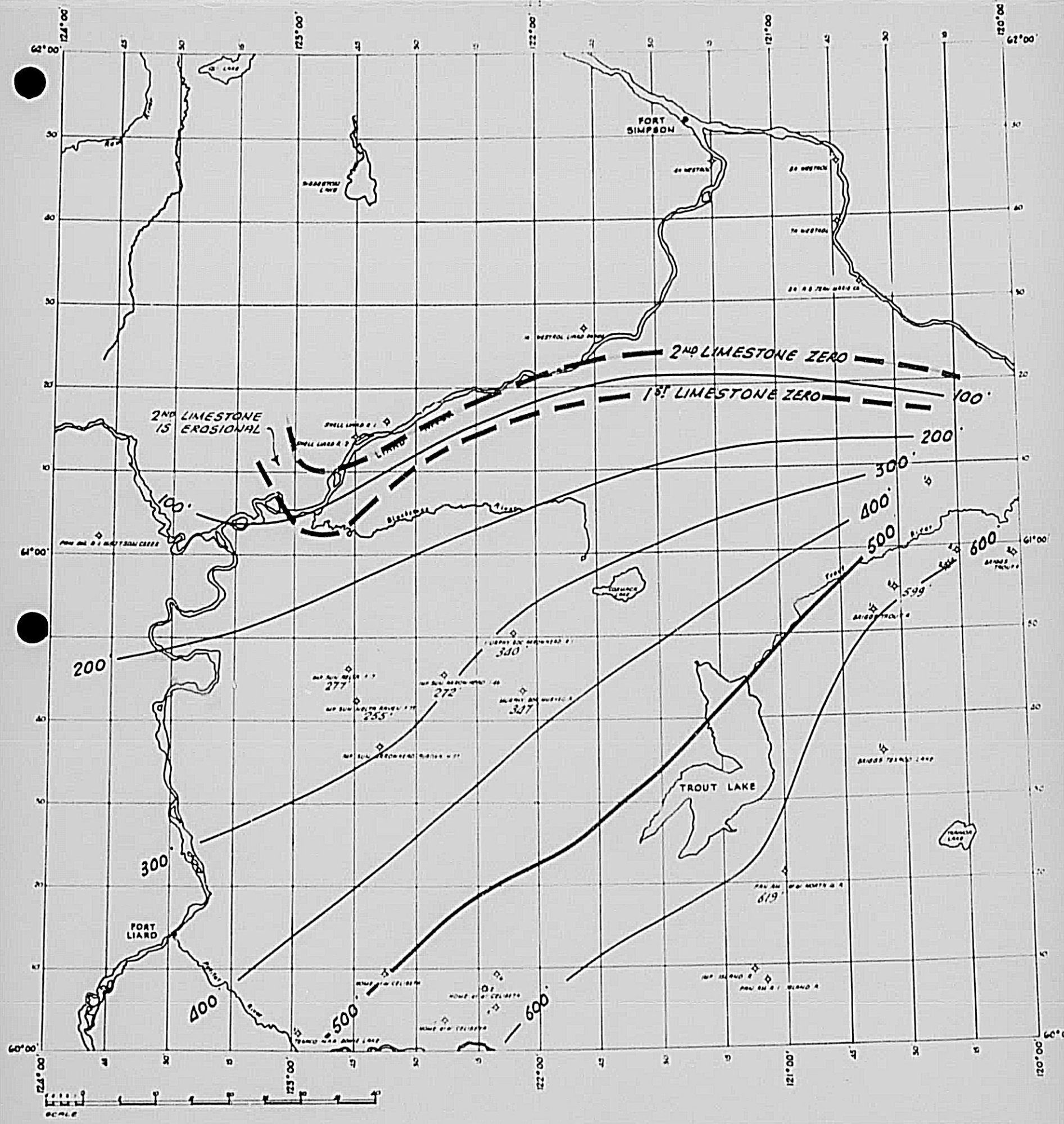


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Wabamun Gr) TO
UPPER DEVONIAN (Second Limestone)
contour interval 0.5 feet per millisecond

MAP NO. 5C

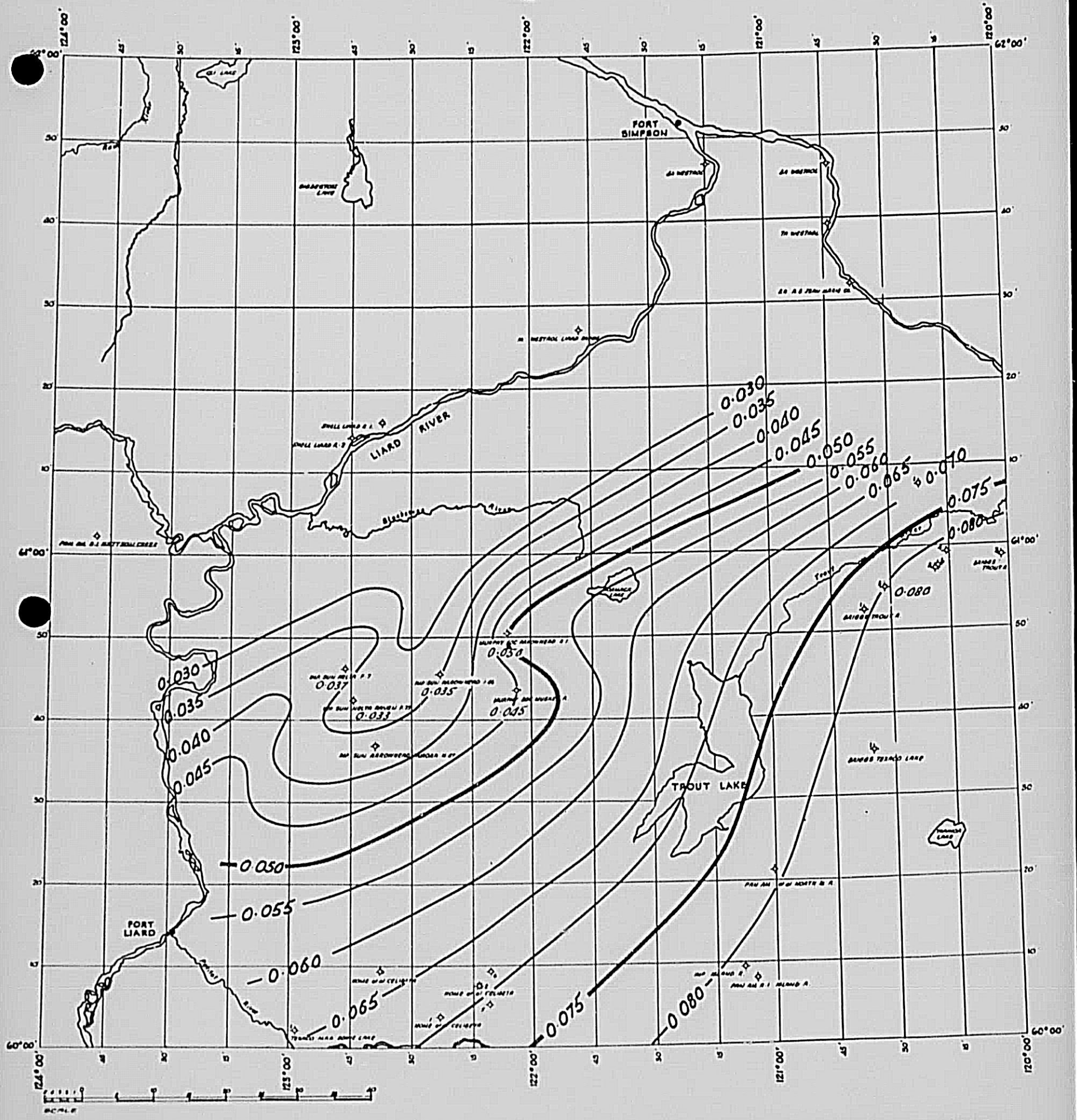


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 100 feet

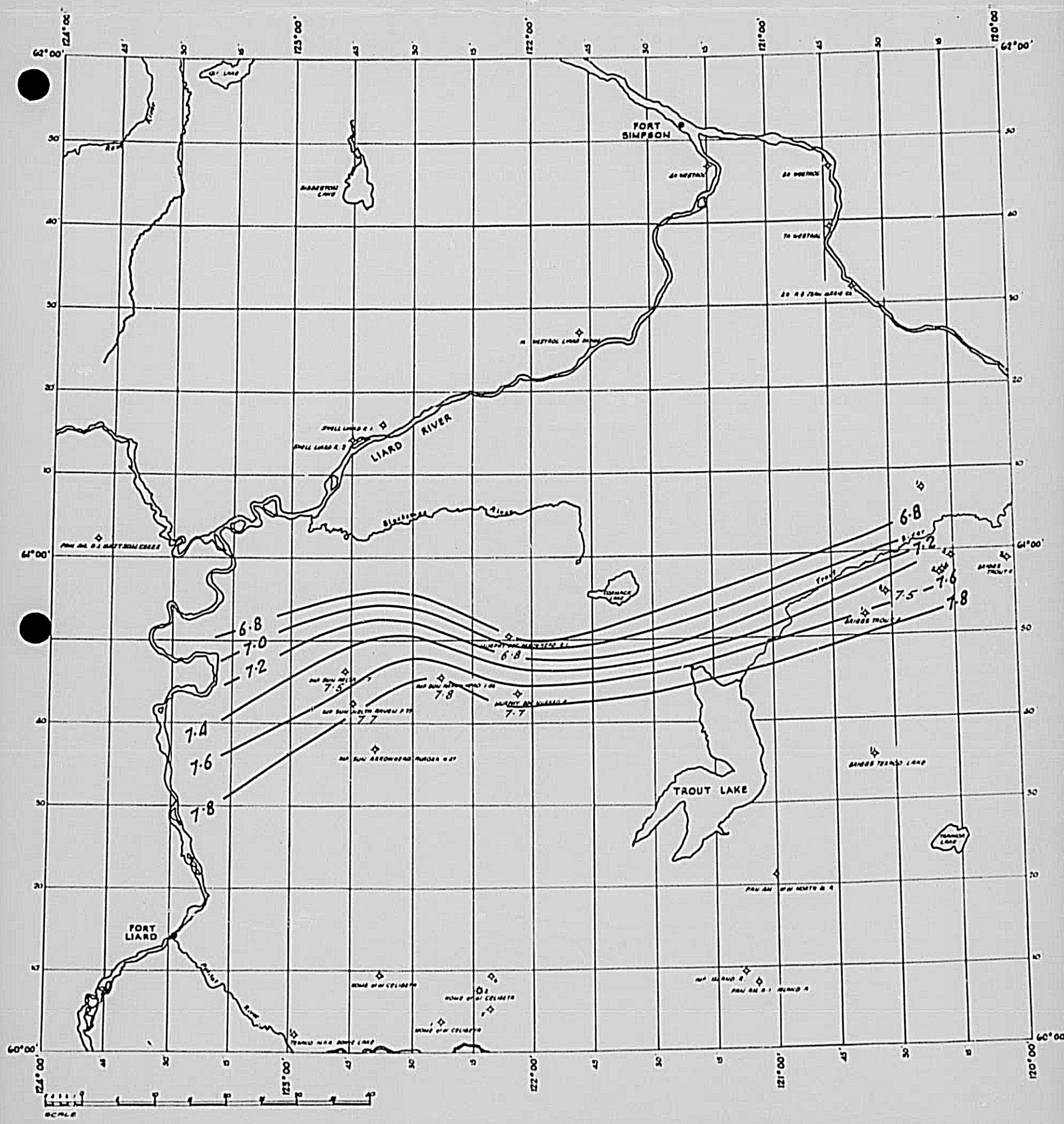
MAP NO. 6A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 0.005 seconds MAP NO. 6B

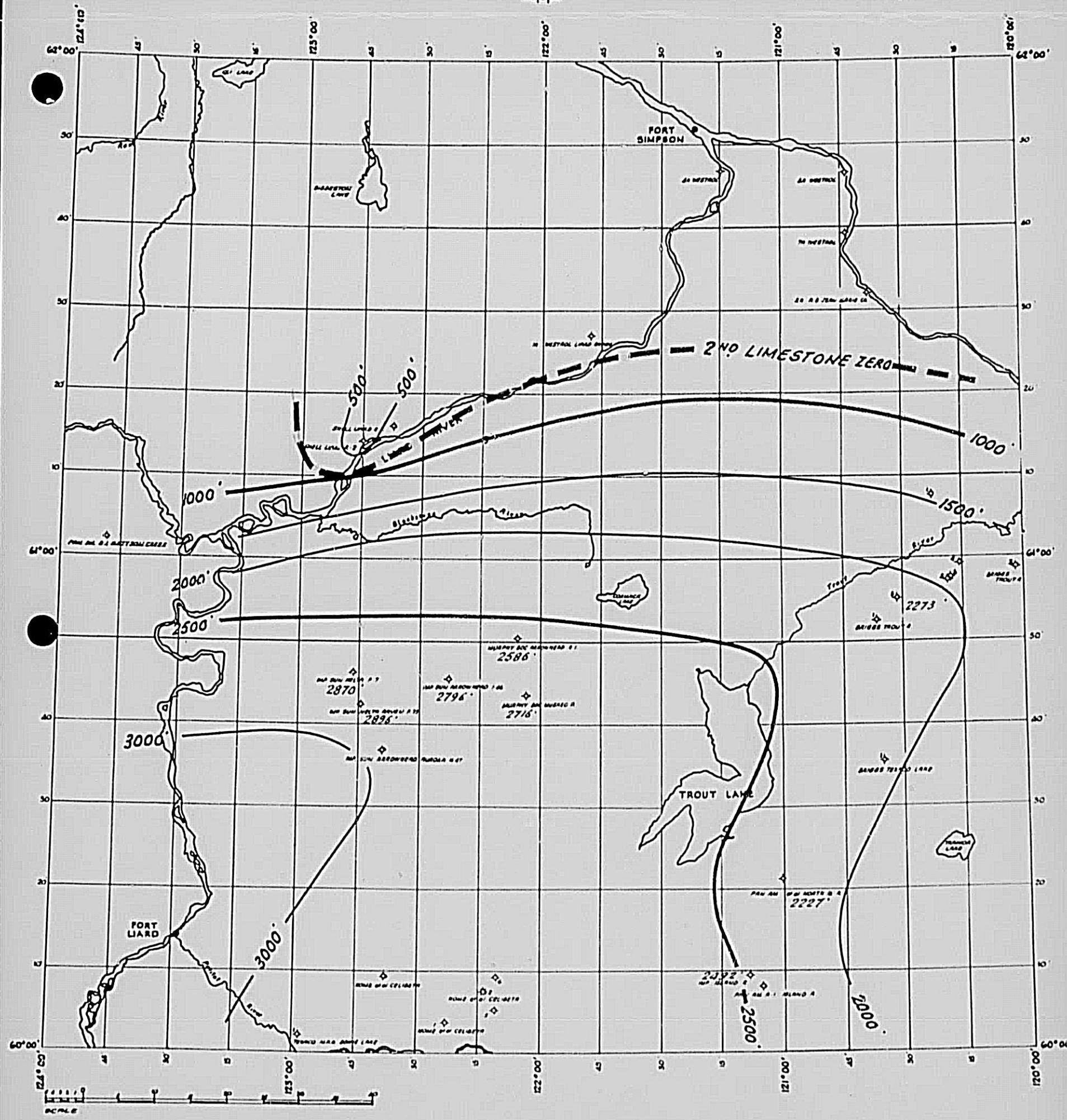


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 0.2 feet per millisecond

MAP NO. 6C

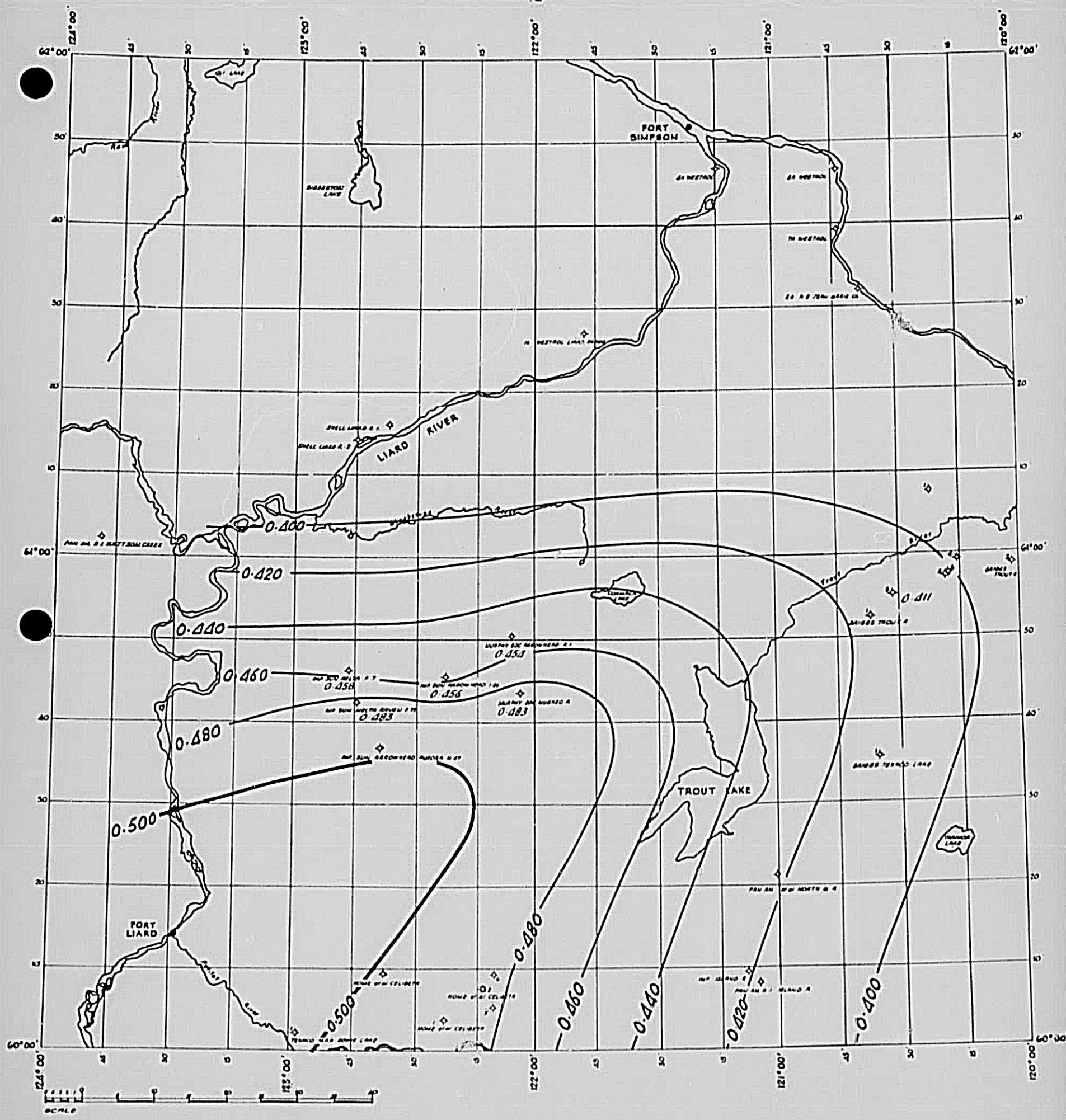


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Base of Second Limestone)
TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 500 feet

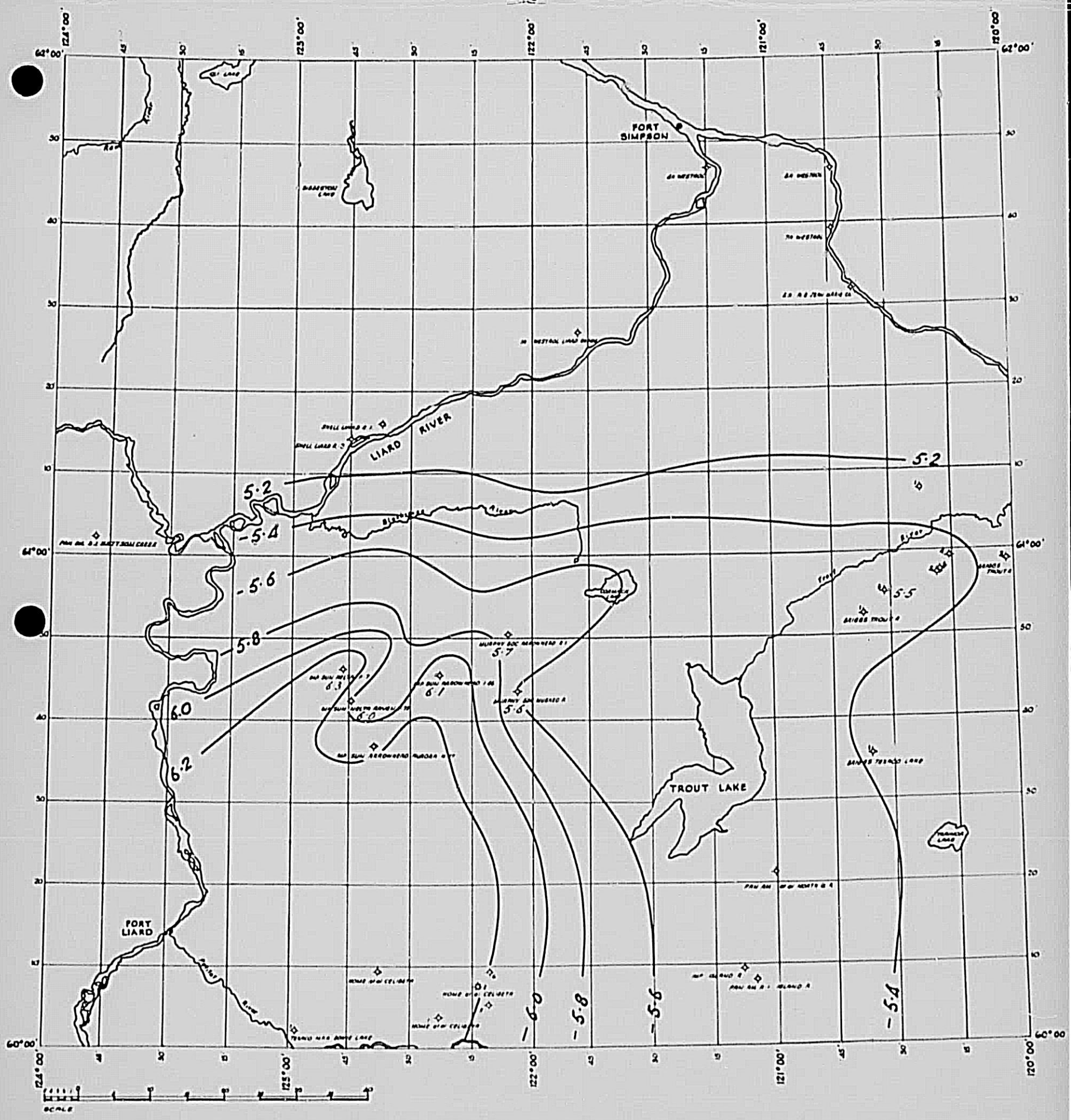
MAP NO. 7A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Base of Second Limestone)
TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.020 seconds MAP NO. 7B

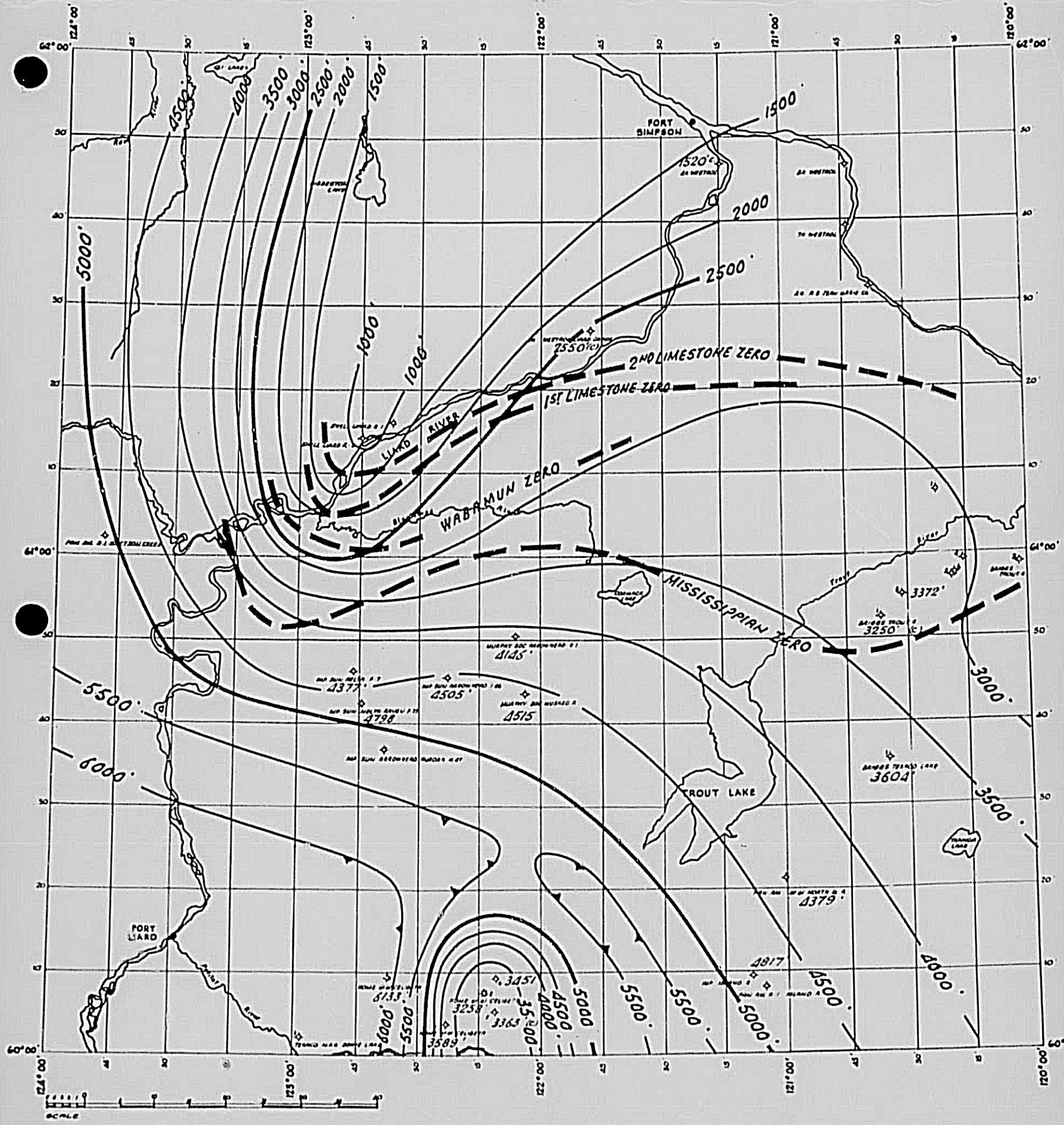


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Base of Second Limestone) TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.2 feet per millisecond

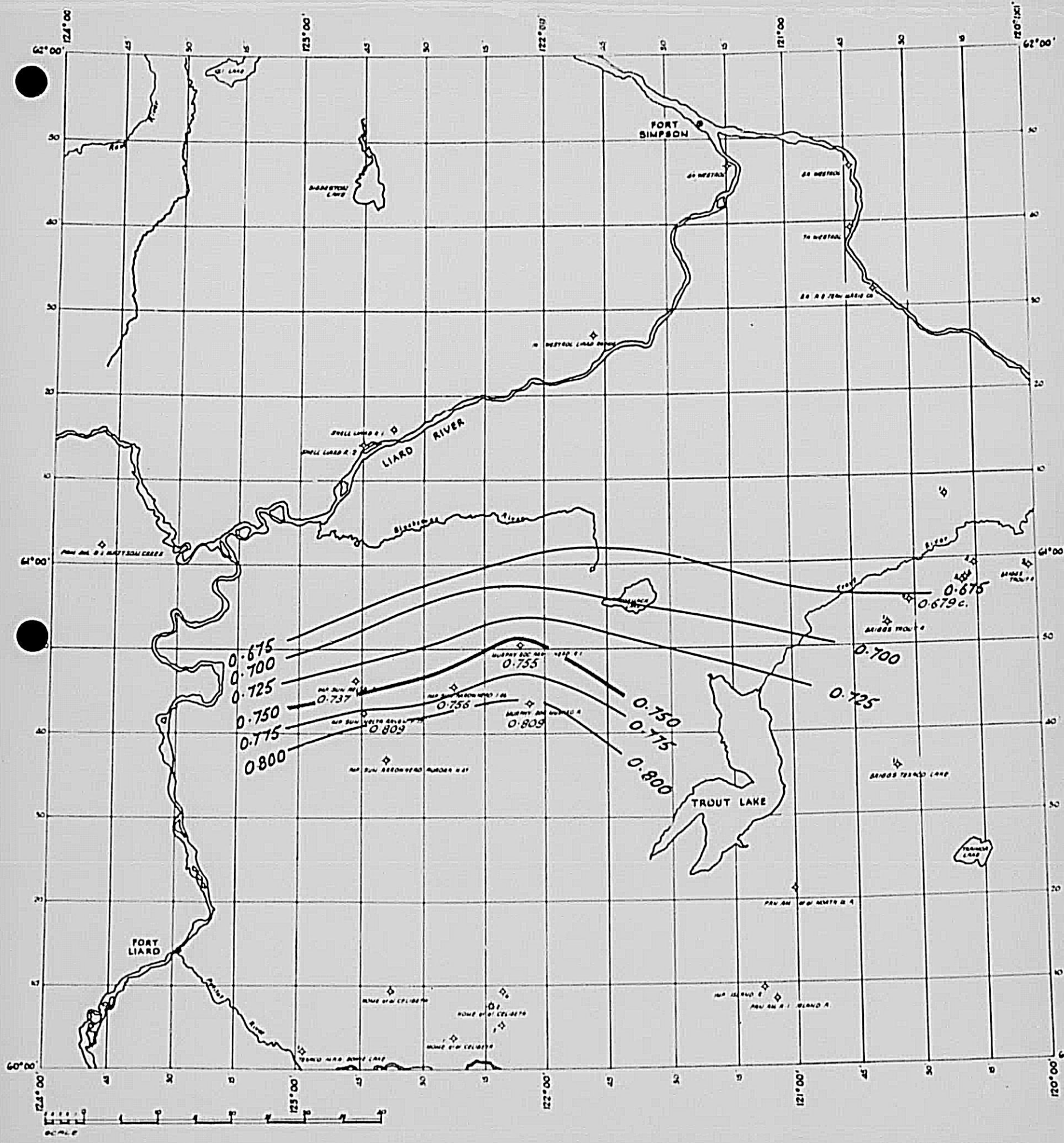
MAP NO. 7C



REGIONAL ISOPACH DEVONIAN and MISSISSIPPIAN - erosional TO MIDDLE DEVONIAN (Slave Point Fm)

A·E·PALLISTER CONSULTANTS LTD.

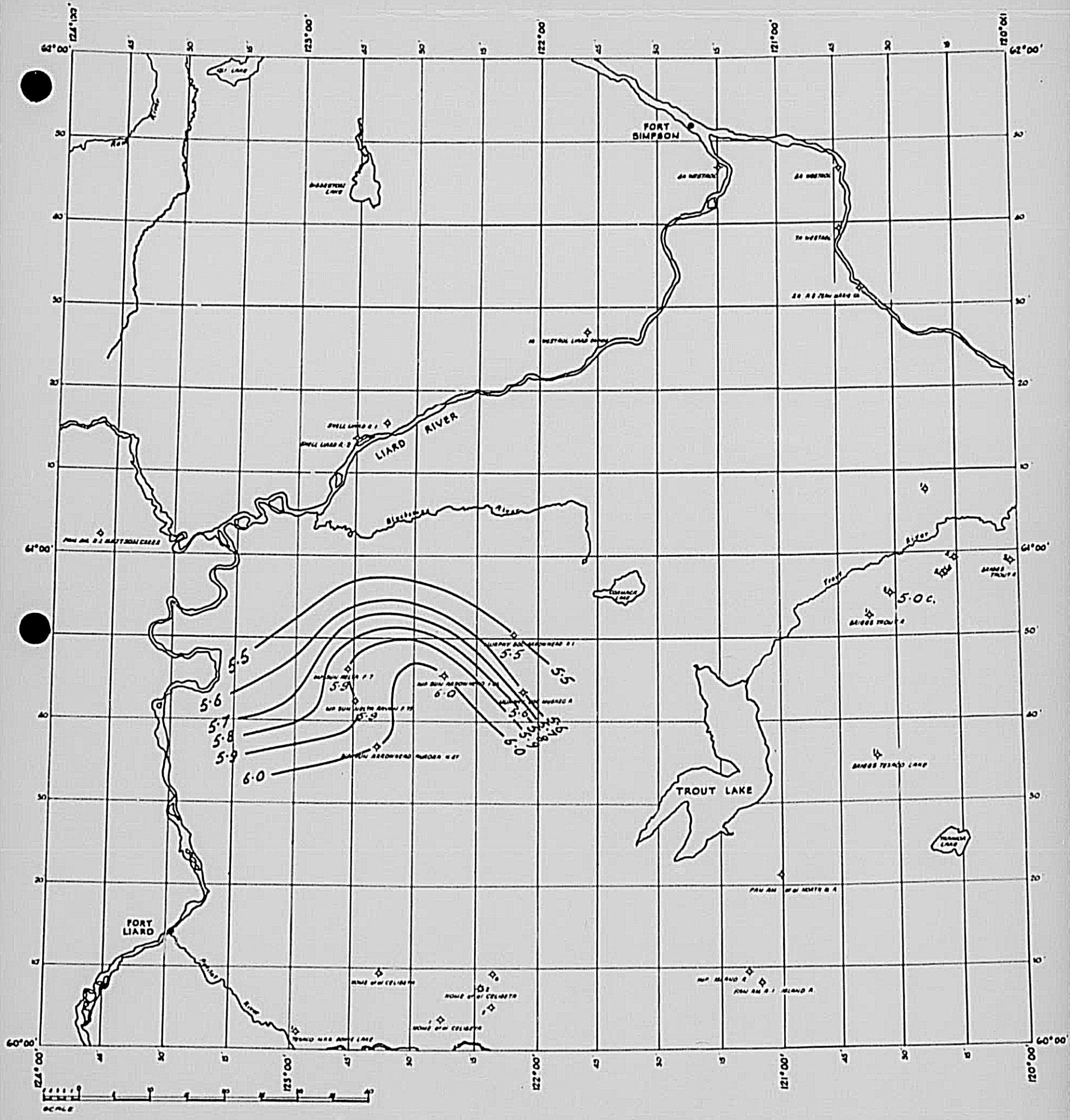
contour interval 500 feet MAP NO. 8A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN – erosional TO
MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.025 seconds MAP NO. 8B

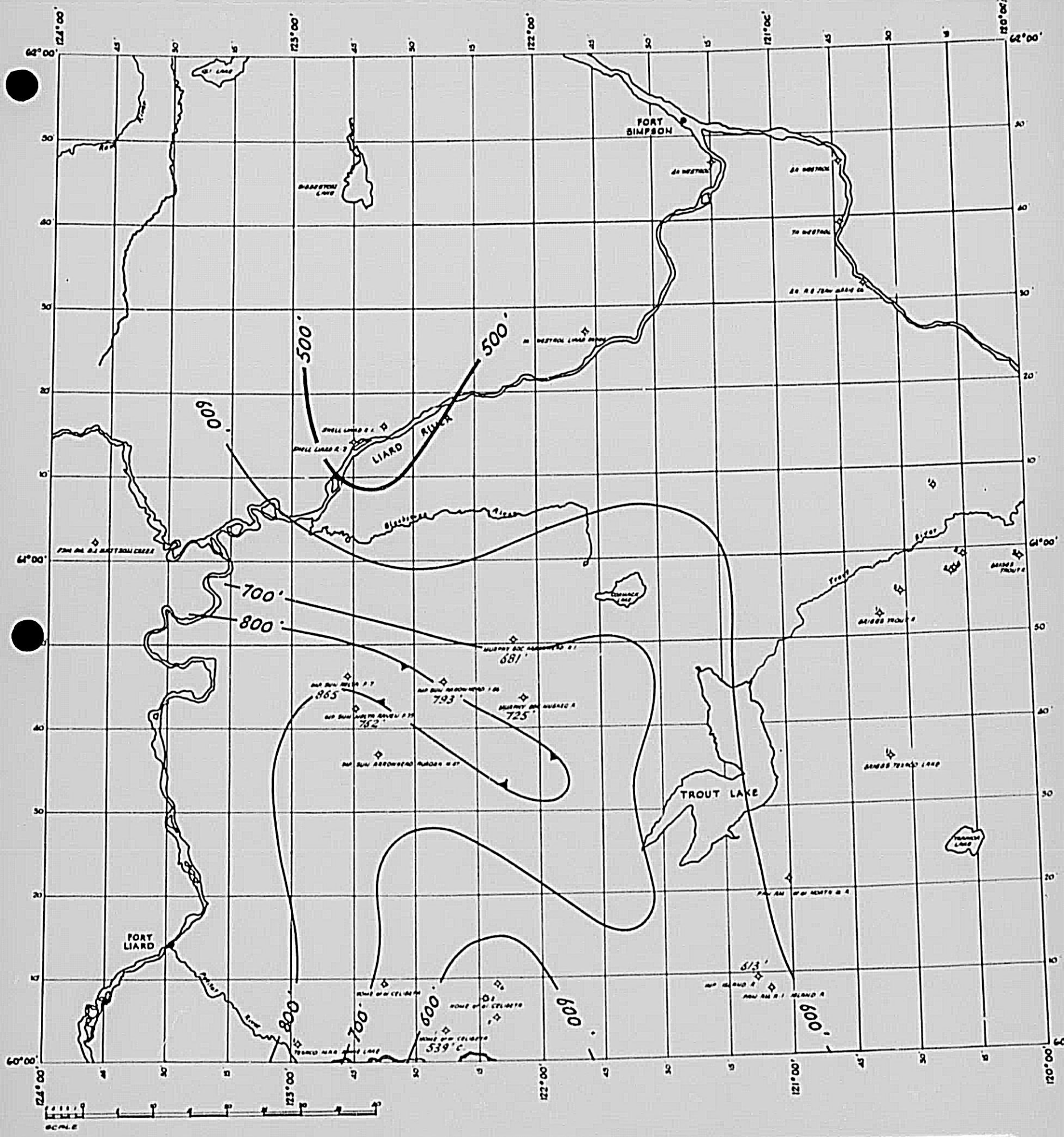


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN – erosional TO
MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.1 foot per millisecond

MAP NO. 8C

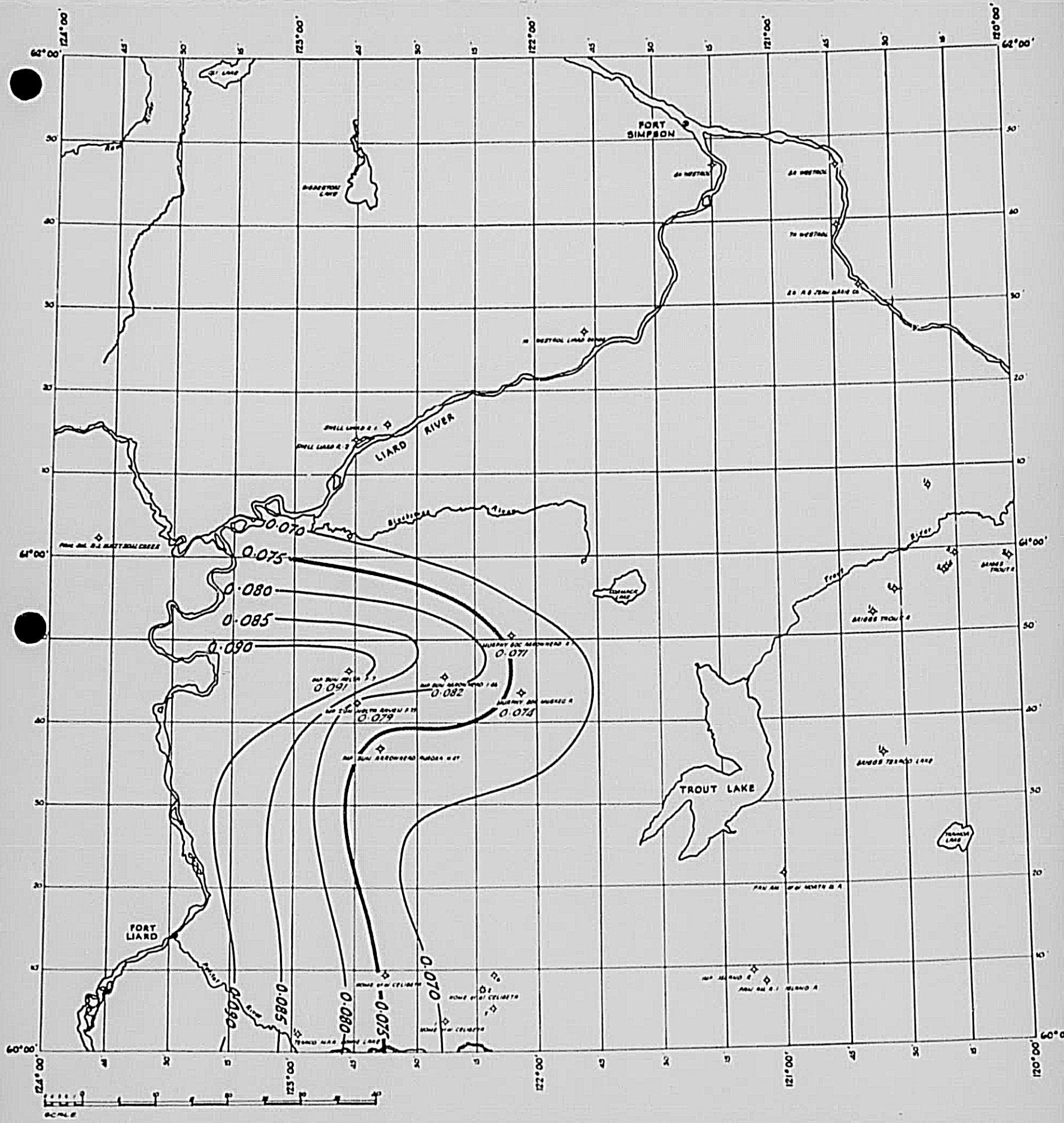


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

MIDDLE DEVONIAN (Slave Point Fm) TO
MIDDLE DEVONIAN (Keg River Fm)
contour interval 100 feet

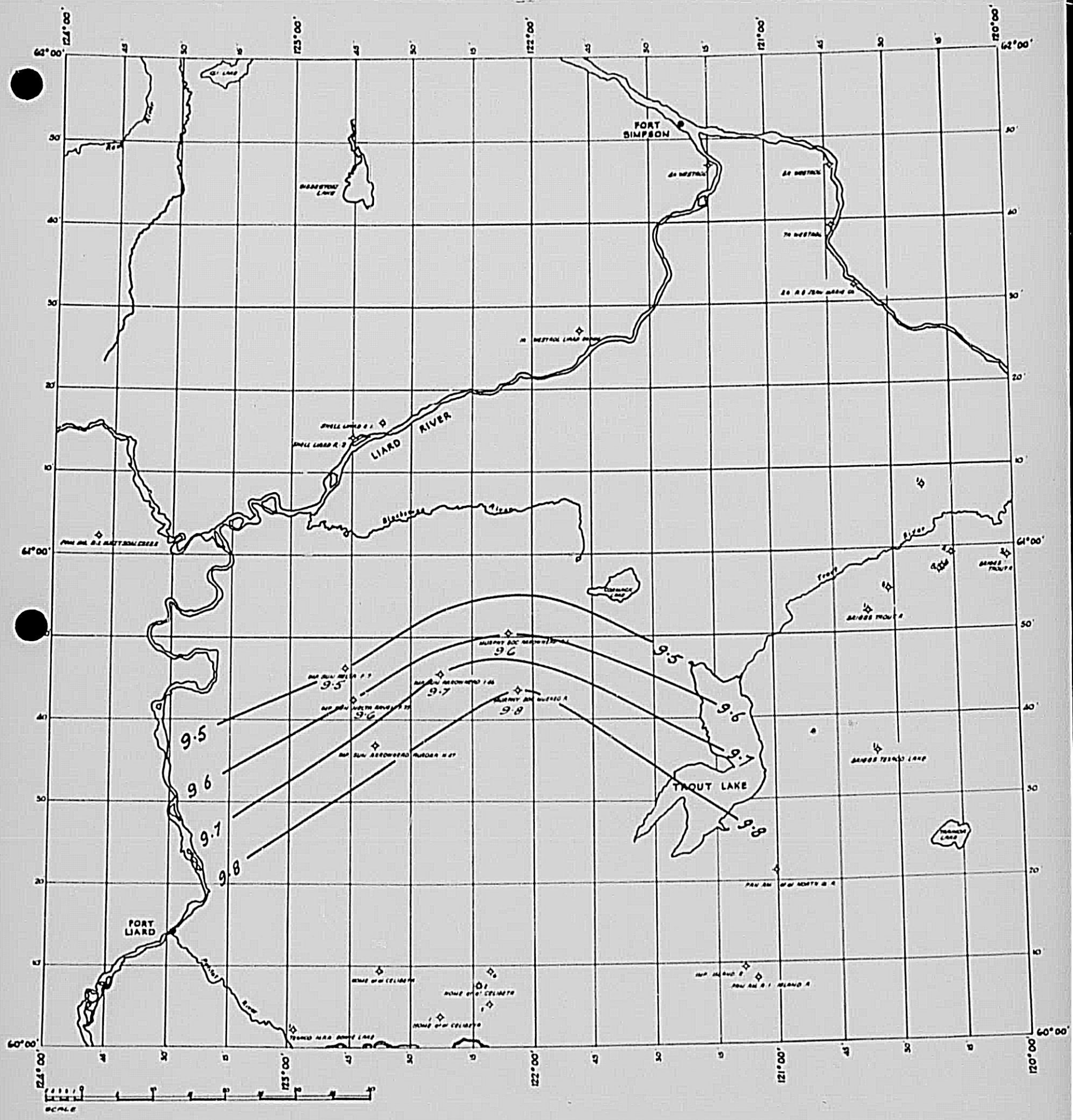
MAP NO. 9A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

MIDDLE DEVONIAN (Slave Point Fm) TO
MIDDLE DEVONIAN (Keg River Fm)
contour interval 0.005 seconds MAP NO. 9B



REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

MIDDLE DEVONIAN (Slave Point Fm) TO
MIDDLE DEVONIAN (Keg River Fm)
contour interval 0.1 foot per millisecond

MAP NO. 9C

PROJECT SUMMARY

Project LIARD RIVER

Project No. 461
Contract No. 302
Party No.

PART III - INTERPRETATION

PRINCIPAL GEOPHYSICIST A. E. Pallister SEISMOLOGIST R. G. Walker

NATURE OF PROJECT AND NUMBER OF SHOTPOINTS ANALYZED

Interpretation of Current Field Data None
Interpretation of Past Field Data (See below)
Supervision Only (Field Project)

DATA

Source*	Contractor-Date	No. of S.P.'s	Instruments	Tape System	Type of Data Received
Purchased	Accurate Exp. Ltd.	37.6 mis	Sparker		Prints of Sections
Client's	Velocity Surveys Ltd	42			Original and prints of
					Marine Seismic
					Seismograms

* Current Data, Client's Data, Trade Data, Purchased Data, etc.

COMPUTING

METHOD N/A

Base Filter _____ Datum Sea Level Datum Velocity 11,400 ft./sec.

Depth Conversion Method _____

R. V. A. Area 6 Velocity Analyses

PLAYBACK SECTIONS

Company N/A

Presentation N/A

Dynamic Correction Function N/A

Static Correction Function N/A

REPRODUCTION	Number of Copies	Destination
Final Reports	4	3 to Client - 1 to A.E.P. File
Seismograms		
Microfilm		
Sections		
Tapes		
Maps		

[redacted] VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 55' 03" N 120° 31' 34" W

NAME BRIGGS TROUT RIVER #5

R.V.A. AREA ..... K.B. 1263

INFORMATION SOURCE Sonic Log ..... T.D. 3931

INTEGRATION INTERVAL FROM 500 TO 3900 TOTAL 3400

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT./SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	500	+763				0.000
2nd Ls	760	+503	260	0.063	4.1	0.063
	1359	-96	599	0.080	7.5	0.143
3rd Ls	1750	-487	391	0.070	5.6	0.213
Simp	1810	-547	60	0.009	6.9	0.222
SpR.	3578	-2315	1768	0.322	5.5	0.544
Sl.Pt.	3632	-2369	54	0.010	5.3	0.554
	3743	-2480	111	0.015	7.3	0.569
TD(Log)	3900	-2637	157	0.016	9.7	0.585

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC

2 Ls

3 Ls

Simp

Sp.R.

Sl.Pt.

COMPUTATIONS AND REMARKS PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH .....

SHOT ELEV. .....

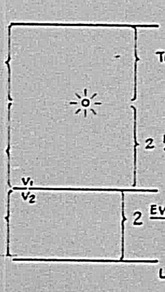
H .....

EV_2 .....

EV_2 - S.D. .....

SURVEY DATUM .....

K.B. - .....



ADDITIVE TO SURVEY TIME =====

[redacted] A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE ..... 19..

CHECKED BY ..... DATE ..... 19..

[redacted] VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 50' 22" N 122° 5' 50" W

NAME MURPHY B.O.C. ARROWHEAD RIVER #1

R.V.A. AREA ..... K.B. 2078

INFORMATION SOURCE Sonic Log T.D. 6669

INTEGRATION INTERVAL FROM 1000 TO 6650 TOTAL 5650

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+1078				0.000
			114	0.027	4.3	
	1114	+964				0.027
			367	0.091	4.0	
Det	1481	+597				0.118
			69	0.018	3.8	
Miss	1550	+528				0.136
			123	0.029	4.3	
Wab	1673	+405				0.165
			137	0.028	4.8	
1st Ls	1810	+268				0.193
			785	0.156	5.0	
	2595	-517				0.349
			45	0.009	5.0	
2nd Ls	2640	-562				0.358
			340	0.050	6.8	
	2980	-902				0.408
			852	0.159	5.3	
3rd Ls	3832	-1754				0.567
			88	0.010	8.5	
Simp	3920	-1842				0.577
			1697	0.302	5.6	
Sp.R	5617	-3539				0.879
			79	0.012	6.5	
Sl.Pt.	5696	-3618				0.891
			681	0.071	9.6	
Keg R.	6377	-4299				0.962
			67	0.007	9.8	
Sh	6444	-4366				0.969
			206	0.025	8.3	
TD(Log)	6650	-4572				0.994

INTERVAL VELOCITY

ONE HALF AND FULL IN THOUSANDS OF FT/SEC

Det
Miss
Wab
1 Ls
2 Ls
3 Ls
Simp
Sp.R
Sl. Pt.
Keg R
Sh

COMPUTATIONS AND REMARKS PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV.

SHOT DEPTH ..... Tuh. .....

SHOT ELEV. .....

H ..... $2\ H/V_1$ .....

EV_2 ..... V_1 / V_2

EV_2 - S.D. ..... $2\ \frac{EV_2 - S.D.}{V}$ .....

SURVEY DATUM .....

K.B. – ..... LAG .....

ADDITIVE TO SURVEY TIME

[redacted] VELOCITY ANALYSIS

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.
N.W.T. 60° 43' 38" N 122° 3' 45" W

NAME MURPHY - BOC MUSKEG RIVER #1

R.V.A. AREA ..... K.B. 2235

INFORMATION SOURCE Sonic Log ..... T.D. 7320

INTEGRATION INTERVAL FROM 600 TO 7300 TOTAL 6700

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	600	+1635				0.000
			400	0.100	4.0	
	1000	+1235				0.100
			374	0.084	4.4	
	1374	+861				0.184
			356	0.082	4.3	
Det	1730	+505				0.266
			55	0.014	4.0	
Miss	1785	+450				0.280
			580	0.127	4.6	
Wab	2365	-130				0.407
			157	0.032	5.0	
1st Ls	2522	-287				0.439
			774	0.138	5.6	
	3296	-1061				0.577
			71	0.013	5.4	
2nd Ls	3367	-1132				0.590
			347	0.045	7.7	
	3714	-1479				0.635
			844	0.149	5.6	
3rd Ls	4558	-2323				0.784
			89	0.010	9.2	
Simp	4647	-2412				0.794
			1602	0.286	5.6	
SpR.	6249	-4014				1.080
			51	0.009	5.9	
Sl.Pt.	6300	-4065				1.089
			725	0.074	9.8	
Keg R.	7025	-4790				1.163
			130	0.014	9.6	
Sh	7155	-4920				1.177
			145	0.018	8.0	
TD(Log)	7300	-5065				1.195

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC

Det
Miss
Wab
1 Ls
2 Ls
3 Ls
Simp
SpR.
Sl.Pt.
Keg R.
Sh

COMPUTATIONS AND REMARKS PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh. .....

SHOT ELEV. .....

H ..... $2\frac{H}{V_1}$ .....

EV_2 .....

EV_2 - S.D. ..... $2\frac{EV_2 - SD.}{V}$ .....

SURVEY DATUM K.B. – ..... LAG .....

ADDITIVE TO SURVEY TIME _____

[redacted] VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 50' N 122° 15' W

NAME IMP. SUN ARROWHEAD 1-46

R.V.A. AREA ..... K.B. 1905

INFORMATION SOURCE Sonic Log T.D. 7423

INTEGRATION INTERVAL FROM 1000 TO 7400 TOTAL 6400

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+905				0.000
	1205	+700	205	0.045	4.5	0.045
Det	1577	+328	372	0.084	4.4	0.129
Miss	1637	+268	60	0.015	4.1	0.144
Wab	2003	-98	366	0.077	4.7	0.221
1st Ls	2189	-284	186	0.036	5.2	0.257
	2968	-1063	779	0.133	5.9	0.390
2nd Ls	3074	-1169	106	0.019	5.6	0.409
	3346	-1441	272	0.035	7.9	0.444
3rd Ls	4104	-2199	758	0.133	5.7	0.577
Simp	4415	-2510	311	0.034	9.2	0.611
SpR.	6078	-4173	1663	0.279	6.0	0.890
Sl.Pt.	6142	-4237	64	0.010	6.2	0.900
Keg R.	6935	-5030	793	0.082	9.7	0.982
Sh	7080	-5175	145	0.015	9.7	0.997
TD(Log)	7400	-5495	320	0.040	8.0	1.037

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC

Det
Miss
Wab
1 Ls
2 Ls
3 Ls
Simp
SpR.
Sl.Pt.
Keg R.
Sh

COMPUTATIONS AND REMARKS PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh .....

SHOT ELEV. .....

H ..... $2\ H/V_1$ .....

EV_2 ..... V_1/V_2

EV_2 - S.D. ..... $2\ \frac{EV_2 - SD}{V}$ .....

SURVEY DATUM .....

K.B. - ..... LAG .....

ADDITIVE TO SURVEY TIME _____

[redacted] A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY [redacted] DATE Feb 1953

CHECKED BY W.R.S. DATE Mar 5 1953

[redacted] VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 50' N 122° 45' W

NAME IMP. SUN NETLA F-7

R.V.A. AREA ..... K.B. 2019

INFORMATION SOURCE Sonic Log ..... T.D. 7775

INTEGRATION INTERVAL FROM 1000 TO 7750 TOTAL 6750

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT / SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+1019				0.000
	1620	+399	620	0.135	4.6?	0.135
Miss?	1956	+63	336	0.069	4.9	0.204
Wab	2050	-31	94	0.022	4.2	0.226
1st Ls	2306	-287	256	0.048	5.3	0.274
	3094	-1075	788	0.142	5.6	0.416
2nd Ls	3186	-1167	92	0.016	5.6	0.432
	3463	-1444	277	0.037	7.4	0.469
	5670	-3651	2207	0.366	6.0	0.835
SpR.	6236	-4217	566	0.092	6.2	0.927
Sl.Pt.	6333	-4314	97	0.014	6.8	0.941
Keg R.	7198	-5179	865	0.091	9.5	1.032
Sh	7430	-5411	232	0.022	10.5	1.054
TD(Log)	7750	-5731	320	0.039	8.2	1.093

INTERVAL VELOCITY

ONE HALF AND FULL IN THOUSANDS OF FT /SEC

Miss?
Wab
1st Ls
2nd Ls
SpR.
Sl.Pt.
Keg R.
Sh

COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh. .....

SHOT ELEV. .....

H ..... $2\ H/V_1$ .....

EV_2 ..... V_1

EV_2 - S.D. ..... V_2 $2\ \frac{EV_2 - S.D.}{V}$ .....

SURVEY DATUM .....

K.B. - ..... LAG .....

ADDITIVE TO SURVEY TIME _____

[redacted] A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE .....

CHECKED BY ..... DATE .....

[redacted] VELOCITY ANALYSIS

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.
N.W.T. 60° 50' N 122° 30' W

NAME IMP. SUN NETLA RAVEN F-73

R.V.A. AREA ..... K.B. 1966

INFORMATION SOURCE Sonic Log T.D. 7959

INTEGRATION INTERVAL FROM 1000 TO 7950 TOTAL 6950

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT./SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+966				0.000
			695	0.143	4.8	
	1695	+271				0.143
			342	0.070	4.9	
Det	2037	-71				0.213
			59	0.014	4.3	
Miss	2096	-130				0.227
			450	0.095	4.7	
Wab	2546	-580				0.322
			229	0.042	5.4	
1st Ls	2775	-809				0.364
			840	0.138	6.1	
	3615	-1649				0.502
			108	0.018	5.8	
2nd Ls	3723	-1757				0.520
			255	0.033	7.7	
	3978	-2012				0.553
			1159	0.192	6.0	
Simp?	5137	-3171				0.745
			1027	0.175	5.9	
	6164	-4198				0.920
			603	0.100	6.0	
SpR.	6767	-4801				1.020
			107	0.016	6.8	
Sl.Pt.	6874	-4908				1.036
			762	0.079	9.6	
Keg R.	7636	-5670				1.115
			314	0.032	9.9	
TD(Log)	7950	-5984				1.147

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT./SEC

Det
Miss
Wab
1 Ls
2 Ls
Simp?
SpR
Sl Pt.
Keg R.

COMPUTATIONS AND REMARKS PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....
SHOT DEPTH ..... Tuh. .....
SHOT ELEV. .....
H ..... $2\frac{H}{V_1}$ .....
EV_2 .....
EV_2 - S.D. ..... $2\frac{EV_2 - S.D.}{V}$ .....
SURVEY DATUM .....
K.B. - ..... LAG .....

ADDITIVE TO SURVEY TIME _____

EVALUATION

FROM GEOPHYSICAL DATA

OF THE

LIARD RIVER AREA

OF

NORTHWEST TERRITORIES, CANADA

FOR

WESTERN DECALTA PETROLEUM LTD.

BY

A. E. PALLISTER CONSULTANTS LTD.

Calgary, Alberta, Canada November, 1963

PROJECT NO. 461

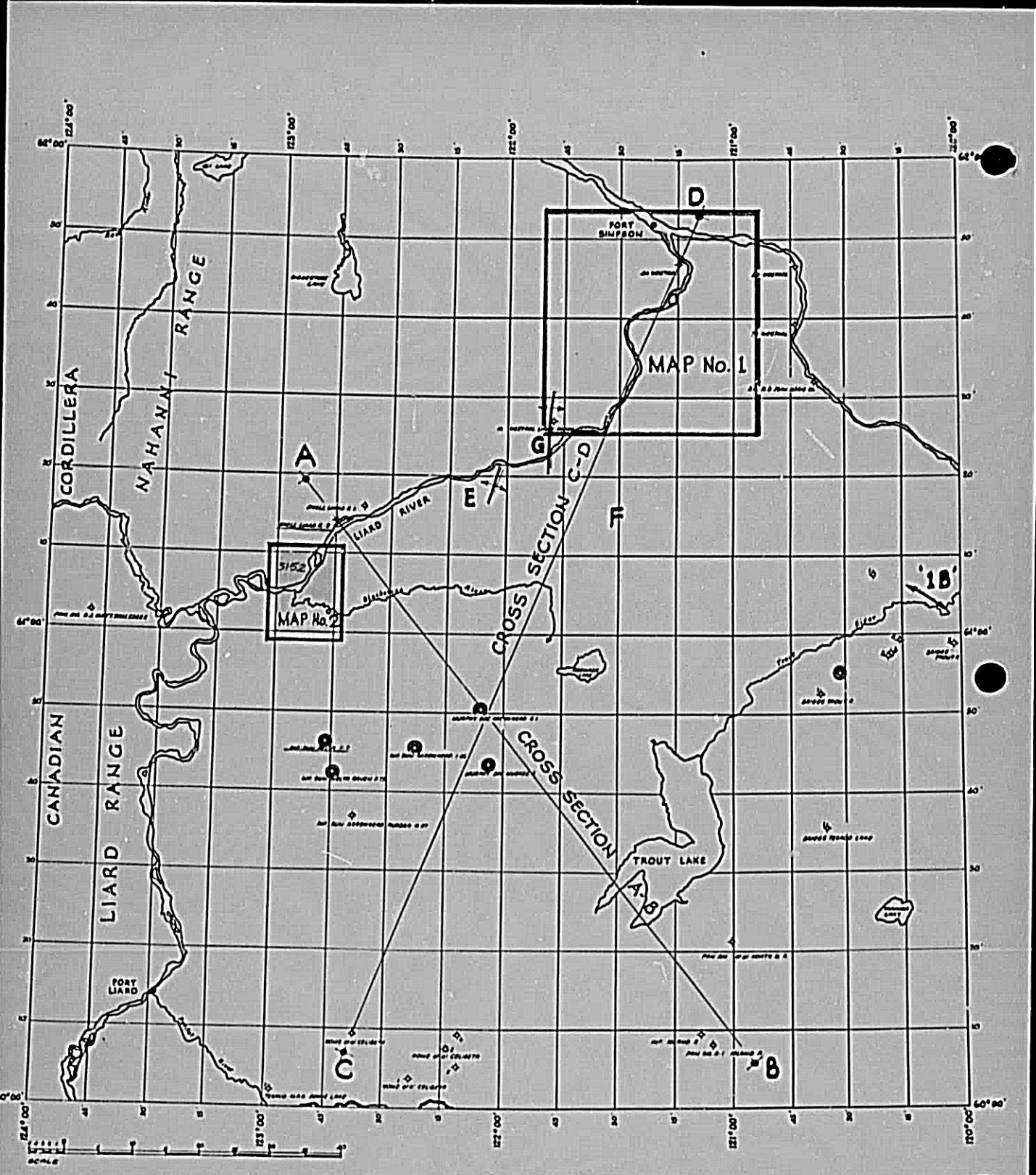
CONTENTS

PART I

EVALUATION

PART II

TECHNICAL DISCUSSION



INDEX MAP OF LIARD RIVER REGION

A·E·PALLISTER CONSULTANTS LTD.

SONIC LOG WITH VELOCITY ANALYSIS
PERMIT No. 3152

SPARKER SURVEY

PART I

EVALUATION

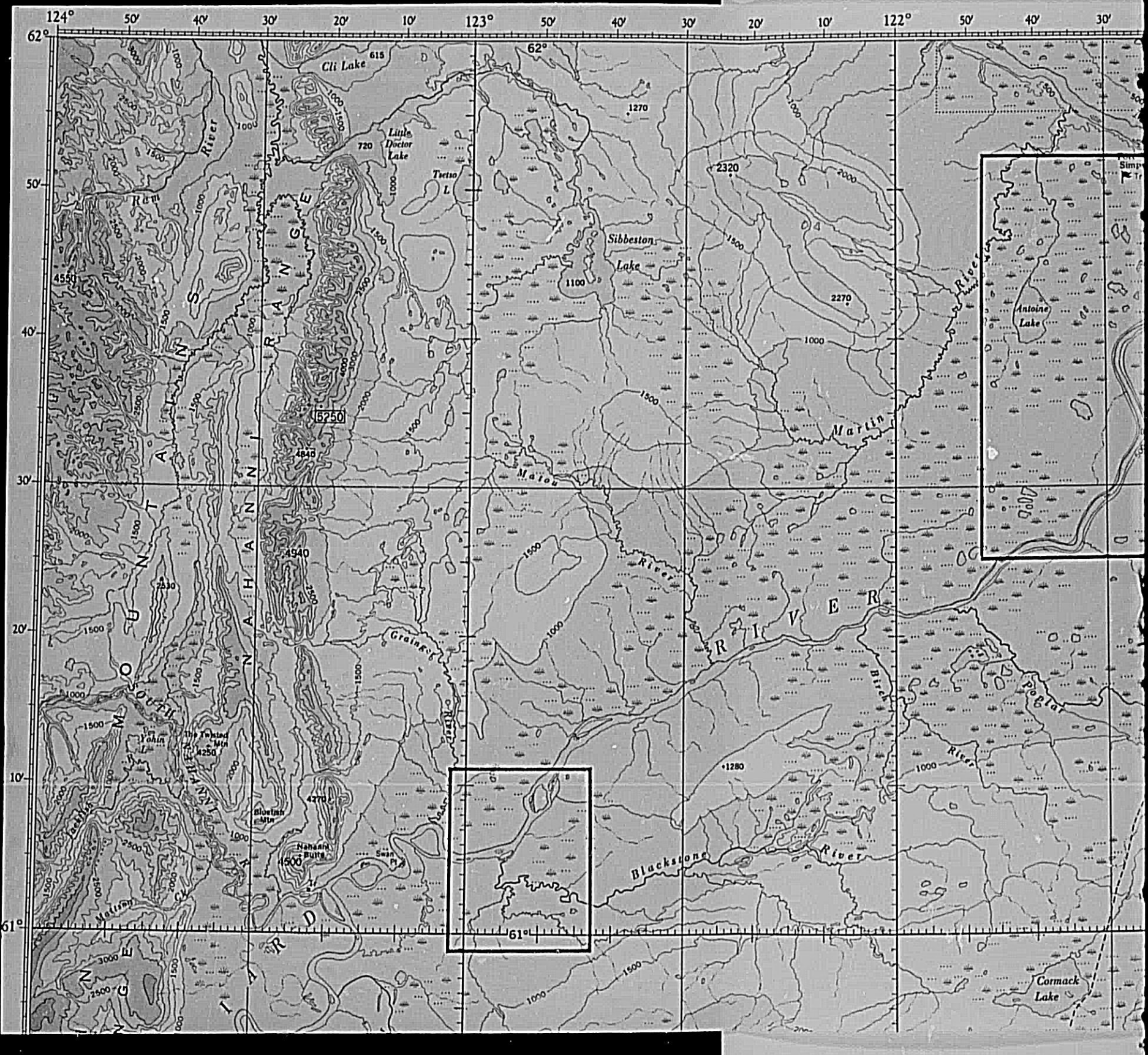
ABSTRACT

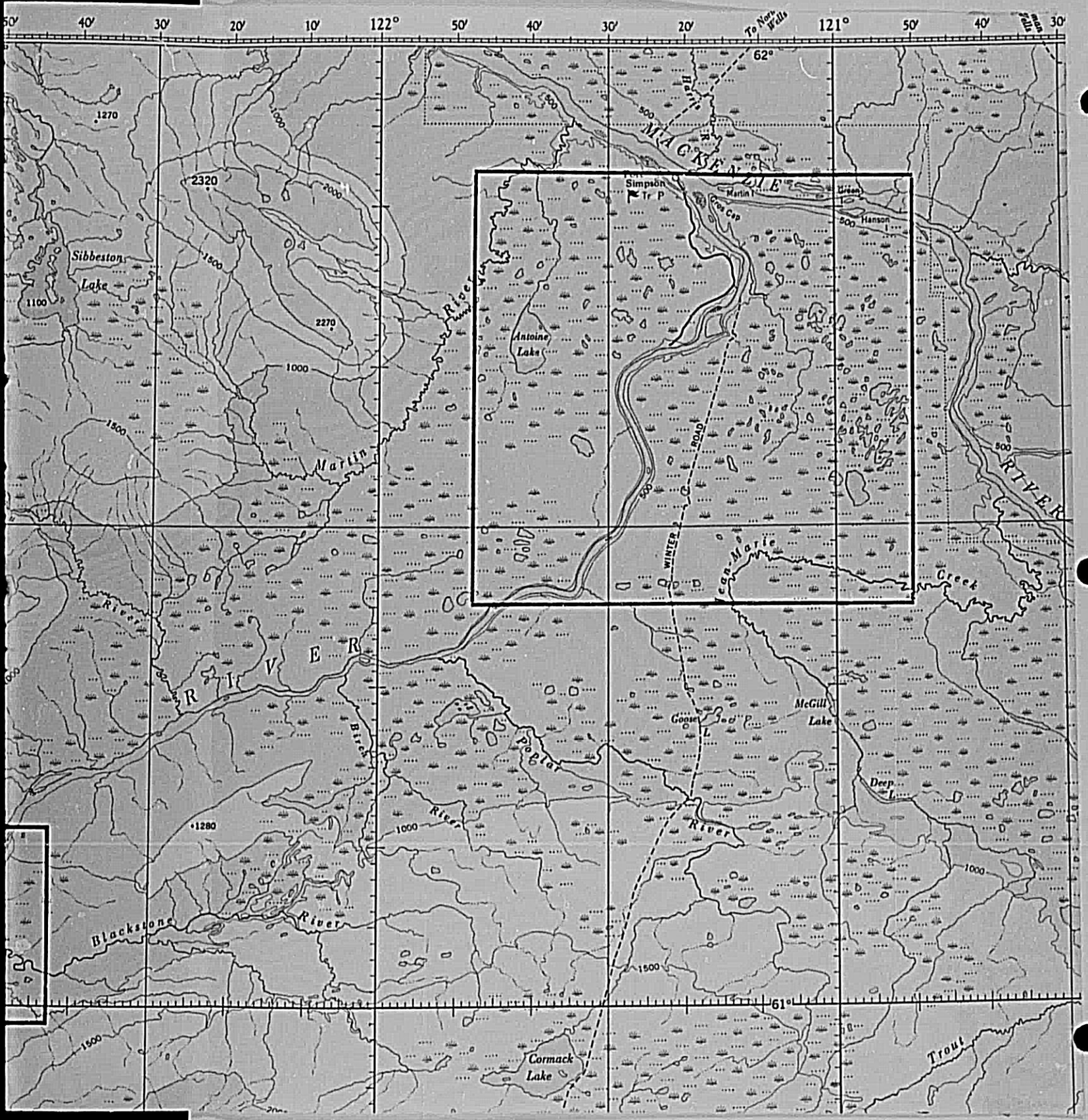
The Liard River prospect is located in the Canadian Northwest Territories, some 70 miles north of the British Columbia boundary. The area is of interest, since considerable structure is known to be present, and porosity and facies changes take place laterally within the Devonian carbonates. To date, little oil or gas has been encountered in these environs; however, well control is extremely sparse.

In order to evaluate a petroleum and natural gas permit, several types of geophysical data, which included continuous marine-borne sparker, correlation water-located seismic, and geophysical acoustical logs were analysed. These data were sufficient to locate major structural anomalies, by extrapolating Slave Point geologic contours into areas without well control.

From the sparker data, three anticlinal axes were shown near the mouth of the Liard River, while one major anticlinal axes was indicated within Permit No. 3152 from the seismic data. The control was not sufficient to postulate structural closure in these anomalous areas. The Regional Velocity Analysis indicated the lateral behavior of velocity/rock-units, from velocity, thickness and transit-time standpoints. The acoustical logs also served to indicate the location of numerous formational sub-crops.

The combination of results derived from these three sources provided maps which can guide future geophysical exploration.


124°
50'
40'
30'
20'
10'
123°
50'
40'
30'
20'
10'
122°
50'
40'
30'
62°
50'
40'
30'
20'
10'
61°
Cli Lake
615
Little Doctor Lake
720
Tretso L.
1270
2320
Sibbeston Lake
1100
2270
Antoine Lake
Simpson Trail
Ram River
MUNTAINNI RANGE
5250
4840
4550
4940
2830
Martin River
Maton River
Grainger River
Birch River
Poplar River
Blackstone River
MOUNTAINS
SOUTH
Yohin
The Twisted Mtn
4250
Bluefish Mtn
4270
Nahaani Butte
4500
Swan Pt.
Cormack Lake
1280
1000
1500
2000
2500
3000


50'
40'
30'
20'
10'
122°
50'
40'
30'
20'
To Norman Wells
121°
50'
40'
30'
62°
MACKENZIE
RIVER
Harris R.
Simpson Tr P
Martin L
Green L
Gros Cap
Hanson L
Sibbeston Lake
Antoine Lake
Martin River
WINTER ROAD
Jean-Marie Creek
Blackstone River
Birch River
Poplar River
Goose Feet P.
McGill Lake
Deep L.
Trout
Cormack Lake
61°
1270
2320
2270
1280
1100
2000
1500
1000
500

EXPLORATION PROGRAM

The prospect is located near the junction of the Liard and South Nahanni Rivers, some 70 miles up-stream from Fort Simpson, which is located at the junction of the Liard and Mackenzie Rivers. The permit is 300 miles south-southeast of Norman Wells, where oil production is being obtained from the limestone member of the Ramparts Formation (Kee Scarp Limestone) of the Upper Devonian.

The major potential reservoir for oil and gas production in this area is in the Middle Devonian-Slave Point Formation, where porosity can be present, sometimes from a reef facies. The area is the scene of structural folding, as illustrated by Shell-Liard River No. 2, 6 miles north of the permit. The structural attitude of the reservoir beds can be measured from seismograph and sparker data. As a means of providing reconnaissance structural control, seismic shotpoints were recorded in water bodies within Permit No. 3152, and sparker control was obtained in the navigable part of the Liard River, up to the Liard Rapids. These methods were used, since they provide a reduced cost reconnaissance-type control, utilizing water bodies, eliminating the need for a fully-equipped seismic crew.

Acoustical logs in nearby wells were studied from a geophysical viewpoint, in order to show regional velocity conditions in direct evaluation of the permit area, and in the determination of future geophysical methods compatible with all known geological and geophysical parameters.

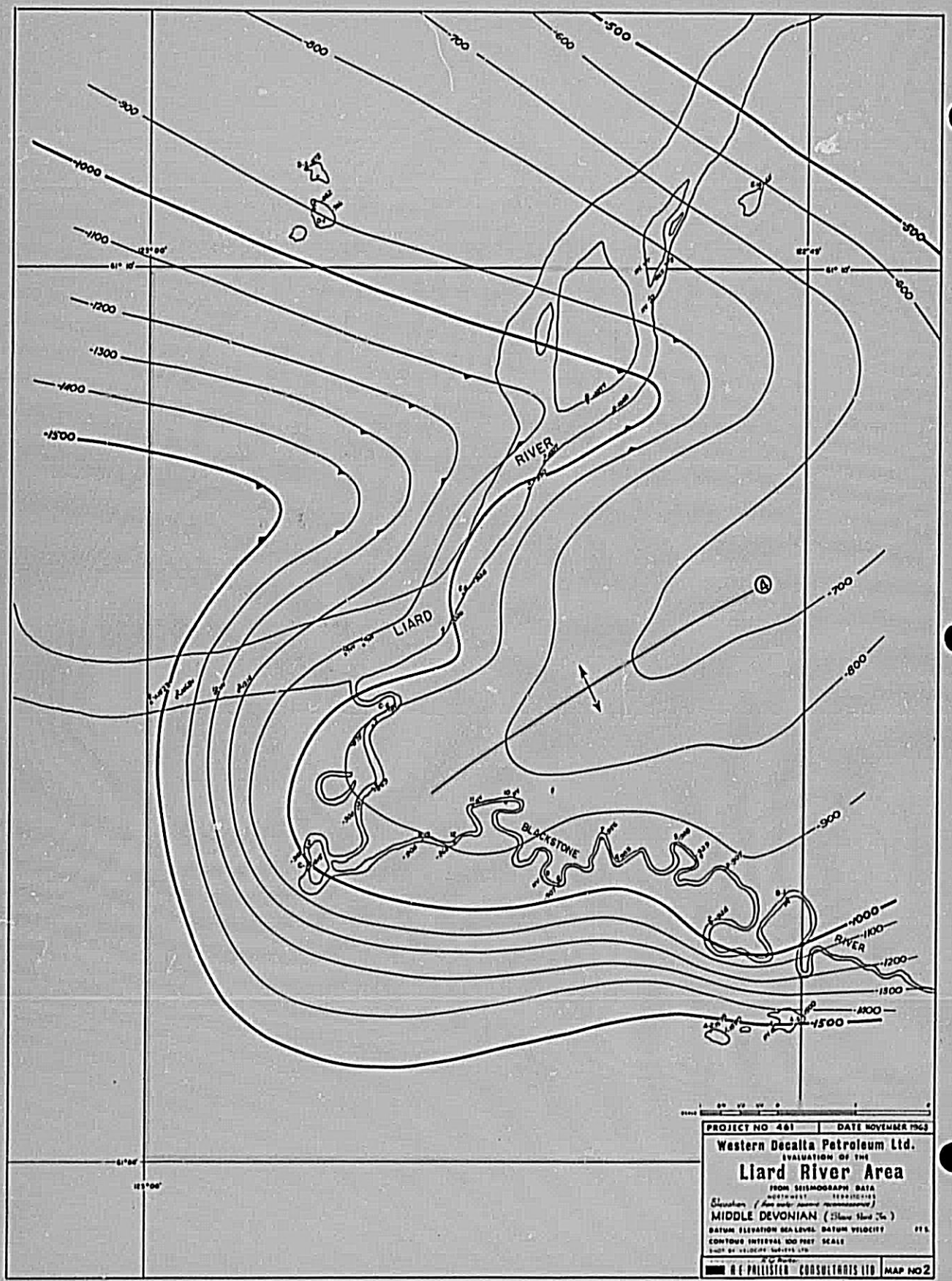
An emphasis was placed on the mapping and assessment of the Slave Point, the prime objective. In the areas of geophysical control, very little sediments are preserved above the Slave Point.

CONCLUSIONS

Four features of interest were mapped from the geophysical data. The first three, in the lower Liard River, are indicated to be anticlinal trends associated with the Simpson Arch to their northwest. The structural reversal flanking these trends is quite minor, with Feature Two showing the maximum reversal of some 80 feet - on the line of control.

Within the permit, Feature Four is indicated as a southwest-plunging anticlinal trend which may possess closure to the northeast. Additional control would be necessary to confirm this postulation. This anticline shows some 700 feet of relief on its flanks, and can be contoured as a southwestern extension of the anomaly encountered at Shell-Liard River No. 2, with the Slave Point indicated to be some 1,000 feet lower within the permit area than at the Shell test. Although this interpretation is subject to contour options, the most structurally interesting area is Feature Four.

The results of this evaluation should be used in eventual geophysical surveys, in the confirmation of these anomalies, and in the exploration for areas where closure is present.



PROJECT NO 461 | DATE NOVEMBER 1963

Western Decalta Petroleum Ltd.

EVALUATION OF THE

Liard River Area

FROM SEISMOGRAPH DATA

Elevations (from sonic control recommended)

MIDDLE DEVONIAN (Slave Point Fm.)

DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.

CONTOUR INTERVAL 100 FEET SCALE

SHOT BY VELOCITY SURVEYS LTD.

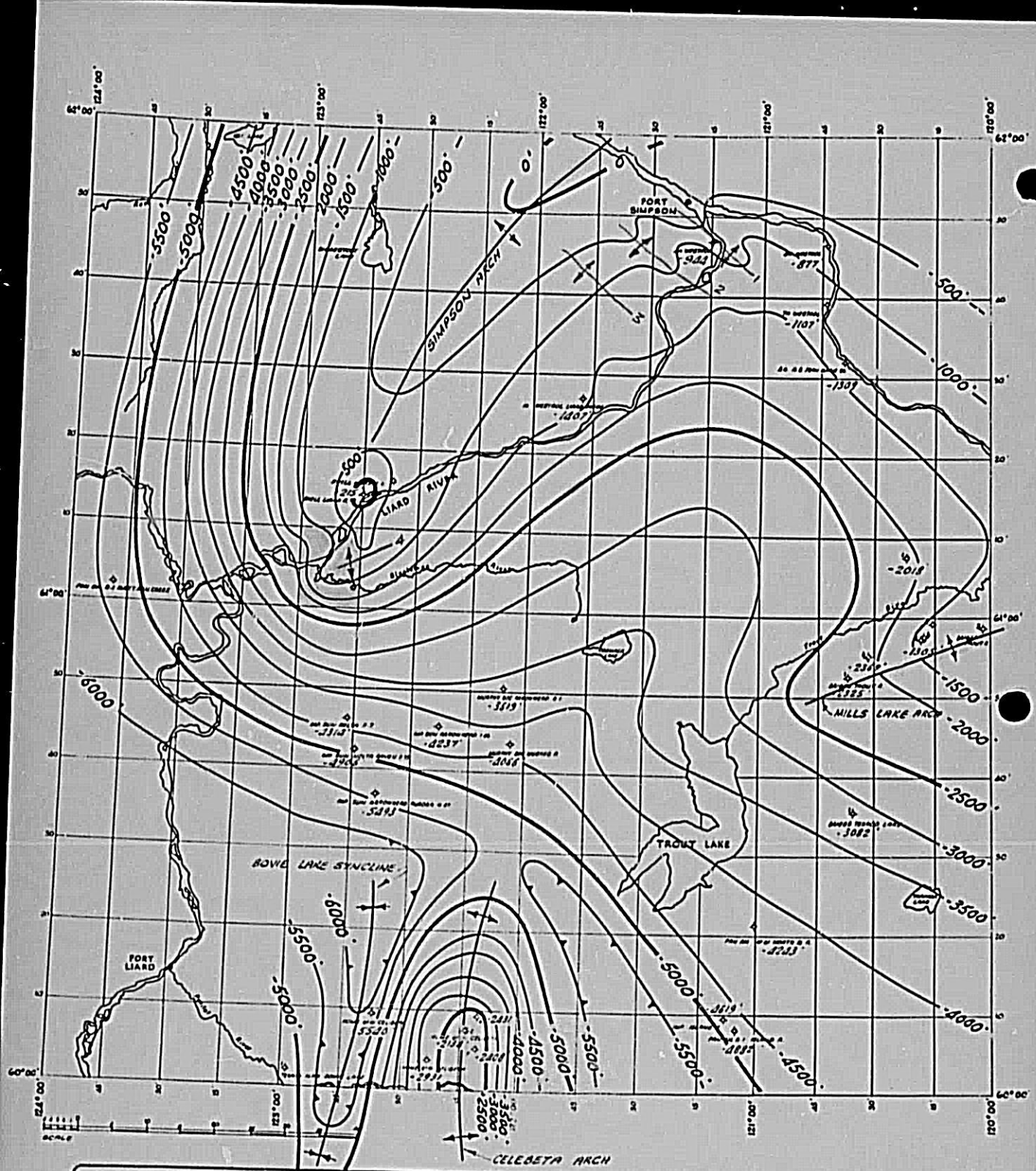
R. E. PHILLIPSON CONSULTANTS LTD | MAP NO 2

Detracting from the interpretation are:

(a) Limited reliability of conclusions from weak geophysical information, which cannot be expected to be as definitive as conventional (and more costly) seismic reflection shooting techniques.

(b) The position of the control leaves the seismologist with many options of contouring.

The conclusions derived from this reconnaissance analysis are restricted to a structural evaluation, and are subject to confirmation. Geologic considerations of facies characteristics and changes will be equally important in acreage assessment.



SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm).

A·E·PALLISTER CONSULTANTS LTD

contour interval 500 feet

MAP NO. 3A

RECOMMENDATIONS

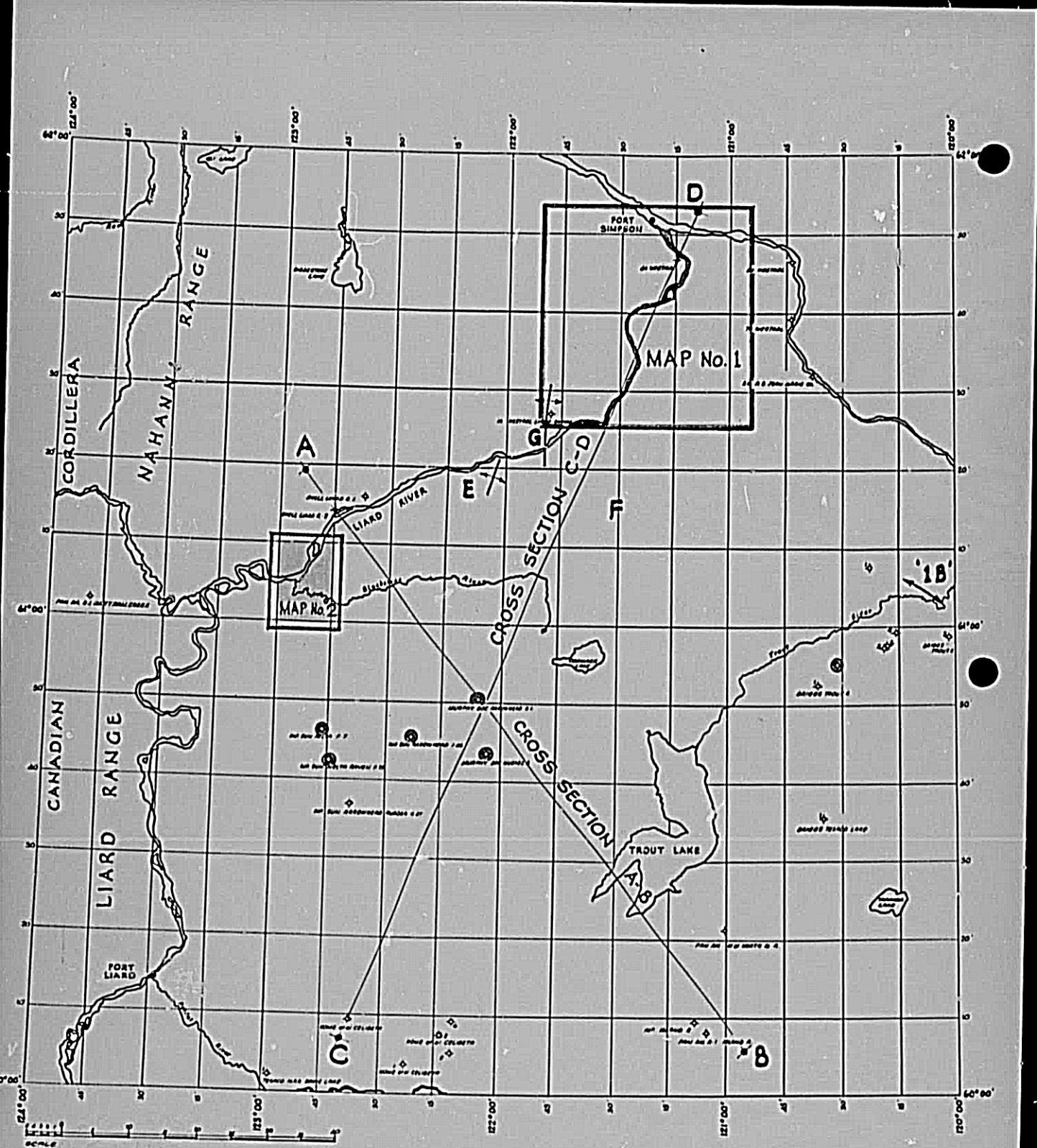
The location of the anomalous areas, as indicated by this analysis, can be used in the guidance of land acquisition, and in the eventual positioning of other geophysical surveys, which should precede stratigraphic testing.

The information available to date is not sufficient to recommend a test location; however, this evaluation has resulted in providing a good basis from which to conduct future exploration.

Particular attention is drawn to the structural anomaly, Feature Four, located within Permit No. 3152.

Respectfully submitted,

A. E. Pallister, P. Geoph.
Principal Geophysicist.



INDEX MAP OF LIARD RIVER REGION

A·E·PALLISTER CONSULTANTS LTD·

SONIC LOG WITH VELOCITY ANALYSIS
PERMIT No. 3152

SPARKER SURVEY

PART II

TECHNICAL DISCUSSION

GEOLOGIC CONTROL

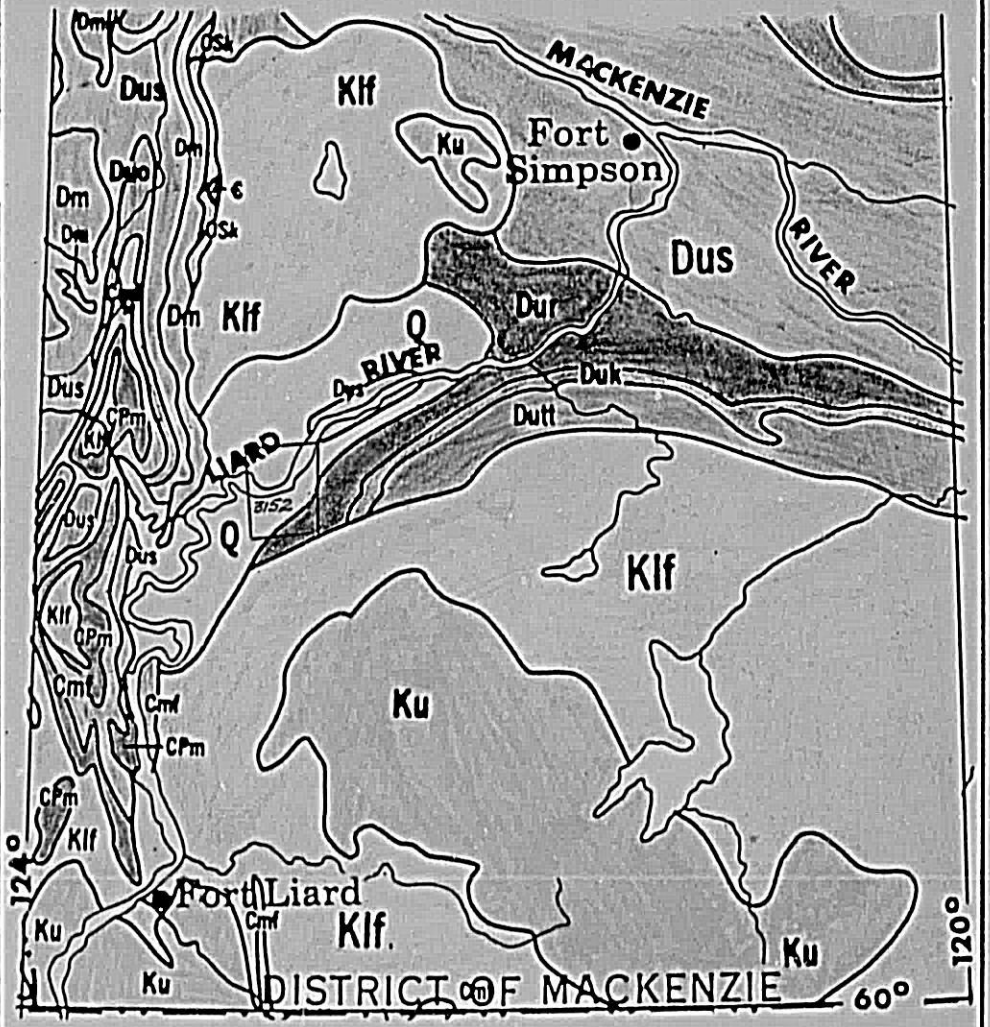
The Liard River Area is located in the southwestern interior plains of the Northwest Territories, on the south side of the Liard River, about 70 miles southwest of Fort Simpson. The project lies on the east edge of the Canadian Cordillera at the south end of the Nahanni Range, and directly east of the Liard Range.

Five structural trends are superimposed on the Western Canada Sedimentary Basin within the regional map area:

1. Simpson Arch - The Simpson Arch enters the map area from the north and trends south-southwest.
2. Celibeta Arch - The Celibeta Arch enters from the south, east of the Home-et al-Celibeta No. 1 well, and trends north.
3. Bovie Lake Syncline - The Bovie Lake Syncline enters the map area from the south, west of Home-et al-Celibeta No. 7 well, and trends north.
4. Mills Lake Arch - Trends southwest, north of Briggs Tetcho Lake well.
5. Rocky Mountain Cordillera - The first thrust fault is present 15 miles west of the permit area. There are no indications of foothills in the zone east of the Rockies, such as those that exist further south.

From the accompanying Geologic Map, it can be seen that the outcrops, 45 miles along the Liard River from the Mackenzie River, are composed of Upper Devonian shales and limestones. Quaternary and Recent deposits are present along the rest of the Liard River, within the map area.

ERA	PERIOD	LEGEND OF GEOLOGY FOR LIARD RIVER REGION	
CENOZOIC	QUATERNARY AND RECENT	Q	SURFICIAL DEPOSITS
MESOZOIC	UPPER CRETACEOUS	Ku	FORT NELSON, KOTANEELEE, ETC.
		Klf	FORT ST. JOHN GROUP
PALEOZOIC	MISSISSIPPIAN	CPm	MATTSON, FANTASQUE
		Cmf	FLETT, CLAUSEN, YOHIN
		DC	SHALE, SLATE, SILTSTONE (Devonian & Mississippian)
	UPPER DEVONIAN	Dur	REDKNIFE
		Duo	ONSE BAY
		Dutt	TROUT RIVER, TETCHO
		Duk	KAKISA
		Dus	FORT SIMPSON (may include Middle Dev. Sh.)
	MIDDLE DEVONIAN	Dm	NAHANNI, BEAR ROCK, HUME.
	ORDOVICIAN & SILURIAN	OSk	MOUNT KINDLE, FRANKLIN MOUNTAIN
	CAMBRIAN	€	SANDSTONE, SHALE



GEOLOGIC MAP OF THE LIARD RIVER REGION

taken from Geological Survey of Map No 30 - 1963

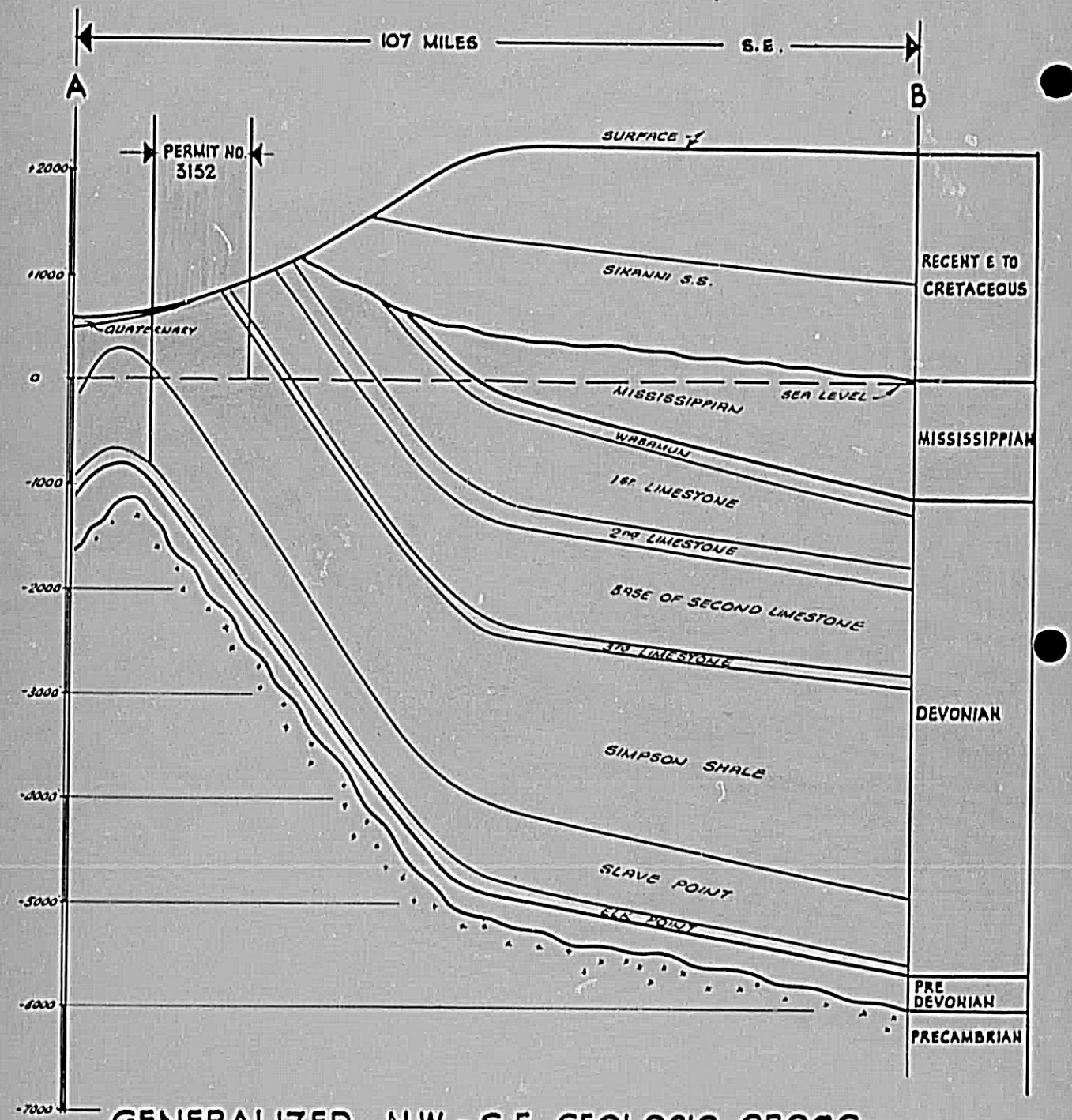
Seven wells have been drilled near Fort Simpson and along the Liard River; six other wells are located between Trout Lake and Liard River. All of these wells were dry and abandoned except for the Imperial-Sun-Netla No. F-7, which is a shut-in Slave Point gas well.

South of 61° north latitude, and west of 123° west longitude, the Slave Point Formation dips southwest at approximately 140 feet per mile. East of 122° west longitude, and north of 61° north latitude, the Slave Point horizon dips 30 feet per mile to the southwest, between 60° 00' and 60° 30' north latitude, and east of 123° west longitude, the Slave Point Formation dips north at 120 feet per mile. The Mesozoic erosional surface and formations above it have little dip.

GEOLOGIC SYSTEM	THICKNESS (Ft)
Recent and to Cretaceous	0 - 1700
Mississippian - erosional	0 - 2600
Devonian	1200 - 4700
Pre-Devonian	0 - 500 (estimate)
TOTAL	1200 - 9500

Average geologic column in the Liard River Area.

Devonian rocks outcrop on the north edge of the basin, which is developed in the Trout Lake region. Along the Liard River, the Simpson Shale is outcropping; thus, between the basin and the Liard River, approximately 8,000 feet of the above total section disappears.



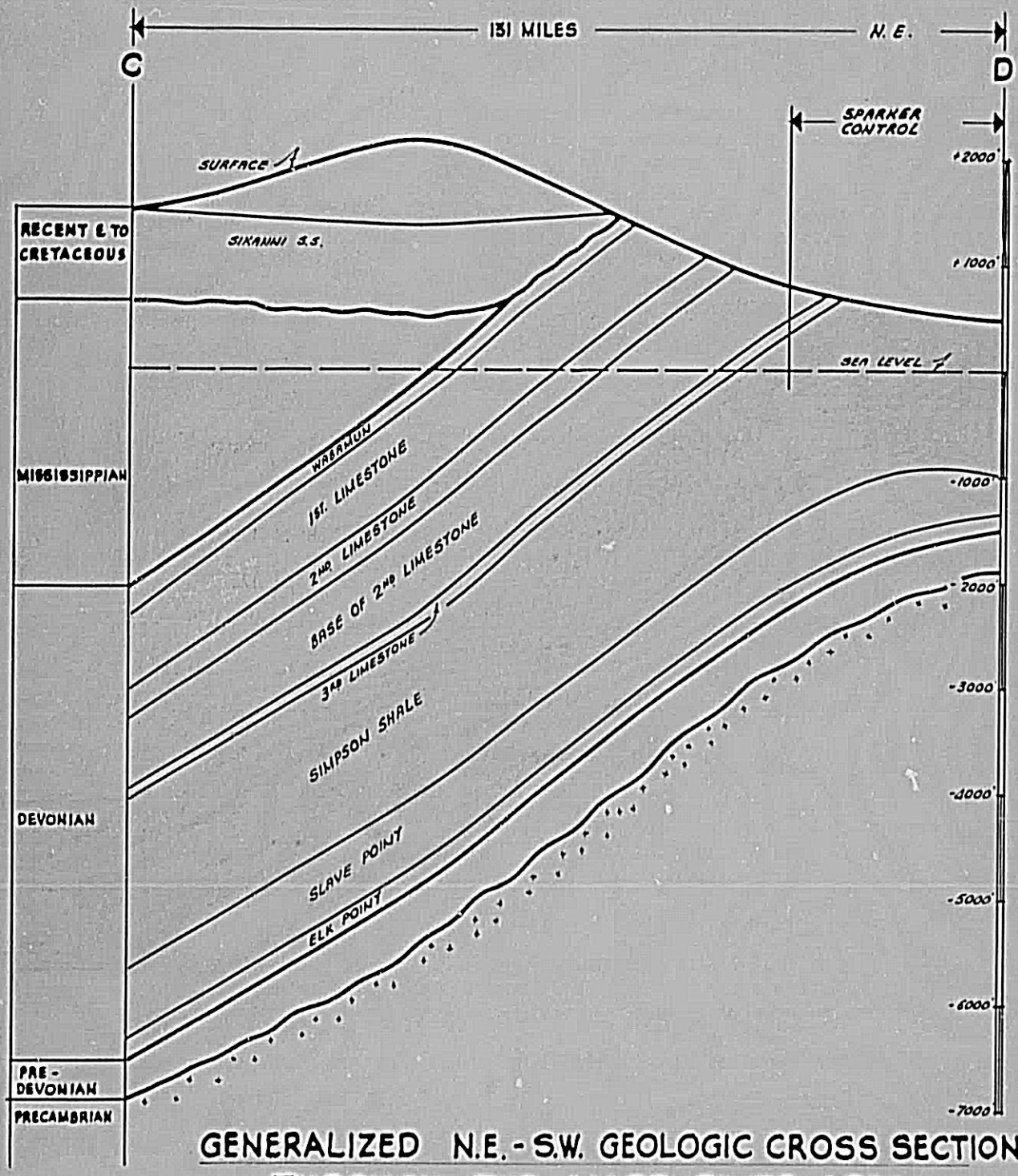
GENERALIZED N.W. - S.E. GEOLOGIC CROSS SECTION THROUGH THE LIARD RIVER AREA

Geologic reports available at the Department of Northern Affairs point out some interesting surface anomalies in the region. A report written, in 1952, by L. J. Martin for The British American Oil Company Limited, discusses the existence of domal structures along the Trout River. A location approximately 61° north latitude and 120° west longitude, Feature "IB" (see Index Map), appears as a domal structure three-quarters of a mile long with 3° dip up-stream, and 2° down-stream, possibly draping over a reef body in the Hay River Limestone (Base of Second Limestone?).

A report, by G. Dann, 1952, mentions the existence of small, sharp folds along the Matou River. Other features in the Hay River Formation, possibly associated with reef drape, also were described along Birch River (Feature E) and Poplar River (Feature F.)

A letter by C. Warren Hunt, November 2, 1953, contained in the Westerol 1A File (Department of Northern Affairs) outlined some of the preliminary thought that went into the drilling of the Westerol wells.

> "The Westerol 3A well found the thin sedimentary cover above the basement rocks that had been hoped for, Precambrian being encountered slightly above total depth of 2,422 feet. Unfortunately, the Devonian reef, which had been sought, was not developed and, while the well found small oil showings in the Middle Devonian, no substantial porosity was found.....
>
> "Three further wells were drilled during the summer, the Westerol 7A, Westerol 4A and B.A.-Hudson Bay-Trail Creek No. 1. These wells succeeded in establishing very definitely an east-west strike, and a south dip of some 35 feet per mile. Secondly, a showing of oil and some porosity was encountered in the Westerol 7A well in the Middle Devonian.....



GENERALIZED N.E. - S.W. GEOLOGIC CROSS SECTION THROUGH THE LIARD RIVER AREA

"Westerol Liard Rapids 1A was drilled basically as a stratigraphic test..... The well was located on the best known structure in the area, an anticline outcropping on the banks of the (Liard) River above the main rapids. The anticline has a northward dip of about 20° and gave evidence of having about 200 - 300 feet of amplitude on the river section. No closure could be proved northward or southward in the direction of the axis....."

VELOCITY ANALYSIS

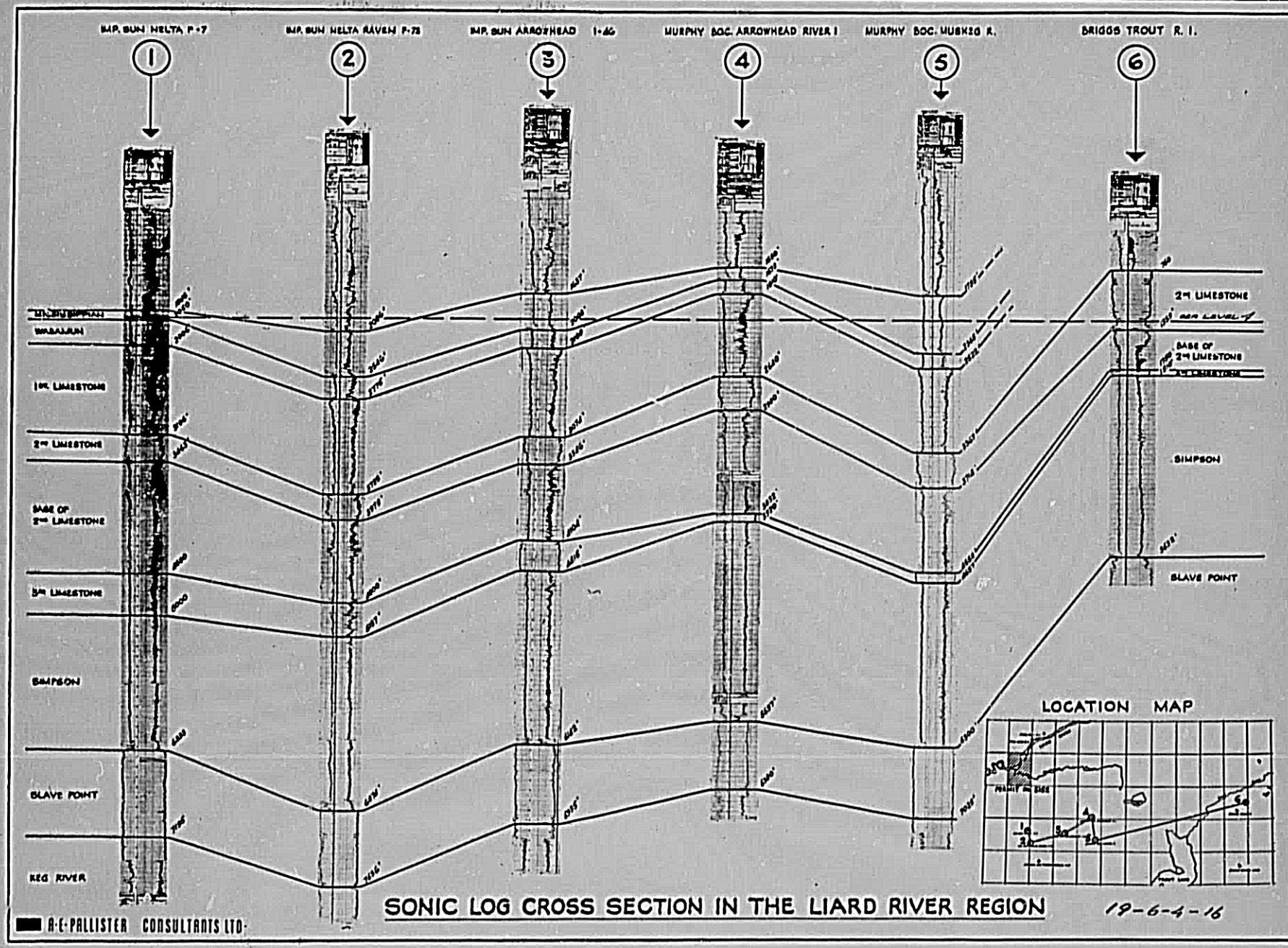
Velocity information for the area was obtained by the integration of the sonic logs from the following wells:

Murphy-B.O.C.-Muskeg River No. 1	-	60° 43' 38" N 122° 3' 45" W
Imperial-Sun-Arrowhead I - 46	-	60° 45' 30" N 122° 23' W
Imperial-Sun-Netla-Raven F-73	-	60° 42' 30" N 122° 44' W
Imperial-Sun-Netla F-7	-	60° 46' 30" N 122° 45' 50" W
Murphy-B.O.C.-Arrowhead River No. 1	-	60° 50' 22" N 122° 5' 50" W
Briggs-Trout River No. 5	-	60° 55' 03" N 120° 31' 34" W

A total of 35,850 were integrated from the above wells.

No velocity information was available in the area of seismic control. Mean interval velocities and isopachs were calculated from control, which is located south of the project area.

The next step, after calculating the velocities and isopachs, was to project the calculated velocities into the area of seismic control. This was done by studying the geology of the prospect area; for example, Simpson-Shale outcrops along the Liard River. Since the horizon of interest in this report is the Slave Point Formation,



SONIC LOG CROSS SECTION IN THE LIARD RIVER REGION

19-6-4-16

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the velocity down to it, along the Liard River, can be narrowed down to that of the Simpson Shale, plus the velocity of the low-velocity zone. In the case where the sparker seismic was used, this low-velocity layer would include the river, and the zone below the river. Since the depth of the water and the saturated zone is shallow, in comparison with the thickness of the Simpson Shale, the water and the saturated layer would not greatly alter the average velocity down to the Slave Point Formation.

VELOCITY/ROCK-UNIT	AVERAGE ISOPACH (Ft)	AVERAGE HALF-VELOCITY (Ft/0.001 sec)
K.B. - 1000 to Detrital Zone	706	4.5
Detrital Zone to Mississippian	61	4.1
Mississippian to Wabamun	323	4.6
Wabamun to First Limestone	193	5.2
First Limestone to Second Limestone	878	5.6
Second Limestone to Base of Second Limestone	348	7.5
Base of Second Limestone to Third Limestone	711	5.6
Third Limestone to Simpson Shale	137	8.7
Simpson Shale to Spence River	1672	5.7
Spence River to Slave Point	75	6.4
Slave Point to Keg River	765	9.6
Remainder of Section	Not Known	

Average isopachs and interval velocities in the Liard River Area.

In Permit No. 3152, the depth of the Slave Point Formation increases from about - 500 feet to - 1500 feet below sea level and, thus, a gradient velocity can be seen on the accompanying maps.

The changes in velocities are in a direct proportion to the depth of present day burial of the various formations. It can be seen on the generalized dip sections that the depth of burial increases rapidly southward from Permit No. 3152 and the Liard River.

The "Average velocity and average isopach" table was calculated from sonic logs, and should not be applied as such to any particular area without compensating for the depth of burial and lithologic changes. The variations in isopachs and velocities can be readily seen on the accompanying maps (Map Nos. 4A to 9C.)

If further seismic work is to be carried out in this area, reflections could be predicted to arrive from the following velocity interfaces:

Detrital/Mississippian

Wabamun/First Limestone

First Limestone/Second Limestone

Second Limestone/Base of Second Limestone

Base of Second Limestone/Third Limestone

Third Limestone/Slave Point Formation

Slave Point Formation/Keg River Formation

Interfaces expected to produce seismic reflections.

Due to the fact that the Slave Point Formation was located at a depth of 407 feet, in the Shell-Liard River No. 2 well, long off-set shooting would not be recommended. There is a very good possibility that, if long off-sets were used in the Shell-Liard River No. 2 area, refractions instead of reflections will be recorded.

GEOPHYSICAL APPRAISAL

A sparker survey of the Liard River was carried out by Accurate Exploration Ltd., on July 26th and 30th, 1959. Velocity Surveys Ltd. shot a reconnaissance water seismic survey of Permit No. 3152 on September 13th to 16th, 1961.

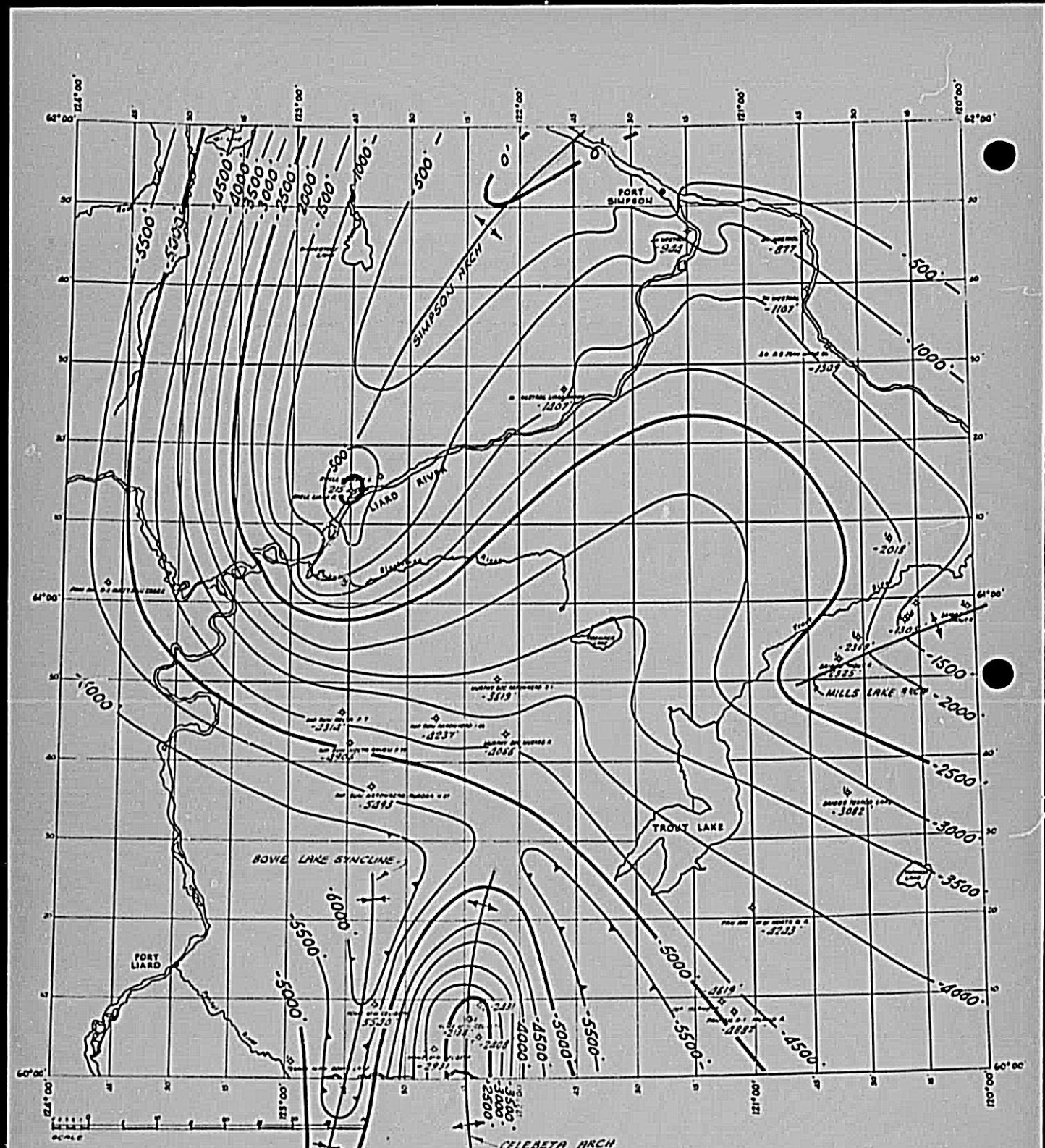
The sparker records for this survey were below par, due to high noise level caused by high boat speed down the river, and also vibration on the survey boat. The record quality of the water seismic was poor to fair.

Due to large off-sets on the water seismic, and the shallowness of the section, only one or two reflections were recorded. Jump correlations on these records were hampered by the fact that the reflection picked was located very close to the first breaks. Frequency and character changes also added to the correlation problem.

One phantom horizon was projected on the sparker records. Numerous multiples were apparent on the sparker data, but these did not interfere with the fictitious horizon picked. The sparker seismic was conducted as a single nearly straight-line traverse. This traverse makes it almost impossible for the interpreter to determine three dimensional geology.

The water seismic was shot with charges varying from 1¼ to 15 pounds, with a shot depth varying from 2 to 7 feet. The sparker records were recorded by towing an electrode 250 feet astern of the survey boat. This electrode is controlled to emit a spark of 10,000 volts every 2 to 4 seconds. This method provided a continuous section of the geologic structure beneath the survey boat.

The Regional Velocity Analysis served to indicate the behavior of velocity/rock-units laterally, from both a velocity and a thickness standpoint (see Map Nos. 4A to 9C.) The Velocity Analysis also helped to simplify the geologic correlation and will be useful for any further seismic interpretations in the area.



SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm).

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contour interval 500 feet

MAP NO. 3A

GEOPHYSICAL - GEOLOGICAL INTEGRATION

The Slave Point Elevation Map was prepared from the Sparker Survey in the following manner:

An isochron was calculated for the interval from sea level to the Slave Point horizon at the Westerol 4A well. A half-velocity of 5.7 feet per millisecond was used to compute this isochron; this isochron then was marked on the sparker record adjacent to the 4A well. Reflection dips were picked on all records. A phantom horizon was projected, on the sparker records, from the tie point at the Westerol 4A well. The phantom horizon reached the limit of penetration of the sparker records as the depth of the section increased. A new phantom then had to be started at the top of the record. This phantom horizon was based on the deeper reflection dips.

At all points along the traverse, the isochrons were converted to depth, by using a half-velocity of 5.7 feet per millisecond.

It has been found, from well control, that the Middle Devonian drops 463 feet between the Westerol 4A well and the Westerol-Liard Rapids 1A well. Over this same interval, the fictitious horizon drops 930 feet. The Westerol-Liard Rapids 1A well is located 10 miles west and up-dip from the Liard River, thus accounting for the difference in the drop of the Middle Devonian over this interval.

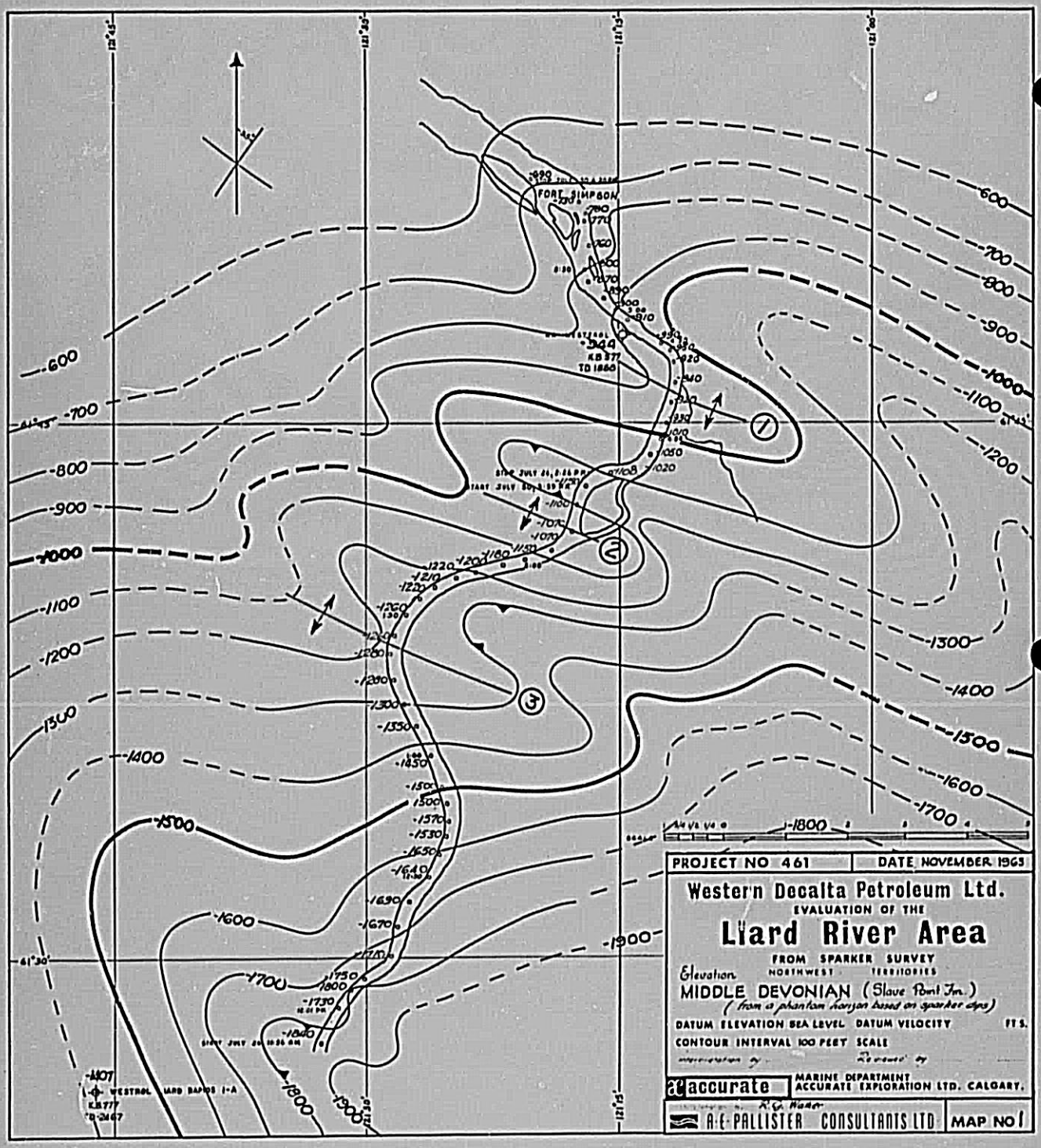
The Slave Point Elevation Map was prepared from the water seismic reconnaissance in the following manner:

All first breaks were checked to see if they gave velocities indicative of reflection or refraction energy. All records except a few (these are shown as N.V.) indicated velocities associated with reflections.

The closest well to Permit No. 3152 is the Shell-Liard River No. 2. Elevation of the Slave Point at this well is +215. Regional dip then was projected to Shotpoint No. E-16, and an identification of the Slave Point Reflection was made, using a half-velocity of 5.7 feet per millisecond. This reflection was carried throughout the project area.

All reflection times were converted to depth, using a half-velocity of 5.7 feet per millisecond. The elevation of the shotpoints was subtracted from the depth conversions to give the elevation of Slave Point horizon. No computations were made to allow for low-velocity problems. The normal move-out for the off-set of the geophones was not calculated, and remains in the depths mapped.

TABLE OF MAPS


FORT SIMPSON
KB 877
TD 1860
WESTROL LARD RAPIDS I-A
KB 777
TD 2467
PROJECT NO 461
DATE NOVEMBER 1965
Western Decalta Petroleum Ltd.
EVALUATION OF THE
Liard River Area
FROM SPARKER SURVEY
Elevation NORTHWEST TERRITORIES
MIDDLE DEVONIAN (Slave Point Fm.)
(from a phantom horizon based on sparker data)
DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.
CONTOUR INTERVAL 100 FEET SCALE
accurate
MARINE DEPARTMENT
ACCURATE EXPLORATION LTD. CALGARY.
A.E. PALLISTER CONSULTANTS LTD
MAP NO 1

19-6-4-16

90%

MAP DISCUSSION

Maps No. 1, No. 2 and No. 3A Elevation and Seismogeological Regional Elevation - MIDDLE DEVONIAN (Slave Point Fm)

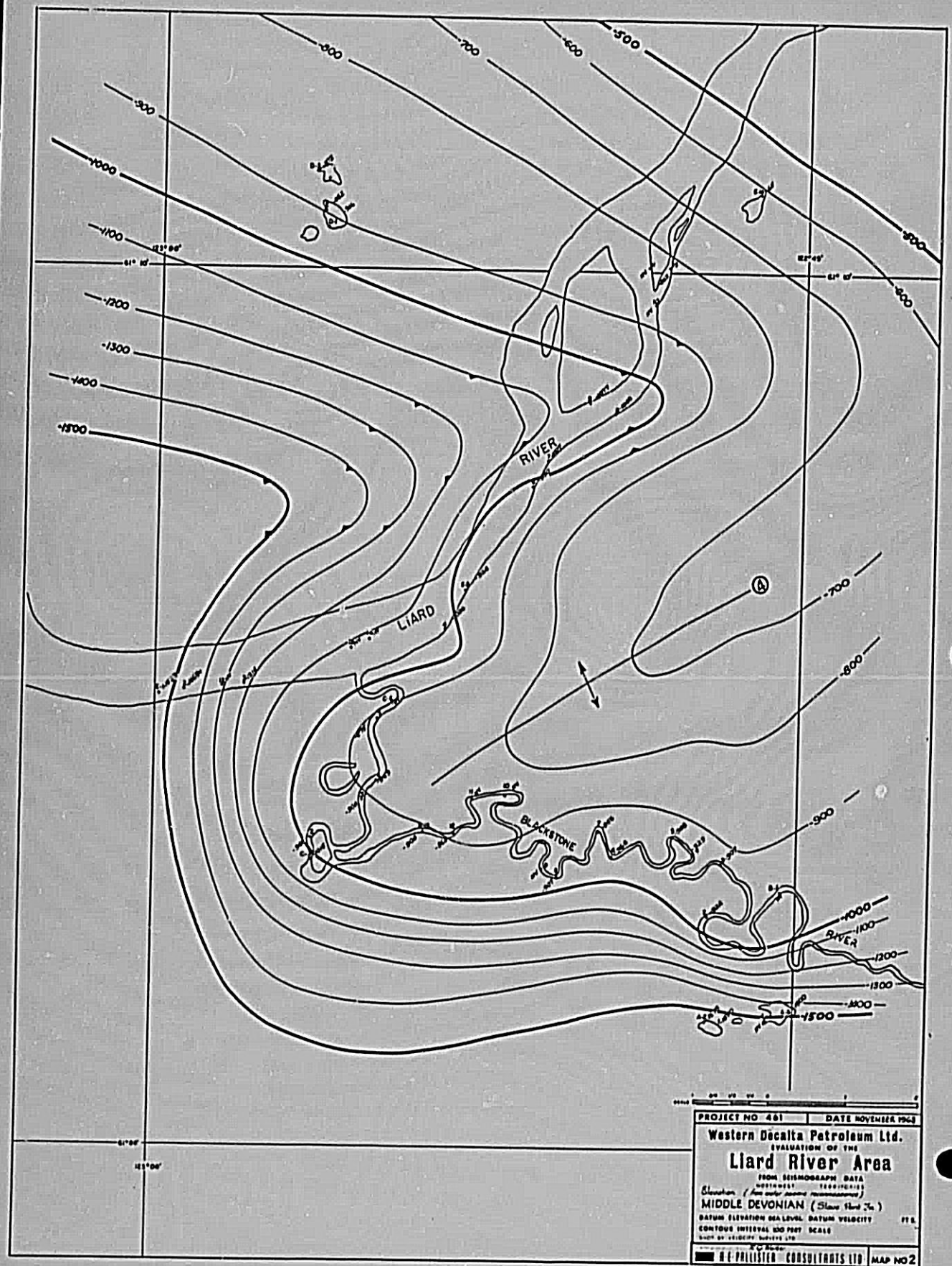
These maps were prepared in order to evaluate any structure on the Slave Point horizon. Porous Slave Point potential has been indicated at the shut-in gas well Imperial-Sun-Netla No. F-7, which is approximately 15 miles south of Permit No. 3152. Several indications of geologic structure, which could be the result of reef build-up, have been noted in geologic outcrops. These maps were contoured in harmony with the regional framework.

MAP NO. 1 - (Slave Point Formation from phantom horizon based on sparker dips)

Regionally, the map area is located on the southeast flank of the Simpson Arch. The Arch rises northwest of the map area at 60 feet per mile.

This map was prepared by picking a phantom horizon, utilizing reflection dips on the sparker records. These phantom values were then converted to depth by using a half-velocity of 5.7 feet per millisecond. The elevation of the river then was subtracted from the converted phantom values. A phantom horizon such as this is highly interpretive.

Three structural highs are noted on this map; no entrapments are indicated on these highs. The three features shown are compatible with trends indicated in outcrops along the Liard River. The series of tight folds indicated along the river in



PROJECT NO 461 | DATE NOVEMBER 1963

Western Decalta Petroleum Ltd.

EVALUATION OF THE

Liard River Area

FROM SEISMOGRAPH DATA

MIDDLE DEVONIAN (Slave Point Fm.)

DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.

CONTOUR INTERVAL 100 FOOT SCALE

R. C. PALLISTER CONSULTANTS LTD | MAP NO 2

outcrop appear to have north-south trending axes, while the structures on this map have northwest-southeast axes.

It is next to impossible to determine three dimensional geologic structure from a single nearly straight-line traverse. This traverse gave the interpreter several contour options. The contour option used for this map was one of trying to show any possible highs, which extend from the flank of the arch, and to show possible closure on these highs.

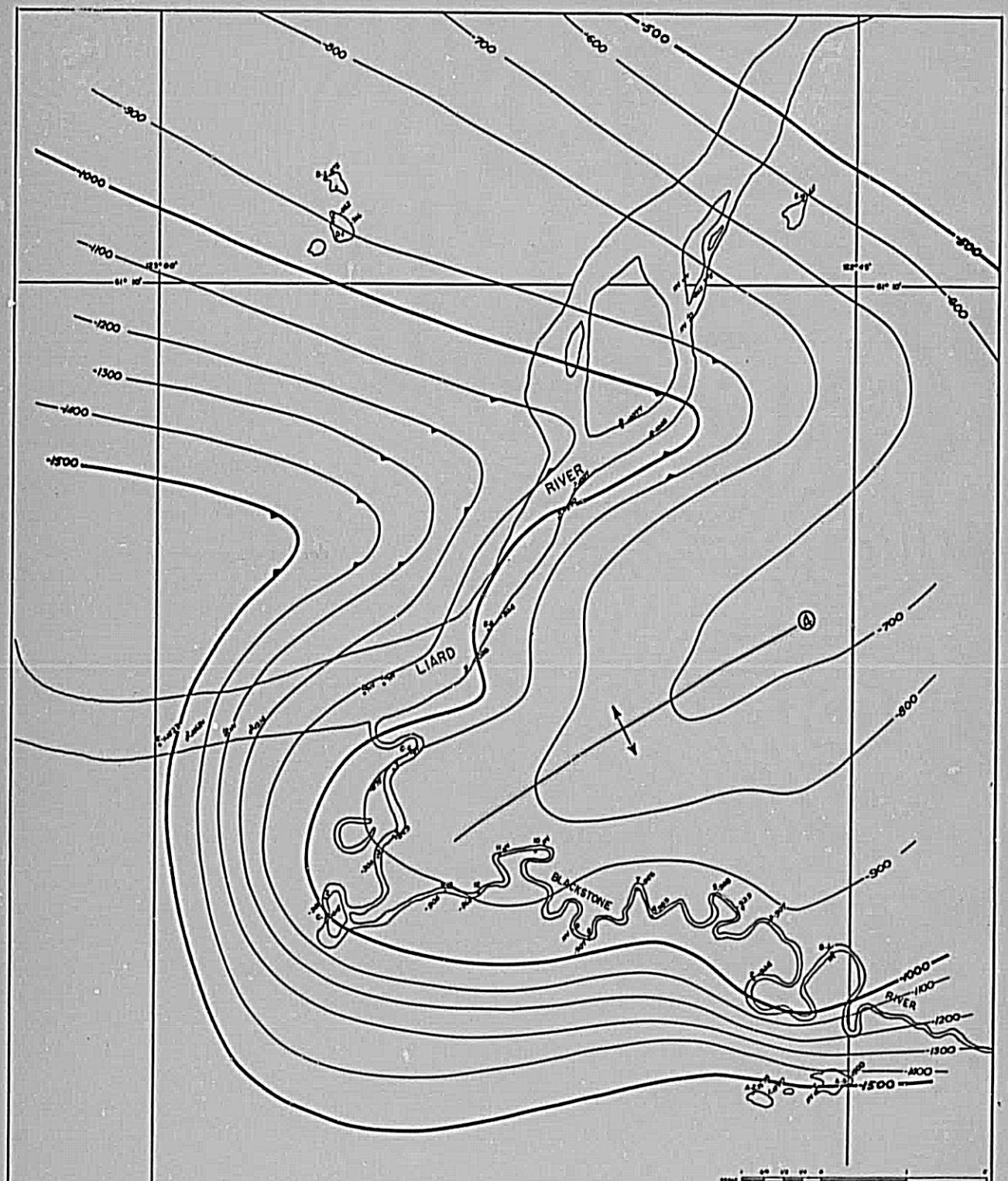
Any further evaluation of the highs shown would require additional conventional seismic control across and along these highs.

Porosity in the third limestone, which should pinch-out close to this area, could be of interest, along with the major play in the Slave Point Formation.

MAP NO. 2 - (Slave Point Formation from water seismic reconnaissance)

Regionally, this horizon portrays southwest dip of approximately 140 feet per mile. North of the Liard River the regional picture is very much distorted by the southwest trending Simpson Arch. This arch apparently cuts directly across the permit area. The Slave Point Formation was penetrated at +215 feet in the Shell-Liard River No. 2 well.

The Nose, Feature Four, could be considered a southwest extension of the anomaly on which the Shell-Liard well was drilled. Any closure on this feature, within the permit area, would have to be evaluated by further seismic control. It is suggested that, if future seismic work is to be done, a few lines should be shot across this nose and also along its axis.



PROJECT NO 461 | DATE NOVEMBER 1963

Western Decalta Petroleum Ltd.

EVALUATION OF THE

Liard River Area

FROM SEISMOGRAPH DATA

NORTHWEST TERRITORIES

Elevation (Feet below mean sea level)

MIDDLE DEVONIAN (Slave Point Fm.)

DATUM ELEVATION SEA LEVEL DATUM VELOCITY FT/S.

CONTOUR INTERVAL 100 FEET SCALE

SHOT BY VELOCITY SURVEYS LTD

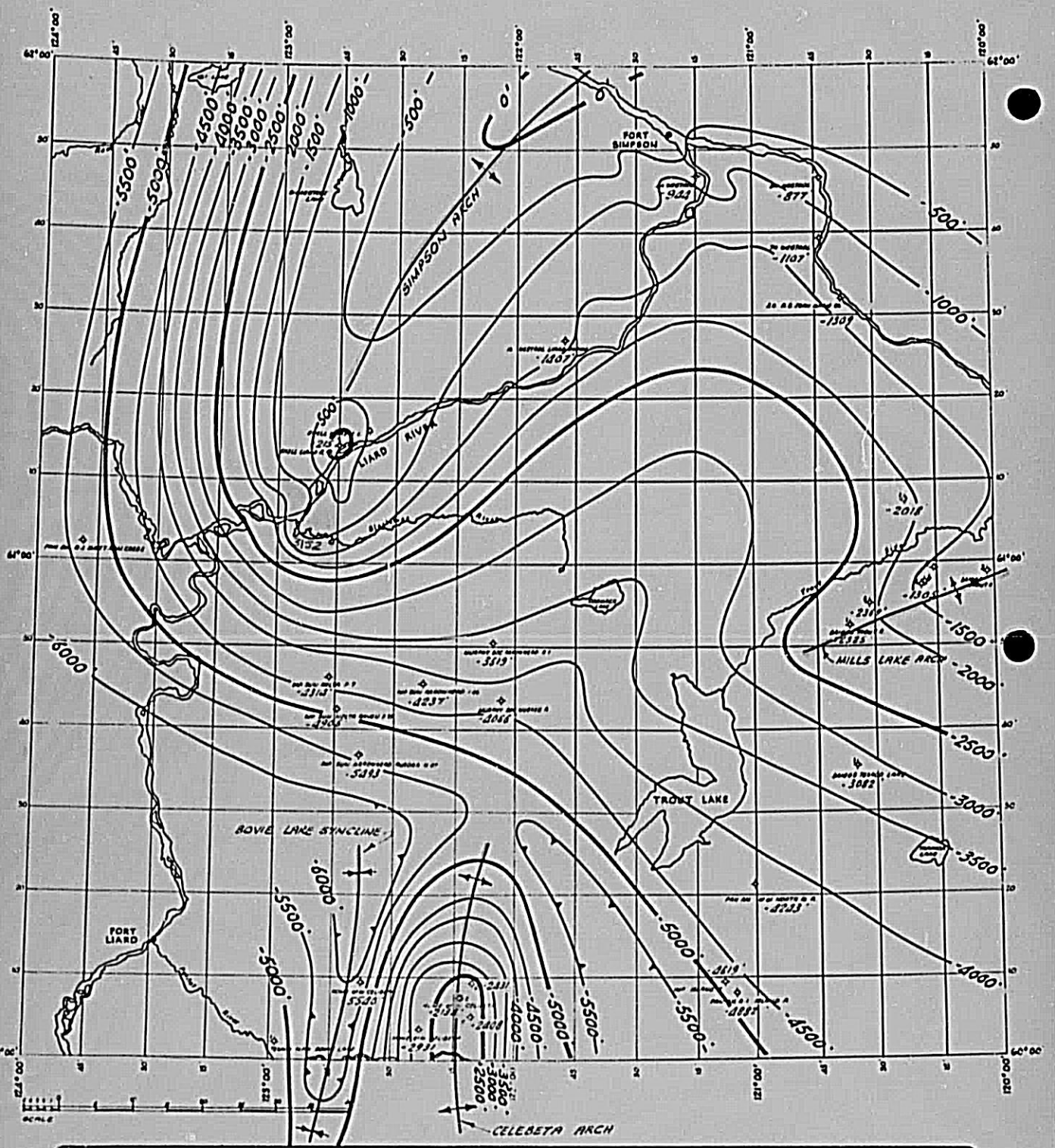
R. E. PRELLER - CONSULTANTS LTD | MAP NO 2

This map was prepared by making an identification of the Slave Point Reflection at Shotpoint No. E-16. This reflection then was carried throughout the prospect by jump correlations. The reflection times, used to convert to depth, were not corrected for normal move-out. Normal move-out was not calculated for the reason that the off-set distance was essentially constant at all shotpoints. The accuracy of the results, of course, are limited by three conditions: one, the difficulty in making correlations close to first breaks; secondly, by the use of jump correlations; and, thirdly, by the possibility that a velocity change could take place locally, so that the conversion velocity used would be incorrect through a portion of the area. A half-velocity of 5.7 feet per millisecond was used to convert to depth throughout the prospect.

Reliability of the jump correlations is dependent on the closeness of the reflection to the first breaks and the severity of frequency changes; thus, these correlations could not be considered completely reliable, and would only produce approximate results.

Here, again, a few contour options were available and the option taken was one to show a high extending from the Simpson Arch. Since the results are only approximate, there is a good possibility that closure could exist on the high shown as Feature Four.

In addition to Slave Point production possibilities, any porosity associated with the Second Limestone zero edge should not be overlooked. Facies changes and zero edge relationships associated with the First and the Second Limestone are also of interest (see Sonic Log Cross-Section and Geologic Cross-Sections.)



SEISMOGEOLOGICAL REGIONAL ELEVATION MIDDLE DEVONIAN (Slave Point Fm)

A·E·PALLISTER CONSULTANTS LTD

contour interval 500 feet MAP NO. 3A

MAP NO. 3A - (Slave Point Seismogeological Regional Elevation)

This Seismogeological Map was prepared from elevations taken from well control. Its purpose is to show the regional structure on the Slave Point Formation. The contouring was done as smoothly as possible to retain the structure on this horizon.

This map portrays four strong features in this portion of the Western Canada Sedimentary Basin. The largest feature, and possibly the most important, is the Simpson Arch. The Simpson Arch enters the map area from the north, trending southwest and cutting across Permit No. 3152.

The second largest feature is the Celibeta Arch, which enters the map area from the south and trends north.

West of the Celibeta Arch lies the Bovie Lake Syncline. There is approximately 3,500 feet difference between the Bovie Lake Syncline and the Celibeta Arch.

The fourth major structure shown on this map is the Mills Lake Arch, which enters the map from the east and trends southwest.

This map summarizes the regional structure on the Slave Point Formation. The values from the sparker survey (Map No. 1) and water seismic (Map No. 2), were added to the regional picture to produce this seismogeological map. These values influence the regional contours only in the areas of geophysical control.

Maps No. 4A to No. 9C inclusive - Regional Velocity Analysis Maps

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These maps were prepared to display regional isopachous, isochronal and interval-velocity variations within the region.

Isopach values were obtained from published and released well control. Only those geologic horizons which represented strong velocity changes were used. Several nomenclatural problems were experienced in these correlations.

Velocity information was gained from six acoustic type logs. The logs were integrated to obtain interval velocities and transit time values. The interval velocities show a general increase to the southwest, in response to the deepening of the basin. Distinct velocity log interfaces were of value in solving correlation problems.

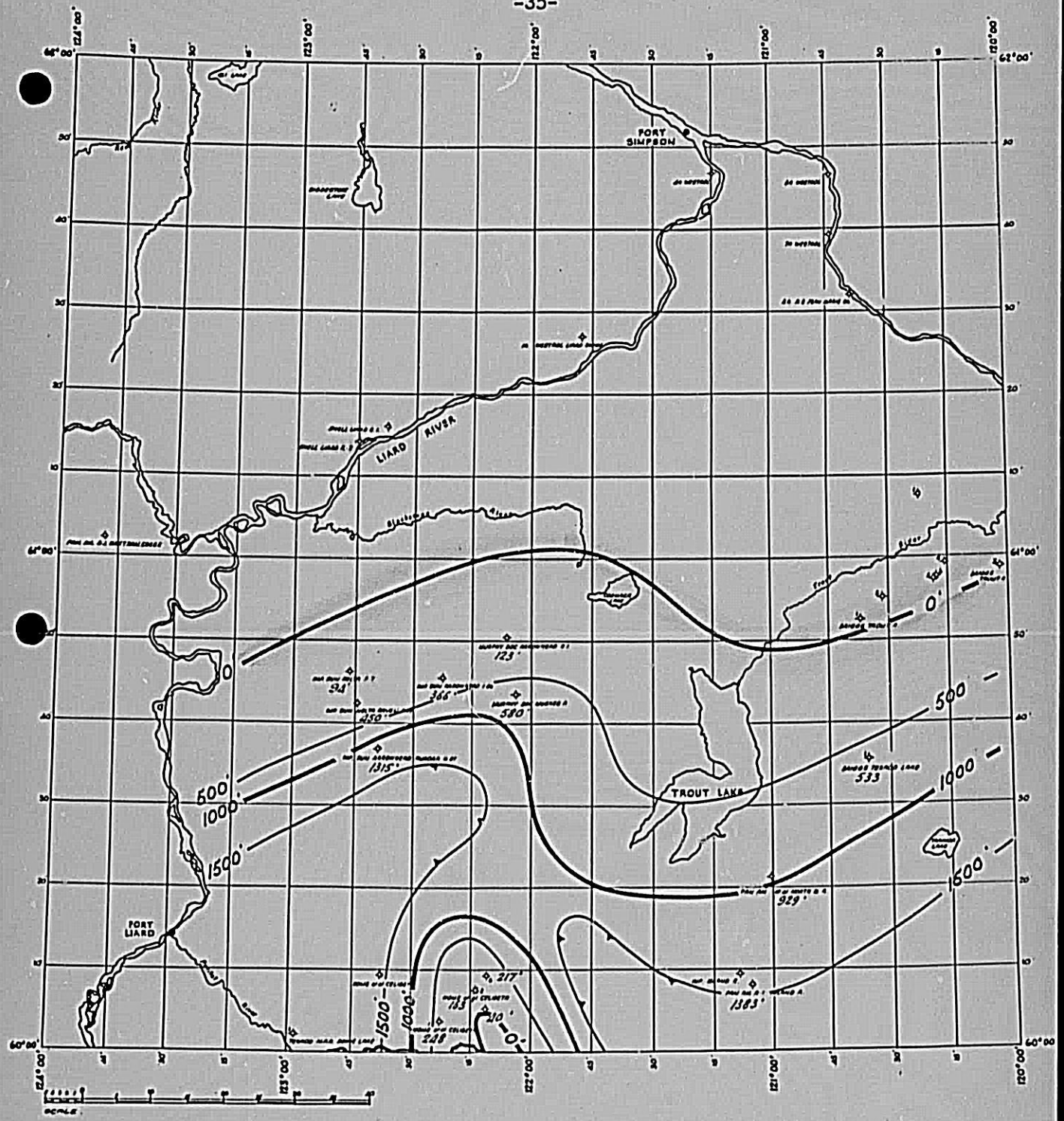
The regional velocity values may be used with confidence for any future seismic depth conversions in the area. However, as further acoustic log control becomes available, it should be included with this analysis. Nomenclatural problems may be resolved as further study is completed; however, this will alter little, the results of this R.V.A., since only obvious velocity breaks were correlated and, no doubt, will be associated with major sedimentary changes.

Isochronal values were computed from the known isopachs and average interval velocities.

This Regional Velocity Analysis will be of value for future seismic work that may be carried out in this area.

Respectfully submitted,

R. G. Walker,
Seismologist.



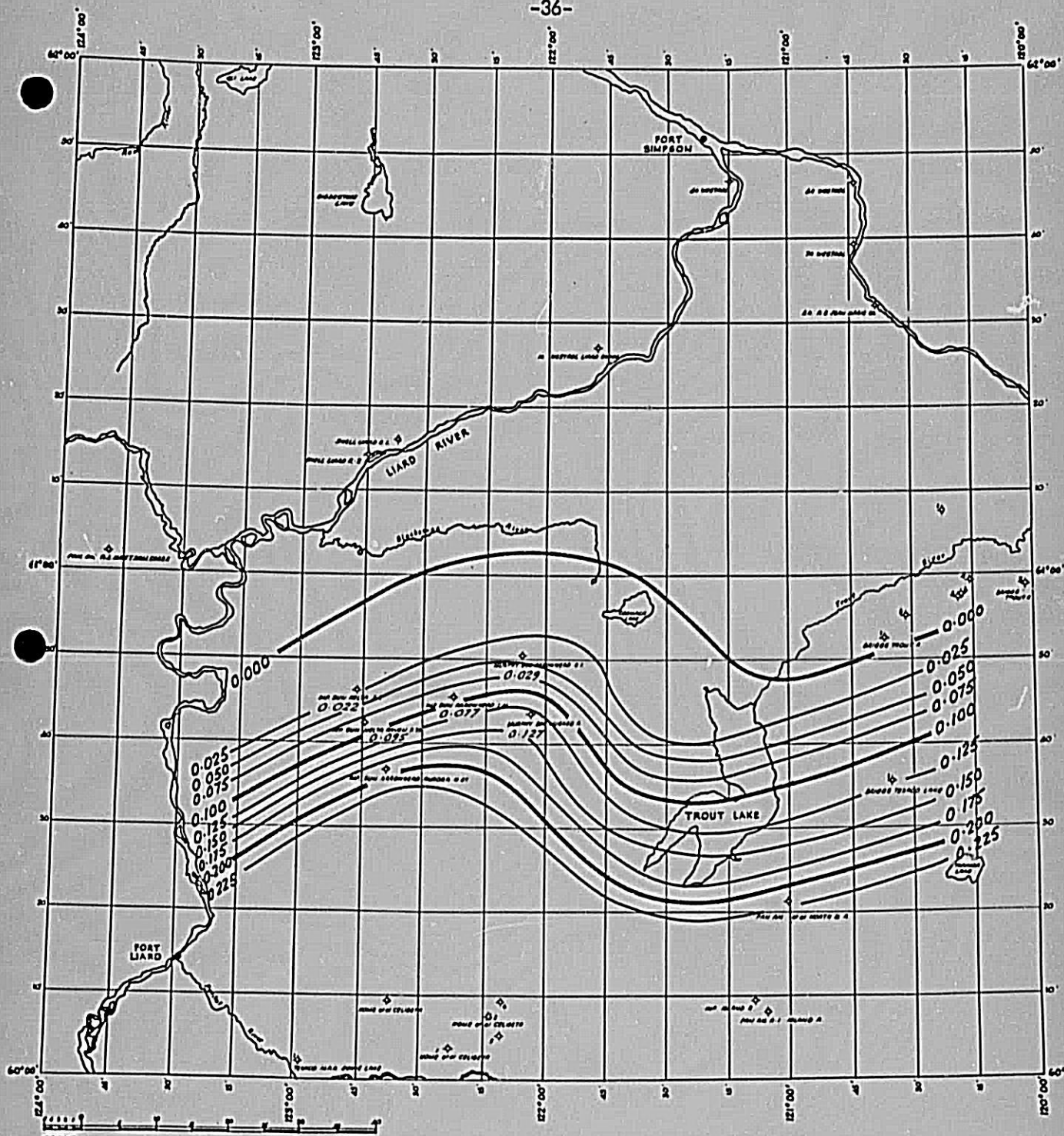
REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN - erosional TO UPPER DEVONIAN (Wabamun Gr)

contour interval 500 feet

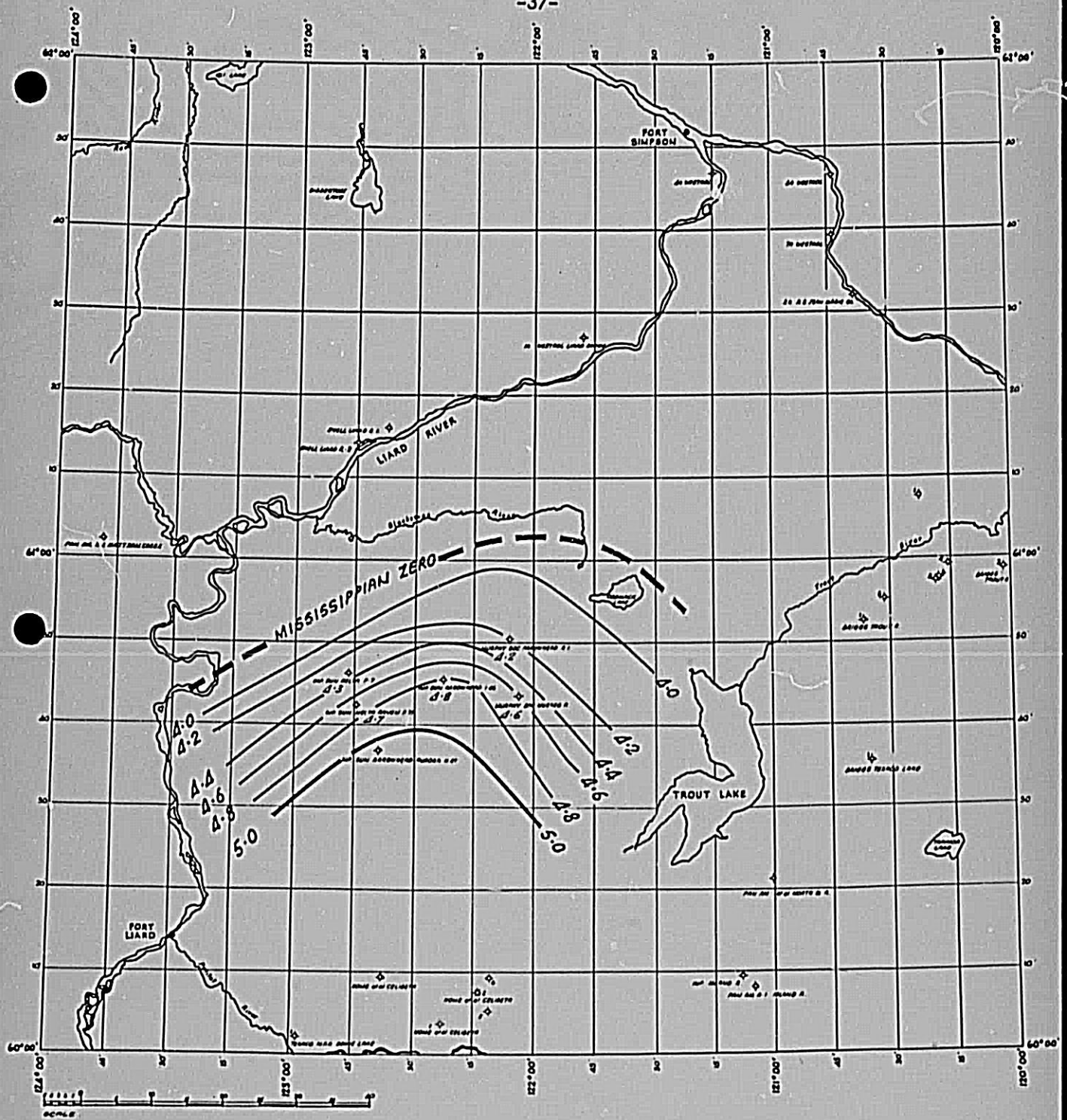
MAP NO. 4A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

MISSISSIPPIAN - erosional TO
UPPER DEVONIAN (Wabamun Gr)
contour interval 0.025 seconds MAP NO. 4B

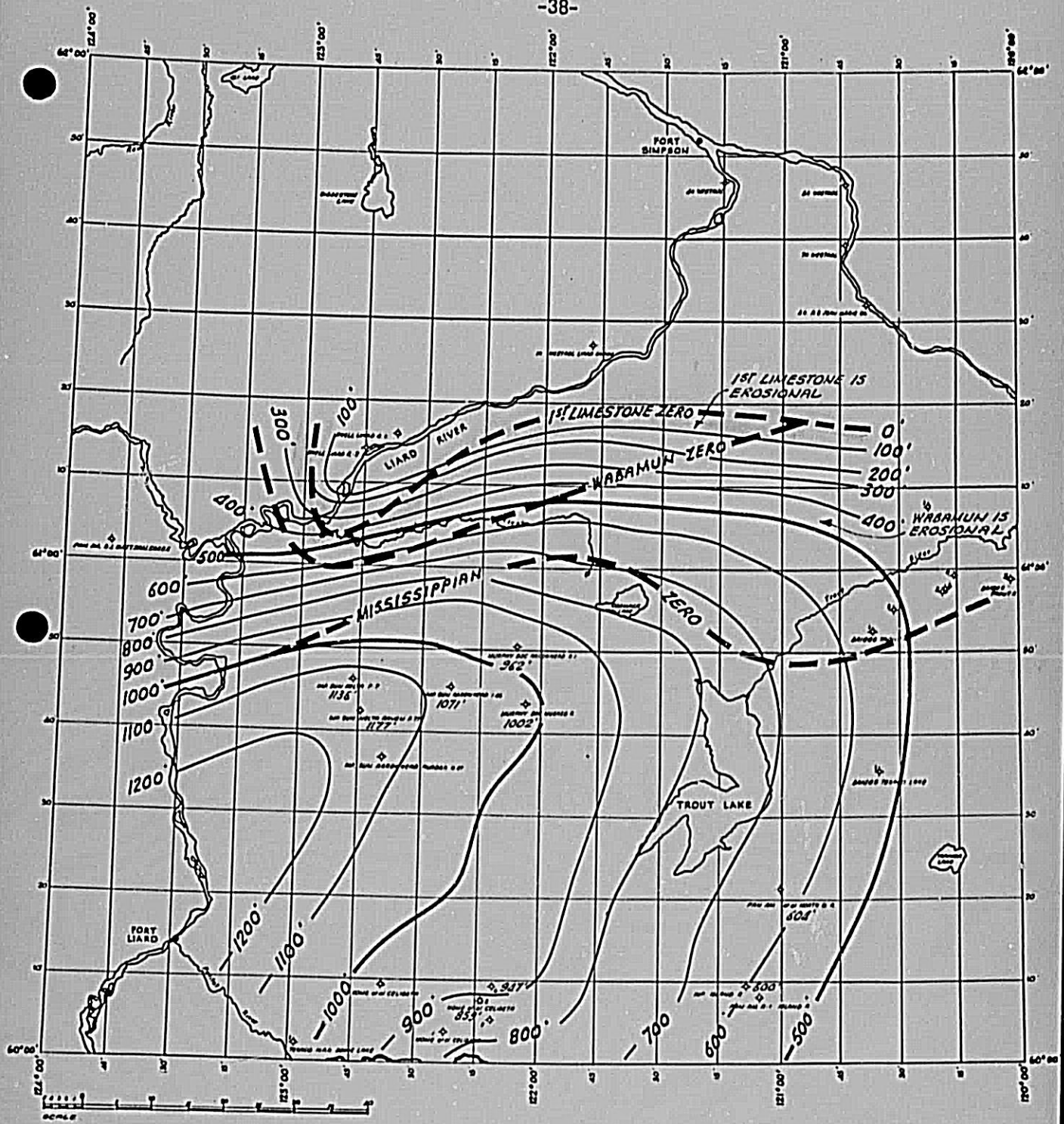


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

MISSISSIPPIAN – erosional TO UPPER DEVONIAN (Wabamun Gr)
contour interval 0.2 feet per millisecond

MAP NO. 4C

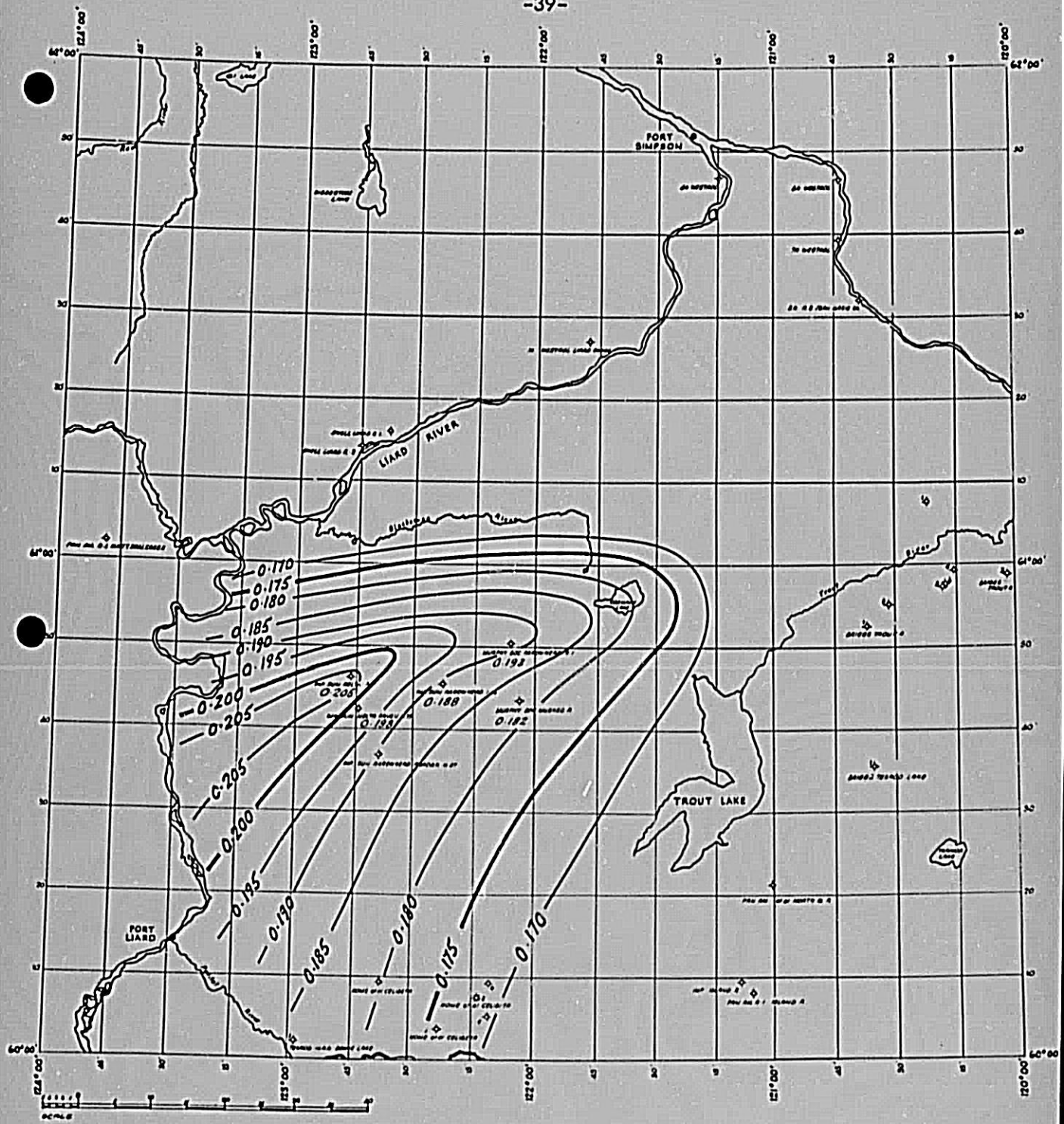


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Wabamun Gr.) TO
UPPER DEVONIAN (Second Limestone)
contour interval 100 feet

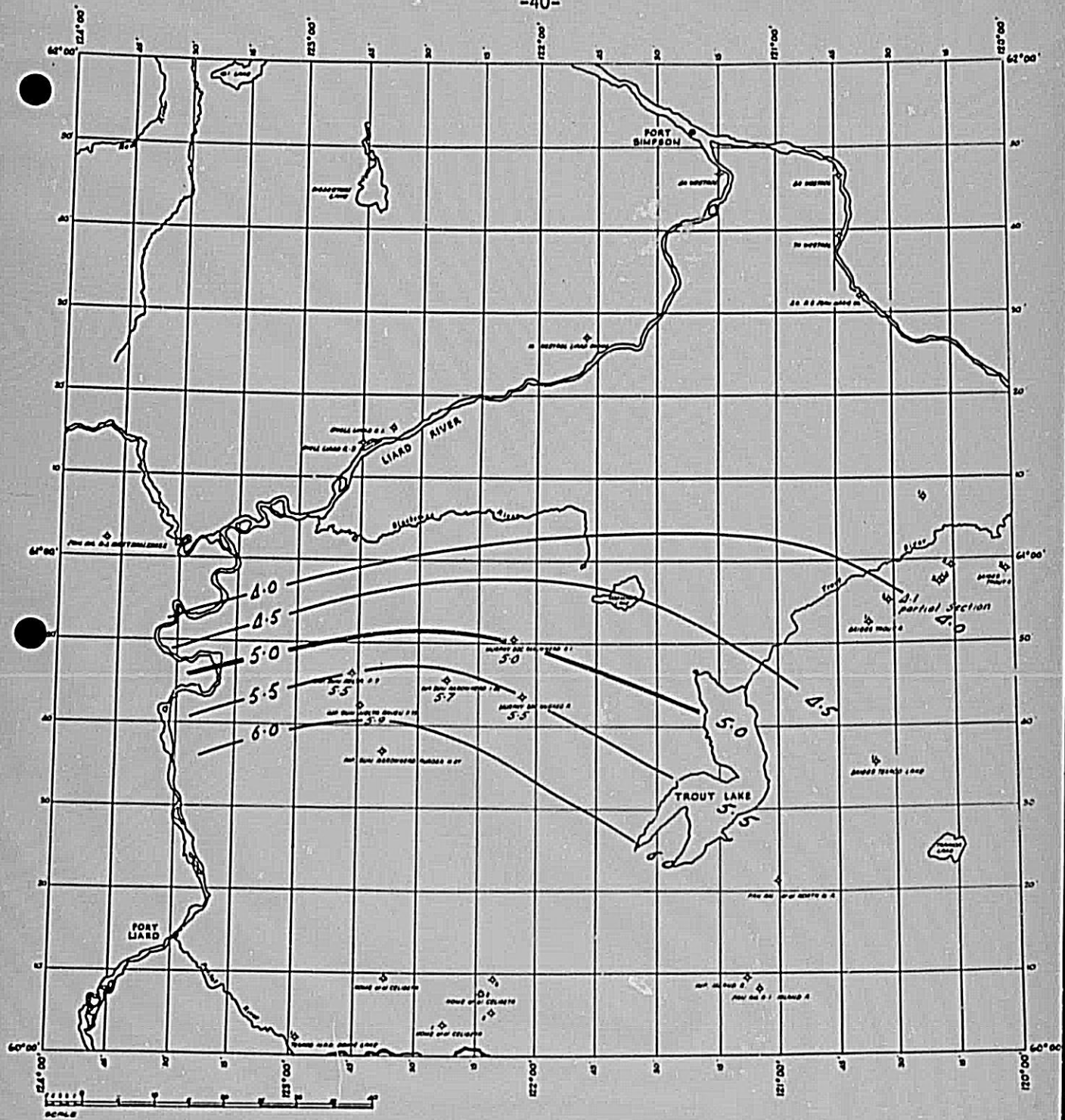
MAP NO. 5A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Wabamun Gr) TO
UPPER DEVONIAN (Second Limestone)
contour interval 0.005 seconds MAP NO. 5B

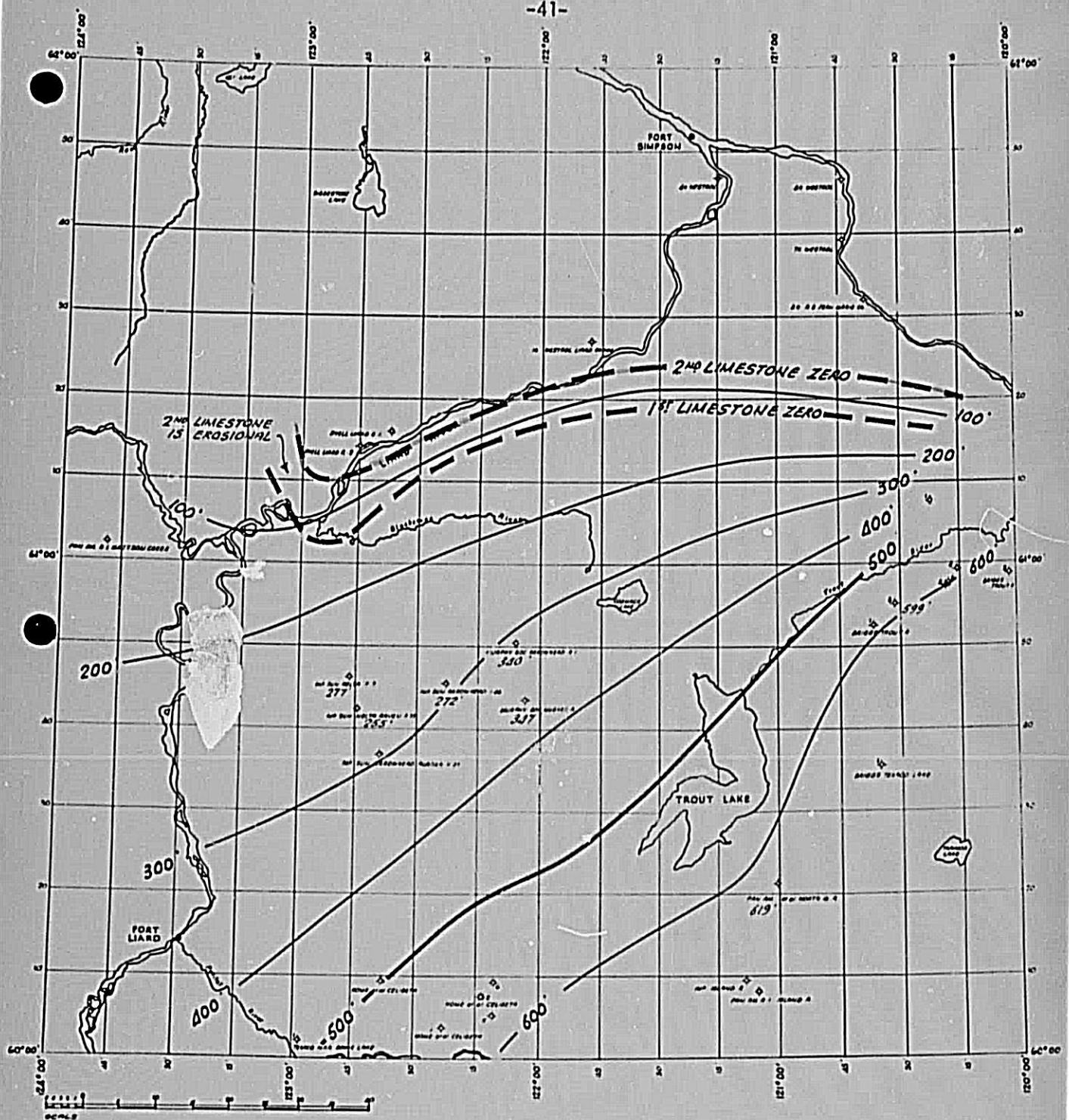


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Wabamun Gr) TO
UPPER DEVONIAN (Second Limestone)
contour interval 0.5 feet per millisecond

MAP NO. 5C

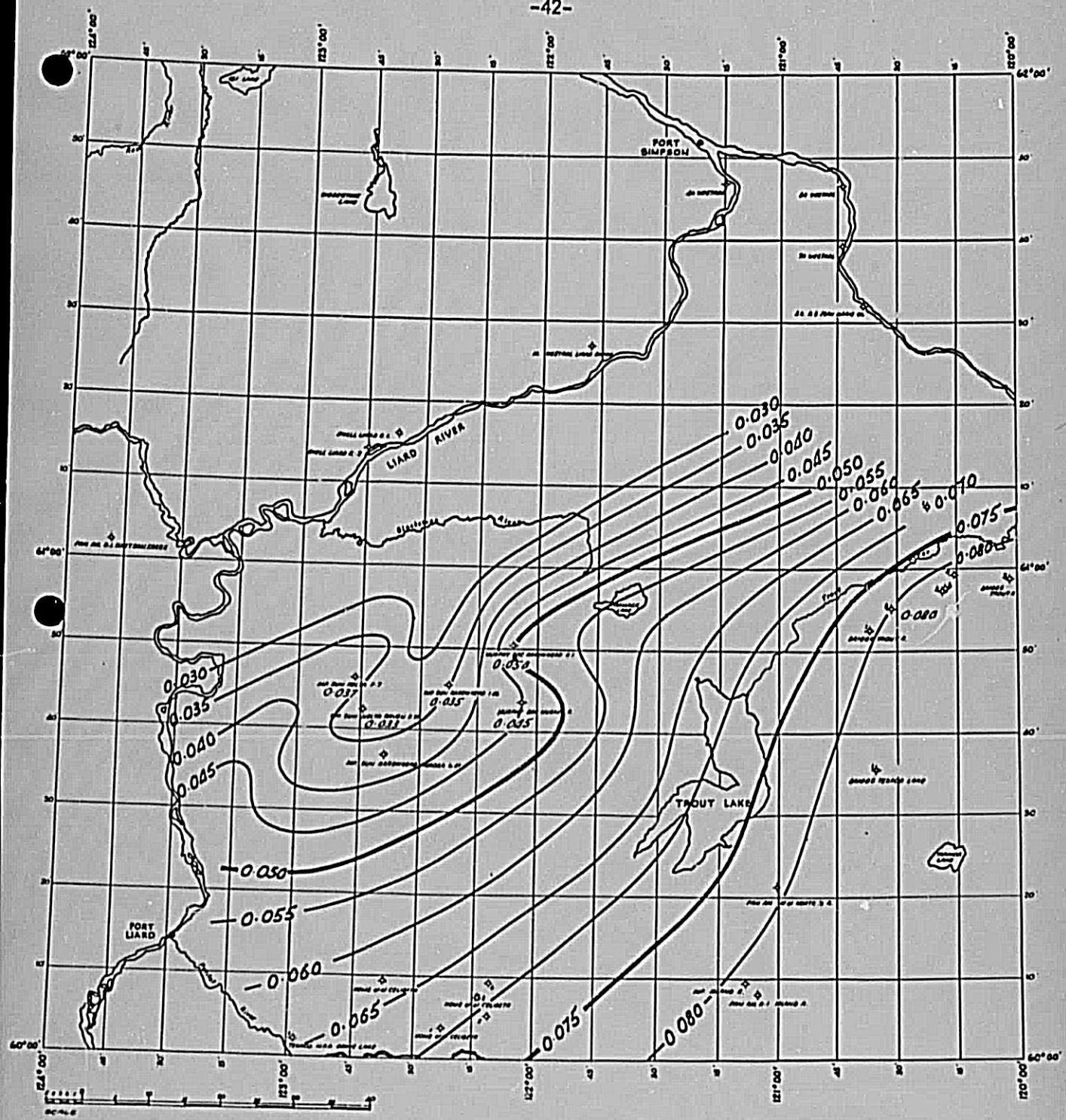


REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 100 feet

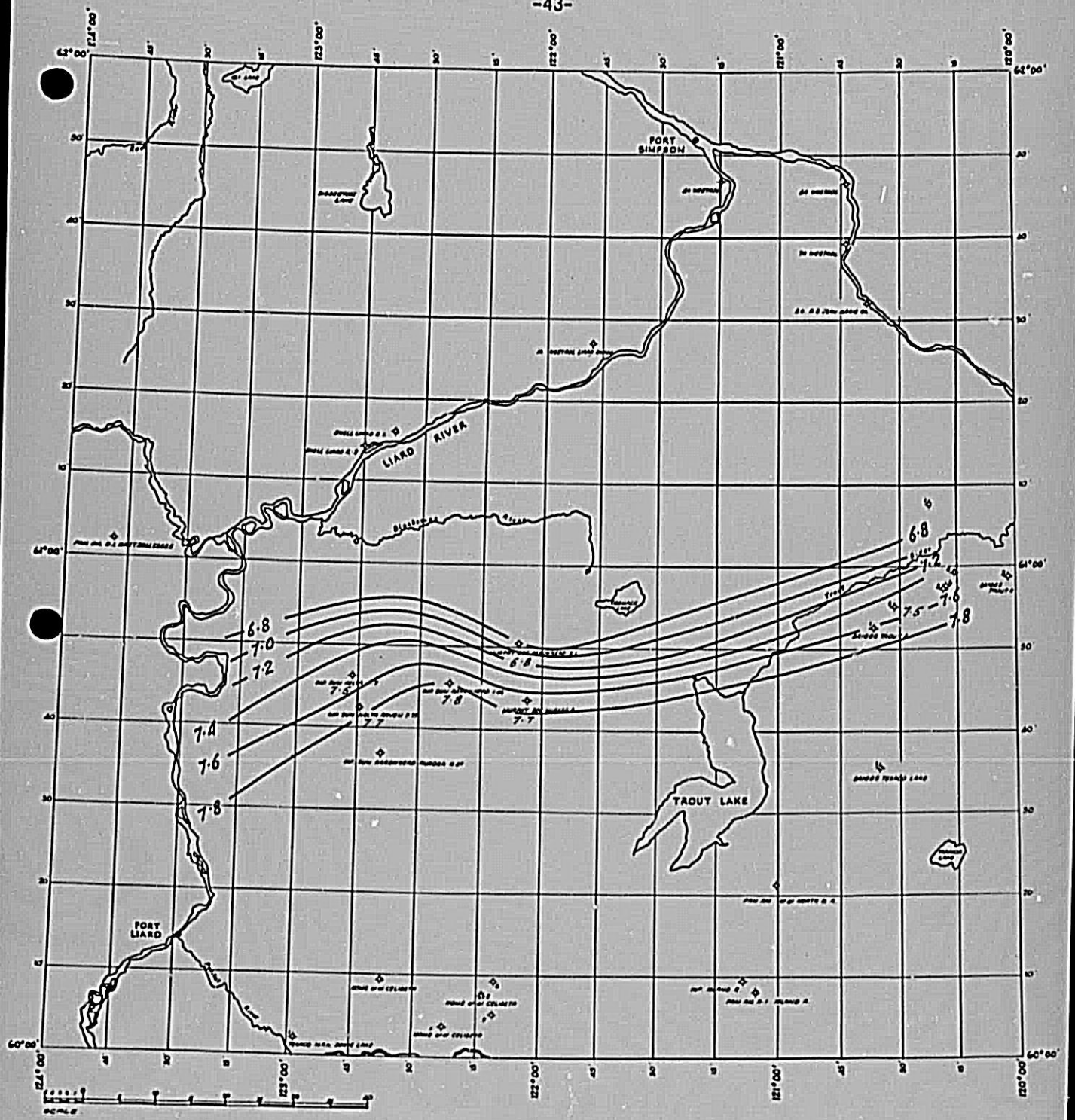
MAP NO. 6A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 0.005 seconds MAP NO. 6B

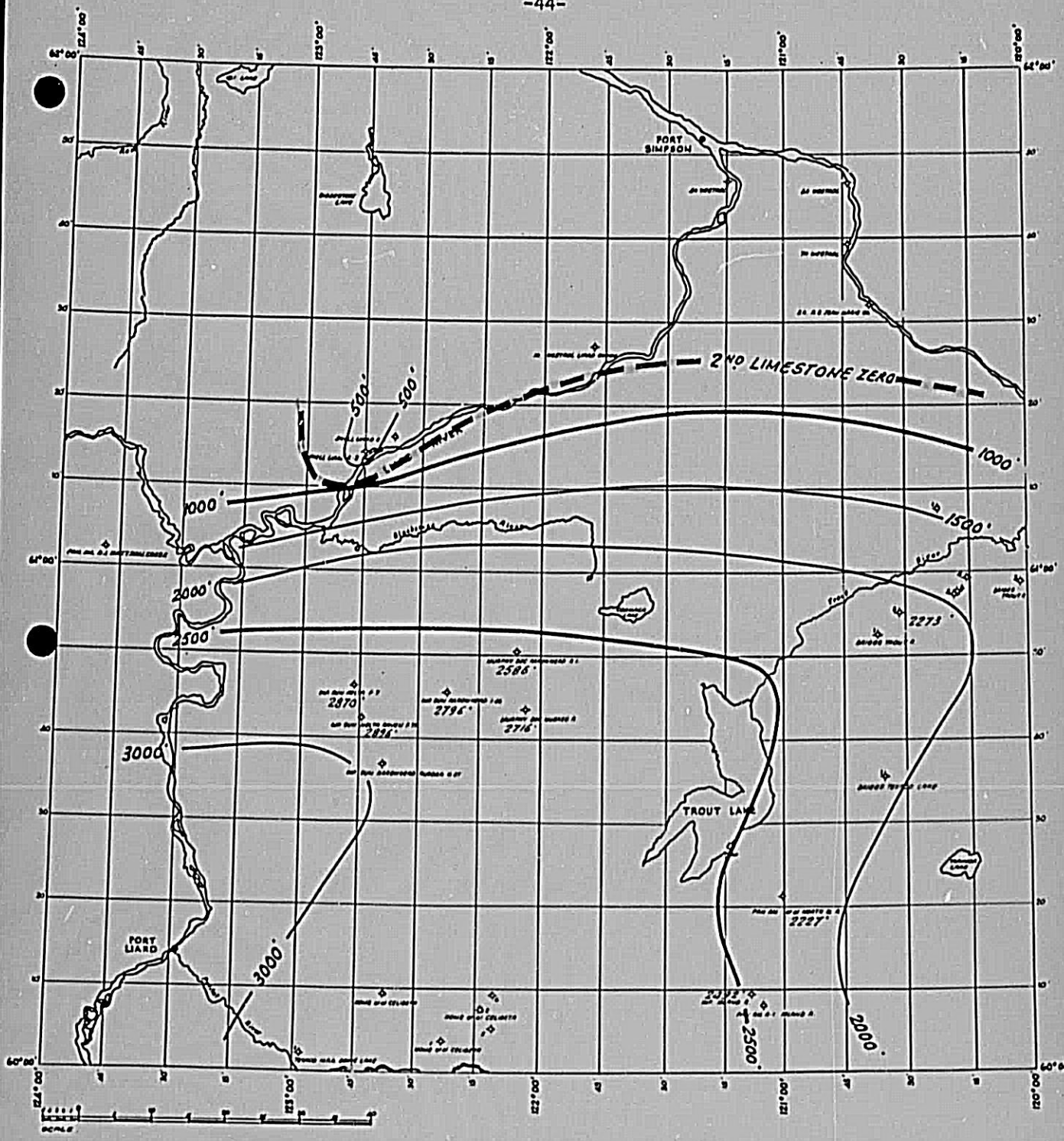


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Second Limestone) TO
UPPER DEVONIAN (Base of Second Limestone)
contour interval 0.2 feet per millisecond

MAP NO. 6C



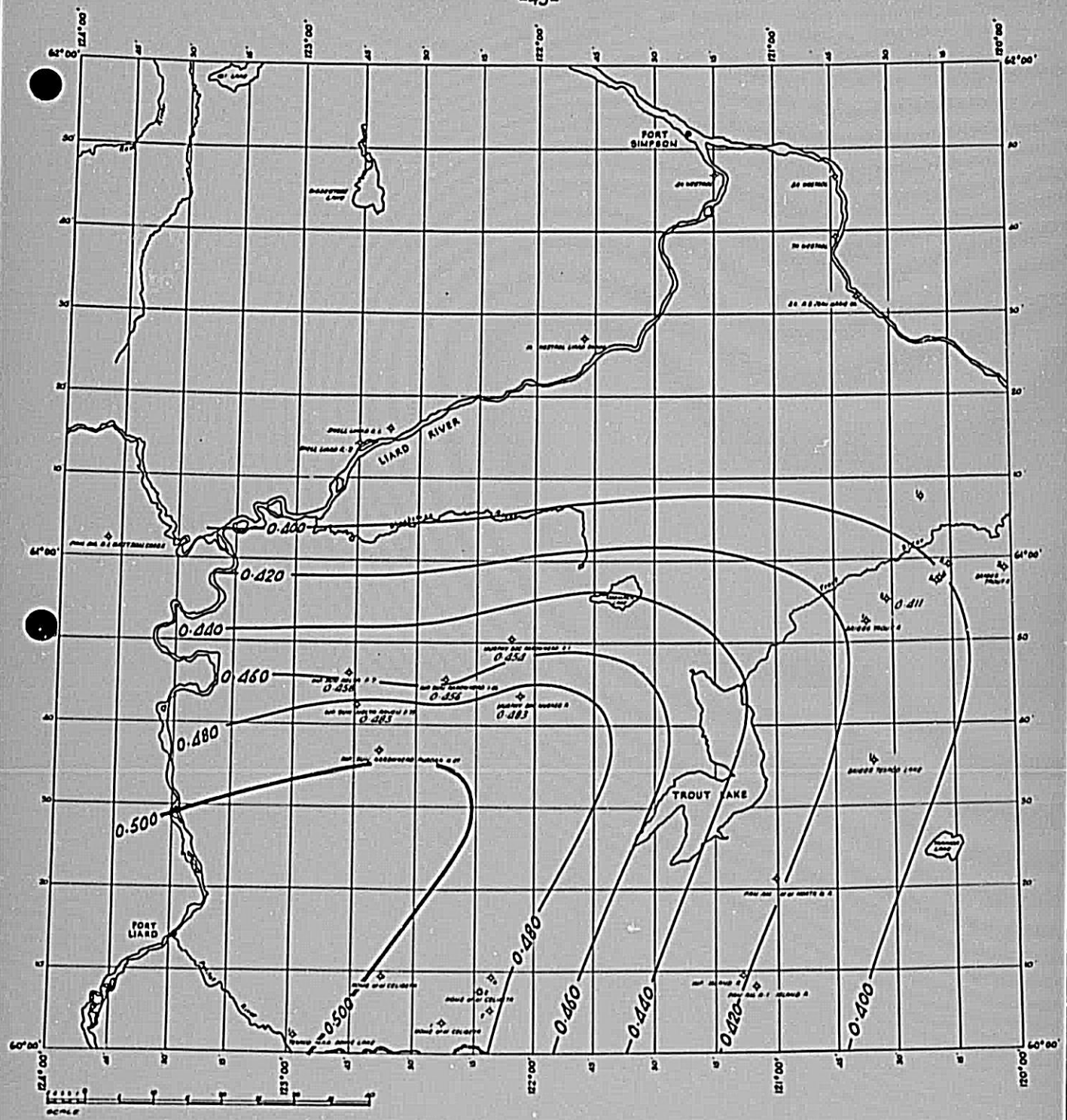
REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Base of Second Limestone) TO MIDDLE DEVONIAN (Slave Point Fm)

contour interval 500 feet

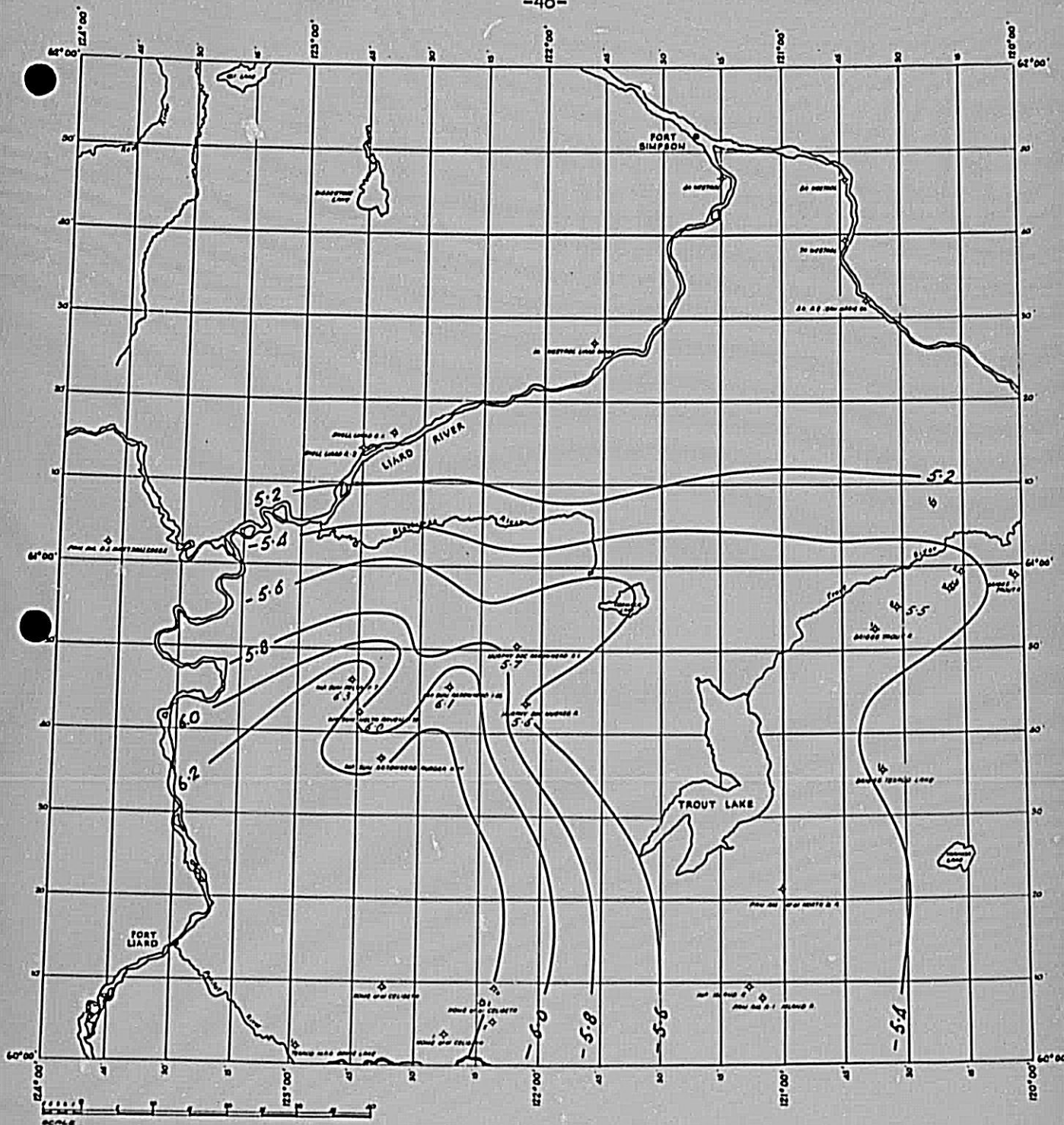
MAP NO. 7A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

UPPER DEVONIAN (Base of Second Limestone)
TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.020 seconds MAP NO. 7B

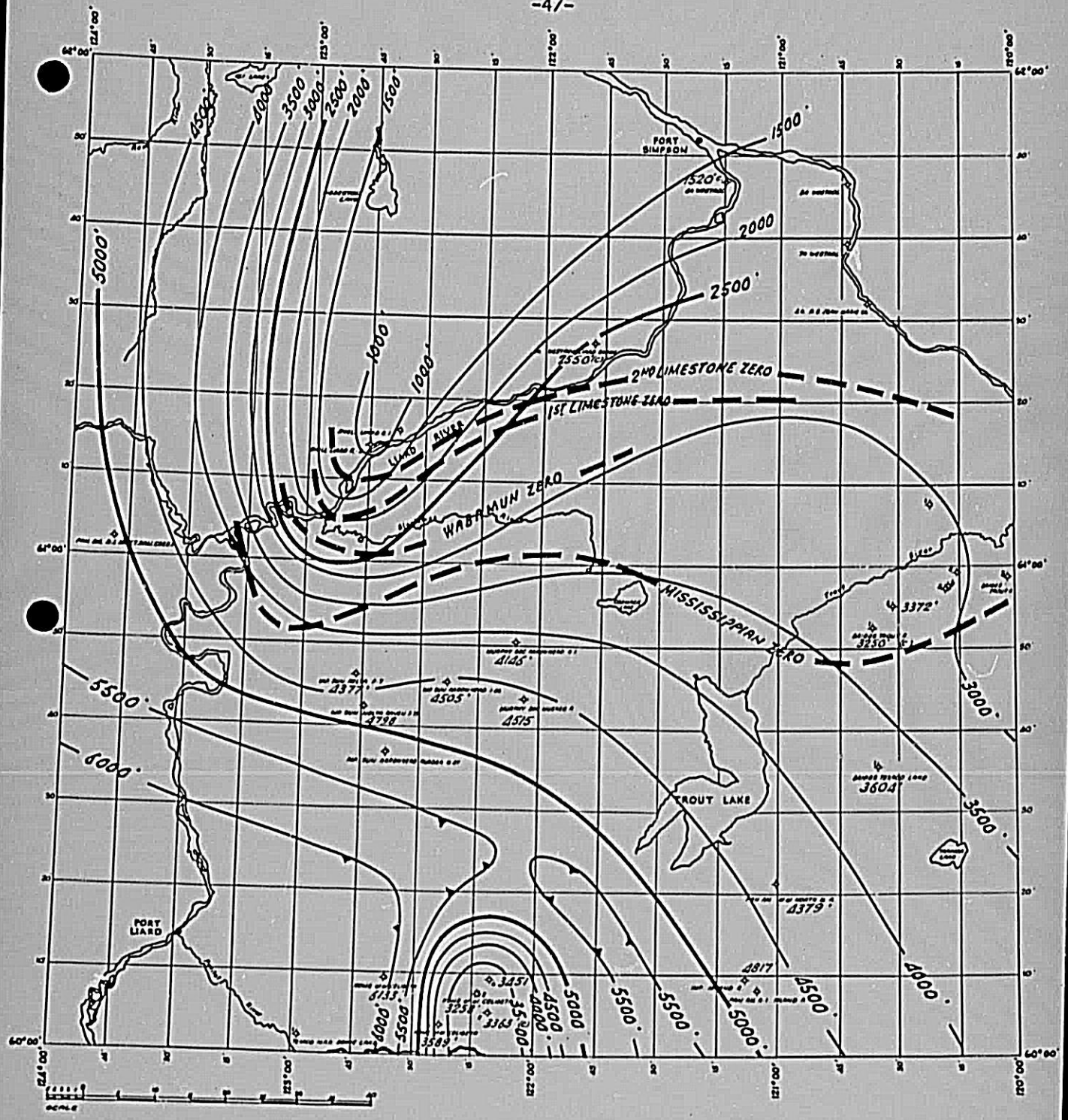


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

UPPER DEVONIAN (Base of Second Limestone)
TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.2 feet per millisecond

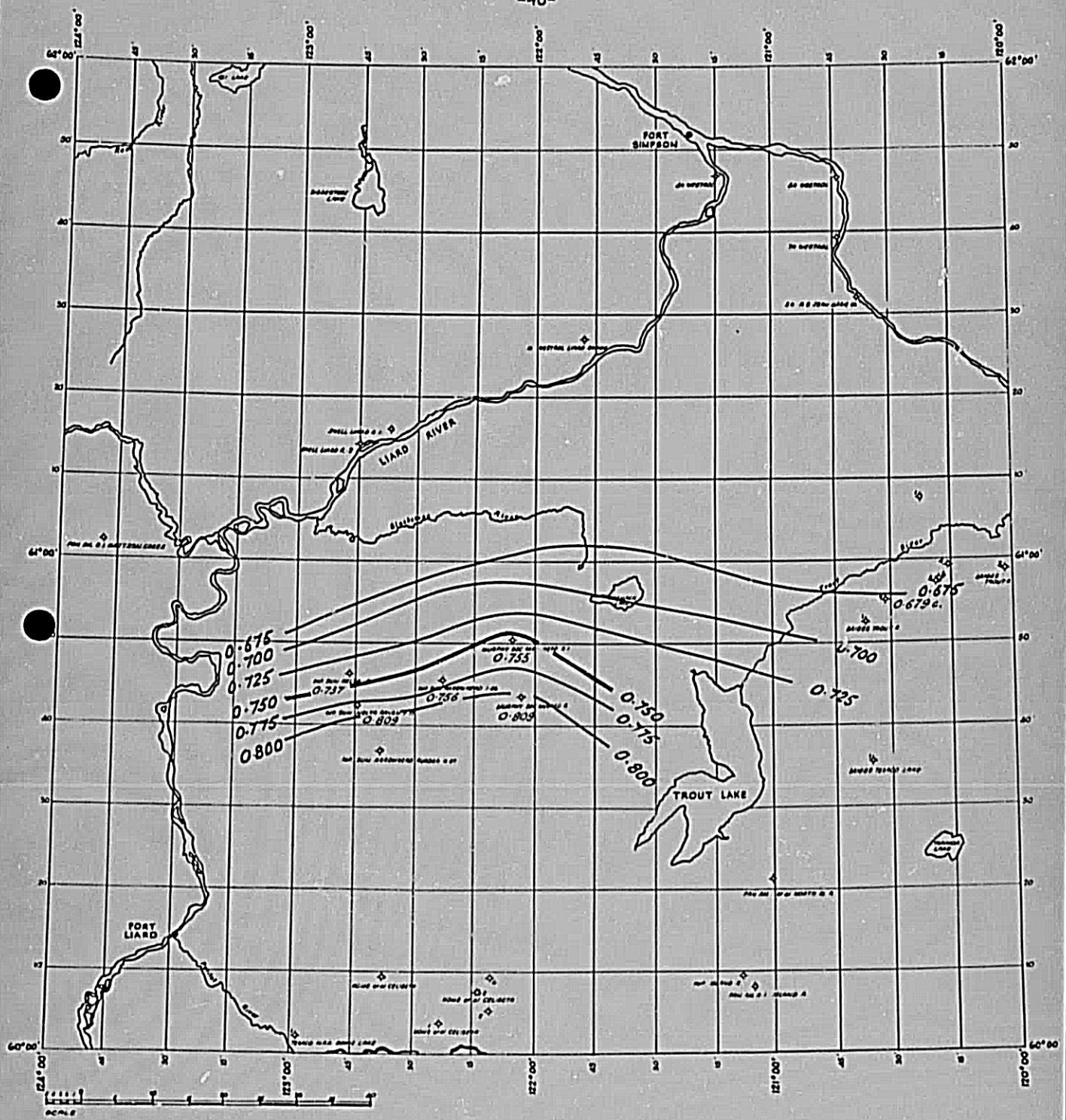
MAP NO. 7C



REGIONAL ISOPACH DEVONIAN and MISSISSIPPIAN – erosional TO MIDDLE DEVONIAN (Slave Point Fm)

A·E·PALLISTER CONSULTANTS LTD.

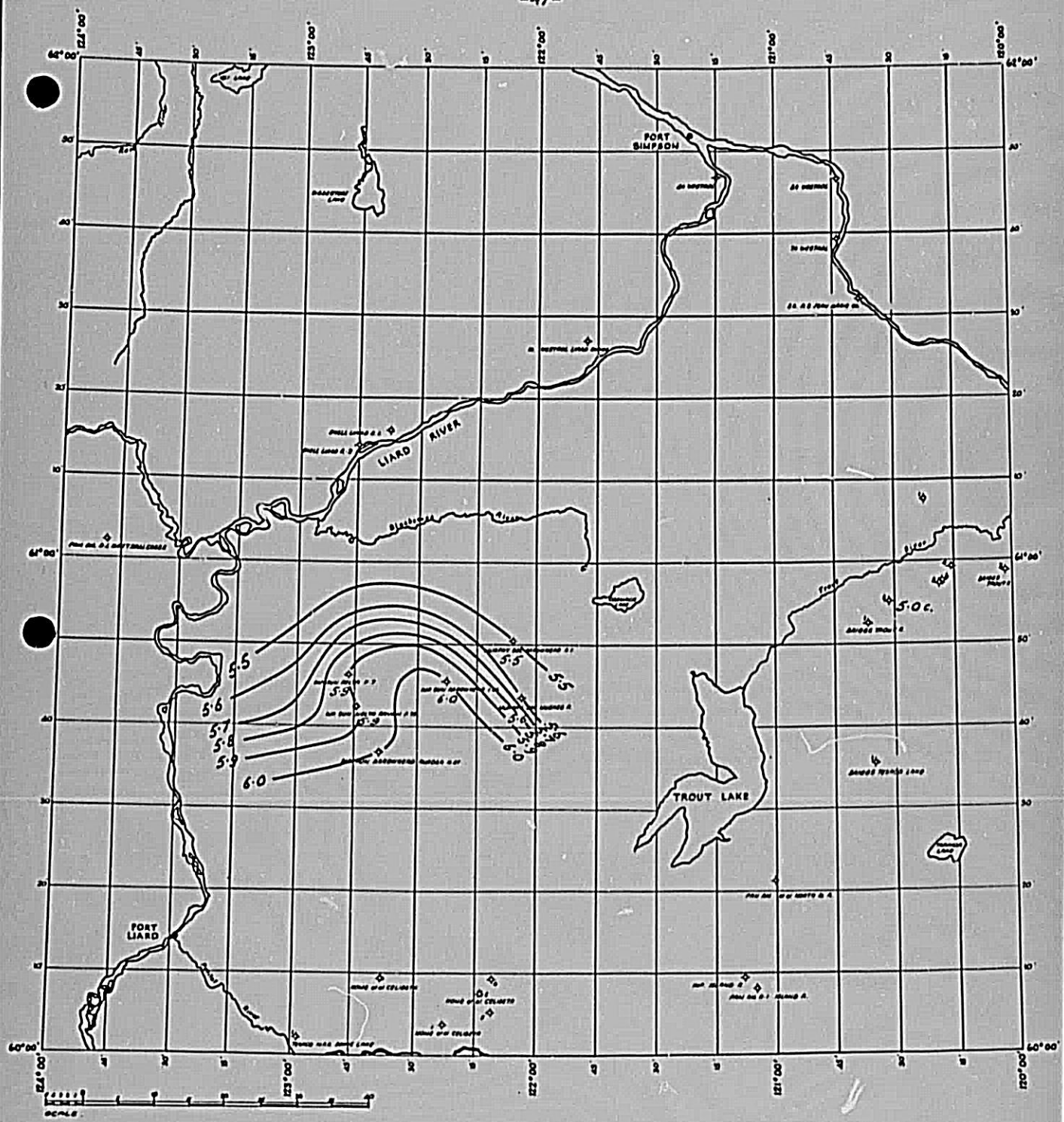
contour interval 500 feet MAP NO. 8A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD·

MISSISSIPPIAN – erosional TO
MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.025 seconds MAP NO. 8B

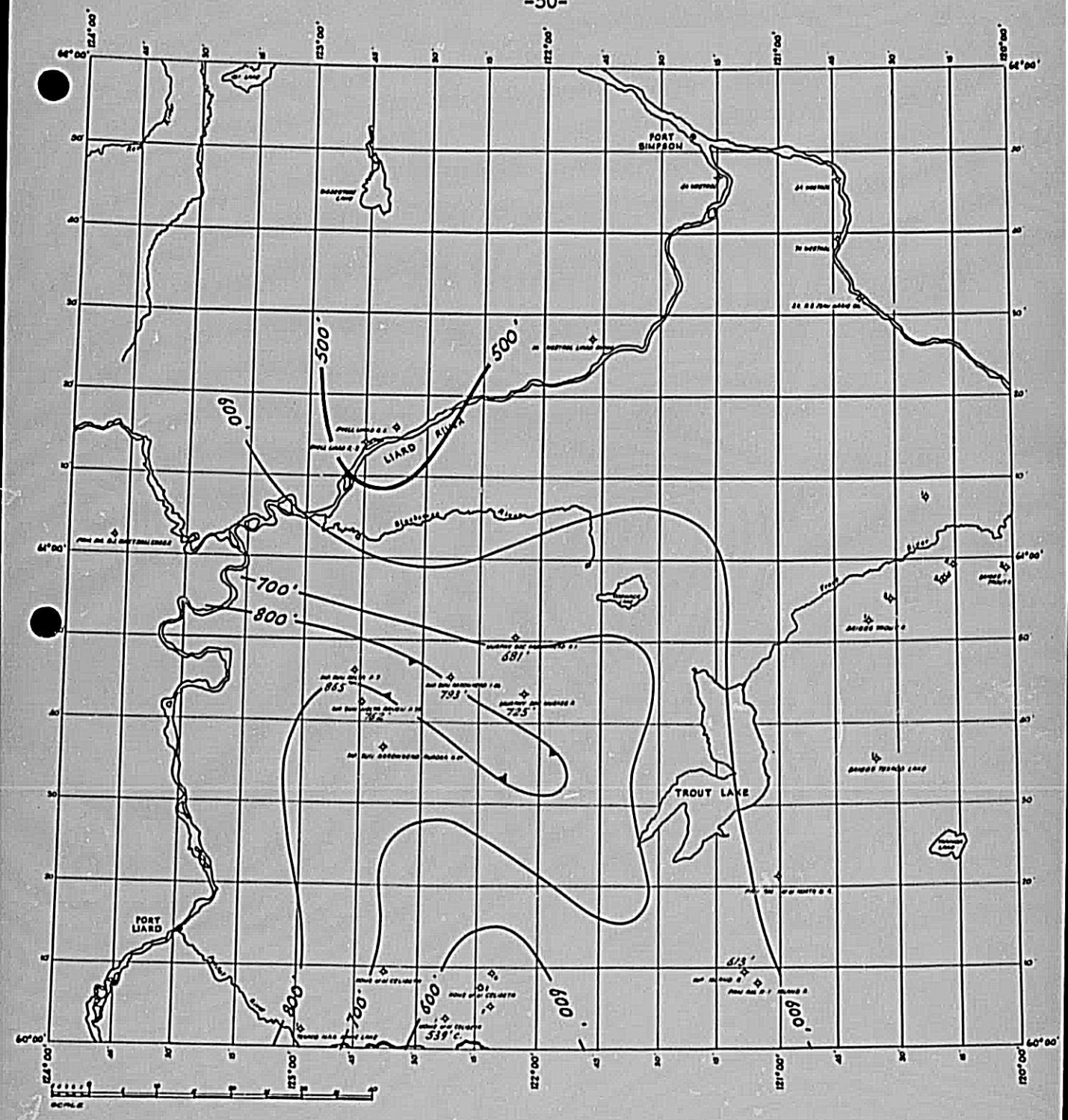


REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD.

MISSISSIPPIAN – erosional TO MIDDLE DEVONIAN (Slave Point Fm)
contour interval 0.1 foot per millisecond

MAP NO. 8C



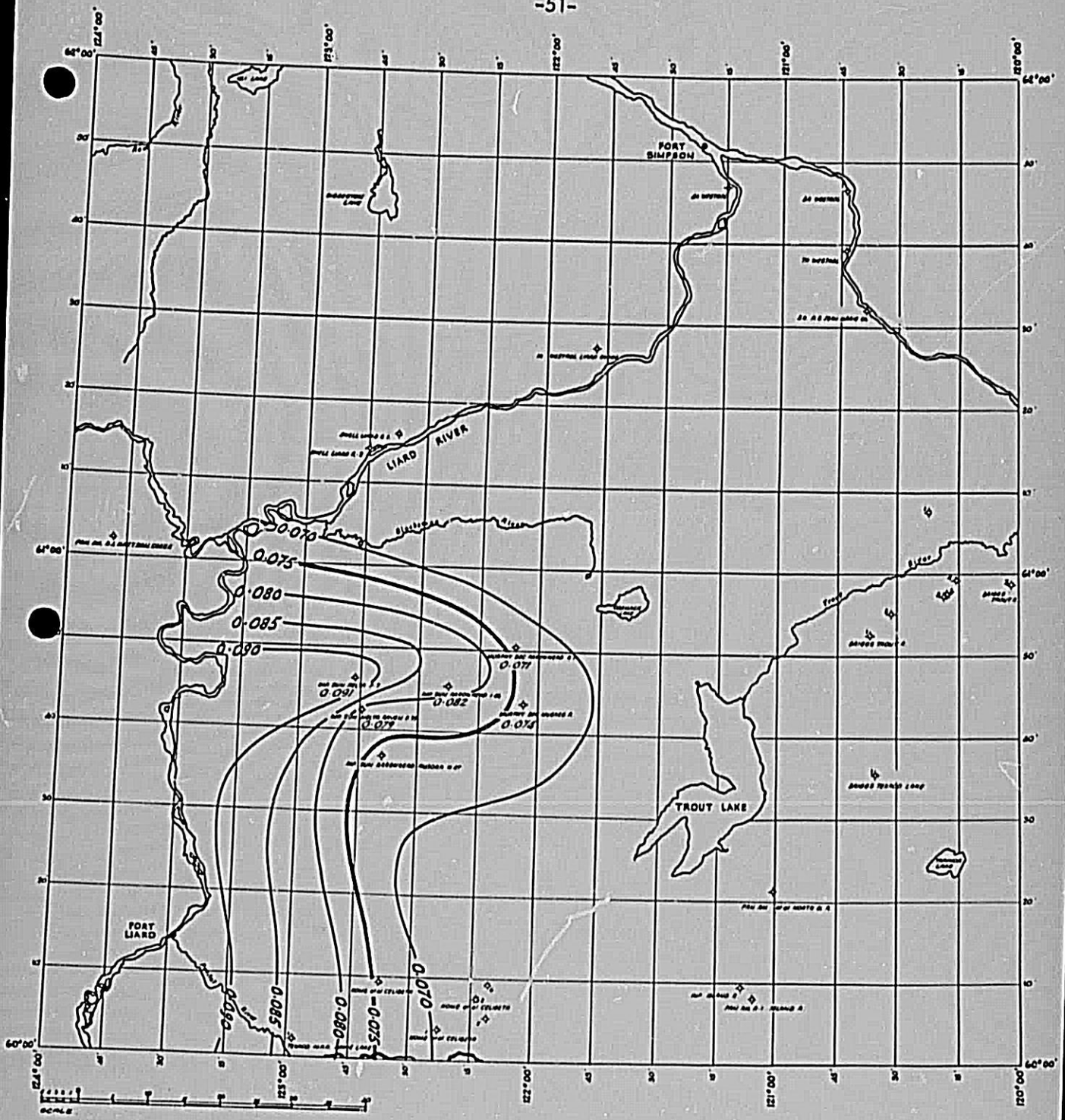
REGIONAL ISOPACH

A·E·PALLISTER CONSULTANTS LTD.

MIDDLE DEVONIAN (Slave Point Fm) TO MIDDLE DEVONIAN (Keg River Fm)

contour interval 100 feet

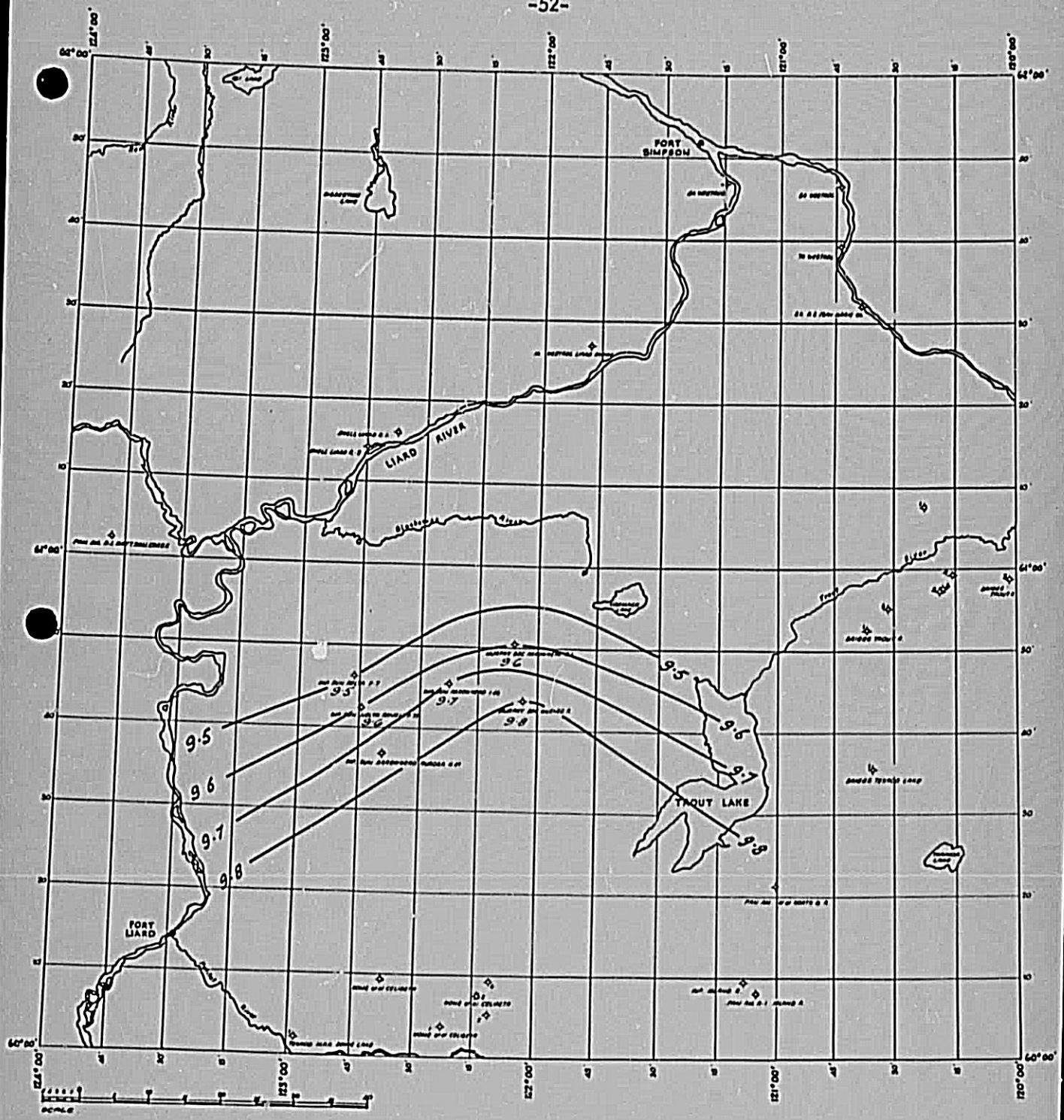
MAP NO. 9A



REGIONAL ISOCHRON

A·E·PALLISTER CONSULTANTS LTD.

MIDDLE DEVONIAN (Slave Point Fm) TO
MIDDLE DEVONIAN (Keg River Fm)
contour interval 0.005 seconds MAP NO. 9B



REGIONAL HALF-VELOCITY

A·E·PALLISTER CONSULTANTS LTD·

MIDDLE DEVONIAN (Slave Point Fm) TO
MIDDLE DEVONIAN (Keg River Fm)
contour interval 0.1 foot per millisecond

MAP NO. 9C

PROJECT SUMMARY

Project LIARD RIVER

Project No. 461
Contract No. 302
Party No.

PART III - INTERPRETATION

PRINCIPAL GEOPHYSICIST A. E. Pallister SEISMOLOGIST R. G. Walker

NATURE OF PROJECT AND NUMBER OF SHOTPOINTS ANALYZED

Interpretation of Current Field Data	None
Interpretation of Past Field Data	(See below)
Supervision Only (Field Project)	

DATA

Source*	Contractor-Date	No. of S.P.'s	Instruments	Tape System	Type of Data Received
Purchased	Accurate Exp. Ltd.	37.6 mis	Sparker		Prints of Sections
Client's	Velocity Surveys Ltd	42			Original and prints of
					Marine Seismic
					Seismograms

* Current Data, Client's Data, Trade Data, Purchased Data, etc.

COMPUTING

METHOD N/A

Base Filter _____ Datum Sea Level Datum Velocity 11,400 ft./sec.

Depth Conversion Method _____

R. V. A. Area 6 Velocity Analyses

PLAYBACK SECTIONS

Company N/A

Presentation N/A

Dynamic Correction Function N/A

Static Correction Function N/A

REPRODUCTION

	Number of Copies	Destination
Final Reports	4	3 to Client - 1 to A.E.P. File
Seismograms		
Microfilm		
Sections		
Tapes		
Maps		

VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 50' N 122° 45' W

NAME IMP. SUN NETLA F-7

R.V.A. AREA ..... K.B. 2019

INFORMATION SOURCE Sonic Log ..... T.D. 7775

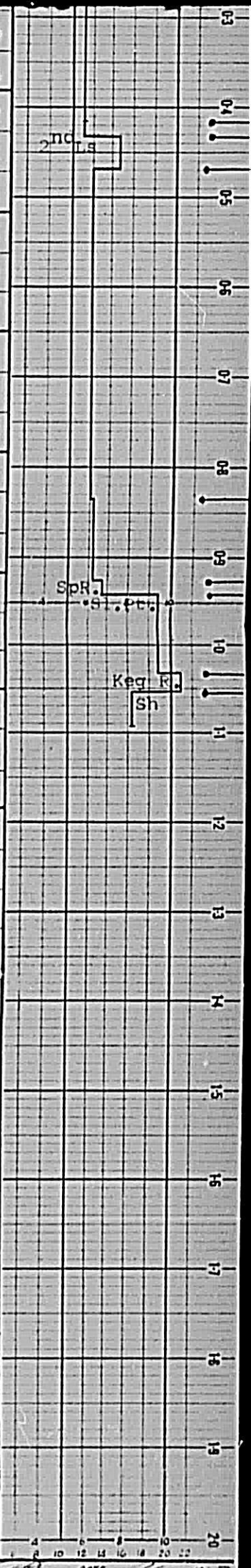
INTEGRATION INTERVAL FROM 1000 TO 7750 TOTAL 6750

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+1019				0.000
	1620	+399	620	0.135	4.6?	0.135
Miss?	1956	+63	336	0.069	4.9	0.204
Wab	2050	-31	94	0.022	4.2	0.226
1st Ls	2306	-287	256	0.048	5.3	0.274
	3094	-1075	788	0.142	5.6	0.416
2nd Ls	3186	-1167	92	0.016	5.6	0.432
	3463	-1444	277	0.037	7.4	0.469
	5670	-3651	2207	0.366	6.0	0.835
SpR.	6236	-4217	566	0.092	6.2	0.927
Sl.Pt.	6333	-4314	97	0.014	6.8	0.941
Keg R.	7198	-5179	865	0.091	9.5	1.032
Sh	7430	-5411	232	0.022	10.5	1.054
TD(Log)	7750	-5731	320	0.039	8.2	1.093

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC

Miss?
Wab
1st Ls
2nd Ls
SpR.
Sl.Pt.
Keg R.
Sh

	3463	-1444	277	.037	7.4	
	5670	-3651	2207	0.366	6.0	0.469
SpR.	6236	-4217	566	0.092	6.2	0.835
Sl.Pt.	6333	-4314	97	0.014	6.8	0.927
Keg R.	7198	-5179	865	0.091	9.5	0.941
Sh	7430	-5411	232	0.022	10.5	1.032
TD(Log)	7750	-5731	320	0.039	8.2	1.054
						1.093



COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH .....

SHOT ELEV. .....

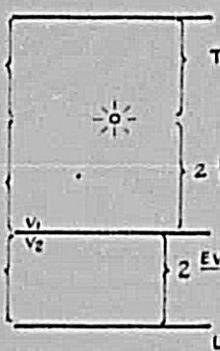
H .....

EV_2 .....

EV_2 - S.D. .....

SURVEY DATUM .....

K.S. – .....



ADDITIVE TO SURVEY TIME

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE .....

CHECKED BY ..... DATE .....

[redacted] VELOCITY ANALYSIS

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.
N.W.T. 60° 50' N 122° 30' W

NAME IMP. SUN NETLA RAVEN F-73

R.V.A. AREA ..... K.B. 1966

INFORMATION SOURCE Sonic Log ..... T.D. 7959

INTEGRATION INTERVAL FROM 1000 TO 7950 TOTAL 6950

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+966				0.000
	1695	+271	695	0.143	4.8	0.143
Det	2037	-71	342	0.070	4.9	0.213
Miss	2096	-130	59	0.014	4.3	0.227
Wab	2546	-580	450	0.095	4.7	0.322
1st Ls	2775	-809	229	0.042	5.4	0.364
	3615	-1649	840	0.138	6.1	0.502
2nd Ls	3723	-1757	108	0.018	5.8	0.520
	3978	-2012	255	0.033	7.7	0.553
Simp?	5137	-3171	1159	0.192	6.0	0.745
	6164	-4198	1027	0.175	5.9	0.920
SpR.	6767	-4801	603	0.100	6.0	1.020
Sl.Pt.	6874	-4908	107	0.016	6.8	1.036
Keg R.	7636	-5670	762	0.079	9.6	1.115
TD(Log)	7950	-5984	314	0.032	9.9	1.147

REFLECTION TIME SCALE

FORMATION

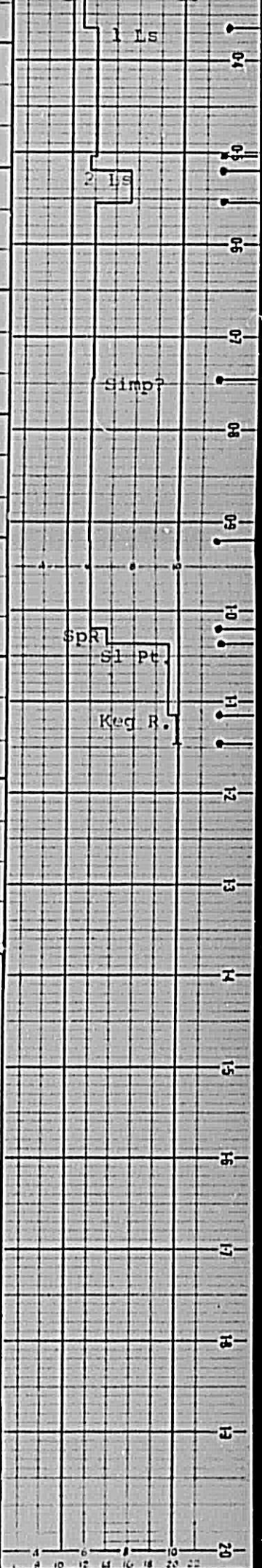
ADDITIVE TO SURVEY TIME

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC

Det
Miss
Wab
1 Ls
2 Ls
Simp?
SpR
Sl Pt
Keg R.

	3978	-2012
Simp?	5137	-3171
	6164	-4198
SpR.	6767	-4801
Sl.Pt.	6874	-4908
Keg R.	7636	-5670
TD(Log)	7950	-5984

255	0.033	7.7	0.553
1159	0.192	6.0	0.745
1027	0.175	5.9	0.920
603	0.100	6.0	1.020
107	0.016	6.8	1.036
762	0.079	9.6	1.115
314	0.032	9.9	1.147



COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH .....

SHOT ELEV. .....

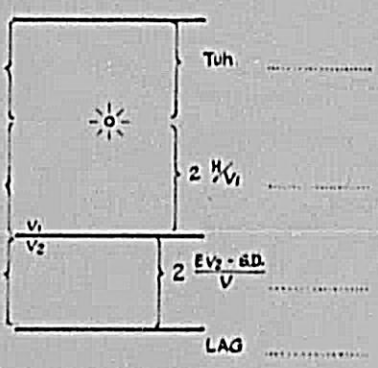
H .....

EV_2 .....

EV_2 - S.D. .....

SURVEY DATUM .....

K.B. – .....



ADDITIVE TO SURVEY TIME _____

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE 19

CHECKED BY ..... DATE 19

[redacted] VELOCITY ANALYSIS

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.
N.W.T. 60° 55' 03" N 120° 31' 34" W

NAME BRIGGS TROUT RIVER #5

R.V.A. AREA ..... K.B. 1263

INFORMATION SOURCE Sonic Log ..... T.D. 3931

INTEGRATION INTERVAL FROM 500 TO 3900 TOTAL 3400

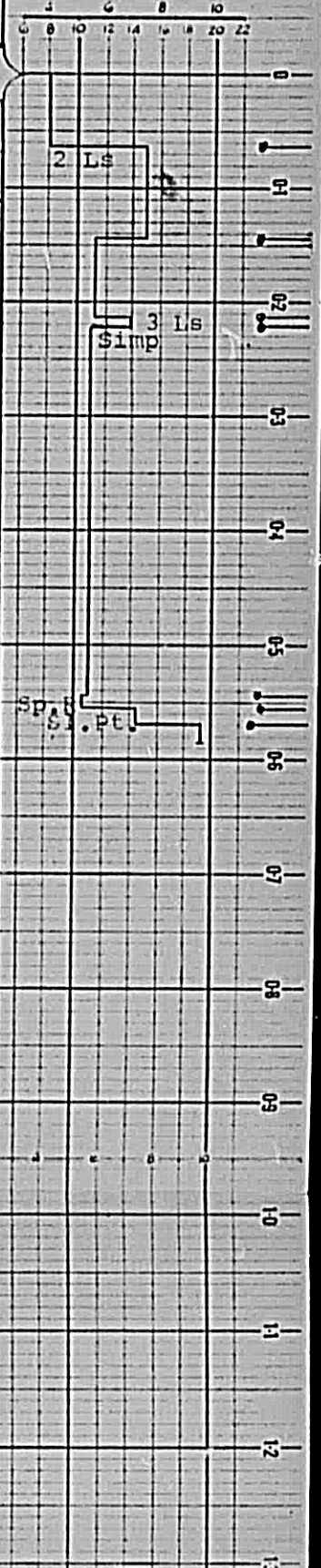
FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	500	+763				0.000
2nd Ls	760	+503	260	0.063	4.1	0.063
	1359	-96	599	0.080	7.5	0.143
3rd Ls	1750	-487	391	0.070	5.6	0.213
Simp	1810	-547	60	0.009	6.9	0.222
SpR.	3578	-2315	1768	0.322	5.5	0.544
Sl.Pt.	3632	-2369	54	0.010	5.3	0.554
	3743	-2480	111	0.015	7.3	0.569
TD(Log)	3900	-2637	157	0.016	9.7	0.585

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC



TD(Log)	3900	-2637	157	0.016	9.7	0.585

Sp.Pt.
Sh.Pt.

COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh .....

SHOT ELEV. .....

H ..... $2\frac{H}{V_1}$ .....

EV_2 ..... V_1 / V_2

EV_2 - S.D. ..... $2\frac{EV_2 - S.D.}{V}$ .....

SURVEY DATUM .....

K.B. – ..... LAG .....

ADDITIVE TO SURVEY TIME _____

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE ..... 19..

CHECKED BY ..... DATE ..... 19..

[redacted] VELOCITY ANALYSIS

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.
N.W.T. 60° 50' 22" N 122° 5' 50" W

NAME MURPHY B.O.C. ARROWHEAD RIVER #1

R.V.A. AREA ..... K.B. 2078

INFORMATION SOURCE Sonic Log ..... T.D. 6669

INTEGRATION INTERVAL FROM 1000 TO 6650 TOTAL 5650

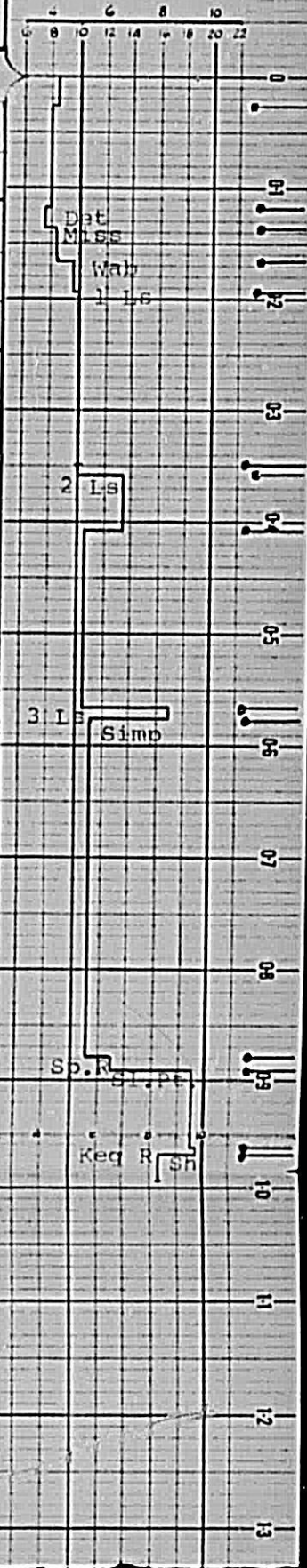
FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+1078				0.000
	1114	+964	114	0.027	4.3	0.027
Det	1481	+597	367	0.091	4.0	0.118
Miss	1550	+528	69	0.018	3.8	0.136
Wab	1673	+405	123	0.029	4.3	0.165
1st Ls	1810	+268	137	0.028	4.8	0.193
	2595	-517	785	0.156	5.0	0.349
2nd Ls	2640	-562	45	0.009	5.0	0.358
	2980	-902	340	0.050	6.8	0.408
3rd Ls	3832	-1754	852	0.159	5.3	0.567
Simp	3920	-1842	88	0.010	8.5	0.577
Sp.R	5617	-3539	1697	0.302	5.6	0.879
Sl.Pt.	5696	-3618	79	0.012	6.5	0.891
Keg R.	6377	-4299	681	0.071	9.6	0.962
Sh	6444	-4366	67	0.007	9.8	0.969
TD(Log)	6650	-4572	206	0.025	8.3	0.994

REFLECTION TIME SCALE

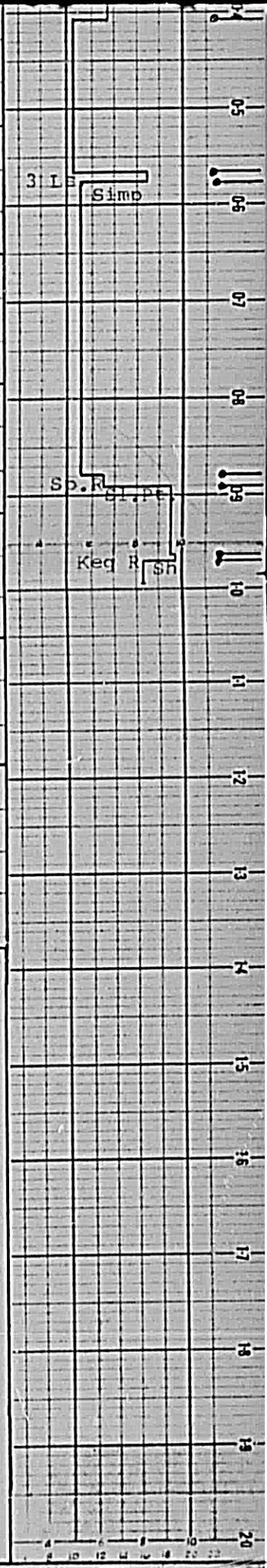
FORMATION

ADDITIVE TO SURVEY TIME

INTERVAL VELOCITY
ONE HALF AND FULL IN THOUSANDS OF FT/SEC



3 Ls	3832	-1754				0.567
Simp	3920	-1842	88	0.010	8.5	0.577
Sp.R	5617	-3539	1697	0.302	5.6	0.879
Sl.Pt.	5696	-3618	79	0.012	6.5	0.891
Keg R.	6377	-4299	681	0.071	9.6	0.962
Sh	6444	-4366	67	0.007	9.8	0.969
TD(Log)	6650	-4572	206	0.025	8.3	0.994



COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH .....

SHOT ELEV. .....

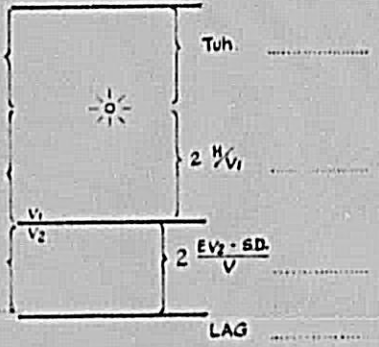
H .....

EV_2 .....

EV_2 - S.D. .....

SURVEY DATUM .....

K.B. - .....



ADDITIVE TO SURVEY TIME

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE .....

CHECKED BY ..... DATE .....

VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 43' 38" N 122° 3' 45" W

NAME MURPHY - BOC MUSKEG RIVER #1

R.V.A. AREA ..... K.B. 2235

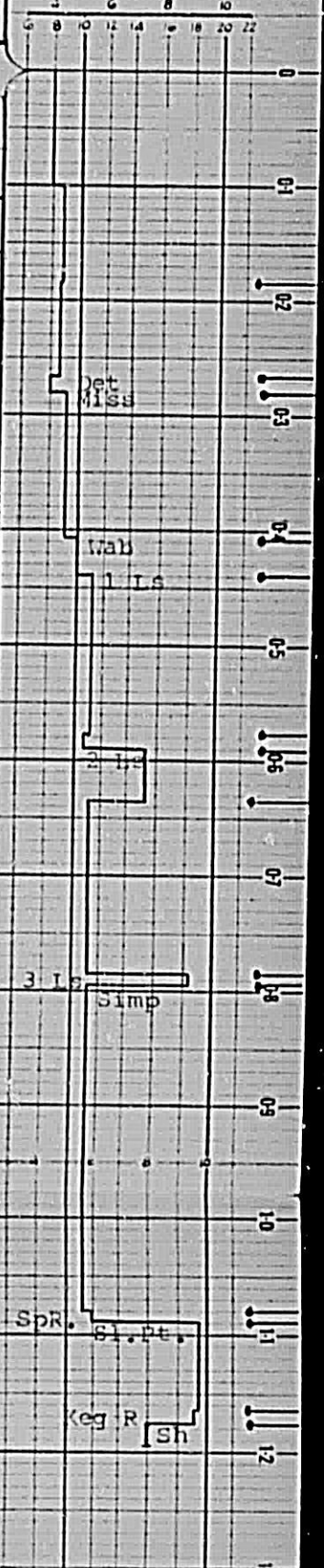
INFORMATION SOURCE Sonic Log T.D. 7320

INTEGRATION INTERVAL FROM 600 TO 7300 TOTAL 6700

FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	600	+1635				0.000
	1000	+1235	400	0.100	4.0	0.100
	1374	+861	374	0.084	4.4	0.184
Det	1730	+505	356	0.082	4.3	0.266
Miss	1785	+450	55	0.014	4.0	0.280
Wab	2365	-130	580	0.127	4.6	0.407
1st Ls	2522	-287	157	0.032	5.0	0.439
	3296	-1061	774	0.138	5.6	0.577
2nd Ls	3367	-1132	71	0.013	5.4	0.590
	3714	-1479	347	0.045	7.7	0.635
3rd Ls	4558	-2323	844	0.149	5.6	0.784
Simp	4647	-2412	89	0.010	9.2	0.794
SpR.	6249	-4014	1602	0.286	5.6	1.080
Sl.Pt.	6300	-4065	51	0.009	5.9	1.089
Keg R.	7025	-4790	725	0.074	9.8	1.163
Sh	7155	-4920	130	0.014	9.6	1.177
TD(Log)	7300	-5065	145	0.018	8.0	1.195

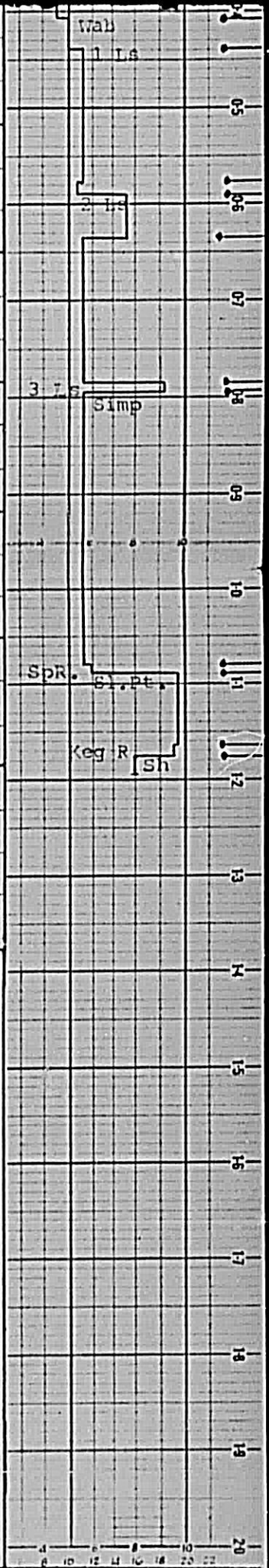
INTERVAL VELOCITY

ONE HALF AND FULL IN THOUSANDS OF FT/SEC



POSITIVE TO SURVEY TIME

	3714	-1479	844	0.149	5.6	0.635
3rd Ls	4558	-2323	89	0.010	9.2	0.784
Simp	4647	-2412	1602	0.286	5.6	0.794
SpR.	6249	-4014	51	0.009	5.9	1.080
Sl.Pt.	6300	-4065	725	0.074	9.8	1.089
Keg R.	7025	-4790	130	0.014	9.6	1.163
Sh	7155	-4920	145	0.018	8.0	1.177
TD(Log)	7300	-5065				1.195



COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh .....

SHOT ELEV. .....

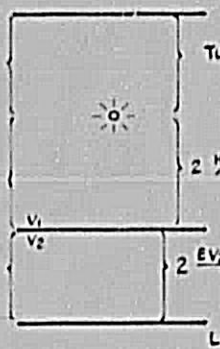
H .....

EV_2 .....

EV_2 - S.D. .....

SURVEY DATUM .....

K.B. - .....



ADDITIVE TO SURVEY TIME .....

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE ..... 19..

CHECKED BY ..... DATE ..... 19..

[redacted] VELOCITY ANALYSIS

REFLECTION TIME SCALE

FORMATION

ADDITIVE TO SURVEY TIME

LOCATION L.S.D. ..... SEC. ..... TWP. ..... RGE. ..... W. ..... M.

N.W.T. 60° 50' N 122° 15' W

NAME IMP. SUN ARROWHEAD 1-46

R.V.A. AREA ..... K.B. 1905

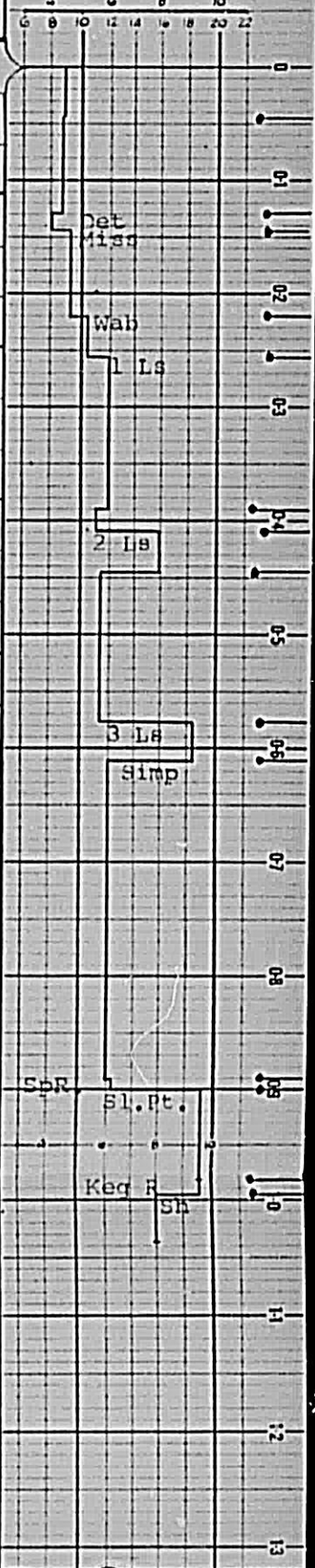
INFORMATION SOURCE Sonic Log ..... T.D. 7423

INTEGRATION INTERVAL FROM 1000 TO 7400 TOTAL 6400

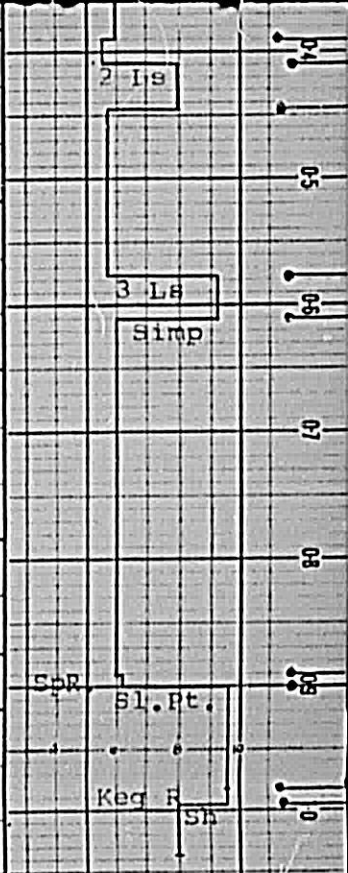
FORMATION	DEPTH BELOW K.B.	ELEV. A.S.L.	ISOPACH INTERVAL THICKNESS IN FEET	ISOCHRON INTERVAL TWO-WAY TIME IN SECONDS	INTERVAL VELOCITY ONE HALF OF ACTUAL IN THOUSANDS OF FT/SEC	CUMULATIVE TWO-WAY TIME IN SECONDS
	1000	+905				0.000
	1205	+700	205	0.045	4.5	0.045
Det	1577	+328	372	0.084	4.4	0.129
Miss	1637	+268	60	0.015	4.1	0.144
Wab	2003	-98	366	0.077	4.7	0.221
1st Ls	2189	-284	186	0.036	5.2	0.257
	2968	-1063	779	0.133	5.9	0.390
2nd Ls	3074	-1169	106	0.019	5.6	0.409
	3346	-1441	272	0.035	7.9	0.444
3rd Ls	4104	-2199	758	0.133	5.7	0.577
Simp	4415	-2510	311	0.034	9.2	0.611
SpR.	6078	-4173	1663	0.279	6.0	0.890
Sl.Pt.	6142	-4237	64	0.010	6.2	0.900
Keg R.	6935	-5030	793	0.082	9.7	0.982
Sh	7080	-5175	145	0.015	9.7	0.997
TD(Log)	7400	-5495	320	0.040	8.0	1.037

INTERVAL VELOCITY

ONE HALF AND FULL IN THOUSANDS OF FT./SEC



	5345	-1441	758	0.133	5.7	0.444
3rd Ls	4104	-2199	311	0.034	9.2	0.577
Simp	4415	-2510	1663	0.279	6.0	0.611
SpR.	6078	-4173	64	0.010	6.2	0.890
Sl.Pt.	6142	-4237	793	0.082	9.7	0.900
Keg R.	6935	-5030	145	0.015	9.7	0.982
Sh	7080	-5175	320	0.040	8.0	0.997
TD(Log)	7400	-5495				1.037



COMPUTATIONS AND REMARKS

PROJECT NO.

TIE TO S.P. ..... SH. NO. ..... MON./P.B.

SURFACE ELEV. .....

SHOT DEPTH ..... Tuh .....

SHOT ELEV. .....

H ..... $2\frac{H}{V_1}$ .....

EV_2 ..... V_1

EV_2 - S.D. ..... V_2 $2\frac{EV_2 - S.D.}{V}$ .....

SURVEY DATUM .....

K.B. - ..... LAG .....

ADDITIVE TO SURVEY TIME ——

A·E·PALLISTER CONSULTANTS LTD.

PREPARED BY ..... DATE .....

CHECKED BY ..... DATE .....