

## LEGEND

- SHOT POINT LOCATIONS SUPPLIED BY PAN AMERICAN.
- VELOCITY SURVEY LOCATIONS TIED INTO PAN AMERICAN LOCATIONS.
- ✓ MIGRATED REFLECTION DATUM POINT AND CORRESPONDING DEPTH.
- ✗ DEPTH, DIP AND STRIKE, FROM CROSS-SPREAD INFORMATION.

UD FA

VELOCITY FUNCTION:  $V = 12,400$

SEISMIC REVIEW OF

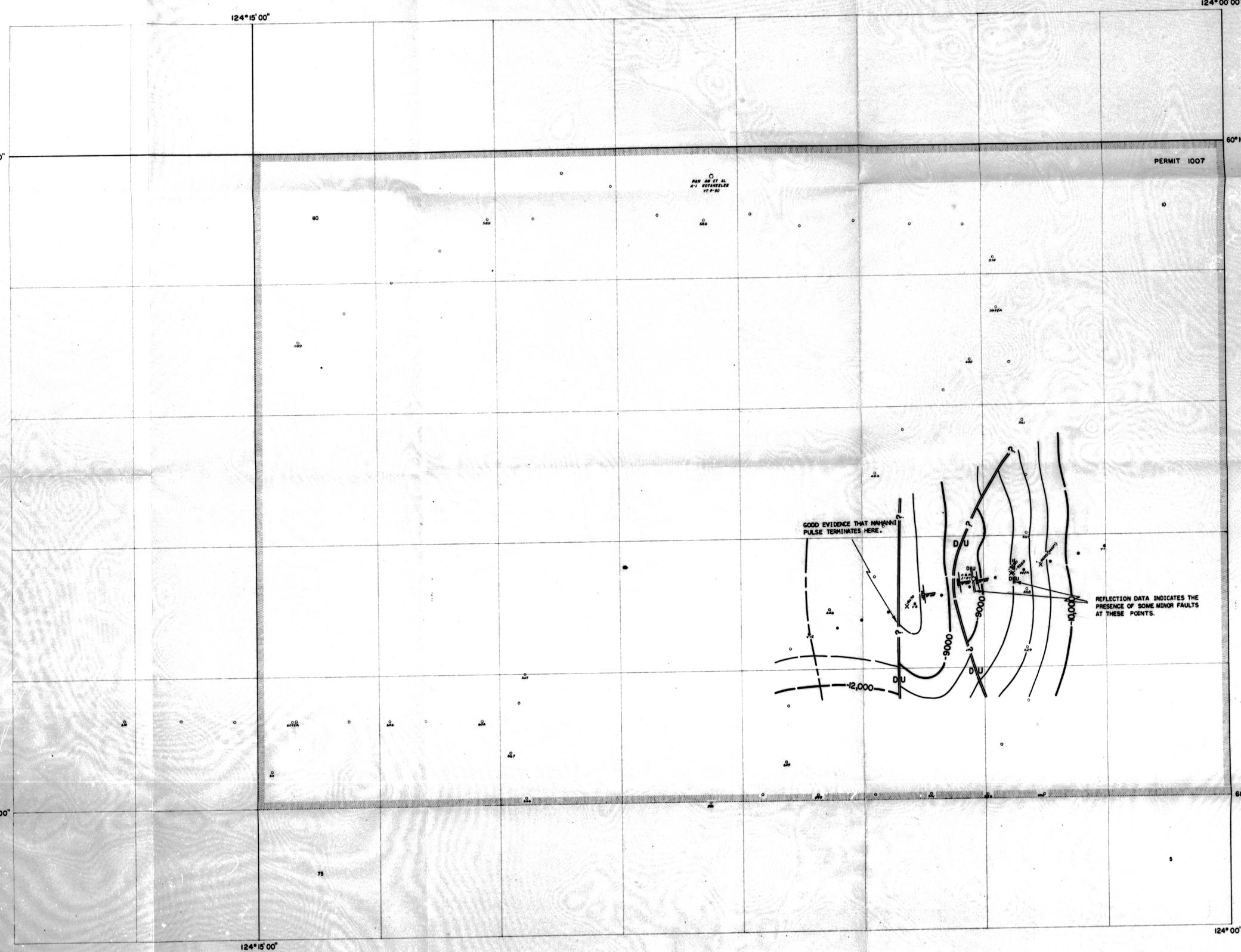
PERMIT 1007 - YUKON TERRITORY  
APPROXIMATE BASE OF  
CARBONIFEROUS SANDSTONE  
(SUB-SEA)

SEISMIC DATUM PLANE: + 1500 FEET CONTOUR INTERVAL: 250 FEET  
DATUM VELOCITY: 10,000 FT/SEC DATE: MAY 27, 1963

SCALE: 1 INCH = 2000 FEET

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JOHN A. LEGGE, JR. LTD.  
GEOPHYSICAL CONSULTANTS



124° 15' 00"

124° 00' 00"

60° 10' 00"

PERMIT 1007

60° 05' 00"

60° 05' 00"

124° 00' 00"

VELOCITY FUNCTION: V = 12,400

LEGEND

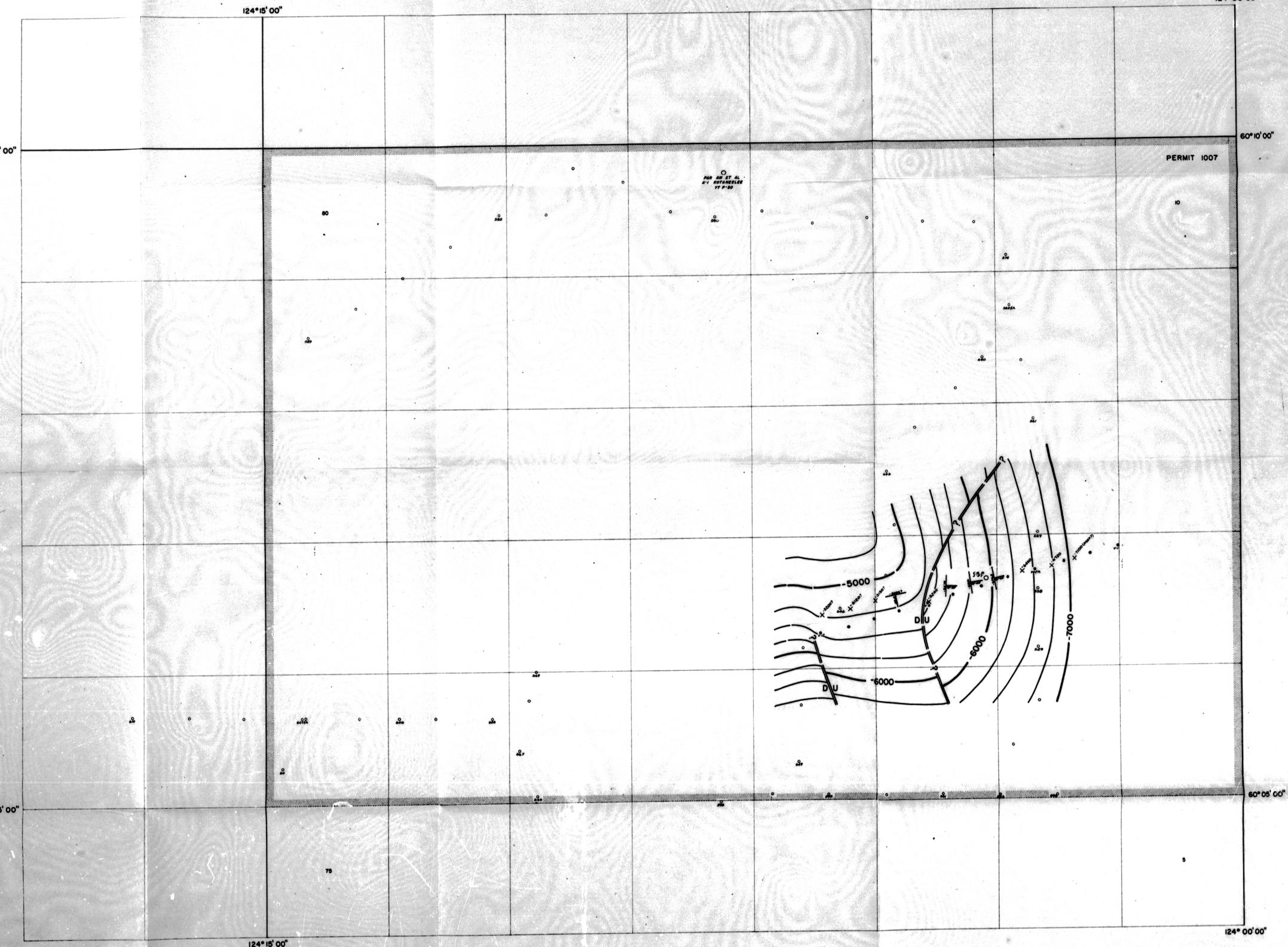
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- DEPTH, DIP AND STRIKE, FROM CROSS-SPREAD INFORMATION
- FAULT

CANADA SOUTHERN PETROLEUM LTD.

SEISMIC REVIEW OF  
PERMIT 1007 - YUKON TERRITORY  
APPROXIMATE TOP OF NAHANNI  
(SUB-SEA)

SEISMIC DATUM PLANE = 1500 FEET CONTOUR INTERVAL: 250 FEET  
DATUM VELOCITY: 10,000 FT/SEC. DATE: MAY - 27, 1963  
SCALE: 1 INCH = 2000 FEET

JOHN A. LEGGE, JR. LTD.  
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CANADA SOUTHERN PETROLEUM LTD.

SEISMIC REVIEW OF

PERMIT 1007 - YUKON TERRITORY

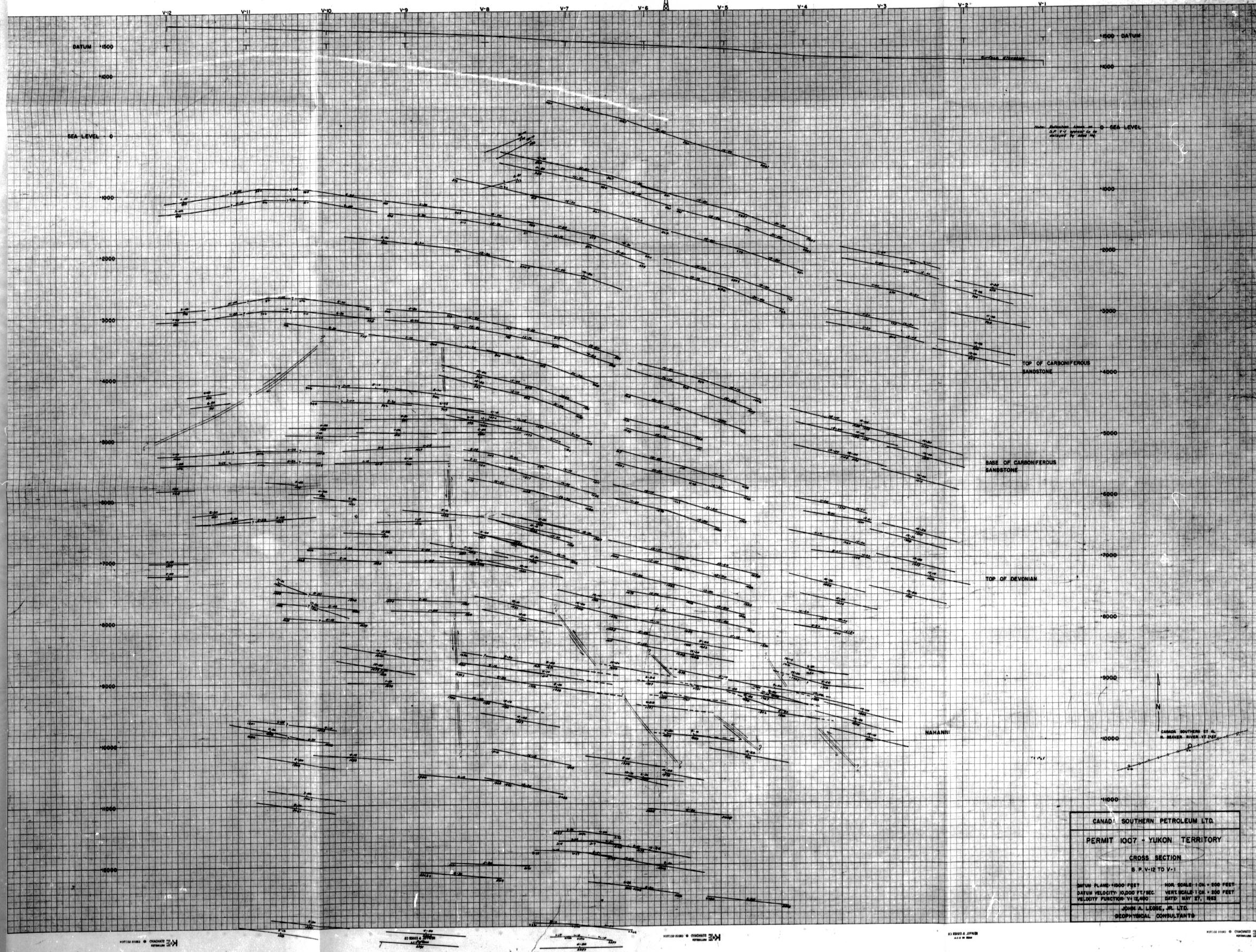
APPROXIMATE TOP OF DEVONIAN  
(SUB-SEA)

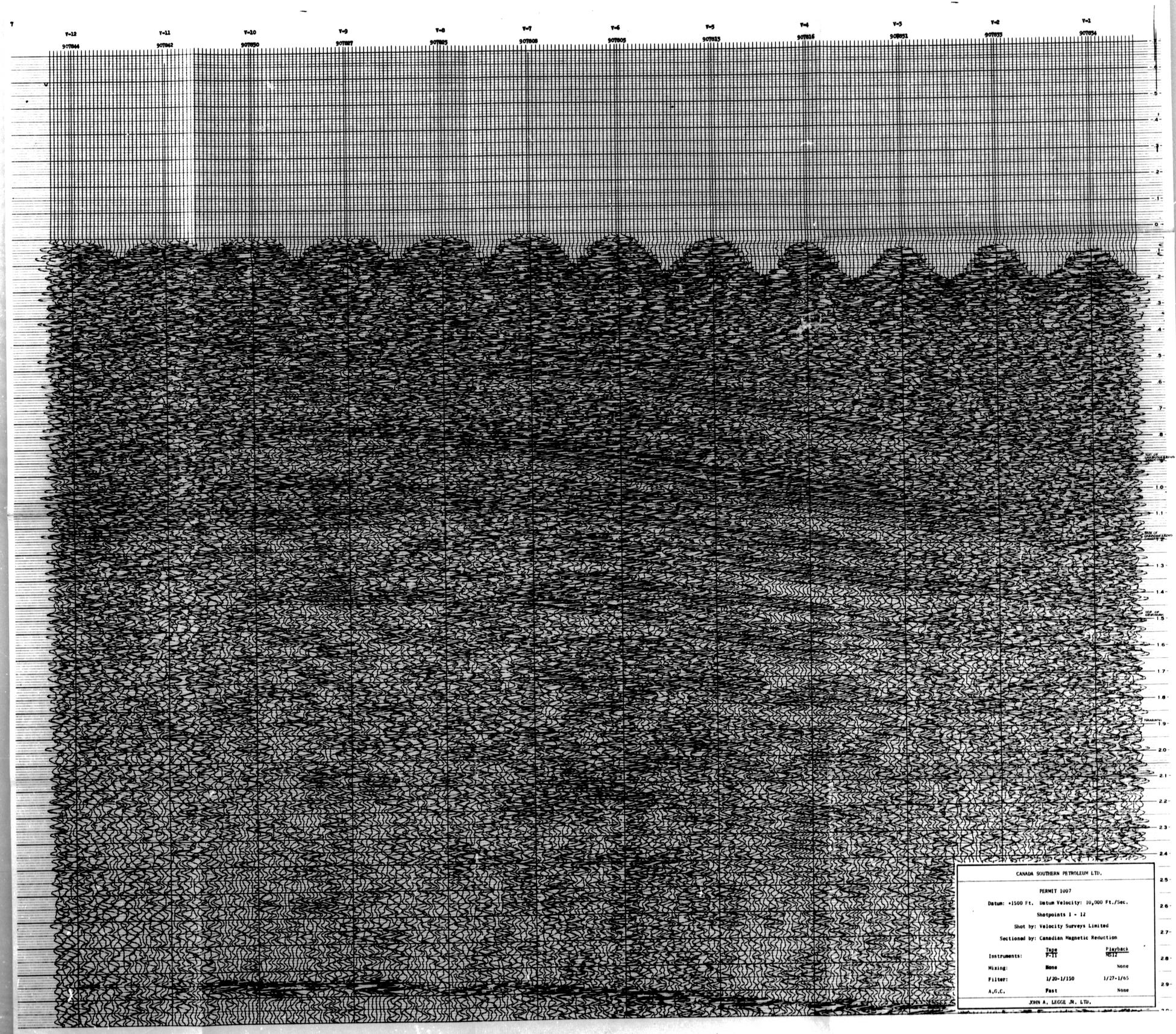
SEISMIC DATUM PLANE = 1500 FEET CONTOUR INTERVAL 250 FEET  
DATUM VELOCITY: 10,000 FT/SEC. DATE: MAY 27, 1965  
SCALE: 1 INCH = 2000 FEET

JOHN A. LEGGE, JR. LTD.  
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N 74° E

CANADA SOUTHERN ET AL  
N. BEAVER RIVER YT'I-27





CANADA SOUTHERN PETROLEUM LTD.		
PERMIT 1007		
Datum: +1500 Ft. Datum Velocity: 10,000 Ft./Sec.		
Shotpoints 1 - 12		
Sectional by:	Velocity Surveys Limited	2.7
Sectional by:	Canadian Magnetic Reduction	2.8
Instruments:	Type V-11	Playback 1012
Mixing:	None	None
Filter:	1/20-1/150	1/27-1/65
A.G.C.	Fast	None
JHN A. LEGGE JR., LTD.		

PERMIT 1007  
FILE 165  
MIX-20-60-20

V.11

V.10

V.9

V.8

V.7

V.6

V.5

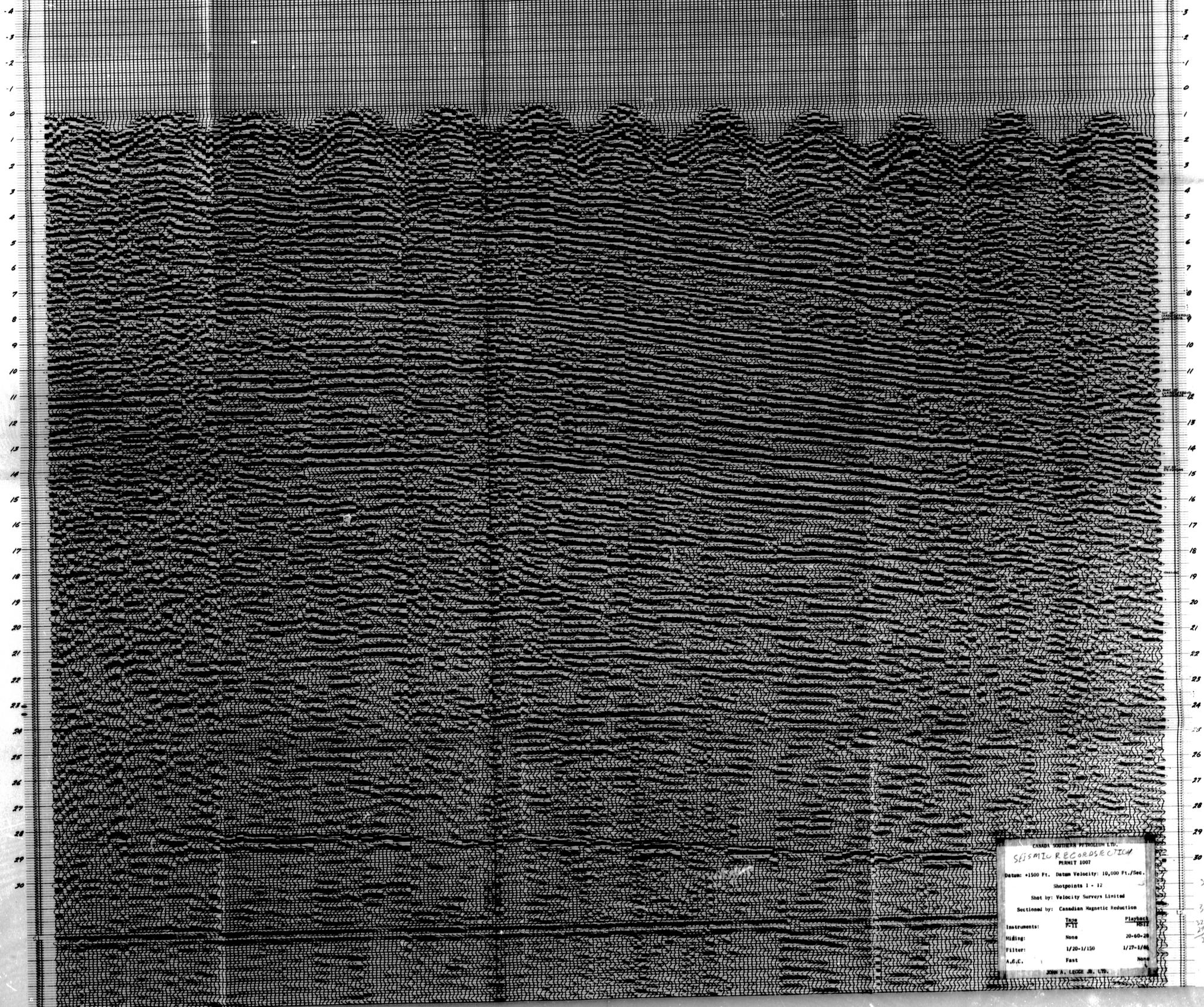
V.4

V.3

V.2

XX-100

V.12



CANADA SOUTHERN PETROLEUM LTD.  
SEISMIC RECORD SECTION  
PERMIT 1007

Datum: +100 Ft. Datum Velocity: 10,000 Ft./Sec.

Shotpoints 1 - 12

Shot by: Velocity Surveys Limited

Sectioned by: Canadian Magnetic Reduction

Instrument: Tape 7-11

Height: None 20-60-20

Filter: 1/20-1/150 1/27-1/60

A.G.C. Fast None

JOHN A. LOGUE JR. LTD.

31  
32  
33  
34

Abstracted for  
Geo-Science Data Index

Date



SUPPLEMENTAL SEISMOGRAPH SURVEY

of

PERMIT 1007,  
YUKON TERRITORY

for



CANADA SOUTHERN PETROLEUM LTD.

CALGARY, ALBERTA

JOHN A. LEGGE, JR. LTD.

Geophysical Consultants

Calgary, Alberta

T A B L E   O F   C O N T E N T S

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T A B L E   O F   C O N T E N T S

III.      Maps - continued

    3.      Approximate top of Nahanni (sub-sea)

Sections -

    Migrated Depth Section

    S.P. V-1 to V-12

Record Sections

    S.P. V-1 to V-12 Wiggly-trace unmixed

    S.P. V-1 to V-12 Variable density-galvo  
    mixed.

410 BENTALL BUILDING  
CALGARY, ALBERTA

JOHN A. LEGGE JR. LTD.  
*Geophysical Consultants*

OFFICE AMHERST 6-6808  
AMHERST 9-1420  
HOME CHESTNUT 3-3725

INTRODUCTION:

During the period March 19 to March 24, 1963 a reflection seismograph survey of approximately 3 miles of coverage was carried out on Permit 1007 in the extreme southeastern corner of the Yukon Territory.

The purpose of the brief program was to obtain some detailed control on a portion of the east flank of the Kotaneelee anticline, a prominent surface feature of considerable intensity extending north and south of Permit 1007. To find the Nahanni carbonate of the Devonian in a structurally favourable position is the principal target of economic importance in the prospect.

In February and March, 1962, Pan American Petroleum Corporation conducted a reflection seismograph survey on the east and west flanks of the anticline, with one line crossing the structure where it is breached by the La Biche River near the north boundary of Permit 1007. Subsequently, the Pan American Kotaneelee P-50 test was

drilled on the axis of the surface anticline just north of the La Biche River.

A cursory examination of the Pan American record sections in February, 1963 led to the postulation that the Kotaneelee anticline is the surface expression of a highly complex interaction of up-to-the-east and up-to-the-west fault systems.

The preliminary results of a detailed study of the Pan American records appeared to confirm the concept of a major up-to-the-east block at the Nahanni level on the east "flank" of the anticline. While the re-analysis was in progress a location was selected in section 27, grid area 60° 10', 124° 00' to test the up-lifted Nahanni block on the east "flank" of the Kotaneelee anticline. This proposed test, Canada Southern North Beaver River I-27, appeared to be located well to the east of the rather indeterminate west edge of the up-lift.

A more detailed picture of the structural configuration in the immediate vicinity of the proposed well was considered to be of the utmost importance in view of the results in the Pan American Kotaneelee P-50 well at that time.

The supplemental program was recommended to

obtain critically important data on which to base the permissible deviation of the North Beaver River test to avoid drilling west of the point where the Nahanni reflection appeared to terminate.

With the impending spring break-up a seismograph crew operated by Velocity Surveys Limited was hastily moved into the area from Ft. Nelson.

The program was set out to obtain approximately 2-3/4 miles of coverage from the La Biche River through the North Beaver River I-27 well site and continuing southwest as far as terrain would permit. In addition it was planned to re-shoot Pan American's shot point U-558 to tie the reflections on the two sets of seismograms. Further, to obtain absolute dip and strike determinations, four cross-spreads were shot at selected points along the profile with particular emphasis on obtaining data in a migrated position in the vicinity of the North Beaver River test.

The field interpretation and supervision of the shooting program was carried out by Mr. W. Schlarb of John A. Legge, Jr. Ltd.

FIELD PROCEDURES:

The prospect is located in rough, heavily wooded

terrain. Using D-7 and D-7E bulldozers a line was cut northeast and southwest from the Pan American Kotaneelee access road through a narrow creek passing between two prominent topographic highs rising abruptly on either side of the creek.

To provide accommodation for the crew personnel a mobile trailer camp was moved into the prospect from Ft. Nelson.

Three conventional rotary rigs were used for shot hole drilling. Drilling conditions were not difficult except for the holes on the east end of the line down on the river flat, where boulders and gravel were encountered. Because of the plan to use multiple hole patterns from the outset, it was felt that extra drill power would assure the completion of the program and securing the necessary information for a satisfactory picture, at the North Beaver River well, before the imminent spring thaw.

The surveying of shot point locations was carried out by transit traverse and chainage. The elevation and location of shot point U-558 were used as take-off for the vertical and horizontal control. The seismograph crew's traverse was tied, as well, to the engineering traverse to the North Beaver River well site.

A truck-mounted set of 24, S.I.E. model P-11 amplifiers with FM tape was used for recording. A monitor record was obtained with each shot and a tape was simultaneously recorded for field playbacks and record sectioning. In addition to the conventional split-profiles at each location an end-on shot was recorded for p-wave breaks.

The essential information regarding instrumentation and recording technique is summarized in Appendix I accompanying this report.

COMPUTATION PROCEDURE:

The reflection times were reduced to a datum plane of 1500 feet above sea level using a datum velocity of 10,000 feet per second. Corrections for the delay time caused by the presence of low velocity material below the shot were computed using intercept times and the laws of refraction for simple rectilinear ray paths.

Record sections accompanying this report were prepared for shot points V-1 to 12. Correction data for sectioning were supplied to Canadian Magnetic Reduction's playback center. Using the S.I.E. model MS-12 playback machine unmixed wiggly-trace and mixed variable density-galvo presentations were prepared on shot points V-1 to 12.

Dip calculations were carried out for the above shot points and the migrated depth section accompanying this report was prepared using a constant velocity function of 12,400 feet per second.

The cross-spreads at shot points V-4, 5, 6 and 9 were incorporated with the in-line profiles at the same location to compute the depth, and dip and strike for the principal reflecting horizons at these locations.

MAPS AND INTERPRETIVE TECHNIQUE:

The following maps were prepared using the reflection identification and velocity information provided by Pan American:

1. Approximate base of Carboniferous sand-stone (sub-sea)
2. Approximate top of Devonian (sub-sea)
3. Approximate top of Nahanni (sub-sea)

To prepare these maps, depths were read from the plotted cross-section and spotted in the migrated position of the datum point as indicated by an "X" on the map. For the depths on shot points V-10 to 12 an approximate direction of strike and the cross-component of dip has been obtained from a generalized interpretive picture using reflection times from the Pan American records.

Dip and strike determinations were made at shot points V-4, 5, 6 and 9 where cross-shots were obtained. The dip, depth and displacement for the reflection times on these shot points are indicated by the dip and strike symbols plotted in the migrated positions out of the corresponding shot point. These computations were carried out using a constant velocity of 12,400 feet per second.

The velocity survey in the Pan American Beaver River b-63-K gas well indicates that the use of an average velocity of 12,400 feet per second gives a reasonably accurate picture of the dips on the reflecting horizons mapped in this area.

The presence of a thick section of the high velocity Carboniferous sandstone (approximately 16,000 feet per second) and lower velocity beds above (approximately 11,000 feet per second) produces a marked deviation in the time-depth curve from the assumed average velocity of 12,400 feet per second. This results in the reflections above the base of the Carboniferous sandstone being plotted too deep by amounts dependent upon the corrected reflection time. For instance, the top of the Carboniferous sandstone is plotted approximately 450 feet too deep as a result of the velocity

deviation described above.

In addition to the variations of velocity within the section, all reflection times are subject to the effects of instrument lag and phase correction. Though the magnitudes of the lags caused by these factors are not known exactly, it is estimated that the reflection times are lagged by an amount equivalent to approximately 250 feet in depth.

RESULTS:

An attempt has been made to prepare maps and sections which provide a picture of the general structural relationships in the immediate vicinity of the Canada Southern North Beaver River I-27 test.

In general, the structural picture down to the Carboniferous sandstone level appears to be conformable with the surface structure. However, at the top of the Devonian and the Nahanni level there is evidence for the presence of several down-to-the-west faults.

In the immediate vicinity of the North Beaver River I-27 test, between shot points V-4 and 7, the records and sections provide data indicating that the well is being drilled on the up-thrown block of an up-to-the-east fault at the Devonian level. The magnitude

of this fault as implied by control to the north and south is in the order of 2,000 to 3,000 feet at the Nahanni level. There is reasonably good evidence to interpret the loss of the Nahanni reflection at shot point V-7, as the west edge of the up-thrown block. The migrated position of the data on shot point V-7 lies approximately 2,000 feet west of the shot point as indicated by the fault symbol on the Nahanni map.

Several minor breaks, three in all, occur east of the major fault on the up-thrown block. One of these minor faults appears to have a displacement of the order of 100 to 200 feet and has been indicated on the map approximately 1,000 feet west of shot point V-6.

CONCLUSIONS AND SUMMARY:

The results of the supplemental seismograph program indicate that a complex structural relationship exists between the horizons above and below the top of the Devonian in the vicinity of the North Beaver River I-27 test.

There is geological evidence for this variance in the structural deformation at different horizons in this area. The surface expression of the Kotaneelee anticline appears as a relatively simple,

intense fold trending nearly north-south through the central portion of Permit 1007. However, at levels below the base of the Carboniferous sandstone the non-conformity and complexity of the structural deformation with depth is clearly indicated by the results of the Pan American Kotaneelee P-50 test.

The identification of the horizons is based entirely on the work done by Pan American between this prospect and the Beaver River A-1 well. The velocity survey in that well has been examined and the average velocity of 12,400 feet per second that has been used throughout this work for the computation of depth and dip is consistent with the reflection classification suggested by Pan American.

In conclusion, it is estimated at this time that the Canada Southern North Beaver River I-27 test will encounter the Nahanni carbonate at an approximate depth of 10,400 feet. Further, with the migration of the reflection data recorded in the vicinity of the I-27 test it appears that there should be little risk of drilling west of the major fault postulated some 3,000 feet west of the location, provided of course

that the well does not deviate excessively from the vertical.

Yours truly,

JOHN A. LEGGE, JR. LTD.

William Schlarb  
William Schlarb - Seismologist

John A. Legge Jr.

May 27, 1963

APPENDIX I - Summary of Instrumentation and  
Recording Technique

Amplifiers: 24 S.I.E. Model P-11

Tape: 27 Channel FM  
S.I.E. Model PMR-20 Tape  
Recorder

Geophones: 17 per channel  
HS-J Model K 28 c.p.s. 20 ohm.

Filter Settings: Record - 1/20 - 1/150  
Field Playback - 0 - 1/64

Mix: Record - no mix  
Field Playback - one straight  
- one mixed  
(10% bi-directional)

Gain Control: Record - A.G.C.  
Field Playback - A.G.C.

Gain: Record - 50% +  
Field Playback - less than 50%

Shot-Hole Interval: Standard 1320 feet  
Trace 12 and 13 110 foot gap

Trace Interval: 110 feet

Geophones: 17 at 7 feet, in-line  
Station 12 and 13 pulled back  
to flag

Shot-hole pattern: 3 at 55 feet, in-line

Hole depth: Variable (25 to 100 feet)

Charge size: Generally 3 x 5 pounds, split profile.  
End-on shots single hole, variable  
charge.

APPENDIX II - Statistical Summary

Recording Crew:

First day shooting	March 20, 1963
Last day shooting	March 24, 1963

Move Ft. Nelson to Permit 1007 and return	22.50 hours
Field days	5
Field recording time	50.25 hours
Field driving time	2.75 hours
Total field time	53.00 hours

Profiles shot

Split reflection profiles	17
Refraction profiles	12
Total sub-surface coverage	4.11 miles
Total shots	63
Magnetic tapes	42

Explosives:

Dynamite	949.375 lbs.
Caps	143

Shot Hole Drilling (3 rigs):

Move Ft. Nelson to Permit 1007 and return	67.5 hours
Field days	17
Field drilling time	183.5 hours
Field driving time	8.5 hours
Total field time	192.0 hours
Number of holes drilled	57
Total footage drilled	3815 feet
New rock bits used	8
Re-tipped rock bits used	11
Polygel mud	2600 lbs.
Bran	1700 lbs.

APPENDIX III - PRODUCTION RATES

	<u>Per Profile</u>	<u>Per Mile of Sub-surface Coverage</u>
<u>Recording Crew:</u>		
Hours of field recording time	2.96	12.23
Hours of field travel time	.16	.67
Total hours field time	3.12	12.90
Tapes	2.47	10.22
Dynamite	32.74*	230.99
Caps	4.93*	34.79
Shots	2.17*	15.33

\*Includes reflection and refraction profiles

<u>Shot Hole Drilling (3 rigs):</u>		
Hours of field drilling time	10.79	44.65
Hours of field driving time	.50	2.07
Total hours field time	11.29	46.72
Footage	224.41	928.22
Holes	3.35	13.87

	<u>Per Ten Hour Day</u>
<u>Profiles</u>	3.21
Miles of Sub-surface coverage	.78
Holes drilled	2.97
Footage drilled	198.70