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GEOPHYSICAL REPORT ON THE

GRUMBLER AREA,

NORTHWEST TERRITORIES

1965-1968

TO: Government of Canada

Shell Canada Limited
Southern Division Exploration
Edmonton, Alberta, March 31, 1968

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GEOPHYSICAL REPORT ON THE GRUMBLER AREA, NORTHWEST TERRITORIES 1965-68

I INTRODUCTION

In compliance with Section 54 (1) and (2) of the Canada Oil and Gas Land Regulations this report is submitted after the third anniversary of Permits P-4145 to P-4150, inclusive, located in the Grumbler Area of the Northwest Territories between approximately 60° 10' and 60° 30' North latitude and 115° 37-1/2' and 116° 15' West longitude.

II HISTORY OF PERMITS

On March 11, 1965 Hudson's Bay Oil and Gas Company Limited obtained exploratory permits on Permit Nos. P-4145 to P-4150 in the Grumbler Area in the Northwest Territories. Subsequently Shell Canada Limited entered into an agreement with Hudson's Bay Oil and Gas Company Limited by which Shell Canada Limited could, subject to the terms of this agreement, earn an interest in the above-mentioned Permits.

This report covers all geophysical work done on these permits during the period March 11, 1965 to March 11, 1968.

III SEISMIC WORK PERFORMED

A. 1967

1. Reflection stacking - conventional

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B. 1968

1. Reflection stacking - conventional
2. Reversed inline refraction
3. Velocity profile
4. Microspread recording
5. Vibroseis survey - conducted by Northern Geophysical Limited under contract to Shell Canada Limited.

IV SEISMIC

1. Equipment and Personnel

A. 1967

See the enclosed report (Enclosure No. 1) submitted by Seismotech Limited who conducted the survey under contract to Shell Canada Limited.

B. 1968

(i) Surveying - Surveying operations were conducted by a Shell Canada Limited survey crew. Horizontal distances were laid out using a normal calibrated surveyor's chain. Horizontal and vertical ties were obtained from:

(a) Well location Shell HB Grumbler F7
(b) 34th base line
(c) Boundary of Wood Buffalo National Park
(d) Alberta-Northwest Territories Boundary

(ii) Dozing - Dozing was conducted by four locally contracted units:

Contractor	Unit
Krause Brown and Associates	DC-6
Krause Brown and Associates	DC-6
Hachwell Construction Limited	DC-6
Hachwell Construction Limited	DB-6

(iii) Drilling - Shot-hole drilling was done by nine locally contracted drills:

Contractor	Drill	Mounted On
Two-way Drilling	Mayhew 1000	Ford 700
Seisform Drilling	Mayhew 1000	Ford 700
Seisform Drilling	Failing CFD1	Ford 700
Seisform Drilling	Failing CFD1	Ford 700
Trans. Provincial Drilling	Failing CFD1	Dodge
Trans. Provincial Drilling	Failing CFD1	Dodge Tandem
Hi Mac Drilling	Mayhew 1500	
Hi Mac Drilling	Wintweiss 1500	
Northland Drilling	Sewell Auger	Ford

(iv) Shooting and Recording - 1968 field operations (other than the Vibroseis work) were conducted by a Shell Canada Limited seismic crew. The following equipment was supplied:

(a) Instrument truck - a 30-channel amplifier (Shell manufacture type AG-6A) fitted with a Shell wet-recording camera was mounted on an International truck equipped with Terratyres.

(b) Shooting truck - a G.M.C. Avis-contracted pickup truck equipped with charge-setting and shooting accessories was used for the shooting truck.

(c) Intercommunication system for all crew vehicles.

(d) 60 sets of EVS-2 geophones with 8 geophones/set plus 200 single GEOSPACE HSJ geophones.

(e) Approximately 12-Shell employees to operate the seismic shooting and recording equipment.
Field operations were supervised by Mr. K.E. Thompson.

(f) Northern Geophysical Limited, under contract to Shell Canada Limited provided a Vibroseis crew to conduct a small Vibroseis survey for the purpose of comparison with conventional seismic.

V SHOOTING METHODS AND OBSERVATIONS

A. 1967

The conventional reflection stacking survey conducted by Seismotech Limited is described in the enclosed report, (Enclosure No. 1).

B. 1968

General Observation:

(i) Topography and Surface Cover - Elevations over the Permit area vary from 990' in the West end of the block gradually sloping down to 860 feet in the East of the block. The terrain is thus flat and monotonous but the seismic lines were very rough

due to the frozen muskeg which extends over nearly all the permit area.

(ii) Weather Conditions - Conditions encountered varied from extremely cold weather (as low as 50° below zero) to a short spell of very warm weather (50° above zero) which threatened to curtail operations as the vehicles began to break through the muskeg.

(iii) Drilling - Drilling was generally quite difficult over the permit area with each drill averaging about 8 holes per day. This was mainly due to the Hay River limestone formation which is near the surface in the western half of the area, outcropping in the northwest corner of the prospect. The limestone disappears in the eastern half of the area where shales are encountered below the subsurface cover. Nearly all holes were drilled to 35 feet. Formations logged vary from 1 to 20 feet muskeg, clay and boulders, and limestone in the west to 1 to 10 feet muskeg, clay and boulders, and shale in the east end of the prospect. Charge size varied from one-quarter (1/4) of a pound to two and one-half (2-1/2) pounds of dynamite but five-eights (5/8) of a pound was generally used.

1. Reflection stacking - conventional

At the start of the seismic survey a conventional split spread recording procedure was employed with a 100 foot station spacing and a

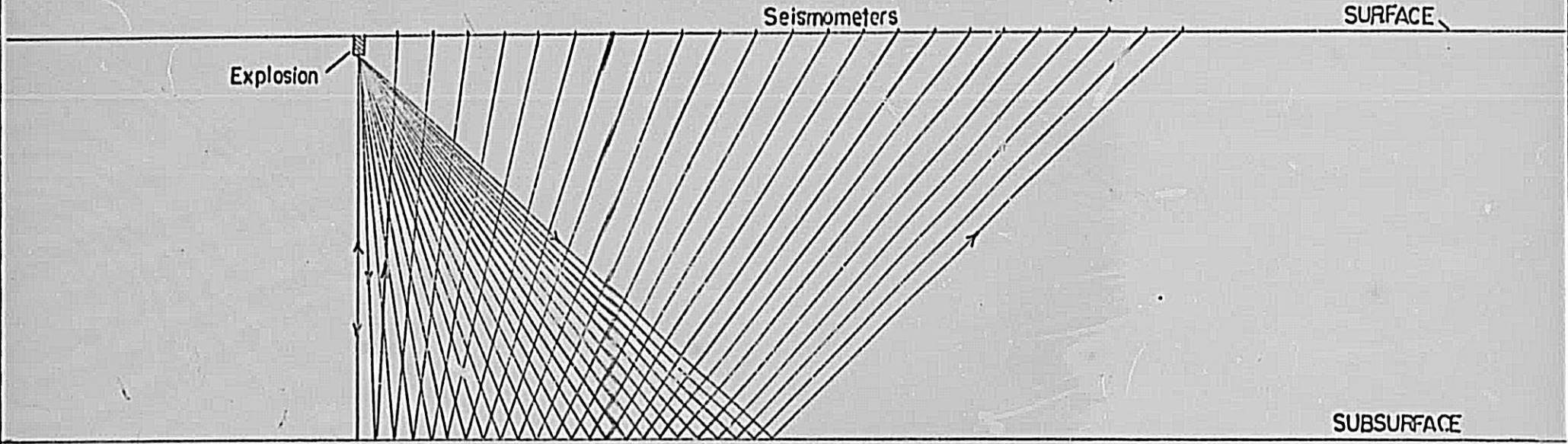
maximum station distance of 1200 feet. Eight EVS-2 seismometers spaced at ten foot intervals were used for each station of the 24-station split spread. The shotpoint interval was 400 feet. Due to variable velocity noise and drastic subshot weathering produced by erosional channels filled with muskeg, clay and rocks the field procedure was modified and employed over a major portion of the prospect. This consisted of a 24 station ender recording procedure with 33 or 67 foot station spacings (the lesser station spacing was used for areas with extremely bad subshot weathering) and using one GEOSPACE HSJ seismometer per station, (figure 1). The shotpoint interval remained at 400 feet. In the 33 foot station spacing shooting, two shots were taken per hole, assisted by a Sewell drill, simulating an ender with a maximum shooting distance of 1566 feet. Shooting procedure used yielded two or three-fold multiplicity in subsurface coverage. Two-fold coverage was obtained over a major portion of the lines shot.

Simultaneous recordings of the detected signals were made on 12 inch paper monitor records and magnetic tapes.

Record quality generally deteriorated (to poor and unusable) to the south and east due to extreme subsurface weathering, noise arrivals and frequency filtering introduced by the subsurface weathering, (Figure 2). Record quality generally improved to the north and east where these problems are not quite as severe and in many cases were able to see a continuous reflection from a geological horizon, (Figure 3).

Over the whole prospect the record quality is as follows:

GOOD - 15%, FAIR - 35%, POOR to UNUSABLE - 50%.



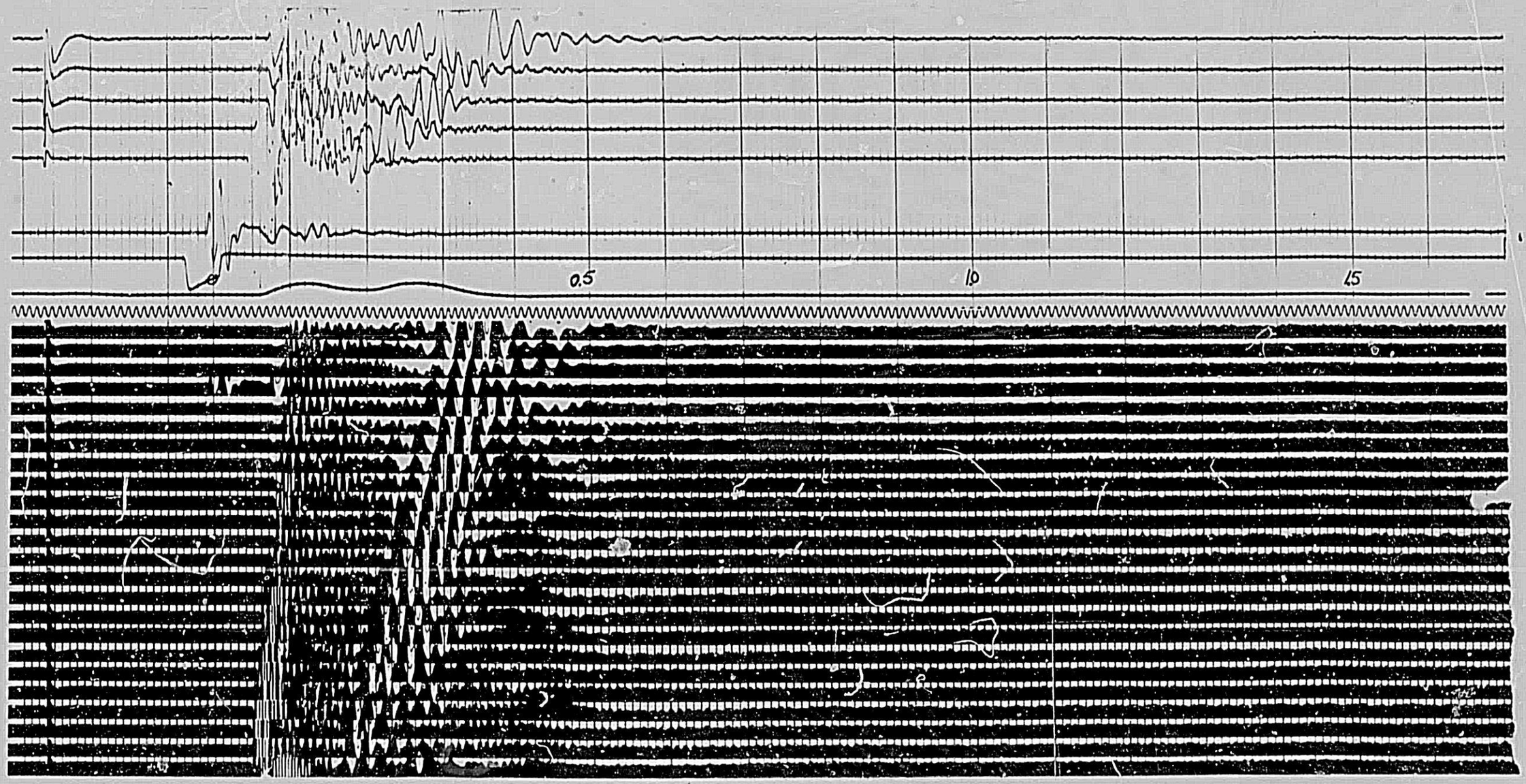
Scale

0 200 Feet

100 100

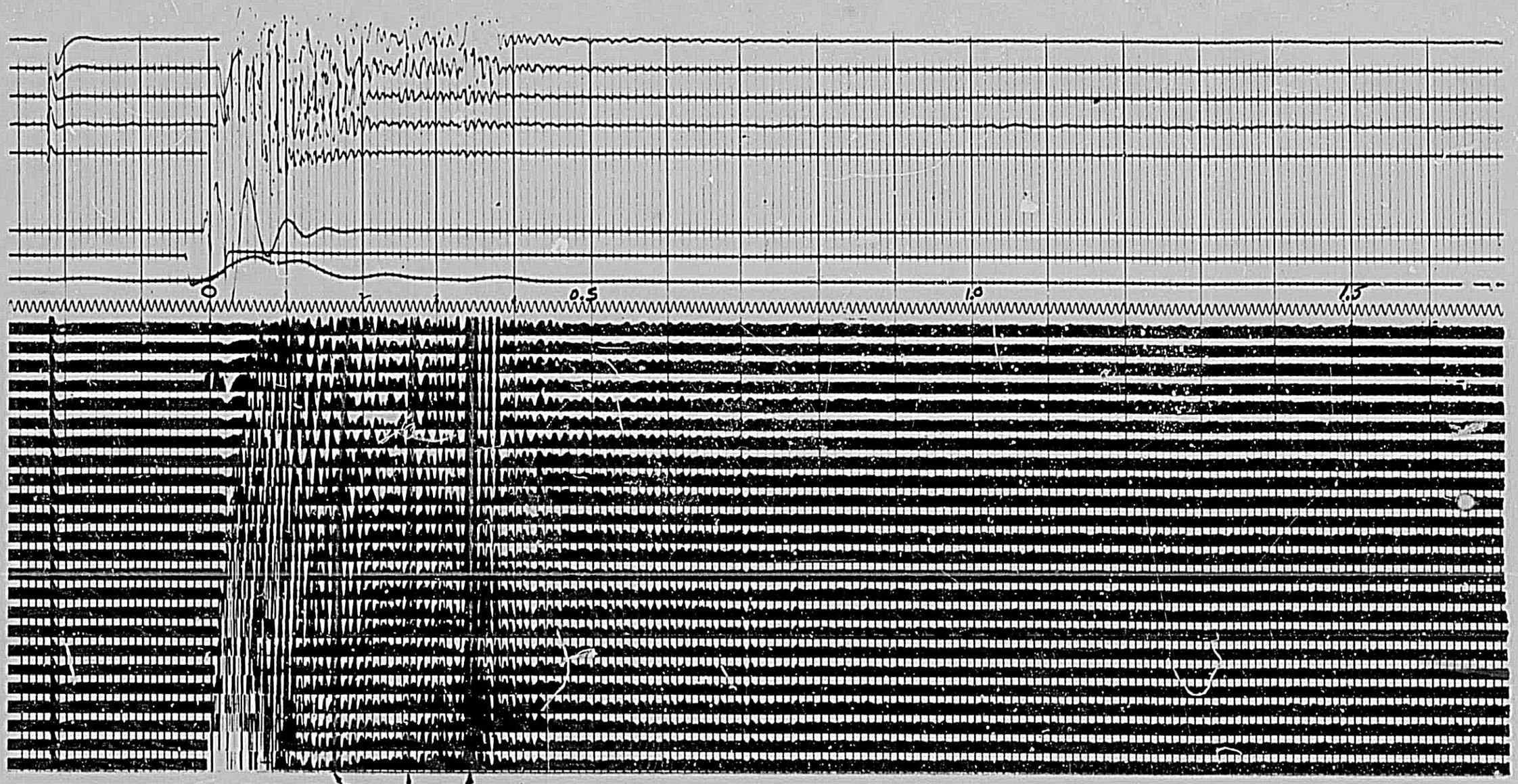
REFLECTION TECHNIQUE

Figure 1



POOR REFLECTION RECORD

Figure 2.



VERY GOOD REFLECTION RECORD

Figure 3.

2. Reversed Inline Refraction

One reversed inline refraction survey was shot to ascertain whether this type of survey could be used as a reconnaissance tool where reflection methods provided no usable results. On this refraction survey two shotpoints were spaced 14,400 feet apart. A 24-station spread (with 100' station intervals) was moved down the line from one shotpoint to the other and the instrument truck recorded shots from the one shotpoint at 2400' intervals, (Figure 4). The shooting truck would then move to the second shotpoint location and again 6 shots would be recorded into the spread as it was moved back to the first shotpoint.

3. Velocity Profile

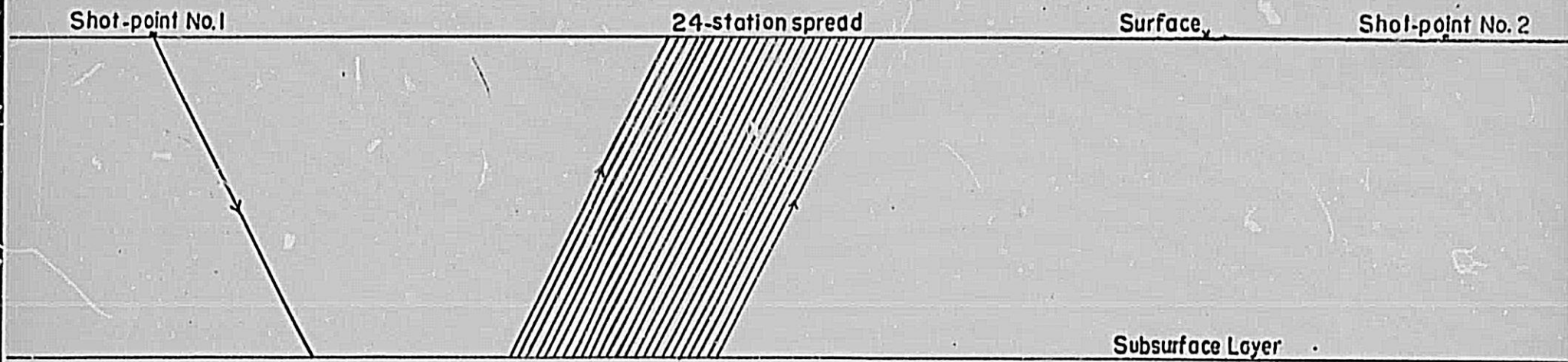
Combination reflection-refraction spreads were shot to determine velocity measurements of various reflection horizons.

4. Microspreads

A number of small microspread surveys were shot using ender geometry reflection techniques with station intervals of 10', 20' or 30'. The microspreads show the severe subsurface weathering and variable velocity noise arrivals one has to cope with in this area. Figure 5 is an example of microspread data.

5. Vibroseis reflection stacking

"Vibroseis" is a seismic technique in which a six second sinusoidal signal of continuously varying frequency is applied to the



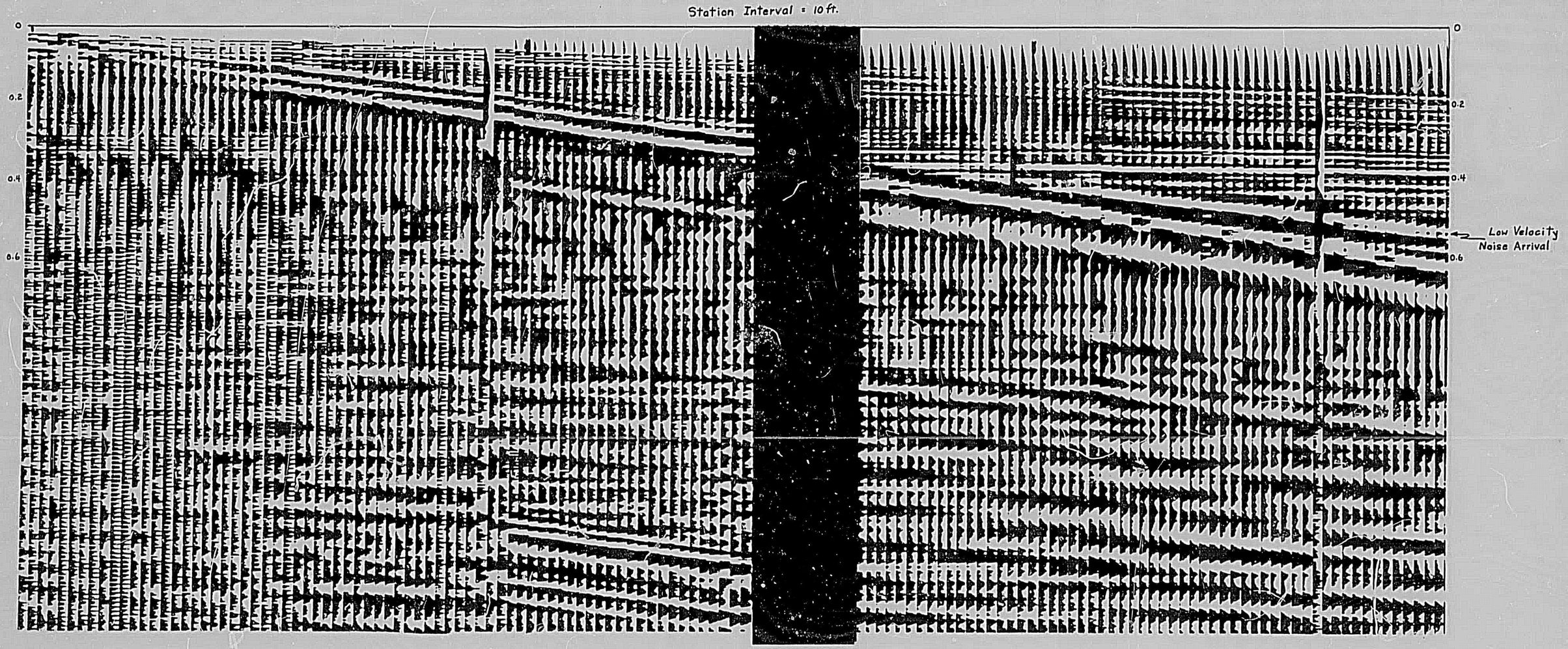
Scale

0 2000 Feet

1000 1000

REFRACTION TECHNIQUE

Figure 4



MICROSPREAD DATA

Figure 5.

surface of the ground as opposed to the conventional technique whereby an almost instantaneous signal is generated by the explosion of dynamite in the subsurface. The Vibroseis sinusoidal signal, called a "sweep", is mechanically coupled to the ground through a truck mounted "vibrator". The seismic signals, recorded with conventional seismic amplifiers and a decatrack tape recorder, are correlated with the applied signal to obtain a "correlogram" similar in appearance to a conventional seismogram.

Enclosure No. 2 is a shotpoint and elevation map showing the location of the reflection stacking, refraction, velocity profiles, micro-spread and Vibroseis data obtained to March 18, 1968.

VI OPERATIONAL STATISTICS

A. Timing of 1968 Grumbler Survey

1. Surveying of seismic program commenced ..... December 7, 1967
2. Line cutting and clearing commenced ..... December 9, 1967
3. Drilling of shotholes commenced ..... December 18, 1967
4. Field crew commenced shooting and recording .. January 4, 1968
5. Vibroseis program commenced ..... February 25, 1968
6. Vibroseis program completed ..... March 6, 1968
7. Line cutting and clearing completed ..... March 11, 1968
8. Drilling completed ..... March 17, 1968
9. Surveying completed ..... March 17, 1968
10. Program completed by field crew ..... March 18, 1968

B. Coverage

Reflection stacking	332 profiles
	220.9 miles
Refraction	20 profiles
	0.9 miles
Velocity profiles	17 profiles
	0.7 miles
Microspread	106 profiles
	9.7 miles
Vibroseis	10 miles
Amount of powder used	3066 3/8 pounds

VII PROCESSING AND INTERPRETATION

A. 1967 Seismic Work

Reflection data obtained by Seismotech Limited was processed digitally and interpreted by the contractor and is described in the enclosed report prepared by Seismotech Limited, (Enclosure No. 1).

To provide velocity measurements and geological data, a basement test well, Shell HB Grumbler F-7, is being drilled. The location of this well is given in Enclosure No. 2.

In December, 1967 and January, 1968 the reflection data was digitally reprocessed by Shell Canada Limited but no re-interpretation of these data has been done.

B. 1968 Seismic Work

No processing or interpretation of 1968 seismic data has been done as of the date of this report.

B.M. Veilleux
Manager-Southern
Division Exploration

FINAL REPORT

OF THE

SEISMOGRAPH SURVEY

OF THE

GRUMBLER RAPIDS AREA

OF

NORTHWEST TERRITORIES, CANADA

FOR

SHELL CANADA LIMITED

CALGARY, ALBERTA

JUNE, 1967

ENCLOSURE I.

FINAL REPORT

of a

SEISMIC REFLECTION SURVEY

of the

GRUMBLER RAPIDS AREA

N. W. T., CANADA

for

SHELL CANADA LIMITED

by

SEISMOTECH 64 LTD.

PARTY 12.

Submitted by:

M. E. Baker

M. E. Baker - P. Eng.

July, 1967.

I N D E X

INTRODUCTION:

This seismic report covers the results of a survey conducted in the Grumbler Rapids Area of the Northwest Territories, Canada, for Shell Canada Limited by Seismotech 64 Ltd., Field Party No. 12 during February and March, 1967.

Sixfold coverage has produced generally fair representation of the sedimentary section, with the Horizon B (probably Slave Point) event being the most outstanding and the basement event being the weakest. Because no velocity information was attained for the purpose of identifications of reflections some doubt must be placed on the interpretation.

Limited experimentation with shooting and recording techniques has provided useful information for future surveys.

CONCLUSIONS:

The most outstanding anomaly is a basement high which strikes northwest immediately west of the intersection of Lines 50 and 52, and intersects Line 51 to the north. This feature is accompanied at its edges by steep "basement" dips and on its crown by surface outcropping or near-outcropping of the Devonian limestone. It is of particular interest that no limestone was reached by the shot hole drill east of the northeast flank of this anomaly. Thinning is observed in the "Slave Point to basement" interval over the high.

It would appear that the Union Alexander Falls Nos. 4 and 5 wells were drilled well down the southwest flank of this high anomaly.

Another feature of potential importance is the possibility that a "salt" reflection is recorded along the easternmost 2 miles of Line 51. This "salt basin" is flanked on the west by distinct phasing (possibly thickening of the upper Middle Devonian) of the "Slave Point" west on Line 51 in particular and to a lesser degree on the eastern few miles of Line 52. This phasing phenomenon disappears on those records where a "salt" reflection is recorded.

The validity of the shallow isochron Horizon A to Horizon B, representing a section of the Devonian above the "Slave Point" is questioned because of the quality of reflection "A" in part and failure to identify its origin.

Without the aid of sufficient well data or velocity surveys one must classify the above conclusions as speculative.

It may be worthwhile to attempt mapping the limestone outcrops say by aerial photography in an attempt to guide future planning of survey program and to thereby include all potentially high subsurface structures.

FIELD PROCEDURES AND RECOMMENDATIONS:

In view of the difficulty and expense of drilling shot holes in limestone it is the writer's opinion that shot holes can be shallowed without loss of results, to stop at 30 feet where limestone is not encountered and to stop at the limestone or 10 feet whichever is the greater.

Some consideration should be given to the employment of pattern holes (3 holes) which comprised less than 10% of the shooting and which was distributed throughout the survey. It is noteable that the pattern holes provided a more sharply resolved recording, doubtlessly as a result of distributing the charge through the three holes and propagating a flat wavefront. Possibly the same result could have been achieved by lessening the charge below 5/8 pound in single holes where limestone is not encountered; and a better result, by using 3 hole patterns where the limestone is encountered at less than 30 feet, laying the charges directly on top of the limestone and possibly diminishing the high frequency content thereby. Due to the freezing of shot holes it was not possible to reload.

It is noted that changing the tripping time of the instruments within the area of first arrivals did not help to improve reflection quality but conversely ruined the first breaks.

Where 5/8 of a pound was used above the limestone, undesirably low frequency was generated in some areas probably as a result of too great a charge. Shots of varying sizes in the limestone generated too high a frequency.

COMPUTATION:

The records were reduced to a reference plan at 800 feet above sea level by using a simple uphole method and a reference velocity of 6000 feet per second. Having done each shot hole in this fashion provided a fixed pattern of corrections throughout each line, the traces of each recording being corrected accordingly. An NMO study was done by playing back an effective cross-section of the area and employing a moveout function determined from the field monitor records. As a result, a fixed NMO function was used throughout the area and sample point sorts were played back to check the result.

A matter for concern is the complexity of the near-surface velocities encountered in the Grumbler Area. A study of first breaks across the area has revealed the presence of the highest subdrift velocities (15,500 feet per second) in the western portion of the area west of and including Line 50; lowest subdrift velocities (8000 to 9000 feet per second), east of Line 50. The drift material of 6500 feet per second is present in measurable quantities mainly east of Line 50.

This set of conditions suggests that the younger limestone beds remain over the high structure in the west of the prospect, and have been completely eroded east of the structure where the lower velocities (8000 to 12,000 feet per second) suggest the presence of shale bedrock.

First breaks have been sacrificed in a large portion of the recording in an attempt to develop noise-free recordings of reflections, particularly as a result of the practice of tripping the amplifiers before the complete arrival of all the first break energy. This trip time was delayed at the east end of Line 51 for several miles to give better first breaks.

Three 4000 refraction profiles were recorded in an attempt to refract from the Slave Point and thereby, identify the reflection. This attempt failed because the charges were too light (5 lbs.) and the first breaks from the deeper horizons were not legible. Plots of these results reveal a velocity of 12,000 feet per second from first, second and third break patterns.

INSTRUMENTATION:

S.I.E. PT. 100 amplifiers (modified for pre-input transformer filters after Shell's specifications)

S.I.E. PMR20 magnetic tape recorder

E.U.S. - 2B geophones - 9 per trace in series parallel - 28 cps. and 240 ohm shunt

Vector cables - common depth point

Time break communication - by twisted-pair conductors

S.I.E. communicator blaster - remotely fired

Mayhew 1000 and equivalent drills - truck mounted

Sewell Auger drill - limited application

Gurley Transit survey instrument - with prismatic attachment for Polaris observation.

STATISTICS:

Recording Hours -	318
Profiles Recorded -	1051
Drill Hours -	2882½
S.W.T. Hours -	828
No. of Holes Drilled -	1407
Footage -	42,291
Dynamite (lbs.) -	1671 3/8
Caps -	1545
Bulldozer Hours -	1435

MISCELLANEOUS OBSERVATIONS:

Terrain & Vegetation -

Mostly muskeg. Some high ground to the West.

Condition of cut lines -

Poor until drag used.

Average Distance to Field (from camp) -

10 miles.

Recording problems -

Insufficient holes.

Drilling -

Limestone encountered on west end of prospect.

Hard digging.

Shooting - Nil -

Bulldozing.

Rough cut lines. Open muskeg on south end of

Line 50. Impassable.

Survey Reference - 34th Baseline.

Driving -

Long drives on account of very rough lines.

General:

Consistently cold weather.

Distance from Camp to Town or Highway -

17 miles to Highway;

53 miles to Hay River.

SEISMIC MAP
GRUMBLER RAPIDS AREA
N.W.T. CANADA
SURFACE TOPOGRAPHY

Contour Interval 25 ft. Datum +800 ft. A.S.L.
Interpretation M.E. Baker Date July 1967
Seismotech 64 Ltd.

MERCATOR GRID REFERENCE, NTF
SHELL CANADA LIMITED
STRIP MAP NC-15
SCALE: 1"=4000'
FEB. 1967

NTR-699
63,212 Ac.
50%

NTR-698
63,212 Ac.
50%

NTR-697
31,606 Ac.
50%

NTR-696
63,540 Ac.
50%

NTR-695
63,534 Ac.
50%

NTR-694
31,767 Ac.
50%

P-4150

P-4149

P-4148

P-4147

P-4146

P-4145

SHELL-U.S. GRUMBLER F-1

WINTER ROAD

GRUMBLER

WOOD BUFFALO PARK

BUFFALO

LEGEND

VELOCITY PROFILE

REFRACTION

VIBROSEIS

MICROSPREAD

NOTE: LINES 12-50, 12-51, 12-52
SHOT BY SEISMOTECH 64 LTD.
(SHOT IN 1967)

DEPT. OF INDIAN AFFAIRS & NORTHERN DEVELOPMENT
OIL & MINERAL RESOURCES BRANCH
JUN 3 1969
CALGARY, ALBERTA

SHELL CANADA LIMITED	EXPLORATION AND PRODUCTION DEPARTMENT	SOUTHERN EXPLORATION DIVISION

GRUMBLER AREA N.W.T.

SHOTPOINT LOCATION AND ELEVATION MAP.

Party : 192	Datum :
Interpreter :	Elevation Corr. Velocity :
Supervisor :	Filter Base (Corr. 0) :
Date : April 1968	Shot Depths (Ds) :
Maps :	Wx Comp. :
Contour Interval : 25'	
Wavefront Title	
B Function :	Load Factor Corr. :
Map Scale : 1" = 4000'	Grade Key :
Enclosure No. : 2	

To Accompany Geophysical Progress Report, Grumbler N.W.T. Operations 1965-1968.

646
31,927 Ac.

MACKENZIE HIGHWAY

NORTHWEST TERRITORIES

ALBERTA

SEISMIC MAP
GRUMBLER RAPIDS AREA
N.W.T. CANADA

SURFACE TOPOGRAPHY

Contour Interval 25 ft Datum +800 ft. A.S.L.
Interpretation M.E. Baker Date July 1967
Seismotech 64 Ltd.

JUN 3 1968

SHELL CANADA LIMITED
STRIP MAP NC-25
SCALE: 1"= 4000'
FEB. 1967

EC-