REPORT ON THE REFLECTION SEISMOGRAPH SURVEY

In the

NORMAN WELLS AREA

N.W.T.(Canada)

From March 17 to December 7,1943.

By: Marvin Romberg Party Chief

Lt.Woodson Dawson, Jr. Computer

Date submitted: February 16,1944.

Read and accepted by: Max Lincoln

Date: 2/18/44

CONFIDENTIAL

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SUMMARY AND CONCLUSIONS

The results of the seismograph survey are shown on three maps. Plate II pictures the top of the Reef Limestone, Plate III (A, B and C) the top of the Beavertail Limestone, and Plate IV the time interval between the two horizons.

Regional Considerations

The regional picture of the Beavertail Limestone (Plate III) shows an asymmetrical structural basin between the Mackenzie and Carcajou rivers. The axis of this syncline is approximately three miles from the Carcajou River and it is roughly parallel to that river. In the northeast portion of the basin the contours tend to follow the Mackenzie River, and the Discovery Range.

The thin bedded limestone found at the base of the coral reef at Norman Wells is indicated to exist regionally in the area surveyed downstream from Norman Wells and west of Loon Creek with the exception of the immediate vicinity of the Loon Creek No. 1 location. However, there are indications that this bed thins towards the south and possibly disappears entirely near the Carcajou river. A local increase in time interval (Plate IV) between the reflection from this limestone and the reflection from the top of the Beavertail is interpreted as indicating a coral reef growth as atNorman Wells, Mac 1, and at Hoosier Ridge. The fact that reflections were not obtained from the "reef horizon" in the area upstream from Norman Wells (See Record from Shot Point 149 Plate VII) is interpreted to mean either that the bedded limestone is entirely missing or that it is too thin to reflect seismic energy.

Local Anomalies

(1) The Reef Condition at Norman Wells, Bear and Goose Islands, and at Mac No. 1 is shown to extend further down dip in a southwesterly direction to the boundary of the survey at shot point 62. The isopach time interval of .150 second (Plate IV) along this trend indicates the reef to be about the same thickness over the entire distance from Norman Wells to shot point 62. Two well locations, namely, Mac No. 2 and Ray's Creek No. 1 have been made along this trend for the purpose of investigating the possibility of a stratigraphic trap due to local variations in porosity within the Coral Reef. It should be noted that the proposed location of Seepage Lake No. 1 about one mile North 26 degrees East of the Norman Wells Discovery Well is in line with the trend of this reef.

(2) The Loon Creek Structure is located approximately five miles south of the Mackenzie River. It has an almost East-West trend and rises from the Whitehorse Highway in the western part of the survey to the eastern boundary of the survey at Loon Creek. The Loon Creek No. 1 well location has been made between Loon Creek and shot point 87a which is the highest point of the structure within the limits of the area covered by the seismograph survey (Plate III). At this point the Beavertail Limestone is indicated to be .130 second or from 500 to 650 feet higher than at Mac No. 1.

The western plunge of the structure is well defined, but existence of closure towards the east has not been established. However, the magnitude of the structural relief and the fact that the Beavertail limestone at the Loon Creek location is only four contour intervals deeper than on the north bank of the Mackenzie river strongly suggests closure, especially in view of the fact that the Loon Creek structure

is not reflected in the contours upstream from Norman Wells on the north bank of the Mackenzie River.

The fact that the "reef reflection" was not recorded in the vicinity of Loon Creek No. 1 location suggests that the reef is missing at that point. However, further west there is some reflection evidence which if optimistically interpreted, suggests a reef condition along the Loon Creek axis which is nearly parallel to the reef on which the Norman Wells pool is located. If this reef actually exists, it would have closure due to folding on the north, south, and west, and closure to the east due to the reef pinching out in that direction. The Loon Creek Extension No. 1 well location, near shot point 82, is on the culmination of the inferred reef, which is considered the optimum place to test the area for a stratigraphic trap on the plunge of a definite structure.

(3) A structural anomaly, about midway between Prohibition and Nota creeks, is suggested by the configuration of the contours in that vicinity. However, additional seismograph work is needed to clarify the situation. This is in the vicinity of the so-called "Half-Way Structure".

(4) When additional seismograph work east of Loon Creek is being planned, the change of strike (Plate III) near shot point 216 at the headwaters of Loon Creek should be considered as possibly indicating the existence of a structure to the east of the creek.

(5) The reversal at Hoosier Ridge is based on extremely sketchy information. Insufficient work has been done to determine whether or not the so-called Morrow Creek Reversal is a continuation of the Hoosier Ridge structure. Nothing has therefore been added to the structural

picture. It should be noted, however, that a reef is indicated on the flanks, especially on the north flank of the structure by the large isopach interval of .150 second. As such a reef is known to exist, the seismograph work in this locality may be said to have further substantiated the criterion used in determining the presence or absence of a coral reef by means of the reflection seismograph.

Respectfully submitted,

Marvin Romberg

Lt. Woodson Dawson Jr. Marvin Romberg

Introduction

The reflection seismograph survey was conducted by The Carter Oil Company under subcontract to the Imperial Oil Limited - Canol Project. The purpose of the survey was to discover new oil reserves for use of the United States army. Seismograph equipment was obtained from the Carter Oil Company. Tractors, shot-hole drill, camp equipment, and miscellaneous supplies were obtained from the Canol Project.

During the spring months, the personnel consisted of a party chief from the Carter Oil Company, three officers, and from four to thirteen enlisted men from the United States army, and from one to three civilian men from the Imperial Oil Limited - Canol Project. Beginning in September the army personnel was gradually replaced by civilians from the Imperial Oil Limited - Canol Project until only one officer remained with the crew at the time operations were suspended in December.

The results of the survey from March 17 to June 19, 1943 were reported in July 1943 by Marvin Romberg. The details of the velocity survey of Mac No. 1 were given by Lt. Woodson Dawson, Jr. in a report dated December 13, 1943. For the sake of completeness, a large part of the text of these two previous reports is incorporated herewith.

Location and Extent of Area Examined

The area surveyed is located in the Northwest Territories of Canada on the Mackenzie River, approximately eighty miles south of the Arctic Circle, (Plate I). A total of 220 square miles was covered. This area can be roughly divided into three parts, namely, (1) the area between the Mackenzie River and the Carcajou River, south and southwest of Norman Wells, (2) a narrow strip along the northeast bank of the Mackenzie River upstream from Norman Wells, and (3) a narrow strip along

the northeast bank of the Mackenzie River downstream from Norman Wells. In addition, a few shot points were located on the southwest side of the Mackenzie River near Hoosier Ridge in the northernmost part of the survey and also near the Little Bear River in the southeastern part of the survey.

Accessibility

In the winter and spring, Norman Wells (headquarters of Imperial Oil Limited - Canol Project) can be reached only by airplane from Edmonton, Alberta, Canada. (However, in the winter and spring of 1943 some freight was brought to Norman Wells by "tractor train" over a newly opened winter road). In the summer the roads are impassable but freight can, with the exception of one portage, be shipped from the railhead at McMurray by way of the Slave River, Great Slave Lake, and the Mackenzie River. During the thaw and freeze-up periods it is often impossible to reach Norman Wells from Edmonton. Also, for about a month during these periods it is dangerous or impossible to cross the Mackenzie River except by airplane.

The area surveyed is largely covered by lakes or muskeg, which becomes swamp in the summer. Muskeg is an accumulation of moss-like plant that grows very rapidly in warm weather, together with swamp grasses, lilies and other similar vegetation. During the winter this water saturated muskeg freezes. Each new crop then acts as insulation and the vegetation accumulates, sometimes to a depth of ten feet. Eventually, however, this muskeg, together with the later grown tree roots, etc. decays, and slowly forms into peat.

The seismograph equipment and living quarters were mounted on sleds and pulled through the area with tractors. The transportation difficulties encountered vary with the season somewhat as described below.

From the middle of March to the middle of May was found to be the best period of the year for carrying on seismograph operations in the Norman Wells area. The temperature ranges from ten below to fifty degrees above zero Fahrenheit, which is within the operating range for which the mechanical equipment was designed. The muskeg is entirely frozen and there is still enough snow left on the ground so that sleds and bunkhouse cabooses can be pulled comparatively easily. Another advantage to working during the first part of this period is that the trees and undergrowth are still frozen and brittle so that they will break when trails are being cleared.

From the middle of May to the middle of June, transportation becomes more and more difficult. The snow disappears so that it is very difficult to drag heavy equipment on sleds. Parts of the area are covered with water, and the top of the muskeg is beginning to soften. Large quantities of it will frequently collect in front of a sled making it necessary to stop, unhook the tractor, and bulldoze the accumulated muskeg out of the way. Tractors will become mired and will also fall into deep holes that are hidden by muskeg which has grown out over the ice and water. Walking becomes extremely tiresome. By June 1st. it is impossible to move any tractor-drawn equipment except on a few well drained and thickly wooded hills. By June 15th. travel between the Mackenzie and Carcajou rivers is so difficult that for all practical purposes this area is no longer suitable for seismograph operations.

From June 19th. until the latter part of September, accessible locations for shot points could not be found, except on top of the well drained and thickly wooded bluffs near the Mackenzie River bank. As it was necessary to locate shot points well above the water level, in order to obtain reflections, considerable stretches along the river bank could

not be surveyed because the banks are so steep that equipment could not be winched up to the shot point location. Often the drill could be moved from one such shot point to another on the beach along the water's edge. When this was not possible everything was loaded on barges, and unloaded again on the beach near the next shot point location. Some locations were inaccessible because the water was too shallow to move barges close to shore. The transportation of living quarters was a relatively simple matter as these were mounted on barges.

From an accessibility standpoint it is impractical to carry on seismograph field operations in October. The water level in the river is too low for landing equipment from barges. Also all marine equipment must be dry-docked before the freeze up, which occurs in the latter part of October. Land operations are not feasible because the muskeg swamps have not yet frozen deep enough to support any heavy equipment.

The seismograph crew resumed land operation in the first part of November. It was found that the muskeg was very treacherous. Tractors frequently fell through the thin surface layer of ice and froze-in making it very difficult to extricate them. It was not until the latter part of November and the early part of December that the muskeg could be traversed with any reasonable degree of safety. By this time the weather had become so cold that the mechanical equipment could not be kept functioning satisfactorily.

Topography and Drainage

The elevations in the area surveyed between the Mackenzie and Caribou rivers increase southward from 270 feet (Plate V) at the Mackenzie River to 1200 feet in a series of terraces and decrease sharply as the Caribou River valley is approached. There are also several long ridges, probably of glacial origin, which cross the area in an east-west

direction. The entire area is dotted with numerous small lakes. Streams have formed deep entrenched gorges through these ridges and even the small streams have cut ravines near the Mackenzie and Carcajou Rivers which cannot be crossed with sleds and tractors. The drainage is into the Carcajou and Mackenzie Rivers and their tributaries.

The Mackenzie River has steep banks. Most of the shot points along the river are located just inland from the steep bluff.

Drilling

During the spring months, when transportation was easiest, the drilling of shot holes was the seismograph crew's biggest problem. From March 17th. to May 2nd. drilling was done with a small rig built by the Petty Geophysical Company. After May 2nd. a sled mounted Failing Model S14 (1000 ft.) core drill was used.

Near Norman Wells the surface material was found to be frozen and hard to at least forty feet. Some of the holes were drilled in bed rock and others in glacial deposits. It was often necessary to abandon a location after several futile attempts to drill through a layer of boulders or gravel. On the Bosworth Creek delta the Petty Drill could not penetrate deeper than three feet. The formation is so hard that when an adjacent well was being drilled a rock bit was worn out in the first 90 feet.

On Goose and Bear Islands, drilling was difficult because of a river sand which is several hundred feet thick.

On the southwest bank of the Mackenzie River and extending inland about three miles is found a coarse sand which drills as if it were frozen to a depth of at least 65 feet. In this strip along the river drilling was easier than in any other part of the area.

Further inland there are glacial deposits of boulders, gravel, fine and coarse sand. There is also some sandstone which is usually localized and not very thick. Ordinarily, however, at least one bit is dulled on every hole in which sandstone is encountered. In general a heavy drilling mud is essential for drilling in glacial drift.

In the early spring slush pits can be dug if the frozen muskeg is first loosened by blasting. During the thawing period, however, the digging of slush pits is quite a problem unless it is possible to locate the shot point in a well drained place. In a swampy spot the muskeg is water soaked and disintegrates to form a slush when it is disturbed. This slush then flows back into place before the driller can dig a pit in the ice which is always present below the loose surface muskeg. Under these conditions special care is necessary to mix drilling mud.

Near Norman Wells, and on the islands water was hauled from the Norman Wells boiler house. By the time operations were shifted to the southwest side of the river the snow had begun to melt, and water could be found almost anywhere. In November water was hauled from small lakes which had not yet frozen to the bottom.

For operation during November, the drill had to be winterized. This was done by building a house completely around the drill. The mast was enclosed in a canvas sack and a removable roof allowed it to be raised or lowered. Two stoves and a blowtorch were required to keep the drilling unit thawed-out.

Operating

The recording equipment was mounted on a sled house in much the same way that it is ordinarily mounted in a truck. Twelve trace records were made wherever it was possible to lay out full length profiles. Six

seismometers were placed on a symmetrical spread in two directions from the shot point. This gave a surface coverage of 250 to 1000 feet on two sides of a shot point or a total spread of 2000 feet.

It was always necessary for the seismometers to be placed on a frozen surface in order to obtain reflections. In the winter the snow could be cleared away with the toe of a boot and the seismometers placed directly on top of the frozen muskeg. In the late spring, as the muskeg thawed, the placement of seismometers became more difficult as holes sometimes had to be dug four feet deep in order to reach frozen ground. In the fall it was necessary to dig the seismometer holes through the frozen surface muskeg and then through from six inches to four feet of soft muskeg to the permanent ice.

The seismograph equipment supplied by The Carter Oil Company was specially designed for cold weather use. These instruments functioned satisfactorily in - 30°F. weather which was the coldest experienced.

Surveying

Near Norman Wells no surveying was done as an accurate topographic contour map was available for spotting holes and obtaining elevations. On the southwest side of the river accurate maps were not available and a plane table and alidade survey was made. Plate V shows the tractor trails and survey loops. The maximum vertical closure error was three feet and the maximum horizontal closure error was 300 feet. The elevation of each shot point, relative to the assumed elevation of 200 feet at the discovery well, is shown on the map.

On Plate V the location of the topographic features is determined by the point of contact with the survey lines. Their shape and extent beyond the point of contact with the survey lines is taken from

a base map which has been reduced from aerial photographs.

The shot points along the Mackenzie River were spotted with respect to topographic features and no attempt was made to adjust the map to fit the seismograph survey data.

Velocity Survey of Bear Island No. 4.

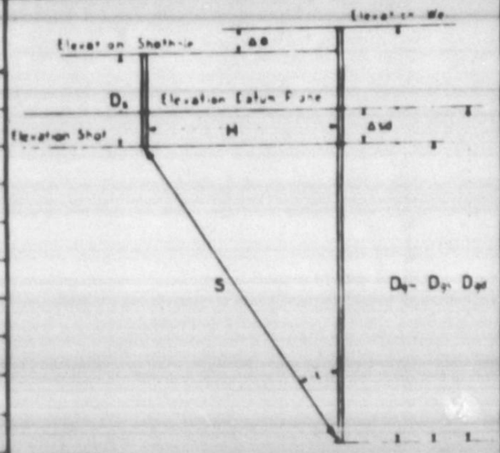
The velocity survey of Bear Island No. 4 was completed in four hours actual shooting time on June 19,1943. The measurements were made by recording the energy travel time from a shot hole located 300 feet from the well to a pickup suspended in the well. This pickup was lowered into the well on a Haliburton well surveying cable. Good "first kicks" were obtained at four points in the well ranging from 2090 to 900 feet (See Well Survey Computation Sheet). Shallower than 900 feet the first arrivals were obscured by extraneous disturbances. Plate VIA shows the arrival times (corrected to vertical travel path) plotted against depth. Plate VIB is a graph of the average and interval velocities. The overall or average velocity from the datum plane to the Reef Limestone is 9,100 feet per second. The (interval) velocity of the Upper Fort Creek shales is shown to be 10,000 feet per second.

The velocity measurements show that the "early cycle" of a reflection on record 120 SW, at the well, is from the top of the reef limestone.

The "reef reflection" arrival times at Norman Wells, where the depth of the reef is known, indicate that the rocks overlying the reef have very nearly the same overall velocity as at Bear Island.

Shothole information:- Elevation, Distance & Direction from Well	Company	Well	Elevation	Total Depth	LOCATION
1 #120 296' 300' NW	Imperial Oil Co	Bear Island #4	299	2318	Coordinates / Section, Township, Range / County / Area or Field: Norman Wells, N.W.T. Canada
2					
3					

Record Number	Shothole Number	D_{gm}	D_s	t_{us}	t	T	D_{gs}	H	tan i	cos i	T_{gs}	T_{gd}	D_{gd}	ΔD_{gd}	ΔT_{gd}	V_i Interval Velocity	V_a Average Velocity
1	120	0	48	.005													
2		2090	48	.005													
3		2090	50	.006		.226	2037	300	.14727	.9893	.224	.224	2037				9090
4		1850	50											240	.024	10,000	
5		1850	50	.006		.203	1797	300	.16694	.9863	.200	.200	1797				8990
6		1400	50	.006		.159	1347	300	.22272	.9761	.155	.155	1347	450	.045	10,000	8690
7		900	50	.006		.111	847	300	.35419	.9426	.105	.105	847	500	.050	10,000	8060
8		0	50	.006												8,060	



D_{gm} - Geophone depth measured from well elevation
D_{gs} shot
D_{gd} datum
D_s Depth of shot
H Horizontal distance from well to shotpoint
S Straight line travel path from shot to well geophone
t_{us} Uphole time at shotpoint
T Observed time from shotpoint to well geophone
Δe Difference in elevation between well & shotpoint
Δsd shot & datum plane
D_{gs} $D_{gm} - D_s \pm \Delta e$; $\tan i = \frac{H}{D_{gs}}$
T_{gs} $\cos i\, T$ = Vert travel time from shot elev to geophone
T_{gd} $T_{gs} \pm \frac{\Delta sd}{V}$ datum plane
D_{gd} $D_{gs} \pm \Delta sd$ = vert distance
V_i Interval velocity = $\frac{\Delta D_{gd}}{\Delta T_{gd}}$
V_a Average = $\frac{D_{gd}}{T_{gd}}$

The Carter Oil Co
Surveyed by Seismograph Party
Date June 19, 1943
Weathering Data

Casing Record _____

57.10

Velocity Survey of Mac No. 1.

On October 20,1943, an attempt was made to shoot Mac No. 1. in order to determine the overall Velocity to the Beavertail Limestone and especially the interval Velocity between the tops of the Reef Limestone and the Beavertail Limestone.

After taking a few shots in order to check the deep hole geophone with regular geophones, the deep hole geophone was then lowered into the well until it reached the top of the Beavertail Limestone. As the well was located within one-quarter of a mile from Bechtel-Price-Callahan's power plant at Camp Canol, the alternating current disturbance from this power plant was so great that it was impossible to decrease the sensitivity of the deep hole geophone sufficiently to eliminate the alternating current disturbance and still record the seismic wave from the shot hole. As a result the Velocity determination in Mac No. 1 was temporarily abandoned while arrangements were made with Bechtel, Price, Callahan to shut down their power plant.

Bechtel, Price, Callahan agreed to stop their power plant between 2:30 A.M. and 4:00 A.M. on October 22nd. at which time the Velocity determination was carried out. Two shots were taken with the deep hole geophone at 3130 feet, near the top of the Beavertail Limestone, and two more shots at 2100 feet, the top of the Reef Limestone. Velocity measurements could not be made at other depths due to the limited time available.

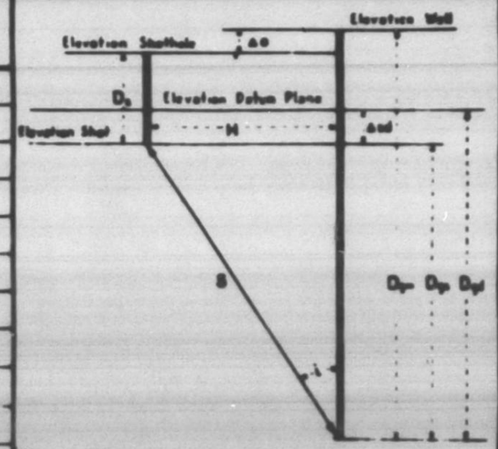
The overall Velocity, that is, from the surface to the Beavertail limestone was found to be 10,200 feet per second. The overall Velocity to the Reef Limestone was 9,500 feet per second, and the interval Velocity between the Reef Limestone and the Beavertail Limestone was 13,550 feet per second. Computations are shown on the attached chart.

Shothole Information:- Elevation, Distance & Direction from Well			
1 214 A	286'	500'	N.W.
2 214	286'	420	N.W.
3			

Company	Well	Elevation	Total Depth
I. O. L.	Mac "I"	296'	3146

LOCATION			
Coordinates.	Section, Township, Range.	County.	Area or Field.
			Norman Wells N.W.T.

Record Number	Shothole Number	D_{gm}	D_s	t_{us}	t	T	D_{gs}	H	tan i	cos i	T_{gs}	T_{gd}	D_{gd}	ΔD_{gd}	ΔT_{gd}	V_i Interval Velocity	V_a Average Velocity
1	214A	3130	60	013		.306	3060	500	.1634	.9904	.303						10,100
2	214	3130	100	021		.299	3020	420	.1391	.9905	.296					13550	10,200
3	214	2100	100	022		.225	1990	420	.21105	.97836	.220						9500
4	214	2100	100	019		.227	1990	420	.21105	.97836	.222						8960



D_{gm} · Geophone depth measured from well elevation

D_{gs} · " " shot "

D_{gd} · " " datum

D_s · Depth of shot

H · Horizontal distance from well to shotpoint

S Straight line travel path from shot to well geophone

t_{us} · Uphole time at shotpoint

T · Observed time from shotpoint to well geophone

Δe · Difference in elevation between well & shotpoint

Δsd · " " " " shot & datum plane

D_{gs} · $D_{gm} - D_s \pm \Delta e$; $\tan i = \frac{H}{D_{gs}}$

T_{gs} · cos i T = Vert. travel time from shot elev. to geophone

T_{gd} · $T_{gs} \pm \frac{\Delta sd}{V}$ = " " " datum plane " "

D_{gd} · $D_{gs} \pm \Delta sd$ = Vert. distance " "

V_i · Interval velocity = $\frac{\Delta D_{gd}}{\Delta T_{gd}}$

V_a · Average " = $\frac{D_{gd}}{T_{gd}}$

Surveyed by Lt Woodson Dawson

Date Oct 22, 1943

Weathering Data

Casing Record 10" @ 286'

F-7-17

Attention is called to the possibility that the Reef Limestone has a somewhat higher velocity than the Lower Fort Creek Shales. If this were the situation the velocity of the Limestone would be higher than 13,550 feet per second, which is the measured average velocity of both limestone and shale. The contour interval (.010 second) on the isopach map (Plate IV) would therefore have a minimum equivalent value of about 70 feet. As the velocity of the Reef Limestone might conceivably be as high as 18,000 feet per second, the equivalent value of the contour interval might be as great as 90 feet.

Analysis of Data

In general the reflection quality is excellent over the entire area covered by the survey. However, at a few shot points reflection quality was poor or the reflections were entirely missing. On Goose and Bear Islands the poor quality of the reflections is due to a river sand which is present from the surface to a depth of several hundred feet. The failure to obtain reflections at other points is due either to their being located too near the river bank or to insufficient shot hole depth.

In some localities two prominent shallow reflections (See sample records Plate VII) were recorded. Plates II and III are time contour maps showing respectively the travel time of the shallow and deep reflection below a time datum plane at 200 feet above sea level. A velocity of 8000 feet per second was used in making corrections to this datum plane. The letters NR are used to indicate that "no reflection" was obtained on that location from the horizon contoured on the respective map.

The deeper of the two reflections is persistent over the entire area surveyed. The velocity measurements in Bear Island 4, and Mac No. 1 show that this reflection is from the top of the Beavertail Limestone.

As the top of the Reef Limestone is the only horizon in which closure exists at the original Norman Wells producing field, the fact that Plate II shows some closure at the field, even though not as much as actually exists, is good evidence that the reflection mapped on Plate II originated at the top of the reef or from some discontinuity near the top of the reef. The velocity measurements in Bear Island No. 4 and Mac No. 1 further substantiate this theory. For example, it is significant that the measured "one-way" travel time between the top of the Reef and the top of the Beavertail, at Mac No. 1, is just half of the interval between the two prominent shallow reflections in that immediate locality.

Geologists familiar with the area believe that a bedded limestone, about 80 feet thick, overlies the Lower Fort Creek Shales in large parts of the Norman Wells area. The top of this bedded limestone seems to reflect seismic energy except when it is immediately overlain by a coral reef, as at Norman Wells and probably also at Hoosier Ridge, where the top of the reef apparently becomes the reflecting surface. In other words, from a reflection seismograph standpoint the two limestones may be considered as a single homogeneous bed of varying thickness. Therefore in this report, the shallower of the two prominent reflections is called the "Reef Reflection" even though in parts of the area the reflector is actually the bedded limestone.

It may be concluded that the variation in time interval between the two reflections as shown on the isopach map (Plate IV) is a measure of the variation in thickness of the Reef Limestone, provided the assumption is made that the bottom of the Reef and the top of the Beavertail Limestone are separated by a constant interval. The reflection data have therefore, been interpreted as follows:

(1) The fact that the "reef reflection" was not recorded (See sample records Plate VII) at Loon Creek No. 1 location and between Norman Wells and Bluefish Creek, indicates that the bedded limestone and reef limestone are both either missing or that the physical properties of these limestones and/or their immediately overlying sediments are so changed that they no longer act as reflectors of seismic energy, or that the limestones are too thin to act as reflectors of seismic energy.

(2) Wherever the "Reef Reflection" is recorded and the isopach interval (Plate IV) is .110 second or less, probably only the bedded limestone exists. This condition would prevail on the northeast bank of the Mackenzie River between Norman Wells and Hoosier Ridge.

(3) Wherever the "Reef Reflection" is recorded and the isopach interval is .120 second or greater, both the bedded limestone and a reef exist.

The isopach map (Plate IV) indicates a maximum thickness (time interval approximately .150) of Reef Limestone along a trend extending from Norman Wells through Goose and Bear Islands, Mac No. 1, and on eastward to the bounds of the survey at Ray's Creek. The "Reef Reflection" is recorded with maximum amplitude along this trend and the information indicating a reef condition is rather definite (Plate VII).

Another reef is indicated near shot point 82 (Plate IV) and westward down the plunge of the Loon Creek structure. The reflections indicating the existence of this reef are, however, much poorer than along the trend from Norman Wells to Ray's Creek. In fact it is necessary to "pick" the reflections in the most optimistic manner in order to bring out or suggest the possibility that a reef exists in this area. It should

be noted that the reef is not indicated to extend as far east as the Loon Creek No. 1 location near shot point 87A.

There are insufficient shot points on the Hoosier Ridge structure to allow definite conclusions concerning the shape of the structure. The isopach time interval on the flanks, however, strongly suggests the presence of a reef in this locality.

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PLATE I

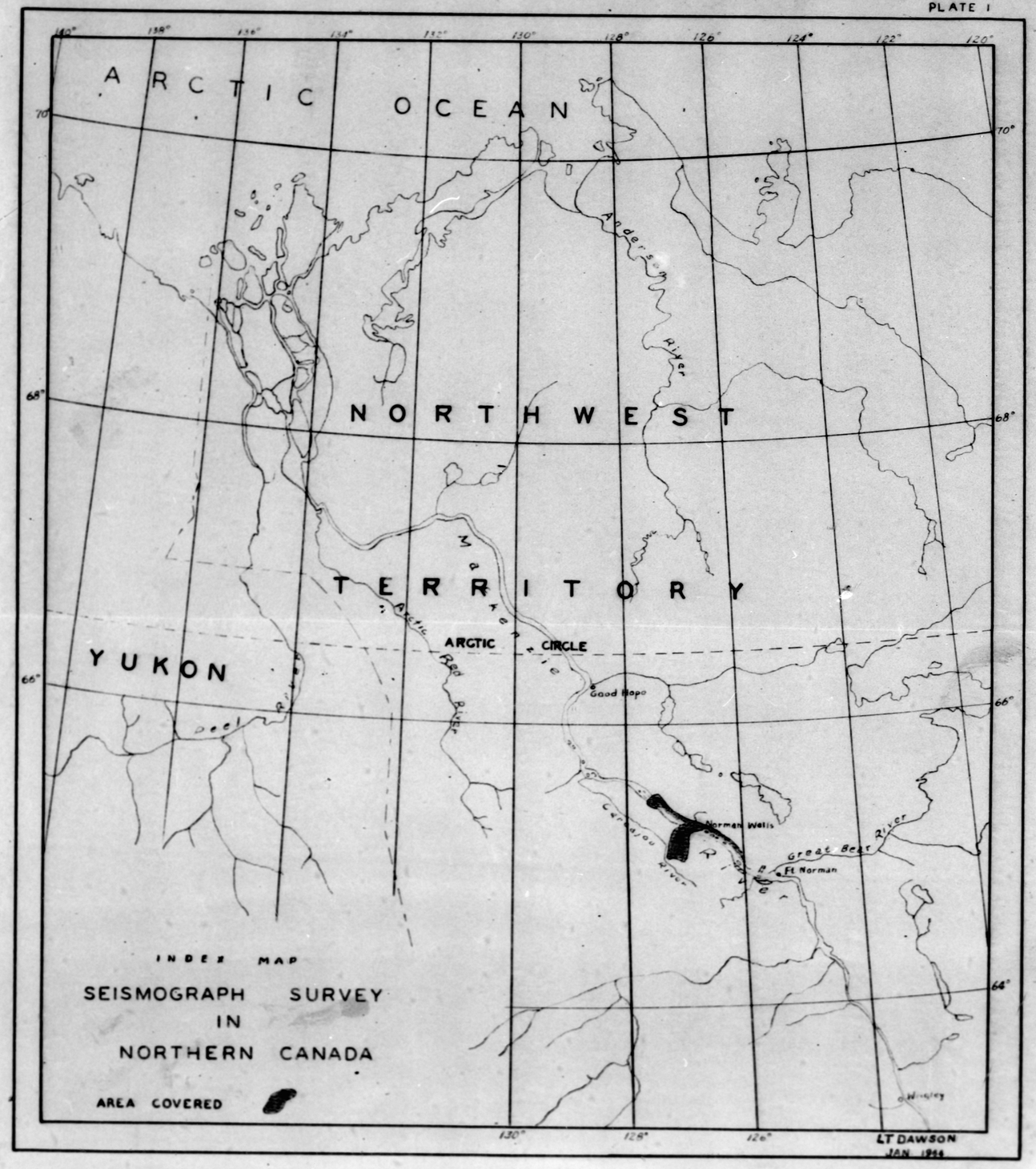

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PLATE II

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REFLECTION SEISMOGRAPH MAP

NORMAN WELLS AREA
N.W.T., CANADA
CONTOURS ON REEF LIMESTONE

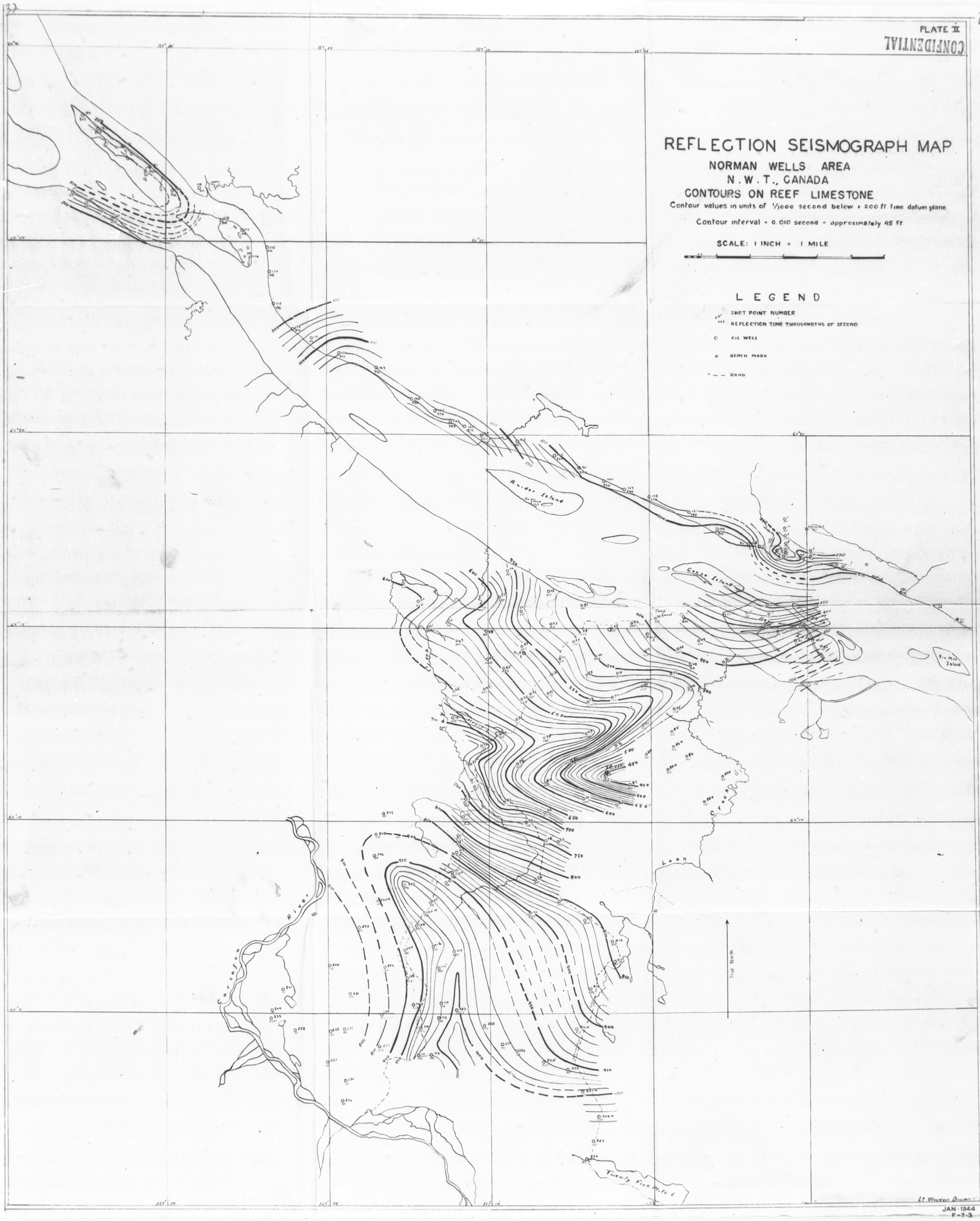
Contour values in units of 1/1000 second below + 200 ft time datum plane

Contour interval = 0.010 second = approximately 45 ft

SCALE: 1 INCH = 1 MILE

LEGEND

- SHOT POINT NUMBER
- REFLECTION TIME THOUSANDTHS OF SECOND
- OIL WELL
- BENCH MARK
- ROAD



Lt Warren Dunn

JAN 1944
F-7-3

PLATE IIIA

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REFLECTION SEISMOGRAPH MAP

NORMAN WELLS AREA
N.W.T., CANADA

CONTOURS ON BEAVERTAIL LIMESTONE

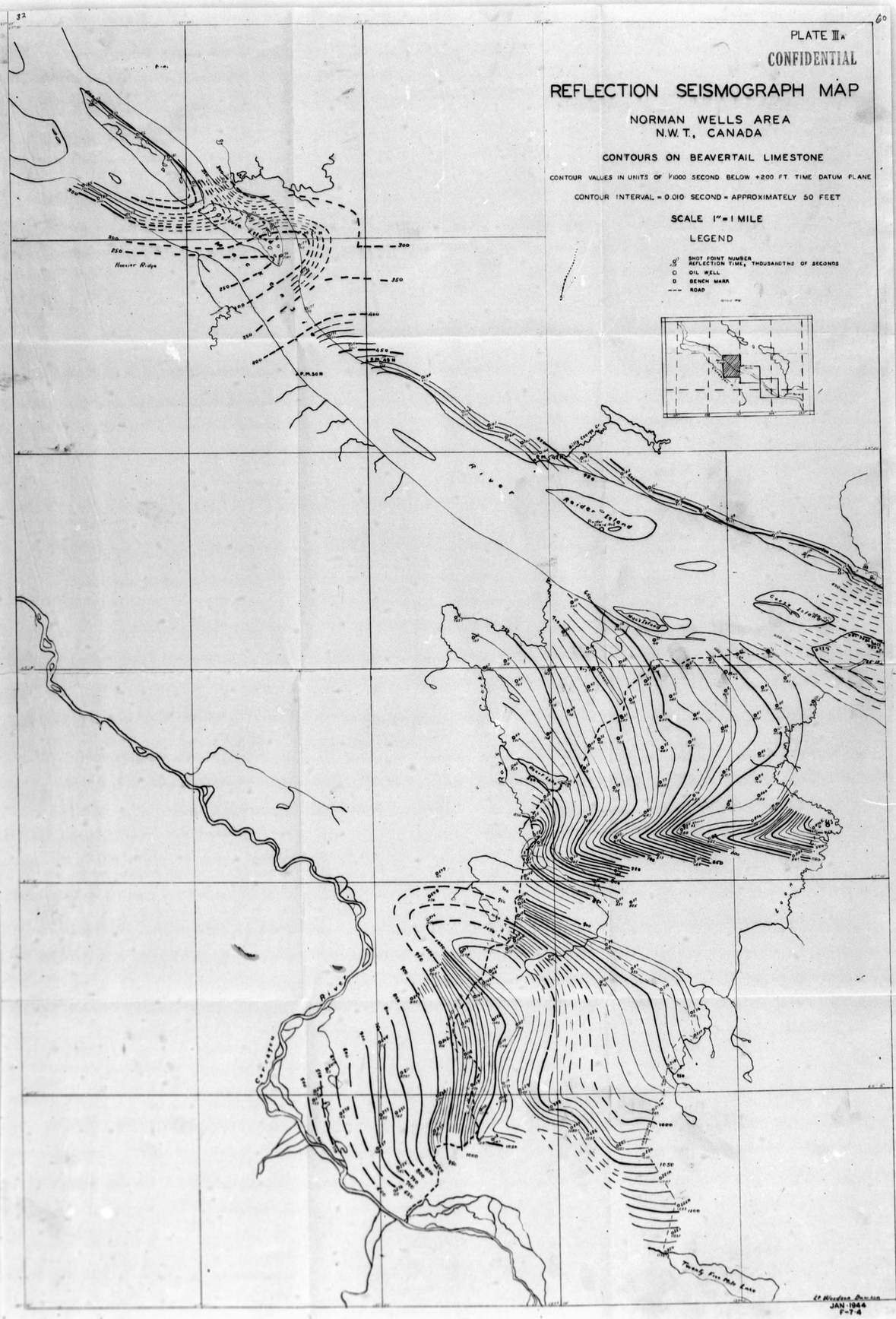
CONTOUR VALUES IN UNITS OF 1/1000 SECOND BELOW +200 FT. TIME DATUM PLANE

CONTOUR INTERVAL = 0.010 SECOND = APPROXIMATELY 50 FEET

SCALE 1" = 1 MILE

LEGEND

- SHOT POINT NUMBER, REFLECTION TIME, THOUSANDTHS OF SECONDS
- OIL WELL
- BENCH MARK
- ROAD



Lt Hayden Dawson
JAN. 1944
F-7-4

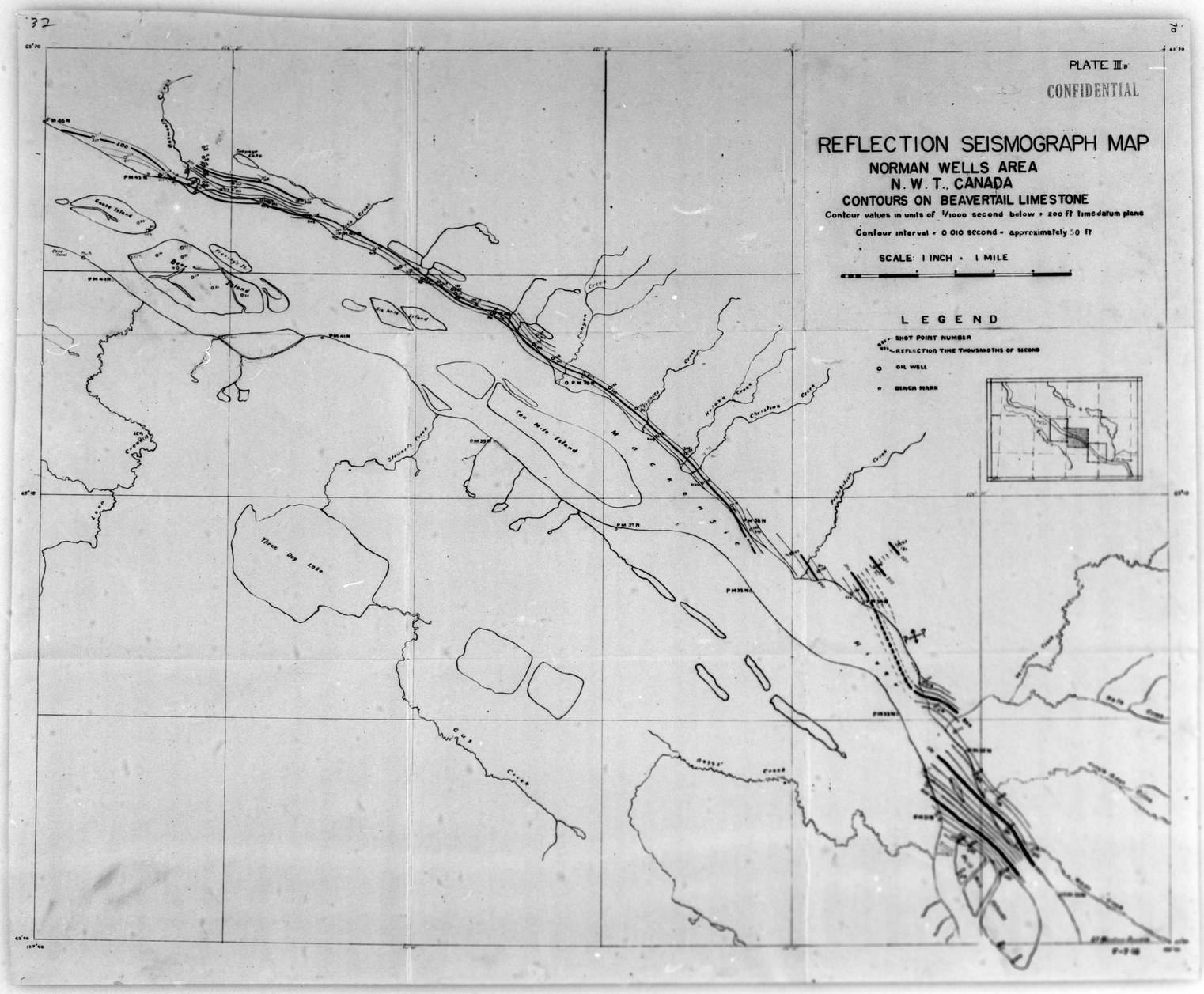


PLATE III
CONFIDENTIAL
REFLECTION SEISMOGRAPH MAP
NORMAN WELLS AREA
N. W. T., CANADA
CONTOURS ON BEAVERTAIL LIMESTONE
Contour values in units of 1/1000 second below + 200 ft time datum plane
Contour interval = 0.010 second = approximately 50 ft
SCALE: 1 INCH = 1 MILE
LEGEND
SHOT POINT NUMBER
REFLECTION TIME THOUSANDTHS OF SECOND
OIL WELL
BENCH MARK
Ten Mile Island
Three Day Lake
Christina Creek
Hidden Creek
Stanley Creek
Cranberry Lake
Goose Island
Eagle Island
Fox Hill Island
Mackenzie River

60-32

PLATE III c

CONFIDENTIAL

REFLECTION SEISMOGRAPH MAP

NORMAN WELLS AREA
N. W. T. CANADA

CONTOURS ON BEAVERTAIL LIMESTONE

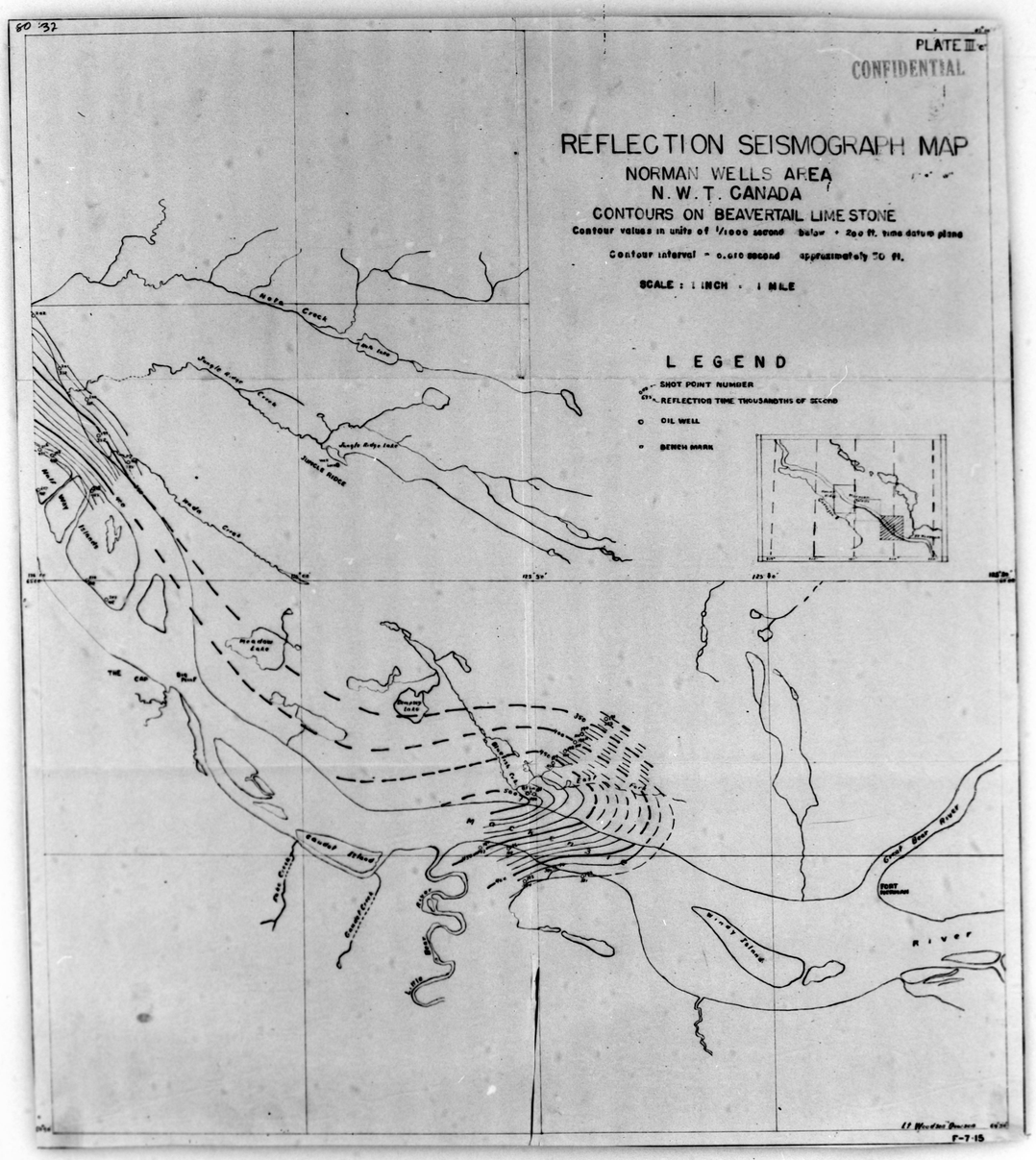
Contour values in units of 1/1000 second below + 200 ft. time datum plane

Contour interval = 0.010 second approximately 50 ft.

SCALE : 1 INCH = 1 MILE

LEGEND

- SHOT POINT NUMBER
- REFLECTION TIME THOUSANDTHS OF SECOND
- OIL WELL
- BENCH MARK



F-7-15

30x

PLATE IV

CONFIDENTIAL

REFLECTION SEISMOGRAPH ISOPACH MAP

NORMAN WELLS
N.W.T., CANADA

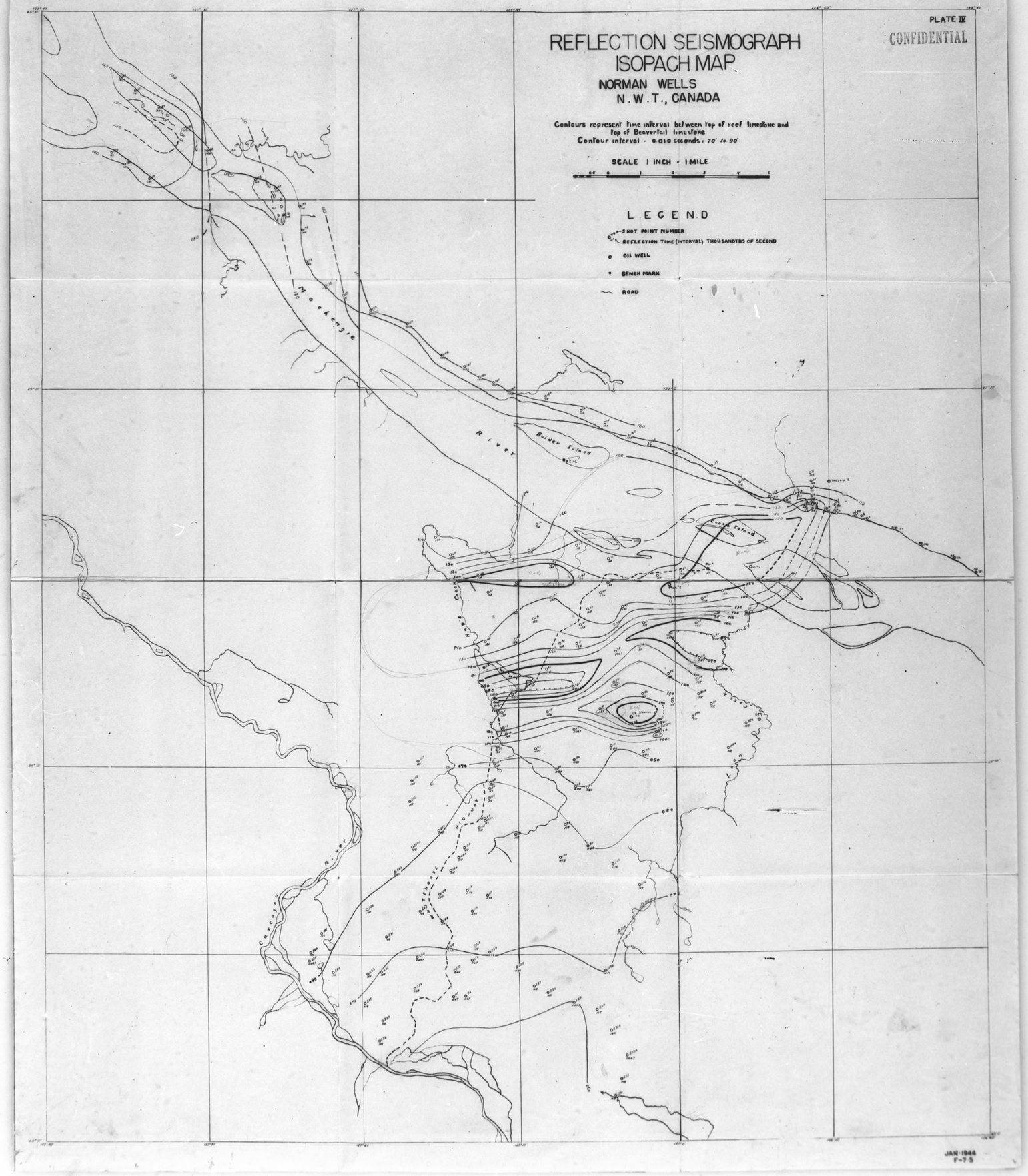
Contours represent time interval between top of reef limestone and top of Beaverfoil limestone
Contour interval - 0.010 seconds = 70' to 90'

SCALE 1 INCH = 1 MILE

.5 0 1 2 3 4 5

LEGEND

- SHOT POINT NUMBER
- REFLECTION TIME (INTERVAL) THOUSANDTHS OF SECOND
- OIL WELL
- BENCH MARK
- ROAD

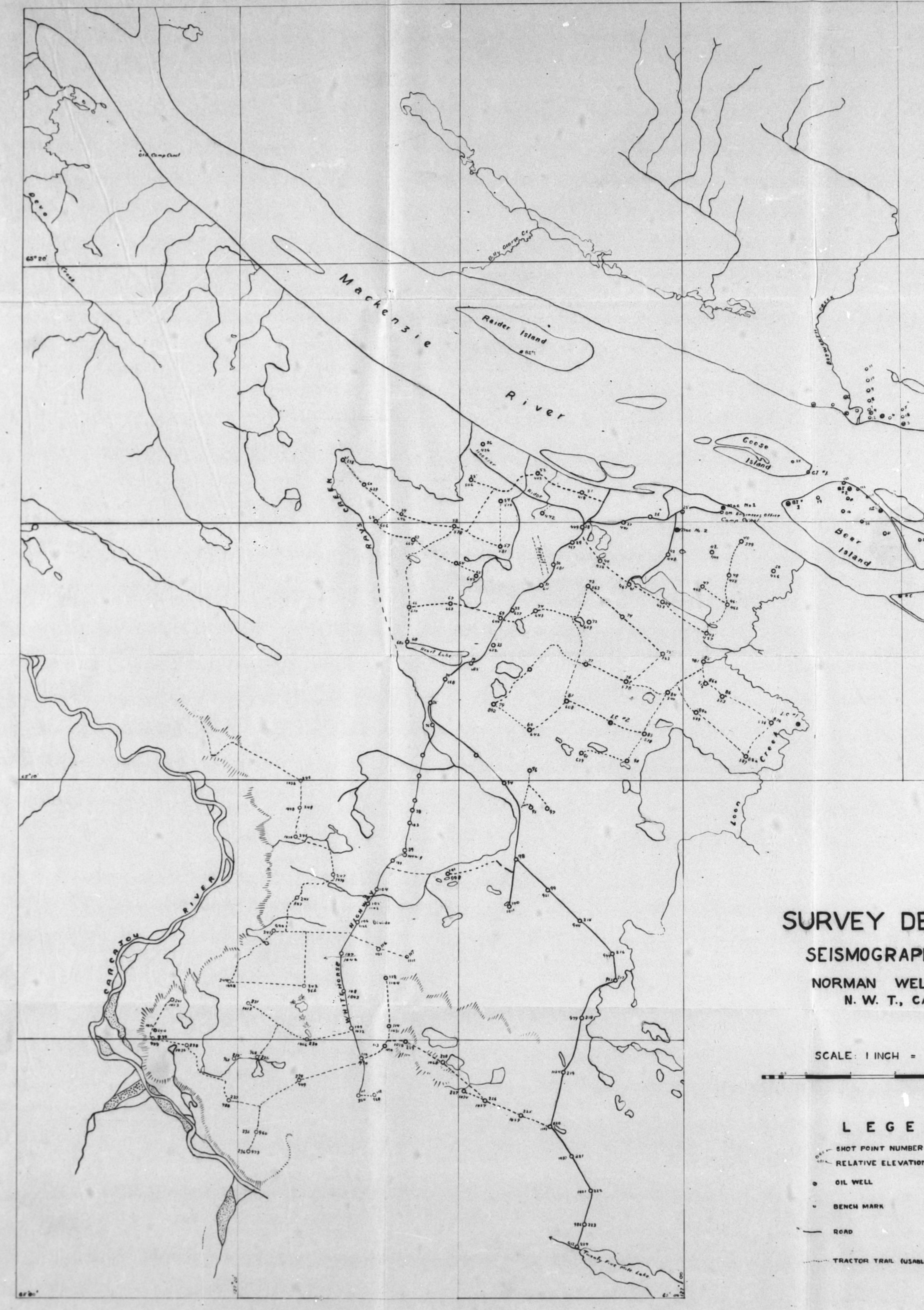


JAN. 1944
F-75

60 32

PLATE V

CONFIDENTIAL



SURVEY DETAIL MAP
SEISMOGRAPH PARTY
NORMAN WELLS AREA
N. W. T., CANADA

SCALE: 1 INCH = 1 MILE

L E G E N D

- SHOT POINT NUMBER
- RELATIVE ELEVATION OF SHOT POINT
- OIL WELL
- BENCH MARK
- ROAD
- TRACTOR TRAIL (USABLE IN WINTER ONLY)

Woodson Dawson Jr.
JAN·1944
F-7·7

32

CONFIDENTIAL

PLATE VI-A

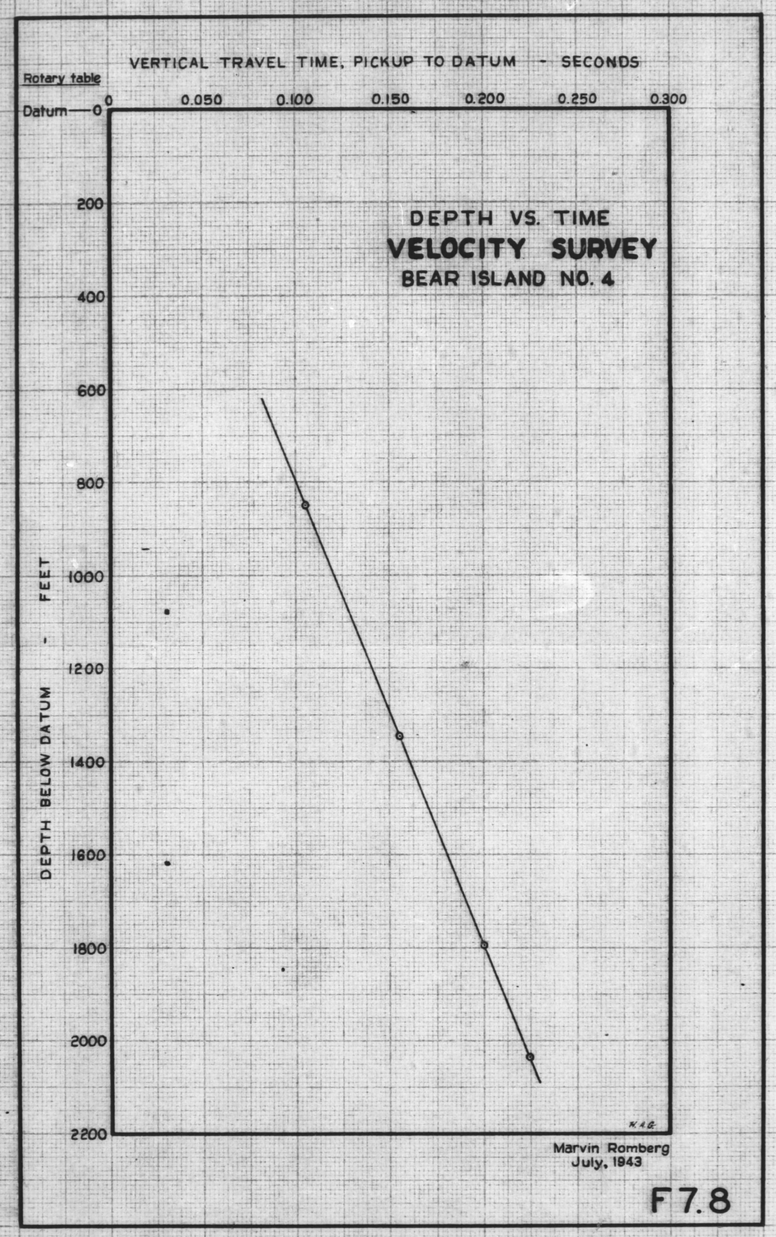
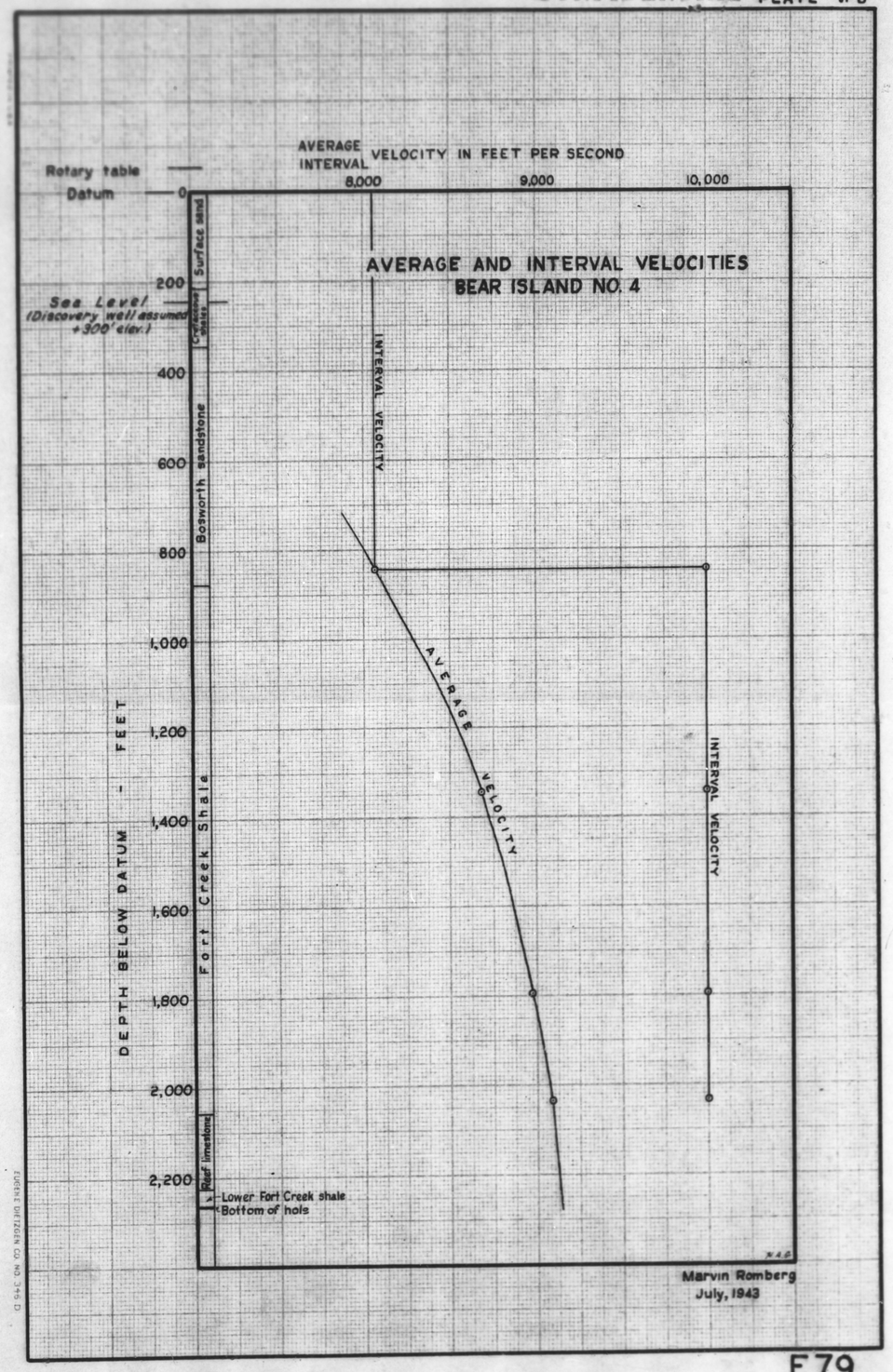


PLATE VI-B

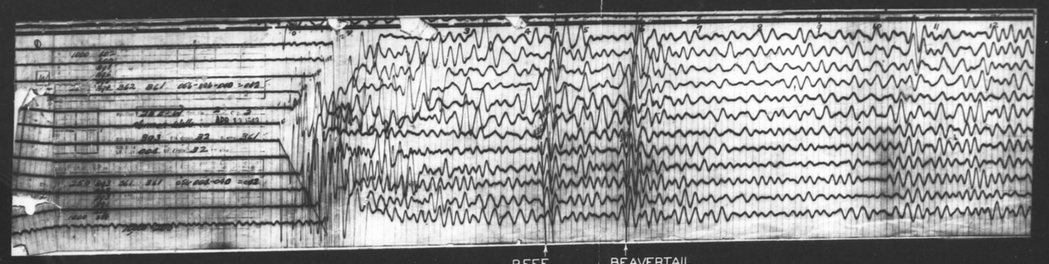


F 7.9

PLATE VII

SAMPLE – REFLECTION SEISMOGRAPH RECORDS

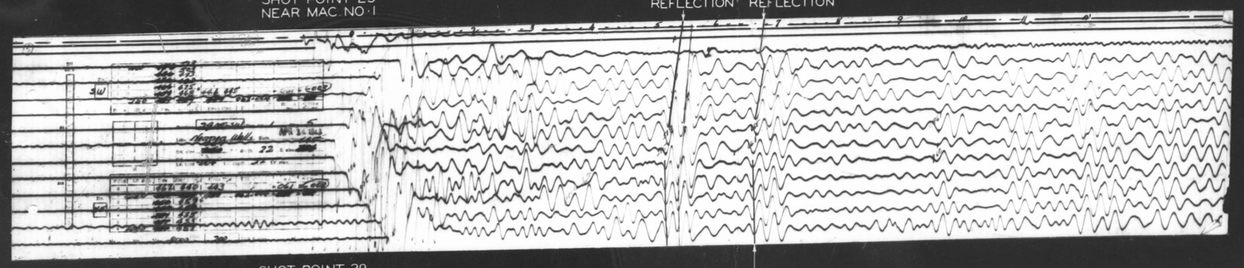
NORMAN WELLS AREA



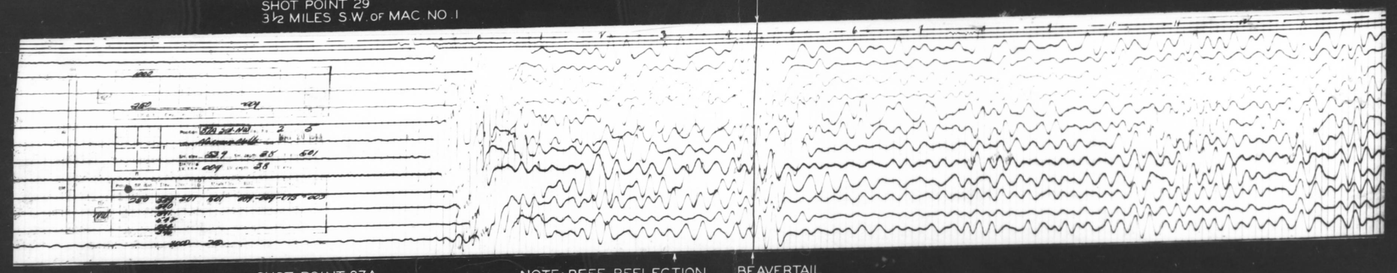
SHOT POINT 25
NEAR MAC NO. 1

REEF REFLECTION

BEAVERTAIL REFLECTION



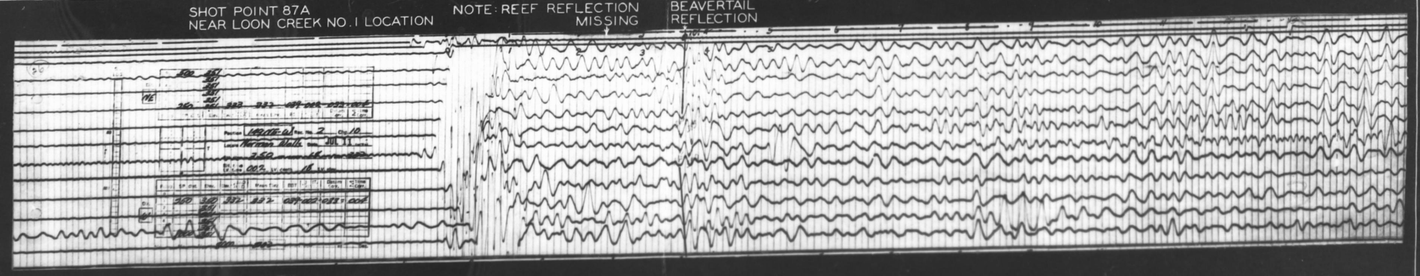
SHOT POINT 29
3½ MILES S.W. OF MAC NO. 1



SHOT POINT 87A
NEAR LOON CREEK NO. 1 LOCATION

NOTE: REEF REFLECTION MISSING

BEAVERTAIL REFLECTION



SHOT POINT 149
10 MILES UPSTREAM FROM NORMAN WELLS

F-7-18

16x

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