NOTE:

Abstracted for
Geo-Science Data Index

REPORT SUBMITTED SEPTEMBER 10, 1969

Date ____________________

THESE DATA ARE NOT SUBJECT TO NORMAL RELEASE DATES. PLEASE REFER TO DR. H. W. WOODWARD'S LETTER DATED JULY 11, 1968, YOUR FILE NUMBER R-1799-319.

693-15-4-2

EVALUATION

FROM GEOPHYSICAL AND GEOLOGICAL DATA

OF THE

JEAN-MARIE PROJECT

NORTHWEST TERRITORIES, CANADA

FOR

OPERATION GEOQUEST

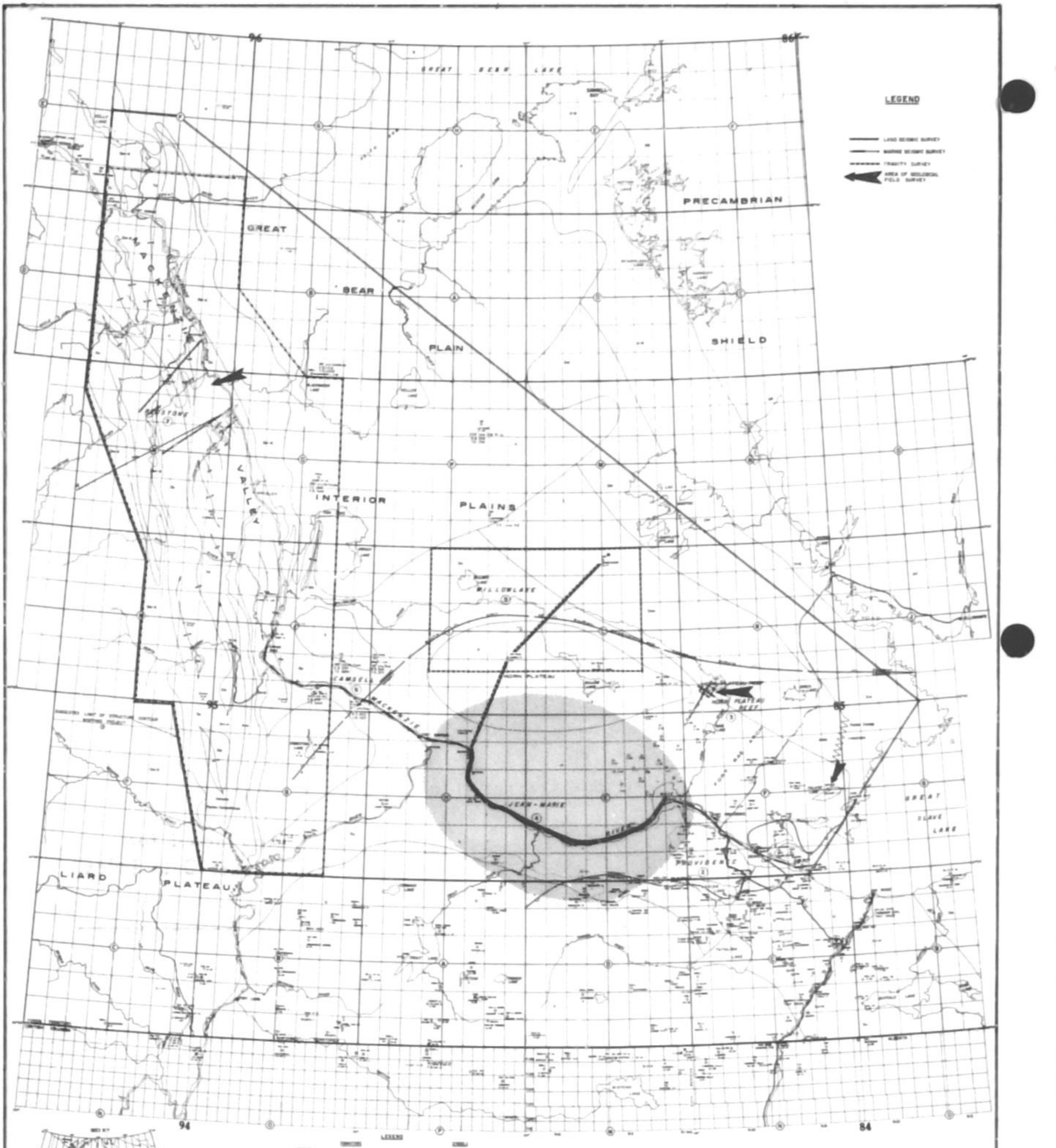
By

PALLISTER and ASSOCIATES

V. Zay Smith
ASSOCIATES LTD

April, 1969

PRINTED IN CANADA BY ACORN GRAPHICS LTD.



OPERATION GEOQUEST

SOUTHERN DISTRICT OF MACKENZIE
PETROLEUM EXPLORATION PROGRAM

OPERATION GEOQUEST CONCEPT

Operation Geoquest - an Operation of the Kenting group of companies and V. Zay Smith Associates Ltd. - is a combined geological/geophysical exploration program designed for the purpose of solving some of the basic geological and geophysical problems in the Northwest Territories of Canada.

Six areas of geologic significance including reefs, carbonate fronts, salt basins, Foothills structure and geosynclinal hinge line, were selected for study.

The Director of Resource and Economic Development Group, Department of Indian Affairs and Northern Development, Ottawa, has approved in principle that expenditures incurred in Operation Geoquest may be allocated to permits or group of permits in the Yukon and Northwest Territories. Application of these expenditures will be honoured up to the total cost of the entire survey.

An extended release date of these data has also been granted by the Department.

The following is a report of the work conducted in the Jean-Marie Project within the Operation Geoquest area.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ABSTRACT

The Jean-Marie Project is located in the Interior Plains structural province along the Mackenzie River between the towns of Fort Simpson and Fort Providence.

A combined seismic and geologic survey was conducted to determine effective methods of exploration that will locate folds, faults, solution collapse structures, Precambrian topographic features and carbonate build-ups.

The seismic program consists of a continuous profile beginning at the Westerol 3A well, approximately 25 miles east of Fort Simpson, and extending along the channel of the Mackenzie River to near the centre of Mills Lake. Geologic work includes a study of pertinent well cuttings and logs from wells in the area, and integration of subsurface geology with seismic data.

Results of the combined survey indicate a regional westerly thickening of Middle Devonian sediments along the line of investigation. Carbonate build-ups have been interpreted to include a bioherm, a carbonate bank and a carbonate front. Faults, folds, solution collapse structures and Precambrian topographic highs have also been interpreted on the geologic cross section.

The use of 300% common-depth-point marine shooting was found to be an effective exploration technique in the evaluation of this area.

PART I

REGIONAL GEOLOGIC SETTING

Page

P A R T I

REGIONAL GEOLOGIC SETTING

PHYSIOGRAPHY

Operation Geoquest covers parts of two major physiographic divisions: the Interior Plains and the Cordilleran Belt. The Mackenzie River is the main drainage. It originates in Great Slave Lake and flows west-northwesterly across the Interior Plains entering the Cordilleran Belt near Camsell Bend; from there it flows north-northwesterly through the Mackenzie Valley.

INTERIOR PLAINS

The Interior Plains form a vast area of low topographic relief lying between the Precambrian Shield on the east and the Cordilleran Belt on the west. The land surface is gently undulating at most places.

The Interior Plains are about 300 miles wide in the south in the vicinity of Great Slave Lake, narrowing to the north to a width of approximately 175 miles near Great Bear Lake. The land is poorly drained; for the most part, lakes and ponds are numerous. Interior Plains elevations within the Operation Geoquest area range from a low of 250 feet in the vicinity of Great Bear River to as much as 2,500 feet in the Horn Plateau that surmounts the plain. At most places, however, the land stands at elevations ranging from about 500 feet to 1,500 feet.

The Interior Plains are underlain by flat-lying to gently dipping strata comprised of carbonates, clastics and evaporites of Paleozoic and Mesozoic age. Bedrock is mantled by a variable thickness of glacial drift. Thus, outcrops are relatively sparse over most of the area. Some exposures exist along streams which have cut through the glacial cover; others are present in the rims of plateaus. Numerous significant exposures are located in the eastern part of the Interior Plains near the Precambrian Shield. Some gentle cuestas dipping gently to the southwest are present, providing an opportunity to study at the surface early Paleozoic rocks which are buried in the basin down-dip to the southwest.

Several scattered plateaus rise abruptly several hundred feet to nearly 2,000 feet above the general level of the Interior Plains. These include the Horn Plateau located northwest of Great Slave Lake, and the Ebbutt and Martin Hills located in the western part of the Interior Plains in front of the Cordillera. These broad features represent erosional remnants of flat-lying to gently dipping Cretaceous beds.

Evidence of continental glaciation is widespread in the Interior Plains. The Operation Geoquest area has been subjected to several periods of glaciation during the Pleistocene Epoch. A variety of glacial deposits is present. Drumlins indicate that the ice tended to move westerly and northwesterly from the Great Slave Lake area across the Interior Plains during the latest glacial advance. The plateaus that surmount the plains tended to deflect the ice around them. The continental ice sheets appear to have coalesced with the piedmont glaciers along the Cordilleran Belt. As deglaciation proceeded, vast proglacial lakes formed in the Interior Plains. These lakes were the ancestral Great Slave and Great Bear Lakes which formed part of a vast series of glacial lakes extending from the Great Lakes area of the United States and eastern Canada to Great Bear Lake.

At one time, Great Slave Lake stood about 500 feet higher than its present level. It surrounded the Horn Plateau and may have stretched 350 miles to the west to the vicinity of the Cordilleran Belt.

In summary, the landscape of the Interior Plains consists of a varied plains and low-lying plateau region that had reached the late mature stage in the erosional cycle before being subjected to multiple continental glaciation during the Pleistocene Epoch. Much of the area has been reverted to the initial stage in the erosional cycle and is being subjected to light to moderate erosion.

CORDILLERAN BELT

The Cordilleran Belt lies west of the Interior Plains and covers parts of three physiographic subdivisions: the Mackenzie Mountains, the Franklin Mountains and the Mackenzie Valley. The Operation Geoquest area includes rugged, moderately complex mountains and a broad intermontane valley. The Mackenzie River flows through the valley lying between Mackenzie Mountains on the west and the Franklin Mountains on the east.

The Mackenzie Mountains form an important subdivision of the Cordilleran Belt. They extend from the southern part of the Operation Geoquest area near South Nahanni River, northwesterly to the western project boundary at Keele River. Sediments of mainly Paleozoic age are well exposed throughout much of the length of the Mackenzie Mountains. Summit elevations are in the order of 4,500 to 5,000 feet, and local topographic relief of about 3,000 feet is present. The topography consists of a series of north-northwesterly trending ridges and valleys produced by differential erosion under the influence of structural control.

The Franklin Mountains form the leading edge of the Cordilleran Belt. They extend from Nahanni Butte, at the southern project boundary, northerly and northwesterly to the northern part of the Operation Geoquest area, a distance of 325 miles. The Franklin Mountains rise abruptly above the Interior Plains and are made up of a series of distinct, linear ranges which are named, from south to north, the Nahanni, Camsell, McConnell and Norman Ranges. Summit elevations range from about 4,500 to 5,000 feet. As much as 3,000 feet of topographic relief are present.

Outcrops of Paleozoic strata are common throughout the length of the mountains where the configuration of topography strongly reflects rock structure and lithology. In some areas, the ranges have been overridden by glaciers.

The Mackenzie Valley is an area of relatively low to moderate topographic relief lying between the Franklin and Mackenzie Mountains. It trends north-northwesterly parallel to the geologic grain of the region. It is an elongate intermontane structural basin varying in width from 30 to 50 miles, and is nearly 300 miles long within the Operation Geoquest area. Although the general level of the valley stands at about 500 to 1,500 feet, elevations as low as 200 feet occur along the Mackenzie River and as high as 3,000 feet exist in some places.

Bedrock is comprised of comparatively soft clastics of Upper Devonian, Cretaceous and Tertiary age. Some resistant Paleozoic beds are exposed along structural uplifts such as in the Mackay Range in the north. Outcrops are common in such areas.

In the southern two-thirds of the Mackenzie Valley, the topography reflects variations in structure and lithology of bedrock. Exposures are relatively widespread. To the north, however, bedrock appears to change character and is partly concealed beneath deposits of glacial drift. In some of these areas outcrops are relatively scarce except where tributaries of the Mackenzie River have incised beneath the glacial drift.

In summary, the Cordilleran Belt consists of a moderately complex mountain region that had attained the late youthful to early mature stage in the erosional cycle before undergoing multiple Pleistocene glaciation. It is being very vigorously eroded by streams at present.

STRATIGRAPHY

In the following paragraphs, concepts dealing with the regional stratigraphic development in the Operation Geoquest area are reviewed and discussed. Details of the stratigraphy have been reported in the literature by geologists who have studied the area in past years. Thus, one may refer to pertinent publications listed in the Selected Bibliography in order to review details. The age, correlation and lithology of the various stratigraphic units are shown in the accompanying stratigraphic correlation chart. More detailed discussions of the local stratigraphy of the Jean-Marie Project will be included under Part III of this report.

Sediments of Proterozoic, Paleozoic, Mesozoic and Cenozoic age are present within that part of the Mackenzie Basin covered by Operation Geoquest. The Paleozoic assemblage is comprised of Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Permian carbonates, clastics and evaporites. The Mesozoic sequence is made up of Cretaceous sandstone and shale. Tertiary clastics, Quaternary alluvium and glacial drift make up the Cenozoic section. Although many periods of the geologic column are represented, important gaps exist in the geologic record. Recurring cycles of subsidence, deposition, uplift and erosion have taken place.

Sediments were deposited in two main depositional environments which have tended to persist since the beginning of the Paleozoic Era. The Cordilleran geosyncline lay to the west along the present day location of the Cordilleran Belt. Relatively stable shelf conditions were present in the Interior Plains. During the Paleozoic Era, carbonates, clastics and evaporites were deposited in dominantly marine environments. Marine shale and sandstone accumulated during the Mesozoic Era and were derived from uplifts in the geosyncline to the west and partly from the Precambrian Shield to the east.

A thick sedimentary sequence accumulated in the miogeosynclinal belt, and the total sedimentary section probably exceeds 20,000 feet in thickness. In contrast, the sedimentary sequence is comparatively thin over the stable shelf where the present stratigraphic section ranges from a thin edge to about 5,000 feet in thickness.

Paleozoic sedimentation in the Operation Geoquest area probably began in the Cordilleran Belt as the miogeosyncline was subsiding. Marine waters gradually encroached on the stable shelf, advancing toward the Precambrian Shield where well-sorted coarse clastics were deposited under shallow-water marine conditions.

Subsidence continued very slowly in the Interior Plains. Interbedded carbonates, clastics and evaporites were laid down in a marine, shallow-water restricted environment. Extensive tidal flats probably were present and different parts of the area were probably emergent at various times. In the miogeosynclinal belt to the west, thicker deposits of carbonates, clastics and evaporites accumulated.

During Upper Ordovician and Silurian time, well-aerated marine waters were present and thick deposits of carbonates were laid down. Marine organic life was widespread and reefs grew in places. Although this depositional environment persisted into Lower Devonian time in the Cordilleran geosyncline, the stable shelf was emergent and subjected to widespread erosion. This period of uplift and erosion probably coincided with the Caledonian epeirogeny.

In the Interior Plains of the Operation Geoquest area, the stratigraphic succession was truncated progressively from west to east toward the Precambrian Shield. Erosion was most conspicuous in the southern part of the Operation Geoquest area where strata of Cambrian, Ordovician and Silurian age are interpreted to have been removed over a broad area. Their southern limit is bounded by a line drawn from the north arm of Great Slave Lake west-north westerly along the north edge of the Horn Plateau and southwesterly towards Nahanni Butte. Broad differential uplifts occurred in the Cordilleran Belt as indicated by thinning in various places such as in the Redstone Arch and the Fort Norman area.

Renewed subsidence during Middle Devonian time effected further sedimentation. At first, three different sedimentary environments originated. A shallow evaporitic basin was present over the stable shelf lying east in the Interior Plains. The present location of the Franklin Mountains and Mackenzie Valley cover a transitional zone between the evaporite basin to the east and an area of carbonate deposition to the west. It appears that some areas in the transition zone were emergent at times resulting in the development of karst topography. Continued subsidence permitted the advance of warm, well-aerated marine waters and deposition was dominated by carbonates. Environments were satisfactory in places for the prolific growth of marine life and reef development.

Coinciding with this period of carbonate deposition, or shortly thereafter, very fine clastics and, in a few places, evaporites were deposited. During Upper Devonian time, a change in the depositional pattern occurred whereby clastic deposition dominated over carbonate sedimentation.

To the west, in the rapidly subsiding geosyncline, a thick sequence of fine clastics accumulated during Upper Devonian time and was probably derived from uplifts within the geosyncline to the west and from the Precambrian Shield to the east. Subsidence and deposition probably persisted in the Mississippian, Pennsylvanian and Permian Periods over most of the Operation Geoquest area. However, much of the stratigraphic record of these three systems has been removed during a widespread period of uplift and erosion that probably occurred in accompaniment with late Paleozoic crustal movements. Nevertheless, stratigraphic evidence present in the southern part of the Cordilleran Belt included by Operation Geoquest and in areas to the south indicates that clastics, both fine and coarse, argillaceous carbonates and carbonates were deposited in a pattern reflecting the shelf-miogeosyncline environments that had persisted throughout the Paleozoic Era.

The stratigraphic record of Mesozoic sedimentation in the Operation Geoquest area is restricted to the Cretaceous Period. During Cretaceous time, marine seas invaded the area. Subsidence continued and resulted in the accumulation of dominantly marine shale and sandstone which were derived from uplifts within the Cordilleran Belt to the west and from an eastern source, the Precambrian Shield. Sedimentation in the Cordilleran Belt may have resulted in the accumulation of approximately 10,000 feet or more of Cretaceous rocks, whereas deposits were thinner over the Interior Plains - in the order of 2,000 to 3,000 feet.

The Cretaceous Period culminated in the Laramide orogeny. Deformation, uplift and erosion were widespread. During and after the orogeny, thick deposits of nonmarine coarse to fine clastics were deposited in local basins during the Tertiary Period. It is also conceivable that Tertiary deposition under continental conditions was widespread in the Operation Geoquest area, the stratigraphic record having been removed by subsequent erosion. Thereupon, the area was subjected to multiple continental glaciation during the Pleistocene Epoch. Following deglaciation, erosion was renewed and continues today.

STRUCTURE

Operation Geoquest covers parts of two main structural provinces which correspond closely to the physiographic divisions. They are the Interior Plains and the Cordilleran Belt. The Operation Geoquest area has been subjected to several periods of orogenic and epeirogenic deformation since the Precambrian.

Important structural movements occurred in the Paleozoic Era during late Silurian and/or Lower Devonian time (Caledonian epeirogeny). Other structural movements took place during early Upper Devonian time and presumably during late Paleozic time. Laramide orogenesis, the most important Mesozoic deformation, originated late in the Cretaceous and continued during early Tertiary time.

A variety of structural features occur in the Operation Geoquest area. Orogenic folds and faults characterize the Cordilleran Belt; less intense tectonic structures are present in the Interior Plains. Compaction folds and solution collapse structures are also anticipated. Some likelihood exists that salt flowage and tectonic accumulation associated with deformation may have occurred in the Cordilleran Belt.

Structures caused by igneous activity are not known within the Operation Geoquest area but should not be overlooked because they are known elsewhere in the Mackenzie Basin. However, their effects are very local. Of lesser importance are structures that could have been caused by the dislocation of surface bedrock during glaciation and isostatic rebound following deglaciation.

INTERIOR PLAINS

The Interior Plains structural province forms a vast area of gentle to moderate structural intensity lying between the Precambrian Shield on the east and the Cordilleran Belt to the west. The area was relatively stable during the Paleozoic and Mesozoic Eras. Near the eastern part of the Interior Plains, in the vicinity of the Precambrian Shield, Paleozoic strata dip very gently to the west and southwest toward the Cordilleran Belt at rates ranging from 15 to 20 feet per mile. The rate of dip gradually increases into the basin, but rarely exceeds 250 feet per mile.

The Paleozoic sequence is unconformably overlain by Cretaceous strata that are preserved as erosional remnants over broad areas. Cretaceous beds appear to be flat-lying to gently dipping. Some gentle folds and flexures are present in the Interior Plains in addition to other major structural elements. These include the Tathlina and Fort Rae Arches, an unnamed uplift west of Fort Simpson, and the northerly trending structural hinge line present in the western part of the Interior Plains.

The Tathlina Arch is a major structural feature in the Interior Plains southwest of Great Slave Lake. Only the north flank of it is covered by Operation Geoquest. This broad positive feature originated early in the Paleozoic Era and remained positive at least into Middle Devonian time. Some parts of the uplift probably were controlled by basement faults. The Fort Rae Arch may represent a subsidiary part of the Tathlina Arch. Stratigraphic evidence for the arch occurs along the edge of the Interior Plains, east of the Operation Geoquest area, where Paleozoic strata thin over the arch in the vicinity of Fort Rae, suggesting it to be a broad gentle positive feature.

In the western part of the Interior Plains in front of the Cordillera, a northerly trending zone of relatively steeper dip is present. It separates the Interior Plains from the Cordilleran Belt. This structural hinge line trends northerly along longitude 123°W. Some local structural elements are developed along it; one of them is an unnamed uplift which is interpreted to be present west of Fort Simpson in the area lying within the drainage loop, convex to the east, formed by the lower reaches of the Liard River and part of the Mackenzie River. This positive element was uplifted and truncated during post-Mississippian, pre-Cretaceous time and was further elevated during the Laramide orogeny.

CORDILLERAN BELT

The Cordilleran Belt is located in the western part of the Operation Geoquest area where moderate to very intense deformation prevailed during the Laramide orogeny. Although parts of the area had been subjected to pre-Laramide crustal movements, most of the deformation was accomplished during the Laramide disturbance. Numerous folds and faults are present, and they range from simple to complex and moderate to intense. Regional structural trend is north-northwesterly although considerable local variation exists.

Operation Geoquest covers parts of three structural subprovinces: the Mackenzie and Franklin Mountains and the intervening Mackenzie Valley.

The Franklin Mountains form the eastern leading edge of the Cordilleran Belt and are characterized by moderate folds and faults developed mainly in strata of Cambrian through Middle Devonian age. A major northerly to northwesterly trending thrust fault marks the eastern boundary of the Franklin Mountains at many places. It gives a sense of motion towards the Interior Plains.

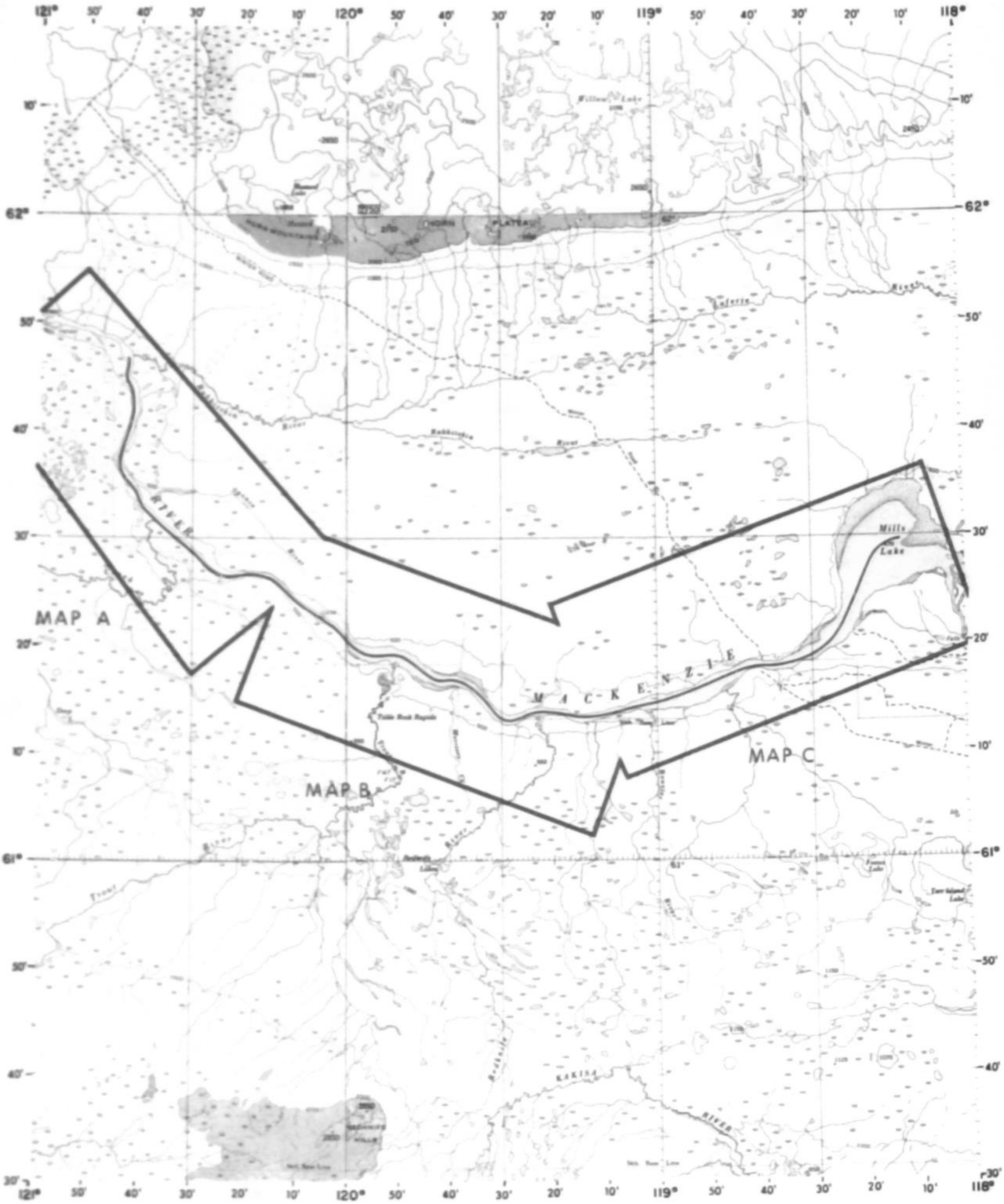
Only a small part, the eastern front, of the Mackenzie Mountains is included in the project. Structural trend is to the north-northwest. Structures consist of a series of moderately to intensely deformed folds and faults.

The Mackenzie Valley forms a narrow, elongate structural basin lying between the Franklin Mountains on the east and the Mackenzie Mountains on the west. This north-northwesterly trending synclinorium is characterized by gently to moderately and locally intensely folded and faulted structures parallel to the structures in the Mackenzie and Franklin Mountains. Folds at the surface are defined mainly in rocks of Upper Devonian and younger age. Thus, Middle Devonian and older strata, which contain promising reservoirs, are buried in the subsurface.

PART II

SEISMIC EXPLORATION

Page



PROJECT FOUR
JEAN - MARIE

P A R T I I

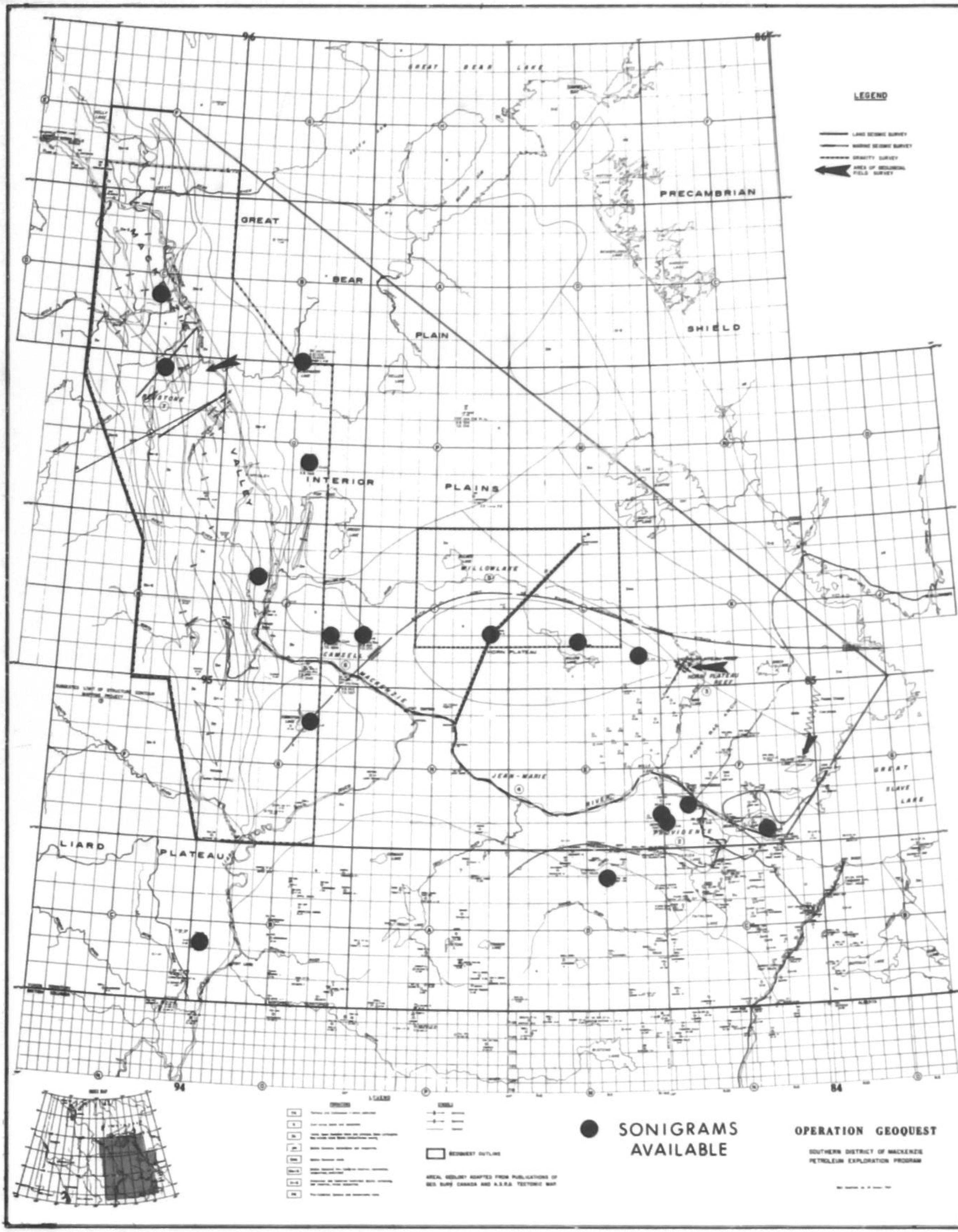
SEISMIC EXPLORATION

EXPLORATION PROGRAM

The Jean-Marie Project of Operation Geoquest is located about 200 miles north of the prolific Middle Devonian Keg River reef fields of northwestern Alberta. Geophysical and geological surveys were conducted during the summer of 1968 to gain new information and develop optimum exploration techniques for future exploratory work in the area.

A 111-mile seismic survey was conducted on the Mackenzie River, extending from the Westerol 3A well, 25 miles east of Fort Simpson, to the approximate centre of Mills Lake. The survey ties with the Camsell Project to the west and the Providence Project to the east. Data were recorded using SIE PT-800 binary gain amplifiers and a PDR-89 digital tape system. Recording was carried out in a mode to provide a 300% subsurface coverage.

Reflections representing the top of the Middle Devonian carbonate (Lonely Bay Formation) and basal Paleozoic were correlated. Reflection time and interval maps were prepared to evaluate the survey area.



GREAT BEAR LAKE
LEGEND
LAND SEISMIC SURVEY
MARINE SEISMIC SURVEY
GRAVITY SURVEY
AREA OF GEOLOGICAL FIELD SURVEY
PRECAMBRIAN
SHIELD
GREAT
BEAR
PLAIN
INTERIOR
PLAINS
VALLEY
WILLOWLAKE
HORN PLATEAU
HORN PLATEAU REEF
CAMSELL
MACKENZIE
JEAN-MARIE
RIVER
PROVIDENCE
GREAT SLAVE LAKE
LIARD
PLATEAU
96
86
95
85
94
84
INDEX MAP
GEOQUEST OUTLINE
AREAL GEOLOGY ADAPTED FROM PUBLICATIONS OF GEO. SURV. CANADA AND A.S.P.G. TECTONIC MAP
SONIGRAMS AVAILABLE
OPERATION GEOQUEST
SOUTHERN DISTRICT OF MACKENZIE
PETROLEUM EXPLORATION PROGRAM

SEISMOGEOLOGIC INTEGRATION

The playback sections were prepared by referencing the time break to zero and applying normal moveout and static corrections. The river level was used as the datum, and was determined using existing bench marks along the river.

Identification of the seismic reflections was made by reference to formation tops from wells drilled along the Mackenzie River. These reflecting horizons are consistent with those mapped in the Camsell Project to the west and the Providence Project to the east. Sonigrams, as shown on opposite page, were used in determining average velocities for identification purposes.

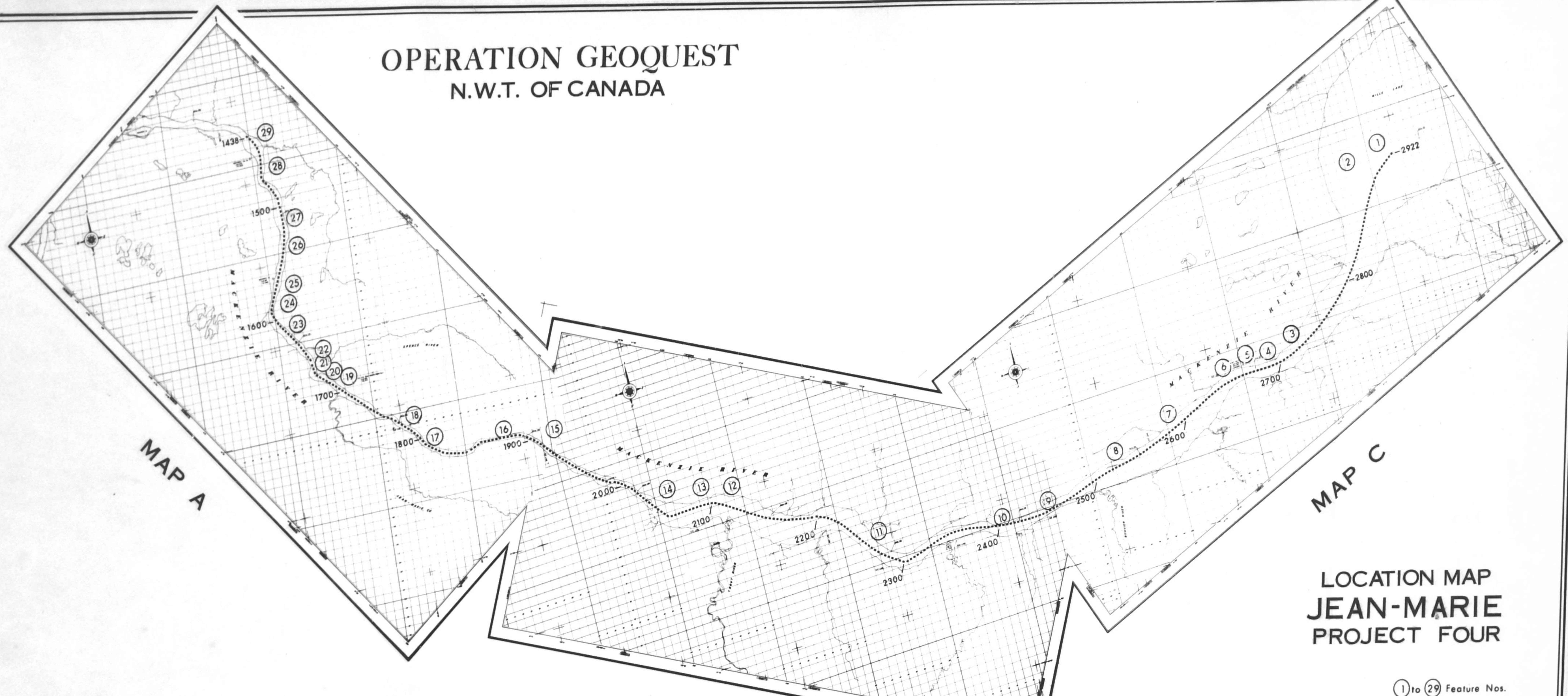
Record quality varied from good to poor. In general, the reflection identified as the top of the Middle Devonian carbonate (Lonely Bay) has better continuity than the basal Paleozoic reflection. Because the lithologic change at the top of the carbonate is from a shale to a high-velocity carbonate, a strong reflection was expected at this point.

In order to obtain better continuity, the basal Paleozoic event was picked one-half cycle higher in the Jean-Marie Project than the same reflection in the Providence Project. Changes in record quality on this horizon have been attributed to variations in the thickness of red beds in the Mirage Point Formation.

The reflections from the top of the Middle Devonian carbonate and basal Paleozoic were the only two correlated. A reflection is present above the carbonate in some areas, but is not continuous. This energy is possibly from limestone stringers within the overlying Hay River shale.

In parts of the section, a "shingling" - a record-to-record mistie with the appearance of records not corrected for normal moveout - was observed in the shallow zone above the carbonate. The shingling may be a result of improperly corrected moveout on a valid reflection, thus indicating radical near-surface velocity changes. Alternatively, it may be an effect of multiples from a very shallow reflecting horizon; or a combination of reflection and refraction, with the reflection reaching its critical angle and a refraction appearing on the remaining traces.

OPERATION GEOQUEST
N.W.T. OF CANADA



LOCATION MAP
JEAN-MARIE
PROJECT FOUR

1 to 29 Feature Nos.

MAP DISCUSSION

Map 1 — Reflection Time

TOP OF MIDDLE DEVONIAN CARBONATE

The reflection from the top of the Middle Devonian carbonate is the shallowest correlatable horizon in this area. Earlier reflections are either within the zone of first arrival interference or are not continuous. From the known geology, the top of the Middle Devonian carbonate (Lonely Bay) is correlative throughout this survey and the reflection from this horizon is considered reliable.

To determine the approximate subsea elevation of the carbonate, two velocity functions were used. In the eastern part of the project, a constant one-half velocity (4,700 feet per second) was applied. This velocity is consistent with the velocity used in the western portion of the Providence Project.

West of shotpoint 1930, approximate subsea elevations were determined by use of a time-depth function prepared from existing velocity control, well data and seismic times. This velocity function (opposite Page 15) ties the Jean-Marie Project with the Camsell Project. The values on this map, as in the case of all reflection time maps, are subject to near-surface velocity change.

Twenty-nine significant features, as shown on the enclosed maps, correspond with the features numbered on the condensed record section and have been tabulated on the following pages. Contouring of the maps beyond the lines of control should be considered speculative.

No.	Central or High Shotpoint	Relief in ms	Comments
1	2914	18	Local high
2	2890	14	Local high
3	2722	43	Local high
4	2696	30	Local high
5	2670		Tie to N.W.T. 2 well
6	2656	31	Local high
7	2586	19	Reef - steep flanks at shotpoints 2586-7 and 2582-4
8	2532	39	Steep dip on east flank
9	2450	24	Frequency change below basal Paleozoic
10	2386		Abrupt dip to west at shotpoint 2391, carbonate pick absent, opposing directions of shingling at edges of feature - may be significant if this is reflected energy
11	2264	19	Local high
12	2110	21	Local high
13	2080	20	Local high
14	2040		Consists of steep east dip
15	1922		Thinning of interval between horizons - may indicate salt collapse
16	1868	20	Local high

No.	Central or High Shotpoint	Relief in ms	Comments
17	1816	21	Local high
18	1758	20	Approximate projected location of B-48 well
19	1690		Tie to B.A.-H.B. Jean Marie Creek No. 1 well
20	1675		Fault downthrown to the west - evidence is in the unusual dip for the area and in weakening of the carbonate pick
21	1662	18	Structural high in graben
22	1651		Fault downthrown to the east - evidence is in carbonate's appearing offset
23	1622	29	Local high
24	1593		Fault downthrown to the east - evidence is in poor character of carbonate and in projection of stronger energy from each side
25	1556	7	Local high - also tie to Westerol 7A well
26	1540		Abrupt dip, thinning to the east
27	1510	17	Local high
28	1462	20	Local high
29	1448		Tie to Westerol 3A well

Map 2 Time Interval

TOP OF MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

Facies changes, differential build-up of the Middle Devonian carbonate, and relief on the eroded Paleozoic surface, are indicated in the Jean-Marie area. Each of these features could cause a local change in the time interval for Middle Devonian carbonates and older sediments.

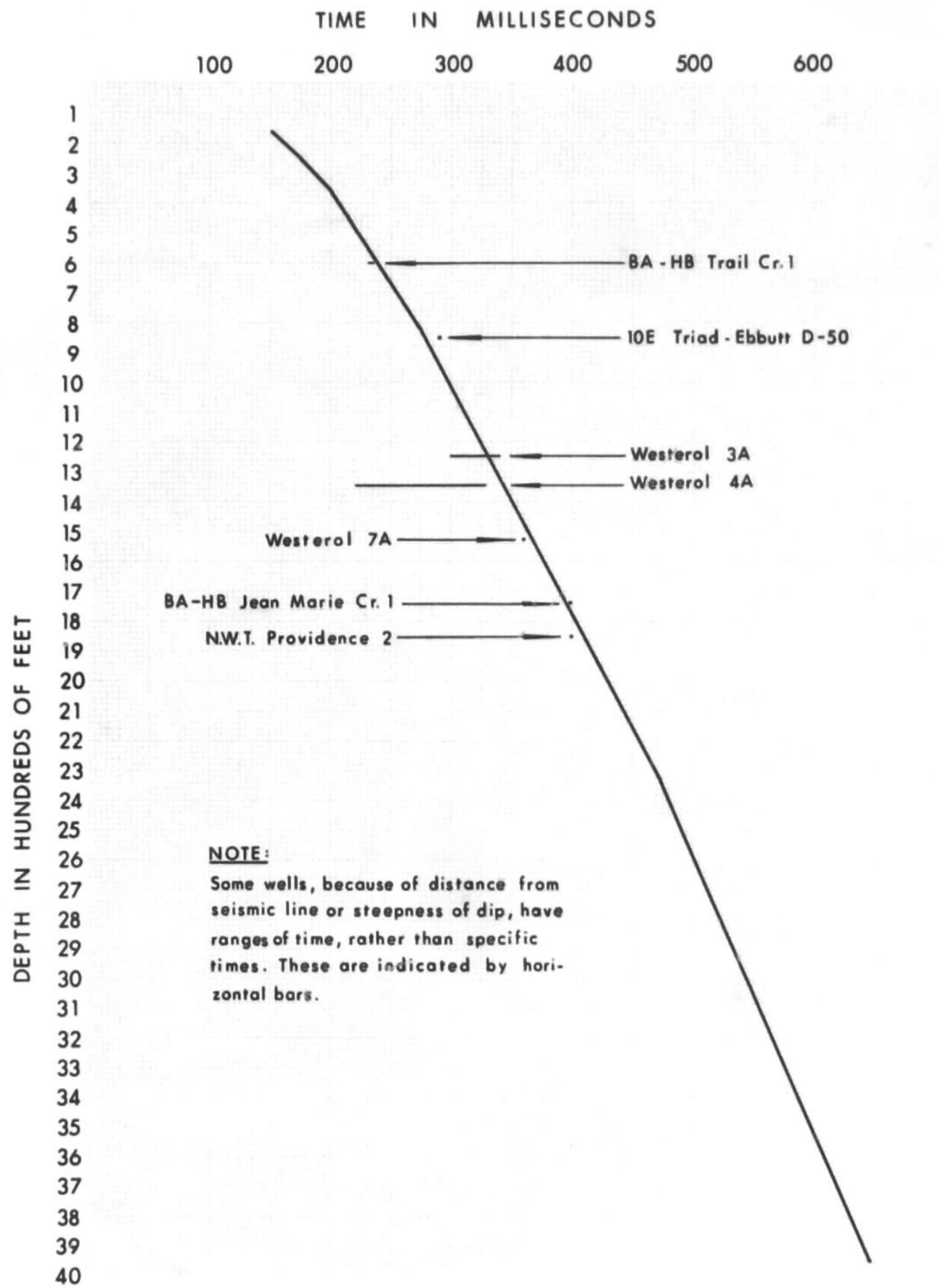
(1) Where porous reef is surrounded by high-velocity dense carbonates, shales, or anhydrite, an increase in this time interval would occur.

(2) Carbonate build-ups on or above the top of the Lonely Bay Formation would also be indicated by an increase in this interval.

(3) A topographic high on the eroded Precambrian surface would be expressed as a decrease in the carbonate-to-basal Paleozoic interval.

The carbonate-to-basal Paleozoic time interval values were converted to thickness by the addition of 0.015 seconds and the use of a constant one-half velocity of 8,000 feet per second for all points east of the B.A.-H.B. Jean Marie Creek No. 1 test. West of this well the velocity was progressively increased to a maximum of an 8,500 foot per second half-velocity at the Westerol 3A well. These velocities are consistent with those used in the adjoining Providence and Camsell Projects.

The Middle Devonian carbonate-to-basement interval displays a regional westerly thickening with local variations. The more prominent of these variations are numbered features on the accompanying condensed seismic section.



PROJECT 004
JEAN-MARIE AREA

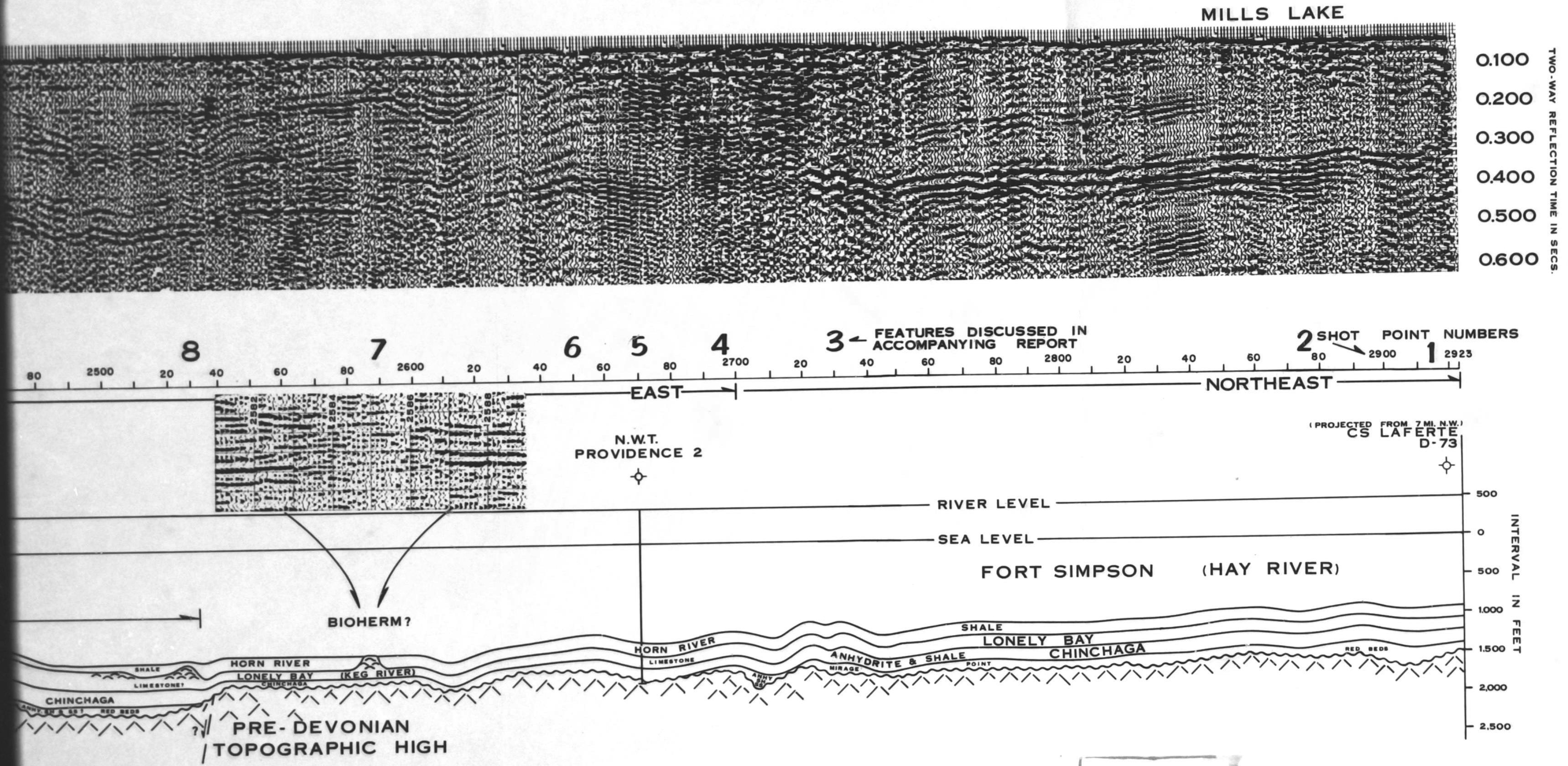
TIME-DEPTH FUNCTION
FOR
WATER SURFACE TO CARBONATE PICK

TWO-WAY REFLECTION TIME IN SECS.
0.100
0.200
0.300
0.400
0.500
0.600
29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13
1440 60 80 1500 20 40 60 80 1600 20 40 60 80 1700 20 40 60 80 1800 20 40 60 80 1900 20 40 60 80 2000 20 40 60 80 2100
SOUTH
Closely spaced, post-Devonian folds are indicated in the area west of shotpoint 1700 where the top of the Middle Devonian carbonate locally displays structural relief and is generally parallel to the underlying basal Paleozoic reflection. Some of these features may result in part from local variation of seismic velocity in near-surface sediments.
WESTEROL 3-A
WESTEROL 7-A
BA-HB JEAN MARIE CR. 1
(PROJECTED FROM 3.5 MI. S.W.)
CAN. SUP. JEAN MARIE B-48
INTERVAL IN FEET
500
0
500
1,000
1,500
2,000
2,500
RIVER LEVEL
SEA LEVEL
FORT SIMPSON SHALE
CARBONATE FRONT ?
SOLUTION (SALT) COLLAPSE ?
HORN RIVER
LIMESTONE
DOLOMITE
LONELY BAY
SHALE
ANHYDRITE
ANHYDRITE, SALT & SHALE
35% HALITE
RED BEDS
HORN RIVER SHALE
LONELY BAY
CHINCHAGA
ANHYDRITE ?
LIMESTONE
DOLOMITE
LONELY BAY
DOLOMITE
ANHYDRITE ?
(EVAP. SHALE & SAND)
(MIRAGE POINT)
RED BEDS
HORN
(KEG RIVER)
RIVER
SHALE
AND
DOLOMITE
LIMESTONE
HORN RIVER
CHINCHAGA
SHALE
RED BEDS
PRECAMBRIAN

1 of


Top of Middle Devonian Carbonate
Basal Paleozoic
7·5 MILES
13
12
11
10
9
8
7
6
5
4
3 ← FEATURES DISCUSS
ACCOMPANYING RE
SOUTHEAST
EAST
The top of the Middle Devonian carbonate and the top of basement on the Geologic cross section are positioned from seismic data. They correspond to the two colored reflections shown on the seismic profile.
N.W.T. PROVIDENCE 2
RIVER LEVE
SEA LEVEL
FORT SIMPSON SHALE
FORT
? CARBONATE BANK ?
BIOHERM ?
SHALE
LIMESTONE ?
LONELY BAY
? ANHYDRITE & SHALE ?
RED BEDS
CHINCHAGA
LONELY BAY LIMESTONE & DOLOMITE ?
? ANHYDRITE AND SHALE ?
HORN RIVER
LONELY BAY (KEG RIVER)
ANHYDRITE & SHALE
PRECAMBRIAN
PRE-DEVONIAN TOPOGRAPHIC HIGH

2 of



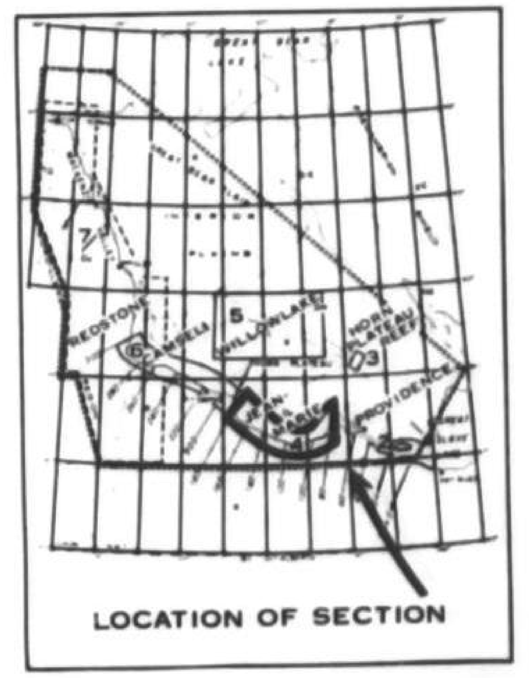
PALLISTER and ASSOCIATES

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

PROJECT FOUR
JEAN - MARIE

CONDENSED SEISMIC PROFILE AND GEOLOGIC CROSS SECTION
ALONG THE CHANNEL OF THE MACKENZIE RIVER
FROM MILLS LAKE TO WESTEROL 3-A

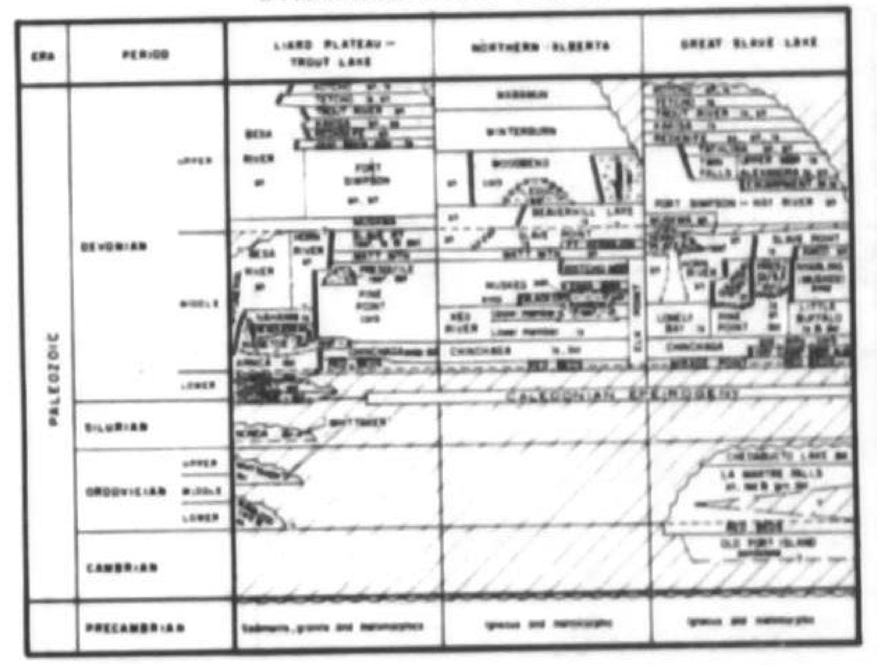


LOCATION OF SECTION

APPROXIMATE HORIZONTAL SCALE
0 8,800'

TOTAL LENGTH OF PROFILE
APPROX. 111 MILES

STRATIGRAPHIC CHART



GEOLOGICAL SYMBOLS

	FORMATIONAL CONTACT
	ERODED SURFACE
SH LS	FACIES CHANGE
	PROJECTED POSITION OF EXPLORATORY WELL MAY BE PROJECTED UP-DIP OR ALONG STRIKE
	CARBONATE BUILD-UP OR REEF, INFERRED
	PRECAMBRIAN IGNEOUS BASEMENT
	FAULT AND DIRECTION OF MOVEMENT

CONDENSED SEISMIC SECTION PREPARED BY REFORMATING ONE TRACE FROM EACH SEISMIC RECORD. TRACE NO. 2 WAS USED FOR UNIDIRECTIONAL SPREADS AND TRACE NO. 5 WAS USED FOR SPREADS SHOT ASYMMETRICALLY

VELOCITIES USED FOR TIME - DEPTH CONVERSION DISCUSSED IN FINAL REPORT.

BANDPASS FILTER 23-28/73-78
VERTICAL SCALE 0 0.2 Secs

CDP COMPUTER DATA PROCESSORS LTD
Calgary House Calgary 1, Alberta

343

CONCLUSIONS

Reflection seismic exploration is effective in locating structural featu-es and interval anomalies in the Jean-Marie area. The use of digital seismic instruments with binary gain recording aids considerably in obtaining shallow record information.

Anomalies located by the survey are illustrated on the reflection time and interval maps and also on the condensed seismic section(opposite page) prepared by using one trace from each record.

Additional exploration would be required to define the areal extent of these anomalies.

By:

J. A. Coffeen, P. Geoph.,
Geophysical Consultant.

C. I. Klipfel, B.S., P. Geoph.,
Manager, Evaluation Department.

PALLISTER and ASSOCIATES

P A R T I I I

GEOLOGIC EXPLORATION

PART III

GEOLOGIC EXPLORATION

INTRODUCTION

Geologic work in the Jean-Marie Project can be separated into two classifications: 1. subsurface geology, and 2. the co-ordination of subsurface geology with seismic data. The co-ordination of subsurface geology and seismic information is illustrated by a geologic cross section accompanying the condensed seismic record section.

Subsurface geologic exploration consisted in large part of a study of bore-hole samples, cores and logs from a number of exploratory wells in the Jean-Marie Project area. The projected positions of several of these exploratory wells are shown on the accompanying cross section.

STRATIGRAPHY

Sediments of Cretaceous and Devonian age form bedrock in the Jean-Marie Project. Cretaceous rocks occur as erosional remnants in the area north and south of the survey, which extends along the Mackenzie River from Mills Lake downstream to the Westerol 3A exploratory well. Along the Mackenzie River a succession of Devonian red beds, evaporites, carbonates, and shales unconformably overlies the Precambrian crystalline basement. The thickness of the Devonian succession ranges from about 2.000 to 3,000 feet. The thinner sections correspond to topographically or structurally high areas on the eroded Precambrian surface. The Horn River Formation and older Devonian rocks thicken westward from approximately 600 feet at Mills Lake to more than 1,200 feet near the Westerol 3A test.

On the basis of gross lithology, Devonian rocks can be separated into three broad units. The upper of these is predominately made up of shale (Fort Simpson and Horn River Formation) and locally includes limestones and coarser clastic rocks. The middle unit (Lonely Bay Formation) is made up of limestones with some dolomites and is interpreted to locally contain carbonate build-ups, banks and bioherms. The lower unit of the Devonian succession in the Jean-Marie area is characterized by evaporites and includes the Chinchaga and Mirage Point Formations which correlate with the Lower Elk Point beds of northern Alberta.

Over much of the area between Mills Lake and the Westerol 3A well, the Chinchaga Formation is made up of anhydrite. The underlying red beds, which correlate with the Mirage Point Formation in the area immediately west of Great Slave Lake, contain varicolored thin beds of anhydrite, shale, halite and sandstone.

Regionally, the Jean-Marie Project lies northwest of the Middle Devonian carbonate bank (Slave Point front). Rocks of the carbonate bank are typically fossiliferous and locally contain biostromes and bioherms. In the area northwest of the carbonate bank, including the Jean-Marie Project, generally nonporous, well-bedded limestones accumulated in an open marine environment through much of Lonely Bay time. The northwest limit of the Middle Devonian carbonate bank lies southeast and south of the Jean-Marie area and is illustrated by Bassett & Stout (1967) and others.

CHINCHAGA AND MIRAGE POINT FORMATIONS

The base of the sedimentary succession in the Jean-Marie Project is formed by the Middle and Lower Devonian Mirage Point Formation. It is locally absent over topographically high features on the eroded Precambrian surface and is characterized by varicolored (generally red and green) anhydrite, shale, dolomite, gypsum and some salt. It ranges in thickness from the depositional edge to a maximum of approximately 400 feet. As shown on the accompanying geologic cross section, the areas of maximum thickness of the Mirage Point Formation are interpreted to be where the beds have infilled topographic lows on the eroded Precambrian surface. The red beds are absent south of the Jean-Marie profile over the crest of the Tathlina High. This feature can be described as a generally east-west trending, broad, positive area which remained above sea level during the deposition of the Mirage Point beds and also during the deposition of the early Chinchaga beds. The Tathlina High occupies much of the area from the survey to the Alberta border.

The Chinchaga Formation conformably overlies Mirage Point red beds and consists for the most part of anhydrite with minor dolomites. The formation thickens to the west from approximately 200 feet at Mills Lake to 350 feet near the Westerol 3A well. Locally, the Chinchaga Formation was deposited on the eroded Precambrian surface and thins over topographically high features which remained positive during the deposition of the Mirage Point red beds. A pre-Devonian topographic high is indicated on the accompanying condensed seismic profile and geologic cross section between shotpoints 2540 and 2600. There, a thickness of less than 100 feet of Chinchaga beds is indicated.

LONELY BAY FORMATION AND ASSOCIATED CARBONATE BUILD-UPS

Limestones and dolomites characterize the Lonely Bay Formation along the Jean-Marie seismic profile. The beds are generally nonporous, sparsely fossiliferous and are regarded as having been deposited in open marine conditions below wave base. The formation ranges in thickness from 150 feet at Mills Lake to 360 feet in the Westerol 3A well.

The lithology of the Lonely Bay Formation is characterized by limestones in the eastern part of the Jean-Marie survey. To the west the formation contains an upper limestone and a lower dolomitic limestone. The B.A.-H.B. Jean Marie Creek No. 1 well penetrated the Lonely Bay Formation in the western part of the survey. There, the formation is 285 feet thick and is made up of an upper dolomitic, argillaceous limestone and a lower argillaceous dolomite.

Several carbonate build-ups, banks and bioherms are interpreted on the accompanying geologic cross section. Many of these features are structurally high at the top of the Middle Devonian Series and are also marked by a thickening of the interval between the top of the Middle Devonian carbonate and the basal Paleozoic reflection.

The carbonate build-ups have been interpreted to indicate a bioherm, a carbonate bank and a carbonate front. At each of these features, the Lonely Bay Formation is believed to have formed the platform beds. The carbonate build-ups occur as reef growth in the interval above the Lonely Bay Formation; thus, the age of the interpreted reef is Lonely Bay or younger (late Middle Devonian). An interesting comparison can be made with the Horn Plateau Formation, a bioherm exposed northeast of the Jean-Marie survey, and with the Slave Point carbonate bank to the southeast and south (Norris, 1965; Bassett & Stout, 1967).

A bioherm is interpreted to overlie the Lonely Bay platform beds at shotpoint 2586 (Feature 7). There, relief on the top of the Middle Devonian carbonate is indicated to be approximately 180 feet. A carbonate bank is interpreted over the area extending from shotpoints 2258 to 2534. This area generally corresponds with a thickening of the interval from the top of the Middle Devonian carbonate to the basal Paleozoic reflection. Local thickening (reef growth) is indicated along the margins of the interpreted carbonate bank where the top of the Middle Devonian carbonate is structurally high.

A carbonate front is interpreted on the accompanying geologic cross section in the area west of shotpoint 1888. There, a general westward thickening of the Lonely Bay and older Devonian rocks is indicated from seismic data together with local increases in the interval from the top of the Middle Devonian carbonate to the basal Paleozoic reflection. Carbonate build-ups west of the front are interpreted to have relief in the order of 150 feet.

MIDDLE AND UPPER DEVONIAN SHALE UNIT

A thick section of dark grey and dark green shales of Middle and Upper Devonian age overlies Middle Devonian carbonates in the Jean-Marie area. These rocks include the Fort Simpson and Horn River Formations. They are between 1,000 and 2,300 feet thick along the Jean-Marie seismic profile. The upper beds of the Fort Simpson Formation locally contain lenses of limestone, siltstone and sandstone, and are generally greenish in color.

This is in contrast with the typically dark grey, noncalcareous shales of the underlying Horn River Formation of Middle Devonian age. As shown on the accompanying geologic cross section, the Horn River shales are interpreted to be depositionally thinner over build-ups or reefs in the underlying carbonate rocks. The profile locally shows reflections from within the Fort Simpson Formation. These may represent lenses of limestone and sandstone developed within that unit.

STRUCTURE

The Jean-Marie Project lies in the Interior Plains structural province and is characterized by generally undisturbed beds which dip regionally south at approximately 30 feet per mile. The sedimentary succession has undergone only moderate deformation and the structural pattern reflects the relatively stable environment which has persisted since Precambrian time.

Several types of structural features are known or can be expected in the map area. These include:

(1) Pre-Devonian faults and associated topographic features on the eroded Precambrian surface.

(2) Post-Devonian folds and faults which presumably involve basement rocks.

(3) Compaction folds over irregularities such as basement hills and ridges or carbonate build-ups.

(4) Solution collapse structures.

The accompanying geologic cross section along the seismic survey illustrates interpreted examples of several of these types of structural features. Pre-Devonian faults and associated scarps are interpreted to underlie the margins of the carbonate bank shown between shotpoints 2258 and 2534; thus, the deposition of carbonates in the bank may have been initiated during minor Devonian movement along these faults.

Collapse structures resulting from solution of halite are anticipated in the Jean-Marie area. A solution collapse structure is interpreted on the accompanying cross section near shotpoint 1922 where the interval from the top of the Middle Devonian carbonate to the basal Paleozoic reflection is anomalously thin and the top of the Middle Devonian carbonate is structurally low. This feature is believed to be the result of post-Devonian solution of halite originally deposited in the red beds underlying the Chinchaga Formation.

Closely spaced, post-Devonian folds are indicated in the area west of shotpoint 1700 where the top of the Middle Devonian carbonate locally dispiays structural relief and is generally parallel to the underlying basal Paleozoic reflection. Some of these features may result in part from local variation of seismic velocity in near-surface sediments.

CONCLUSIONS

Middle Devonian rocks of the Jean-Marie project display a regional westerly thickening from Mills Lake to the Westerol 3A well. Carbonate build-ups including bioherms and banks are interpreted at several localities where a thickening of the Middle Devonian carbonate interval corresponds to a structural high on the top of the Middle Devonian carbonate. Thus, a bioherm is indicated at Feature 7 (shotpoint 2586), a carbonate bank is inferred between shotpoints 2258 and 2534 and a carbonate front is indicated in the area extending west from shotpoint 1888. These carbonate build-ups are regarded as reef growth on limestones of the Lonely Bay Formation. They may correlate with the Horn Plateau Formation, a late Middle Devonian reef exposed in the Interior Plains to the northeast. Carbonate build-ups interpreted in the Jean-Marie Project rise approximately 150 to 200 feet above the Lonely Bay Formation.

Structure of the Middle Devonian carbonate section is characterized by regional south dip in the order of 30 feet per mile. Thus, an up-dip or northward termination of the carbonate bank, or a northwestward extension to the carbonate front, would form an up-dip pinchout of possibly porous and permeable beds and a combination stratigraphic and structural trap. Also traps formed along folds and/or faults are anticipated in the Jean-Marie area. Accordingly, reservoir rocks and traps can be envisioned in carbonate build-ups and in structural closures in the Middle Devonian succession of the Jean-Marie area and the adjacent Interior Plains.

By: G. M. Collins, P. Geol.,
Manager.

J. F. Conrad,
Senior Geologist.

V. ZAY SMITH ASSOCIATES LTD.

SELECTED BIBLIOGRAPHY

BASSETT, H.G. and STOUT, J.G., (1967). "Devonian of Western Canada" in International Symposium on the Devonian System, Vol. 1, Alberta Society of Petroleum Geologists, pp. 717 - 752.

BELYEA, H.R., (1964). "Upper Devonian" in Geological History of Western Canada, Alberta Society of Petroleum Geologists, pp. 60 - 88.

BELYEA, H.R., (1968). "Facies Distribution and Reactivation of a Pre-Devonian Uplift, Southern District of Mackenzie", paper presented to Alberta Society of Petroleum Geologists, Luncheon Meeting, May 8, 1968. (Summary in OILWEEK, May 27, 1968, pp. 9 - 10).

BELYEA, H.R. and McLAREN, D.J., (1962). "Upper Devonian Formations, Southern Part of Northwest Territories, Northeastern British Columbia, and Northwestern Alberta", Geological Survey of Canada, Paper 61-29.

BELYEA, H.R. and NORRIS, A.W., (1962). "Middle Devonian and Older Paleozoic Formations of Southern District of Mackenzie and Adjacent Areas", Geological Survey of Canada, Paper 62-15.

DOUGLAS, R.J.W., (1959). "Great Slave and Trout River Map-Areas, Northwest Territories", Geological Survey of Canada Paper 58-11.

DOUGLAS, R.J.W. and NORRIS, D.K., (1960). "Horn River Map-Area, Northwest Territories and Yukon", Geological Survey of Canada, Paper 59-11.

GEOLOGICAL SURVEY OF CANADA, (1965). "Tectonic Map of the Canadian Shield", Map 4-1965.

GRAYSTON, L.D., SHERWIN, D.F. and ALLAN, J.F., (1964). "Middle Devonian", in Geological History of Western Canada, editors: R. G. McCrossan and R. P. Glaister, Alberta Society of Petroleum Geologists, pp. 49 - 59.

McCAMIS, J.G. and GRIFFITH, L.S., (1967). "Middle Devonian Facies Relationships, Zama Area, Alberta", Bulletin of Canadian Petroleum Geology, Vol. 15, No. 4, pp. 434 - 467. Bulletin American Association of Petroleum Geologists, Vol. 52, No. 10, (October, 1968) pp. 1899 - 1924.

NORRIS, A.W., (1965). "Stratigraphy of Middle Devonian and Older Paleozoic Rocks of the Great Slave Lake Region, Northwest Territories", Geological Survey of Canada, Memoir 322.

PART IV

SUMMARY OF CONCLUSIONS

Page

PART IV

SUMMARY OF CONCLUSIONS

Combined geophysical and geological surveys - specifically, reflection seismic and subsurface geologic surveys - are effective in investigating and solving basic geologic problems in the Jean-Marie Project.

Carbonate build-ups and structural features including a Middle Devonian carbonate front, a carbonate bank, a bioherm, folds, faults and a solution collapse structure are interpreted from the seismic data.

The geophysical and geological survey indicates that reflection seismic exploration is effective in mapping structure of Paleozoic beds and defining carbonate build-ups and fronts in Middle Devonian strata. These and similar features anticipated in the adjacent Interior Plains are possible oil and gas traps. The use of digital seismic instruments with binary gain recording aids considerably in obtaining shallow record information.

Respectfully submitted,

C. I. Klipfel

C. I. Klipfel, B.S., P. Geoph.,
Manager, Evaluation Department

PALLISTER and ASSOCIATES

G. M. Collins

G. M. Collins, P. Geol.,
Manager.

V. ZAY SMITH ASSOCIATES LTD.

INDEX MAP

BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP A

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN
CARBONATE
Seismic Time

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
C. I. KLIPFEL B. S., P. Geoph.
J. A. COFFEEN P. Geoph.

MAP NO. 1.

LEGEND

△ SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM
N. T. S. MAPS

ISLAND NAMES TAKEN FROM
PUBLIC WORKS OF CANADA
PUBLICATION SHOWING CHANNEL
AND MARKERS TO SEPT. 1967

- C.U.T.M. GRID CO-ORDINATES
IN FEET.

▪ BENCH MARKS – WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

1 OF 2

INDEX MAP

BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP A

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE

Seismic Time

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT /SEC.

Interpretation By:

C. I. KLIPPEL B. S., P. Geoph.

J. A. COFFEEN P. Geoph.

MAP NO. 1.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N. T. S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

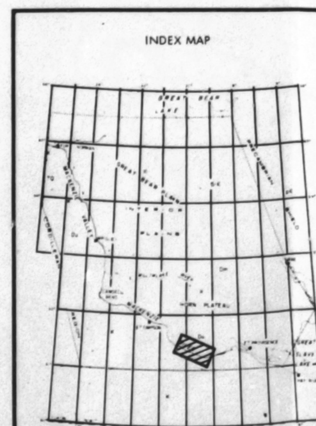
=C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS – WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

(2 of 2

INDEX MAP



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP B

PROFESSIONAL GEOPHYSICIST C. I. KLIPFEL ALBERTA

SCALE 1:50,000

1 0 1 2 3 Miles 4

1000 0 1000 2000 3000 4000 5 Meters 6

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN
CARBONATE
Seismic Time

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:

C. I. KLIPFEL B.S., P. Geoph.
J. A. COFFEEN P. Geoph.

MAP NO. 1.

LEGEND

SS10 - SHORE STATION TEN

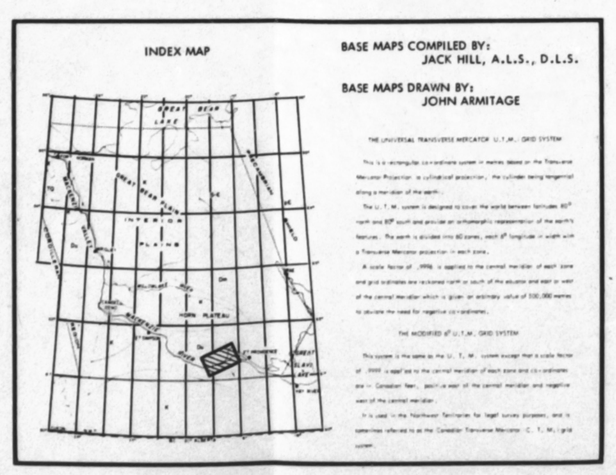
TOPOGRAPHY TAKEN FROM N. T. S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 196

C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS – WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN
CARBONATE
Seismic Time

CONTOUR INTERVAL 10 ms

DATUM ELEVATION | DATUM VELOCITY FT /SEC.

Interpretation By:
C. I. KLIPPEL B.S., P. Geoph.
J.A. COFFEEN P. Geoph.

MAP NO. 1.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

17,630 = C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS — WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

THIS COPYRIGHTED MAP, FILM AND/OR PRINT OF FILM IS DELIVERED BY PALLISTER AND ASSOCIATES, AS LICENSOR, TO ____________

AS LICENSEE, EXPRESSLY SUBJECT TO THE TERMS AND CONDITIONS AS OUTLINED IN THE SECRECY CLAUSE, MEMORANDUM OF AGREEMENT, CONTRACT NO. 802 ____________

INDEX MAP

BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA — C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
C.I. KLIPPEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 2.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT., 1967

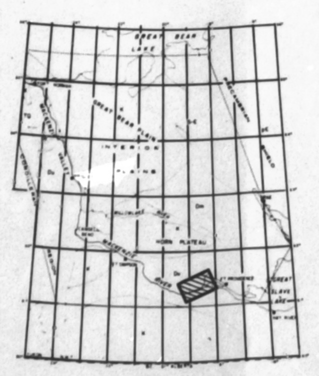
[illegible] = C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS - WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

1 OF 2

INDEX MAP



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPFEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO
BASAL PALEOZOIC
Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
C. I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 2.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N. T. S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

= C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS - WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

2 of 2

PART V

APPENDIX

PART V

APPENDIX

SEISMIC FIELD PARAMETERS

RECORDING

Amplifiers	-	SIE PT-800 digital binary gain
Recorder	-	SIE PDR-89/MU-80
Sampling Interval	-	0.001 second
Final Gain	-	15 (90 db)
Release Rate	-	0.030 seconds
Filters	-	16 c.p.s. low cut 125 c.p.s. high cut alias
Tape Format	-	9 track SEG-A format
Record Length	-	0.003 seconds
Cable	-	Marsh - flotation
Hydrophones	-	Crystal pressure sensitive, Hall Sears MP-8
Energy Source	-	Dynamite

Direct playback made for every recording

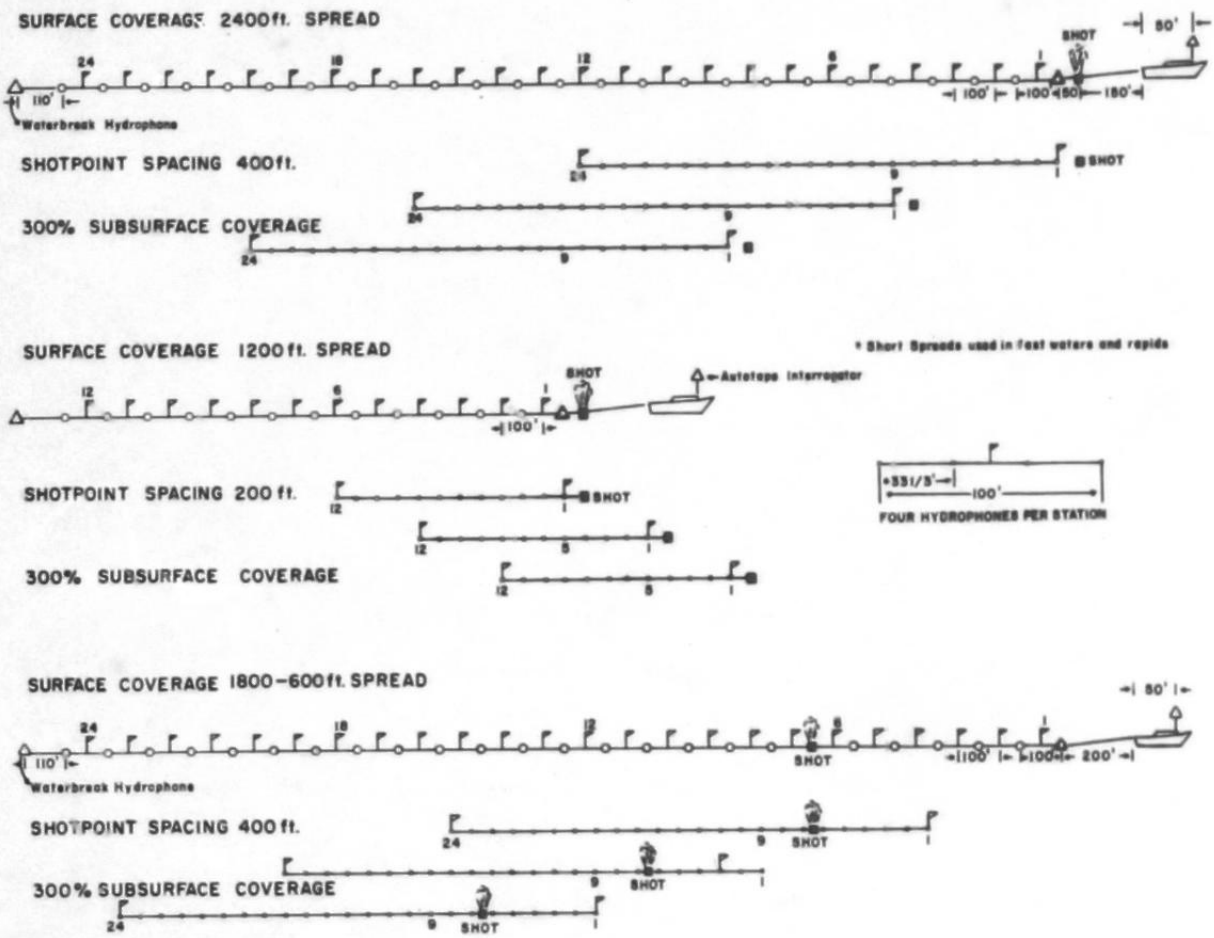
SPREAD DIAGRAMS

- a 300% subsurface coverage was obtained using a standard streamer of 2400 feet with a shot located every 400 feet.

- shotpoints 2803 - 2812 were recorded using an asymmetrical spread of 1800 - 600 feet, but this type spread could not be used due to the fast water conditions of the river.

- four hydrophones were used for each station, with water break phones installed at the first hydrophone and on the end of the streamer.

- the recording technique diagrams illustrate the types of spreads used (see Plate 1).



HUNTEC LTD., PETROLEUM GEOPHYSICS DIVISION

SEISMIC MARINE - RECORDING TECHNIQUE

PLATE I

FIELD TESTS

Daily: Initial low cut and high cut alias filters

- early gain setting 1 - 10
- final gain setting 15
- monitor checked against playback
- oscillator tests every 4 to 5 hours
- every fifth reel, head skew checked by recording last 200 feet, all 1's
- at beginning of each project, systems noise test

SURVEYING

Method	-	Cubic Autotape DM-40 electronic positioning
Equipment	-	1 interrogator 2 responders 1 omnidirectional antenna
Technique	-	The Autotape employs microwaves to establish ranges to fixed or moving locations along the radio line-of-sight. The system measures the slope distance between two or more responders and visually displays the range in five metric digits.

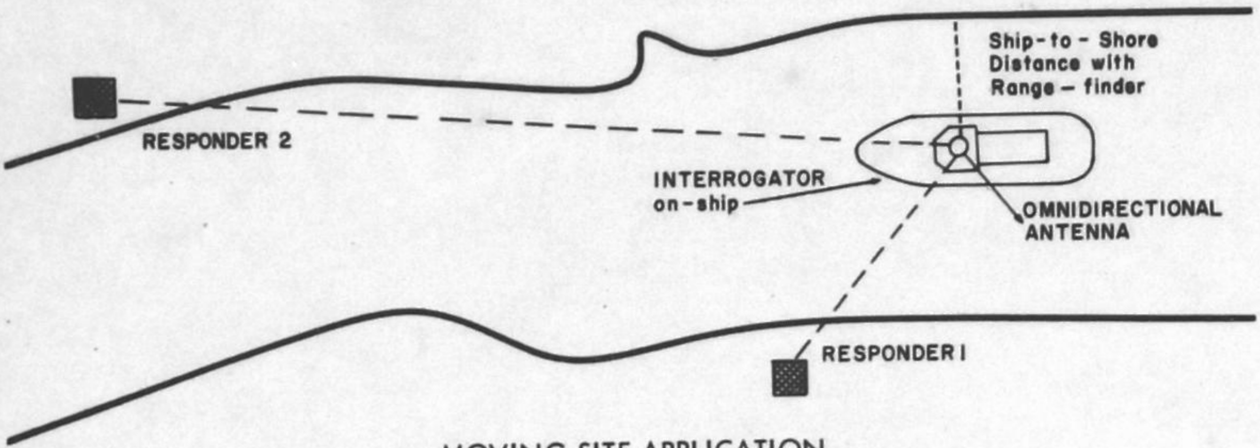
One interrogator and two shore-based responders (beaming into an omnidirectional antenna) were used.

The interrogator provides visual read-out of two ranges simultaneously. A digital read-out of distances is obtained, with the shot location being marked numerically and by double spacing on the paper tape read-out (Plate 2).

Air photos were used to locate the shore stations which were then marked on navigator's and survey maps. The stations were moved on the riverbanks or islands whenever necessary to be in line-of-sight.

CUBIC AUTOTAPE DM-40

ELECTRONIC POSITIONING SYSTEM



MOVING SITE APPLICATION

SAMPLE DIGITAL READ-OUT

RESPONDER 1	RESPONDER 2	
1 6 6 6 2	7 0 5 3 3	VISUAL READ-OUT USED BEYOND LOCATION,
1 6 6 4 5	7 0 5 0 6	DIGITAL UNIT SWITCHED ON UNTIL SP SHOT,
1 6 6 4 0	7 0 4 9 7	AND BEHIND AS ADDITIONAL DISTANCE AND
1 6 6 0 9	7 0 4 9 3	SYSTEM CHECK.
1 6 5 9 9	7 0 4 8 7	
1 6 5 9 5	7 0 4 7 2	
001382		LOCATION
1 6 5 8 8	7 0 4 5 5	
1 6 5 6 6	7 0 4 6 5	DRIFTING BACK ON LOCATION
1 6 5 4 2	7 0 4 4 5	
1 6 5 3 4	7 0 4 3 6	
1 6 5 3 1	7 0 4 2 6	
1 6 5 0 9	7 0 4 1 4	BOAT DISTANCE BEYOND SP LOCATION

READ-OUT IN METERS

RESPONDER
I

RESPONDER
2

In operation, the navigator advises the pilot of his position. The charge is dropped beyond the shot location, engines shut down and the boat allowed to drift back onto location, while the streamer drops below the surface (4 feet). The charge is detonated, power applied and the boat repeats the procedure. With good conditions, a location was shot every three minutes.

In addition to the DM-40 system, side-bearings were taken with a range finder (1000-yard range).

PERSONNEL AND EQUIPMENT

A minimum staff of 17 was required to operate the river program. The crew consisted of:

- Party Manager
- Operator
- Assistant Operator
- Shooter
- Shooter's Assistants (3)
- Navigator
- Small craft pilots and deck hands (3)
- River Pilot
- Mechanic
- Clerk Computer
- Cook
- Survey Assistants (2)

River Boats

	Approximate Length	Approximate Beam
MV/Tiliruk	70	20
MV/Wild Goose	30	10
MV/Pilot II	40	12

The Tiliruk, a wooden river boat, was utilized for recording and living quarters. The Wild Goose was tied alongside the Tiliruk and served as auxiliary power and towed the streamer.

Two river-scows, flat-bottomed and wide-beamed, were used to move the Autotape responders to their locations, and for ship-to-supply aircraft and ship-to-shore transportation.

The Pilot II, was used to increase the Tiliruk's progress in fast waters and rapids.

GENERAL STATISTICS

Commencement Date	-	August 9, 1968
Completion Date	-	August 16, 1968
Miles Shot	-	109.1
Miles Per Day	-	13.6
Shotpoints	-	1,460
Shotpoints Per Day	-	183
Total Hours	-	99.5
Dynamite Used	-	18,647 pounds
Average Charge	-	12 pounds
Boosters Used	-	1,481
Caps Used	-	1,482
Weather Days	-	NIL

Weather and river conditions in the Jean-Marie area were good and fair, respectively.

CONCLUSIONS AND RECOMMENDATIONS

Due to the effect of fast waters, rapids and the naturally erratic course of the Mackenzie River on a long streamer, the use of a shorter spread, either uni-directional or asymmetrical, is recommended to increase the effectiveness of recording common subsurface points.

River crafts with greater horsepower will be used in the future, for faster recording and ease of navigating the extremely fast waters of the Mackenzie, and possibly its tributaries.

Generally, the data obtained were fair, with poor to NR recordings in severe rapids.

By: J. C. Pelletier,
Geophysicist.

PALLISTER and ASSOCIATES

SEISMIC DATA PROCESSING

PRELIMINARY TESTS

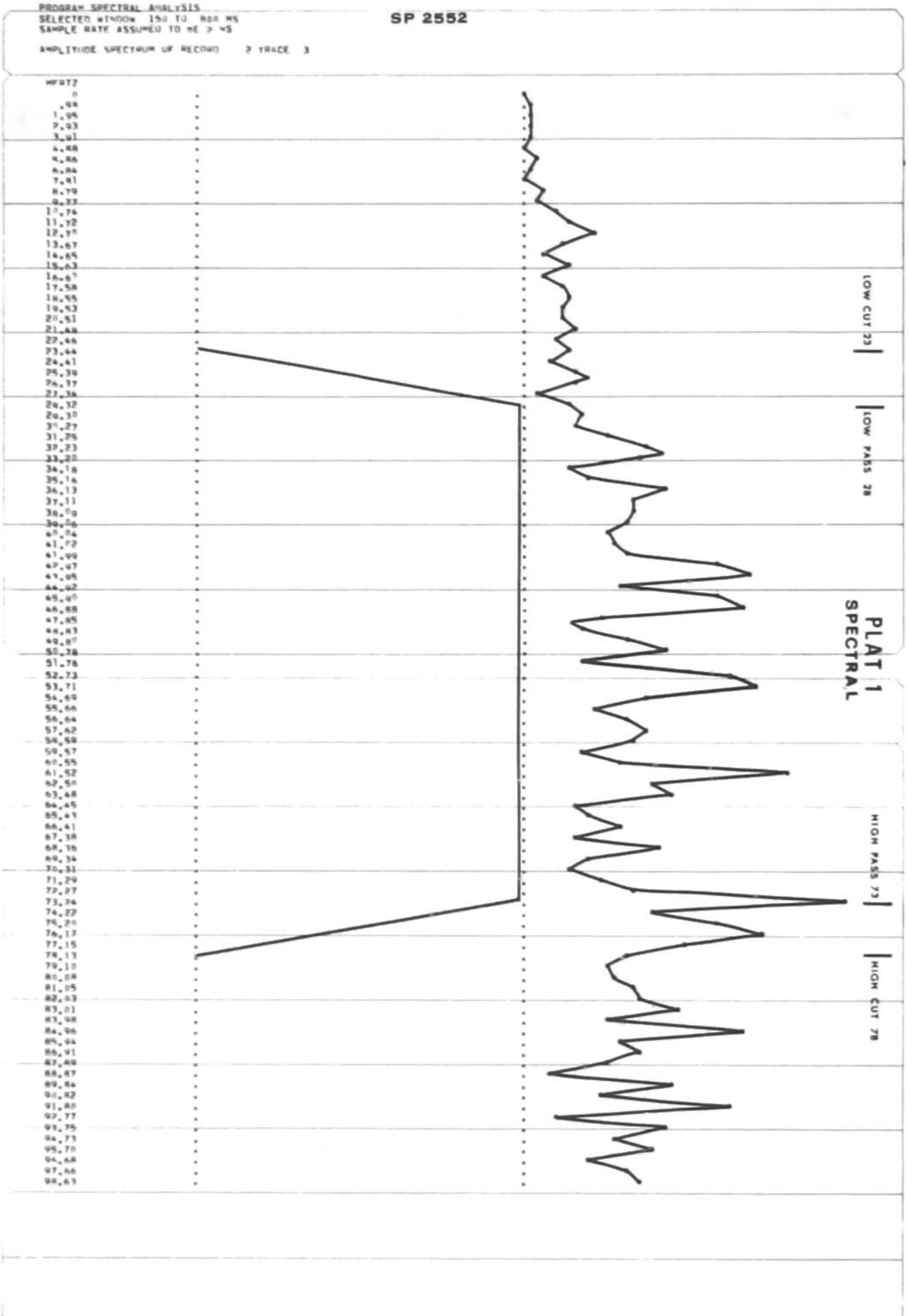
(a) Spectral Analysis and Autocorrelation -

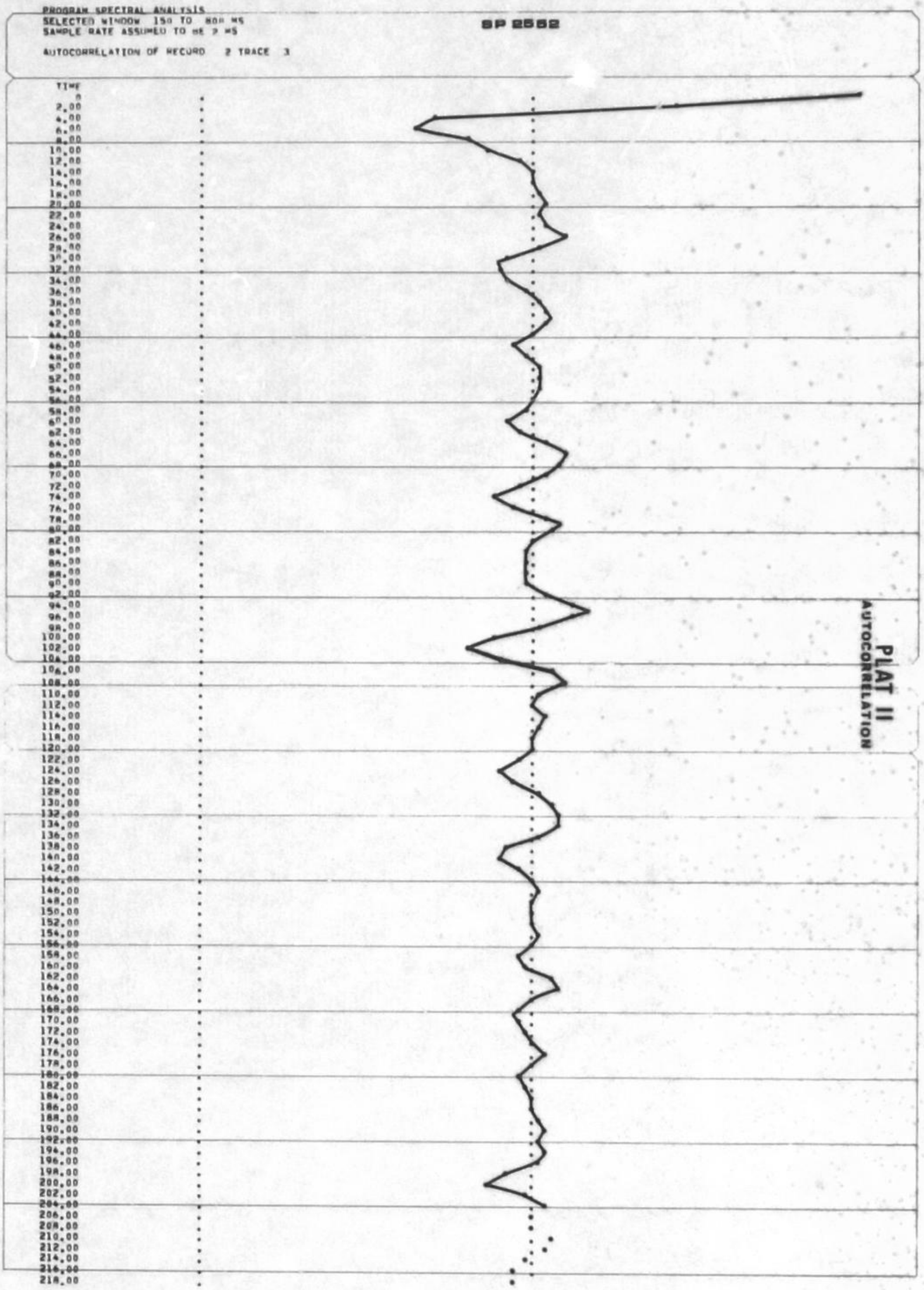
an analytic program which displays the autocorrelation and power density curve from a selected window of a designated trace. The amplitude spectra output from the program are utilized in the development of bandpass operators. Spectrals were processed for shotpoints 1957 and 2522. Representative of these spectrals is shotpoint 2552, Plat I, Page 35 and Plat II, Page 36.

(b) Bandpass Display -

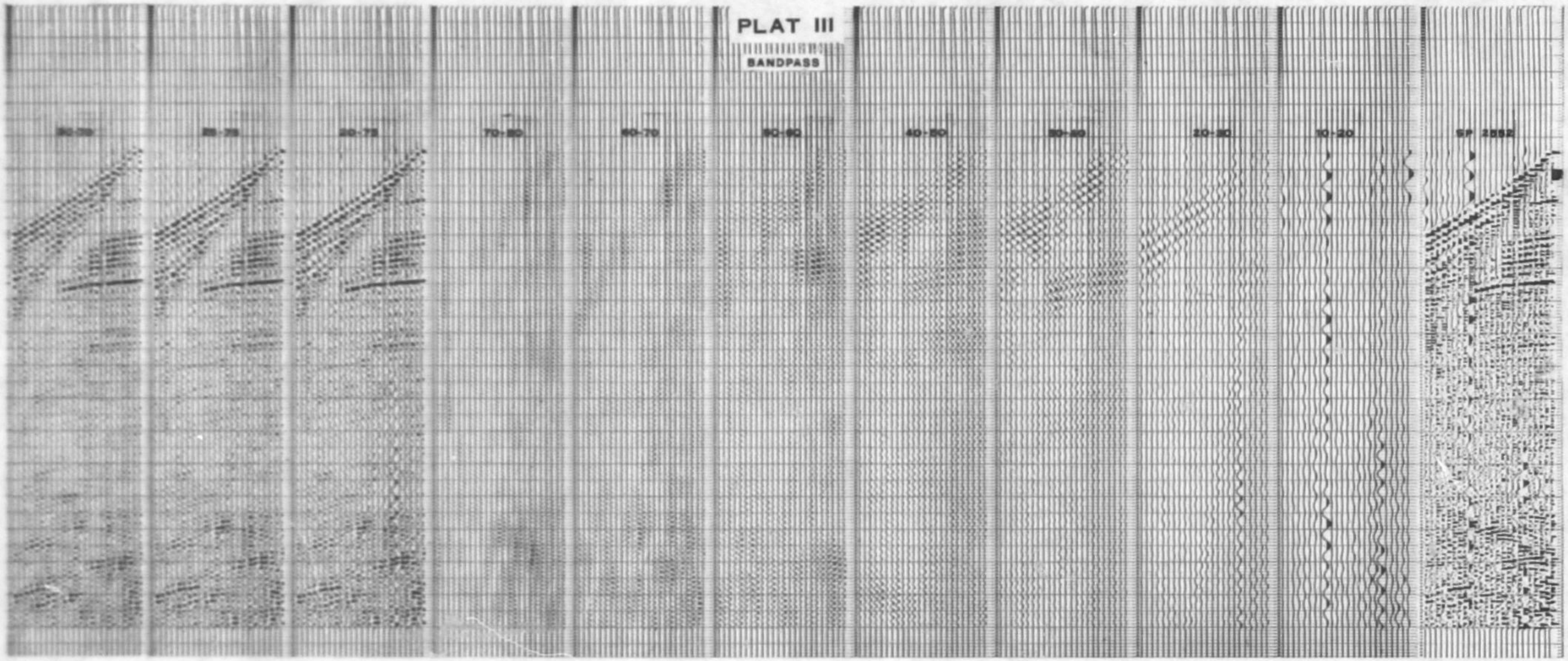
enables the determination of the relative amount of energy within a specified series of frequency ranges or bandpass filters on seismic records.

Output records are scaled to the same relative amplitudes to allow comparison of frequency contents from record to record. Shotpoints 1957 and 2522 were selected for the Jean-Marie Project. A display of shotpoint 2552 is shown on Plat III, Page 37.


PROGRAM SPECTRAL ANALYSIS
SELECTED WINDOW 150 TO 800 MS
SAMPLE RATE ASSUMED TO BE 2 MS
SP 2552
AMPLITUDE SPECTRUM OF RECORD 2 TRACE 3
HERTZ
LOW CUT 23
LOW PASS 28
PLAT 1
SPECTRAL
HIGH PASS 73
HIGH CUT 78



PLAT II
AUTOCORRELATION


PLAT III
BANDPASS
20-75
70-80
60-70
50-60
40-50
30-40
20-30
10-20
SP 2552

PROCESSING

1. (a) Tapescan

This program has been designed to do a preliminary edit on multiplexed digital seismic tapes to determine the reel contents and their validity.

(b) Demultiplex

The demultiplex program converts multiplexed seismic records to sequential digital tapes.

A number of options are included to allow muting, decimation or truncation of a record.

(c) Binary gain normalization

Normalizes the amplitudes of all traces on a seismic record.

2. (a) Record reformat

This program reformats or changes the sequence of individual traces and/or records from several sequential reels onto one reel.

(b) Re-sample

This program rewrites a sequential digital seismic tape in a sample rate differing from the original sampling.

3. (a) NMO removal

Final records were used to determine normal moveout curves which would best fit the data and still allow for dipping formations to be corrected without manipulation, Plat IV, Page 39.

The preliminary curves were validated by checking the velocity information obtained against available wells, Plat V, Page 40.

Problems involved in NMO removal were mainly caused by low-velocity front end noise which, in parts of the area, tended to interfere with clear definition of seismic events.

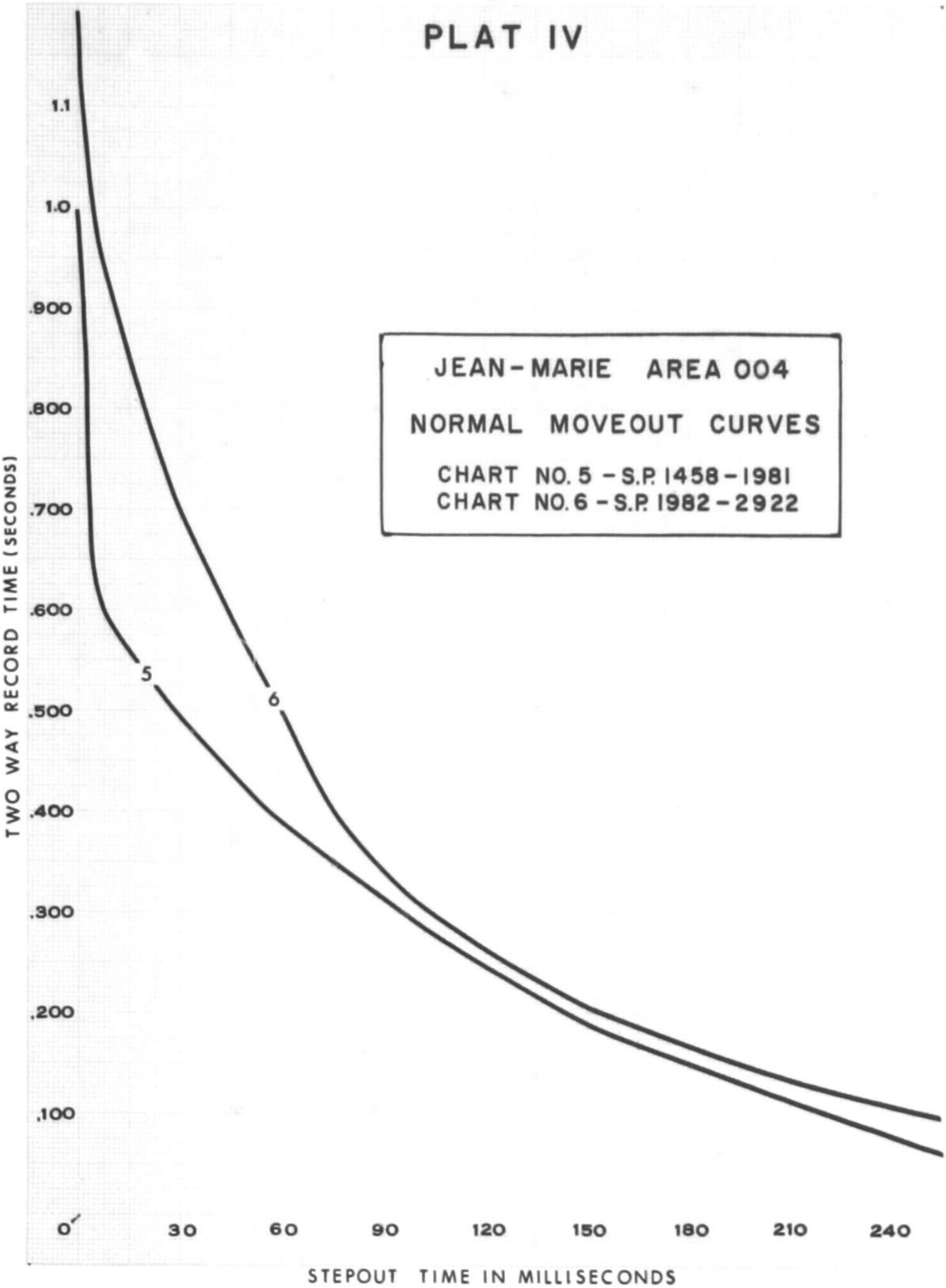
(b) Fastband

A bandpass filter program based on the Fourier time-to-frequency transform method.

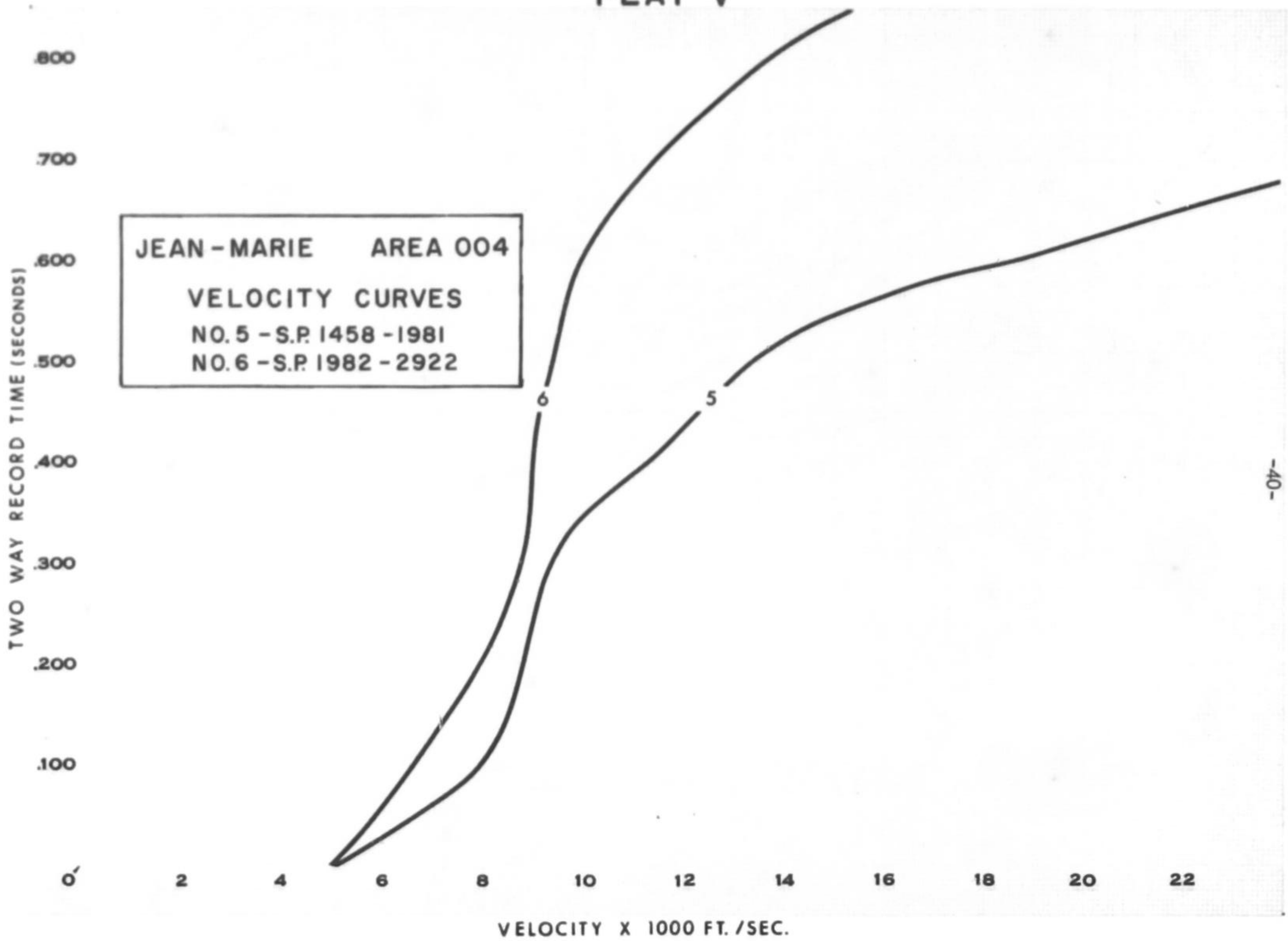
(c) Multiplex out

Converts sequential 7-track digital tapes to the multiplex format prior to displaying any seismic data on drywrites, wetwrites or films.

PLAT IV


JEAN-MARIE AREA 004
NORMAL MOVEOUT CURVES
CHART NO. 5 - S.P. 1458 - 1981
CHART NO. 6 - S.P. 1982 - 2922
TWO WAY RECORD TIME (SECONDS)
1.1
1.0
.900
.800
.700
.600
.500
.400
.300
.200
.100
0
30
60
90
120
150
180
210
240
5
6
STEPOUT TIME IN MILLISECONDS

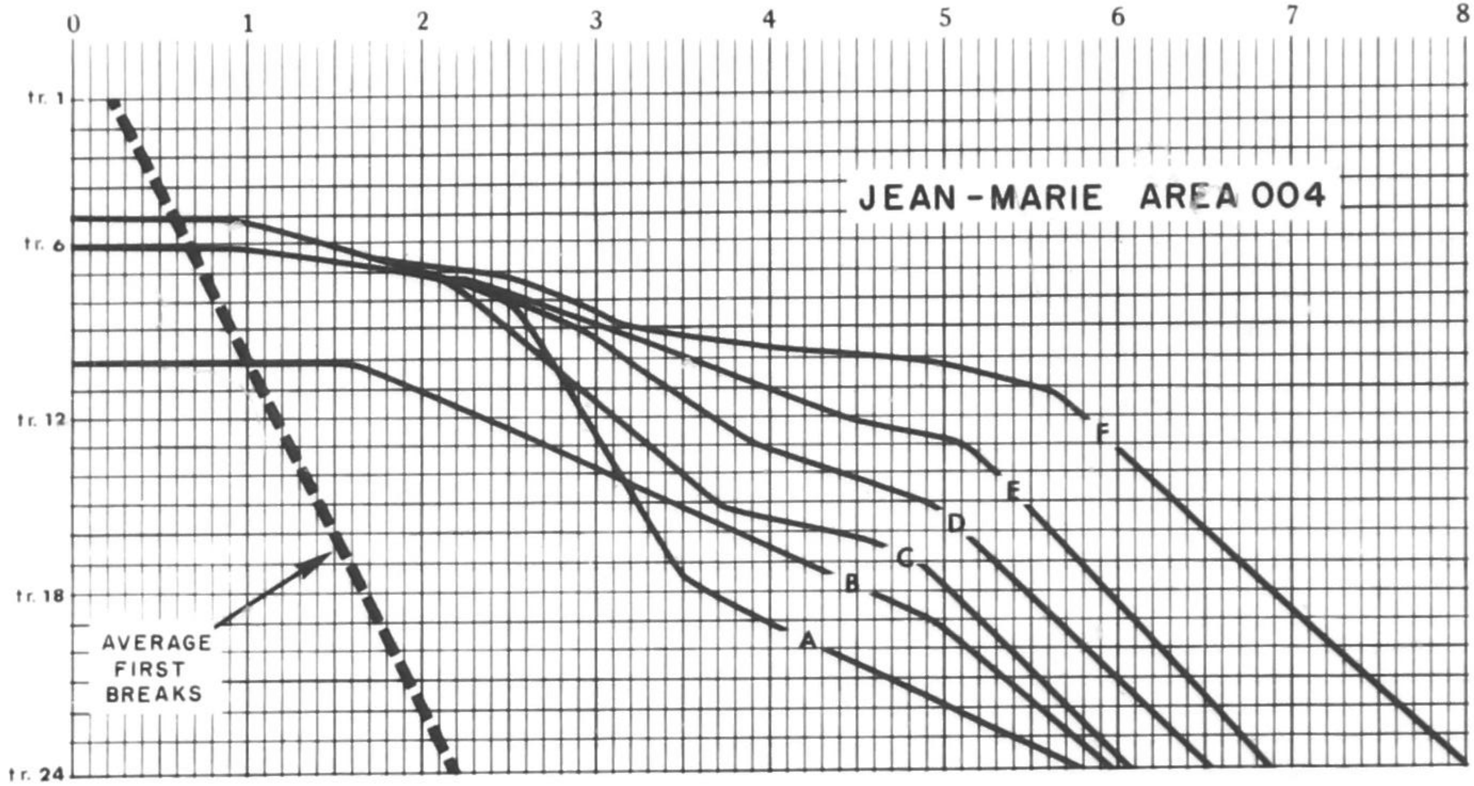
PLAT V



JEAN-MARIE AREA 004
VELOCITY CURVES
NO. 5 - S.P. 1458 - 1981
NO. 6 - S.P. 1982 - 2922
6
5
TWO WAY RECORD TIME (SECONDS)
.800
.700
.600
.500
.400
.300
.200
.100
0
2
4
6
8
10
12
14
16
18
20
22
VELOCITY X 1000 FT. /SEC.

PLAT VI

SEQUENTIAL MUTE PATTERNS



4. (a) Smoothing statics

Were derived by correlation of common subsurface points plotted in time and proper position.

(b) Sequential mute

Was used to increase front end muting on the seismic records according to variable patterns. These patterns have been coded in letters A to F, which appear on the final sections, see Plat VI, Page 41. Input and output are in CDP standard sequential tape format.

5. (a) Trace gather

Reformats sequential seismic tapes to facilitate preparation for stacking.

(b) Stack

The program processes the output from the trace gather program. A stacked trace is produced by summing all the traces representing a common-depth-point. Traces which have been muted are compensated for in order to normalize the amplitude relationship on the output trace.

ADDITIONAL PROCESSING

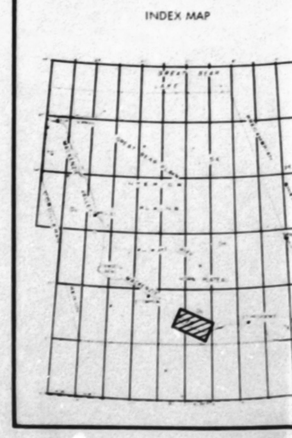
(a) 100% test sections were made covering shotpoints 1588 - 1602 and 1648 - 1681 inclusive in an attempt to improve recovery of reflections. No significant improvement was noted.

(b) A power average was used across shotpoints 1925 - 1966 and 2574 - 2594 to improve recovery and gain a clearer definition of primary events. The results were fair to good.

(c) A condensed section was made using one trace to represent each shotpoint - trace No. 2, for all end-on spreads and trace No. 5 where the few asymmetrical spreads were shot.

By: R. J. Labun,
Geophysical Technologist.

PALLISTER and ASSOCIATES



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN-MARIE
MAP B

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

Interpretation By:
C.I. KLIPPEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

PROFESSIONAL GEOPHYSICIST ALBERTA C. KLIPPEL

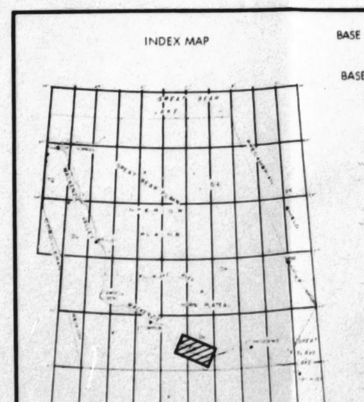
MAP NO. 2.

BENCH MARKS - WATER LEVEL

NOTE: SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

1 of 2

INDEX MAP



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP B

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO
BASAL PALEOZOIC
Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION DATUM VELOCITY FT./SEC.

Interpretation By:
C.I. KLIPPEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 2.

LEGEND

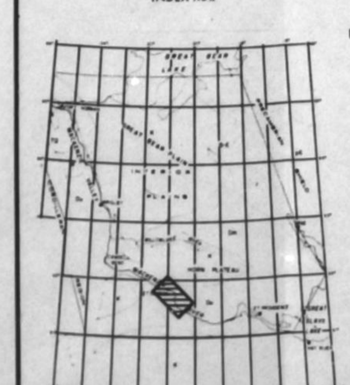
TOPOGRAPHY TAKEN FROM N.T.S. MAPS

BENCH MARKS - WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

2 of 2

INDEX MAP



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE MAP A

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA — C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:

C.I. KLIPPEL B.S., P.Geoph.

J.A. COFFEEN P. Geoph.

MAP NO. 2.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

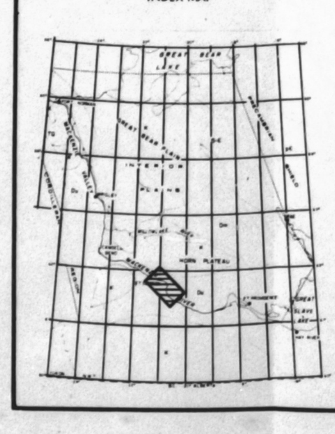
= C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS – WATER LEVEL

NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

1 OF 2

INDEX MAP



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP A

SCALE 1:50,000

1 0 1 2 3 Miles 4

1000 0 1000 2000 3000 4000 5 Meters 6

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PROFESSIONAL GEOPHYSICIST ALBERTA
C. I. KLIPPEL

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

Seismic Time Interval

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:

C.I. KLIPPEL B.S., P.Geoph.

J.A.COFFEEN P. Geoph.

MAP NO. 2.

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

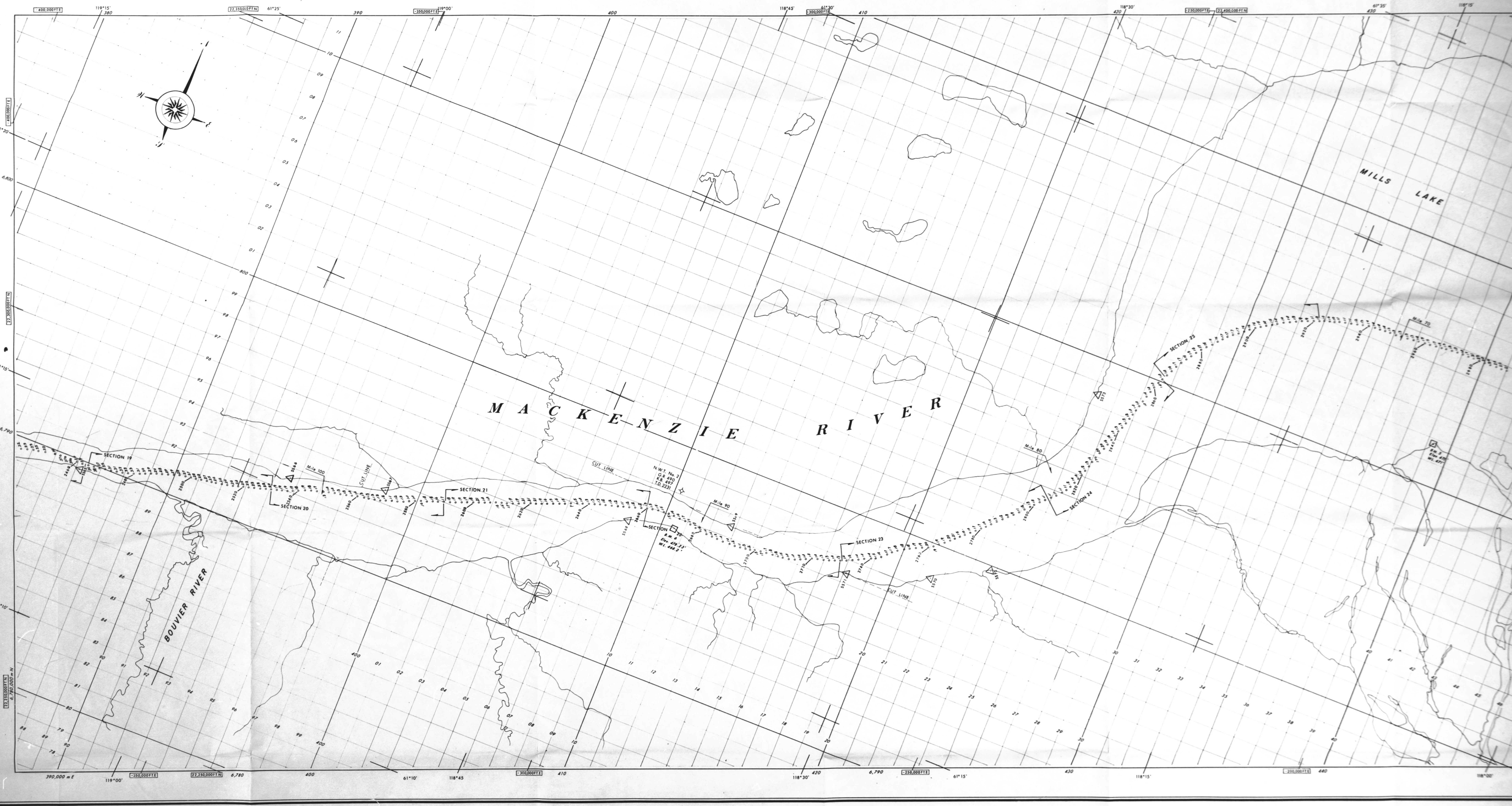
ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

- C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS – WATER LEVEL

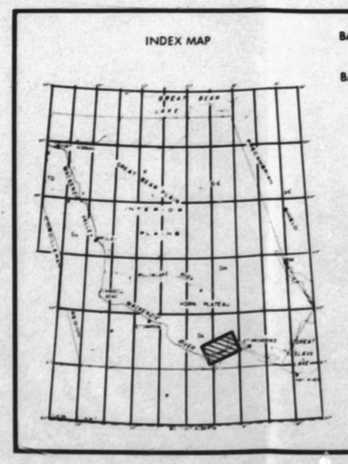
NOTE:- SEE PART II OF REPORT FOR TIME-DEPTH CONVERSION.

2 of 2



THIS COPYRIGHTED MAP, AND/OR PRINT OF FILM IS [illegible] BY PALLISTER AND ASSOCIATES, [illegible]OR, TO ____________ AS LICENSEE, EXPRESS[illegible] SUBJECT TO THE TERMS AND CONDITIONS AS OUTLINED IN THE SECRECY CLAUSE, MEMORANDUM OF AGREEMENT, CONTRACT NO. 802 ____________

INDEX MAP



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP C

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

SHOTPOINT LOCATION and WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:

C.I. KLIPFEL B.S., P.Geoph.

J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

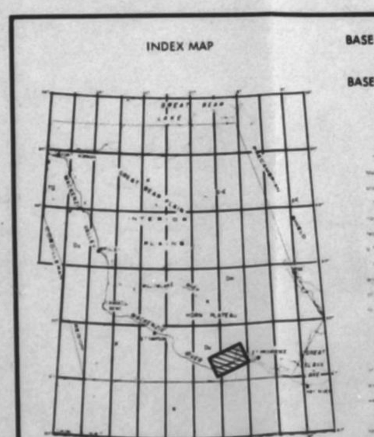
ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

= C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS – WATER LEVEL

1 OF 2

INDEX MAP



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP C

SCALE 1:50,000

1 0 1 2 3 Miles 4

1000 0 1000 2000 3000 4000 5 Meters 6

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

SHOTPOINT LOCATION and WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
C.I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

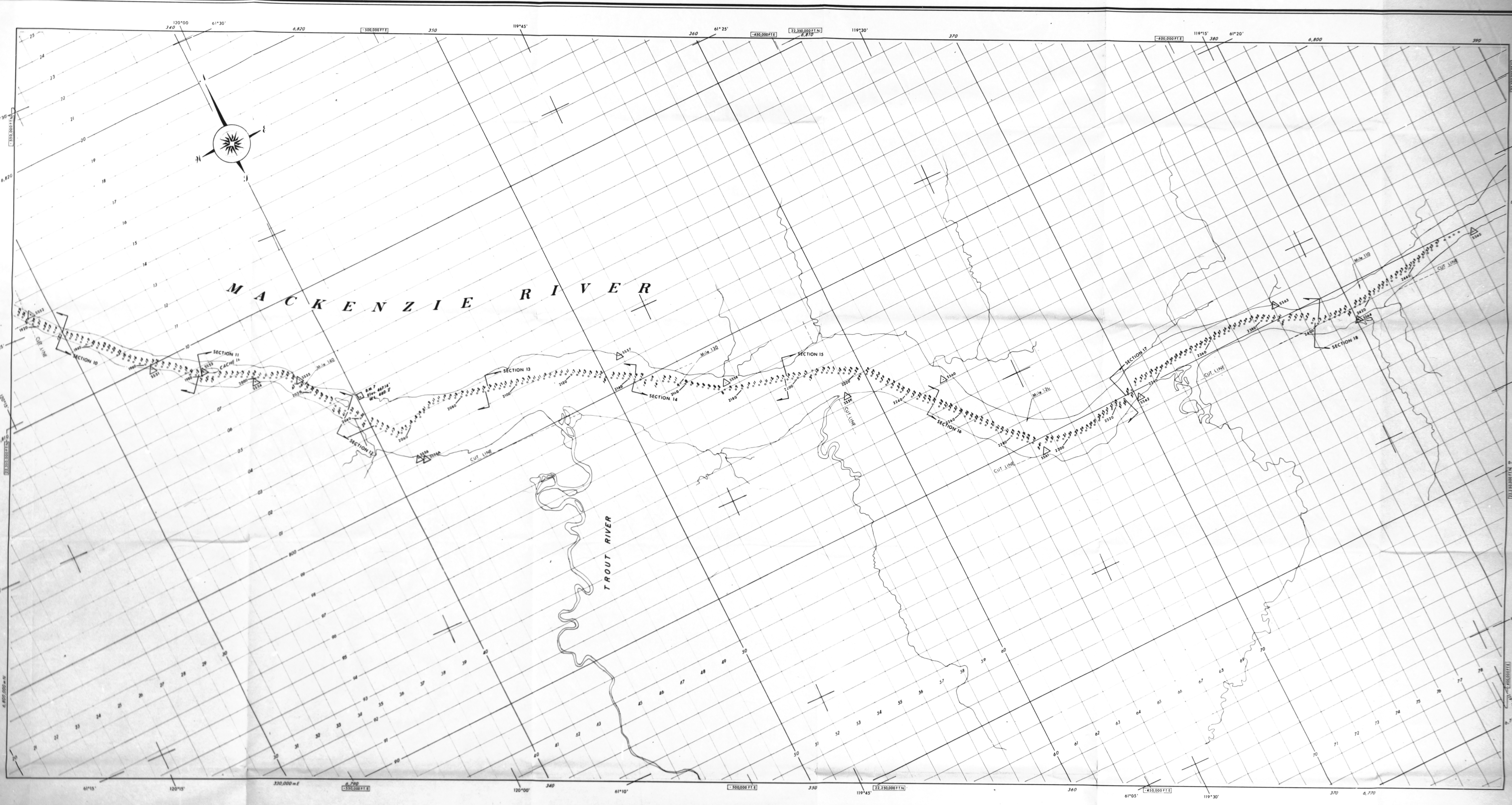
TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

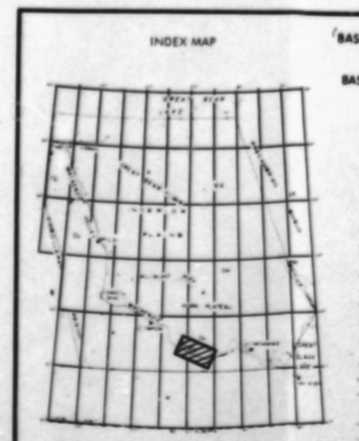
17650 = C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS — WATER LEVEL

2 of 2



THIS COPYRIGHTED MAP, FILM AND/OR PRINT OF FILM IS DELIVERED BY PALLISTER AND ASSOCIATES, AS LICENSOR, TO ______________ AS LICENSEE, EXPRESSLY SUBJECT TO THE TERMS AND CONDITIONS AS OUTLINED IN THE SECRECY CLAUSE, MEMORANDUM OF AGREEMENT, CONTRACT NO. 802 ______________



BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP B

SCALE 1:50,000

1 0 1 2 3 Miles 4

1000 0 1000 2000 3000 4000 5 Meters 6

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

J. Jay Smith

SHOTPOINT LOCATION and
WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT /SEC.

Interpretation By:
C.I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS — WATER LEVEL

1 OF 2

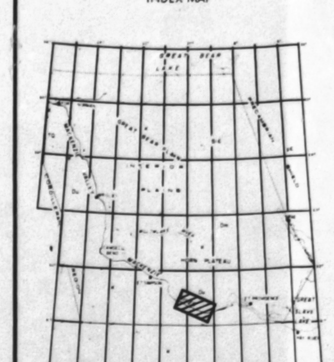
THIS COPYRIGHTED MAP, FILM AND/OR PRINT OF FILM IS DELIVERED BY PALLISTER AND ASSOCIATES, AS LICENSOR,

TO ______________________

AS LICENSEE, EXPRESSLY SUBJECT TO THE TERMS AND CONDITIONS AS OUTLINED IN THE SECRECY CLAUSE, MEMORANDUM OF AGREEMENT,

CONTRACT NO. 802 ______________

INDEX MAP



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP B

SCALE 1:50,000

1 0 1 2 3 Miles 4

1000 0 1000 2000 3000 4000 5 Meters 6

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

J. Jay Smith

SHOTPOINT LOCATION and WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION DATUM VELOCITY FT /SEC.

Interpretation By:
C.I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

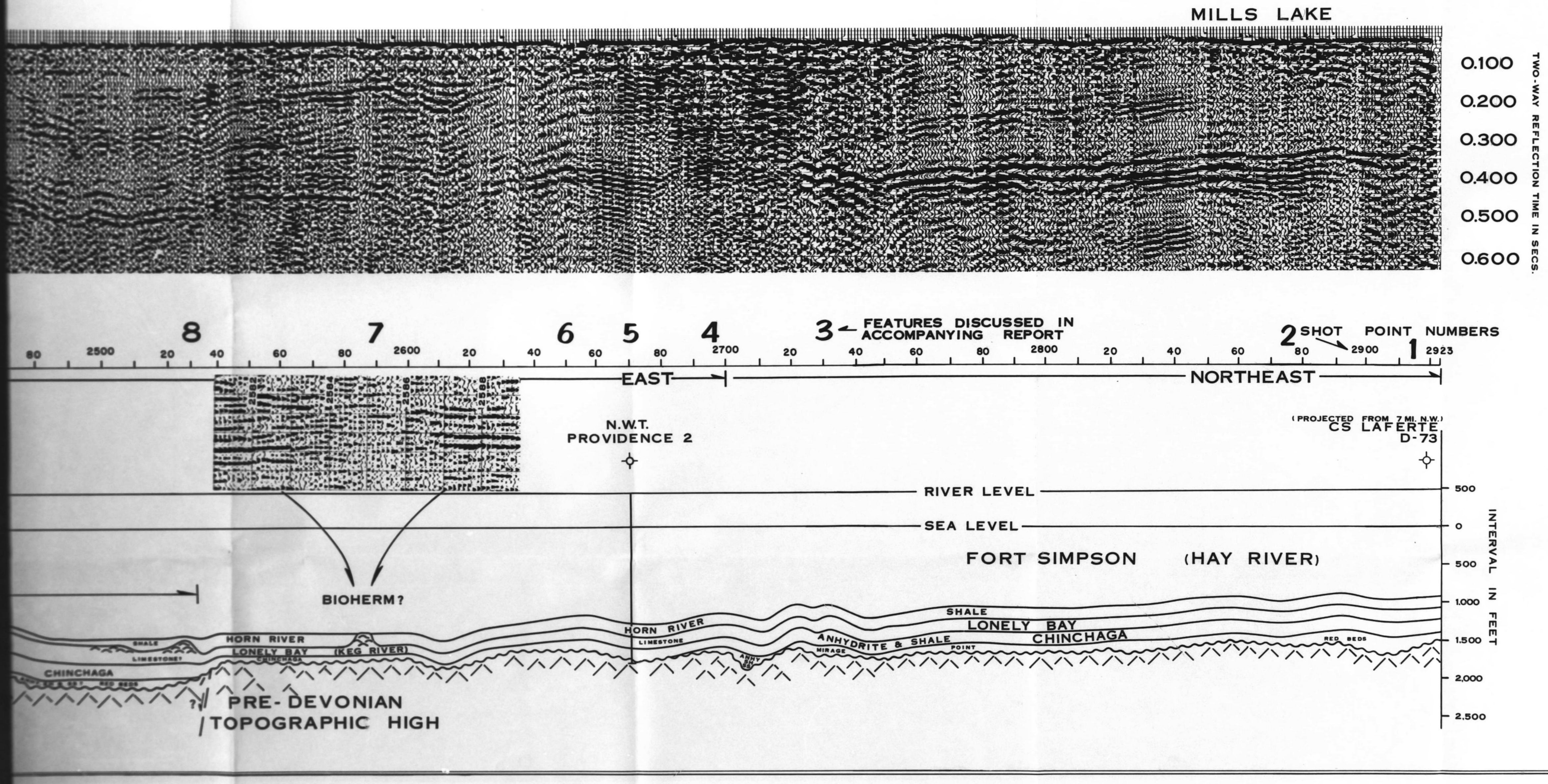
C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS — WATER LEVEL

2 of 2


TWO-WAY REFLECTION TIME IN SECS.
0.100
0.200
0.300
0.400
0.500
0.600
29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13
1440 60 80 1500 20 40 60 80 1600 20 40 60 80 1700 20 40 60 80 1800 20 40 60 80 1900 20 40 60 80 2000 20 40 60 80 2100
SOUTH
Closely spaced, post-Devonian folds are indicated in the area west of shotpoint 1700 where the top of the Middle Devonian carbonate locally displays structural relief and is generally parallel to the underlying basal Paleozoic reflection. Some of these features may result in part from local variation of seismic velocity in near-surface sediments.
WESTEROL 3-A
WESTEROL 7-A
BA-HB JEAN MARIE CR. 1
(PROJECTED FROM 3.5 MI. S.W.)
CAN. SUP. JEAN MARIE B-48
INTERVAL IN FEET
500
0
500
1,000
1,500
2,000
2,500
RIVER LEVEL
SEA LEVEL
FORT SIMPSON SHALE
CARBONATE FRONT ?
? SOLUTION (SALT) COLLAPSE ?
HORN RIVER SHALE
LIMESTONE DOLOMITE
LONELY BAY
ANHYDRITE
ANHYDRITE, SALT & SHALE
RED BEDS
HALITE
HORN RIVER SHALE
LONELY BAY
CHINCHAGA
ANHYDRITE ?
LIMESTONE DOLOMITE
DOLOMITE
ANHYDRITE ?
LONELY BAY
(KEG RIVER)
RIVER AND DOLOMITE
LIMESTONE
HORN RIVER
CHINCHAGA
RED BEDS
?EVAP. SH. SS.?
?EVAP. SHALE & SAND?
(MIRAGE POINT)
RED BEDS
SHALE
PRECAMBRIAN
1 of

Top of Middle Devonian Carbonate
Basal Paleozoic
7.5 MILES
14
13
12
11
10
9
8
7
6
5
4
80
2000
20
40
60
80
2100
20
40
60
80
2200
20
40
60
80
2300
20
40
60
80
2400
20
40
60
80
2500
20
40
60
80
2600
20
40
60
80
2700
SOUTHEAST
EAST
The top of the Middle Devonian carbonate and the top of basement on the Geologic cross section are positioned from seismic data. They correspond to the two colored reflections shown on the seismic profile.
2582
2584
2586
2588
N.W.T. PROVIDENCE 2
FORT SIMPSON SHALE
? CARBONATE BANK ?
BIOHERM ?
HORN RIVER
LIMESTONE
LONELY BAY LIMESTONE & DOLOMITE ?
SHALE
LONELY BAY
(KEG RIVER)
CHINCHAGA
? ANHYDRITE AND SHALE ?
LIMESTONE ?
? ANHYDRITE & SHALE ?
RED BEDS
PRECAMBRIAN
PRE-DEVONIAN TOPOGRAPHIC HIGH
RIVER



PALLISTER and ASSOCIATES

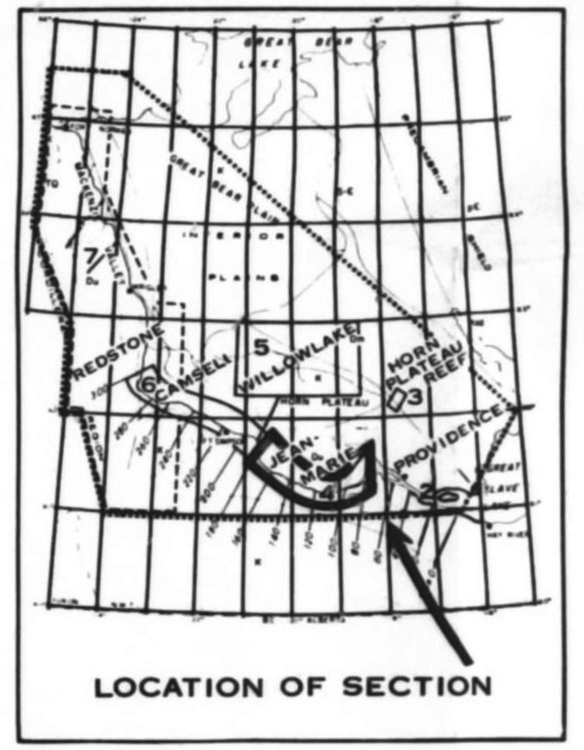
V. Gary Smith

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

PROJECT FOUR
JEAN - MARIE

CONDENSED SEISMIC PROFILE AND GEOLOGIC CROSS SECTION
ALONG THE CHANNEL OF THE MACKENZIE RIVER
FROM MILLS LAKE TO WESTEROL 3-A



LOCATION OF SECTION

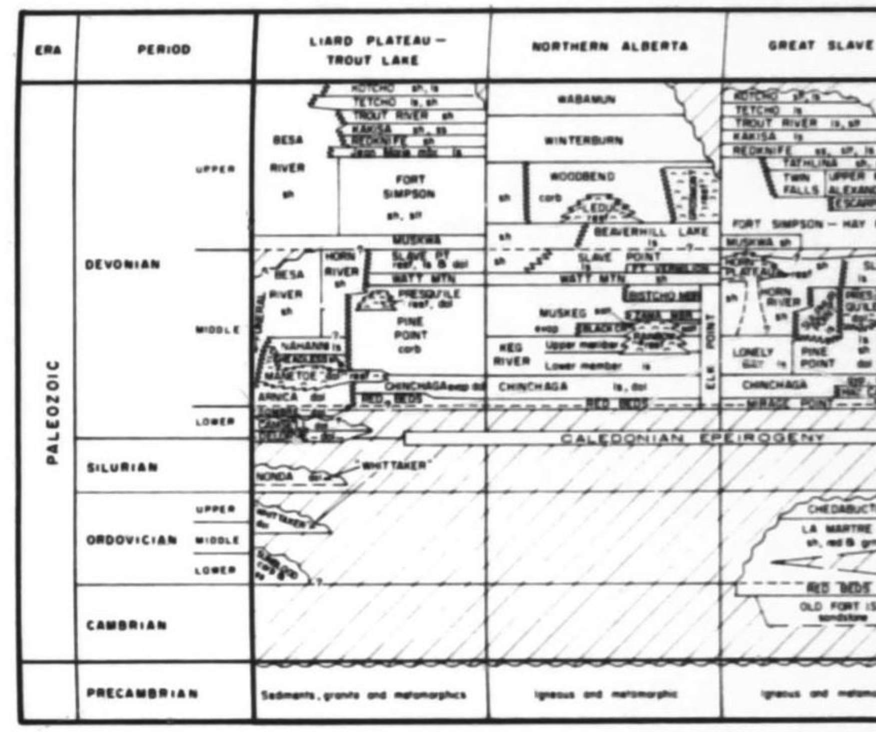
APPROXIMATE HORIZONTAL SCALE

0 — 8,800'

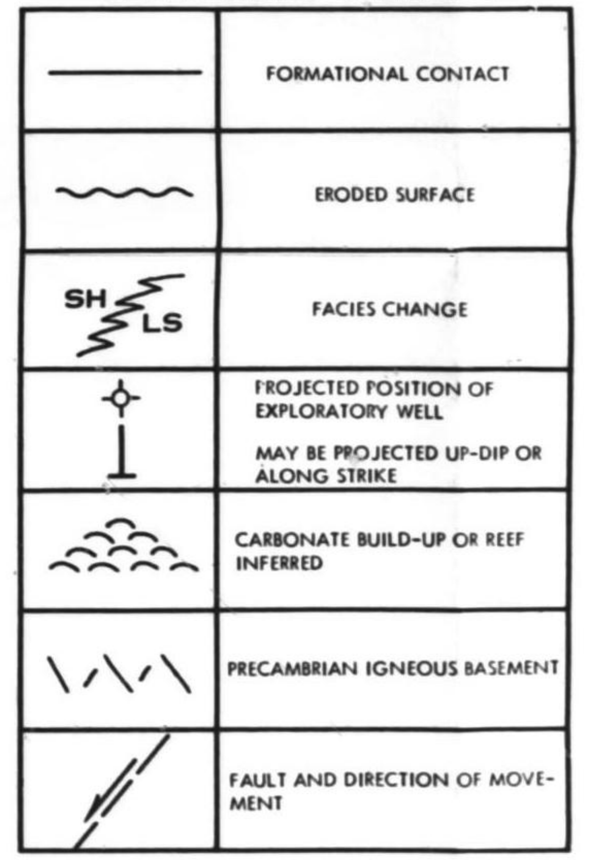
TOTAL LENGTH OF PROFILE

APPROX. 111 MILES

STRATIGRAPHIC CHART



GEOLOGICAL SYMBOLS



CONDENSED SEISMIC SECTION PREPARED BY REFORMATING ONE TRACE FROM EACH SEISMIC RECORD. TRACE NO. 2 WAS USED FOR UNIDIRECTIONAL SPREADS AND TRACE NO. 5 WAS USED FOR SPREADS SHOT ASYMMETRICALLY

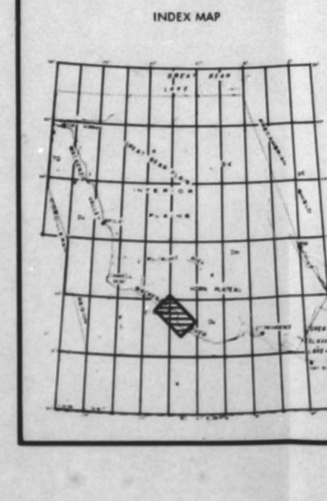
VELOCITIES USED FOR TIME - DEPTH CONVERSION DISCUSSED IN FINAL REPORT.

BANDPASS FILTER 23-28/73-78

VERTICAL SCALE 0 — 0.2 Secs.

CDP COMPUTER DATA PROCESSORS LTD.
Calgary House Calgary 1, Alberta

INDEX MAP



BASE MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP A

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

SHOTPOINT LOCATION and
WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
C.I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM
N. T. S. MAPS

ISLAND NAMES TAKEN FROM
PUBLIC WORKS OF CANADA
PUBLICATION SHOWING CHANNEL
AND MARKERS TO SEPT. 1967

= C.U.T.M. GRID CO-ORDINATES
IN FEET.

BENCH MARKS — WATER LEVEL

1 OF 2

INDEX MAP

BASE MAPS COMPILED BY: JACK HILL, A.L.S., D.L.S.

BASE MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

JEAN - MARIE
MAP A

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

SHOTPOINT LOCATION and WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT /SEC.

Interpretation By:
C.I. KLIPFEL B.S., P.Geoph.
J.A. COFFEEN P.Geoph.

MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

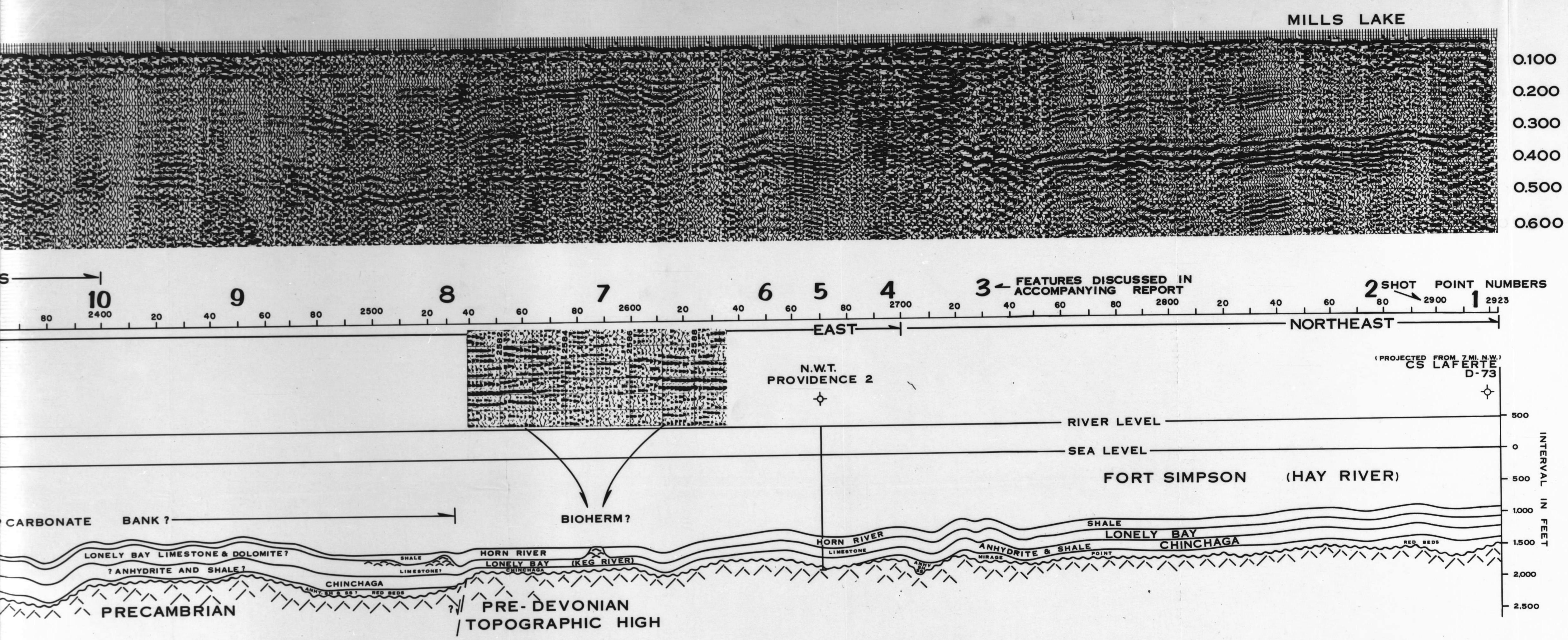
TOPOGRAPHY TAKEN FROM N.T.S. MAPS

ISLAND NAMES TAKEN FROM PUBLIC WORKS OF CANADA PUBLICATION SHOWING CHANNEL AND MARKERS TO SEPT. 1967

- C.U.T.M. GRID CO-ORDINATES IN FEET.

BENCH MARKS — WATER LEVEL

2 of 2



PALLISTER and ASSOCIATES

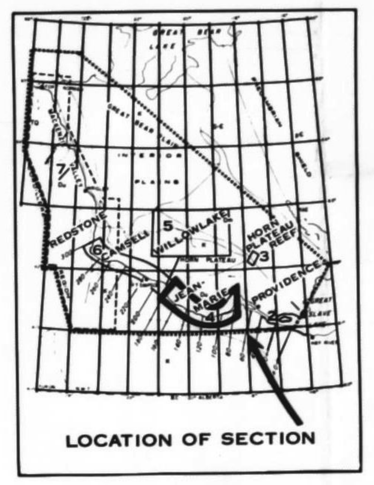
V. Zay Smith Associates Ltd

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

PROJECT FOUR
JEAN - MARIE

CONDENSED SEISMIC PROFILE AND GEOLOGIC CROSS SECTION
ALONG THE CHANNEL OF THE MACKENZIE RIVER
FROM MILLS LAKE TO WESTEROL 3-A

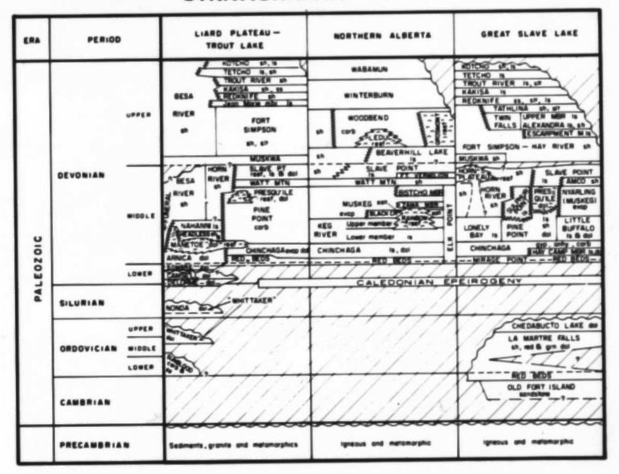


LOCATION OF SECTION

APPROXIMATE HORIZONTAL SCALE
0 8,800'

TOTAL LENGTH OF PROFILE
APPROX. 111 MILES

STRATIGRAPHIC CHART



GEOLOGICAL SYMBOLS

- FORMATIONAL CONTACT
- ERODED SURFACE
- SH / LS FACIES CHANGE
- PROJECTED POSITION OF EXPLORATORY WELL; MAY BE PROJECTED UP-DIP OR ALONG STRIKE
- CARBONATE BUILD-UP OR REEF INFERRED
- PRECAMBRIAN IGNEOUS BASEMENT
- FAULT AND DIRECTION OF MOVEMENT

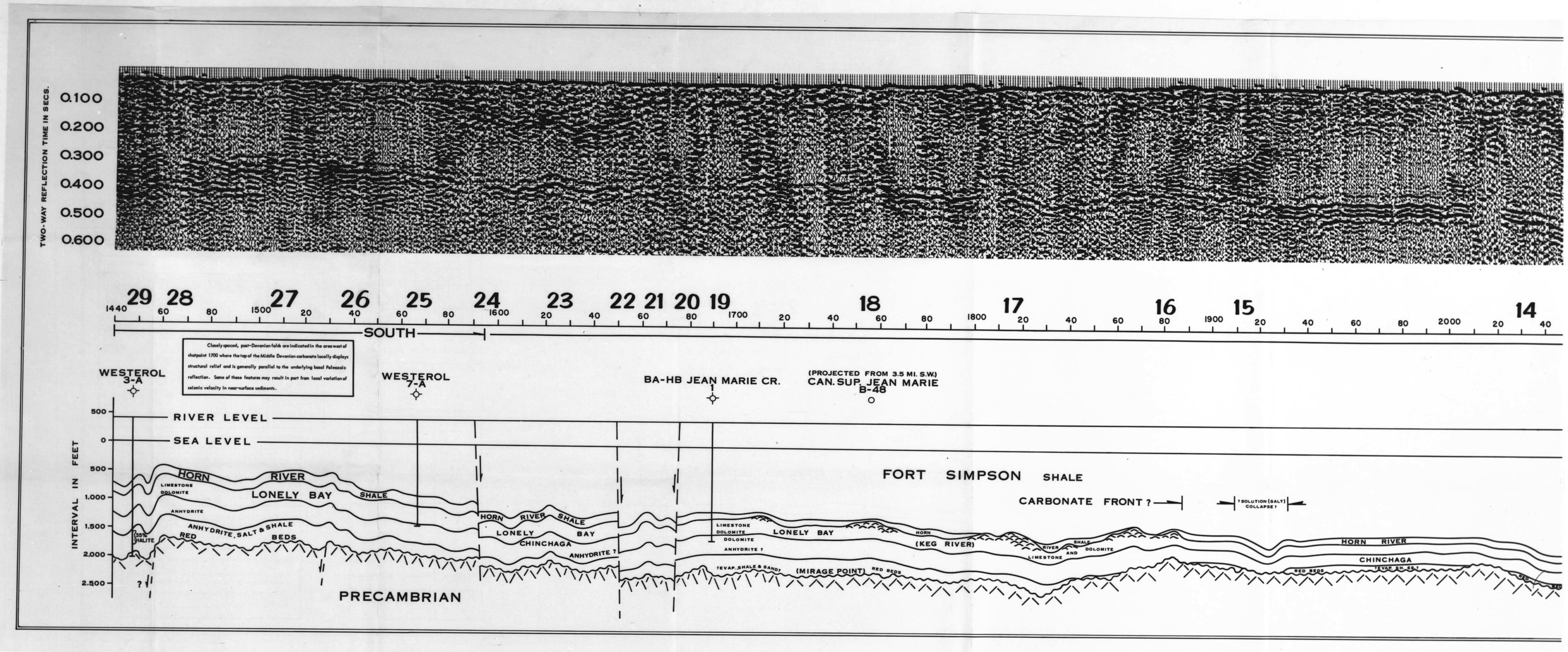
CONDENSED SEISMIC SECTION PREPARED BY REFORMATING ONE TRACE FROM EACH SEISMIC RECORD. TRACE NO. 2 WAS USED FOR UNIDIRECTIONAL SPREADS AND TRACE NO. 5 WAS USED FOR SPREADS SHOT ASYMMETRICALLY

VELOCITIES USED FOR TIME - DEPTH CONVERSION DISCUSSED IN FINAL REPORT.

BANDPASS FILTER 23-28/73-78
VERTICAL SCALE 0 0.2 Secs.

CDP COMPUTER DATA PROCESSORS LTD.
Calgary House Calgary Alberta

Top of Middle Devonian Carbonate
Basal Paleozoic
18
17
16
15
14
13
12
11
10
9
8
7·5 MILES
SOUTHEAST
JECTED FROM 3.5 MI. S.W.)
N. SUP. JEAN MARIE
B-48
The top of the Middle Devonian carbonate and the top of basement on the Geologic cross section are positioned from seismic data. They correspond to the two-colored reflections shown on the seismic profile.
FORT SIMPSON SHALE
CARBONATE FRONT ?
? SOLUTION (SALT) COLLAPSE ?
HORN RIVER
(KEG RIVER)
CHINCHAGA
SHALE
LIMESTONE ?
LONELY BAY
? ANHYDRITE & SHALE ?
RED BEDS
FORT SIMPSON SHALE
? CARBONATE BANK ?
LONELY BAY LIMESTONE & DOLOMITE?
? ANHYDRITE AND SHALE ?
CHINCHAGA
PRECAMBRIAN


TWO-WAY REFLECTION TIME IN SECS.
0.100
0.200
0.300
0.400
0.500
0.600
29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14
1440 60 80 1500 20 40 60 80 1600 20 40 60 80 1700 20 40 60 80 1800 20 40 60 80 1900 20 40 60 80 2000 20 40
SOUTH
Closely spaced, post-Devonian folds are indicated in the area west of shotpoint 1700 where the top of the Middle Devonian carbonate locally displays structural relief and is generally parallel to the underlying basal Paleozoic reflection. Some of these features may result in part from local variation of seismic velocity in near-surface sediments.
WESTEROL 3-A
WESTEROL 7-A
BA-HB JEAN MARIE CR.
(PROJECTED FROM 3.5 MI. S.W.)
CAN. SUP. JEAN MARIE B-48
INTERVAL IN FEET
500
0
500
1.000
1.500
2.000
2.500
RIVER LEVEL
SEA LEVEL
HORN RIVER SHALE
LIMESTONE DOLOMITE
LONELY BAY
ANHYDRITE
ANHYDRITE, SALT & SHALE
RED BEDS
HALITE
PRECAMBRIAN
CHINCHAGA
ANHYDRITE ?
FORT SIMPSON SHALE
CARBONATE FRONT ?
SOLUTION (SALT) COLLAPSE ?
(KEG RIVER)
TEVAP. SHALE & SAND
(MIRAGE POINT) RED BEDS
LIMESTONE AND DOLOMITE
HORN RIVER
CHINCHAGA
RED BEDS