NOTE:

REPORT SUBMITTED SEPTEMBER 10, 1969

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.

693-15-5-4

EVALUATION

FROM GEOPHYSICAL AND GEOLOGICAL DATA

OF THE

CAMSELL PROJECT

NORTHWEST TERRITORIES, CANADA

FOR

OPERATION GEOQUEST

By

PALLISTER and ASSOCIATES

V. Zay Smith
ASSOCIATES LTD.

May, 1969

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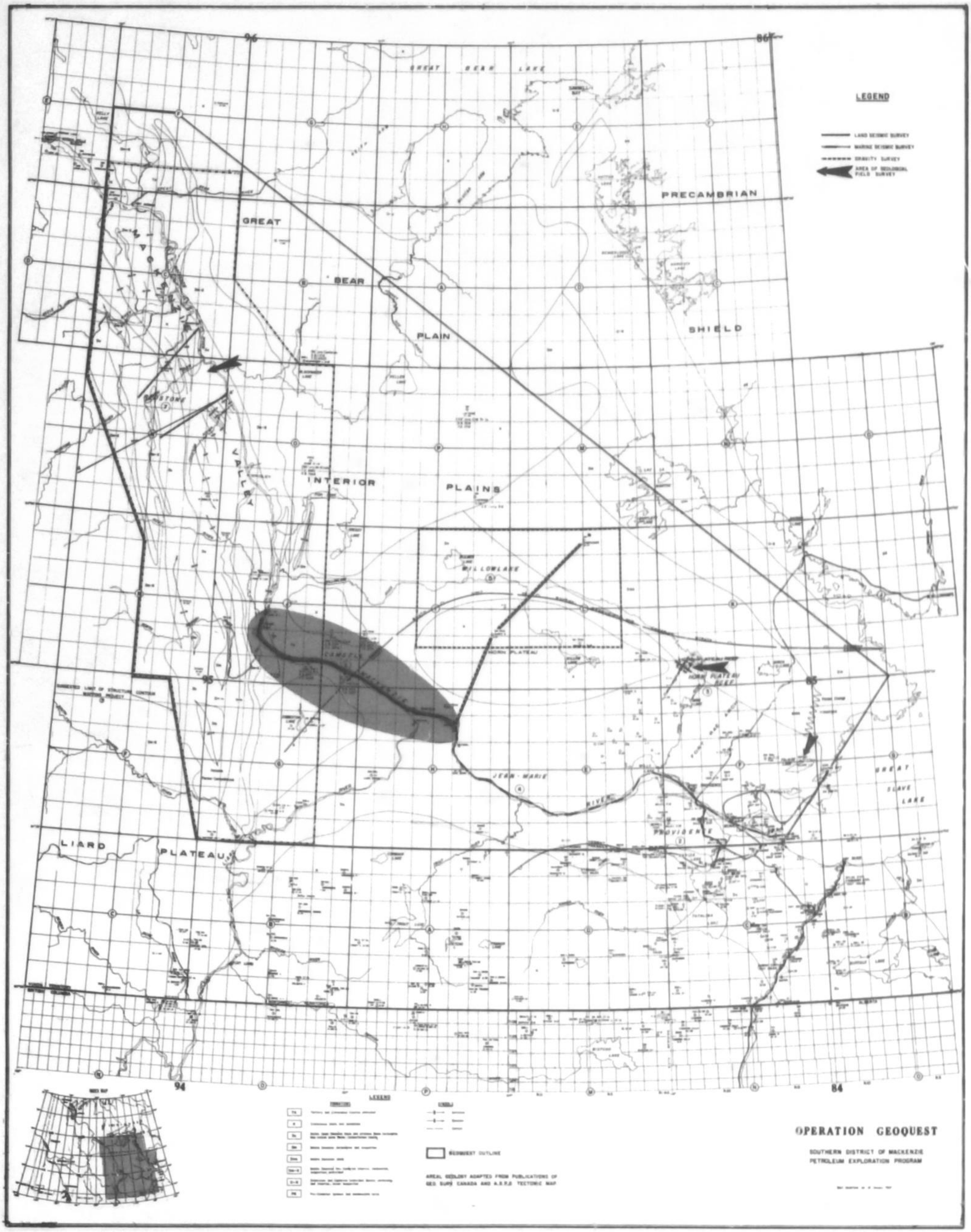
LEGEND
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MARINE SEISMIC SURVEY
GRAVITY SURVEY
AREA OF GEOLOGICAL FIELD SURVEY
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SHIELD
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OPERATION GEOQUEST CONCEPT

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 Camsell Project within the Operation Geoquest area.

A B S T R A C T

The Camsell Project is located in the Interior Plains and Cordilleran structural provinces and extends along the Mackenzie River from near Camsell Bend to the town of Fort Simpson.

A combined seismic and geologic survey was conducted to determine effective methods of exploration and to locate faults, folds, solution collapse features and stratigraphic changes along the west edge of the "Willowlake" evaporite basin.

The seismic program consists of a continuous profile beginning at the B.A.-H.B. Root River No. 1 well, about ten miles north of Camsell Bend, and extends along the channel of the Mackenzie River to the Westerol 3A well, approximately 25 miles east of Fort Simpson.

Results of the combined survey indicate a number of post-Devonian folds and faults and a westward thickening of the Middle Devonian through Cambrian sediments which overlie basement. A significant lithologic change may be indicated by the westward disappearance of the basal Paleozoic reflection at about shotpoint 1,000.

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

PART 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 Camsell 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, thei: 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.

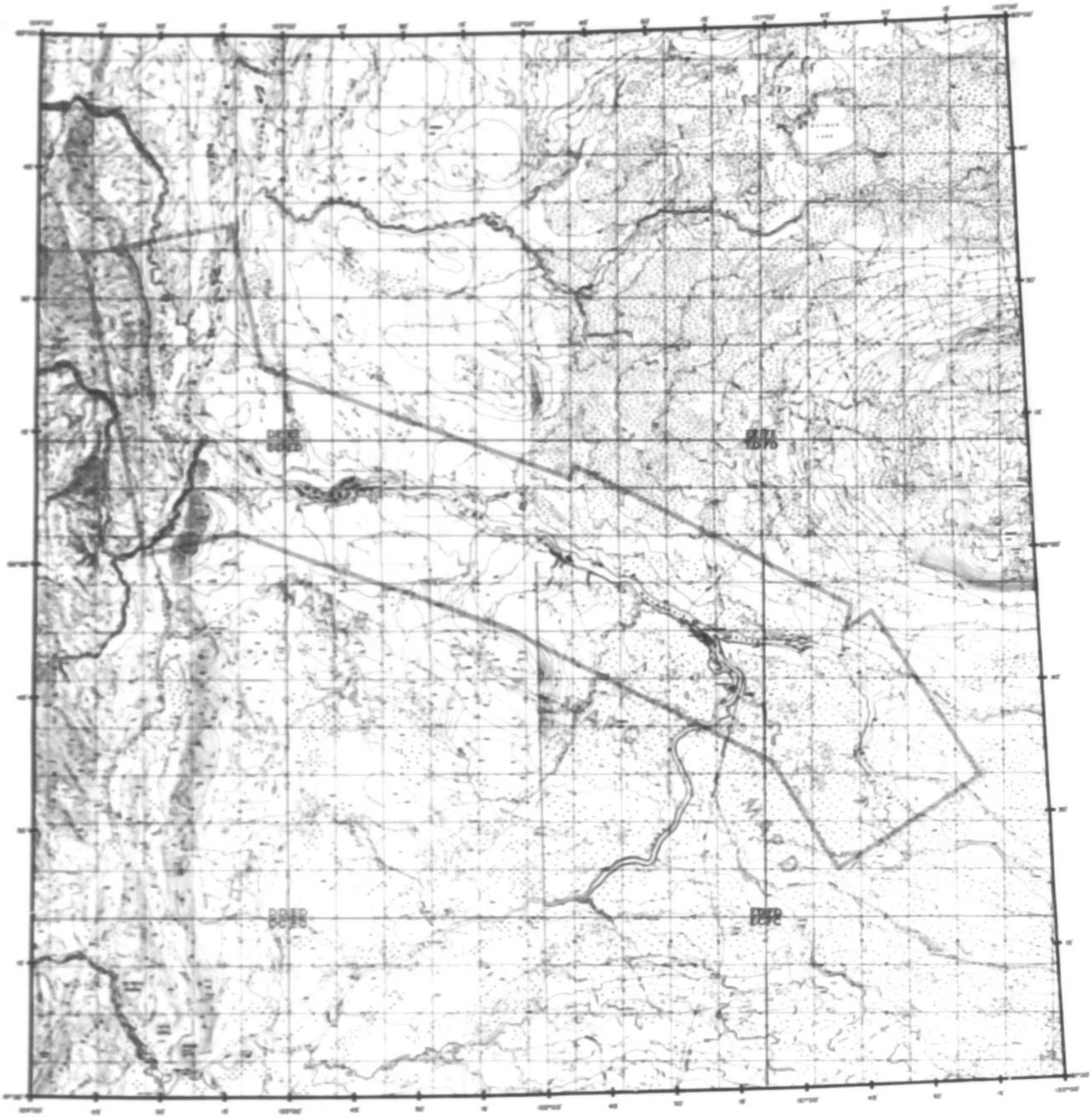
The Franklin Mountains form the eastern leading edge of the Cordilleran Belt and are characterized by moderate folds and faults developed mainly in strata of Cambrian through Middle Devonian age. A major northerly to northwesterly trending thrust fault marks the eastern boundary of the Franklin Mountains 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



PROJECT SIX
CAMSELL

PART II

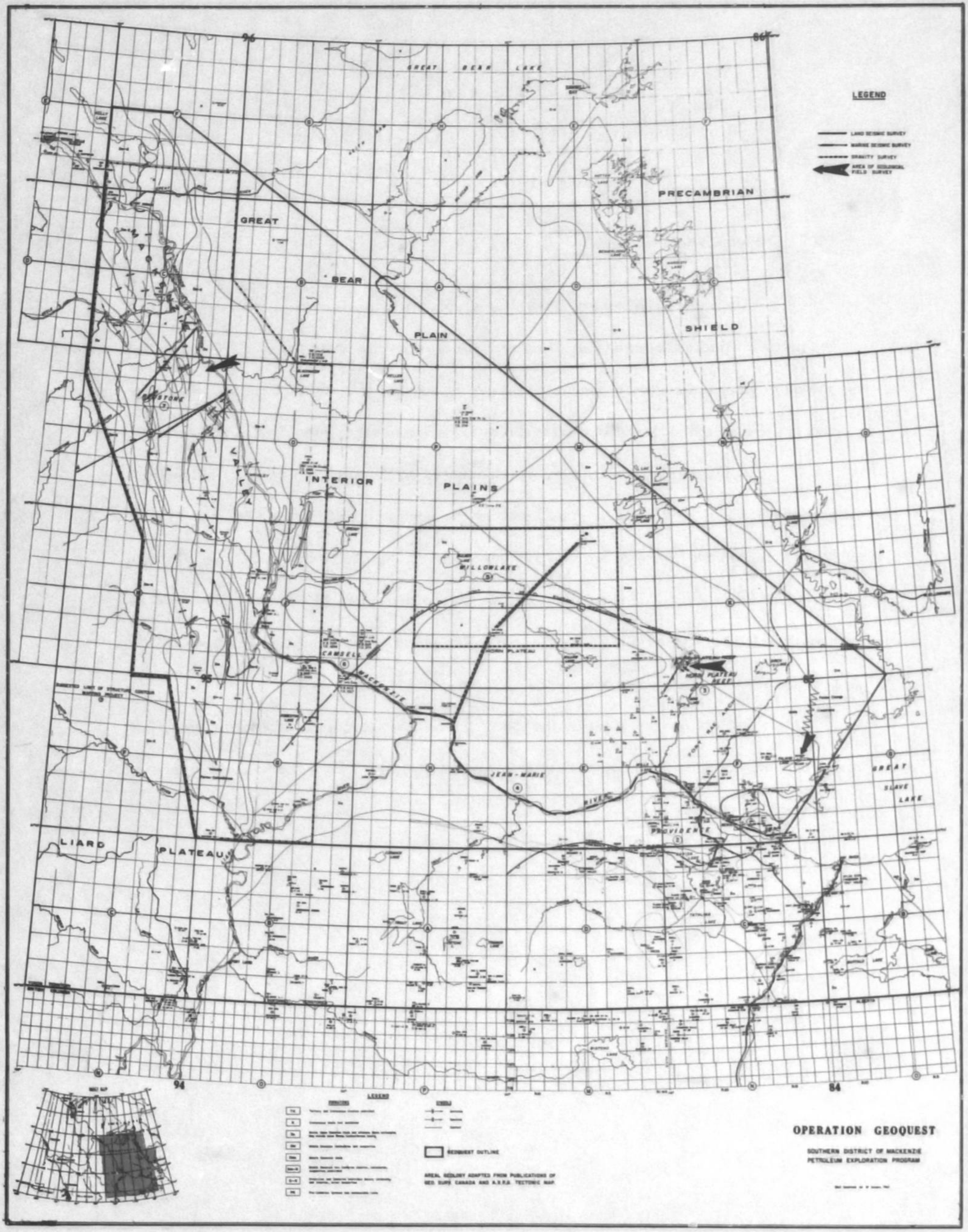
SEISMIC EXPLORATION

EXPLORATION PROGRAM

The Camsell 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 to develop optimum exploration techniques for future exploratory work in the area.

A 120-mile seismic survey was conducted on the Mackenzie River, extending from the B.A.-H.B. Root River No. 1 well at the confluence of the Root River and the Mackenzie, to the Westerol 3A well, 25 miles east of Fort Simpson. The survey ties with the Jean-Marie 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 or Nahanni Formation) and basal Paleozoic were correlated. Reflection time and interval maps were prepared.



GREAT BEAR LAKE
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OPERATION GEOQUEST
SOUTHERN DISTRICT OF MACKENZIE
PETROLEUM EXPLORATION PROGRAM

SEISMOGEOLOGIC INTEGRATION

The playback sections were prepared by setting the time break at 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 Jean-Marie Project to the east. Sonigrams, as shown on the opposite page, were used for reflection identification.

Record quality varied from good to poor. In general, the reflection identified as the top of the Middle Devonian carbonate 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 is expected.

In order to obtain better continuity, the basal Paleozoic event was picked one-half cycle higher in the Camsell and Jean-Marie Projects 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, and to the westward lithologic changes discussed under Geologic Exploration.

The reflections from the top of the Middle Devonian carbonate and basal Paleozoic were the only two correlated. Reflections are present above the carbonate in some places but are 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.

Seismically, the area falls into three different categories, each occupying about a third of the line. They are:

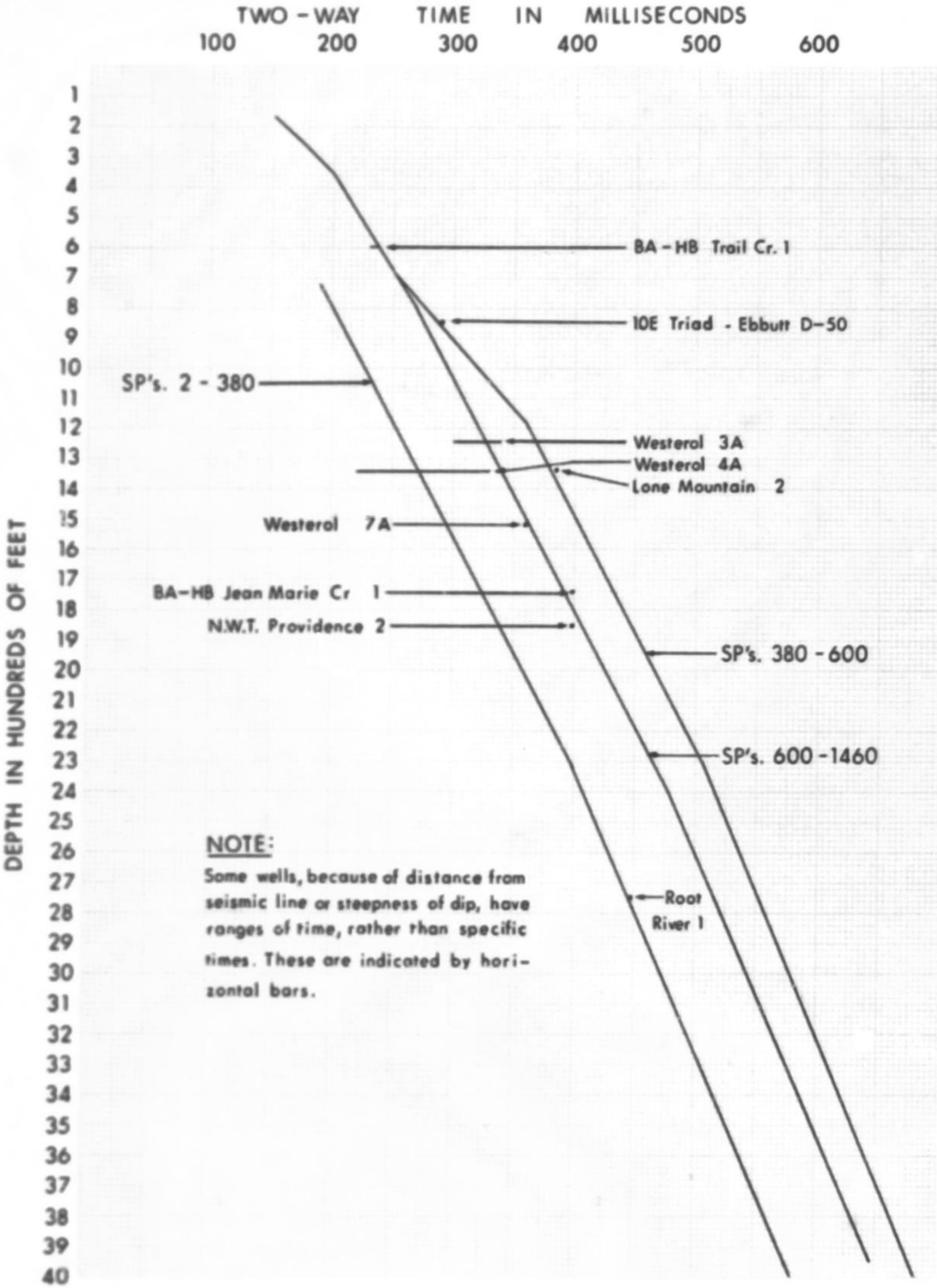
East - having moderate dip with generally good, correlatable reflections on the two horizons.

Central - a gently folded arch with the top of Middle Devonian carbonate difficult to correlate and with no basal Paleozoic reflection at most shotpoints.

West - an area of steeper dips, probable faulting, and an apparent syncline caused by the change in direction of the line at Camsell Bend.

OPERATION GEOQUEST
N.W.T. OF CANADA

LOCATION MAP
CAMSELL
PROJECT SIX



PROJECT 006
CAMSELL AREA

TIME-DEPTH FUNCTION
FOR
WATER SURFACE TO CARBONATE PICK

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, Nahanni) is correlative throughout this survey. The reflection from this horizon is considered reliable in the eastern part of the area, but is discontinuous to the west.

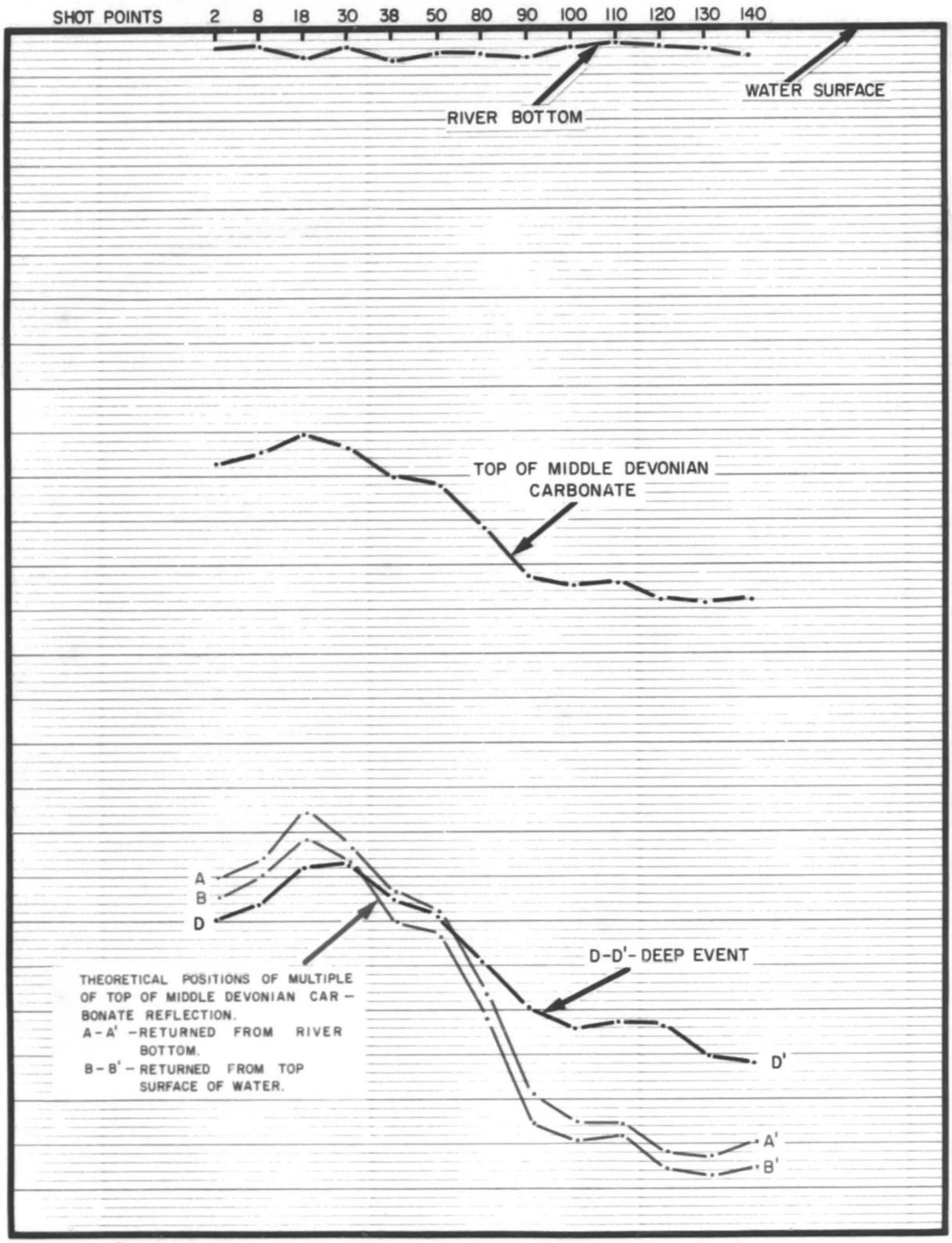
To determine the approximate subsea elevation of the carbonate, three velocity functions were used. East of shotpoint 600 they were determined by use of a time-depth function prepared from existing velocity control, well data and seismic times. This velocity function is consistent with that used in the western portion of the Jean-Marie Project. Similar velocity functions were applied west of shotpoint 380 and from shotpoint 380 to 600. The values on this map, as on all reflection time maps, are subject to near-surface velocity change.

West of shotpoint 1033 the top of Middle Devonian carbonate is discontinuous. The separate segments have been picked and are interpreted as representing the same horizon. This is recognized as being a less than perfect assumption, but the segments are considered to be fairly well related to the actual carbonate depths. The breaks in continuity are indicated on Map 1. Some of the large breaks have been interpreted as faults on the Condensed Seismic Profile and Geologic Cross Section.

Twenty-five significant features, 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.

Feature No.	Central or High Shotpoint	Relief in ms	Comments
1	1448		Well tie - Westerol 3A
2	1432	13	Local high on flank of larger structure
3	1411		Top of large structure
4	1363	36	Local structure
5	1324	7	Local structure
6	1231	27	Local structure
7	1218		Well tie - Westerol 4A
8	1162	12	Local structure
9	1112	8	Upper horizon unpickable, structure on basal Paleozoic
10	1088	34	Upper horizon unpickable, structure on basal Paleozoic
11	1060	14	Upper horizon unpickable, structure on basal Paleozoic
12	1033		End of reliable carbonate pick
13	1000		Approximate end of basal Paleozoic pick - probably associated with lithologic change
14	950		Deep energy - may be diffraction
15	784		Regional high - highest carbonate point of entire line
16	780		Well tie I.O.E. Triad-Ebbutt J-70
17	740		Well tie B.A.-H.B. Trail Creek No. 1

Feature No.	Central or High Shotpoint	Relief in ms	Comments
18	632		Well tie - I.O.E. Triad-Ebbutt D-50. Sonigram indicates discontinuous pick to be near carbonate
19	518		Well tie - B.A.-H.B. Lone Mountain No. 2
20	400		Well tie - B.A.-H.B. Lone Mountain No. 1
21	380		Approximate location of probable major fault
22	240		Steep west dip from about shotpoint 190 to about 300
23	170		Bend in line of shotpoints at Camsell Bend. Apparent dip reversal on record sections is result of change in direction of line
24	100		Deep reflection - shows best on 100% section
25	18		Well tie - B.A.-H.B. Root River No. 1



INVESTIGATION OF DEEP EVENT

DEEP EVENT COMPARED WITH POSITIONS AT WHICH MULTIPLE OF TOP OF MIDDLE DEVONIAN CARBONATE WOULD OCCUR.

Map 2 Time Interval

TOP OF MIDDLE DEVONIAN CARBONATE TO BASAL PALEOZOIC

East of shotpoint 1,000, the top of Middle Devonian carbonate and basal Paleozoic horizons are generally parallel. This is also true west of shotpoint 160. Between these two parts of the area, carbonate build-ups may exist. However they are not detectable as no basal Paleozoic reflection can be picked there.

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 8,500 feet per second. This velocity is consistent with that used in the adjoining Jean-Marie Project.

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.

East of shotpoint 980 the basal Paleozoic reflection is generally reliable. West of that point, it can not be picked. This is interpreted as evidence of lithologic change, reducing or removing the velocity contrast (see discussion in Geologic Exploration).

In most of the area west of this point, then, the interval is not mapped.

A deep event in the western part of the area has some of the appearance of a multiple of the carbonate reflection. However, an investigation - see opposite page - shows that it does not follow a predictable multiple pattern and is therefore considered a true reflection, and is interpreted as a Cambrian sand. It is basal Paleozoic control, and where present, is used in the interval mapping.

To obtain depth information in the absence of deep wells nearby, Sonigrams from widely-scattered wells were compared. Thus, approximate overall formation velocities were obtained. From these, an interval velocity of 20,000 feet per second was found to be well fitted to the top of Middle Devonian carbonate to basal Paleozoic (the Cambrian sand) interval.

The identifications, though, of the events interpreted as top of Middle Devonian carbonate and Cambrian sand are uncertain. In an alternate identification, the lower of these horizons may be the top of Middle Devonian carbonate, and the upper, another formation that occurs some distance above it.

This uncertainty is caused by a lack of deep well information nearby, and discontinuities of the seismic reflections.

The only known formation that might thus be the source of this upper reflection is a 100 - 200-foot thick limestone bed exposed west and northwest of the Root River No. 1 well. This bed is about 3,300 feet above the top of Middle Devonian carbonate, and provides the one significant velocity contrast in a largely shaly section.

The 3,300-foot separation requires a Fort Simpson interval velocity of approximately 14,000 feet per second, which is reasonable for this depth of burial. If this bed is considered the source of the upper reflection, then the regional fault (Feature 20, at shotpoint 380) does not exist. Rather, the formation producing the lower reflection must be assumed to extend eastward to meet the top of Middle Devonian carbonate reflection at shotpoint 380. Also, the upper reflection could be extended eastward from shotpoint 380. This latter extension appears reasonable on the condensed section - less so on the stacked section. However, the limestone layer was not encountered in the B.A.-H.B. Lone Mountain No. 1 well, at shotpoint 400, so little of the extension can be correct.

Therefore, this alternate is less likely to be correct than the interpretation mapped.

CONCLUSIONS

Reflection seismic exploration is effective in locating folds and faults in the Camsell area. In parts of the line, the top of Middle Devonian carbonate and the interval to the basal Paleozoic are well expressed. A significant lithologic change may be indicated by the absence of a basal Paleozoic reflection in the central part of the area. The use of digital seismic instruments with binary gain aids considerably in obtaining information from shallow horizons.

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,

for

PALLISTER and ASSOCIATES

PART III

GEOLOGIC EXPLORATION

PART III

GEOLOGIC EXPLORATION

INTRODUCTION

Geologic work in the Camsell 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 Camsell Project area The projected positions of many of these exploratory wells are shown on the accompanying cross section.

STRATIGRAPHY

Sediments of Cretaceous, Devonian, Silurian, Ordovician and Cambrian age overlie basement in the Camsell Project. Cretaceous beds occur as erosional remnants in the area north and south of the survey which extends along the Mackenzie River from the Westerol 3A exploratory well downstream to the B.A.-H.B. Root River No. 1 test. As illustrated on the accompanying geologic cross section, Devonian rocks unconformably overlie the Precambrian crystalline basement over the eastern half of the Camsell survey including the centrally located "Liard-Sibbeston" uplift. This name is herein applied to a broad, north-easterly trending structural high which is interpreted to extend from near the Shell-Liard tests on the Liard River as far north as the Mackenzie River. From regional stratigraphic relationships, the Liard-Sibbeston uplift can be dated as post-Devonian, pre-Cretaceous.

West and northwest of the uplift, Silurian, Ordovician, and Cambrian sediments occur unconformably below the Devonian succession and above the Precambrian basement. The thickness of Devonian sediments ranges from about 2,000 to 3,000 feet in the eastern half of the survey. Devonian rocks thicken from about 2,500 feet at the Liard-Sibbeston uplift to a maximum of approximately 8,500 feet near Camsell Bend. The thicker sections generally correspond to structural lows where a thick succession of Upper Devonian terrigenous clastic rocks have been preserved.

Regionally, the Camsell 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 Camsell survey, generally nonporous, well-bedded limestones and shaly limestones accumulated in an open marine environment through much of the Lonely Bay (Nahanni) times. The northern limit of the Middle Devonian carbonate bank lies southeast and south of the Camsell area and is illustrated by Bassett and Stout (1967) and others. In the mountains some distance west of the survey, carbonates of the Nahanni and Arnica Formations grade laterally into argillaceous limestones and shales of the Headless and Funeral Formations. (Douglas and Norris, 1961; Douglas et al, 1963).

PRECAMBRIAN

Precambrian rocks of the Camsell area are believed to include both shield-type crystalline basement and also Proterozoic metasediments correlative with the Purcell Series of British Columbia. The approximate eastern limit of Proterozoic metasediments is indicated by Ziegler (1967, p. 6) to intersect the Mackenzie River at about 122° west longitude (shotpoint 810±).

The lithology of Proterozoic metasediments may be similar to that of Proterozoic beds exposed in the McConnell Range some distance to the north (Douglas and Norris, 1961). There, an interbedded succession of sandstones and shales unconformably underlies Cambrian sediments.

SILURIAN, ORDOVICIAN AND CAMBRIAN

Silurian, Ordovician and Cambrian sediments are believed to unconformably underlie Devonian rocks in the western part of the Camsell survey between shotpoints 2 and 640. To the east the Devonian succession rests on the eroded Precambrian surface. Evidence for the presence of Silurian, Ordovician and Cambrian rocks in the Camsell area is based on regional stratigraphic information and specifically on the section penetrated in the Imperial-Triad-Ebbutt J-70 and D-50 wells located 12 to 18 miles north of the survey. The D-50 test penetrated some 834 feet of Silurian, Ordovician and Cambrian section below the Devonian. The beds are made up mainly of slightly silty, microcrystalline dense dolomite and include several hundred feet of siltstone and shale at the base. The lower beds are of probable Cambrian age. The J-70 well penetrated 141 feet of greyish brown, fine to microcrystalline, cherty and generally porous dolomite below the Devonian. The sub-Devonian dolomites in the Imperial-Triad-Ebbutt wells are believed to correlate with the Silurian and Ordovician Mount Kindle and Franklin Mountain Formations exposed in the McConnell Range to the northwest (Douglas and Norris, 1961).

Thus, Silurian and Ordovician rocks are believed to be characterized mainly by dolomites and are interpreted to thin eastward from a thickness of about 2,000 feet at shotpoint 2 to the sub-Devonian eroded edge near shotpoint 615.

The Cambrian succession of the Camsell area is believed to be characterized by sandstones, shales and dolomites and is presumed to thin depositionally from a thickness of about 1,000 feet at the northwestern end of the survey to the eroded edge below Devonian rocks at shotpoint 640.

DEVONIAN

On the basis of gross lithology, Devonian sediments can be separated into three broad units. The upper of these is made up predominately of shale and siltstone (Fort Simpson and Horn River Formations) and locally includes limestones and coarser clastic rocks. The middle unit of the Devonian system includes the Lonely Bay (Nahanni) Formation and the Headless Formation and is made up of limestones and shaly limestones with some dolomites. These beds correlate with the Keg River Formation of northern Alberta. The lower unit is characterized by anhydrite, dolomite and red beds to the east (Chinchaga and Mirage Point Formations) and by dolomite (Arnica and Manetoe Formations) to the west. The Chinchaga, Mirage Point and Arnica Formations generally correlate with the lower Elk Point beds of northern Alberta.

Chinchaga, Mirage Point, Manetoe, Landry and Arnica Formations

The lower unit of the Devonian system in the Camsell Project unconformably overlies Silurian through Precambrian rocks and is conformably overlain by the Nahanni or Lonely Bay Formations. The unit is Middle and Lower Devonian in age and occurs in three facies in the Camsell Project. Within and west of the Liard-Sibbeston uplift much of the interval from the Nahanni Formation to the Precambrian basement is occupied by 1,100 to 1,300 feet of anhydrites which are correlative with both the Chinchaga and Mirage Point Formations. To the east anhydrites persist in the Chinchaga Formation and are accompanied by some dolomites and limestones. The underlying Mirage Point red beds, characterized by anhydrite, shale, dolomite and salt, are interpreted to extend from about shotpoint 960 eastward beyond the Westerol 3A well. The Chinchaga and Mirage Point Formations thicken from about 700 feet at the Westerol 3A well to approximately 1,000 feet near shotpoint 1,000.

The accompanying geologic cross section illustrates the interpreted westward limit of Mirage Point red beds and the facies change to anhydrite believed to occur over the Liard-Sibbeston uplift. The position of this facies boundary is based mainly on lithologic information from the Imperial-Triad-Ebbutt Hills tests north of the survey and the Amerada-Camsell well south of the survey. Information from these wells indicates a southwesterly increase of anhydrite and corresponding decrease in dolomite and other lithologies in the Chinchaga and Mirage Point equivalents.

Westward from the Liard-Sibbeston uplift the thick anhydrite beds of the Chinchaga and Mirage Point Formations grade laterally into bedded dolomites of the Arnica Formation and limestones of the Landry Formation. The interpreted position of this facies boundary is also shown on the accompanying geologic cross section between shotpoints 660 and 760. It has also been positioned from regional stratigraphic considerations and is in part controlled by lithologic information from the B.A.-H.B. Trail Creek No. 1 test.

The thickness of the Arnica, Landry and Manetoe Formations increases more or less uniformly from about 1,400 feet on the west flank of the Liard-Sibbeston uplift to some 2,100 feet at the northwest end of the survey. The B.A.-H.B. Lone Mountain No. 2 well penetrated the Landry Formation and the upper half of the Arnica Formation. At that locality the Landry Formation is made up of 130 feet of slightly silty, locally argillaceous limestone and dolomitic limestone. The underlying dolomites of the Arnica Formation are medium and dark grey, slightly argillaceous, fine to medium crystalline and contain some zones of pin-point and intercrystalline porosity.

The generally nonporous limestones of the Landry Formation grade westward into the typically porous, coarsely crystalline dolomites of the Manetoe Formation. The facies boundary between these units is illustrated on the accompanying geologic cross section at shotpoint 415. However, it should be pointed out that subsurface control for the location of this important facies boundary is very sparse along and adjacent to the Mackenzie River. The facies boundary can only be positioned west of the B.A.-H.B. Lone Mountain No. 2 well and east of Manetoe dolomite exposures in the Camsell Range (Douglas and Norris, 1961).

A thickness of about 150 feet of generally porous and coarsely crystalline dolomites of the Manetoe Formation is anticipated in the western part of the Camsell Project. The Manetoe dolomites are regarded as excellent potential reservoirs.

Nahanni, Headless and Lonely Bay Formations

Limestones, shaly limestones and some dolomites characterize the middle unit of the Devonian system in the Camsell Project. They conformably overlie the Manetoe, Landry, Arnica and Chinchaga Formations and are in turn conformably overlain by the Horn River shales. To the west the succession is made up of an upper limestone and shaly limestone unit termed the Nahanni Formation and a lower thin series of shaly limestone (Headless Formation). These units generally correlate with the Lonely Bay Formation, a somewhat thinner succession of similar limestones and shaly limestones occurring east of the Liard-Sibbeston uplift. The Lonely Bay, Nahanni and Headless Formations display a uniform, gradual westward thickening from about 350 feet in the east to some 650 feet in the west. These rocks form the top of the Middle Devonian carbonate over much of the district of Mackenzie north of the Slave Point front. (Bassett and Stout, 1967, and others). Isolated carbonate build-ups including biostromes and bioherms occur in the Middle Devonian series above the Nahanni or Lonely Bay Formations at several localities in the Interior Plains north of the Slave Point front. These include the Horn Plateau reef located approximately 100 miles east-northeast of the Westerol 3A well (Norris, 1965) and the productive reefal limestones (Kee Scarp Formation) at the Norman Wells oilfield some 200 miles to the northwest.

At shotpoint 1,100, two carbonate build-ups have been interpreted and may represent reef growth at the top of the Nahanni (Lonely Bay) Formation. They are structurally high features at the top of Middle Devonian carbonate and are also marked by a thickening of the interval from the top of the Middle Devonian carbonate to the basal Paleozoic reflection.

In general, the basal Paleozoic reflection is absent west of shotpoint 1,000 to the northwest end of the survey. Accordingly carbonate build-ups may occur within and above the Middle Devonian succession in the central and western portions of the Camsell survey. However, none are indicated on the accompanying geologic cross section as interval data are lacking.

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 Camsell area. These rocks include the Fort Simpson (Imperial) and Horn River Formations. They range in thickness from about 230 feet over the crest of the Liard-Sibbeston uplift to a maximum of 5,500 feet near Camsell Bend. This marked westward thickening reflects both depositional thickening and post-Devonian erosion.

The Fort Simpson shales and siltstones are Upper Devonian in age and were penetrated by the B.A.-H.B. Root River No. 1 test near the northwest end of the survey. They are characterized there by calcareous, grey and greenish-grey shales, silty shales and siltstones. The Fort Simpson Formation locally contains lenses of limestones, siltstone and sandstone. 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 believed to be between 150 and 200 feet thick and to conformably overlie the Nahanni or Lonely Bay Formations throughout the Camsell Project. The condensed seismic profile illustrates local reflections apparently from within the Fort Simpson Formation. These may represent lenses of limestone or sandstone developed within that unit.

STRUCTURE

The Camsell Project includes portions of the Interior Plains and Cordilleran structural provinces and is characterized by generally undisturbed beds to the east and by faulted, westerly dipping beds to the west. The centrally located Liard-Sibbeston uplift separates the Interior Plains structural province from the westerly dipping, faulted sediments to the west.

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. Post-Devonian folds and faults are the dominant structures of the Camsell Project. The Liard-Sibbeston uplift is a broad, northeasterly trending structural high which can be dated as post-Devonian, pre-Cretaceous from regional stratigraphic relationships.

The sedimentary section of the Camsell Project displays a marked thickening west of the uplift where a number of faults have been interpreted from seismic data. The largest of these occurs at shotpoint 380 where more than 1,800 feet of offset is indicated at the top of the Middle Devonian carbonate. This feature and other nearby faults indicated on the geologic cross section are interpreted to be high-angle reverse faults formed by Laramide compressive forces.

Collapse structures resulting from solution of halite may occur in the eastern portion of the Camsell area where halite is anticipated in the Mirage Point Formation. However, no collapse structures are interpreted from the seismic data of the Camsell survey.

A number of closely spaced, post-Devonian folds are indicated in the area east of the Liard-Sibbeston uplift. 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.

ALTERNATE INTERPRETATIONS

MIDDLE DEVONIAN CARBONATE REFLECTION

Identification of the Middle Devonian reflection is uncertain west of the B.A.-H.B. Lone Mountain No. 1 well. Two seismic reflections are present between shotpoints 2 and 160, either of which could be from the top of the Middle Devonian carbonate. In this report the upper reflection is interpreted to be from the Middle Devonian carbonate. The lower reflection may be from the Cambrian sandstone and shale sequence.

Alternately, the lower reflection may be from the top of the Middle Devonian carbonate. If so, it is believed that the upper reflection is likely from the top of the Fort Simpson shales. Overlying the shales and siltstones of the Fort Simpson Formation are sandstones and siltstones of Upper Devonian age which include a limestone in the Root River area which is locally several hundreds of feet thick.

BASAL PALEOZOIC REFLECTION

Several interpretations have been considered to account for the absence of the basal Paleozoic reflection west of shotpoint 1,000. To the east, the reflection is believed to be caused by a velocity contrast between Mirage Point beds containing shale and salt and the underlying crystalline basement. Thus, west of shotpoint 1,000, a seismic velocity (and lithologic) change is indicated in either the basal Paleozoic or the basement rocks or both.

From regional lithologic information, a number of stratigraphic changes can be anticipated in basal Paleozoic and also in Precambrian strata between shotpoints 600 and 1,000 (Liard-Sibbeston uplift).

These include:

1. A westward facies change to anhydrite in basal Devonian sediments (Mirage Point equivalents).

2. Farther west, a facies change to dolomite (Arnica Formation) in Chinchaga and Mirage Point equivalents.

3. The presence of Silurian, Ordovician and Cambrian rocks (sub-Devonian escarpment).

4. The presence of Proterozoic metasediments above the crystalline basement and unconformably below Paleozoic cover.

Lithologic and velocity information for sub-Devonian rocks of the Liard-Sibbeston uplift is sparse. Silurian and Ordovician rocks are believed to be mainly dolomites and the Cambrian section dominantly low-velocity sandstones and shales. Any Precambrian metasediments present are probably quartzites and argillites.

As illustrated on the accompanying cross section, the facies change to anhydrite in basal Devonian beds (shotpoints 950 to 1,000) is the preferred interpretation to account for the westward absence of the basal Paleozoic reflection.

CONCLUSIONS

Upper Devonian through Cambrian sediments overlie the Precambrian crystalline basement along the Mackenzie River in the Camsell area. The section displays a gradual westward thickening from the Westerol 3A well to the Liard-Sibbeston uplift. West of the uplift the rate of thickening increases so that some 11,300 feet of section overlies basement in the Camsell Bend area. The absence of a basal Paleozoic reflection in the central and western portions of the Camsell survey precludes the identification of carbonate build-ups, solution collapse structures and pre-Devonian topographic and structural features. However, the westward disappearance of this reflection is interpreted to mark an anticipated facies change in basal Devonian beds.

A number of closely spaced, post-Devonian folds are indicated in the eastern portion of the survey between the Westerol 3A well and the Liard-Sibbeston uplift. There, structure is characterized by regional south and southeasterly dip on the order of 35 feet per mile.

A combination structural and stratigraphic trap can be envisioned near the updip limit of porous Manetoe dolomites (shotpoint 415). There these beds are offset by an interpreted major reverse fault (shotpoint 380). Stratigraphic traps may occur where porous Silurian and Ordovician dolomites subcrop below the generally nonporous Arnica Formation in the area between Camsell Bend and shotpoint 600. Thus, reservoir rocks and stratigraphic and/or structural traps can be envisioned in the Middle Devonian through Ordovician succession of the Camsell area and in the adjacent Interior Plains.

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PART IV

SUMMARY OF CONCLUSIONS

PART IV

SUMMARY OF CONCLUSIONS

Reflection seismic exploration is effective in locating folds and faults in the Camsell area. In parts of the line, the reflection from the top of Middle Devonian carbonate and the interval to the basal Paleozoic are well expressed. A significant lithologic change may be indicated by the absence of a basal Paleozoic reflection in the central part of the area. The use of digital seismic instruments with binary gain aids considerably in obtaining information from shallow horizons.

Devonian through Cambrian beds overlie basement and display a westward thickening. A combination stratigraphic and structural trap can be envisioned near the updip, faulted limit of Manetoe dolomites. Stratigraphic traps may occur where porous Silurian and Ordovician beds subcrop below Devonian cover and also along the updip limit of Arnica dolomites.

Thus, reservoir rocks and traps can be envisioned in the Middle Devonian through Ordovician succession of the Camsell area and in the adjacent Interior Plains.

Respectfully submitted,

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P A R T V

APPENDIX

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	-	3 seconds
Cable	-	Marsh - flotation
Hydrophones	-	Crystal pressure sensitive, Hall Sears MP-8
Energy Source	-	Dynamite

Direct playback made for every recording

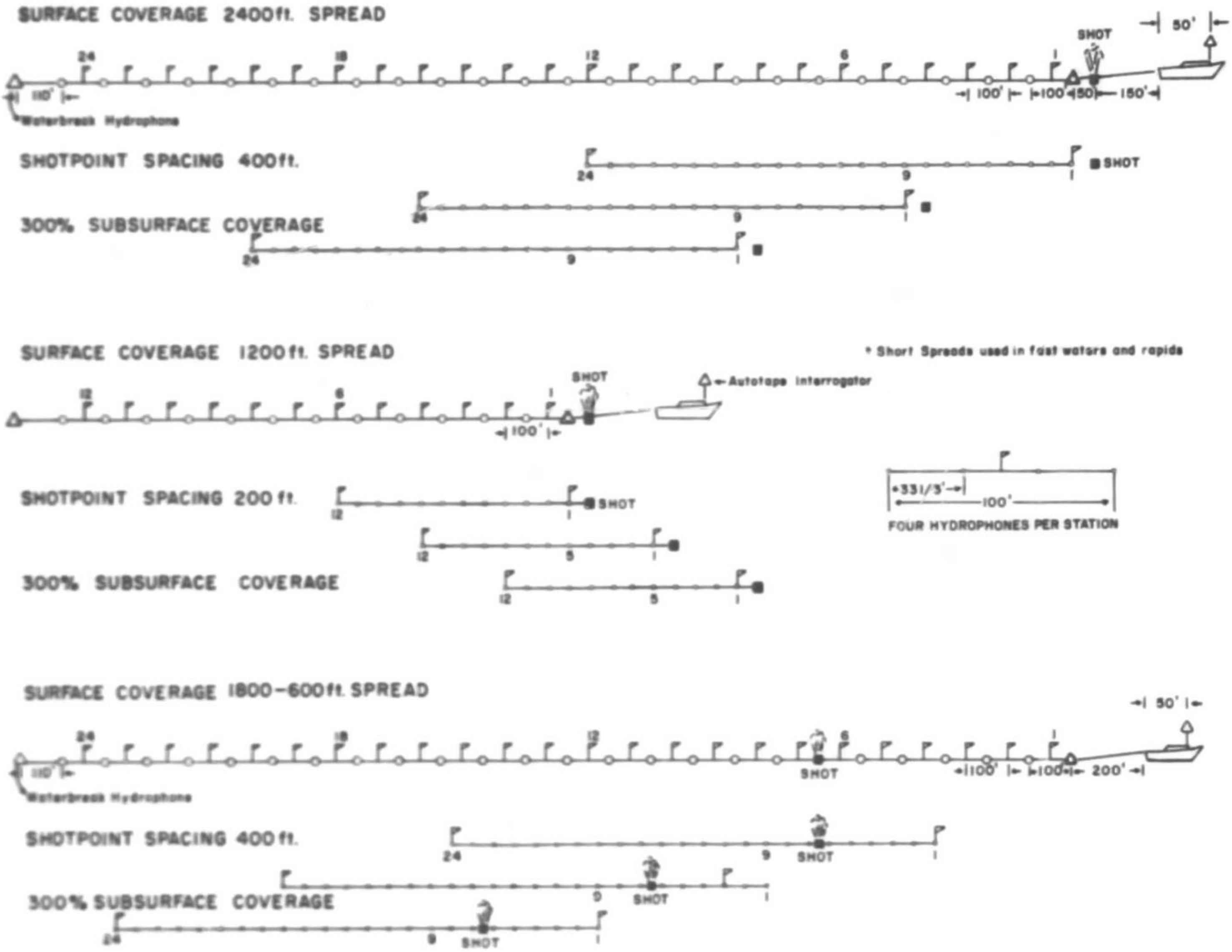
SPREAD DIAGRAMS

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

- several miles were recorded using an asymmetrical spread of 1800-600 feet, but this type spread could not normally be used because of 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.

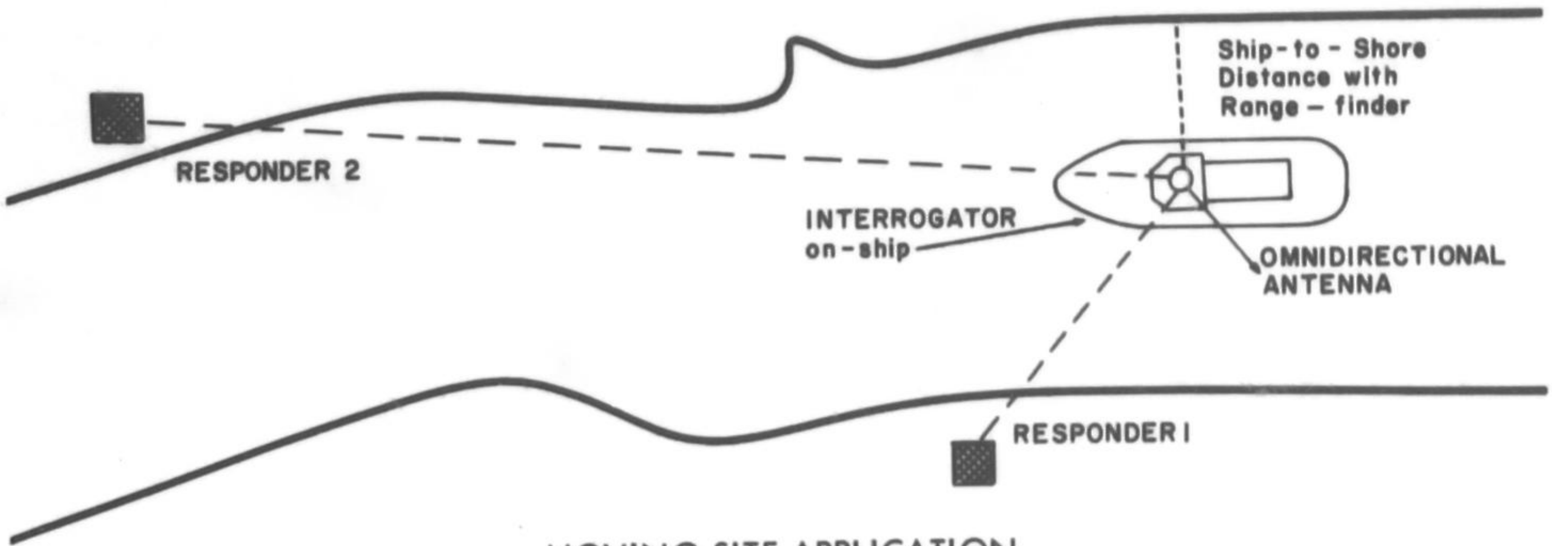
One interrogator and two shore-based responders (beaming into an omnidirectional antenna) were used.

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, DIGITAL UNIT SWITCHED ON UNTIL SP SHOT, AND BEHIND AS ADDITIONAL DISTANCE AND SYSTEM CHECK.
1 6 6 4 5	7 0 5 0 6	
1 6 6 4 0	7 0 4 9 7	
1 6 6 0 9	7 0 4 9 3	
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 1   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	July 27, 1968
Completion Date	August 9, 1968
Miles Shot	110
Miles per Day	8
Shotpoints	1,467
Shotpoints per Day	105
Total Hours	145
Dynamite used	20,862 pounds
Average Charge	14 pounds
Boosters used	1,500
Caps used	1,503
Weather Days	Nil

Of the 14 days in the Camsell 006 area, nine were in rapids and fast waters.


TWO-WAY REFLECTION TIME IN SECS
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
1.100
1.200
25
24
23
22
21
20
19
18
17
16
15
14
NORTH
SOUTHEAST
CONFLUENCE OF NORTH NAHANNI AND MACKENZIE RIVERS
"LIARD - SIBBESTON" UPLIFT
7.5 MILES
BA-HB ROOT RIVER 1
CAMSELL BEND
(NO INFORMATION) (PROJECTED FROM 6 MILES S.W.) GULF AMERADA CLI LAKE G 15
(PROJECTED FROM 1 MILE NORTH) BA-HB LONE MTN. 1
BA-HB LONE MTN. 2
(PROJECTED FROM 12 MILES NORTH) IMP. TRIAD EBBUTT D-50
BA-HB TRAIL CR. 1
(PROJECTED FROM 18 MILES NORTH-NORTHEAST) IMP. TRIAD EBBUTT J-70
RIVER LEVEL
SEA LEVEL
FORT SIMPSON SHALE
INTERVAL IN FEET
DEVONIAN
FORT SIMPSON (IMPERIAL)
SHALE, CALCAREOUS SILTSTONE AND MINOR LIMESTONE
SHALE AND SILTSTONE
FORT SIMPSON SHALE AND SILTSTONE
ALTERNATE INTERPRETATION
LIMESTONE AND SHALY LIMESTONE
DOLOMITE
ARNICA
NAHANNI AND HEADLESS
HORN RIVER SHALE
MANETOE
LIMESTONE & SHALY LIMESTONE
SILURIAN AND ORDOVICIAN
MT. KINDLE AND FRANKLIN MTN.
CAMBRIAN
?SANDSTONE, SHALE, DOLOMITE?
PRECAMBRIAN
LANDRY
NAHANNI
CHINCHAGA AND MIRAGE POINT EQUIVALENTS
MAINLY ANHYDRITE
LIMESTONE AND DOLOMITE
SUB-DEVONIAN ESCARPMENT
DOLOMITE, SILTY DOLOMITE AND SHALE

1 of


PALLISTER and ASSOCIATES
OPERATION GEOQUEST
NORTHWEST TERRITORIES OF CANADA
PROJECT SIX
CAMSELL
CONDENSED SEISMIC PROFILE AND GEOLOGIC CROSS SECTION
ALONG THE CHANNEL OF THE MACKENZIE RIVER
FROM WESTEROL 3-A TO BA-HB ROOT RIVER 1
APPROXIMATE HORIZONTAL SCALE
TOTAL LENGTH OF PROFILE
APPROX. 114 MILES
STRATIGRAPHIC CHART
LOCATION OF SECTION
GEOLOGICAL SYMBOLS
TWO-WAY REFLECTION TIME IN SECS.
FEATURES DISCUSSED IN ACCOMPANYING REPORT
SHOT POINT NUMBERS
"LIARD-SIBBESTON" UPLIFT
BA-HB TRAIL CR. 1
(PROJECTED FROM 18 MILES NORTH-NORTHEAST)
IMP. TRIAD EBBUTT J-70
7.5 MILES
(PROJECTED FROM 7 MILES NORTHEAST)
(NO INFORMATION)
IOE TRAIL RIVER P-13
FORT SIMPSON
CONFLUENCE OF LIARD AND MACKENZIE RIVERS
(PROJECTED FROM 4 MILES SOUTH)
WESTEROL 4-A
RAPIDS NO DATA
(PROJECTED FROM 5 MILES NORTH
NO INFORMATION, OIL SHOW IN DEVONIAN)
IOE STRONG POINT G-24
WESTEROL 3-A
FORT SIMPSON SHALE
HORN RIVER SHALE
NAHANNI
LIMESTONE AND DOLOMITE
LONELY BAY
LIMESTONE
CHINCHAGA
ANHYDRITE & DOLOMITE
ANHYDRITE, DOLOMITE AND LIMESTONE
MIRAGE POINT
ANHYDRITE, SHALE, DOLOMITE AND ? SALT
CHINCHAGA AND MIRAGE POINT EQUIVALENTS
MAINLY ANHYDRITE
PRECAMBRIAN
INTERVAL IN FEET
2 OF 2

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 712, 832, 962, 1060, 1150, 1342 and 1448. Representative of these spectrals are shotpoint 832, Plat I, Page 39 and Plat II, Page 40 and shotpoint 1150, Plat IV, Page 42 and Plat V, Page 43.

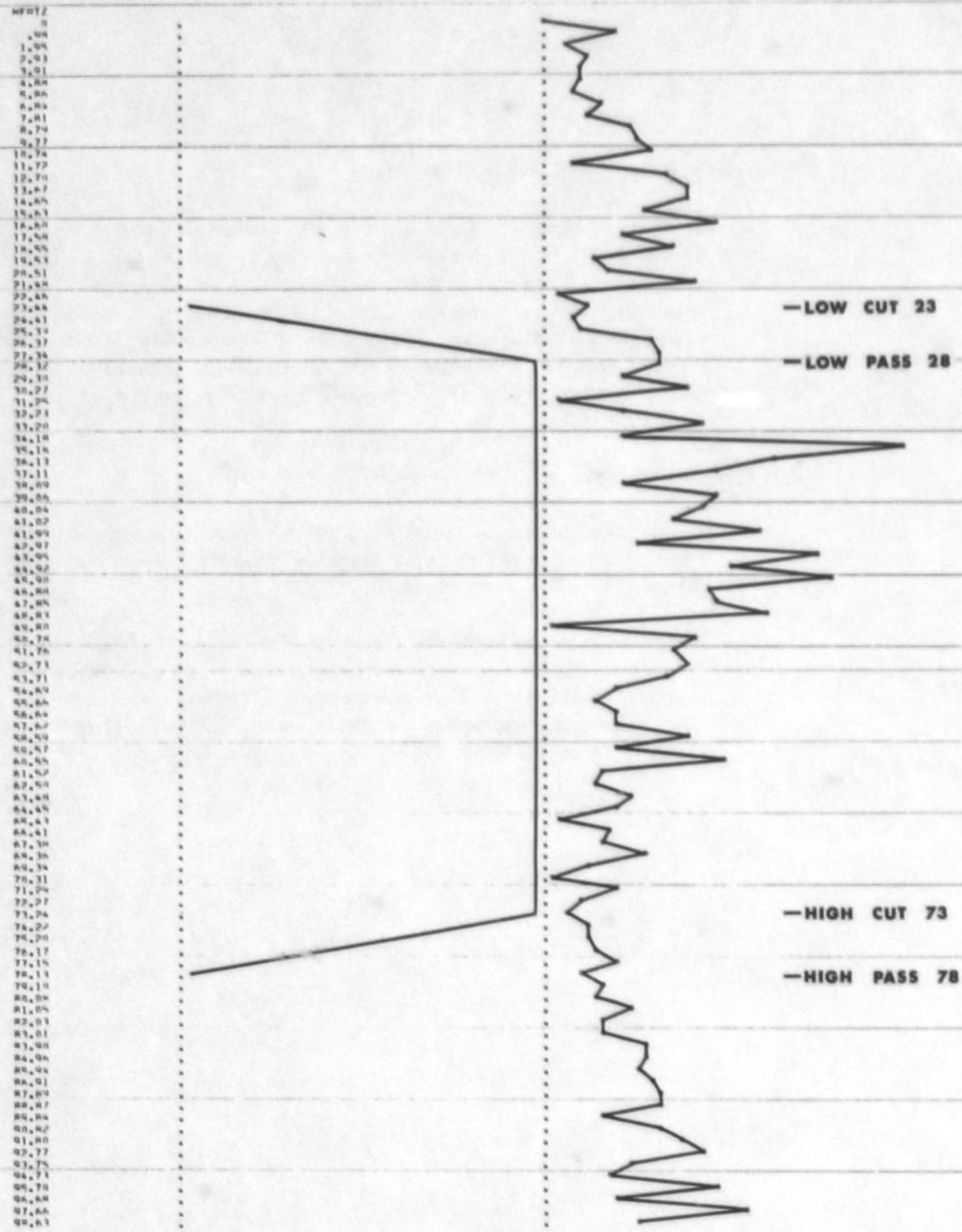
(b) Bandpass Display -

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. As above, shotpoints 832 and 1150 are representative for the Camsell area. Displays of these shotpoints are shown on Plat III, Page 41 and Plat VI, Page 44, respectively.

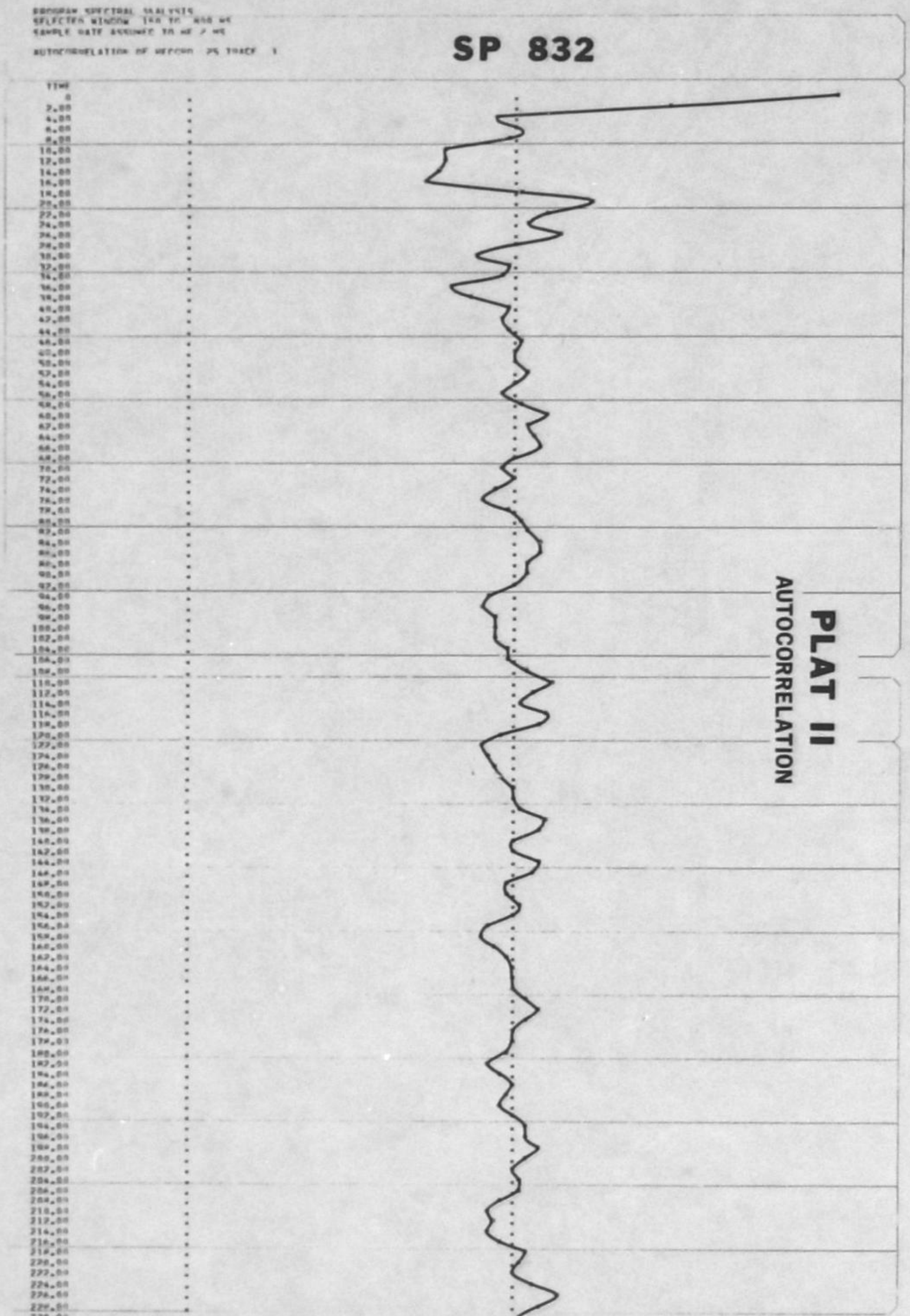
PROGRAM SPECTRAL ANALYSIS
SELECTED WINDOW [illegible] MS
SAMPLE RATE ASSUMED TO BE 2 MS
AMPLITUDE SPECTRUM OF SECOND [illegible] TRACE 3

SP 832

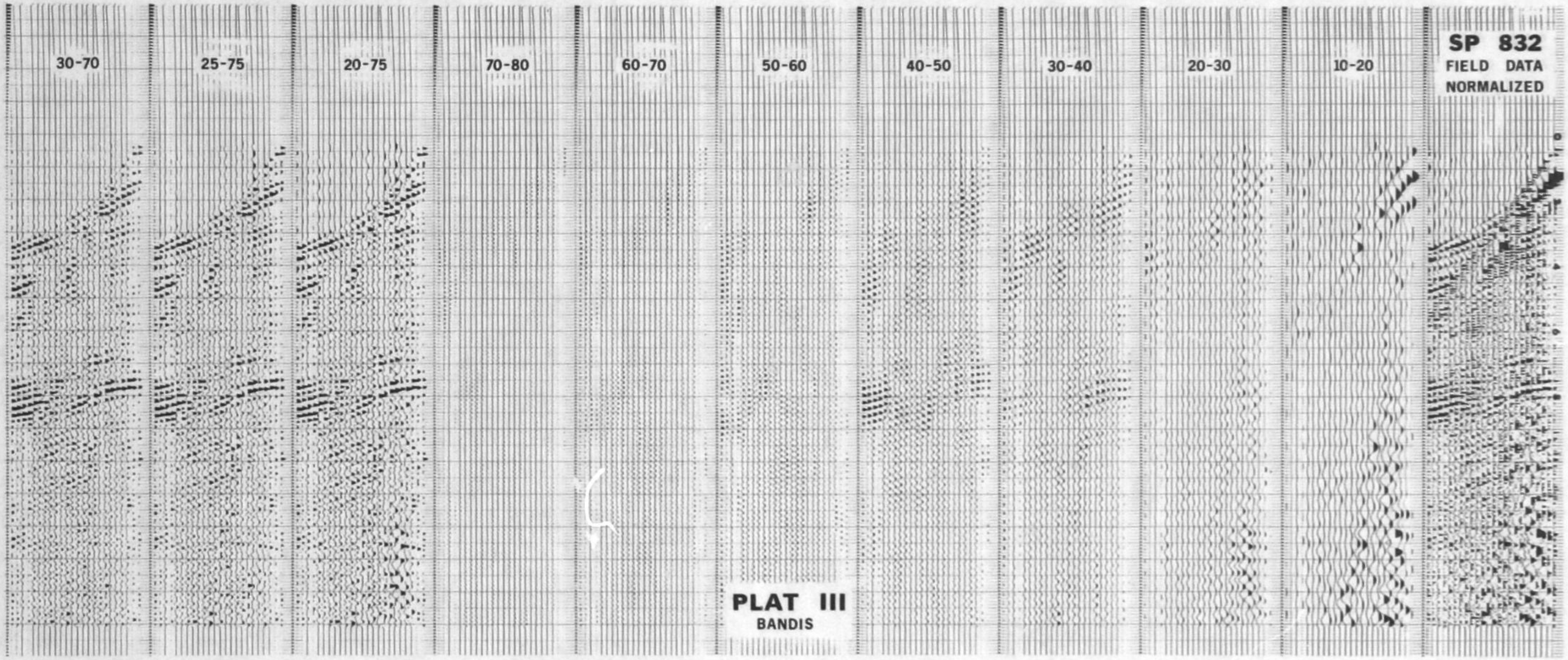


PLAT I

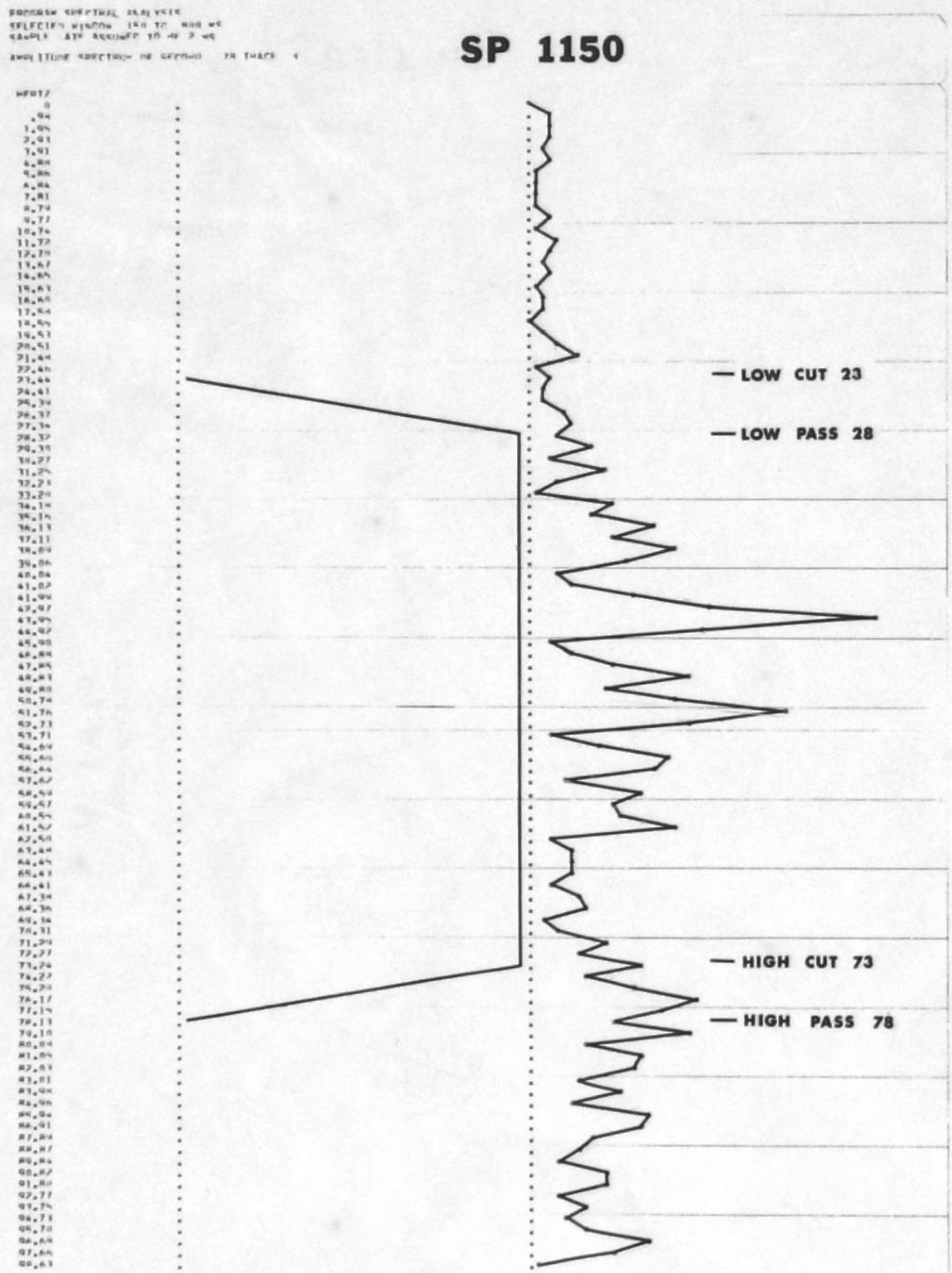
SPECTRAL



PLAT II
AUTOCORRELATION


30-70
25-75
20-75
70-80
60-70
50-60
40-50
30-40
20-30
10-20
SP 832
FIELD DATA
NORMALIZED
PLAT III
BANDIS

SP 1150

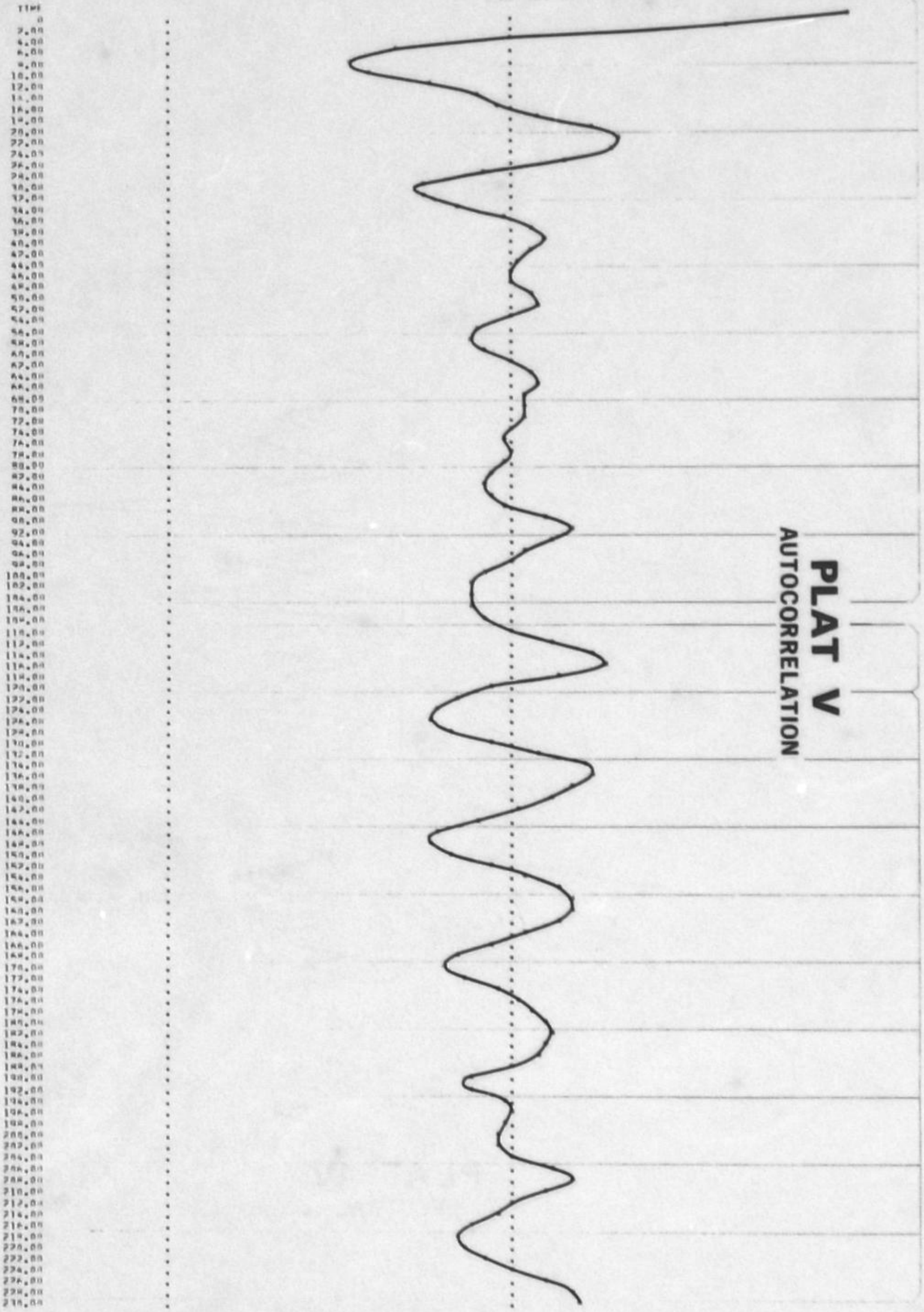


PLAT IV
SPECTRAL

PROGRAM SPECTRAL ANALYSIS
SELECTED WINDOW 150 TO 800 MS
SAMPLE RATE ASSUMED TO BE 2 MS

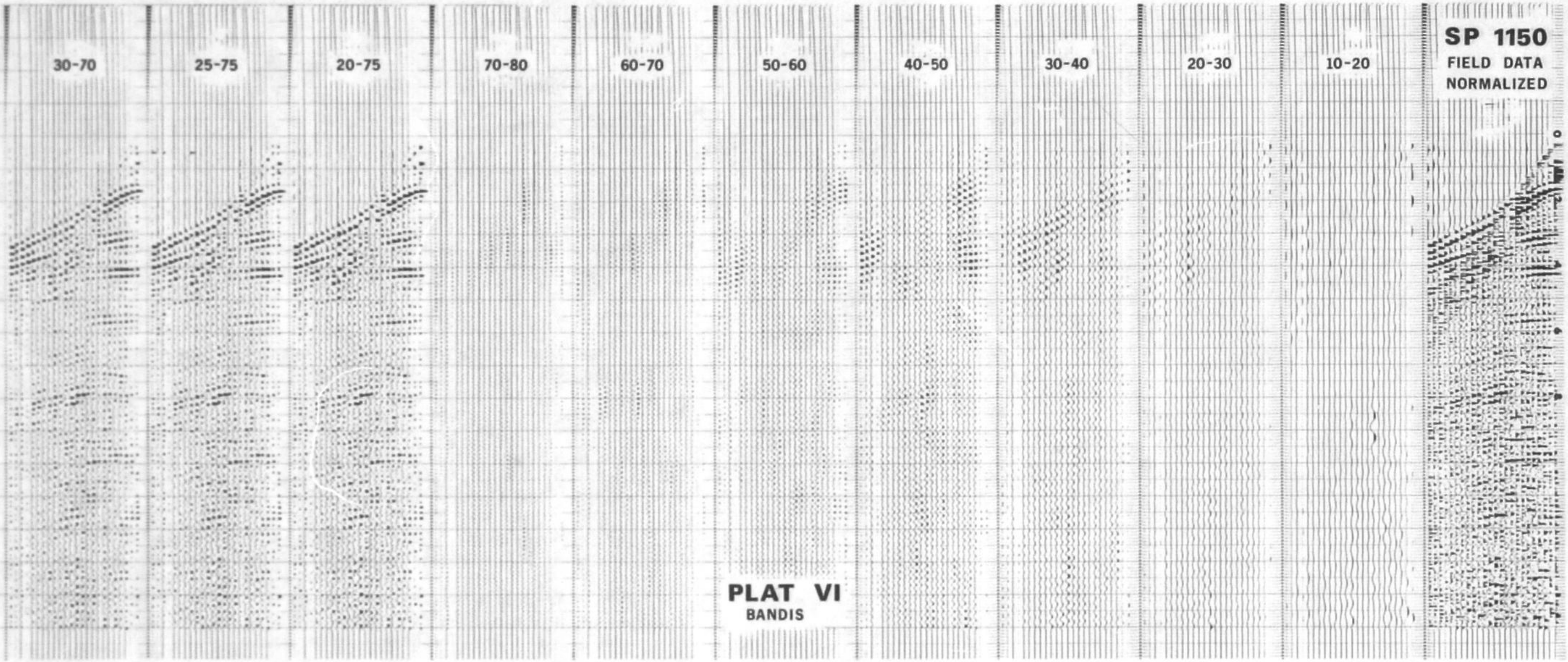
AUTOCORRELATION OF RECORD 78 TRACE 1

SP 1150



PLAT V

AUTOCORRELATION



30-70
25-75
20-75
70-80
60-70
50-60
40-50
30-40
20-30
10-20
SP 1150
FIELD DATA
NORMALIZED
PLAT VI
BANDIS

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 VII Page 46.

The preliminary curves were validated by checking the velocity information obtained against available wells, Plat VIII Page 47.

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.

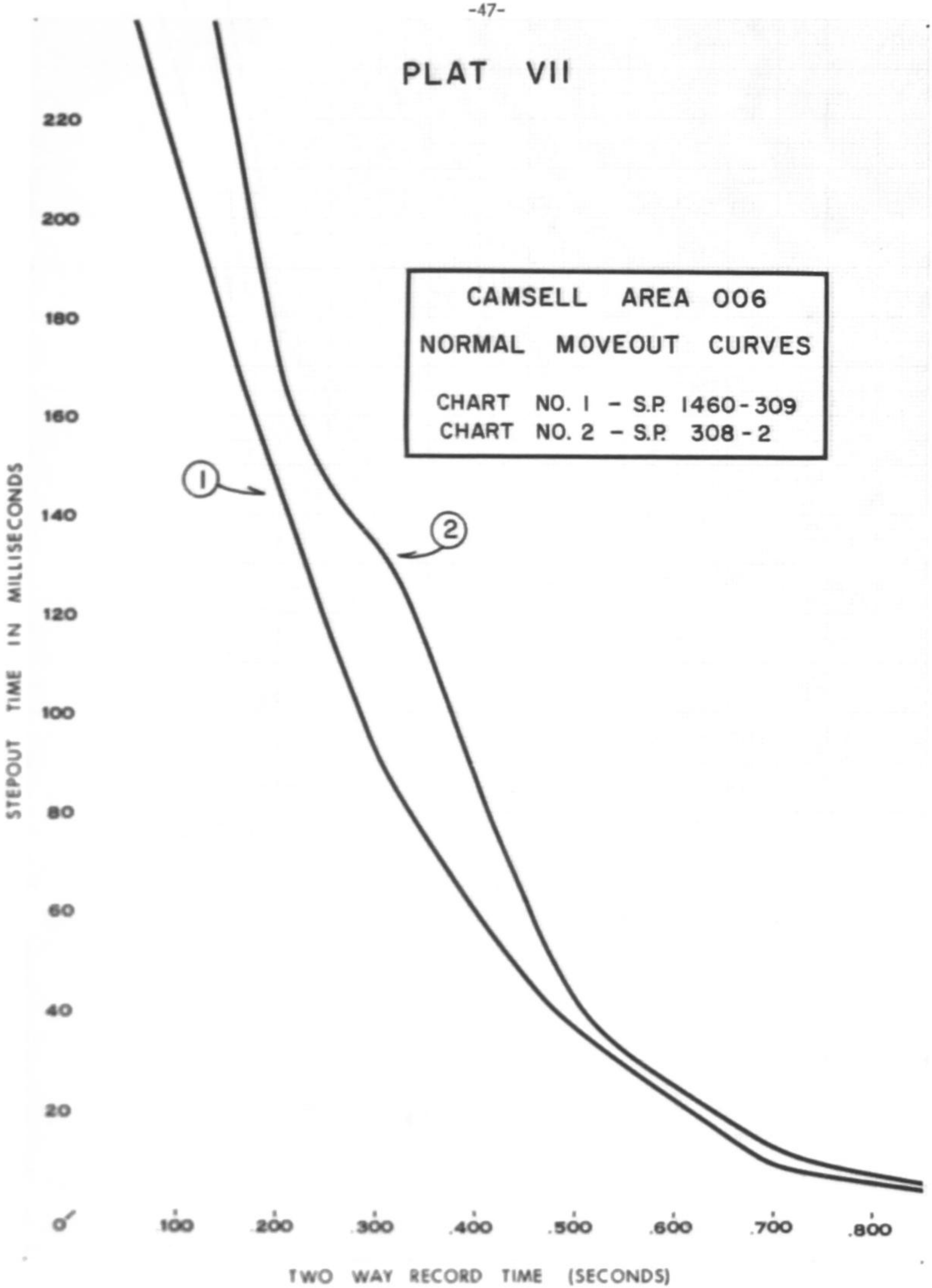
(b) Fastband

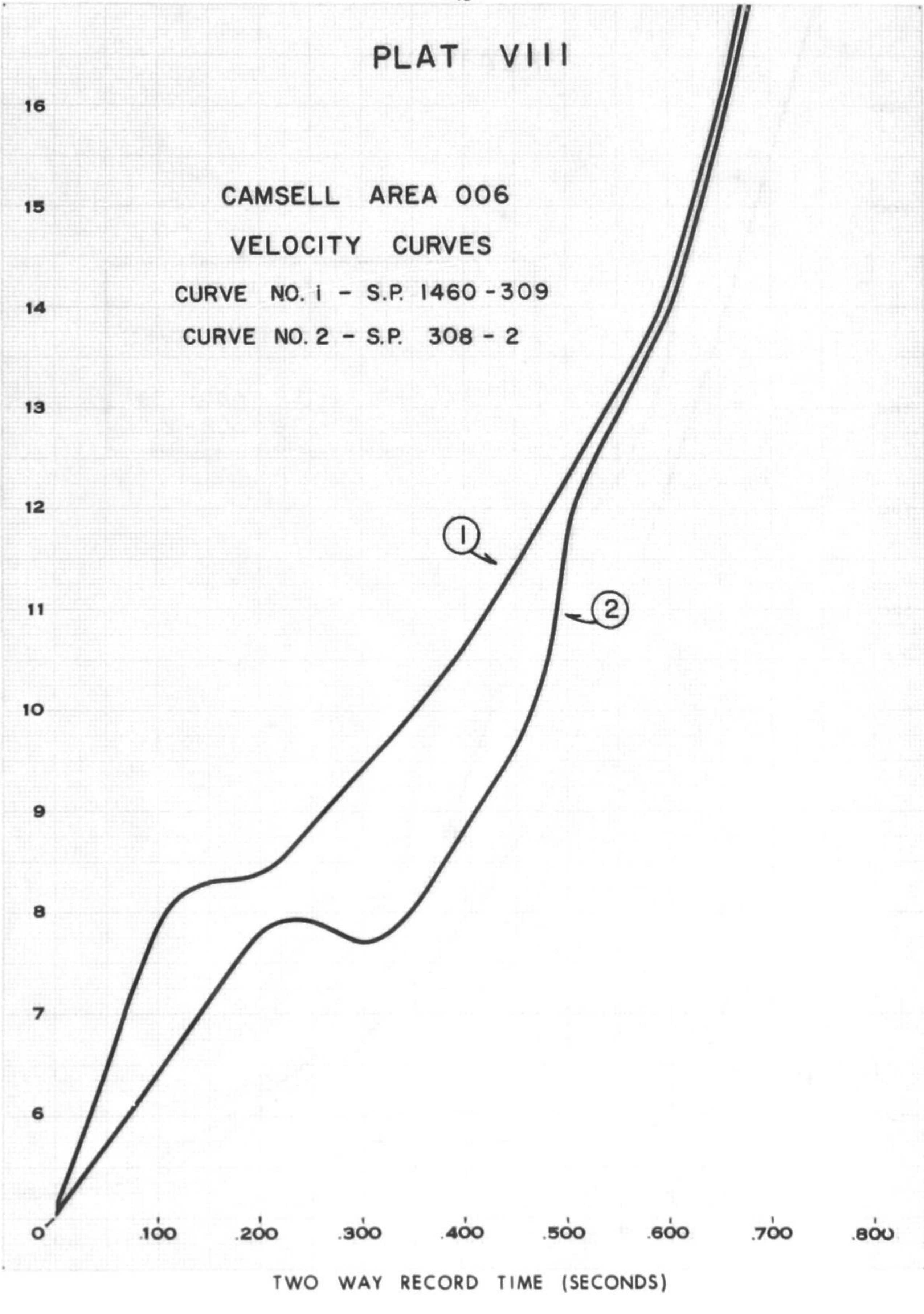
A bandpass filter program based on the Fourier time-to-frequency transform method.

(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 VII


CAMSELL AREA 006
NORMAL MOVEOUT CURVES
CHART NO. 1 - S.P. 1460-309
CHART NO. 2 - S.P. 308-2
1
2
STEPOUT TIME IN MILLISECONDS
220
200
180
160
140
120
100
80
60
40
20
0
100
.200
.300
.400
.500
.600
.700
.800
TWO WAY RECORD TIME (SECONDS)


PLAT VIII
CAMSELL AREA 006
VELOCITY CURVES
CURVE NO. 1 - S.P. 1460-309
CURVE NO. 2 - S.P. 308 - 2
VELOCITY × 1000 FT. / SEC.
16
15
14
13
12
11
10
9
8
7
6
0
.100
.200
.300
.400
.500
.600
.700
.800
1
2
TWO WAY RECORD TIME (SECONDS)

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 IX, Page 49. Input and output are in CDP standard sequential tape format.

(c) Time-varying trace scale

Was applied to shotpoints 2 to 274 and 1363 to 1460 to raise or lower the amplitude across various portions of the trace, linearly relative to each other, in the following proportions:

Time	0	-	.200	=	50%
	.200	-	.500	=	100%
	.500	-	1.500	=	50%

5. (a) Trace gather

Reformats sequential seismic tapes to facilitate preparation for stacking.

(b) Stack

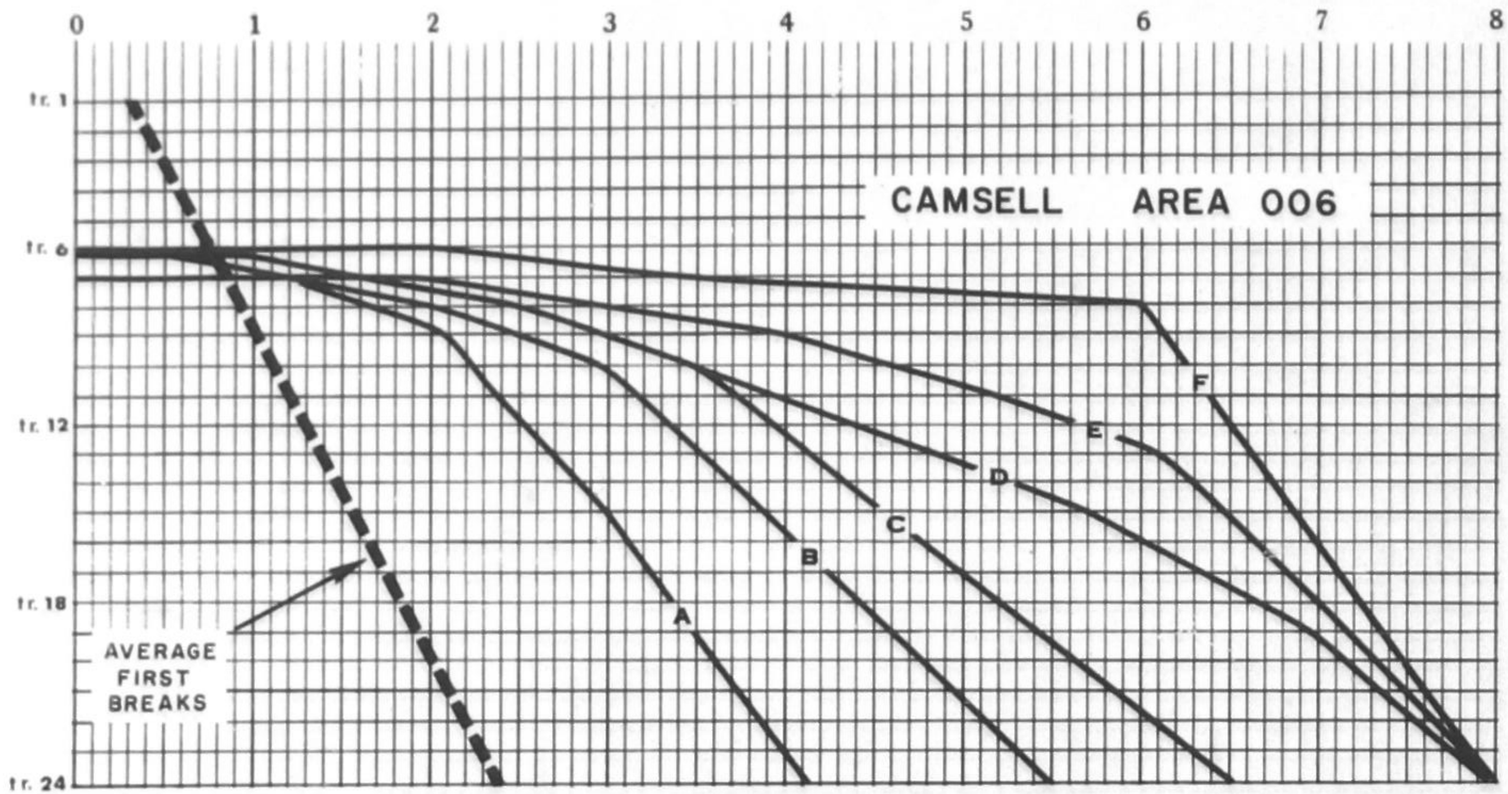
This program processes the output from the trace gather program. A stacked trace is produced by summing all the traces representing a common depth point. Traces which have been muted are compensated for in order to normalize the amplitude relationship on the output trace.

(c) Adjacent trace mix: 20-60-20

Was used on shotpoints 2 through 1362 to enhance the coherence across these data.

PLAT IX

SEQUENTIAL MUTE PATTERNS



ADDITIONAL PROCESSING

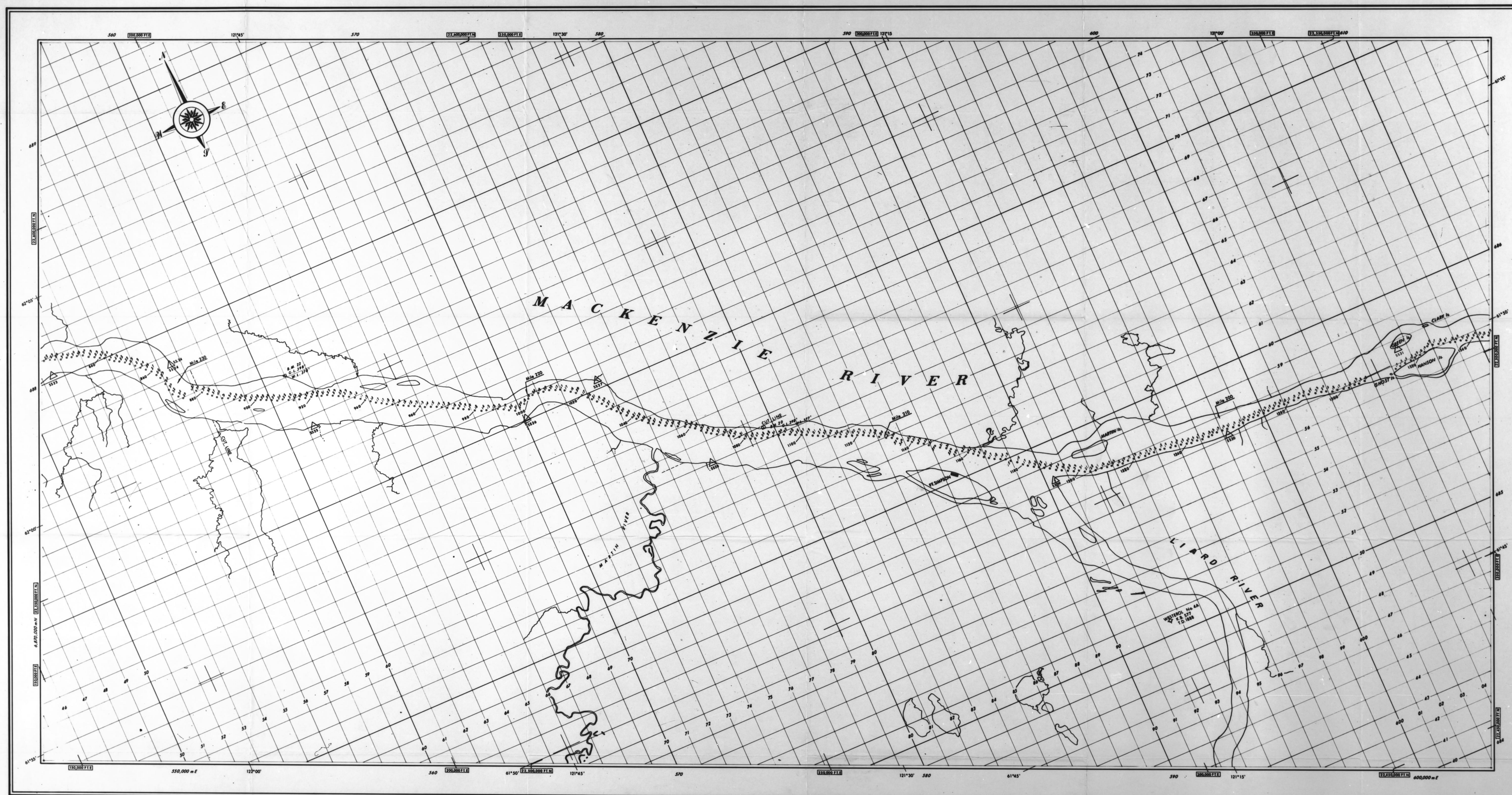
(a) 100% duplicate sections were made covering shotpoints 2 to 485 in an attempt to define more clearly a possible deep reflection and also to validate correlation across the stacked data. The results substantiated the presence of a deep event and on some portions helped secure more reliable picks for the top of the carbonate.

(b) A test was made across shotpoints 113 to 142 displaying the stacked data without time variant trace scaling to determine the attenuating effect of the stack on the deeper reflection. The results showed that cancellation had minimized the continuity and consequently the 100% sections were used to pick times for the later event.

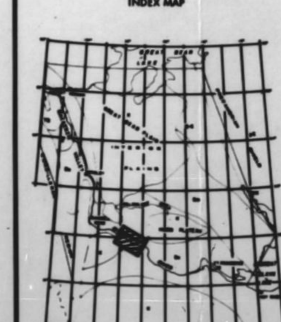
(c) A condensed section was made by using one trace to represent each shotpoint. Trace No. 2 was used for all of Camsell.

By: B. R. Johnson
Geophysical Technician

PALLISTER and ASSOCIATES



INDEX MAP



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

MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP. C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

V. Gary Smith Associates Ltd

SHOTPOINT LOCATION and
WATER DEPTHS

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
J.A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP C
MAP NO. 3

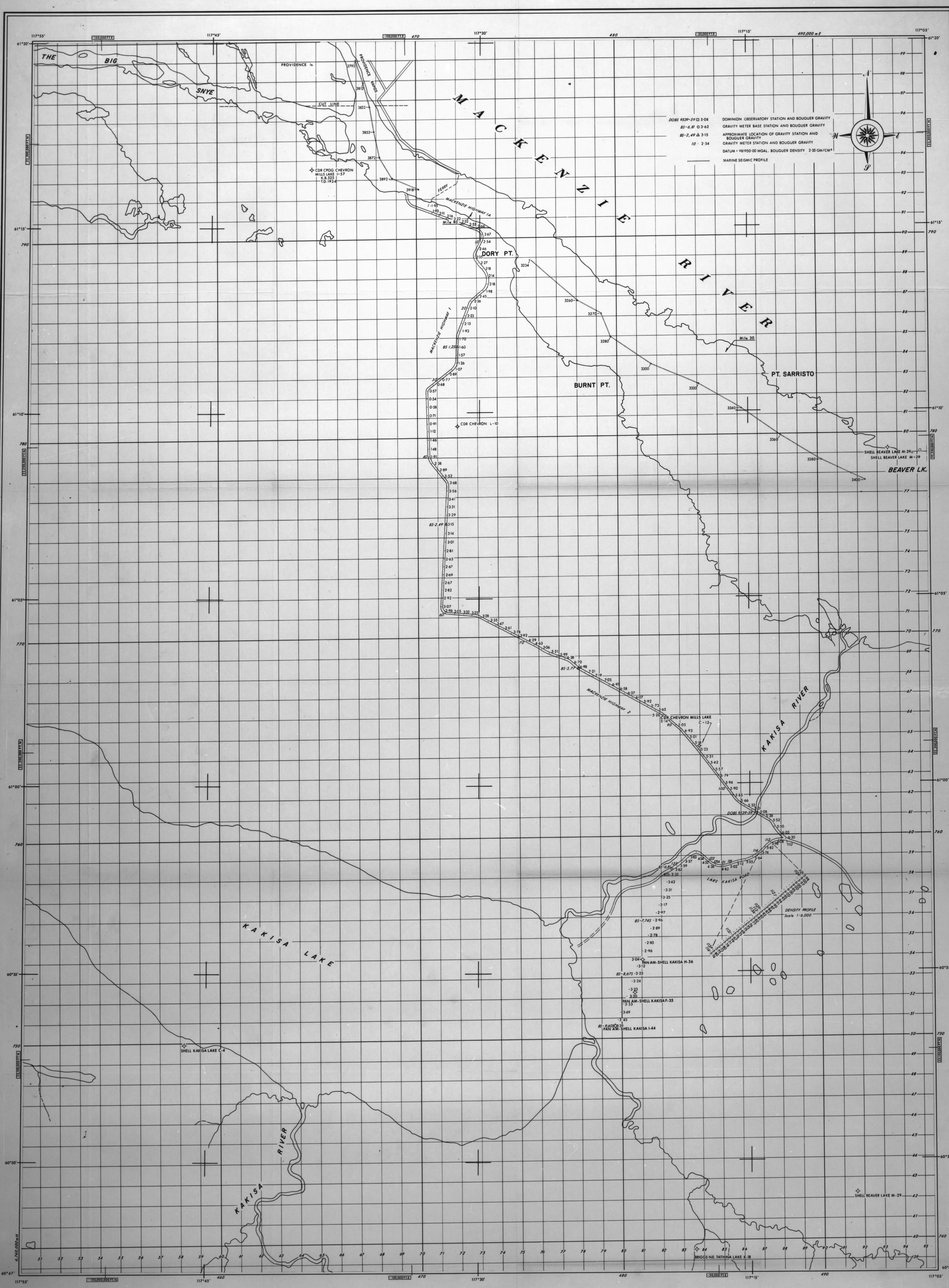
LEGEND

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.



OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

PROVIDENCE
MAP C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

LOCATION MAP

CONTOUR INTERVAL

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
SURVEYED & INTERPRETED BY HUNTEC LIMITED
TORONTO, CANADA - NOVEMBER 1968
IOB No. PH 896/68

FIG. 1

LEGEND

△ SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N. T. S. MAPS

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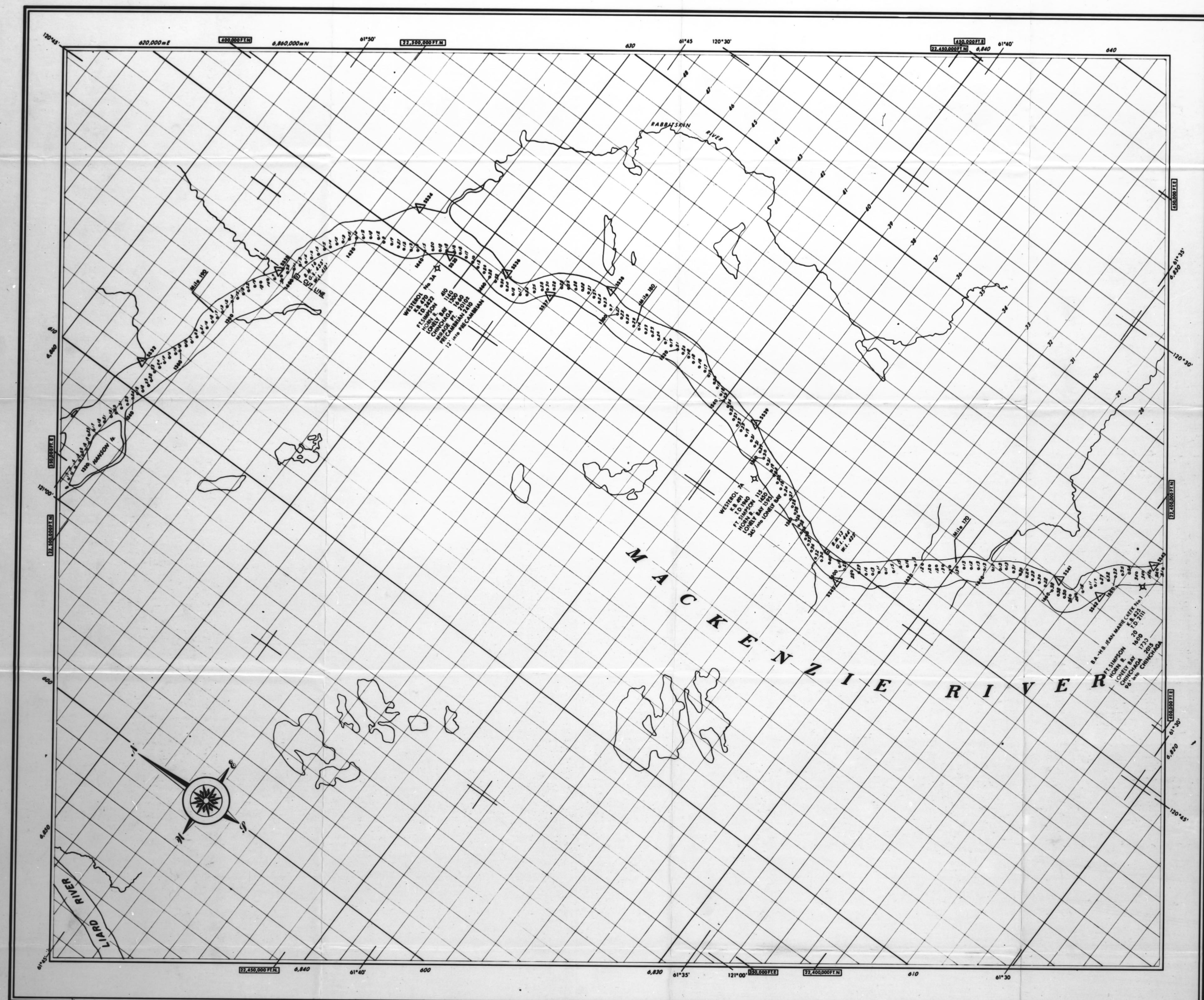
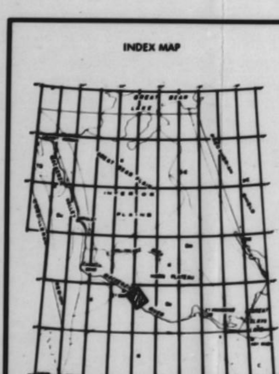


INDEX MAP



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

MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP D

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:
J.A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP D
MAP NO. 3

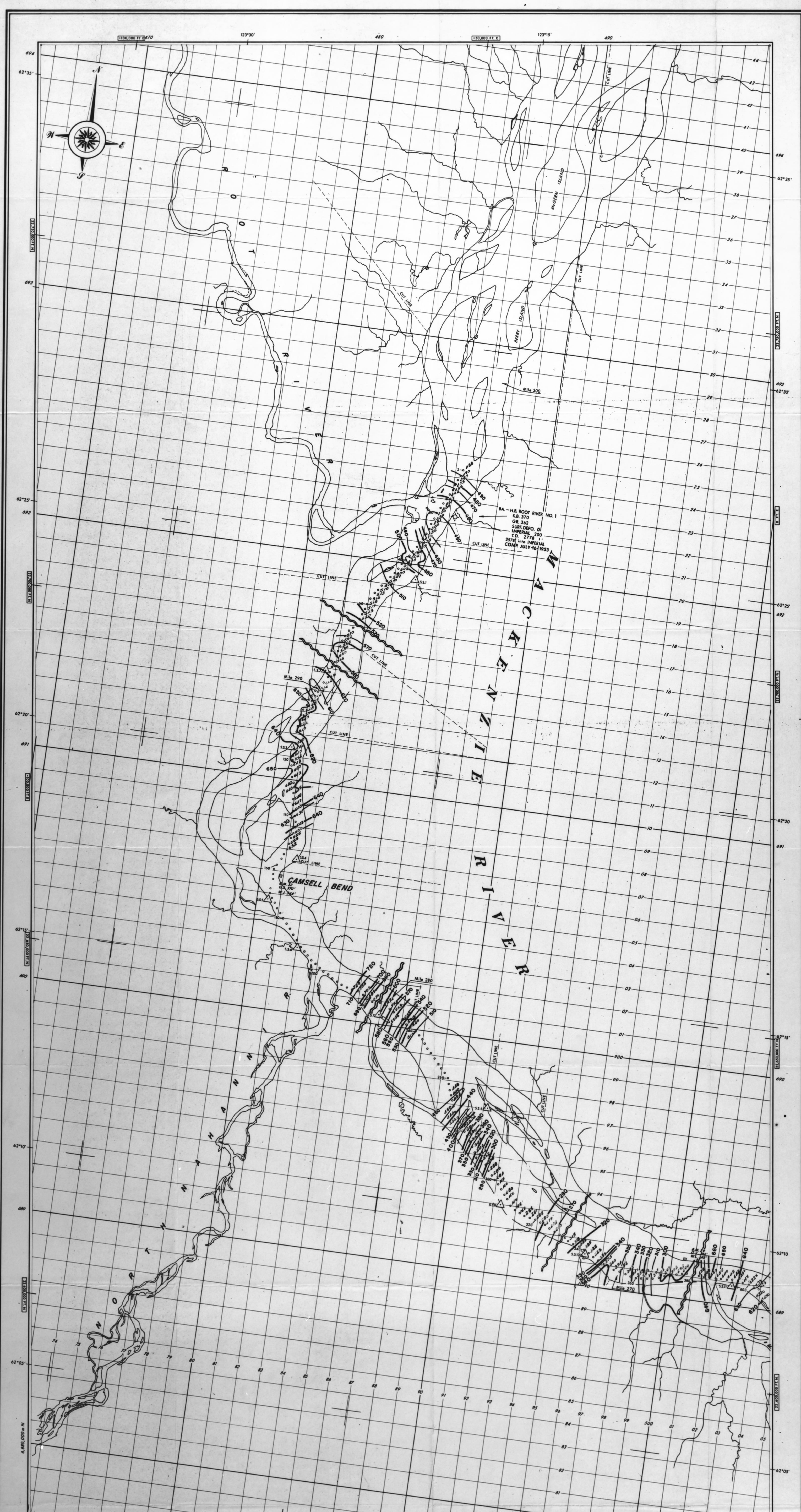
LEGEND

SS10 - SHORE STATION TEN

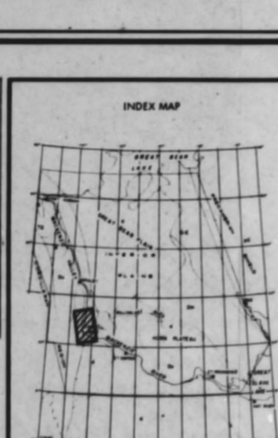
TOPOGRAPHY TAKEN FROM
N. T. S. MAPS

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

17,650 = C.U.T.M. GRID CO-ORDINATES
IN FEET.



INDEX MAP



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JACK HILL, A.L.S., D.L.S.

MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP A

SCALE 1:50,000

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:
J. A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP A
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.

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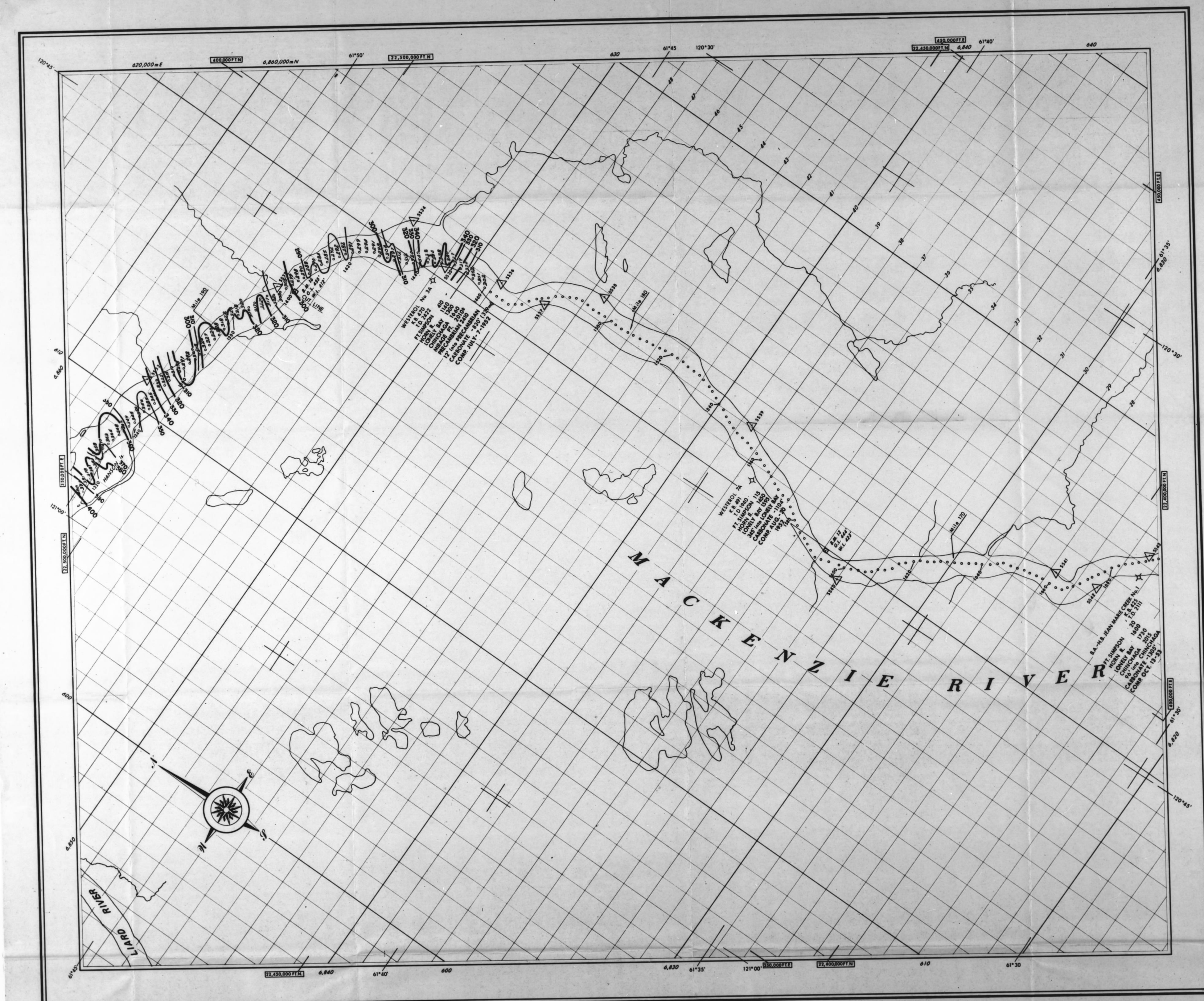

INDEX MAP

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

MAPS DRAWN BY: JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP D

SCALE 1:50,000

ONE THOUSAND METER UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

TOP MIDDLE DEVONIAN CARBONATE

Seismic Time .

CONTOUR INTERVAL 10ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
J. A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP D
MAP NO. 1.

LEGEND

△SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

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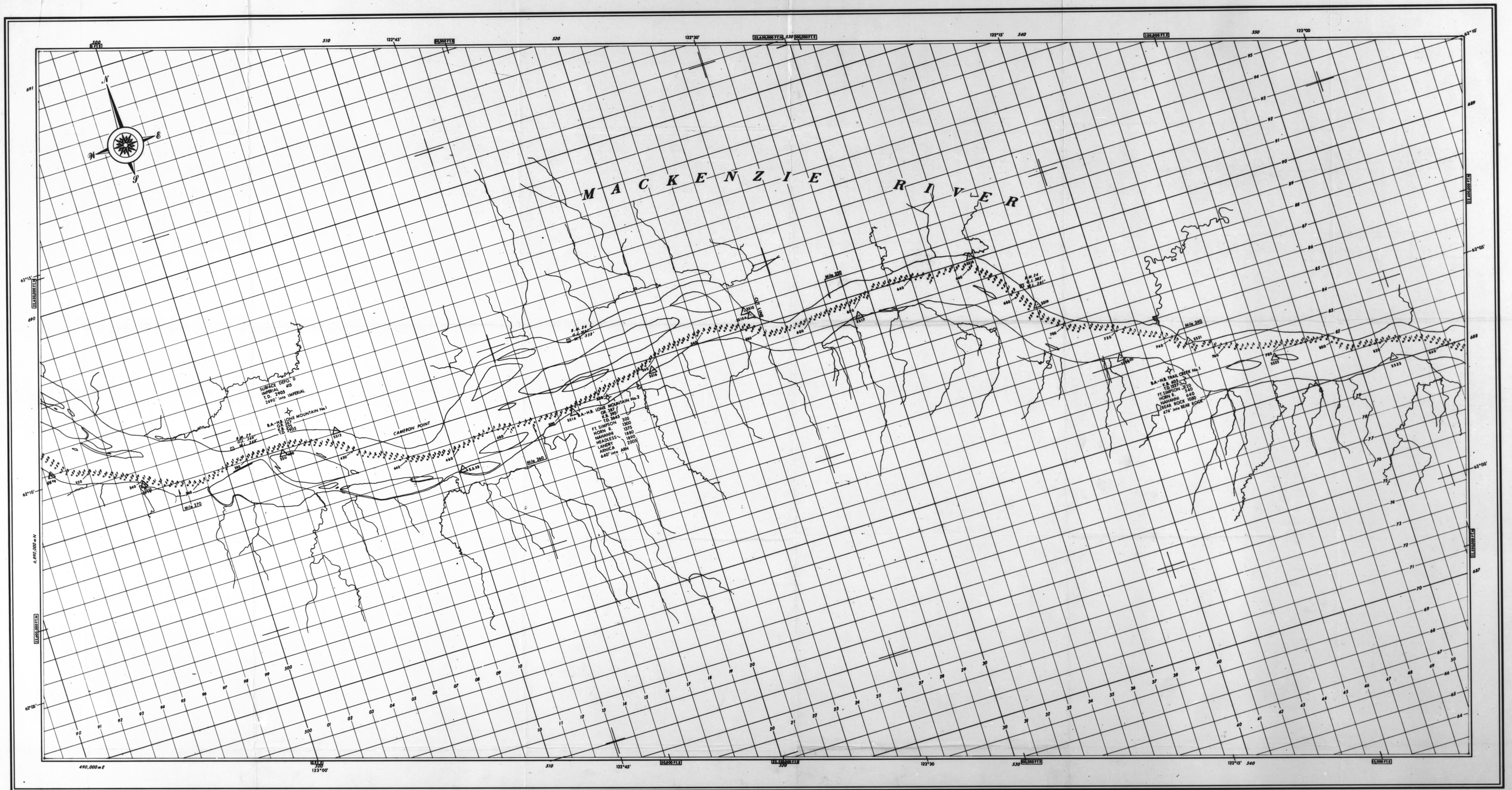

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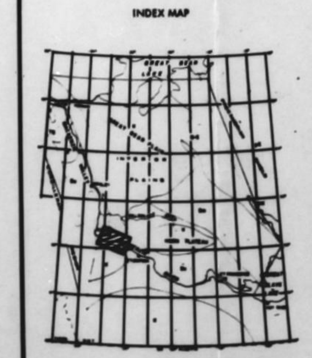

MAPS COMPILED BY:
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JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP B

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:
J.A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP B
MAP NO. 3

LEGEND

SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N. T. S. MAPS

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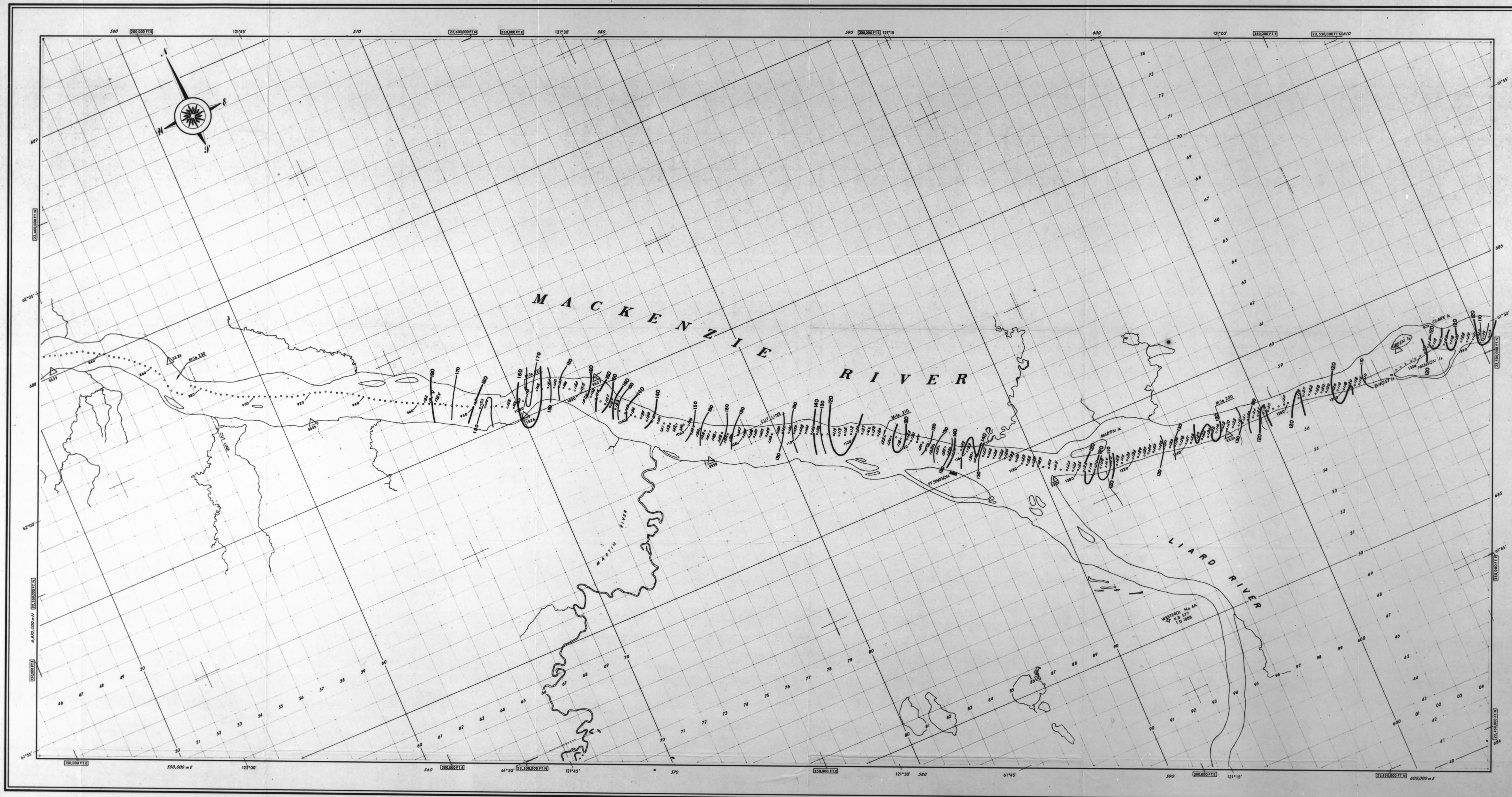

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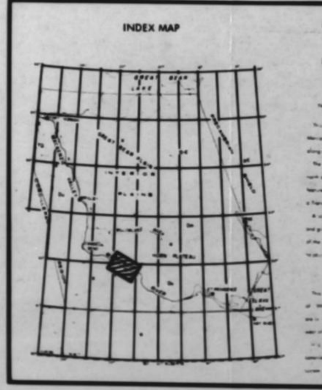

MAPS COMPILED BY:
JACK HILL, A.L.S., D.L.S.

MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP C

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
DATUM VELOCITY FT./SEC.

Interpretation By:
J.A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP C
MAP NO. 2

N.B. MAP "B" NOT INCLUDED. NO DATA.

LEGEND

△ SS10 - SHORE STATION TEN

TOPOGRAPHY TAKEN FROM N.T.S. MAPS

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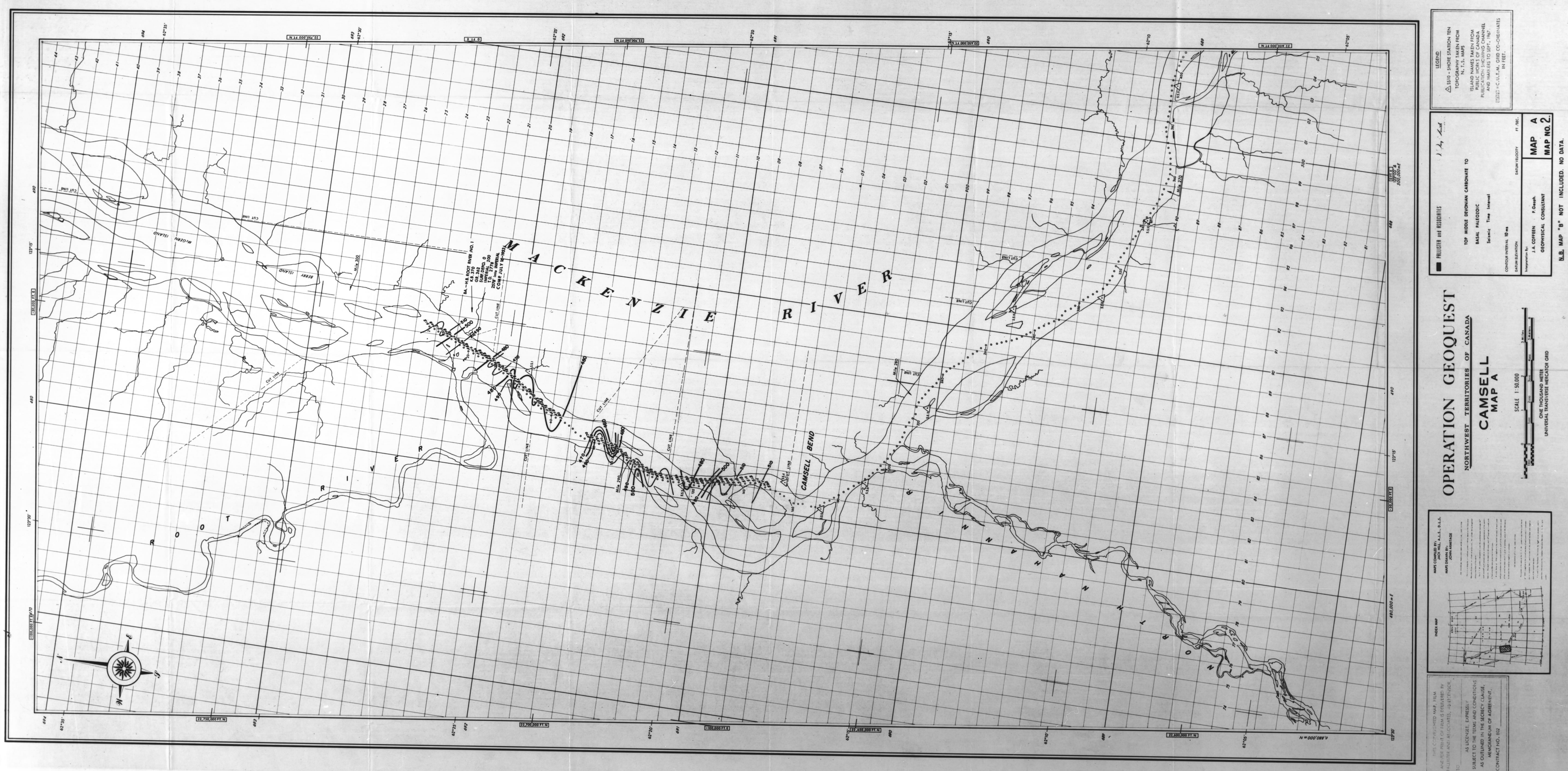

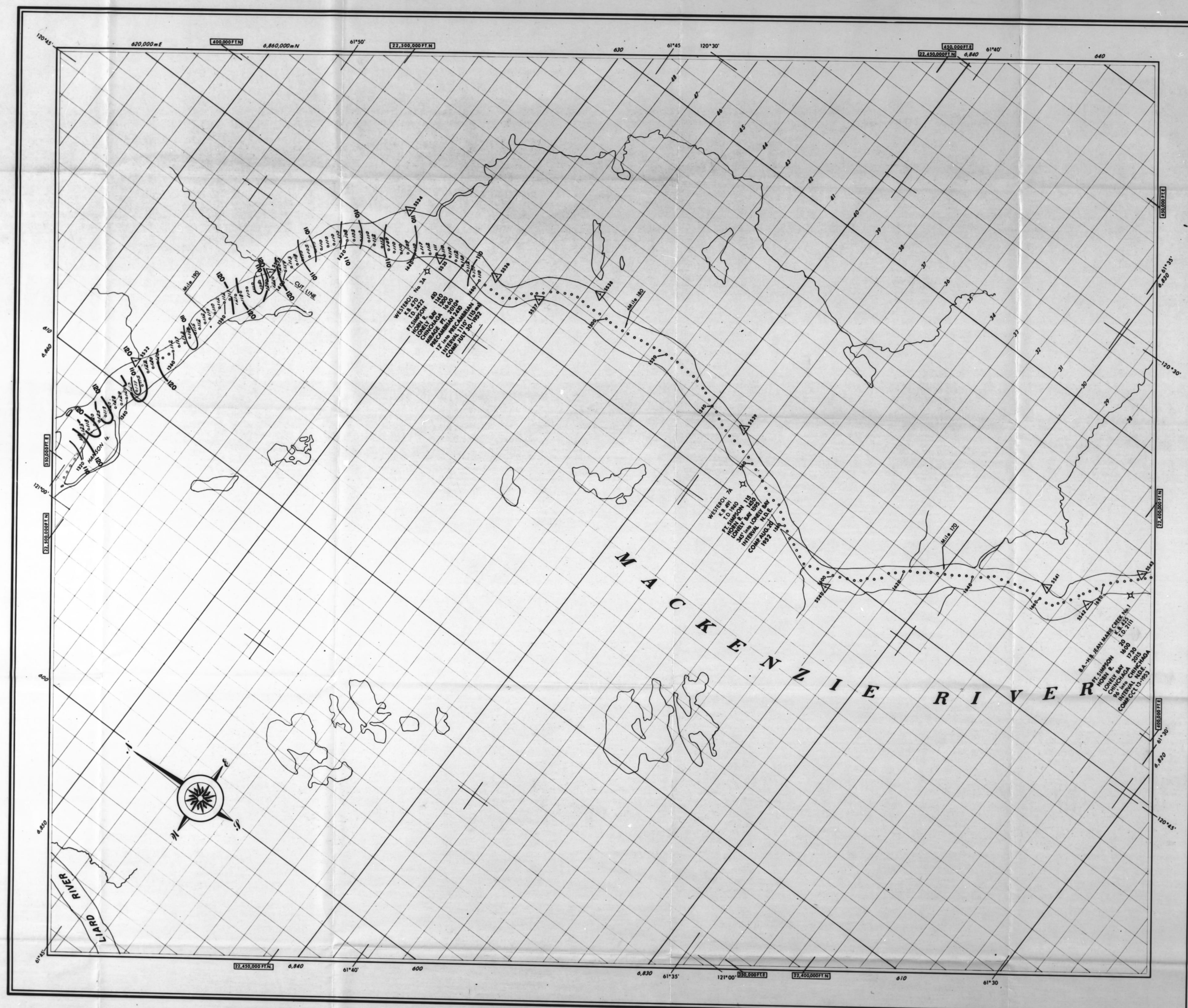

INDEX MAP

MAPS COMPILED BY:
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MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP D

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

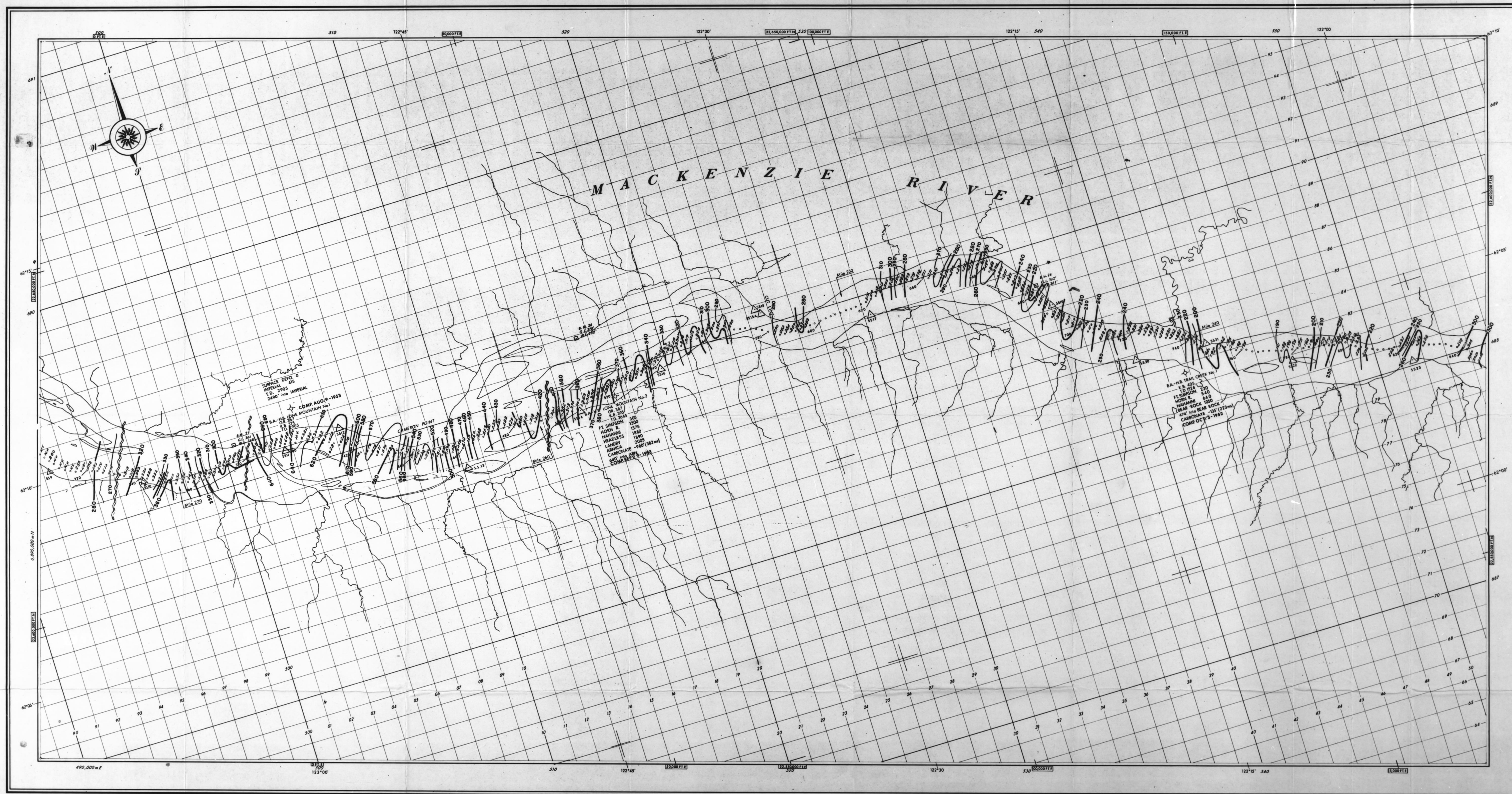
TOP MIDDLE DEVONIAN CARBONATE TO
BASAL PALEOZOIC
Seismic Time Interval

CONTOUR INTERVAL 10 ms
DATUM ELEVATION
DATUM VELOCITY FT./SEC.

Interpretation By:
J. A. COFFEEN P.Geoph.
GEOPHYSICAL CONSULTANT

MAP D
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.



INDEX MAP

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JACK HILL, A.L.S., D.L.S.
MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP B

SCALE 1:50,000

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:
J.A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP B
MAP NO. 1.

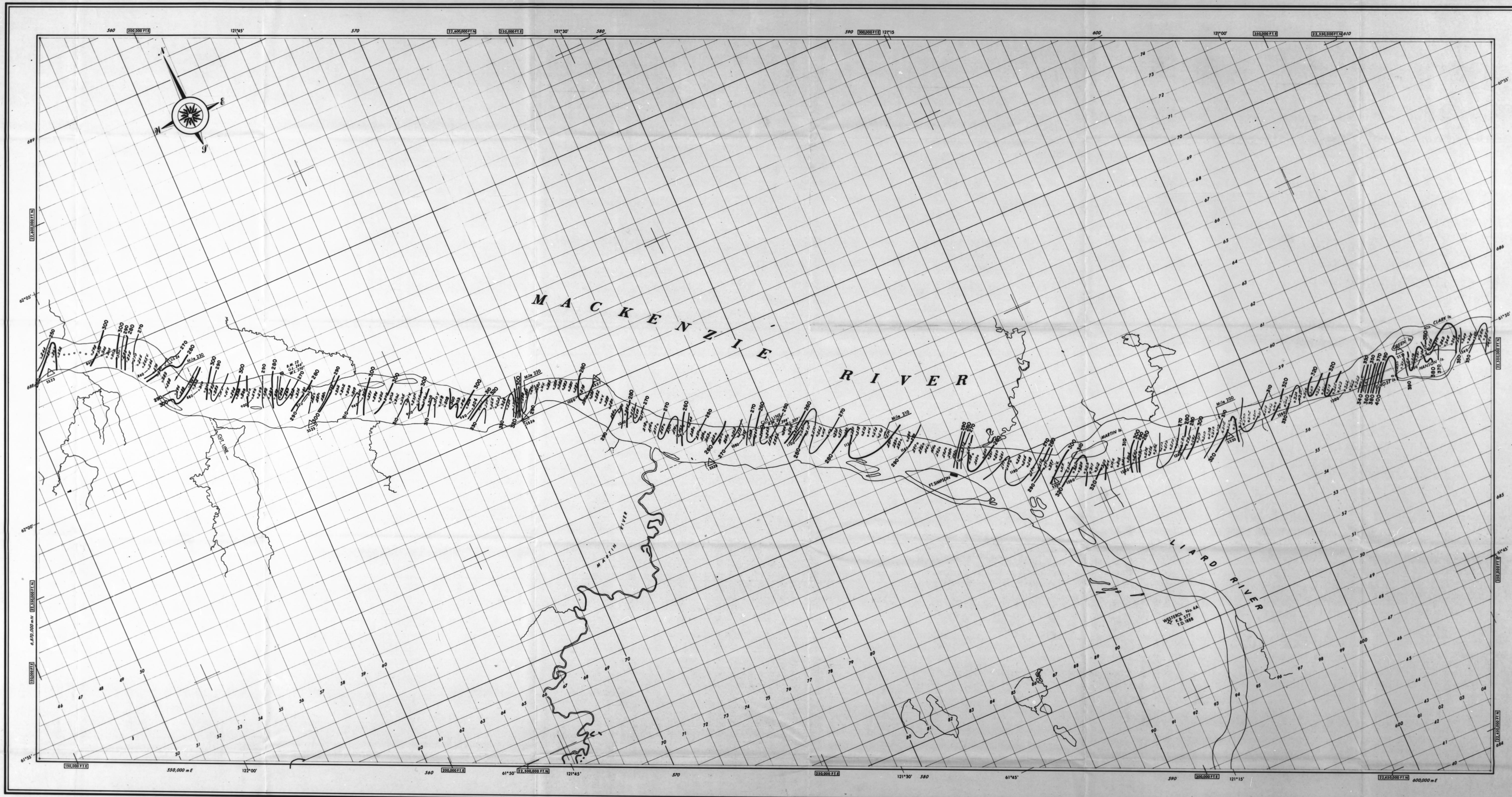
LEGEND

△ 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.

[17,650] = C.U.T.M. GRID CO-ORDINATES IN FEET.



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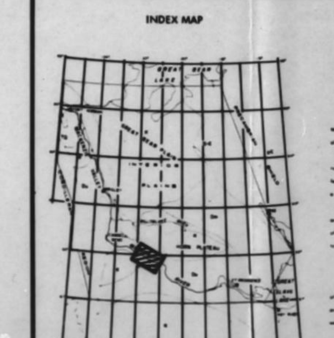
INDEX MAP



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

MAPS DRAWN BY:
JOHN ARMITAGE

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

CAMSELL
MAP C

SCALE 1:50,000

ONE THOUSAND METER
UNIVERSAL TRANSVERSE MERCATOR GRID

PALLISTER and ASSOCIATES

V. Jay Smith Associates Ltd

TOP MIDDLE DEVONIAN CARBONATE

Seismic Time

CONTOUR INTERVAL 10 ms

DATUM ELEVATION

DATUM VELOCITY FT./SEC.

Interpretation By:
J. A. COFFEEN P. Geoph.
GEOPHYSICAL CONSULTANT

MAP C
MAP NO. 1.

LEGEND

SS10 - SHORE STATION TEN

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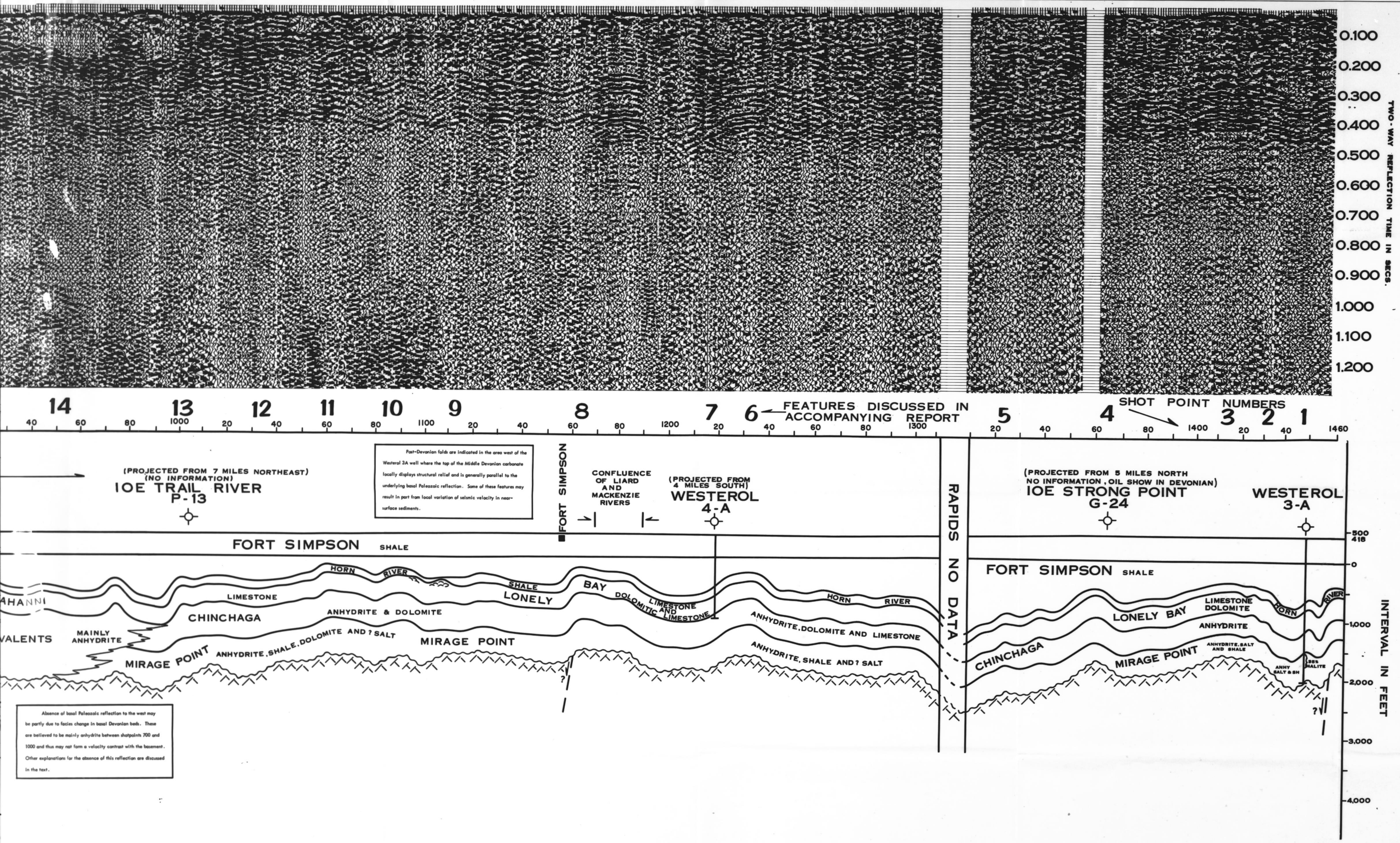


Post-Devonian folds are indicated in the area west of the Westerol 3A well where the top of the Middle Devonian carbonate locally displays structural relief and is generally parallel to the underlying basal Paleozoic reflection. Some of these features may result in part from local variation of seismic velocity in near-surface sediments.

Absence of basal Paleozoic reflection to the west may be partly due to facies change in basal Devonian beds. These are believed to be mainly anhydrite between shotpoints 700 and 1000 and thus may not form a velocity contrast with the basement. Other explanations for the absence of this reflection are discussed in the text.

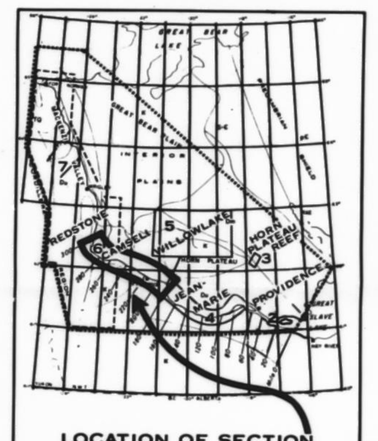
PALLISTER and ASSOCIATES
V. Zay Smith Associates Ltd.

OPERATION GEOQUEST

NORTHWEST TERRITORIES OF CANADA

PROJECT SIX
CAMSELL

CONDENSED SEISMIC PROFILE AND GEOLOGIC CROSS SECTION
ALONG THE CHANNEL OF THE MACKENZIE RIVER
FROM WESTEROL 3-A TO BA-HB ROOT RIVER 1

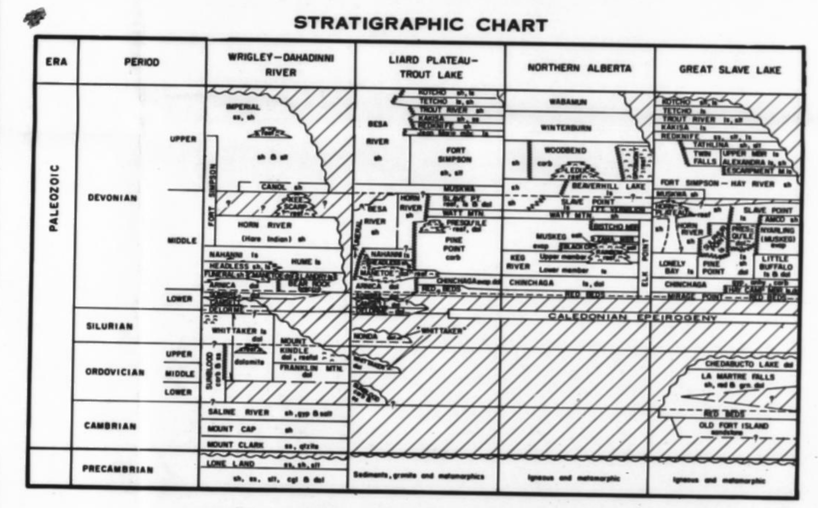


LOCATION OF SECTION

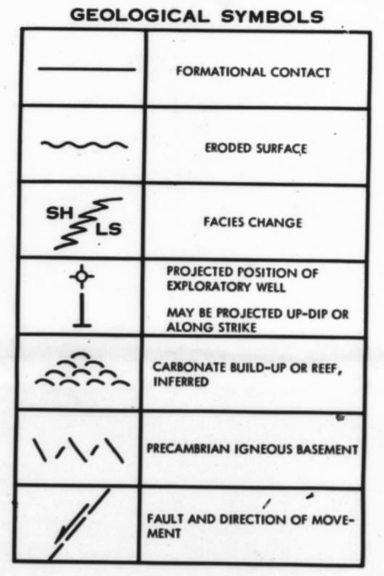
APPROXIMATE HORIZONTAL SCALE 0 — 8,800'

TOTAL LENGTH OF PROFILE
APPROX. 114 MILES

STRATIGRAPHIC CHART



GEOLOGICAL SYMBOLS



CONDENSED SEISMIC SECTION PREPARED BY REFORMATING ONE TRACE FROM EACH SEISMIC RECORD. TRACE NO. 2 WAS USED

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

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

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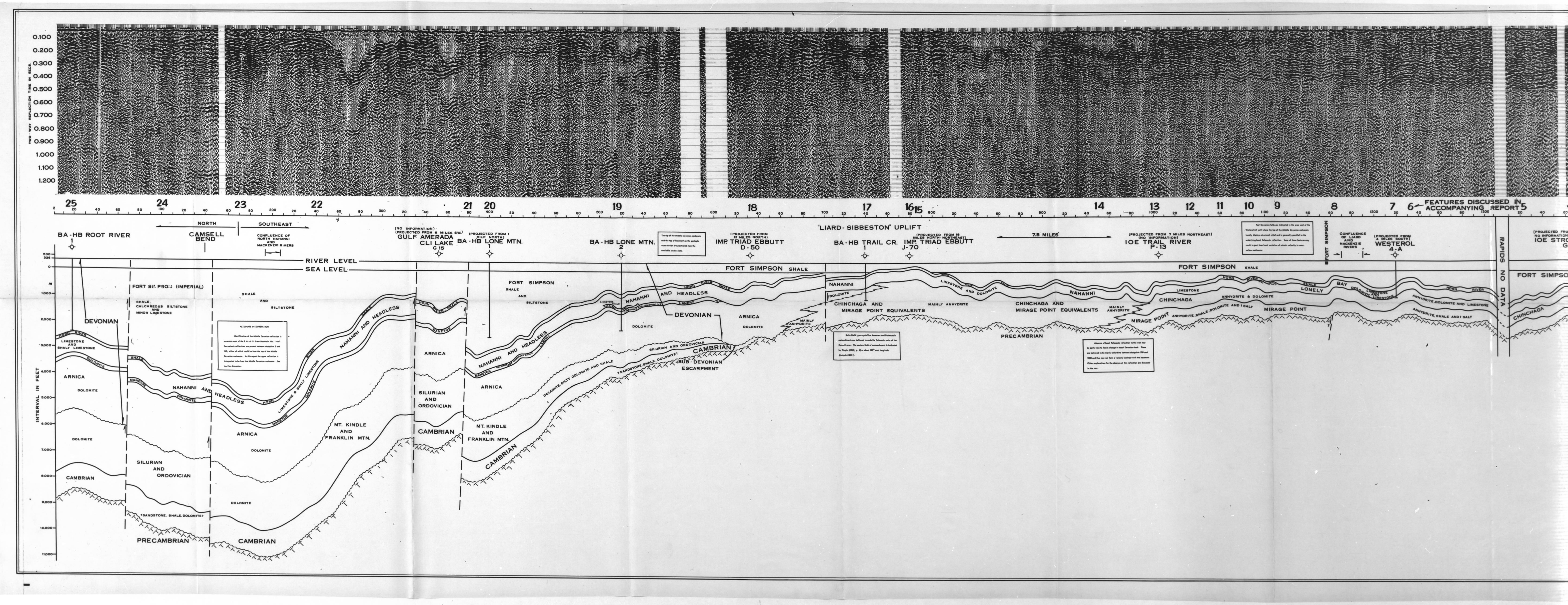
TWO WAY REFLECTION TIME IN SECS.
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
1.100
1.200
25
24
23
22
21 20
19
18
17
16 15
14
13
12
11
10
9
8
7
6
FEATURES DISCUSSED IN ACCOMPANYING REPORT
5
BA-HB ROOT RIVER 1
NORTH
SOUTHEAST
CAMSELL BEND
CONFLUENCE OF NORTH NAHANNI AND MACKENZIE RIVERS
GULF AMERADA CLI LAKE G 15
BA-HB LONE MTN. 1
BA-HB LONE MTN. 2
IMP. TRIAD EBBUTT D-50
"LIARD - SIBBESTON" UPLIFT
BA-HB TRAIL CR. 1
IMP. TRIAD EBBUTT J-70
7.5 MILES
IOE TRAIL RIVER P-13
FORT SIMPSON
CONFLUENCE OF LIARD AND MACKENZIE RIVERS
WESTEROL 4-A
RAPIDS NO DATA
IOE STR
RIVER LEVEL
SEA LEVEL
INTERVAL IN FEET
DEVONIAN
FORT SIMPSON (IMPERIAL)
SHALE CALCAREOUS SILTSTONE AND MINOR LIMESTONE
SHALE AND SILTSTONE
FORT SIMPSON SHALE AND SILTSTONE
FORT SIMPSON SHALE
NAHANNI AND HEADLESS
ARNICA
DOLOMITE
SILURIAN AND ORDOVICIAN
CAMBRIAN
PRECAMBRIAN
MT. KINDLE AND FRANKLIN MTN.
SANDSTONE, SHALE, DOLOMITE?
CAMBRIAN (SUB-DEVONIAN ESCARPMENT)
NAHANNI
CHINCHAGA AND MIRAGE POINT EQUIVALENTS
MAINLY ANHYDRITE
CHINCHAGA
MIRAGE POINT
LONELY BAY
LIMESTONE
ANHYDRITE & DOLOMITE


TWO-WAY REFLECTION TIME IN SECS.
INTERVAL IN FEET
BA-HB ROOT RIVER 1
NORTH
SOUTHEAST
CAMSELL BEND
CONFLUENCE OF NORTH NAHANNI AND MACKENZIE RIVERS
(NO INFORMATION) (PROJECTED FROM 6 MILES S.W.)
GULF AMERADA CLI LAKE G 15
(PROJECTED FROM 1 MILE NORTH)
BA-HB LONE MTN. 1
BA-HB LONE MTN. 2
(PROJECTED FROM 12 MILES NORTH)
IMP. TRIAD EBBUTT D-50
"LIARD-SIBBESTON" UPLIFT
BA-HB TRAIL CR. 1
IMP. TRIAD J-70
RIVER LEVEL
SEA LEVEL
FORT SIMPSON (IMPERIAL)
SHALE
CALCAREOUS SILTSTONE
AND
MINOR LIMESTONE
SHALE AND SILTSTONE
FORT SIMPSON SHALE
DEVONIAN
HORN RIVER
LIMESTONE AND SHALY LIMESTONE
DOLOMITE
ARNICA
NAHANNI AND HEADLESS
MANETOE
LIMESTONE & SHALY LIMESTONE
MT. KINDLE AND FRANKLIN MTN.
SILURIAN AND ORDOVICIAN
CAMBRIAN
?SANDSTONE, SHALE, DOLOMITE?
PRECAMBRIAN
LANDRY
CHINCHAGA AND MIRAGE POINT EQUIVALENTS
MAINLY ANHYDRITE
DOLOMITE, SILTY DOLOMITE AND SHALE
SUB-DEVONIAN ESCARPMENT
ALTERNATE INTERPRETATION
Identification of the Middle Devonian reflection is uncertain west of the B.A.-H.B. Lone Mountain No. 1 well. Two seismic reflections are present between shotpoints 2 and 160, either of which could be from the top of the Middle Devonian carbonate. In this report the upper reflection is interpreted to be from the Middle Devonian carbonate. See text for discussion.
The top of the Middle Devonian carbonate and the top of basement on the geologic cross section are positioned from the available seismic data.
Both shield type crystalline basement and Proterozoic metasediments are believed to underlie Paleozoic rocks of the Camsell area. The eastern limit of metasediments is indicated by Ziegler (1967, p. 6) at about 120° west longitude (shotpoint 800 ±).


18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
SHOT POINT NUMBE
FEATURES DISCUSSED IN ACCOMPANYING REPORT
"LIARD - SIBBESTON" UPLIFT
7.5 MILES
(PROJECTED FROM 12 MILES NORTH)
IMP. TRIAD EBBUTT
D-50
BA-HB TRAIL CR.
1
(PROJECTED FROM 18 MILES NORTH-NORTHEAST)
IMP. TRIAD EBBUTT
J-70
(PROJECTED FROM 7 MILES NORTHEAST)
(NO INFORMATION)
IOE TRAIL RIVER
P-13
Post-Devonian folds are indicated in the area west of the Westerol 3A well 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.
FORT SIMPSON
CONFLUENCE OF LIARD AND MACKENZIE RIVERS
(PROJECTED FROM 4 MILES SOUTH)
WESTEROL
4-A
RAPIDS NO DATA
(PROJECTED FROM 5 MILES NORTH
NO INFORMATION, OIL SHOW IN DEVONIAN)
IOE STRONG POINT
G-24
FORT SIMPSON SHALE
HORN RIVER SHALE
NAHANNI
DOLOMITE
LIMESTONE AND DOLOMITE
CHINCHAGA AND MIRAGE POINT EQUIVALENTS
MAINLY ANHYDRITE
ARNICA
DOLOMITE
LIMESTONE
CHINCHAGA
ANHYDRITE & DOLOMITE
LONELY BAY
DOLOMITIC AND LIMESTONE
MIRAGE POINT
ANHYDRITE, SHALE, DOLOMITE AND ? SALT
ANHYDRITE, DOLOMITE AND LIMESTONE
ANHYDRITE, SHALE AND ? SALT
LIMESTONE DOLOMITE
ANHYDRITE
ANHYDRITE, SALT AND SHALE
PRECAMBRIAN
CAMBRIAN
-DEVONIAN
SCARPMENT
Both shield type crystalline basement and Proterozoic metasediments are believed to underlie Paleozoic rocks of the Camsell area. The eastern limit of metasediments is indicated by Ziegler (1967, p. 6) at about 120° west longitude (shotpoint 800 ±).
Absence of basal Paleozoic reflection to the west may be partly due to facies change in basal Devonian beds. These are believed to be mainly anhydrite between shotpoints 700 and 1000 and thus may not form a velocity contrast with the basement. Other explanations for the absence of this reflection are discussed in the text.