REPORT ON
RECONNAISSANCE SEISMIC

KEITH AND MCVICAR ARMS
GREAT BEAR LAKE - N.W.T.

Prepared by

JORDAN LEWIS & JOSE
GEOPHYSICAL CONSULTANTS LTD.

June 1972

Abstracted for
Geo-Science Data Index

Date _____

REPORT ON RECONNAISSANCE SEISMIC
KEITH AND MCVICAR ARMS GREAT BEAR LAKE - N.W.T.

INTRODUCTION

In July 1971, a 400 mile marine seismic reflection survey was conducted in Keith and McVicar Arms of Great Bear Lake. This survey was shot across some 1.3 million acres of Permit lands held by Alminex Limited, Ram Petroleums Ltd., Yellowknife Bear Mines Ltd., Midcon Oil and Gas Ltd., Inter Rock Oil Co., and Canadian Export Gas and Oil Ltd. This program was originally planned as a 60 mile land seismic program to be shot along the south and east shores of Keith Arm however it was thought that, despite the uncertainties of marine seismic quality, more coverage could be obtained over the actual permit area.

The program was shot by Teledyne Exploration Ltd. - field and playback operations were supervised by Jordan Lewis & Jose Ltd. A full report by Teledyne on field and playback operations is attached to this report. The only basic changes made in recording parameters compared to those previously used were an increase in air gun capacity from sixty cubic inches to one hundred twenty cubic inches, and an increase of minimum offset from three hundred and fifty feet to five hundred and twenty-five feet. These changes were made in the field and were designed to give more useful refraction information and reflection stepout for velocity analysis.

Plans had been made to shoot three long spread reversed refraction profiles utilizing sonabuoys - because of failure of the air compressor in the final stages of the program only half (one way) of one refraction profile was obtained. Because of lack of a reverse profile this data was difficult to interpret. However, it did indicate the presence of a faulted, shallow, carbonate refractor some four hundred to eight hundred feet below the lake bottom.

GEOLOGICAL DISCUSSION

Paper 71-11, Reconnaissance Geology, Southern Great Bear Plain,

REPORT ON

1971 RECONNAISSANCE SEISMIC PROGRAM

KEITH AND MCVICAR ARMS

GREAT BEAR LAKE - N.W.T.

Prepared by

R.P. JORDAN, P. ENG.

JORDAN LEWIS & JOSE

GEOPHYSICAL CONSULTANTS LTD.

For

ALMINEX LIMITED

TYPE OF SURVEY - Seismic Reflection

OPERATOR - Alminex Limited

CONTRACTORS

Field Supervision and Interpretation - Jordan, Lewis & Jose Geophysical Consultants Ltd.

Field Work - Teledyne Exploration Ltd.

Processing - Teledyne Exploration Ltd.

PERMIT NUMBERS - 6793, 6794, 6795, 6796, 6797, 6798, 6799, 6800, 6801, 6802, 6803, 6804, 6805, 6806, 6807, 6912, 6913, 6914, 6915, 6825, 6826, 6827, 6828, 6829, 6830, 6831, 6832, 6833, 6840, 6841, 6842 (Group 571)

PROJECT NUMBER - 635-9-7-71-1

LIST OF ENCLOSURES

Appendix - Field and Operations Report

Index Map: 1" = 16 miles Bear Rock Structure

2 miles = 1 inch Maps:

- Shot Point Index Map
- Surface and Lake Bottom Topography
- Surface Geology and Lake Bottom Refraction Analysis
- Isopach of Lake Bottom to Carbonate
- Isopach of Lake Bottom to Basement
- Structure Map on Basement

District of Mackenzie - H.R. Balkwill contains useful references to the regional geology of the area. In the project area itself, the south and west sides of Keith Arm are bounded by Cretaceous outcrops. Scattered outcrops of Mount Kindle, and undivided Ronning rocks occur along the south-east and east shores of Keith Arm and along the shores of McVicar Arm. Two major structural events have been mapped - at Manitou Island, Mount Kindle rocks occur in a tightly folded ENE striking anticline; and along Leith Ridge, immediately to the east of McVicar Arm, a prominent NNE striking exhumed Precambrian ridge has been mapped.

Regional outcrop and well data indicates that the pre-Cretaceous unconformity is dipping approximately twenty feet per mile to the west or northwest - this can be modified by local structure and by an interpolated steep west dipping hinge zone west of Ft. Franklin.

Integration of regional geology with the seismic interpretation has not yet been completed, however a regional map of the Bear Rock structure, using well and outcrop information indicates a number of anomalies - first, an extension of the Leith Ridge trend into a possible fault between the Canadian Reserve Signal Keller Lake O-13 and P-14 wells which could extend as far as the Shell Blackwater Lake G-57 well (note - Blackwater Lake could alternately be located on a shelfward extension of the Laramide fold belt present in the McConnel Range to the west). Secondly, the structure at Manitou Island requires a much steeper than regional gradient (on the Mt. Kindle) north from the Buttes et al Blackwater Lake I-54 well (75 feet per mile SSE).

Balkwill reports outcrop porosity developments in the Cambrian Old Fort Sandstone and in the basal Dolomites of the Mount Cap and Saline River formations. Structure can be anticipated as drape over Precambrian topography and along fault zones. A 16 mile to 1 inch index map showing a possible interpretation of structure on the Bear Rock is attached.

GEOPHYSICAL DISCUSSION

Basic shooting and data playback parameters are fully discussed

in the Teledyne operations report (attached). Playback and interpretation of Keith Arm and McVicar Arm marine data presents unique problems, not usually encountered in plains shooting. Because of the rapidly varying water bottom topography and extreme contrast between water velocities of 4600'/s and carbonate at 18 - 20,000'/s, spread correction of CDP data is an almost insurmountable problem. Water bottom ringing occurs throughout the area and is particularly troublesome over the east two-thirds of the project area. The final solution of the spread correction and associated muting problems utilized a judicious juggling of extrapolated outcrop geology and lake bottom short spread refraction data, preliminary interpretation of single fold uncorrected near trace playouts and a routine sampling of velocity scans. The final sections showed a considerable amount of improvement over initial playbacks which were prepared using fixed velocity data. The attached plat showing various geological models and corresponding seismic configurations gives some idea of the complex geometry involved in the CDP marine shooting. Note the considerable amount of delta T on the water bottom rings which should theoretically reduce the effect of water bottom reverberations to a minimum in the zone of interest.

A considerable amount of valuable refraction information was derived from first arrivals on the field monitor records. Routine sampling of refraction arrivals was used to prepare a water bottom velocity map and to calculate depths to the Precretaceous unconformity down dip from the zero edge of the quaternary Cretaceous sequence.

Because of varying water depths and uncertainty of replacement velocities no attempt was made to correct the seismic sections to a fixed datum. After final corrections were made, time values on the Unconformity and on the Pre-Cambrian were converted to depth using velocities of 8500'/s and 18,000'/s for the Quaternary - Cretaceous and Carbonate sections respectively.

Five maps have been prepared - Surface and Lake Bottom Topography, Surface Geology and Lake Bottom Refraction Analysis, Isopach of Lake Bottom to Carbonate, Isopach of Lake Bottom to Basement, and Structure Map on

Basement. These maps (~~except for Isopach of Lake Bottom to Basement~~) on a scale of 4 inches to one mile, are attached.

An approximate cycle identification was obtained by use of interval velocities from velocity scans, correlation to lake bottom refraction velocities and sonigrams from the Imperial Lac Tache C-35 and Sinclair Wolverine D-61 wells. It seems probable that most of the project area occupies a high shelfal position similar to that found at the Imperial Lac Tache and Cartridge wells. Nothing was seen to indicate that the thick Bear Rock and Ronning sequences found at the Wolverine Creek well will occur in the project area.

MAP DISCUSSION

Surface and Water Bottom Topography - Sources for this map are published four mile to one inch topographic sheets, Fathometer readings obtained by Teledyne and soundings published by the Canadian Hydrographic Service. Of particular interest are the pronounced scour channels along the SE and NW edges of Keith Arm and the large topographic high ridge centered on 121° 50'W and 65° 25'N.

Lake Bottom Refraction Analysis - This map shows surface geology (GSC Paper 71-11) and water bottom velocities based on short spread refraction analyses. An attempt has been made to relate these velocities to possible rock types. Note that the velocities shown are those of the deepest refractor present so that areas noted as OSK for instance could still have a hundred feet or more of Quaternary or Cretaceous cover.

Isopach Lake Bottom to Carbonate - This interval has been converted from time at a velocity of 8500'/s. Thickness varies from less than 100' along 122° 00' longitude and along the Manitou Island Structure, to 600' in the north-west side of Keith Arm.

Structure Contours on Basement - This map was constructed by preparing a Lake Bottom to Basement isopach (converting time values from

Carbonate top to Basement at 18,000'/s) and adding to Lake Bottom elevations.

Three distinct linear trends striking roughly NE-SW can be seen in Keith Arm. Perhaps the most outstanding trend is the steep west dipping hinge zone striking almost north south between 121° 45' and 122° 00'. Note that this trend shows up prominently on the Lake Bottom topography -there is some possibility that this correlation could indicate that the mapped Basement is influenced by water bottom multiples. It is also possible that Lake Bottom topography is influenced by Basement structure. Without definitive well ties this anomaly must be considered as very tentative.

CONCLUSIONS AND RECOMMENDATIONS

Overall quality and credibility of the seismic is only fair to poor. Interpretation of data has indicated the possibility of three fairly well-defined fault trends striking NNE-SSW through the permit lands. One of these trends is further supported by outcrop evidence at Manitou Island. Relief on basement could be up to five hundred to a thousand feet. Extremely rugged lake bottom topography, severe water bottom ringing and inability to correct adequately for near-surface velocity changes leave the interpretation in considerable doubt. On the other hand, presence of subsurface structure involving basement at Leith Ridge, Manitou Island, and in the Shell Blackwater Lake and Keller Lake wells, lends some support to the hypothesis of a severely faulted basement and Paleozoic section in the area of Keith Arm.

Interpretation was hindered by lack of subsurface well ties and supporting criteria such as could be supplied by gravity and aeromagnetics.

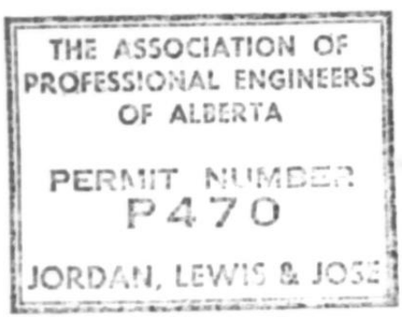
The most obvious conclusions that can be drawn from work done to date are:

(a) Keith Arm appears to be the result of glacial scouring - Quaternary and Cretaceous deposits occur in the western half of the project area. Large ridges and scour channels, possibly modified or controlled by earlier tectonics or basement topography occur in the east half of the area.

(b) Other than evidence of a small Proterozoic basin and presence of a normal amount of Quaternary and Cretaceous cover in the west third of the area there is no evidence of any large scale pre-Cretaceous subsidence or preservation of rocks younger than Ronning in Keith or McVicar Arms. On the contrary, younger rocks, presumably including the Bear Rock and Hume have been largely removed by pre-Cretaceous and glacial erosion.

(c) Additional evaluation should include acquisition of trade seismic to tie wells to the west and south of the project area, acquisition by shooting or trade of a limited amount of land data along the south shore of Keith Arm. Additional marine data should be augmented by short spread (2500 ft.) refraction data and by low energy sparker data for shallow information. In addition, acquisition of trade aero-magnetic data on a regional basis and including coverage over Leith Ridge should be considered.

R.P. Jordan, P. Eng.



APPENDIX

I. INTRODUCTION

During the latter part of July and early August, 1971, a marine seismic survey recorded in digital format was conducted by Teledyne Exploration Ltd. in Keith and McVicar Arms of Great Bear Lake in the Northwest Territories. (See Plate II.)

The survey was performed for ALMINEX LTD. and its partners and comprised 403 miles of reflection traverse and approximately 3 miles of refraction shooting.

II. GENERAL INFORMATION

(a) Location of Survey Area

The area surveyed is located in the Great Bear Lake in the Northwest Territory of Canada between approximate latitudes 64° 55'N to 65° 40'N and longitudes 120° 23'W to 123° 28'W.

(b) Purpose of Survey

The objectives of the survey were as follows:

1. To determine the thickness of sedimentary sections
2. To establish the configuration of sub-surface strata
3. To determine the existence or otherwise of structural features favorable for the accumulation of hydrocarbons within the surveyed area.

(c) Base of Operations

During the survey the village and port of Fort Franklin was used as the operational base, although some fixed wing aircraft and helicopter support was furnished out of Norman Wells.

(d) Time of Operations

On July 12, 1971 the survey crew started setting up the shore stations for the Hastings Raydist electronic positioning system. These stations had been established the previous year for a program operated for the account of ARCO and permission was granted by them for use during 1971. At the same time the party chief began assembling the equipment for mounting on the ship (Radium Gilbert). This equipment had been barged up the McKenzie and Great Bear Rivers just prior to this date.

On July 19,1971 the crew began installing the equipment on the

Radium Gilbert and made some test runs to check the seismic instrument and positioning equipment on July 21. Actual production began July 22 and the reflection program was completed July 30. July 31 was devoted to refraction shooting and the bulk of the crew left Fort Franklin on August 2, 1971 after dismantling and removing the seismic gear from the ship.

(e) Survey Navigation

A Ray-Dist DR-S system was provided and operated by Teledyne Hastings - Raydist to determine the position of the lines and shot points. This system operates by simultaneous transmission from two unmanned shore stations that are recorded on board the survey ship and the position established by the varying phase shift of the two transmissions.

The co-ordinates of the shore stations used are as follows:

STATION	ZONE	LATITUDE	LONGITUDE	CONVERGENCE
MINFIX 05	10	65 37 45.6640	-122 22 60407	0-34 31.3529
MINFIX 06	10	65 23 37.5036	-121 31 45.0760	-1 20 14.2778
MINFIX 07	10	65 0 23.9499	-122 25 39.3092	0-31 7.7324
MINFIX 08	10	65 9 30.2855	-120 25 54.1681	-1 58 58.6412
MINFIX 09	10	65 3 42.7893	-120 31 3.7399	-2 15 3.9810

Pre-plots were made for the program to guide the vessel on its course for each line. Post plots were made on completion of the seismic survey to establish the exact position of the lines and shot points.

(f) Survey Vessel

The recording equipment was installed on the steelhulled Radium Gilbert, 120' x 29' with a crew of six. This vessel operates exclusively on Great Bear Lake and its primary function is that of a supply ship for the

various mining and fishing operations. It was made available for a period not exceeding 20 days and fortunately the survey was completed well within that period. The vessel is equipped with a recording fathometer that had previously been used only intermittently. However, during the seismic survey it was run continuously with only minor interruptions.

(g) Weather

Weather and water surface conditions were generally good during the period of the survey except for a period of less than one day when rough weather damaged one of the on-shore survey stations and forced a temporary shut down. There is no doubt that the larger steel-hulled Radium Gilbert could cope with weather and water surface conditions much better than the 40 foot wooden-hulled Silver Belle that was used the previous summer.

III. RECORDING TECHNIQUES

(a) Recording Method

A single boat continuous tow operation was used. The recording vessel towed the cable continuously along a predetermined line at an approximate speed of 5 knots. Three Bolt 600B air guns equipped with a 40 cubic inch chamber operating at a working pressure of 2000 P.S.I. were used.

The guns were towed behind the survey vessel at a distance of two hundred feet and at a depth of thirty feet, when the correct shotpoint position was reached all guns were fired simultaneously by an electrical impulse synchronized with the recorder.

A Chicago-Pneumatic diesel air compressor supplied the required air.

(b) Marine Cable

The cable used was a neutrally buoyant streamer manufactured by Teledyne Exploration Company. This cable is designed as a continuous tow cable. It is oil filled and contains 50MP 7B hydrophones per 150 foot section. The center of the closest section was 525 feet from the air gun array with the closest geophone in the section 450 feet from the air guns. These distances are 150 feet further than those employed the previous year and often allowed better refraction velocity leverage on lake bottom sediments. Depth control is achieved pneumatically and the operating depth of 30 - 40 feet is determined by two electrical depth transducers, one at either end of the active length. (See Plate I).

(c) Instrumentation Recording

For the 600% coverage the air guns were fired at 75 foot intervals.

Recordings were made on a 1" tape using a Texas Instrument Incorporated digital field recorder Type 10,000. As only six traces were used,

the following channels in the 10,000 system were utilized:

Trace 6	10,000 Channels	1, 7, 13, & 19
Trace 5	10,000 Channels	2, 8, 14, & 20
Trace 4	10,000 Channels	3, 9, 15, & 21
Trace 3	10,000 Channels	4, 10, 16, & 22
Trace 2	10,000 Channels	5, 11, 17, & 23
Trace 1	10,000 Channels	6, 12, 18, & 24

Paralleling of the digital channels was accomplished at the output of the aliasing filters. Two second records were recorded at a sample rate of 4 milliseconds (Note: By paralleling inputs an effective sampling rate of 1 millisecond was obtained.)

Simultaneously with the six channel recording, a single trace facsimile section was made from the near trace. A Raytheon Model 196B recorder using NDK dry paper was utilized for this function.

Drywrite camera monitors were made with a Dynatronics camera every 8 shots for quality control.

IV. DATA PROCESSING

(a) Introduction

The Data obtained from the marine seismic survey of Great Bear Lake was recorded on six traces spaced 150 feet apart. The center of the first trace was located 525 feet from the energy source. Three air guns supplied the seismic pulse and were fired every 75 feet. The above parameters resulted in 600% C.D.P. coverage. The selection of the field technique was based mainly on previous experience in the area and on the assumption that the sedimentary section was very shallow. The nearest well control lies some 75 miles to the southwest. Water depths in the area of the lake surveyed ranged from 10 to 800 feet.

(b) Order of Data Processing

(1) Demultiplex and edit field reels
(2) Digital Filter
(3) Deconvolution
(4) Display of single short trace from each record
(5) Removal of normal moveout
(6) STACK
(7) Digital AGC
(8) 3:1 composite of STACK (3 lines only).

(c) Velocity Function

The velocity functions were supplied by the consulting firm of Jordan, Lewis & Jose. These were based mainly on a refraction survey and a study of the first arrivals. Automatic velocity programs were generally unsatisfactory, due to the shallow section, short spread and the presence of high amplitude water bottom multiples. The velocity of the water in Great Bear Lake was found to be from 4600 to 4650 feet per second. This was somewhat slower than had been previously assumed. Over a large part of the area surveyed, the velocity of the sediments near lake bottom was found to be

20,000 feet per second. This created some problem in designing a moveout curve that could change quickly enough from 4600 to 20,000 feet per second. A thin intermediate layer of sediment with a velocity of approximately 10,000 feet per second was encountered at some locations.

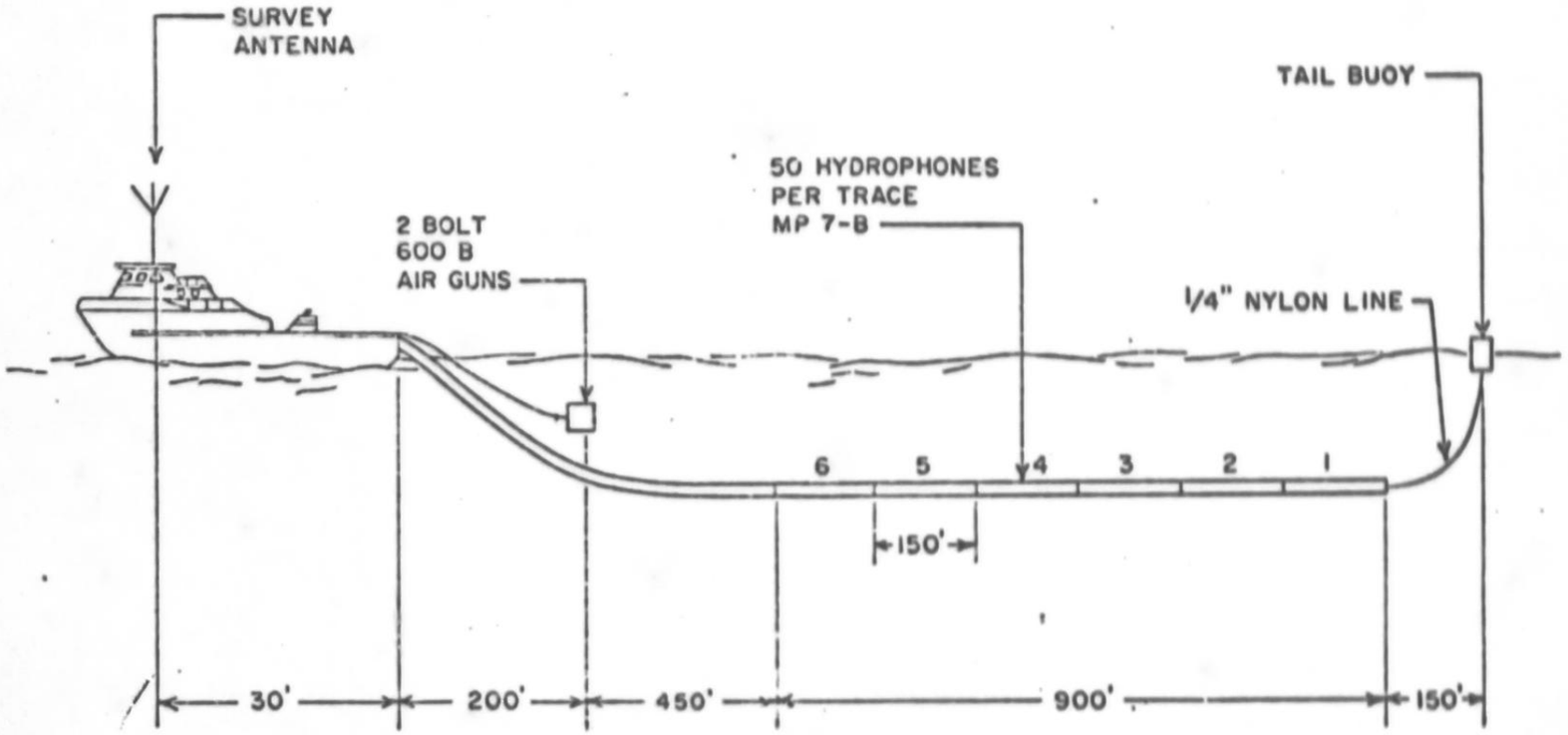
(d) Data Processing Techniques

Deconvolution was performed on the Great Bear Lake data mainly for pulse compression rather than multiple attenuation. The length of the deconvolution operator used was 100 M.S. A 25 cycle Ricker wavelet was used to limit the spectrum. It was felt that the section was too shallow to use a predictive type of deconvolution. The short spread necessary for recording the shallow section limited the effectiveness of multiple attenuation by stacking procedures. Velocity functions and muting patterns were adjusted as water depths changed. A comparison of various digital filters indicated a suitable frequency bond pass to be from 15 to 50 cycles per second.

(e) Conclusions

Although the final stack sections from the Great Bear Lake survey still contained a fairly high multiple content; it is believed that a maximum amount of information was obtained from the field data by using the processing techniques previously outlined. Despite the limitations of the deconvolution filter, it was generally felt that the overall section was enhanced by partial dereverberation and wave shaping.

In the event of any future survey in Great Bear Lake, it is recommended that additional refraction profiles be obtained.

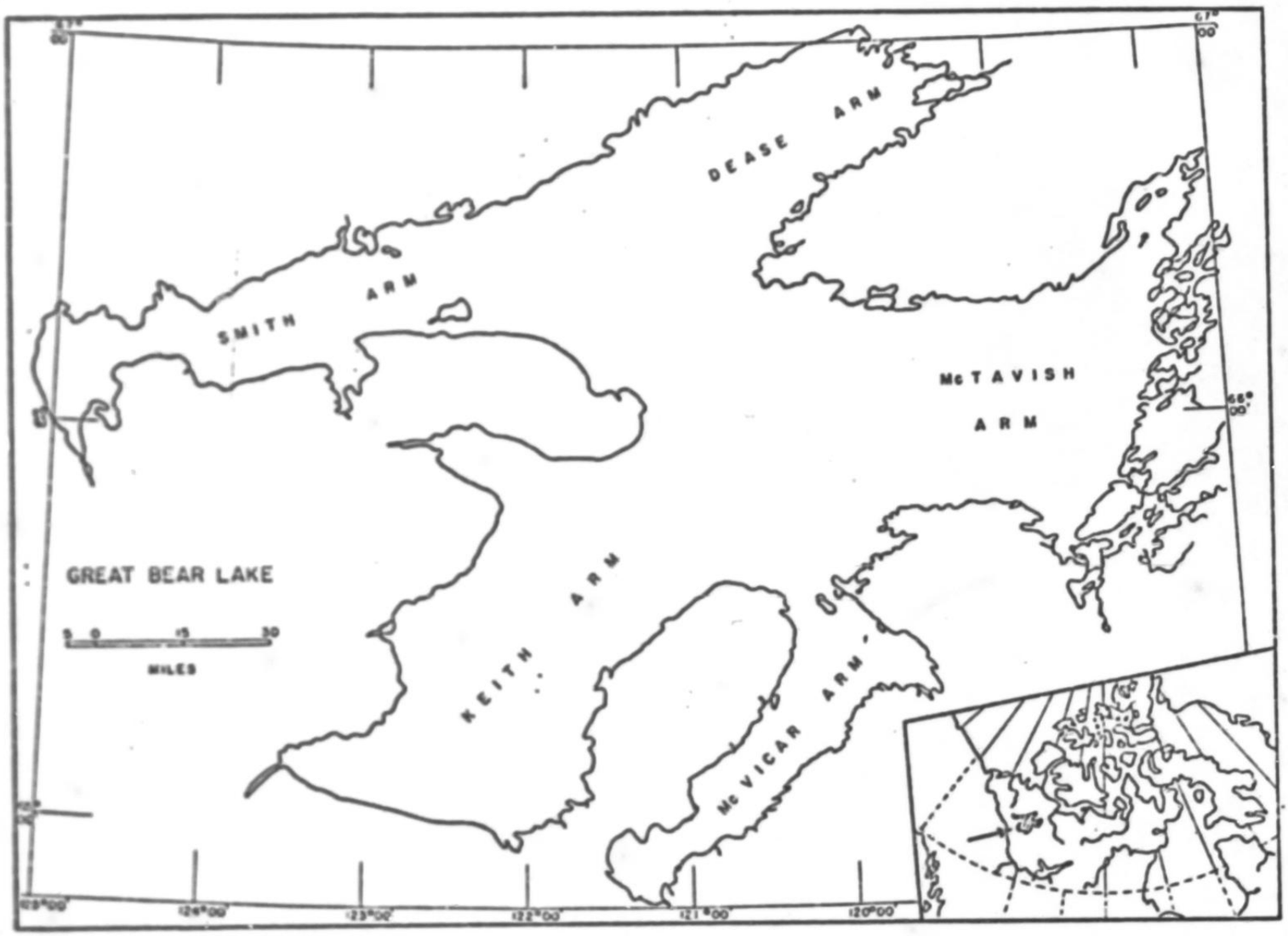


CABLE AND TOWING ARRAY DIAGRAM

TELEDYNE EXPLORATION

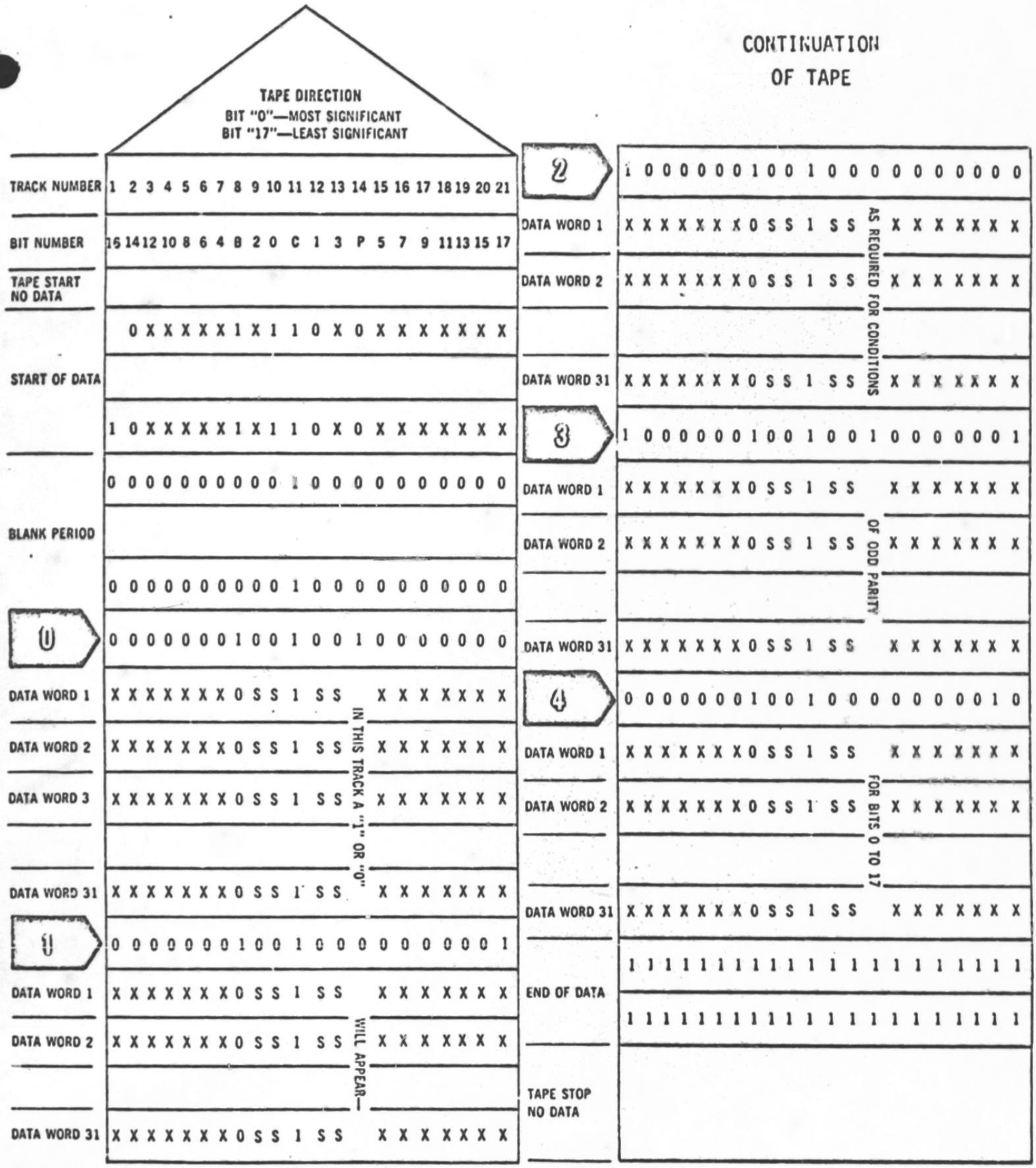
(150' TRACE INTERVAL)

PLATE I



LOCATION MAP GENERAL

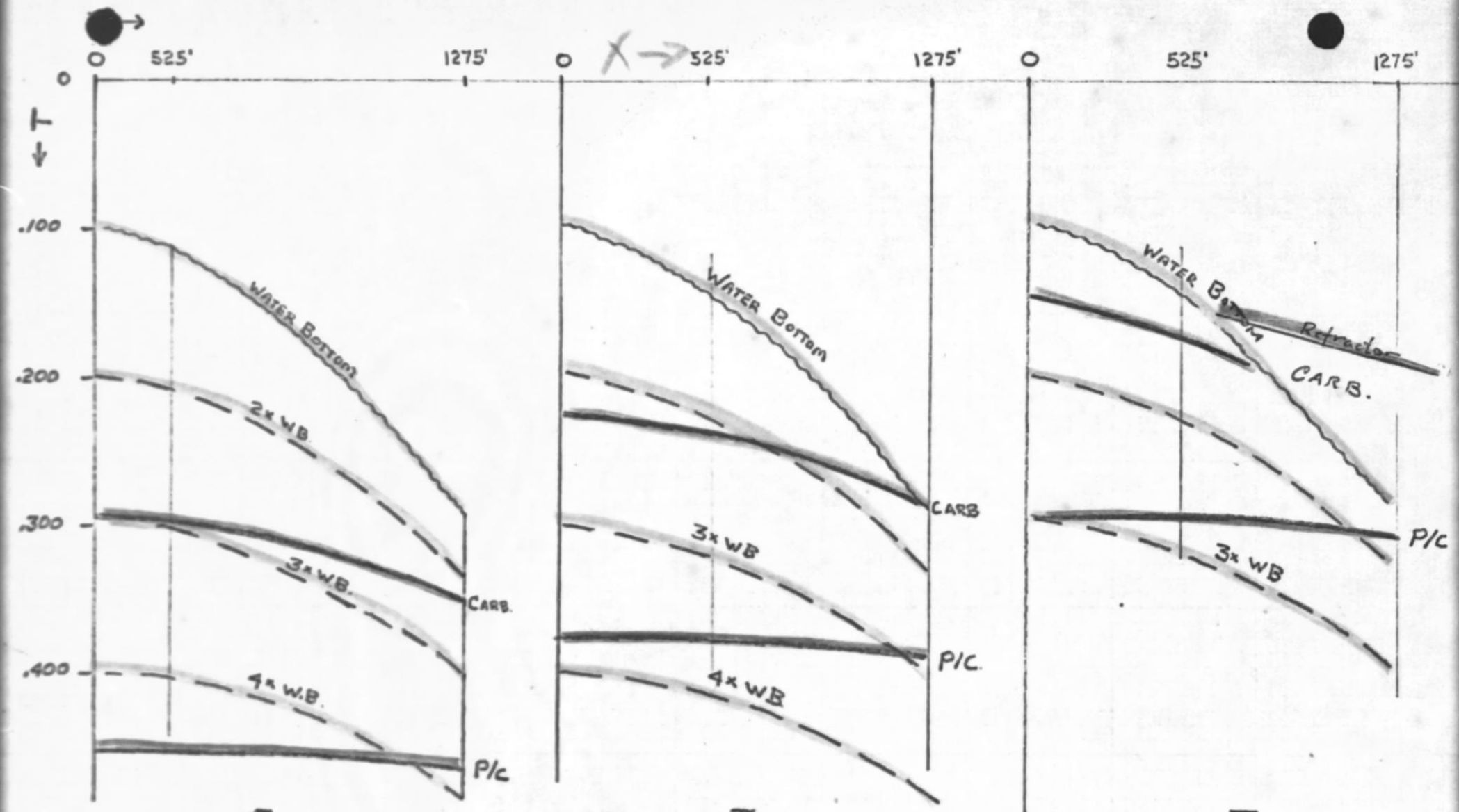
PLATE II



NOTE: ARROWS ABOVE DENOTE TIMING WORDS

TIAC FORMAT

PLATE V



I

230' @ 4600
150' @ 6500 (QUATERNARY)
620' @ 8000 (CRETACEOUS)
1500' @ 20,000 (CARBONATE)

II

230' @ 4600
150' @ 6500 (Q)
320' @ 8000 (K)
1500' @ 20,000 (CARBONATE)

III

230' @ 4600
150' @ 6500 (Q)
1500' @ 20,000 (CARB)

FINAL REPORT

on

MARINE SEISMOGRAPH SURVEY

GREAT BEAR LAKE

NORTHWEST TERRITORY

by

TELEDYNE EXPLORATION LTD.

for

ALMINEX LIMITED

JULY - AUGUST 1971

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Drywrite camera monitors were made with a Dynatronics camera every 8 shots for quality control.

IV. CONCLUSIONS

The overall operation proceeded more efficiently and produced better quality data than during the previous year for the following reasons:

(a) The larger steel-hulled ship could operate in rougher weather and better grounding of the Ray-Dist equipment resulted in more reliable positioning and less electrical crossfeed to the recording equipment.

(b) Using three 40 cubic inch air guns nearly doubled the previous energy output and appeared to improve the record quality; particularly the reliability of the first arrivals.

(c) By extending the offset of the recording cables from the air guns, the refraction penetration was increased to give better velocity control on the shallow horizons.

The latter two changes mentioned above were suggested by Mr. Robert Jordan of Jordan, Lewis and Jose and we are indebted to him and his staff, not only for this, but for their co-operation during the acquisition and processing of the data.

Respectfully submitted,

TELEDYNE EXPLORATION LTD.

NORMAN J. CHRISTIE,
PROFESSIONAL GEOPHYSICIST,
PRESIDENT

V. DATA PROCESSING

(a) Introduction

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(6) Stack.

(7) Digital AGC.

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(c) Velocity Function

The velocity functions were supplied by the consulting

firm of Jordan, Lewis and Jose. These were based mainly on a refraction survey and a study of the first arrivals. Automatic velocity programs were generally unsatisfactory, due to the shallow section, short spread and the presence of high amplitude water bottom multiples. The velocity of the water in Great Bear Lake was found to be from 4,600 to 4,650 feet per second. This was somewhat slower than had been previously assumed. Over a large part of the area surveyed, the velocity of the sediments near lake bottom was found to be 20,000 feet per second. This created some problem in designing a moveout curve that could change quickly enough from 4,600 to 20,000 feet per second. A thin intermediate layer of sediment with a velocity of approximately 10,000 feet per second was encountered at some locations.

(d) Data Processing Techniques

Deconvolution was performed on the Great Bear Lake data mainly for pulse compression rather than multiple attenuation. The length of the deconvolution operator used was 100 M.S. A 25 cycle Ricker wavelet was used to limit the spectrum. It was felt that the section was too shallow to use a predictive type of deconvolution. The short spread necessary for recording the shallow section limited the effectiveness of multiple attenuation by stacking procedures. Velocity functions and muting patterns were adjusted as water depths changed. A comparison of various digital filters indicated a suitable frequency band pass to be from 15 to 50 cycles per second.

(e) Conclusions

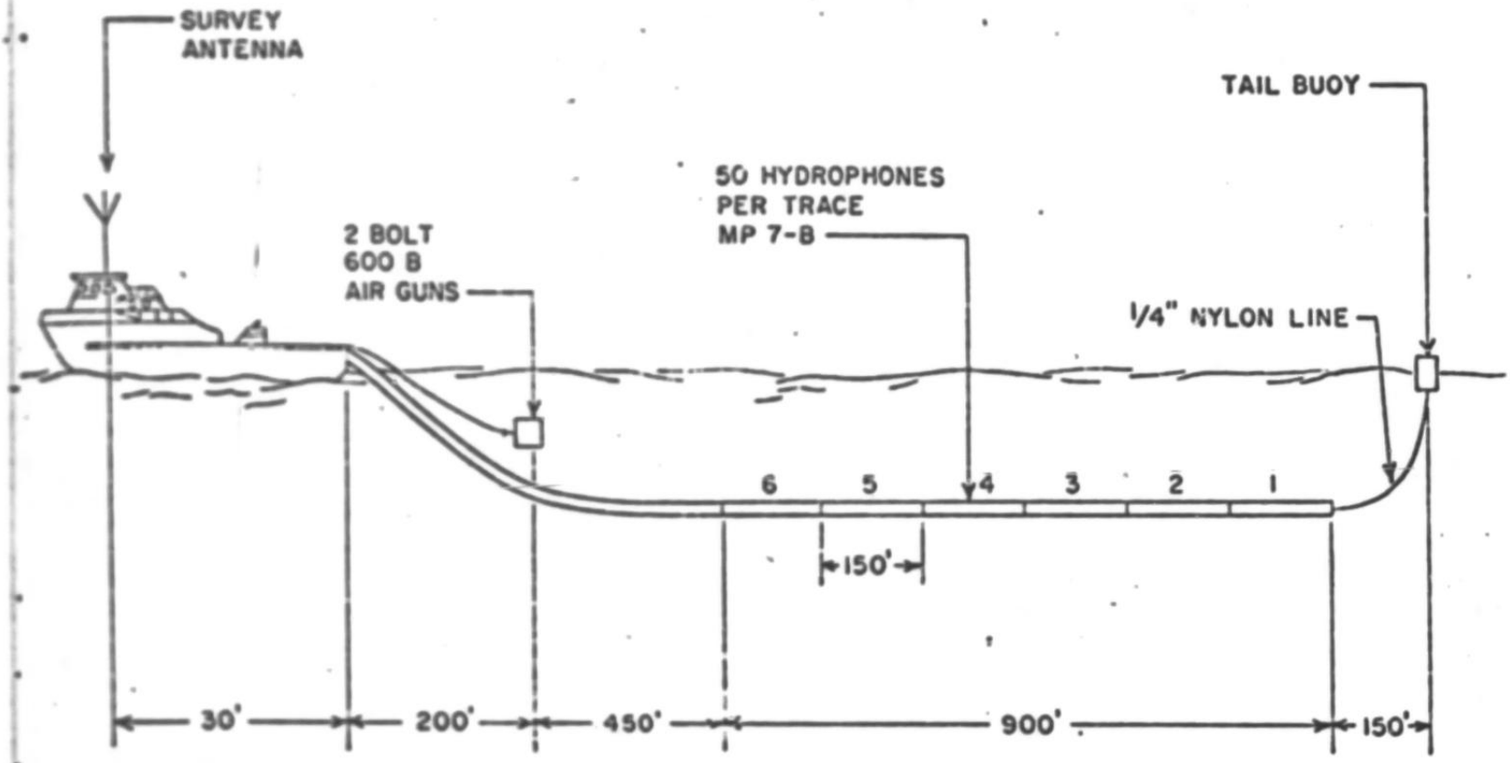
Although the final stack sections from the Great Bear Lake survey still contained a fairly high multiple content; it is believed that a maximum amount of information was obtained from the field data by using the processing techniques previously outlined. Despite the limitations of the deconvolution filter, it was generally felt that the overall section was enhanced by partial dereverberation and wave shaping.

In the event of any future survey in Great Bear Lake, it is recommended that additional refraction profiles be obtained.

Respectfully submitted,
TELEDYNE EXPLORATION LTD.

H.C. Tims

HANK C. TIMS,
SUPERVISOR

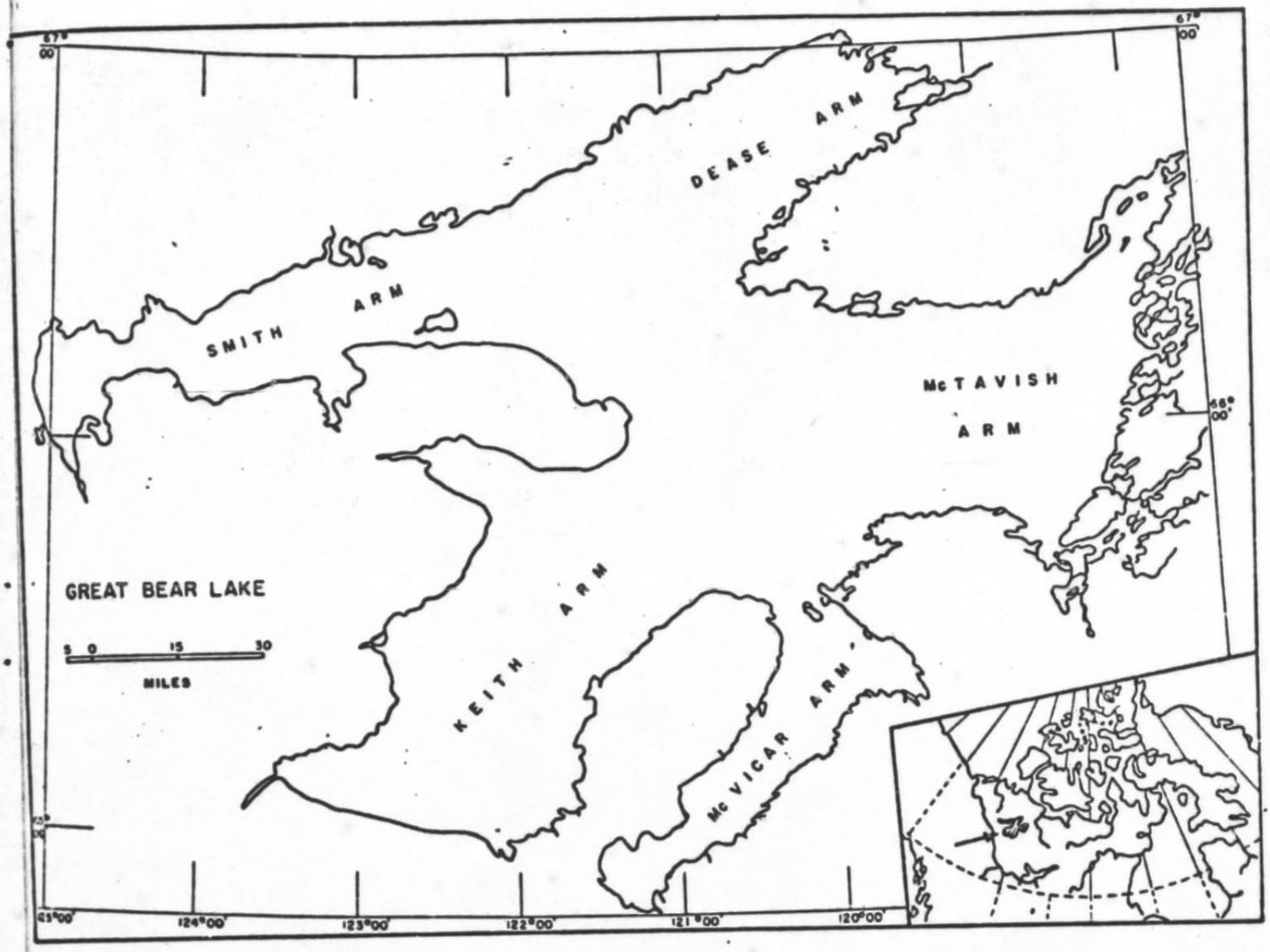


CABLE AND TOWING ARRAY DIAGRAM

TELEDYNE EXPLORATION

(150' TRACE INTERVAL)

PLATE I



LOCATION MAP GENERAL

PLATE II

TELEDYNE EXPLORATION LIMITED
SEISMIC STATISTICAL REPORT
PARTY MANAGER J. DUGGAN
SUPVR. N.J. CHRISTIE
PARTY No. 616
MONTH OF JULY 19 71
PERMIT No.
LICENCE No.
CLIENT ALMINEX
LOCATION GREAT BEAR LAKE N.W.T.

RECORDING UNIT NUMBER
INSTRUMENT TYPE
TYPE OF SHOOTING

MONTH—YEAR / TWP. & RGE / DATE	WEEKLY TOTAL	AUGUST 1971 1	2	3	4	JULY 1971 1	2	3	WEEKLY TOTAL
RECORDING & SHOOTING									
HOURS SHOOTING									
HOURS DRIVING									
HOURS TOTAL									
NUMBER OF HOLES									
NUMBER OF SHOTS									
NUMBER OF PROFILES									
NUMBER OF MILES OF LINE									
TAPES USED									
SHOOTING SUPPLIES									
DYNAMITE RECEIVED									
DYNAMITE USED									
DYNAMITE ON HAND									
CAPS RECEIVED									
CAPS USED									
CAPS ON HAND									
DRILLING: OKANAGAN 206		4.0	(ASS)						
HOURS DRILLING									
HOURS DRIVING									
TOTAL HOURS									
HOLES DRILLED									
FOOTAGE DRILLED									
NORTHWARD OTTER									
HOURS DRILLING									
HOURS DRIVING									
TOTAL HOURS									
HOLES DRILLED									
FOOTAGE DRILLED									
CESSNA 180									
HOURS DRILLING		3.0	3.5	2.0					8.5
HOURS DRIVING									
TOTAL HOURS									
HOLES DRILLED									
FOOTAGE DRILLED									
DRILLING-SUPPLIES: BRAN RECEIVED									
BRAN USED									
MUD RECEIVED									
MUD USED									
DRIVE POINTS & WINGS									
SPARE WATER TRUCK HRS.									
BITS USED									
ROCK BITS									
INSERTS									
STARTERS									
BULLDOZER No. 1									
HOURS OPERATING									
MILES OF LINE CUT									
BULLDOZER No. 2									
HOURS OPERATING									
MILES OF LINE CUT									
DUGGAN									
SKULSKY									
DICKSON									
BLONDIN									

DATE	4	5	6	7	8	9	10	WEEKLY TOTAL
RECORDING & SHOOTING								
HOURS SHOOTING								
HOURS DRIVING								
HOURS TOTAL								
NUMBER OF HOLES								
NUMBER OF SHOTS								
NUMBER OF PROFILES								
NUMBER OF MILES OF LINE								
TAPES USED								
SHOOTING SUPPLIES								
DYNAMITE RECEIVED								
DYNAMITE USED								
DYNAMITE ON HAND								
CAPS RECEIVED								
CAPS USED								
CAPS ON HAND								
DRILLING: OKANAGAN 206								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
NORTHWARD OTTER								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
CESSNA 180								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
DRILLING-SUPPLIES: BRAN RECEIVED								
BRAN USED								
MUD RECEIVED								
MUD USED								
DRIVE POINTS & WINGS								
SPARE WATER TRUCK HRS.								
BITS USED								
ROCK BITS								
INSERTS								
STARTERS								
BULLDOZER No. 1								
HOURS OPERATING								
MILES OF LINE CUT								
BULLDOZER No. 2								
HOURS OPERATING								
MILES OF LINE CUT								
DUGGAN			SETTING UP					
SKULSKY			SURVEY TOWERS.					
DICKSON								
BLONDIN								

DATE	11	12	13	14	15	16	17	WEEKLY TOTAL
RECORDING & SHOOTING								
HOURS SHOOTING								
HOURS DRIVING				SETTING		UP		
HOURS TOTAL								
NUMBER OF HOLES								
NUMBER OF SHOTS								
NUMBER OF PROFILES								
NUMBER OF MILES OF LINE								
TAPES USED								
SHOOTING SUPPLIES								
DYNAMITE RECEIVED		HOURS		RADIUM		GILBERT		
DYNAMITE USED								
DYNAMITE ON HAND								
CAPS RECEIVED								
CAPS USED								
CAPS ON HAND								
DRILLING: OKANAGAN 206							6^{30}	6^{30}
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
NORTHWARD OTTER			1.0	3.0	3.0	3.0	3.0	13.0
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
CESSNA 180								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
DRILLING-SUPPLIES: BRAN RECEIVED								
BRAN USED								
MUD RECEIVED								
MUD USED								
DRIVE POINTS & WINGS								
SPARE WATER TRUCK HRS.								
BITS USED								
ROCK BITS								
INSERTS								
STARTERS								
BULLDOZER No. 1								
HOURS OPERATING								
MILES OF LINE CUT								
BULLDOZER No. 2								
HOURS OPERATING								
MILES OF LINE CUT								
DUGGAN		10	15	18	10	15	15	83
SKULSKY		10	15	18	10	15	15	83
DICKSON								
BLONDIN							13	13

DATE	18	19	20	21	22	23	24	WEEKLY TOTAL
RECORDING & SHOOTING								
HOURS SHOOTING				24	24	24	24	96
HOURS DRIVING		18	18					36
HOURS TOTAL								
NUMBER OF HOLES								
NUMBER OF SHOTS								
NUMBER OF PROFILES								
NUMBER OF MILES OF LINE					65.8	51.5	90.3	207.6
TAPES USED								
SHOOTING SUPPLIES								
DYNAMITE RECEIVED		16.0	24.0	24.0	24.0	24.0	24.0	136.0
DYNAMITE USED								
DYNAMITE ON HAND								
CAPS RECEIVED								
CAPS USED								
CAPS ON HAND								
DRILLING: OKANAGAN 206								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
NORTHWARD OTTER								
HOURS DRILLING								
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
CESSNA 180								
HOURS DRILLING	3.0	3.0	3.0	3.0	3.0	3.0	3.0	21.0
HOURS DRIVING								
TOTAL HOURS								
HOLES DRILLED								
FOOTAGE DRILLED								
DRILLING-SUPPLIES: BRAN RECEIVED								
BRAN USED								
MUD RECEIVED								
MUD USED								
DRIVE POINTS & WINGS								
SPARE WATER TRUCK HRS.								
BITS USED								
ROCK BITS								
INSERTS								
STARTERS								
BULLDOZER No. 1								
HOURS OPERATING								
MILES OF LINE CUT								
BULLDOZER No. 2								
HOURS OPERATING								
MILES OF LINE CUT								
DUGGAN	15							15
SKULSKY	15							15
DICKSON							10	10
BLONDIN								

DATE	25	26	27	28	29	30	31	WEEKLY TOTAL	TOTALS AREA REFLECTION	AREA	AREA REFRACTION	GROSS TOTAL	AVERAGES
RECORDING & SHOOTING													
HOURS SHOOTING	24	24	24	24	24	24	14	158	240		14	254	
HOURS DRIVING												42	
HOURS TOTAL													
NUMBER OF HOLES													
NUMBER OF SHOTS							REFRAC.						PROFILES
NUMBER OF PROFILES													PER SHIFT
NUMBER OF MILES OF LINE	53.5	44.0	16.4	25.7	36.2	19.7	(3.0)	198.5	403.1		3.0	406.1	QUALITY
TAPES USED													
SHOOTING SUPPLIES													
DYNAMITE RECEIVED	24.0	24.0	24.0	24.0	24.0	24.0	16.0	160.0				296.0	DYNAMITE
DYNAMITE USED													PER SHOT
DYNAMITE ON HAND													PER PROFILE
CAPS RECEIVED													
CAPS USED													
CAPS ON HAND													
DRILLING: OKANAGAN 206				6^{10}	3^{40}	2^{05}		11^{55}				22^{25}	@ 240.^{00}
HOURS DRILLING													
HOURS DRIVING													
TOTAL HOURS													HOLE DEPTH
HOLES DRILLED													FOOTAGE PER
FOOTAGE DRILLED													SHIFT
NORTHWARD OTTER												13.0	@ 130.^{00}
HOURS DRILLING													
HOURS DRIVING													
TOTAL HOURS													HOLE DEPTH
HOLES DRILLED													FOOTAGE PER
FOOTAGE DRILLED													SHIFT
CESSNA 180													
HOURS DRILLING	3.0	4^{40}	3.0	4.0	3.0	4.0	5.0	26^{40}				56^{10}	@ 65.^{00}
HOURS DRIVING													
TOTAL HOURS													HOLE DEPTH
HOLES DRILLED													FOOTAGE PER
FOOTAGE DRILLED													SHIFT
DRILLING-SUPPLIES: BRAN RECEIVED													
BRAN USED													
MUD RECEIVED													
MUD USED													
DRIVE POINTS & WINGS													
SPARE WATER TRUCK HRS.													
BITS USED													
ROCK BITS													
INSERTS													
STARTERS													
BULLDOZER No. 1													
HOURS OPERATING													
MILES OF LINE CUT													
BULLDOZER No. 2													
HOURS OPERATING													
MILES OF LINE CUT													
DUGGAN												98.0	
SKULSKY												98.0	
DICKSON												10.0	
BLONDIN												13.0	

INSTRUCTIONS
1. CREWS WILL COMPLETE ALL PERTINENT COLUMNS USING DARK INK
BLANK COLUMNS ON BOTTOM OF FORM TO BE USED FOR ADDITIONAL EQUIPMENT AND/OR FOR DAILY REMARKS
2. CREW WILL FORWARD WEEKLY PORTION OF 2ND COPY TO CALGARY OFFICE
3. CREW WILL FORWARD THE COMPLETED ORIGINAL TO CALGARY ON THE LAST DAY OF EACH MONTH

TAPE DIRECTION
BIT "0"—MOST SIGNIFICANT
BIT "17"—LEAST SIGNIFICANT

TRACK NUMBER	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
BIT NUMBER	16 14 12 10 8 6 4 8 2 0 C : 3 P 5 7 9 11 13 15 17
TAPE START NO DATA	
	0 X X X X X 1 X 1 1 0 X 0 X X X X X X X
START OF DATA	
	1 0 X X X X X 1 X 1 1 0 X 0 X X X X X X X
	0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
BLANK PERIOD	
	0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
①	0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0
DATA WORD 1	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 2	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 3	X X X X X X X 0 S S 1 S S X X X X X X
	IN THIS TRACK A "1" OR "0"
DATA WORD 31	X X X X X X X 0 S S 1 S S X X X X X X
①	0 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 1
DATA WORD 1	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 2	X X X X X X X 0 S S 1 S S X X X X X X
	WILL APPEAR
DATA WORD 31	X X X X X X X 0 S S 1 S S X X X X X X

CONTINUATION
OF TAPE

②	1 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0
DATA WORD 1	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 2	X X X X X X X 0 S S 1 S S X X X X X X
	AS REQUIRED FOR CONDITIONS
DATA WORD 31	X X X X X X X 0 S S 1 S S X X X X X X
③	1 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 1
DATA WORD 1	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 2	X X X X X X X 0 S S 1 S S X X X X X X
	OF ODD PARITY
DATA WORD 31	X X X X X X X 0 S S 1 S S X X X X X X
④	0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 1 0
DATA WORD 1	X X X X X X X 0 S S 1 S S X X X X X X
DATA WORD 2	X X X X X X X 0 S S 1 S S X X X X X X
	FOR BITS 0 TO 17
DATA WORD 31	X X X X X X X 0 S S 1 S S X X X X X X
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
END OF DATA	
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
TAPE STOP NO DATA	

NOTE: ARROWS ABOVE DENOTE TIMING WORDS

TIAC FORMAT

PLATE V

ALMINEX ET AL

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

11 OF 2


Sonobuoy Refraction
BUTTES ET AL
Blackwater Lake J-54
10.5 Miles South
ALMINEX ET AL
MIDCON
RAM
INTER - ROCK
JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA
KEITH ARM PROJECT
GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA
SURFACE & LAKE BOTTOM TOPOGRAPHY
LAKE BOTTOM CONTOURS : 50 Feet
SURFACE CONTOURS : 100 Feet
PROFESSIONAL ENGINEER R. P. JORDAN ALBERTA
SCALE : 1 inch = 2 miles
2 of 2
DATE: March 1972

122° 15' 122° 00' 121° 45' 121° 30' 121° 15' 121° 00' 120° 45' 120° 30' 120° 15'

65° 40' 65° 30' 65° 20' 65° 10' 65° 00' 64° 50'

K

€OS$_r$

OS$_k$

€OR$_{2a}$

€R$_1$

Station 05

Station 06

Station 07

Station 08

Station 09

Sonobuoy Refraction

ALMINEX ET AL

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

1 OF 2

Sonabuoy Refraction

Station 05

Station 06

Station 07

Station 08

Station 09

ϵOS_r

OS_k

ϵOR_{2a}

ϵR_1

K

BUTTES ET AL
Blackwater Lake I-54
10.5 Miles South

ALMINEX ET AL

MIDCON

RAM

INTER - ROCK

2 of 2

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

KEITH ARM PROJECT

GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA

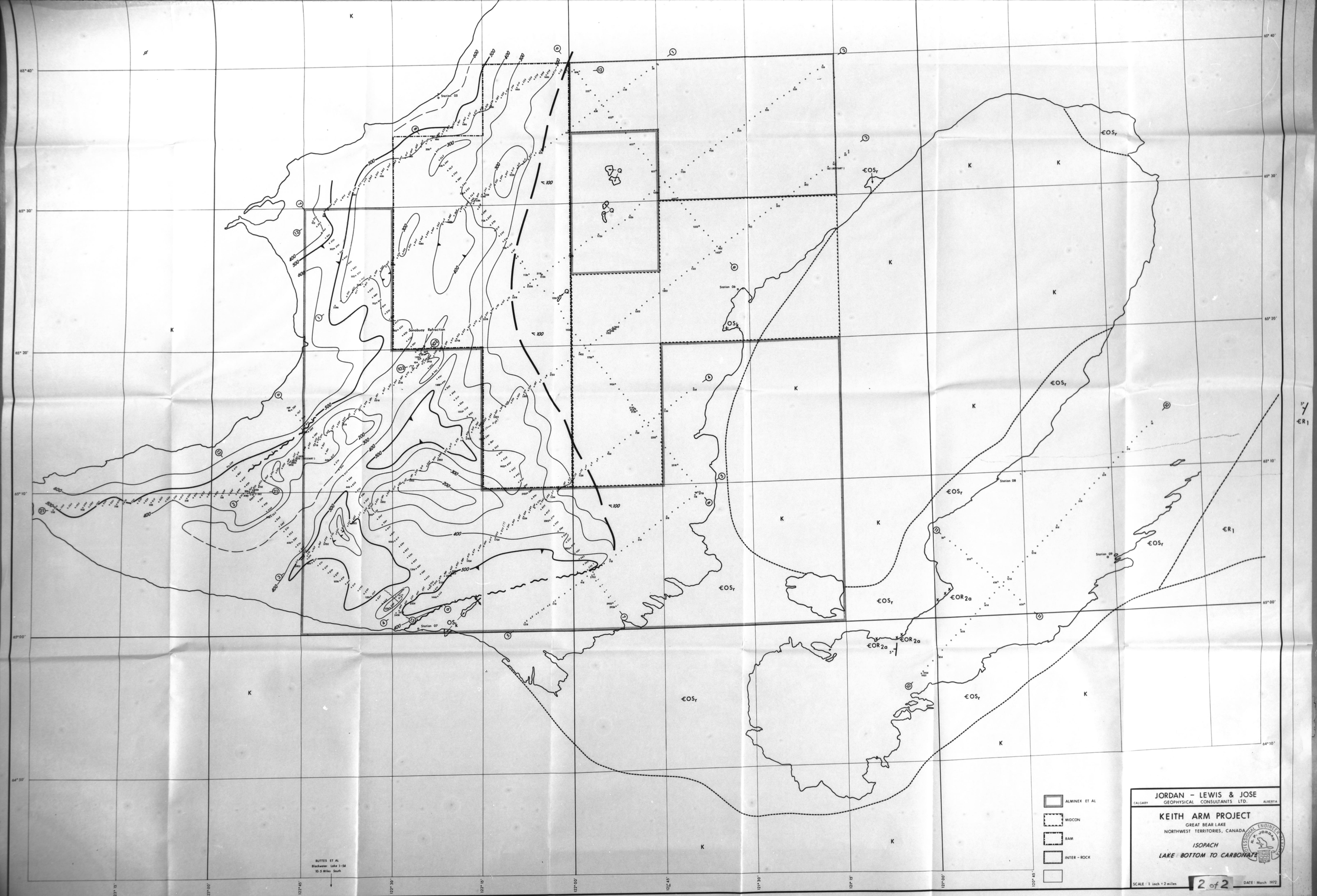
ISOPACH

LAKE BOTTOM TO BASEMENT

SCALE : 1 inch = 2 miles

DATE : March 1972

K
Sonobuoy Refraction
Station 05
Station 06
Station 07
Station 08
Station 09
€OS_r
€OR_2a
€R_1
OS_k
Q
< 100
ALMINEX ET AL
JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA
1 OF 2


Seismic 05
Seismic 06
Seismic 07
Seismic 08
Seismic 09
Sonobuoy Refraction
BUTTES ET AL
Blackwater Lake I-54
10.5 Miles South
ALMINEX ET AL
MIDCON
RAM
INTER - ROCK
JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA
KEITH ARM PROJECT
GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA
ISOPACH
LAKE BOTTOM TO CARBONATE
SCALE : 1 inch = 2 miles
DATE : March 1972
2 of 2

HIGH

POOR FATHOMETER CONTROL
VALUES QUESTIONABLE

Sonabuoy Refraction

Station 08

Station 07

Station 09

K

ϵOS_r

OS_k

ϵOR_{2a}

ϵR_1

ALMINEX ET AL

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

1 OF 2

HIGH

Sonabuoy Refraction

Station 05

Station 06

Station 07

Station 08

Station 09

POOR FATHOMETER CONTROL
VALUES QUESTIONABLE

BUTTES ET AL
Blackwater Lake I-54
10.5 Miles South

ALMINEX ET AL

MIDCON

RAM

INTER - ROCK

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

KEITH ARM PROJECT

GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA

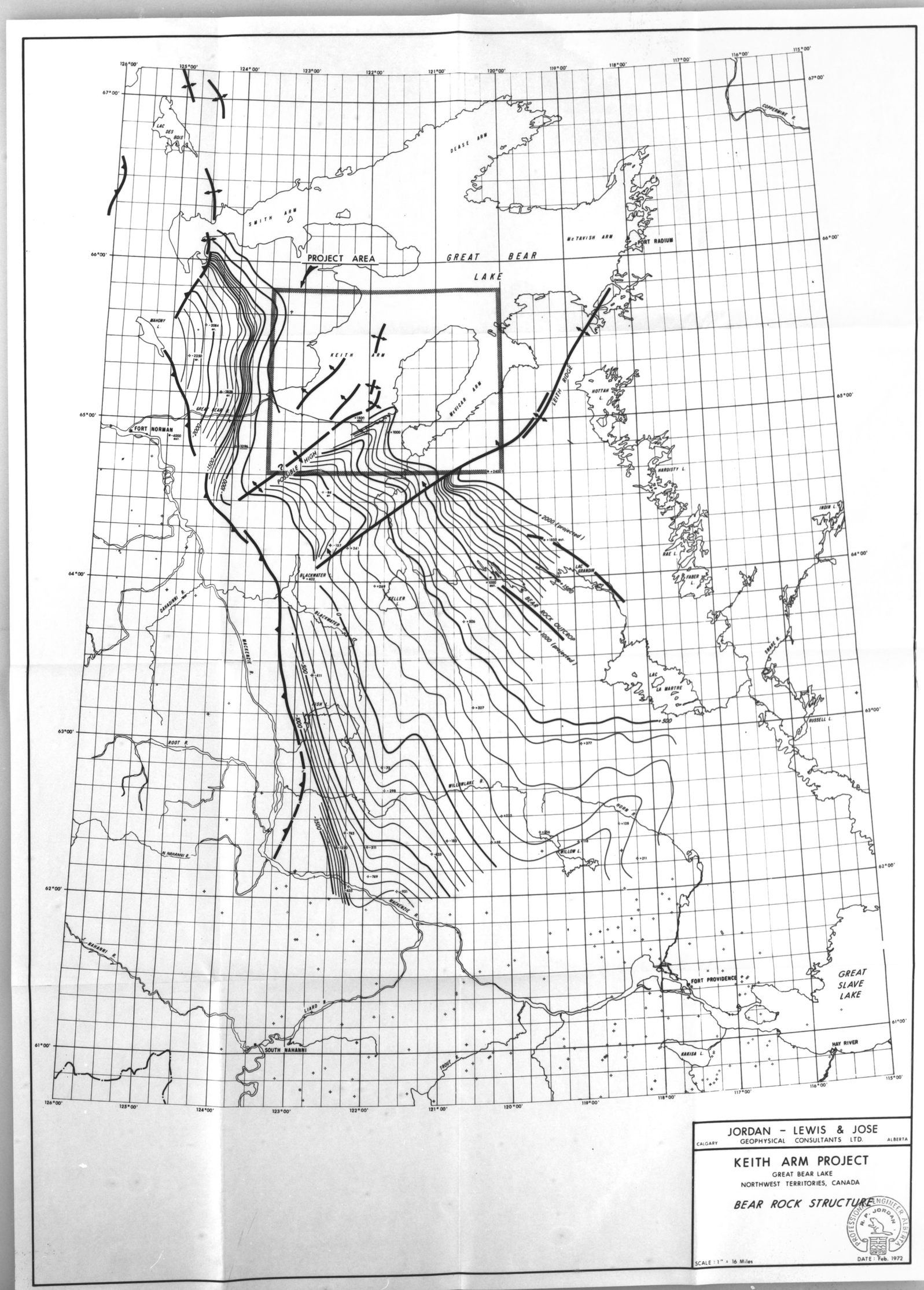
STRUCTURE CONTOURS
BASEMENT

CONTOUR INTERVAL : 100 Feet

SCALE : 1 inch = 2 miles

DATE : March 1972

2 of 2



JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

KEITH ARM PROJECT

GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA

BEAR ROCK STRUCTURE

PROFESSIONAL ENGINEER W. F. JORDAN ALBERTA

SCALE : 1" = 16 Miles

DATE : Feb. 1972

122° 15' 122° 00' 121° 45' 121° 30' 121° 15' 121° 00' 120° 45' 120° 30' 120° 15'

65° 40' 65° 30' 65° 20' 65° 10' 65° 00' 64° 50'

6827 6841 6842 6840 6807 6829 6806 6828 6826 6805 6831 6832 6830 6804 6803 6825 6833 6802 6801 6800 6799 6798 6797 6796 6795 6793 6794 6915 6914 6913 6912

Station 05 Station 06 Station 07 Station 08 Station 09

Sonabuoy Refraction

K €OS$_r$ €OR$_{2a}$ €R$_1$ OS$_k$

ALMINEX ET AL

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

1 OF 2


JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA
KEITH ARM PROJECT
GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA
INDEX MAP
SCALE : 1 inch = 2 miles
DATE: Jan. 1972
ALMINEX ET AL
MIDCON
RAM
INTER - ROCK
PROFESSIONAL ENGINEER ALBERTA
R. P. JORDAN
Station D5
Station D6
Station D7
Station D8
Station D9
Sonobuoy Refraction
K
€OS_r
€OR_2a
OS_k
€R_1
6841
6842
6840
6827
6829
6807
6805
6831
6832
6806
6828
6826
6830
6803
6825
6833
6802
6801
6804
6800
6799
6798
6797
6796
6795
6793
6794
6915
6914
6913
6912
64° 50'
120° 45'
121° 00'
121° 15'
121° 30'
121° 45'
122° 00'
122° 15'
122° 30'
122° 45'
2 of 2


K
K_{ss}
K_{sh}
BR
BR ?
CR_1
O_{sk}
OS_k
Q
Q/K_{ss}
Q/K_{sh}
Q/O_{sk}
Q/CR_1
K_{ss}/O_{sk}
ϵOS_r
ϵOR_{2a}
ϵR_1
Station 05
Station 06
Station 07
Station 08
Station 09
Sonabuoy Refraction
Low Velocity Basal Cretaceous Sand
Shallow Drift (5300'/s - 4500'/s) over Basal Cretaceous Sand
Note : Intermediate Shale (6000 - 8500'/s) at South End
VELOCITIES
> 20,000
ALMINEX ET AL
JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA
1 OF 2

Station 05

Station 08

Station 09

Station 07

Sonabuoy Refraction

Shallow Drift (5300'/s - 6500'/s) over Basal Cretaceous Sand
Note : Intermediate Shale (6000 - 8900'/s) at South End.

Note : Low Velocity Channel

BUTTES ET AL
Blackwater Lake I-54
10.5 Miles South

VELOCITIES
> 20,000
17,500 - 20,000
15,000 - 17,500
< 15,000

X Depth To The High Velocity Layer Below The Water

ALMINEX ET AL
MIDCON
RAM
INTER - ROCK

JORDAN - LEWIS & JOSE
CALGARY GEOPHYSICAL CONSULTANTS LTD. ALBERTA

KEITH ARM PROJECT

GREAT BEAR LAKE
NORTHWEST TERRITORIES, CANADA

LAKE BOTTOM REFRACTION VELOCITIES

SCALE 1 inch = 2 miles

DATE : March 1972

2 of 2