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REPORT PREPARED FOR:

ACCURATE EXPLORATION LTD., CALGARY, ALBERTA, CANADA

SPARKER SURVEY

FORT SIMPSON - FORT PROVIDENCE
MACKENZIE RIVER AREA
N.W.T.

JULY, 1959

REPORT PREPARED BY:

MARINE GEOPHYSICAL SERVICES INTERNATIONAL INC.

DATE: 22 SEPTEMBER, 1959

SIGNATURE: Charles B. Officer

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INTRODUCTION

[illegible] LIARD RIVERS, FOR [illegible] IS GIVEN HEREIN, WAS CONDUCTED [illegible] GEOPHYSICAL SERVICES INTERNATIONAL INC., [illegible] U.S.A. AND ACCURATE EXPLORATION LTD., [illegible] ALBERTA, CANADA, FOR THE ACCOUNT OF ACCURATE EXPLORATION LTD.

THIS SURVEY WAS CONDUCTED DURING THE MONTHS OF JUNE-SEPTEMBER, 1966, ALONG THE MACKENZIE RIVER AND ITS TRIBUTARIES. THE INTERPRETATION GIVEN IN THIS REPORT COVERS ONLY THAT PORTION OF THE SURVEY FROM FORT SIMPSON TO FORT PROVIDENCE ALONG THE MACKENZIE AND LIARD RIVERS.

THE SPARKER EQUIPMENT WAS OPERATED BY MR. J. J. STRONE OF GEOPHYSICAL SERVICES INTERNATIONAL INC. THE NAVIGATION, BOAT OPERATION, LOGISTICS, AND OVERALL SUPERVISION OF THE OPERATION WAS HANDLED BY ACCURATE EXPLORATION LTD. THE NAVIGATIONAL CONTROL WAS DETERMINED FROM TIME PHOTOGRAPHS OF A MAST ON THE SURVEY BOAT AND FROM SEXTANT ANGLES TAKEN FROM THE SURVEY BOAT. THE NAVIGATION MASE MAP WAS [illegible] BY ACCURATE EXPLORATION LTD.

SURVEY PROCEDURE

THE SURVEY COVERED BY THIS REPORT CONSISTED OF A SINGLE TRAVERSE ALONG THE MACKENZIE AND LIARD RIVERS. THE NAVIGATION LOCATION POINTS WERE TAKEN AT IRREGULAR INTERVALS ALONG THE TRAVERSE. INTERPOLATED LOCATION POINTS ARE DESIGNATED BY THE TIME OF DAY OF THE SURVEY BOAT'S LOCATION ALONG THE TRAVERSE.

E.G., 7:15 A.M. LOCATIONS ALONG THE RIVER, WHICH ARE DISCUSSED IN THIS REPORT, ARE REFERRED TO BY THEIR TIME OF DAY FROM THE SURVEY.

THE SPARKER ELECTRODE AND HYDROPHONE WERE TOWED 250 FT. ASTERN OF THE SURVEY BOAT. THE NAVIGATION BASE MAP SUPPLIED BY ACCURAYE WAS MADE WITH RESPECT TO THE SURVEY BOAT. THE SPARKER DATA SHOULD BE PLOTTED 250 FT. ASTERN OF THE LOCATIONS GIVEN ON THE NAVIGATION BASE. ON THE MAP SCALE USED, 1 INCH = 2 MILES, THIS WOULD HAVE MADE AN IMPERCEPTIBLE DIFFERENCE AND WAS NOT APPLIED.

THE SURVEY WAS MADE BY THE SURVEY BOAT PROGRESSING DOWN THE RIVER. THE SPARKER ELECTRODE AND HYDROPHONE WERE STREAMED BEHIND THE SURVEY BOAT, AND A CONTINUOUS SPARKER RECORD WAS MADE AS THE BOAT PROGRESSED DOWN THE RIVER. AT THE TIME A NAVIGATION FIX WAS TAKEN THE SPARKER OPERATOR ACTUATED A SWITCH WHICH MADE A MARK ON THE SPARKER RECORD. THIS PRESERVED DIRECTLY ON THE SPARKER RECORD THE NAVIGATION LOCATIONS.

THE SURVEY BOAT SPEED VARIED FROM 5 TO 10 MILES PER HOUR DEPENDING ON THE RIVER CURRENT VELOCITY. THE HIGH RIVER CURRENT VELOCITY DID PRODUCE A HIGHER NOISE LEVEL THAN IS NORMALLY EXPERIENCED IN SPARKER OPERATIONS.

SPARKER OPERATION

A NUMBER OF ARTICLES HAVE APPEARED ON THE SPARKER. EACH GIVES A BRIEF DESCRIPTION OF THE SPARKER EQUIPMENT AND OPERATION AND SOME OF THE SURVEY RESULTS THAT HAVE BEEN OBTAINED IN VARIOUS AREAS. REFERENCE MAY BE MADE TO THE MARCH 13, 1959 ISSUE OF *PETROLEUM WEEK*; APRIL, 1959 ISSUE OF *WORLD OIL*; JULY, 1959 ISSUE OF *OFFSHORE*; AND THE AUGUST 14, 1959 ISSUE OF *OIL WEEK*. THE FOLLOWING IS QUOTED FROM THE *WORLD OIL* ARTICLE.

"THE DEVICE CONSISTS OF TWO UNITS, AN ACOUSTICAL SOURCE UNIT AND A RECEIVER-RECORDER UNIT. THE SOUND SOURCE UNIT UTILIZES A SIMULATED EXPLOSION IN THE FORM OF A 10,000 VOLT SPARK FIRED UNDERWATER. THE EXPLOSION SENDS OUT A HIGH ENERGY SOUND PULSE. THE SPARK HAS FREQUENCY AND ENERGY CHARACTERISTICS SIMILAR TO THOSE OF A SMALL BLASTING CAP. THE SPARK REPETITION RATE IS CONTROLLED BY THE RECORDING UNIT AND GENERALLY IS SET AT TWO TO FOUR SPARKS PER SECOND.

THE RECEIVER-RECORDER UNIT CONTAINS A SIGNAL DETECTOR MADE UP OF EITHER A SINGLE HYDROPHONE TOWED ASTERN OF THE BOAT OR AN ARRAY OF HYDROPHONES FOR DIRECTIONAL RECEIVING. THE ECHO SIGNALS RECEIVED BY THE DETECTOR GO TO A FIXED GAIN PRE-AMPLIFIER, A BAND-PASS FILTER, A RECORDER AMPLIFIER AND FINALLY TO A HIGH SPEED, HIGH RESOLUTION FACSIMILE RECORDER. THE RECORDER TRANSCRIBES THE SIGNALS ONTO A SPECIAL PAPER. SUCCESSIVE RECORDINGS FROM THE REPEATED SPARK EXPLOSIONS PRODUCE A CONTINUOUS SECTION OF THE GEOLOGIC STRUCTURE BENEATH THE SURVEY SHIP'S TRACK IN MUCH THE SAME MANNER THAT AN ECHO SOUNDER (FATHOMETER) PRODUCES A RECORD OF THE OCEAN BOTTOM.

THE RECEIVING HYDROPHONE AND THE SPARK GAP ELECTRODES ARE TOWED BEHIND THE SURVEY SHIP AT A DISTANCE OF ABOUT 100 FEET AND ARE SEPARATED BY A HORIZONTAL DISTANCE OF ABOUT 20 FEET. THE SHIP MOVES AT A CONSTANT SPEED OF FROM 3 TO 5 KNOTS.

FIGURE 2 ILLUSTRATES THE METHOD OF OPERATION OF THE CONTINUOUS SEISMIC PROFILER. THE RECORD IS COMPOSED OF A SERIES OF VERTICAL SCANS BY THE RECORDER. EACH SCAN BEGINS WITH A SPARK PULSE IN THE WATER AND RECORDS THE SERIES OF ECHOES FROM THAT SPARK. SINCE THE SCANS ARE PLACED SIDE BY SIDE ON THE MOVING PAPER BY THE RECORDER, A CONTINUOUS GEOLOGIC CROSS SECTION IS FORMED. THE DEPTH INTERVAL OF THE RECORDER CAN BE VARIED SO THAT APPROXIMATELY 200, 400, 800, 1,600, OR 3,200 FEET INTERVALS CAN BE OBSERVED."

INTERPRETATION

THE RESULTS OF THE INTERPRETATION ARE GIVEN ON THE ENCLOSED MAP.

THE SPARKER RECORDS FROM THIS SURVEY WERE BELOW PAR OF THOSE RECORDS OBTAINED IN MOST OTHER AREAS. THIS WAS DUE IN PART TO THE HIGH NOISE LEVEL CAUSED BY HIGH BOAT SPEED DOWN THE RIVER AND IN PART TO THE EXCESSIVE VIBRATION ON THE SURVEY BOAT. HOWEVER, THE REFLECTIONS FROM THE UNDERLYING GEOLOGICAL SECTIONS COULD BE FOLLOWED AND MAPPED ALONG THE ENTIRE TRAVERSES OVER TWO SEGMENTS BETWEEN 7:45 A.M. AND 10:00 A.M. ON JULY 22 AND BETWEEN 6:30 P.M. AND 7:15 P.M. ON JULY 23 THERE WAS NO NAVIGATIONAL CONTROL. THESE SEGMENTS WERE TIED BY CARRYING THE APPROXIMATE OR ASSUMED LINES ON EACH SIDE OF THE SEGMENT ACROSS THE SEGMENT ITSELF.

THE INTERPRETATION PROCEDURE WAS TO MARK THE DEEP REFLECTIONS ON THE SPARKER RECORDS. A FICTITIOUS HORIZON WAS THEN DETERMINED FOR THE ENTIRE TRAVERSE FROM THE OBSERVED REFLECTIONS ON THE RECORDS. THE MAP ENCLOSED IS A MAP OF THE DEPTH OF THE FICTITIOUS HORIZON ALONG THE SURVEY BOAT'S TRAVERSES.

ALL DEPTHS ON THIS MAP ARE WITH RESPECT TO RIVER SURFACE LEVEL. THE DEPTHS ARE COMPUTED FROM AN ASSUMED SEISMIC VELOCITY OF 5000 FT./SEC. FOR THE UNDERLYING PREDOMINANTLY SHALE SECTION.

No REFERENCE WAS MADE TO THE WELL DATA DURING THE INTERPRETATION OR THE PREPARATION OF THE MAP ENCLOSED. THIS INTERPRETATION AND THE RESULTS SHOWN ON THE MAP WERE MADE INDEPENDENT OF THE WELL DATA. AS A FINAL CHECK ON THE VALIDITY OF THE INTERPRETATION THE RECORDED VALUES OF THE DEPTH OF THE FICTITIOUS HORIZON WERE CHECKED WITH THE KNOWN TOPS OF THE PRODUCING SANDS IN THE

FIVE WELLS WERE AVAILABLE FOR COMPARISON, N.W.T. #1, N.W.T. #2, BANQUO #1, WESTEROL #2A, AND WESTEROL LIARD PARISH #1. THE INFORMATION FROM THESE WELLS WAS SUPPLIED BY ACCURATE EXPLORATION LTD. THE N.W.T. #1 WELL WAS APPROXIMATELY 1½ MILES EAST OF THE END OF THE SPARKER INTERPRETATION GIVEN ON THE ENCLOSED MAP. BETWEEN THE N.W.T. #1 WELL AND THE N.W.T. #2 WELL THE MIDDLE DEVONIAN DROPS 1485 FT. TOWARD THE N.W.T. #2 WELL. FROM THE START OF THE SPARKER INTERPRETATION THE FICTITIOUS HORIZON DROPS 1140 FT. TO THE N.W.T. #2 WELL. EXTRAPOLATING THE OBSERVED REGIONAL DIP OF THE FICTITIOUS HORIZON OVER THIS INTERVAL BACK TO THE N.W.T. #1 WELL THE FICTITIOUS HORIZON WOULD GIVE A DROP OF 1320 FT. BETWEEN THE N.W.T. #2 WELL AND THE BANQUO #1 WELL THE MIDDLE DEVONIAN RISES 85 FT. THE FICTITIOUS HORIZON FROM THE SPARKER INTERPRETATION RISES 45 FT. OVER THIS SAME INTERVAL. BETWEEN THE BANQUO #1 WELL AND THE WESTEROL #2A WELL THE MIDDLE DEVONIAN RISES 196 FT. OVER THIS SAME INTERVAL THE FICTITIOUS HORIZON RISES 225 FT. BETWEEN THE WESTEROL #2A WELL AND THE WESTEROL LIARD PARISH #1 WELL THE MIDDLE DEVONIAN DROPS 289 FT. OVER THIS SAME INTERVAL THE FICTITIOUS HORIZON DROPS 220 FT.

THIS CORRELATION OF SEVEN ABOVE BETWEEN THE WELL DEPTHS AND THE DEPTHS OF THE FICTITIOUS HORIZON IS CONSIDERED EXCELLENT. IT LENDS CONFIDENCE TO THE GEOLOGICAL CONFIGURATION AND STRUCTURE DETERMINED BY THE SPARKER AND SHOWN ON THE ENCLOSED MAP.

SURVEY RESULTS

THE CONFIGURATION OF THE SUBSURFACE GEOLOGY IS SHOWN BY THE CONTOURS OF THE FICTITIOUS HORIZON ON THE ENCLOSED MAP.

IN GENERAL THE RECTIFIED HORIZON RISES TO THE EAST ALONG THE MACKENZIE RIVER AND DECREASES TO THE WEST.

THERE IS A PROMINENT FAULT ZONE BETWEEN 8:10 P.M. AND 8:15 P.M. ON JULY 21 AND BETWEEN 8:20 P.M. AND 8:25 P.M. ON JULY 21. THIS FAULT ZONE IS DISPLAYED ON THE SPARKER RECORDS AS A SERIES OF STEP FAULTS WITH A TOTAL DISPLACEMENT OF 390 FT. FOR THE FIRST INTERVAL AND 120 FT. FOR THE SECOND INTERVAL.

THE TRAVERSE CUTS ACROSS A SERIES OF ANTICLINAL AXES AT 11:05 A.M. ON JULY 22, 2:55 P.M. ON JULY 22, 5:45 P.M. ON JULY 22, AND 8:20 P.M. ON JULY 22 ALONG THE MACKENZIE RIVER AND AT 2:10 P.M. ON JULY 25 ALONG THE LIARD RIVER. THE LIARD RIVER AXIS APPEARS TO BE CONTIGUOUS WITH NORTHEASTWARD AXIS OF THE MACKENZIE RIVER AND HAS BEEN SHOWN AS SUCH.

THERE IS A SMALL SPARKER VELOCITY OF THE LANCE ISLAND ON THE LIARD RIVER.

FOUR POSSIBLE FAULT LOCATIONS ARE SHOWN ON THE ENCLOSED MAP. THESE ARE INTERPRETED TO BE REFLECTIONS OF UNDERLYING BEDS BECAUSE OF THE ASSOCIATED SIDE OF THE REFLECTIONS ACROSS EACH FEATURE AND THEIR RELATIVE WIDTHS. THE TWO PARTICULAR MOST FEATURES ARE ASSOCIATED WITH POSSIBLE ANTICLINES. THE TWO WESTERLY MOST FEATURES DO NOT APPEAR TO BE ASSOCIATED WITH ANTICLINES.

IT IS REALIZED THAT IT IS IMPOSSIBLE TO DETERMINE THE DIMENSIONAL GEOLOGIC STRUCTURE FROM A SINGLE, NEARLY STRAIGHT LINE TRAVERSE. HOWEVER, IT DOES APPEAR FROM THE GENERAL CONFIGURATION THAT THERE IS A TROUGH OFF FROM THE CANADIAN SHIELD TRENDING SE ACROSS THE MAP AREA NE OF THE JUNCTION OF THE MACKENZIE AND LIARD RIVERS WHICH PLUNGES TO THE NW. ALSO IT APPEARS THAT AN ARCH IS DEVELOPING SW OF THE TRAVERSE ALSO TRENDING SE.

CONCLUSIONS AND RECOMMENDATIONS

There are three main areas which would appear anomalous from the Sparker traverse, The most important is the feature lying at the west river outlet at Mills Lake, where both faulting and a structural feature are indicated. The second area of interest lies adjacent to the possible faulting located approximately 12 miles up river from Fort Providence, with the third area, of least importance, lying some 9 miles downstream from Fort Providence and whereas this feature has been contoured merely as a nose, it is possible that a closed feature could lie just north of the river traverse at this point.

Additional continuous profile work could be added to the present traverse by utilizing the remaining waters of Mills Lake and, if navigable, the alternate channels at the upstream end of Mills Lake. The anomalous portions of the river could be better outlined by additional traverses within the river as, in general at least two traverses could be run separated by one half mile to better outline the anomalous trend. Undoubtedly deeper penetration and better signal to noise ratio could be obtained by using a gas explosion signal source.

Respectfully submitted,
ACCURATE EXPLORATION LTD.

George F. Coote, P.Eng.

DISCUSSION OF RESULTS

The Sparker interpretation has been presented in part on Map No. 1, which is an interpretation of values for a fictitious horizon determined from depths of geologic horizons on Sparker records interpreted by Dr. C. B. Officer, of Marine Geophysical Services International Inc. In addition to Dr. Officer's map, the accompanying interpretational report is enclosed. The interpretational report covers discussion of data downstream from that included in the map.

The portion of the Sparker survey between Fort Providence and Big Island at the mouth of the Mackenzie River has been interpreted subsequently by Mr. J. Meador, of Accurate Exploration and the actual interpretation of the phantom along the river profile has been projected down to the top of the Slave Point, assuming a constant interval between the phantom horizon and the top of the Slave Point. The dips from the phantom horizon mapped by Dr. Officer have been utilized for portions of the traverse.

A cross-section of the projected Slave Point depths has been included with the report and the locations of the Northwest Territories No. 1 and No. 2 Wells are located on the profile.

The quality of the data ranged from fair to very poor, with the poor data generally being due to the fact that the reflection energy was being over-ridden by background noise. The highest background noise was generally found in sections of the river where the velocity of the water was greatest. One of the predominant features noted in the survey was at the outlet of Mills Lake where as a result of the dips of the reflections across each feature, Dr. Officer's interpretation shows faulting on the west side of Mills Lake at Location July 21st between 8:10 and 8:25 p.m.; however, when tying the east end of his interpretation to the

Fort Providence Well, it would indicate that the throw of the fault would be somewhat less than he postulated in the original interpretation.

A short distance downstream from this postulated fault in Mills Lake Dr. Officer noted in his interpretation that a reef could underly the observed dips of the reflections across this feature.

A further fault was postulated from the data located upstream from the Northwest Territories No. 1 Well at Location July 20th - 11:25 p.m. This fault could be an extension of the Rabbit Lake fault mentioned in Paper 58-11 of the Geological Survey of Canada, by R. J. W. Douglas; however, the fault on the river data appears to be faulted down to the north, which is the reverse direction of faulting indicated in Mr. Douglas' report. It should be pointed out that in estimating the throw of faults on the continuous profile data, it is difficult to determine the total amount of throw.