Alberta
RESEARCH COUNCIL

OFR 1975-19

PRIMROSE LAKE AIR WEAPONS RANGE
OIL SANDS EVALUATION PROGRAM
1974-1975

FINAL REPORT

Alberta RESEARCH COUNCIL

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INTRODUCTION

At the request of Alberta Mines and Minerals (now Alberta Energy and Natural Resources) the Alberta Research Council undertook a four-well drilling program on the Department of National Defence, Primrose Lake Air Weapons Range (Fig. 1). The objective of the program as outlined in the agreement between the Alberta Research Council and Alberta Mines and Minerals was as follows: "To locate and determine the extent of oil sands resources in that region of the Province of Alberta located within the boundaries of the Primrose Lake Air Weapons Range."

A proposal for four wells designed to evaluate the southeastern corner of the weapons range was submitted by the Alberta Research Council to Alberta Mines and Minerals on September 4, 1974 and approved by Alberta Mines and Minerals on the condition that the $250,000 budgeted for fiscal year 1974-75 would not be exceeded.

The Primrose Lake Air Weapons Range encompasses an area of about 1990 square miles and is located approximately 180 miles northeast of Edmonton along the Alberta - Saskatchewan border (Fig. 1). The Range is leased by the Department of National Defence from the Province of Alberta and is primarily used for air weapons testing and associated personnel training. Access to the range is limited, however, some trails do exist. The nearest settlements are the towns of Cold Lake and Grand Centre. Canadian Forces Base Cold Lake, which controls all access to the weapons range, is located just outside the town of Grand Centre.

Figure 1. Location map.

The four wells were drilled on the weapons range between January 15 and February 15, 1975. Figure 2 shows the location of these wells, plus one additional well (3A) which had to be abandoned at a depth of 401 feet because of hole problems. The four wells (1-74, 7-3-68-1W4; 2-74, 13-17-68-2W4; 3-74, 3-8-69-3W4 and 4-74, 13-13-68-5W4) were drilled through the Mannville Formation into the underlying Devonian limestones. Well cutting samples were collected at 30-foot intervals within the drift and at 10-foot intervals below the drift to total depth. Surface casing was set in each of the four wells. Geophysical logs (Dual Induction Focussed log, Compensated Density log and Compensated Neutron log) were run on each well except well 1-74 where only the Dual Induction and Density logs were run, because of technical problems. Sidewall cores were taken where geophysical logs and cutting samples indicated the presence of oil. One drillstem test was run on well 2-74. All wells were abandoned by cementing from total depth to surface. Total cost of the drilling program was $240,321.26. Access to the wellsites (Fig. 2) was provided by an all-weather road from Cold Lake around Primrose Lake and then an existing trail from Primrose Lake to Canoe Lake and to wellsite 4-74, which was previously a bombing site.

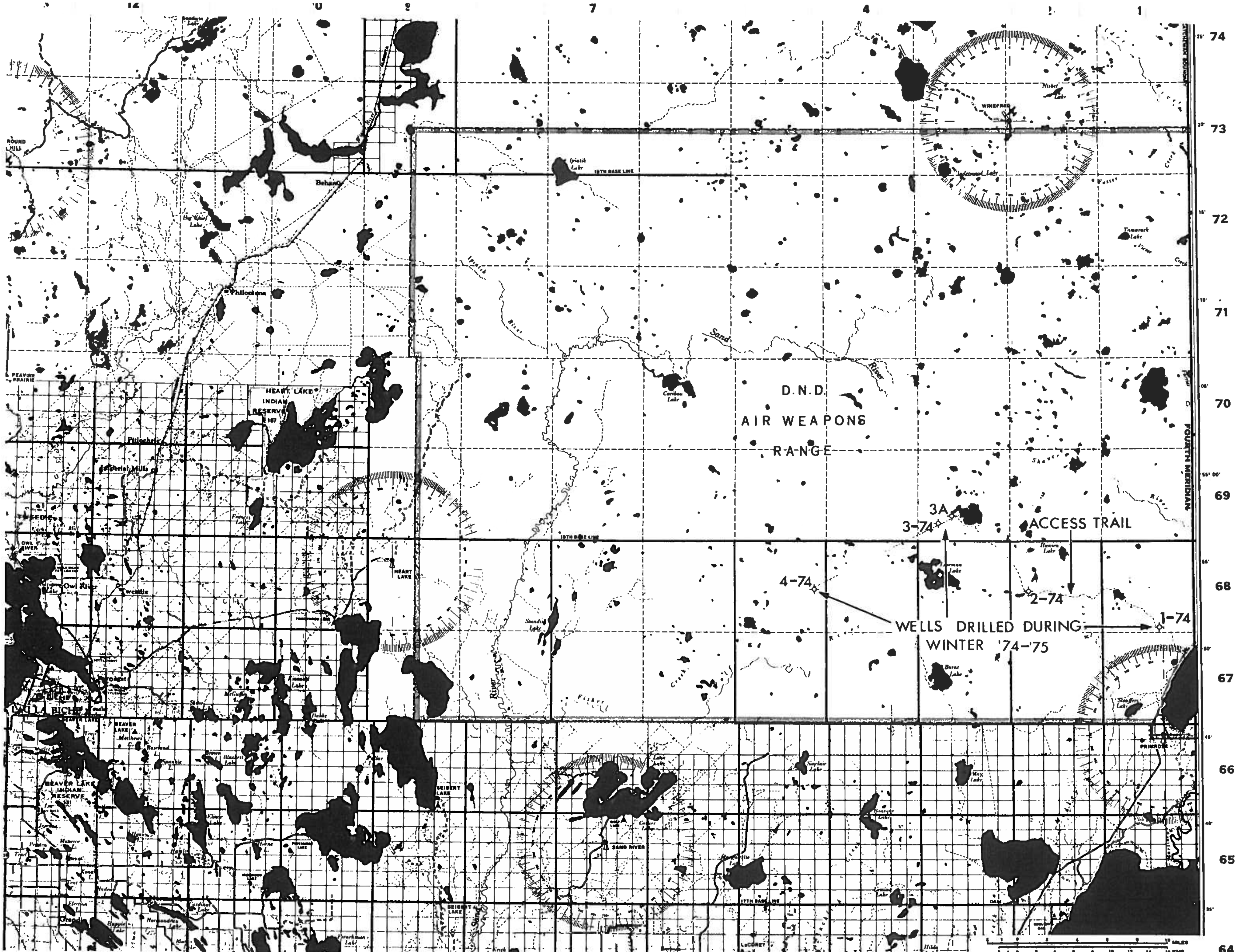


Figure 2. Map showing the location of the wells drilled during

RESULTS OF THE PROGRAM

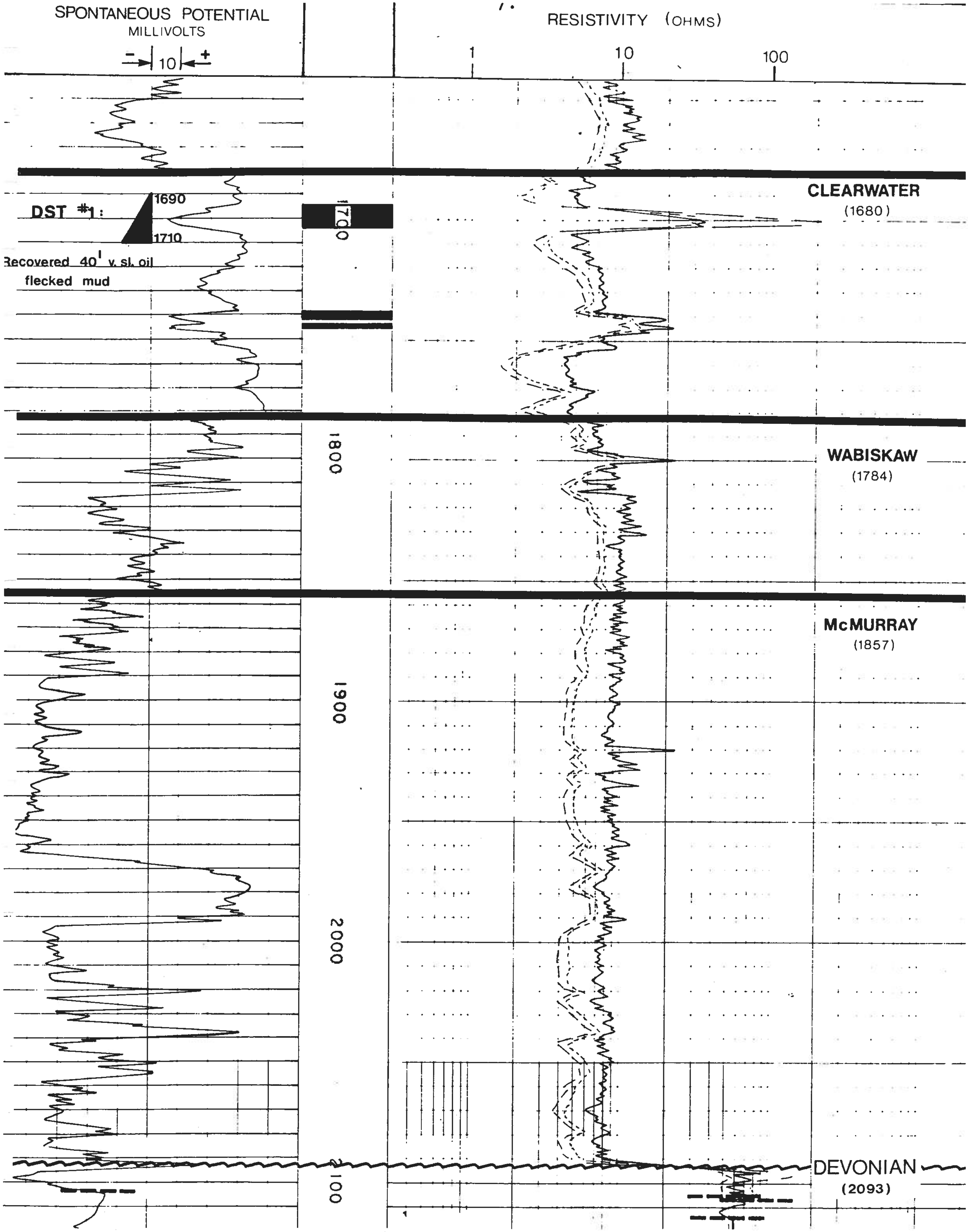
OIL SANDS

Three of the four wells drilled encountered oil sands. Well 2-74 has 11 net feet of oil sand, well 3-74 has 61 net feet of oil sand and well 4-74 has 86 net feet of oil sand. A summary of the well data is given in table 1. Figures 3, 4 and 5 show the net thicknesses of the oil sands zones in wells 2-74, 3-74 and 4-74 respectively. The majority of the oil sands were found in the Clearwater Formation where two sandstone intervals, apparently correlative between wells 2-74, 3-74 and 4-74, contained the oil. Oil was also found in a sand at the top of the Wabiskaw Member in wells 3-74 and 4-74 and well 4-74 also has oil in several sand intervals in the upper portion of the McMurray Formation. A thin zone of oil impregnation (3 feet) was also found in the lower part of the Grand Rapids Formation in well 3-74. No oil sands were found in well 1-74.

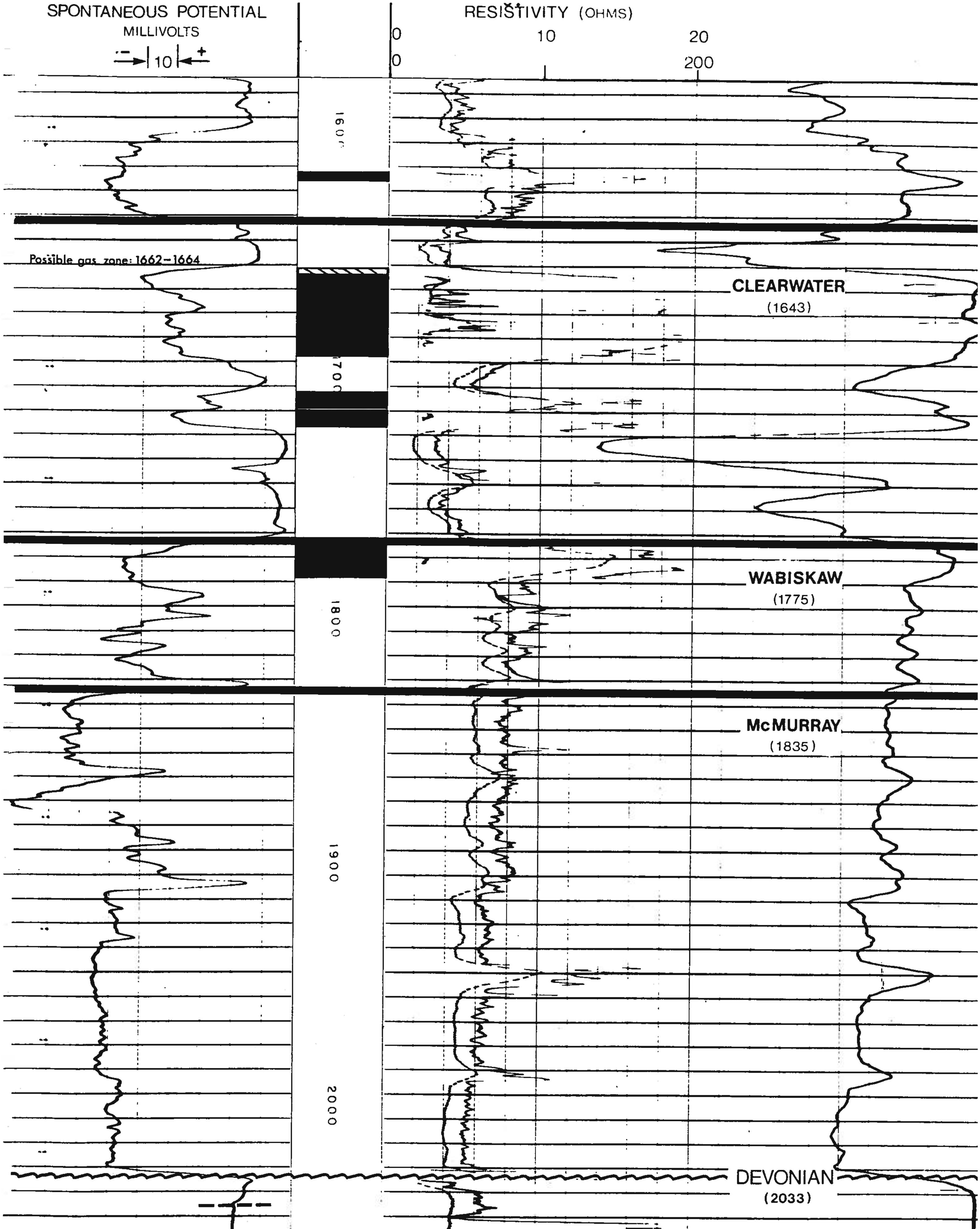
Well 4-74 has the largest net oil sand thickness as well as the best oil saturation, a maximum of 11.8 weight percent. The results of the sidewall core analyses are given in Appendix C. The mean oil gravity for all the oil samples is 10.2° API and the mean sulfur content of the oils is 4.2 percent. Most of the oil sands are fine grained and calculated porosities from the sidewall cores vary from 27 percent to 41 percent. A drillstem test was run over the main oil bearing interval in well 2-74, from 1690 to 1710 feet (K.B.) and only 40 feet of slightly oil flecked mud was recovered.

Table 1. Summary of well data

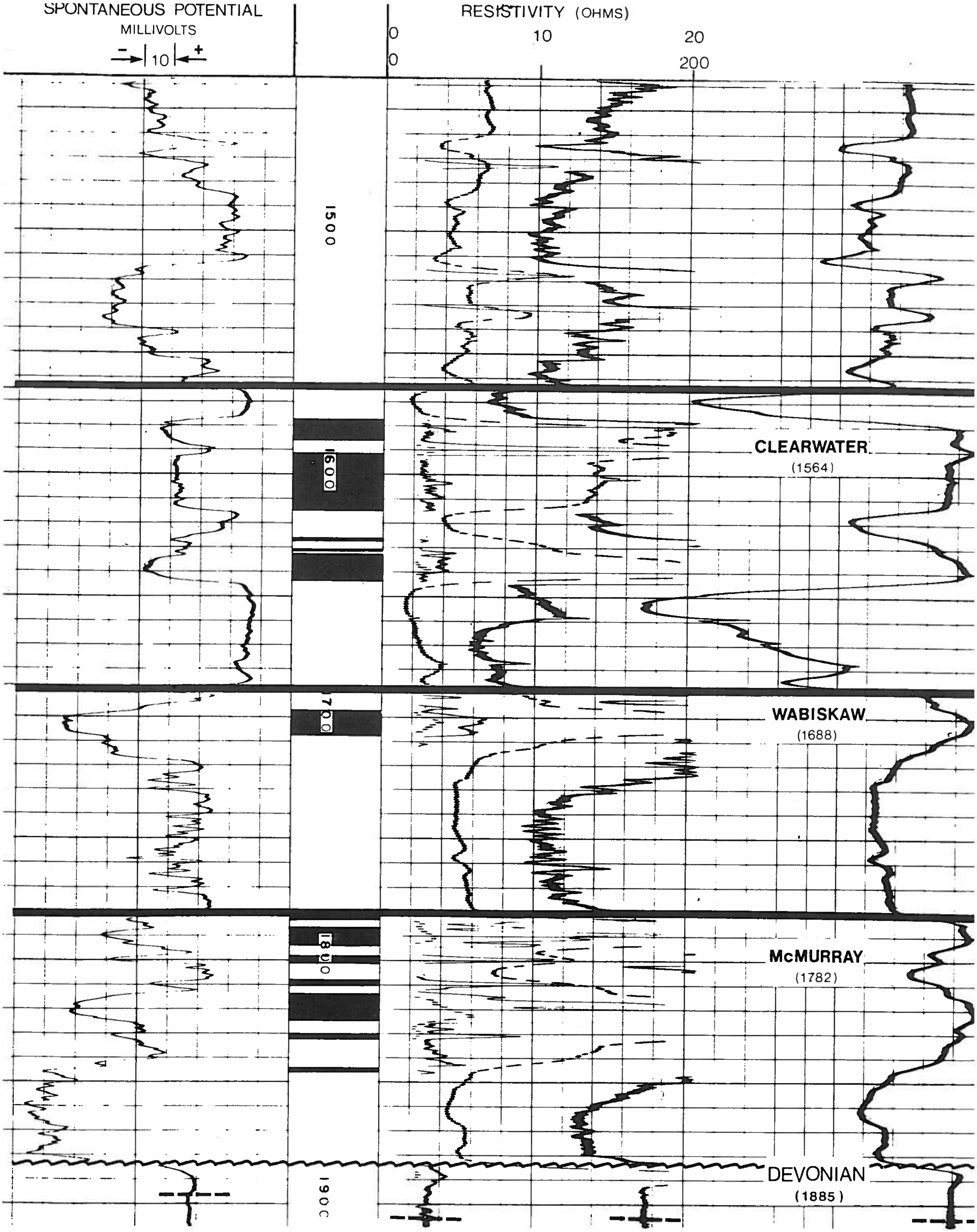
	Research Primrose OV Program 1-74	Research Primrose OV Program 2-74	Research Primrose OV Program 3-74	Research Primrose OV Program 4-74
Location	7-3-68-1W4	13-17-68-2W4	3-8-69-3W4	13-13-68-5W4
KB	2091	2375	2405	2344
Geologic Markers				
Base of drift	270 (+1821)	775 (+1600)	648 (+1757)	658 (+1686)
Base of Fish Scales	792 (+1299)	905 (+1470)	901 (+1504)	809 (+1535)
Viking Equivalent	1073 (+1018)	1154 (+1221)	1146 (+1259)	1073 (+1271)
Grand Rapids	1202 (+ 889)	1298 (+1077)	1281 (+1124)	1200 (+1144)
Clearwater	1575 (+ 516)	1680 (+ 695)	1643 (+ 762)	1564 (+ 780)
Wabiskaw	1659 (+ 432)	1784 (+ 591)	1775 (+ 630)	1688 (+ 656)
McMurray	1758 (+ 333)	1857 (+ 518)	1835 (+ 570)	1782 (+ 562)
Devonian	1970 (+ 121)	2093 (+ 282)	2033 (+ 372)	1885 (+ 459)
Total Depth	1994	2110	2053	1909
Net Oil Sand Thickness (ft)				
Grand Rapids Fm	0	0	3 ?	0
Clearwater Fm	0	11	45	44
Wabiskaw Mbr	0	0	13	10
McMurray Fm	0	0	0	32
Gas shows			2' indicated on logs (1662-1664)	
DST results		DST 1, 1690-1710 40 ft v. sl. oil flecked mud		
Sidewall cores (total number)	0	12	23	18



.gure 3. Well log of Research Primrose OV Program 2-74 (13-17-68-2W4) showing net oil sands in



re 4. Well log of Research Primrose OV Program 3-74 (3-8-69-3W4) showing net oil sands zones in black



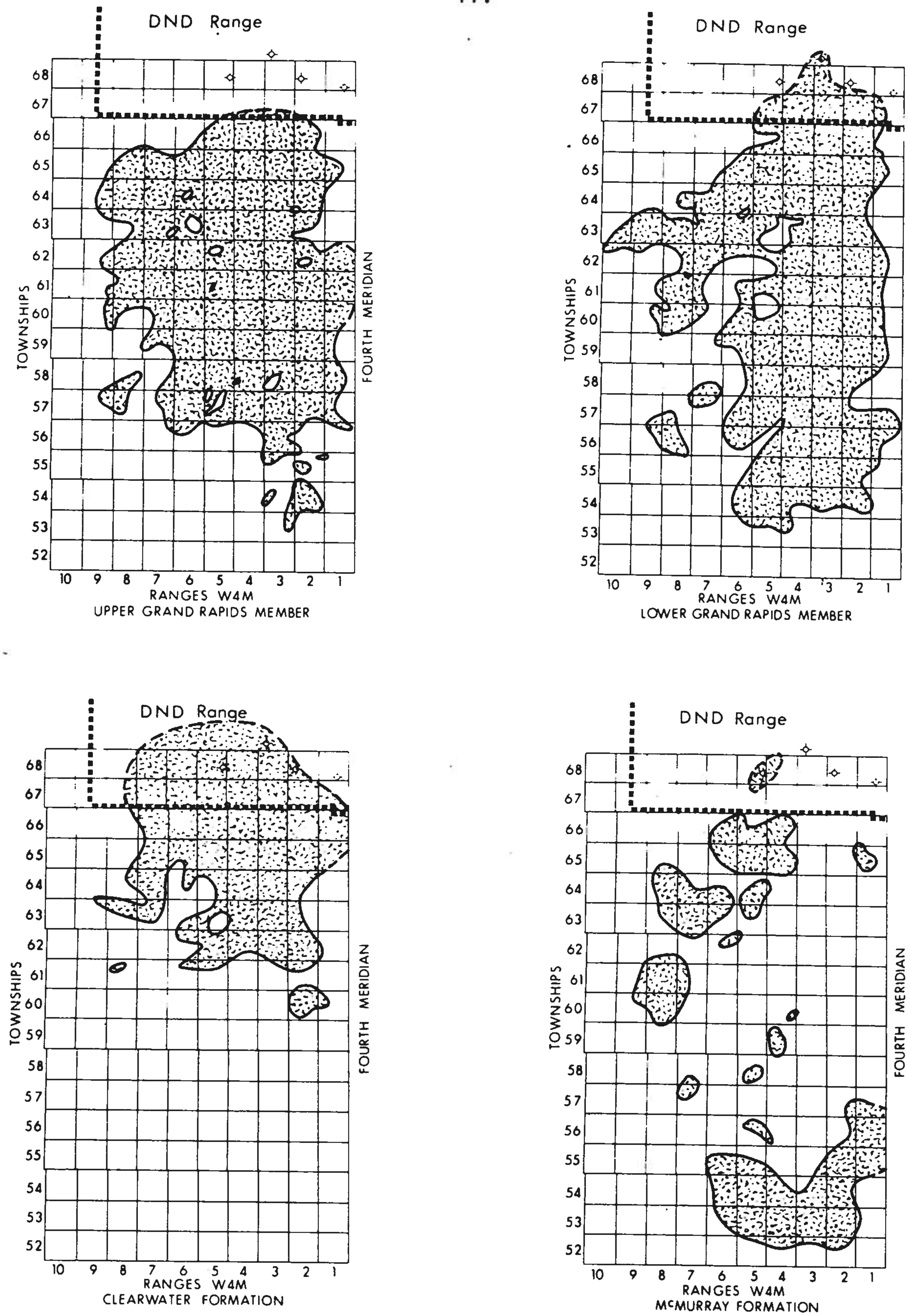
ıre 5. Well log of Research Primrose OV Program 4-74 (13-13-68-5W4) showing net oil sands zones in black

NATURAL GAS

Gas is frequently encountered in the Cold Lake Deposits to the south of the weapons range. However, no indication of gas was found during drilling of these wells. Logs, however, indicated the existence of a possible 2-foot thick gas zone in well 3-74 from 1662-1664 (K.B.) in the Clearwater Formation overlying the main oil sands interval (Fig. 4). This zone was not drillstem tested.

EXTENT OF THE COLD LAKE DEPOSITS UNDER THE AIR WEAPONS RANGE

As a result of this drilling program the approximate northern boundaries of the Cold Lake Oil Sands Deposits can be revised from those shown by the Alberta Energy Resources Conservation Board in its 1973 report on the Geology and Reserves of the Cold Lake Oil Sands Deposits (ERCB Report 73-Geol). These modifications, within the air weapons range, are shown on figure 6. The major change in the boundaries occur in those of the Clearwater Formation. These boundaries have moved approximately 1 to 2 townships north of where they were originally thought to be, except in the extreme southeastern portion of the range (township 67, range 1), where the boundary had to be moved southward because of the lack of oil sands in well 1-74. No changes have been made in the outline of the oil sands within the Upper Grand Rapids Formation. There is a minor change in the outline of the oil sands within the Lower Grand Rapids Formation because of the thin interval of oil sands found in well 3-74 within the Grand Rapids Formation. Another change has occurred in the outline of oil sands within the McMurray



re 6. Areal extent of the oil sands in the Cold Lake Oil Sands Deposits (Boundaries within the D.N.D. Air Weapons Range are modified from A.E.R.C.B. Report 73-Geol.).

Formation, with an area showing oil sands surrounding well 4-74. No estimates have been made of the additional reserves of oil sands that were found through this drilling program, because the distance between wells would make any additional reserve estimates on the weapons range speculative.

GEOLOGY

GENERAL

The Mannville Group of ~~Lower~~ Early Cretaceous age, in which the Cold Lake Oil Sands Deposits are found, can be divided into three formations: the Grand Rapids Formation; the Clearwater Formation and the McMurray Formation (Fig. 7). The Alberta Energy Resources Conservation Board divides the Grand Rapids Formation into an upper and lower unit. The Mannville Group is composed of sandstones and shales that were deposited by a series of delta complexes during stillstands of the sea following periodic transgressions of the Lower Cretaceous Boreal Sea into the Cold Lake area. The Mannville Group is unconformably underlain by Devonian Beaverhill Lake or Ireton strata and is conformably overlain by Lower Colorado marine shales.

The McMurray Formation (Fig. 7) was deposited by a series of rivers flowing from the Canadian Shield to the east into Alberta. These dominantly fluvial sediments filled in most of the irregularities on the pre-Cretaceous erosional surface with mainly well sorted, mature quartz sandstones.

After McMurray deposition the Boreal Sea transgressed southeastward into the Cold Lake area and reworked the uppermost McMurray sands. This resulted in the widespread glauconitic Wabiskaw sands, the basal member of the Clearwater Formation. At about the same time, uplift in the orogenic belt to the west and southwest resulted in another source of sediments, predominantly of volcanic origin, which gradually became dominant over the more mature sediments derived from the Canadian Shield to the east, during Clearwater time. The Clearwater Formation consists of interbedded shales

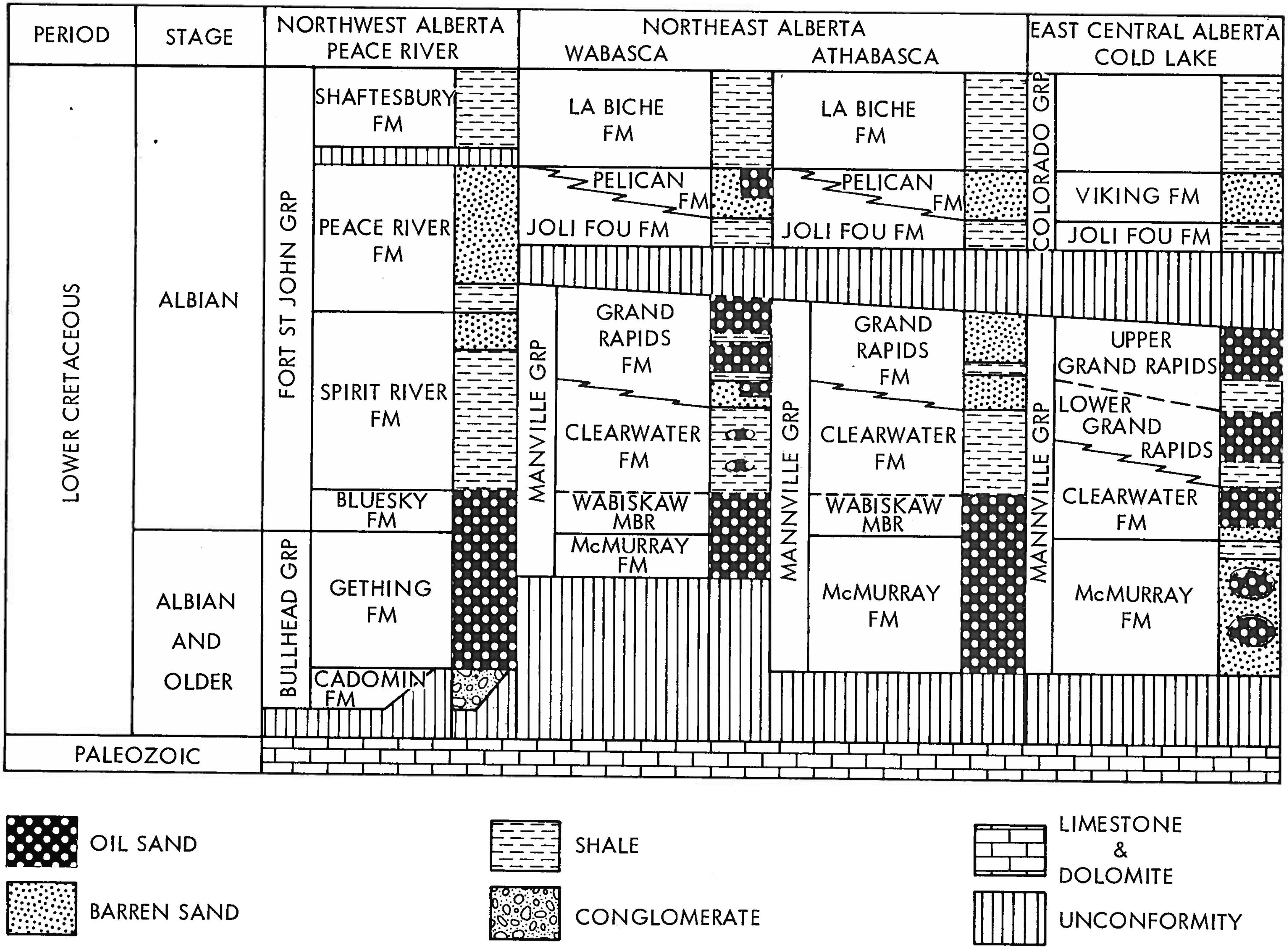


Figure 7. Correlation chart of oil sands deposits in northern Alberta.

and salt and pepper sandstones which are predominantly of a marine origin.

After Clearwater deposition the Boreal Sea started to retreat as a result of prograding Grand Rapids sediments. The Grand Rapids Formation consists of a marine and non-marine sequence of feldspathic, salt and pepper sandstones and siltstones with interbedded shales. Some thin coal beds also occur. At the close of Mannville time the Boreal Sea from the north and the Gulfian Sea coming from the southwest, coalesced and formed a continuous epi-continental sea over most of Alberta in which the marine Upper Cretaceous sediments were deposited.

OIL SANDS DISTRIBUTION

The Cold Lake Oil Sands Deposits differ from the other oil sands deposits in Alberta, in that oil impregnation is found throughout all sands of the Mannville Group (Fig. 7). In the McMurray Formation the oil is found in local sand bodies near the top of the formation, especially over highs in the underlying Paleozoic surface. Oil impregnation is more continuous and extensive in the Clearwater and Grand Rapids Formations. Oil trapping in these two formations appears to have been controlled by structural and stratigraphic conditions (that is the amount of matrix and the number of shale interbeds). Because of the dominantly marine origin of the Clearwater and Lower Grand Rapids sands, the most continuous and cleanest reservoirs are found in these two stratigraphic units, which contain approximately two-thirds of the total oil sands reserves in the Cold Lake Deposits. In the Upper Grand Rapids Formation, where non-marine sedimentation patterns predominated over marine conditions, the best oil saturations are found in the cleaner and thicker sands. The Upper Grand Rapids contains approximately one-quarter of the reserves in the Cold Lake Deposits.

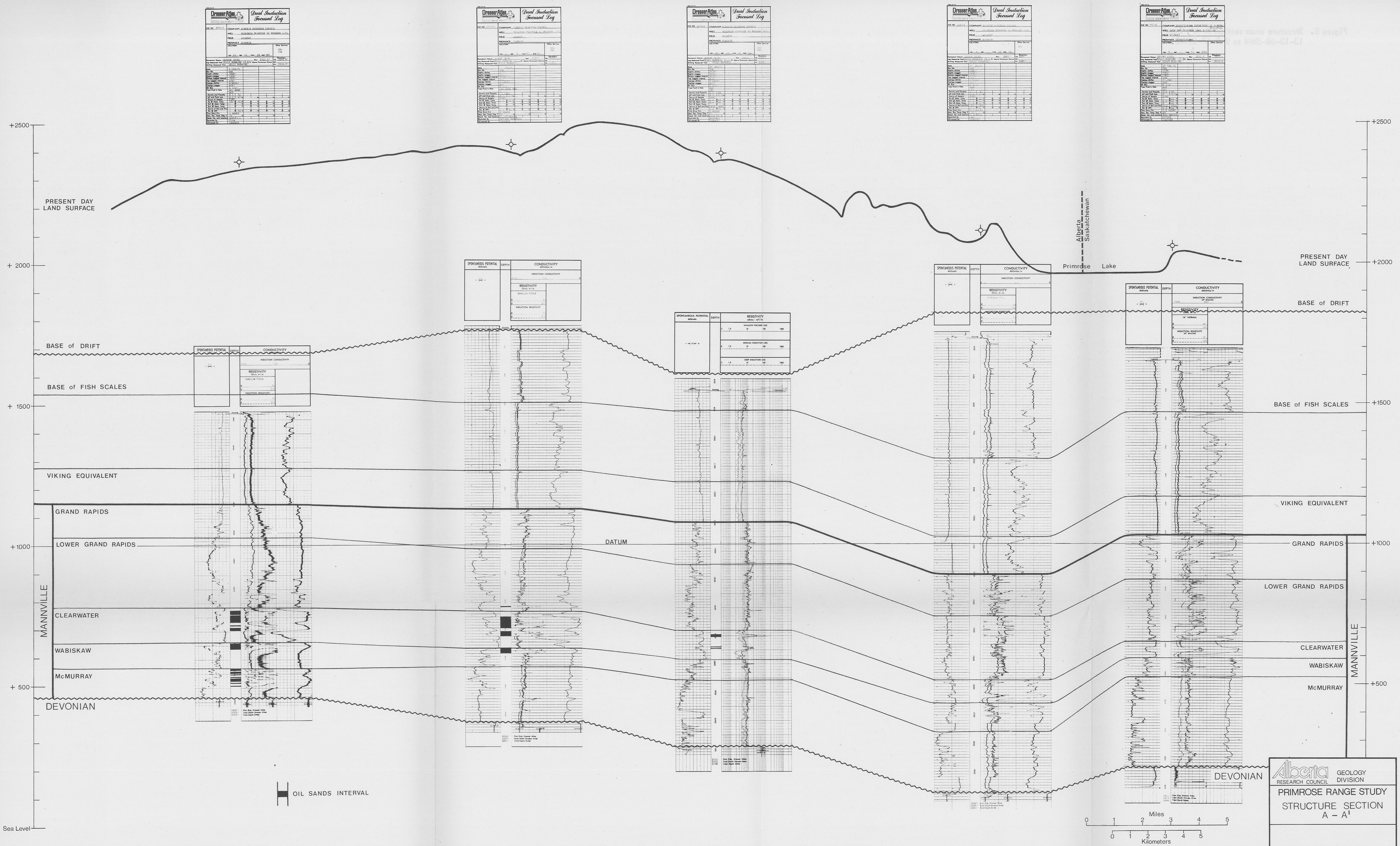
GEOLOGY OF THE AIR WEAPONS RANGE

McMurray Formation

The McMurray Formation in the four wells drilled during the winter of 1974-75 consists of mainly quartzose sands with some interbedded shales. The thickness varies from 103 feet in well 4-74 to 236 feet in well 2-74. In wells 1-74, 2-74 and 3-74 the basal half of the McMurray consists of a coarse- to very coarse-grained quartz sandstone, whereas the upper half and all of the McMurray in well 4-74 is composed of a very fine- to fine-grained quartz sandstone. Correlations between wells, within the McMurray, proved to be impossible.

Oil sands were found in the McMurray Formation in well 4-74 in seven zones (32 net feet) from 1782 to 1848 (Figs. 5 and 8). Although the top of the McMurray in well 4-74 is structurally lower than that in well 3-74 and the base of the oil saturation is structurally lower than the top of the McMurray in wells 2-74 and 3-74 (Fig. 8) no oil was found in the McMurray Formation in these two wells. This supports the belief that sands in the McMurray are limited in lateral extent and that oil saturated sands of the McMurray in well 4-74 are not in communication with barren McMurray sands in the other wells.

Figure 8. Structure cross section A-A', from 13-13-68-5W4 to 9-7-67-26W3.


PRESENT DAY LAND SURFACE
BASE of DRIFT
BASE of FISH SCALES
VIKING EQUIVALENT
GRAND RAPIDS
LOWER GRAND RAPIDS
DATUM
CLEARWATER
WABISKAW
McMURRAY
MANNVILLE
DEVONIAN
Alberta
Saskatchewan
Primrose Lake
OIL SANDS INTERVAL
+2500
+2000
+1500
+1000
+500
Sea Level
Miles
0 1 2 3 4 5
Kilometers
0 1 2 3 4 5
SPONTANEOUS POTENTIAL
DEPTH
CONDUCTIVITY
RESISTIVITY
Dresser Atlas
Dual Induction Focused Log
Alberta RESEARCH COUNCIL
GEOLOGY DIVISION
PRIMROSE RANGE STUDY
STRUCTURE SECTION
A – A'
DATE July 1975
AUTHOR J.W.Kramers

Clearwater Formation

The Clearwater Formation consists of typically Lower Cretaceous very fine- to fine-grained salt and pepper sandstones and siltstones, that are glauconitic in the Wabiskaw Member, with interbedded marine shales. The Wabiskaw Member was distinguished on the basis of a higher glauconite content than other sandstones in the Mannville. The thickness of the Wabiskaw Member varies from 60 feet in well 3-74 to 99 feet in well 1-74 and the total Clearwater Formation varies in thickness from 177 feet in well 2-74 to 218 feet in well 4-74. Two sidewall cores in a shale bed in the Clearwater Formation from well 2-74 (samples 2-74-1 (1762 ft) and 2-74-2 (1756 ft)) were examined for both microfauna and microfloral content. The results of this show that this shale was deposited under marine conditions. Examination of the microflora from a thin shale bed in the main sandstone interval of the Clearwater Formation in well 3-74 (sample 2-74-10 (1693 ft)) indicates that this sand was deposited under shallow, brackish water conditions. The complete results of the micropaleontologic and palynologic analyses are given in Appendix D. Therefore it is suggested that the Clearwater Formation in these four wells was deposited under predominantly marine conditions with some of the sands having been deposited in a nearshore environment.

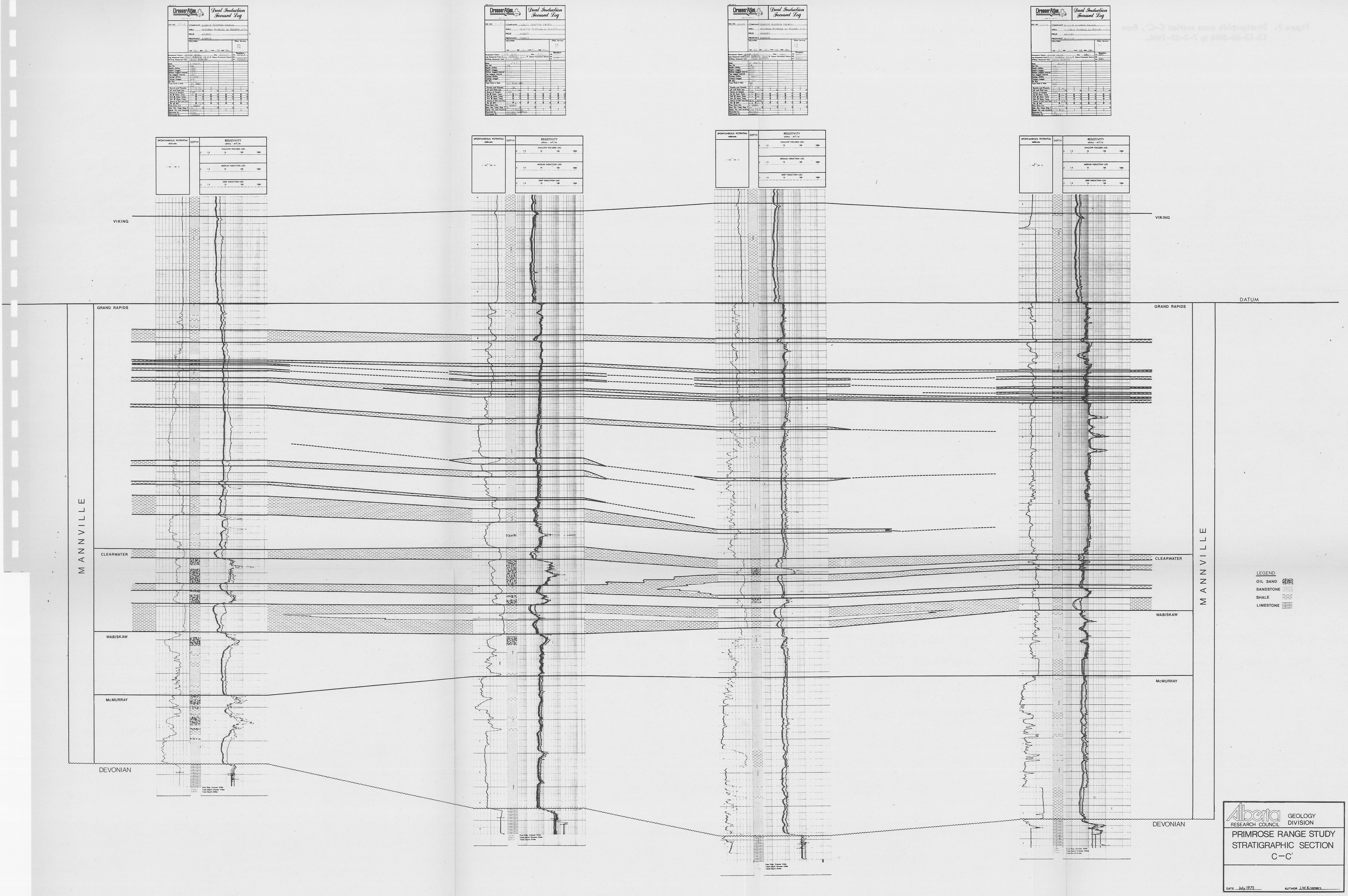
Heavy oil was found in the Clearwater Formation in wells 2-74, 3-74 and 4-74 (Figs. 3, 4 and 5). The Wabiskaw Member of the Clearwater Formation only, had oil in wells 3-74 (13') and 4-74 (10') (Figs. 4 and 5). Structurally the Wabiskaw in wells 1-74 and 2-74 is lower than in 3-74 and 4-74

(Fig. 8), thus explaining why no oil was found there. The main oil bearing sands are found in the upper half of the Clearwater Formation (11 net feet in well 2-74, 45 net feet in well 3-74 and 44 net feet in well 4-74). The oil impregnation is found in two sandstone units, which appear to be correlative from well 1-74 to well 4-74 on the basis of correlating shales between the wells (Fig. 9). Structurally, these sands are low in well 1-74 and the Saskatchewan DMR well that is also shown in figure 8. Well 1-74 is structurally low in all horizons, which may account for the lack of oil saturation in it and to the east of it. The reason for well 1-74 being structurally low is, that it is close to the edge of salt solution in the underlying Devonian Prairie Evaporites, as shown by the NW-SE trending closed lows on the Paleozoic surface (Fig. 10) in the northeast corner of the weapons range and in Saskatchewan just east of the Alberta - Saskatchewan border.

Grand Rapids Formation

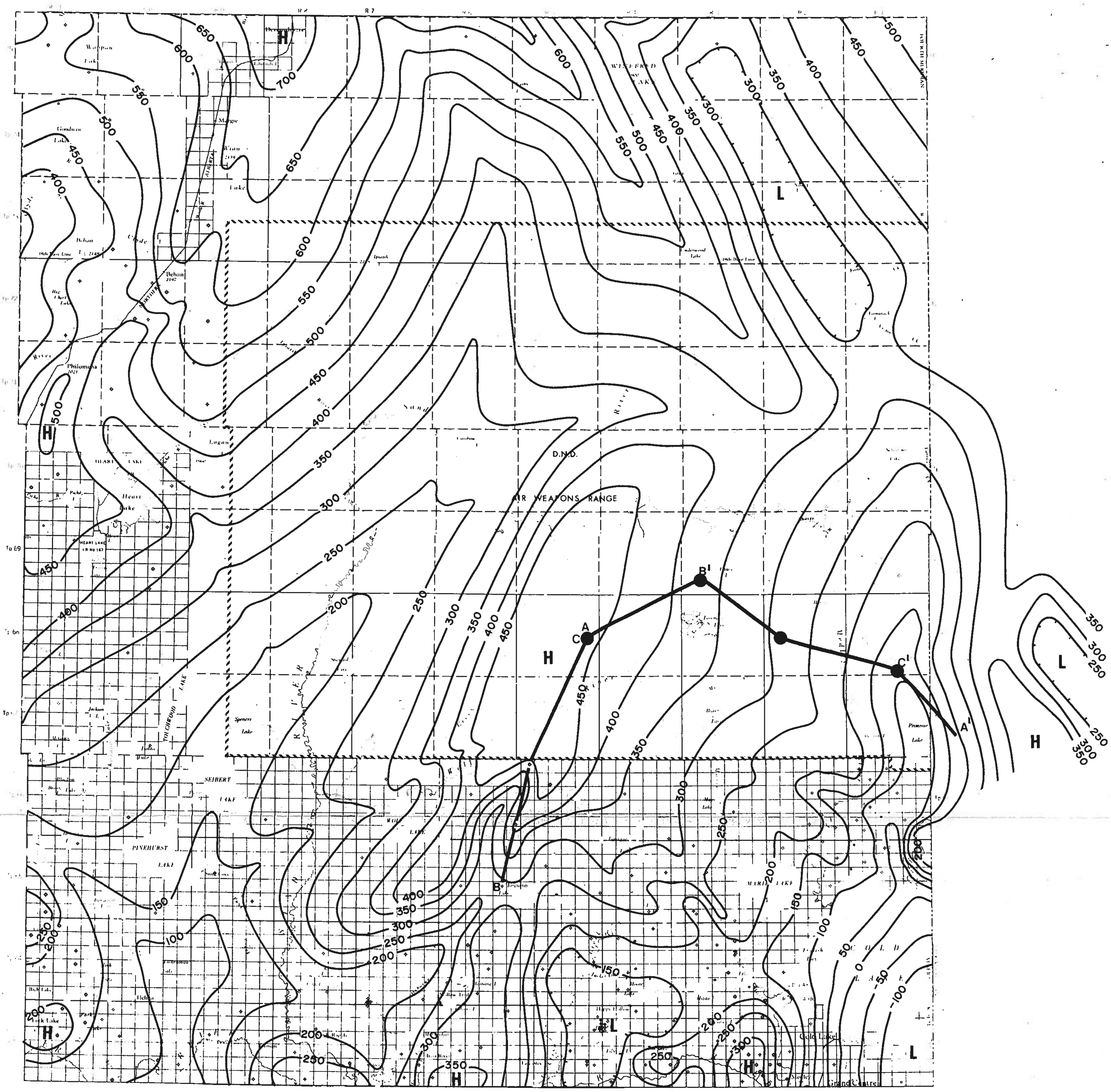
The Grand Rapids Formation, like the Clearwater Formation, consists of interbedded shales and very fine- to fine-grained feldspathic salt and pepper sandstones and siltstones. One sidewall core (No. 3-74-21, 1464 ft) was examined for microfloral content and this indicated a brackish nearshore environment of deposition (Appendix D). Sands in the Grand Rapids are all very fine- to fine-grained to siltstones, which may account for the fact that only one 3-foot zone of oil sands (well 3-74 (1624-1627 ft) figure 4) was found in the Lower Grand Rapids. Structurally the Grand Rapids should have been hydrocarbon bearing in this area.

Figure 9. Stratigraphic cross section C-C', from 13-13-68-5W4 to 7-3-68-1W4.



Dual Induction Focused Log
SPONTANEOUS POTENTIAL
DEPTH
RESISTIVITY
SHALLOW FOCUSED LOG
MEDIUM INDUCTION LOG
DEEP INDUCTION LOG
VIKING
DATUM
GRAND RAPIDS
MANNVILLE
CLEARWATER
WABISKAW
McMURRAY
DEVONIAN
LEGEND
OIL SAND
SANDSTONE
SHALE
LIMESTONE
Alberta RESEARCH COUNCIL
GEOLOGY DIVISION
PRIMROSE RANGE STUDY
STRATIGRAPHIC SECTION
C—C'
DATE July 1975
AUTHOR J.W.Kramers

Figure 10. Structure contours on the Paleozoic surface. (Contour interval = 50 ft.) Lines of cross sections for figures 8, 9 and 11 are shown on this map.



WELL STATUS

- Oil
- Gas
- Abandoned
- Suspended
- S.W. Disposal
- Experimental
- Location
- Abandoned Oil
- Abandoned Gas

SCALE 1:250000

Miles 5 0 5 10 15 20 Miles

Kilometers 5 0 5 10 15 20 25 30 Kilometers

Line of cross section

Wells drilled for Air Weapons Range evaluation program

Alberta RESEARCH COUNCIL GEOLOGY DIVISION

PRIMROSE RANGE STUDY

PALEOZOIC STRUCTURE

Contour Interval: 50 ft.

DATE June 1975 AUTHOR J.W. Kramers

Colorado Group

The Colorado Group in this area is very similar to that further south and consists of marine shales with minor thin lenticular sands and silts. The Viking Formation is not developed under the weapons range but an equivalent siltstone can be picked from electrical well logs. The Base of Fish Scales can be picked from both well cuttings and logs. The Second White Specks was only picked up in wells 1-74 and 3-74. In wells 2-74 and 4-74 erosion has cut down below this level.

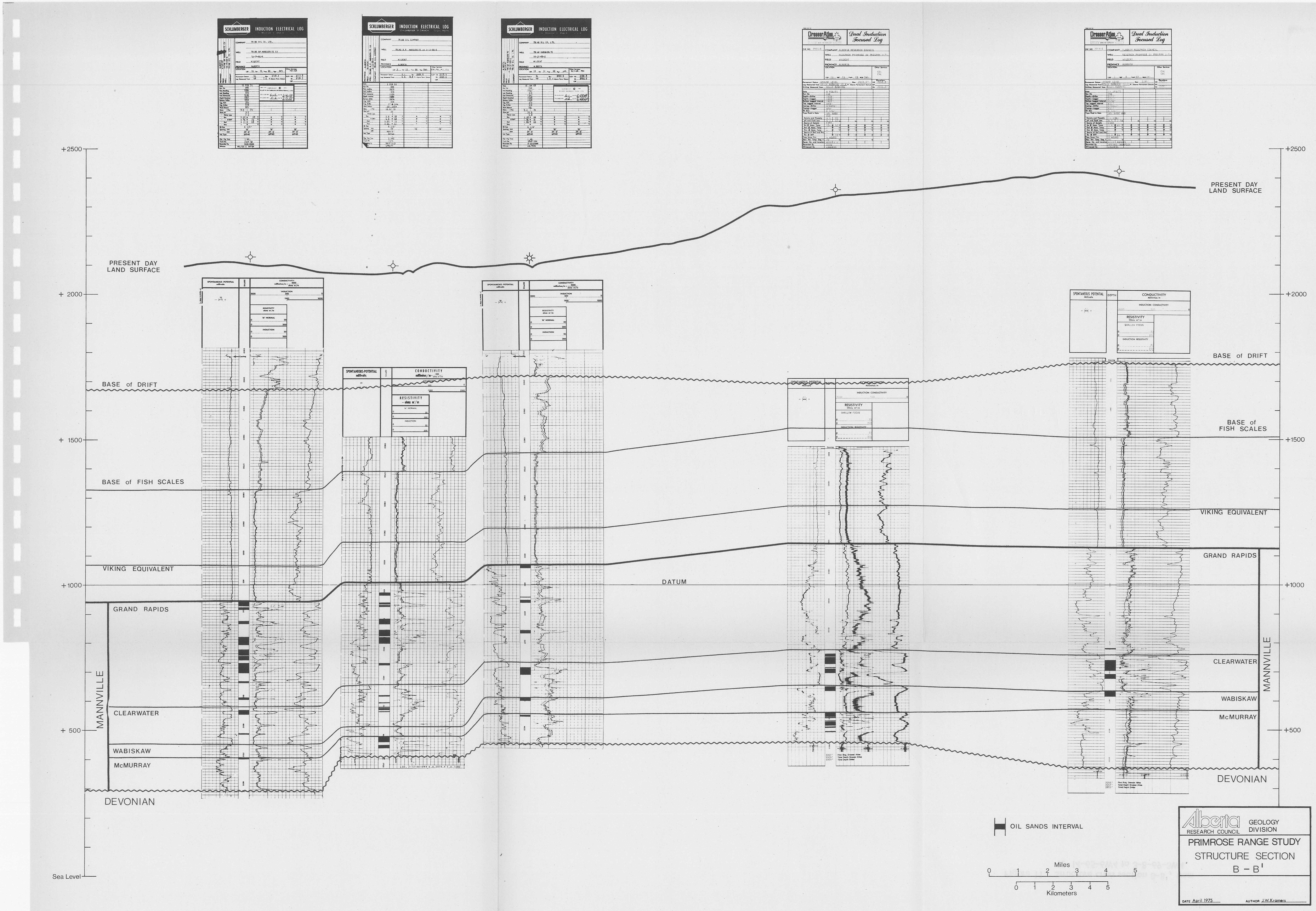
Glacial Drift

The thickness of glacial drift in these four wells varies from 270 feet in well 1-74 to 775 feet in well 2-74. Wells 3-74 and 4-74 also have very thick sections of glacial drift. It is interesting to note that the higher land surfaces have the thicker sections of glacial drift (Figs. 8 and 11). The thickness of glacial drift in wells 2-74, 3-74 and 4-74 also appears to be greater than that south of the Weapons Range (Fig. 11). This may imply that the very thick drift in this area was deposited as a moraine during a standstill of glaciation. This is also suggested by the sandy and gravelly composition of the drift.

CORRELATIONS BETWEEN WELLS

Detailed correlation within the Mannville Group in the Cold Lake area can be problematical. In some formations, such as the McMurray Formation, which was deposited under continental conditions, correlations

Figure 11. Structure cross section B-B', from 10-14-65-6W4 to 3-8-69-3W4.



SCHLUMBERGER INDUCTION ELECTRICAL LOG
Dresser Atlas Dual Induction Focused Log
+2500
+2000
+1500
+1000
+500
Sea Level
PRESENT DAY LAND SURFACE
BASE of DRIFT
BASE of FISH SCALES
VIKING EQUIVALENT
GRAND RAPIDS
DATUM
CLEARWATER
WABISKAW
McMURRAY
MANNVILLE
DEVONIAN
OIL SANDS INTERVAL
Miles
0 1 2 3 4 5
Kilometers
0 1 2 3 4 5
Alberta RESEARCH COUNCIL
GEOLOGY DIVISION
PRIMROSE RANGE STUDY
STRUCTURE SECTION
B – B'
DATE April 1975
AUTHOR J.W.Kramers

between closely spaced wells is almost impossible. Figure 9 is an attempt at correlation between the four wells drilled last winter. These correlations are based on what appear to be correlative shales between the individual wells. Correlation of the sandstone units then usually falls into place, if enough intervening shale breaks exist. It is on the basis of this stratigraphic section that the formation tops shown on table 1 were picked.

From figure 9 it can be seen that the oil impregnated sands within the Clearwater Formation appear to be correlative from well 1-74 to 4-74. Sands, lower down in the Wabiskaw and McMurray and those higher up in the Grand Rapids, do not appear to be as widespread. This stratigraphic section also explains why some of the sands in the Clearwater Formation are barren of oil; because they appear to be separate sands that are not in communication with the oil bearing sands.

In the upper half of the Grand Rapids Formation thin shale beds appear to correlate from well to well. However, the sands between these shales do not appear to be continuous because of their varying log responses. In the lower half of the Grand Rapids Formation shales appear to be correlative between two or maybe three wells at the most. Individual sandstones do not appear to correlate between the wells. Correlations in the Wabiskaw and McMurray become tenuous.

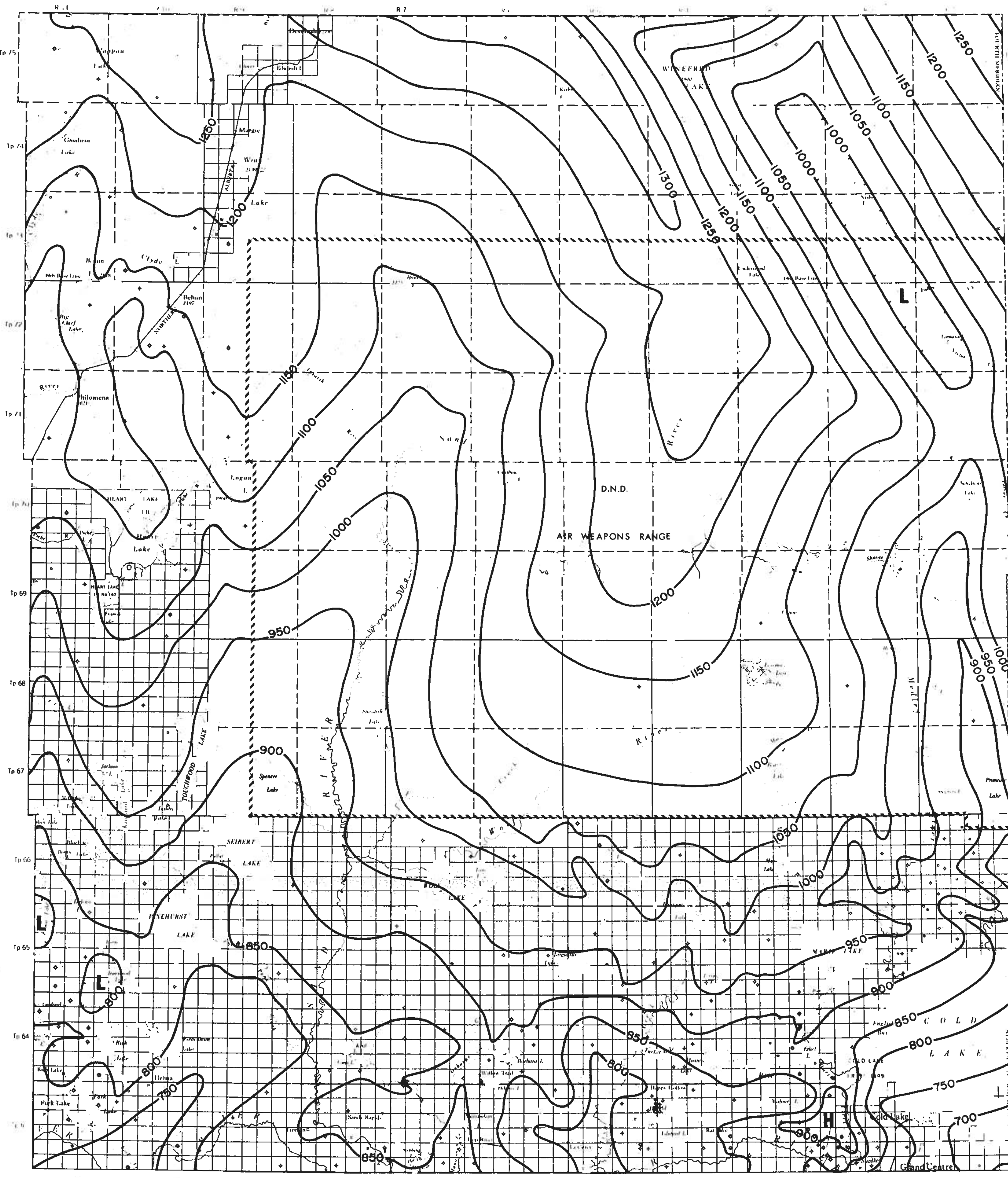
OIL AND GAS POTENTIAL OF THE PRIMROSE LAKE AIR WEAPONS RANGE

Drilling on the Primrose Lake Air Weapons Range during the winter of 1974-75 has shown that the Cold Lake Oil Sands Deposits extend well under the weapons range (Fig. 6). The potential for finding more oil sands under the remaining, unexplored portion of the weapons range is high. Structure appears to partially control the occurrence of oil sands to the south in the Cold Lake Deposits. The occurrence of natural gas is similarly controlled.

A major high on the Paleozoic surface (Fig. 10) extends well into the weapons range from township 66, ranges 5 and 6 W4. The nose of another high comes into the range from the north (approximately twp 74, rge 4 W4), and this high is well reflected in structure contours on the top of the Mannville (Fig. 12). The flank of a third high area on the Paleozoic and Mannville surfaces cuts across the northwest corner of the weapons range. All three of these areas are potential sites for finding oil sands and natural gas, if the lithology is favorable.

Wells south of the weapons range (twp 66, rge 5 W4), on the nose of the major high on the Paleozoic surface are capped gas wells. These wells have tested good gas flows from the Upper Grand Rapids and Clearwater Formations. For example, Triad Marguerite 10-31-66-5W4 tested gas at 1900 Mcf/d from the Upper Grand Rapids and gas at 1500 Mcf/d from the Clearwater. Figure 11, a cross section that runs through this well onto the range, shows that oil sands in the Clearwater Formation in wells 3-74

Figure 12. Structure contours on the top of the Mannville Group. (Contour interval = 50 ft.)



WELL STATUS

- Oil
- Gas
- Abandoned
- Suspended
- S.W. Disposal
- Experimental
- Location
- Abandoned Oil
- Abandoned Gas

SCALE 1:250,000

Miles 5 0 5 10 15 20 Miles

Kilometers 5 0 5 10 15 20 25 30 Kilometers

Alberta RESEARCH COUNCIL — GEOLOGY DIVISION

PRIMROSE RANGE STUDY

MANNVILLE STRUCTURE

Contour Interval: 50 ft.

DATE June 1975 AUTHOR J.W. Kramers

and 4-74 are better than the oil sands in the Clearwater Formation immediately south of the weapons range. This oil leg could be capped by natural gas further on the high. An indication that this may be so is the possible 2-foot gas zone in the Clearwater Formation in well 3-74.

The Cold Lake Deposits are known to extend to at least range 7 W4 along the southern boundary of the weapons range (Fig. 6). This, plus the results of last winters drilling program, makes the southwest corner of the weapons range a highly prospective area for finding additional reserves of oil sands. There is also a good possibility that the Cold Lake Deposits will extend to the north and northwest from where they are known to exist now, across the western portion of the weapons range, where they may join with a southward extension of the Athabasca Oil Sands Deposit.

In wells drilled off the northwest corner of the weapons range, electrical logs show high resistivities in the Grand Rapids and the McMurray Formations. This could be the result of hydrocarbons or fresh water. Natural gas has been tested in some of these wells and some of the sands appear to be oil saturated. Structurally this carries over into the weapons range. Thus the northwest corner of the weapons range has a good potential for both heavy oil and natural gas.

Little well control exists along the northern boundary of the weapons range. There appears, however, to be a structurally high area coming into the northern portion of the weapons range (Figs. 10 and 12). If stratigraphic conditions similar to those in the southern portion of the weapons range exist at the northern end, then this could be another potential area for oil and natural gas.

OPERATIONS

PREPARATIONS FOR THE DRILLING PROGRAM

After approval had been received from the Department of Mines and Minerals to go ahead with the drilling program as proposed, ads for tenders were placed in the Edmonton and Calgary papers to select a drilling contractor. Ads were also placed in the Bonnyville and St. Paul papers to select an operator to do the road and wellsite construction. Other contractors for the program were chosen on the basis of competitive bids. All contractors hired for the program are listed in Appendix A. Negotiations with CFB Cold Lake resulted in a minimum of disruption of the drilling program by base operations and a minimum of interruptions of base operations by personnel of the drilling program. Exceptional cooperation was received from all personnel at CFB Cold Lake.

WELLSITE CONSTRUCTION

During the last half of December 1974, the construction crew went into the area with two D6 bulldozers to start constructing the roads and the wellsites. Exceptionally warm weather during the winter of 1974-75 resulted in suspension of operations from December 30, 1974 to January 15, 1975. On the 15th of January crews went back in the area to finish putting in the roads and wellsites. The drilling rig started to move in on that same day and well 1-74 was spudded on January 17, 1975. The construction crew stayed ahead of the drilling operations so that there was no disruption of drilling operations or waiting for the rig to get on a new wellsite. As soon as a well was abandoned and the drilling crew had moved the rig to the next location, the bulldozers came back and started cleanup operations, in order that a minimum of time would elapse between finishing of drilling operations and complete cleanup of the area.

SURVEYING

Initially it was hoped to have the surveyors go in with the bulldozer operators, however, this was not found feasible and the surveyors went into the area after drilling commenced. This was found to be no problem. Wellsites had been picked out on aerial photographs and maps beforehand, thus there was no delay in getting any operation started. Surveying on the range was found to be difficult, mainly because of a lack of bench marks. The only survey monuments found date back to the early 1900's.

DRILLING OPERATIONS

All drilling operations were carried out on a 24-hour basis, with three crews, each working 8 hours per day. The camp stayed with the rig at all times, thereby minimizing travel on the range itself. The camp was supplied by the drilling contractor on a sub-contract basis and consisted of three bunk houses, one kitchen unit, a trailer for the toolpush, and a wellsite trailer for Alberta Research Council personnel.

A 9 7/8 inch diameter surface hole was drilled to below the base of the drift and 7", 17#, H40, ST&C new casing was used in all wells for surface casing. During the drilling of the surface hole, samples were collected at

30-foot intervals. After the surface hole had been drilled a dummy trip was made with the drillstring, in order to clean out the hole and then the casing was run in and cemented in place. Following cementing, the casing was left alone for 8 hours to allow the cement to set, after which a casing bowl and double B.O.P.'s (blow out preventors) were installed for safety purposes. A minimum time of 12 hours elapsed between the time the casing plug was down and drilling on the main hole started.

Well 3A was abandoned at 401 feet in the glacial drift because of hole problems. A high pressure water sand was penetrated and extreme caving of the well bore resulted. Further drilling was found to be impossible, unless the caving problem could have been solved. The decision was made to abandon well 3A, because the cost of moving to a new location (3-74) and starting again was estimated to be less than the cost of solving the hole problems.

The main hole was 6 1/4" diameter, in order to allow the use of standard logging and testing tools. The mud system was a Gel-Chemical mixture and mud was conditioned starting approximately 200 feet above the expected Mannville top, so that when the Mannville was penetrated the mud would be in good shape. A mud weight of 9.2 to 9.4 lbs per gallon (U.S.), a viscosity of 45-50 sec and a water loss of less than 4.0 cc was maintained during drilling. Because of the shallow nature of the wells, the drilling rig could drill at a fairly fast rate; however, a drilling speed of approximately 2 feet per minute was maintained in order to keep proper hole conditions. Drilling cutting samples were collected at 10-foot intervals, washed and bottled at the wellsite. The bottled drilled cuttings are stored at the Alberta Research Council.

EVALUATION OF THE WELLS

Drilling cuttings were logged and described at the wellsite so that up-to-date data on the formations being drilled was available. It was hoped that core points could be picked from the drill cuttings so that any oil sands intervals could be cored. This, however, proved impossible. Because of the high rate of penetration, by the time oil sands samples came to the surface, the drill bit was already 30-feet deeper, therefore making it impossible to core any oil sands zone less than 30-feet thick. Thus it was decided to take sidewall cores of the oil sands intervals instead.

After drilling, geophysical well logs were run: a Dual Induction Focussed log, a Compensated Neutron log, and a Compensated Density log, except in well 1-74 where only a Compensated Density and Dual Induction Focussed log were run because of technical problems with the logging equipment. These geophysical well logs were examined at the wellsite and combined with the data from the drill cuttings were used to decide where to take sidewall cores. Most of the sidewall cores were taken in zones thought to be oil saturated, however, some were taken in non-saturated zones in order to get an idea of the lithology and mineralogy of the whole Mannville Group in the area. Recovery of sidewall cores was in all cases greater than 90 percent. It is recommended that in future drilling programs on the

Primrose Lake Air Weapons Range, sidewall cores be considered as a standard evaluation technique in addition to full diameter cores where core point can be picked with any certainty. Only one drillstem test was run during this program on well 2-74, and technically it was a success.

Computed logs (Epilogs) were made by Dresser Atlas after the drilling program was completed. These logs show the hydrocarbon saturation; a matrix analysis (clay, silt, sand); a porosity analysis (total and effective porosity and hydrocarbon content), and bulk weight analysis of total water and hydrocarbons. These computer derived logs were found to be less than satisfactory because they consistently showed more oil saturation than what all the other data indicated. In all fairness, however, effective calculation of oil saturation was hampered by a complete lack of data on true formation water resistivity. Therefore, until data on formation water resistivity becomes available for this area, it is recommended that computed logs not be made in future drilling programs on the weapons range.

ANALYSIS OF SIDEWALL CORES

All sidewall cores were frozen at the wellsite and were kept frozen until analyzed, so that none of the light fractions of the oil would evaporate. All oil saturated cores were analyzed for bitumen and water saturation using Dean-Stark separation apparatus. Thin sections were cut off all non-saturated samples, as well as some of the saturated sands. Four sidewall cores were submitted for palynological analysis; two of these were also examined for their microfaunal content.

The oil separated from the oil saturated cores was analyzed for oil gravity (°API), using a Berman torsion microbalance, and for sulphur content. Some of the oil samples were analyzed for oil viscosity, using a Wells-Brookfield microviscometer; asphaltene content; and SARA analysis (% Saturates, % Aromatics, % Resin I, % Resin II, and % Asphaltenes). All of the oil samples did not receive the same analysis because of the small size of the samples. However, for each stratigraphic unit, all analysis were done. In addition, all sidewall cores, except those used for palynology and micro-paleontology, were broken down and their grain size and clay mineral composition determined. The results of all these analyses are given in Appendix C.

ABANDONMENT

After evaluation of the well data, the wells were abandoned by completely cementing the hole from total depth to surface. This was done by running two 2-stage plugs of cement into the well bore. The reason for completely cementing the wells from total depth to surface is that there would be no chance of further communication of formation waters between different horizons in the wells or communication between different horizons in the event that in-situ experiments or in-situ recovery of heavy oil in this area is undertaken in the future. The surface casing was cut off 3-feet below ground level and a steel plate welded on top. A 6-foot riser was then welded to the steel plate and a plate welded on this riser showing the location of the well. This was done so that it would be easier for surveyors to find survey points in future years.

WELLSITE CLEANUP

All the wellsites were cleaned up complying with the requirements of the Alberta Forestry Service. Any garbage was either burned or buried in the pits which were then filled up and the wellsite leveled. Any trees or shrubs which had been disturbed during clearing of the wellsites were then windrowed along the boundary of the lease two bulldozer widths away from the edge of the cleared area. All access roads were cleaned up in a similar manner to the satisfaction of the Alberta Forestry Service.

COMMUNICATIONS

Before the drilling program started, it was anticipated that communications with Edmonton and other communities in Alberta would be a problem. Radio telephones in cars were not found satisfactory. Therefore, two base stations were established to tie in with the AGT radio telephone network. One station was at the Primrose Lake gate and the other at the wellsite in the geologist's trailer. This established an effective means of communication between the wellsite and the gate, which had to O.K. all vehicles entering or leaving the range. It also allowed calling out of contractors at the right time when they were needed during the drilling operations. Reception on the radio telephones was marginal at times, because of the distance to the nearest AGT base station at Bonnyville. In future, when more drilling takes place on the Primrose Lake Air Weapons Range, a better method of communications will have to be found, because the distance to the Bonnyville station will be too great for normal AGT radio telephone communications equipment to handle. In addition, it would be useful in future years if direct communication lines could be established between the rig and the gate at the Primrose Lake so that any communication between these two points does not have to go through the AGT radio telephone network, where at times there are waiting periods of half an hour or more when someone else is using the one available channel.

EMERGENCY PROCEDURES

During the negotiations between CFB Cold Lake and the Alberta Research Council for access to the range, plans were set up for emergency evacuation of any injured personnel or evacuation of the drilling crew, if necessary. Luckily this was not needed. However, this procedure was used once when during a camp move, the kitchen unit fell off the highboy trailer and no eating facilities were available as a result. A CFB Cold Lake helicopter came and picked up the majority of the personnel at the wellsite and flew them into Grand Centre. A skeleton crew remained at the wellsite to keep the boiler going so that everything would not freeze up. This type of cooperation by CFB Cold Lake personnel was very much appreciated by everyone concerned.

ACCOUNTING

A total of $250,000 was made available to the Alberta Research Council for this drilling program. The Alberta Research Council supplied one geologist and one technician plus vehicles, analysis and administrative overhead. Total expenditures on the program were $240,321.26, exclusive of Research Council costs. Of this $1848.81 was paid for directly by Alberta Mines and Minerals for the use of a helicopter in September to visit CFB Cold Lake and scout the trail on the weapons range for possible locations and for commissionaires hired by CFB Cold Lake to man the gate at Primrose Lake on a 24-hour basis. The cost per well ranged from $41,542.33 to $51,848.91, with $49,387.30 not directly attributable to any particular well. Appendix B gives a detailed statement of all the expenses incurred in this program. A breakdown is given on a contractor by contractor basis as well as on a well by well basis. The funds that remained were returned to general revenue at the end of fiscal 1974-75.

Expenses to the Alberta Research Council in terms of salaries and overhead were not included in the above figures. Salaries for this project amounted to $19,155.25. This is made up of 0.75 man years of professional staff time for the project leader and a total of .33 man years of technical staff time for analytical determinations. On projects such as this, cost to the Research Council for administrative overhead, materials and equipment for analysis usually amount to 60% of salaries. Therefore, the total cost of this project to the Alberta Research Council was $30,648.40 ($19,155.25 for salaries plus $11,493.15 overhead). This brings overall expenditures for the drilling program to $270,969.66.

RECOMMENDATIONS FOR FUTURE PROGRAMS

On the basis of the drilling conducted last winter (winter 1974-75) on the Primrose Lake Air Weapons Range it has been shown that the Cold Lake Oil Sands Deposits extend well into the weapons range. It is therefore recommended that more drilling programs be carried out to find the northern boundary of the Cold Lake Oil Sands Deposits under the Primrose Lake Air Weapons Range. In addition, it is likely that the Athabasca Oil Sands Deposit will extend southward into the northern portion of the Primrose Lake Air Weapons Range, and this should also be confirmed by drilling.

The next drilling program to be undertaken on the Primrose Lake Air Weapons Range should probably be located in the southwest quarter of the weapons range to confirm the presence or absence of oil sands in this area. Following this, exploration should move north from there to find the ultimate northern boundary of the Cold Lake Oil Sands Deposits. Included in any future exploration of the Primrose Lake Air Weapons Range should be wells which are drilled to the Precambrian basement, in which the complete Mannville section and portions of any prospective Devonian horizons are cored. In addition to exploration for heavy oils, natural gas should not be discounted and the possibility of finding reserves of natural gas appear to be good.

Future exploration of the air weapons range will be more expensive than the operation carried out last winter because access trails are limited. Thus, more money will have to be spent on road clearance and wellsite construction. Inflation will also tend to increase the cost of these programs.

The ultimate objective of future exploration programs on the Primrose Lake Air Weapons Range should be a comprehensive evaluation of all the heavy oil and natural gas potential of the area and should be carried out on a drilling density of one well per township, including a density of approximately one well every six to nine townships to basement with a considerable amount of full diameter coring.

The following recommendations are made for the operational aspects of future drilling programs on the weapons range.

1. The selection of a drilling contractor should be made as early as possible in order to get the best rig available.

2. Consideration should be given to using a smaller rig, for example, a Failing 1500 size rig with a 2000 foot capacity. A slower penetration rate and trip time will be compensated for by a lower hourly rate and lower rig move cost.

3. The lowest hourly rate should not be the main governing factor in selecting the drilling contractor. Overall rig efficiency and estimated total rig move cost should also be seriously taken into account.

4. Although some savings can be made by drilling a small diameter hole (e.g., 7" surface hole and 4 3/4" main hole), these savings could be more than offset by hole problems for drilling, logging, testing and coring. Thus it is recommended that a 9 7/8" surface hole with 7" surface casing and a 6 1/4" main hole be used on future programs.

5. Letting the drilling contract subcontract the camp, the water hauler and some of the other small services resulted in less headaches for Alberta Research Council personnel, and it is recommended that this practice be continued in future programs. The main services however, should be on individual contracts.

6. Sidewall cores should be used as a standard evaluation technique where full diameter coring is not possible.

7. No computed logs (Epilogs or Saraband) be made until data on true formation water resistivity becomes available.

8. The monies allocated for future drilling programs should be covered by a cheque to a trust rather than an appropriation transfer, so that expenses that occur past the end of the fiscal year can be covered by the contract.

APPENDICES

A. Contracts awarded

B. Details of expenditures

C. Sidewall core and oil analysis reports

D. Palynology and micropaleontology reports

E. Content of well files

APPENDIX A

CONTRACTS AWARDED

CONTRACT	AWARDED TO
Drilling rig and camp	Westburne Drilling (BC) Ltd.
Road and wellsite construction, maintenance and cleanup	Stan Kolodka Construction Ltd.
Cement and cementing services	Halliburton Services Ltd.
Geophysical well logging	Dresser Industries, Inc.
Drilling supervision, and general consultant	Oilfield Consultants Ltd.
Surveying	Canadian Engineering Surveys Ltd.
Diamond coring	Christiansen Diamond Products (Canada) Ltd.
Drillstem testing	Halliburton Services Ltd.
Casing and casing accessories	Wilson Oilfield Supply Ltd.

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APPENDIX B

DETAILS OF EXPENDITURES

SUMMARY STATEMENT OF EXPENSES

Expenses paid for by the Alberta Research Council through vote number K122A	$236,657.70
Expenses paid for by Alberta Mines and Minerals (Helicopter and Commissionaires)	$ 1,848.81
Supplies transferred from Oil Sands Groundwater Program (269.35 ft of 7" casing @ $5.00/ft)	$ 1,346.75
Expenses paid for by Coal Drilling Program through error in accounting office (rental of power tongs)	$ 468.00
Total Expenses	$240,321.26

SUMMARY OF EXPENSES PAID FOR BY ALBERTA RESEARCH COUNCIL
Vote No K122A
(As per invoices received)

Rig, Crew, Camp, Trucking, Water Mud Chemicals, Fuel, Bits, Boiler and winterizing, Miscellaneous (to Westburne Drilling Ltd.)	$137,336.45[1]
Road and wellsite construction, maintenance and cleanup (to Stan Kolodka Construction Ltd. and Setrakov Construction Ltd.)	$ 28,232.00
Cement and Cementing services (to Haliburton Services Ltd.)	$ 21,479.88
Wireline well logging (to Dresser Industries, Inc.)	$ 16,568.82
Casing and casing accessories (to Wilson Oilfield Supply Ltd.)	$ 10,724.26[2]
Drilling supervision and general consultant (to Oilfield Consultants Ltd.)	$ 8,741.84[3]
Wellsite surveying (to Canadian Engineering Surveys Ltd.)	$ 7,578.50
Standby for Diamond Coring and Core Barrel Transport (to Christensen Diamond Products (Canada) Ltd.)	$ 1,570.50
Drillstem Testing Services (to Haliburton Services Ltd.)	$ 850.00
Miscellaneous Expenditures (Alberta Government Telephones, Minor services, Rentals, Supplies, Subsistence and travel allowances)	$ 3,575.45
Total	$236,657.70

[1]This includes a $100.00 credit for 1 joint of casing left with the rig.

[2]This includes $170.50 of casing accessories that were taken over by Oilfield Consultants Ltd.

[3]This includes a $320.20 credit for casing accessories and a used casing bowl taken over by Oilfield Consultants Ltd.

DETAILS OF EXPENDITURES

Expenses not attributed to any particular well	$ 49,387.30
Expenses attributed to 1-74 well	$ 51,848.91
Expenses attributed to 2-74 well	$ 43,102.46
Expenses attributed to 3A-74 well	$ 14,811.15
Expenses attributed to 3-74 well	$ 39,629.11
Expenses attributed to 4-74 well	$ 41,542.33
Total Expenditures	$240,321.26

EXPENSES NOT ATTRIBUTED TO ANY PARTICULAR WELL

Advertisements for public tender of drilling contract and road and wellsite construction	$ 102.37
Safety equipment for ARC staff	$ 91.50
Sample bags, sample bottles and well name stamps	$ 210.62
Transport of surface casing to Primrose Air Weapons Range	$ 1,072.00
License application for two radio telephones	$ 40.00
Radio telephone rental and long distance toll charges	$ 651.06
Miscellaneous supplies	$ 128.10
Road and wellsite construction, maintenance and cleanup	$28,232.00
Drilling supervisor and general consultant	$ 9,062.04
Wellsite location surveying	$ 7,578.50
Subsistence and travel allowances for ARC staff	$ 370.30
	$47,538.49

Expenses paid for by Alberta Mines and Minerals

Helicopter - September 1974	$ 738.00	
Commissionaires	$1,110.81	
	$1,848.81	$ 1,848.81
		$49,387.30

EXPENSES DIRECTLY ATTRIBUTED TO
RESEARCH PRIMROSE OV PROGRAM 1-74

Standby of rig and camp as per contract (14 2/3 days @ $300.00 per day)		$ 4,400.00
Move to gate of Primrose Lake Air Weapons Range as per contract		$ 9,000.00
Move from gate to location		$ 2,807.00
Rig up and tear out (11 hrs @ $1660.00 per day)		$ 760.63
Day work (138 1/4 hrs @ $2110.00 per day)		$12,154.48
Standby, waiting on equipment (7 hrs @ $1660.00 per day)		$ 484.16
Crew travel allowance (8 days @ $50.00 per day)		$ 400.00
Boiler and winterizing (186 hrs @ $125.00 per day)		$ 968.75
Camp (7 1/3 days @ $550.00 per day)		$ 4,033.52
Water		$ 2,027.00
Fuel		$ 1,368.80
Bits		$ 1,359.45
Bit parts (nozzle parts, used on all wells in program)		$ 81.60
Casing bowl ($225.00 less $150.00 credit from Oilfield Consultants. Same casing bowl used on all wells)		$ 75.00
Mud chemicals		$ 1,787.16
Abandonment and welding		$ 217.50
Transportation of groceries		$ 417.60
Casing and casing accessories		$ 1,603.92
Core barrel transportation to wellsite and standby of core hand		$ 681.00
Cement for cementing surface casing and abandonment	$1,800.00	
Surface casing cementing services	$ 858.40	
Abandonment cementing services	$1,444.28	
	$4,102.68	$ 4,102.68
Well logs (D.I.F.L., C.D.L. and Epilog)		$ 3,118.66
		$51,848.91

EXPENSES DIRECTLY ATTRIBUTED TO
RESEARCH PRIMROSE OV PROGRAM 2-74

Move from 1-74 location to 2-74 location		$ 4,941.00
Rig up and tear out (2/3 day @ $1660.00 per day)		$ 1,112.20
Day work (142 hrs @ $2110.00 per day)		$12,484.16
Standby, waiting on equipment (1 3/4 hrs @ $1660.00 per day)		$ 121.04
Crew travel allowance (7 days @ $50.00 per day)		$ 350.00
Boiler and winterizing (168 hrs @ $125.00 per day)		$ 875.00
Camp (7 days @ $550.00 per day)		$ 3,850.00
Water		$ 1,246.00
Fuel		$ 1,226.80
Bits		$ 1,107.02
Plastic for pit lining (all costs included here, but also used on 3A-74, 4-74 and 3-74 wells)		$ 251.15
Mud chemicals		$ 1,058.48
Abandonment and welding		$ 268.40
Rental of power tongs (paid for by Coal Drilling Program through error in accounting office)		$ 468.00
Casing and casing accessories		$ 3,454.64
Drillstem test		$ 850.00
Standby of core hand		$ 491.00
Cement for cementing surface casing and abandonment	$2,307.00	
Surface casing cementing services	$1,333.39	
Abandoment cementing services	$1,526.90	
	$5,167.29	$ 5,167.29
Well logs (D.I.F.L., C.D.L., C.N.L. and Epilog)		$ 3,175.28
Sidewall cores		$ 605.00
		$43,102.46

EXPENSES DIRECTLY ATTRIBUTED TO
RESEARCH PRIMROSE OV PROGRAM 3A-74

Move from 2-74 location to 3A-74 location		$ 3,409.00
Rig up and tear out (11 1/2 hrs @ $1660.00 per day)		$ 795.42
Day work (36 1/2 hrs @ $2110.00 per day)		$ 3,208.96
Crew travel allowance (2 days @ $50.00 per day)		$ 100.00
Boiler and winterizing (48 hrs @ $125.00 per day)		$ 250.00
Camp (2 days @ $550.00 per day)		$ 1,100.00
Water		$ 961.00
Fuel		$ 499.90
Bits		-
Mud chemicals		$ 604.31
Transportation of groceries		$ 208.80
Cement for abandonment	$2,160.00	
Abandonment cementing services	$1,513.76	
	$3,673.76	$ 3,673.76
		$14,811.15

EXPENSES DIRECTLY ATTRIBUTED TO
RESEARCH PRIMROSE OV PROGRAM 3-74

Move from 4-74 location to 3-74 location		$ 4,376.00
Rig up and tear out (18 hrs @ $1660.00 per day)		$ 1,245.00
Day work (122 1/2 hrs @ $2110.00 per day)		$10,769.79
Crew travel allowance (5 2/3 days @ $50.00 per day)		$ 305.21
Boiler and winterizing (146 hrs @ $125.00 per day)		$ 760.42
Camp (6 1/3 days @ $550.00 per day)		$ 3,483.70
Water		$ 1,221.00
Fuel		$ 928.20
Bits		$ 553.51
Mud chemicals		$ 1,285.85
Mud pump rental		$ 400.00
Transportation of mud pump and extra casing		$ 509.50
Abandonment and welding		$ 176.60
Transportation of groceries		$ 208.80
Transport of mud trailer to Bonnyville		$ 240.00
Casing and casing accessories (this includes $1,346.75 of casing transferred from the Oil Sands Groundwater Program)		$ 3,100.95
Transport of core barrel to Edmonton and charges for broken PVC core sleeves		$ 398.50
Cement for cementing surface casing and abandonment	$2,416.75	
Surface casing cementing services	$ 820.00	
Abandonment cementing services	$1,500.80	
	$4,737.55	$ 4,737.55
Well logs (D.I.F.L., C.D.L., C.N.L. and Epilog)		$ 3,832.37
Sidewall cores		$ 1,096.16
		$39,629.11

EXPENSES DIRECTLY ATTRIBUTED TO
RESEARCH PRIMROSE OV PROGRAM 4-74

Move from 3A-74 location to 4-74 location		$ 4,388.00
Rig up and tear out (20 1/2 hrs @ $1660.00 per day)		$ 1,417.92
Day work (132 hrs @ $2110.00 per day)		$11,605.00
Crew travel allowance (8 days @ $50.00 per day)		$ 400.00
Boiler and winterizing (192 hrs @ $125.00 per day)		$ 1,000.00
Camp (6 5/6 day @ $550.00 per day)		$ 3,758.33
Water		$ 2,304.00
Fuel		$ 1,755.05
Bits		$ 805.94
Mud chemicals		$ 1,483.14
Abandonment and welding		$ 234.90
Transportation of groceries		$ 208.80
Casing and casing accessories		$ 3,641.30
Cement for cementing surface casing and abandonment	$1,503.00	
Surface casing cementing services	$ 866.80	
Abandonment cementing services	$1,428.80	
	$3,798.60	$ 3,798.60
Well logs (D.I.F.L., C.D.L., C.N.L. and Epilog)		$ 3,821.35
Sidewall cores		$ 920.00
		$41,542.33

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APPENDIX C

SIDEWALL CORE AND OIL ANALYSIS REPORTS

Alberta
RESEARCH COUNCIL

GEOLOGY DIVISION

SIDEWALL CORE AND OIL ANALYSIS

RESEARCH PRIMROSE OV PROGRAM 2-74
13-17-68-2W4

SUMMARY

Well Name: Research Primrose OV Program 2-74 Location: 13-17-68-2W4 K.B.: 2375

Sample No.	Depth	Recovered	Wt % Oil Saturation	Lithology	Disposition
2-74-1	1762	x	-	sh	Pal.
2-74-2	1756	x	-	sh	Pal.
2-74-3	1745	x	6.4	sltst	OS, TS, G.S., V, CS
2-74-4	1741	x	4.2	sltst (sh)	OS, TS, G.S., V, A, CS
2-74-5	1702	x	7.6	ss	OS, G.S., S, CS
2-74-6	1700	x	6.2	ss	OS, TS, G.S., V, CS
2-74-7	1698	x	8.3	ss	OS, G.S., CS
2-74-8	1697	x	6.1	sltst (sh)	OS, G.S., V, A, CS
2-74-9	1475	x	-	ss	TS, CS
2-74-10	1448	x	-	sltst	TS, CS
2-74-11	1368	x	-	sltst	TS, CS
2-74-12	1362	x	-	sltst	TS, CS

x - positive
\- - negative
OS - bitumen and water saturation
TS - thin section
Pal. - paleontology (micro and palynology)
G.S. - Oil Gravity (°API) and % Sulphur
V - Viscosity of oil
S - SARA analysis of oil
A - Asphaltene content of oil
CS - Clay and silt % and composition

Well Name: Research Primrose OV Program 2-74 Location: 13-17-68-2W4 K.B.: 2375

Sample No.	Depth	Bulk Weight %		Calculated % Pore Sat		Calculated	Lithology
		Oil	Water	Oil	Water	Porosity*	
2-74-3	1745	6.4	10.8	37.4	62.6	35.4	sltst
2-74-4	1741	4.2	15.5	21.4	78.6	39.1	sltst (sh)
2-74-5	1702	7.6	13.6	35.9	64.1	41.6	ss
2-74-6	1700	6.2	14.7	29.7	70.3	41.1	ss
2-74-7	1698	8.3	10.2	44.8	55.2	37.5	ss
2-74-8	1697	6.1	13.8	30.6	69.4	39.6	sltst (sh)

*Porosities are calculated assuming that the oil and water measured constitute the total pore space. Densities are assumed to be 1.00 gm/cc for oil and water, and 2.64 gm/cc for the clean, dry, solid mineral phase.

Well Name: Research Primrose OV Program 2-74 Location: 13-17-68-2W4 K.B.: 2375

ample No.	Depth	Bulk Wt. % Oil	Oil Gravity °API @ 60° F	% S	Viscosity (cps) * 100° F	150° F	200° F	Oil Composition % Asphaltenes	% Saturates	% Aromatics	% Resin I	% Resin I
2-74-3	1745	6.4	8.9	4.4	19702	1869	177					
2-74-4	1741	4.2	8.6	4.5	28541	2423	206	17.4	-	-	-	-
2-74-5	1702	7.6	9.7	4.4				18.7	27.5	26.7	21.4	3.5
2-74-6	1700	6.2	10.8	4.2	1995	540	146					
2-74-7	1698	8.3	10.7	4.2								
2-74-8	1697	6.1	10.2	4.4	8881	1097	135	16.0	-	-	-	-

Viscosity values were calculated using a regression equation derived from measured viscosities at approximately 110° F, 150° F and 180° F.

Well Name: Research Primrose OV Program 2-74 Location: 13-17-68-2W4 K.B.: 2375

		Bulk Wt.	Grain size (%)				<2µ Clay Min. Comp. (%)*				<44µ Clay Min. Comp. (%)*			
Sample No.	Depth	% Oil	<2µ	2-44µ	44-62.5µ	>62.5µ	Kaol	Mont	Ill	Chl	Kaol	Mont	Ill	Chl
2-74-3	1745	6.4	2.6	29.5	23.2	44.7	25	5	60	10	45	5	50	-
2-74-4	1741	4.2	13.5	30.9	12.2	43.5	20	20	50	10	35	10	45	10
2-74-5	1702	7.6	9.5	27.0	8.1	55.4	25	20	40	15	40	10	40	10
2-74-6	1700	6.2	7.3	23.3	8.5	60.9	35	30	30	5	40	10	40	10
2-74-7	1698	8.3	5.1	25.8	10.8	58.4	45	20	30	5	55	-	35	10
2-74-8	1697	6.1	17.9	33.5	5.8	42.9	20	30	40	10	30	20	40	10
2-74-9	1475	-	3.6	17.4	7.0	72.0	55	20	25	-	50	-	40	10
2-74-10	1448	-	3.0	22.5	25.3	49.2	55	10	30	5	60	-	40	-
2-74-11	1368	-	12.6	41.2	24.9	21.3	60	10	25	5	55	-	35	10
2-74-12	1362	-	12.7	33.3	33.5	20.5	20	30	35	15	35	-	60	5

*Clay mineral values are ± 5%.

Alberta
RESEARCH COUNCIL

GEOLOGY DIVISION

SIDEWALL CORE AND OIL ANALYSIS

RESEARCH PRIMROSE OV PROGRAM 3-74
3-8-69-3W4

SUMMARY

Well Name: Research Primrose OV Program 3-74 Location: 3-8-69-3W4 K.B.: 2405

Sample No.	Depth	Recovered	Wt % Oil Saturation	Lithology	Disposition
3-74-1	2008	-	-	-	-
3-74-2	1970	x	-	ss	TS, CS
3-74-3	1949	x	-	ss	TS, CS
3-74-4	1845	-	-	-	-
3-74-5	1786	x	0.01	sltst	OS, CS
3-74-6	1782	x	6.8	sltst	OS, G.S., V, A, CS
3-74-7	1726	x	6.4	ss (silt)	OS, G.S., V, CS
3-74-8	1724	x	8.4	sltst	OS, G.S., S, CS
3-74-9	1717	x	0.13	sltst	OS, G.S., CS
3-74-10	1693	x	x	sh (ss)	Pal., TS
3-74-11	1686	x	8.5	ss	OS, G.S., S, CS
3-74-12	1684	x	6.4	ss	OS, G.S., V, CS
3-74-13	1672	x	6.8	ss	OS, G.S., CS
3-74-14	1668	x	8.6	ss	OS, TS, G.S., V, A, CS
3-74-15	1634	x	8.5	ss	OS, TS, G.S., V, A, CS
3-74-16	1626	x	1.9	ss	OS, G.S., CS
3-74-17	1624	x	0.02	ss	OS, CS
3-74-18	1618	x	-	ss	TS, CS
3-74-19	1522	x	-	ss	TS, CS
3-74-20	1480	x	-	ss	TS, CS
3-74-21	1464	x	-	sh (silt)	Pal., TS
3-74-22	1350	x	-	ss	TS, CS
3-74-23	1300	x	-	sltst (sh)	TS, CS
3-74-24	1282	x	-	sltst	TS, CS
3-74-25	1148	x	-	sltst	TS, CS

x - positive
\- - negative
OS - bitumen and water saturation
TS - thin section
Pal. - paleontology (palynology)
G.S. - Oil Gravity (°API) and % Sulphur
V - Viscosity of oil
S - SARA analysis of oil
A - Asphaltene content of oil
CS - Clay and silt % and composition

Well Name: Research Primrose OV Program 3-74 | Location: 3-8-69-3W4 | K.B.: 2405

Sample No.	Depth	Bulk Weight % Oil	Bulk Weight % Water	Calculated % Pore Sat Oil	Calculated % Pore Sat Water	Calculated Porosity*	Lithology
3-74-5	1786	0.01	16.3	0.1	99.9	34.0	sltst
3-74-6	1782	6.8	10.3	39.7	60.3	35.2	sltst
3-74-7	1726	6.4	8.6	42.6	57.4	31.7	ss (silt)
3-74-8	1724	8.4	8.7	49.0	51.0	35.3	sltst
3-74-9	1717	0.13	17.6	0.7	99.3	36.3	sltst
3-74-11	1686	8.5	9.7	46.6	53.4	36.9	ss
3-74-12	1684	6.4	8.7	42.6	57.4	32.0	ss
3-74-13	1672	6.8	10.3	39.8	60.2	35.2	ss
3-74-14	1668	8.6	6.2	58.2	41.8	31.5	ss
3-74-15	1634	8.5	8.2	50.9	49.1	34.6	ss
3-74-16	1626	1.9	11.5	14.1	85.9	29.0	ss
3-74-17	1624	0.02	12.8	0.2	99.8	28.0	ss

*Porosities are calculated assuming that the oil and water measured constitute the total pore space. Densities are assumed to be 1.00 gm/cc for oil and water, and 2.64 gm/cc for the clean, dry, solid mineral phase.

Well Name: Research Primrose OV Program 3-74 Location: 3-8-69-3W4 K.B.: 2405

ample No.	Depth	Bulk Wt. % Oil	Oil Gravity °API @ 60° F	% S	Viscosity (cps)* 100° F	150° F	200° F	Oil Composition % Asphaltenes	% Saturates	% Aromatics	% Resin I	% Resin I
3-74-5	1786	0.01										
3-74-6	1782	6.8	8.2	4.2	34930	2975	253	16.6	-	-	-	-
3-74-7	1726	6.4	9.0	4.4	37731	3091	253					
3-74-8	1724	8.4	10.7	4.2				15.5	28.3	28.4	25.0	3.8
3-74-9	1717	0.13	7.3	3.6								
3-74-11	1686	8.5	11.2	4.3				14.2	22.0	31.4	24.6	4.0
3-74-12	1684	6.4	10.0	4.1	13056	1431	157					
3-74-13	1672	6.8	11.4	4.1								
3-74-14	1668	8.6	9.7	4.2	12439	1361	149	16.2	-	-	-	-
3-74-15	1634	8.5	10.3	3.9	7952	963	117	15.8	-	-	-	-
3-74-16	1626	1.9	9.6	4.0								
3-74-17	1624	0.02										

*Viscosity values were calculated using a regression equation derived from measured viscosities at approximately 110° F, 150° F and 180° F.

Well Name: Research Primrose OV Program 3-74 Location: 3-8-69-3W4 K.B.: 2405

Sample No.	Depth	Bulk Wt. % Oil	Grain size (%) < 2μ	2-44μ	44-62.5μ	> 62.5μ	< 2μ Clay Min. Comp. (%)* Kaol	Mont	Ill	Chl	< 44μ Clay Min. Comp. (%)* Kaol	Mont	Ill	Chl
3-74-2	1970	-	1.5	12.5	6.0	80.0	70	-	30	-	55	15	30	-
3-74-3	1949	-	1.1	14.4	7.4	77.1	100	-	-	-	80	5	15	-
3-74-5	1786	0.01	3.4	50.1	27.7	18.7	55	15	30	-	55	-	45	-
3-74-6	1782	6.8	3.7	78.2	14.6	3.5	75	-	25	-	60	-	40	-
3-74-7	1726	6.4	5.9	29.5	14.1	50.5	40	-	55	5	40	-	55	5
3-74-8	1724	8.4	2.9	29.3	31.5	36.3	25	10	60	5	30	5	55	10
3-74-9	1717	0.13	33.4	55.1	5.2	6.3	10	20	55	15	15	15	55	15
2-74-11	1686	8.5	3.4	15.5	5.8	75.2	35	20	30	15	40	30	25	5
3-74-12	1684	6.4	2.7	16.2	8.0	73.2	40	15	30	15	40	35	20	5
3-74-13	1672	6.8	2.4	14.8	5.8	77.0	25	20	40	15	50	-	40	10
3-74-14	1668	8.6	4.1	15.7	5.2	74.9	10	25	45	20	25	10	55	10
3-74-15	1634	8.5	2.1	12.9	5.0	80.0	60	15	15	10	50	10	35	5
3-74-16	1626	1.9	12.7	23.9	8.3	55.2	10	45	35	10	20	20	45	15
3-74-17	1624	0.02	9.9	22.7	7.1	60.3	60	5	25	10	50	5	45	-
3-74-18	1618	-	4.6	22.2	11.4	61.9	50	10	35	5	55	15	25	5
3-74-19	1522	-	5.3	23.4	10.5	60.8	50	15	30	5	50	-	50	-
3-74-20	1480	-	4.7	21.0	12.9	61.4	70	5	20	5	45	-	45	10
3-74-22	1350	-	2.4	9.1	3.9	84.6	45	-	45	10	60	5	25	10
3-74-23	1300	-	19.6	27.1	16.0	37.4	5	40	35	20	20	25	45	10
3-74-24	1282	-	20.5	60.5	16.2	2.8	40	10	35	15	40	-	50	10
3-74-25	1148	-	21.1	77.4	1.4	0.1	25	30	35	10	30	5	60	5

* Clay mineral values are ± 5%.

Alberta
RESEARCH COUNCIL

GEOLOGY DIVISION

SIDEWALL CORE AND OIL ANALYSIS

RESEARCH PRIMROSE OV PROGRAM 4-74
13-13-68-5W4

SUMMARY

Well Name: Research Primrose OV Program 4-74   Location: 13-13-68-5W4   K.B.: 2344

Sample No.	Depth	Recovered	Wt % Oil Saturation	Lithology	Disposition
4-74-1	1860	-	-	-	-
4-74-2	1847	x	5.1	ss	OS, TS, G.S., CS
4-74-3	1823	x	11.8	ss	OS, G.S., S, CS
4-74-4	1819	x	10.3	ss	OS, G.S., V, CS
4-74-5	1800	x	5.3	sltst	OS, G.S., V, CS
4-74-6	1791	x	11.3	ss	OS, G.S., S, CS
4-74-7	1785	x	8.6	ss	OS, TS, G.S., V, CS
4-74-8	1711	x	0.44	sltst	OS, G.S., CS
4-74-9	1705	x	6.9	sltst	OS, G.S., V, CS
4-74-10	1703	x	8.2	ss	OS, G.S., S, CS
4-74-11	1641	x	8.8	sltst	OS, G.S., S, CS
4-74-12	1637	x	6.2	sltst	OS, G.S., V, CS
4-74-13	1608	x	7.8	ss (sh)	OS, G.S., CS
4-74-14	1605	x	9.3	ss	OS, G.S., V, A, CS
4-74-15	1599	x	7.8	ss	OS, G.S., V, CS
4-74-16	1584	x	9.3	ss	OS, G.S., S, CS
4-74-17	1582	-	-	-	-
4-74-18	1538	x	-	ss	TS, CS
4-74-19	1526	x	-	ss	TS, CS
4-74-20	1400	x	-	ss	TS, CS

x - positive
\- - negative
OS - bitumen and water saturation
TS - thin section
G.S. - Oil Gravity (°API) and % Sulphur
V - Viscosity of oil
S - SARA analysis of oil
A - Asphaltene content of oil
CS - Clay and silt % and composition

Well Name: Research Primrose OV Program 4-74 **Location:** 13-13-68-5W4 **K.B.:** 2344

Sample No.	Depth	Bulk Weight %		Calculated % Pore Sat		Calculated Porosity*	Lithology
		Oil	Water	Oil	Water		
4-74-2	1847	5.1	10.5	32.8	67.2	32.7	ss
4-74-3	1823	11.8	3.3	78.2	21.8	32.0	ss
4-74-4	1819	10.3	4.4	70.2	29.8	31.3	ss
4-74-5	1800	5.3	6.9	43.6	56.4	26.7	sltst
4-74-6	1791	11.3	3.3	77.6	22.4	31.1	ss
4-74-7	1785	8.6	3.5	71.3	28.7	26.5	ss
4-74-8	1711	0.44	12.0	3.5	96.5	27.4	sltst
4-74-9	1705	6.9	9.5	41.8	58.2	34.1	sltst
4-74-10	1703	8.2	5.3	60.5	39.5	29.1	ss
4-74-11	1641	8.8	6.5	57.5	42.5	32.4	sltst
4-74-12	1637	6.2	9.2	40.3	59.7	32.5	sltst
4-74-13	1608	7.8	9.7	44.8	55.2	35.9	ss (sh)
4-74-14	1605	9.3	9.1	50.4	49.6	37.3	ss
4-74-15	1599	7.8	9.4	45.4	54.6	35.5	ss
4-74-16	1584	9.3	8.7	51.5	48.5	36.7	ss

*Porosities are calculated assuming that the oil and water measured constitute the total pore space. Densities are assumed to be 1.00 gm/cc for oil and water, and 2.64 gm/cc for the clean, dry, solid mineral phase.

Well Name: Research Primrose OV Program 4-74 **Location:** 13-13-68-5W4 **K.B.:** 2344

ample No.	Depth	Bulk Wt. % Oil	Oil Gravity °API @ 60° F	% S	Viscosity (cps)* 100° F	150° F	200° F	Oil Composition % Asphaltenes	% Saturates	% Aromatics	% Resin I	% Resin I
4-74-2	1847	5.1	8.0	4.5								
4-74-3	1823	11.8	8.3	5.0				18.5	22.5	22.4	30.0	8.3
4-74-4	1819	10.3	9.7	4.3	74082	5353	387					
4-74-5	1800	5.3	10.2	4.2	14195	1537	166					
4-74-6	1791	11.3	10.3	4.7				16.7	23.7	21.7	31.3	6.0
4-74-7	1785	8.6	9.9	4.4	13027	1431	157					
4-74-8	1711	0.44	12.3	3.5								
4-74-9	1705	6.9	12.0	4.2	5108	730	104					
4-74-10	1703	8.2	11.1	4.3				14.1	21.5	20.8	38.7	4.6
4-74-11	1641	8.8	10.5	4.2				15.7	26.2	17.4	35.8	5.4
4-74-12	1637	6.2	10.5	4.1	10170	1268	158					
4-74-13	1608	7.8	11.5	4.1								
4-74-14	1605	9.3	12.5	4.0	4608	709	109	15.9	-	-	-	-
4-74-15	1599	7.8	11.1	4.1	6453	823	105					
4-74-16	1584	9.3	12.3	4.0				13.9	27.0	18.5	33.7	5.1

*Viscosities were calculated using a regression equation derived from measured viscosities at approximately 110° F, 150° F and 180° F.

Well Name: Research Primrose OV Program 4-74 Location: 13-13-68-5W4 K.B.: 2344

Sample No.	Depth	Bulk Wt. % Oil	Grain Size (%)				< 2μ Clay Min. Comp. (%)*				< 44μ Clay Min. Comp. (%)*			
			<2μ	2-44μ	44-62.5μ	>62.5μ	Kaol	Mont	Ill	Chl	Kaol	Mont	Ill	Chl
4-74-2	1847	5.1	0.7	9.6	5.9	83.7	60	15	25	-	70	10	20	-
4-74-3	1823	11.8	0.9	13.3	6.0	79.8	50	-	50	-	45	10	45	-
4-74-4	1819	10.3	1.0	15.4	6.7	76.9	55	-	35	10	55	5	40	-
4-74-5	1800	5.3	8.0	29.3	13.7	49.1	55	-	45	-	50	-	50	-
4-74-6	1791	11.3	0.9	12.4	6.0	80.8	55	-	45	-	55	2.5	40	2.5
4-74-7	1785	8.6	1.9	24.9	11.9	61.3	45	-	50	5	50	-	50	-
4-74-8	1711	0.44	16.4	79.3	3.1	1.3	65	-	35	-	55	-	45	-
4-74-9	1705	6.9	2.8	30.9	55.5	10.8	30	10	50	10	35	-	55	10
4-74-10	1703	8.2	2.5	21.3	18.5	57.7	50	-	50	-	50	-	45	5
4-74-11	1641	8.8	2.6	24.9	29.6	42.9	15	-	75	10	35	-	65	-
4-74-12	1637	6.2	5.6	39.1	33.7	21.6	20	10	65	5	25	-	65	10
4-74-13	1608	7.8	5.8	26.9	14.5	52.8	15	25	50	10	30	20	40	10
4-74-14	1605	9.3	3.6	19.7	10.8	66.0	25	20	40	15	35	5	50	10
4-74-15	1599	7.8	4.5	26.8	18.6	50.1	20	15	45	20	40	-	50	10
4-74-16	1584	9.3	3.5	19.9	8.8	67.9	40	15	35	10	30	-	60	10
4-74-18	1538	-	2.7	15.3	7.1	74.8	90	5	5	-	55	-	35	10
4-74-19	1526	-	5.0	18.2	9.5	67.3	75	5	15	5	30	-	65	5
4-74-20	1400	-	2.7	11.7	5.2	80.4	15	15	60	10	25	10	60	5

*Clay mineral values are ± 5%.

Alberta RESEARCH COUNCIL

APPENDIX D

PALYNOLOGY AND MICROPALEONTOLOGY REPORTS

PROVINCE OF ALBERTA

RESEARCH COUNCIL OF ALBERTA

11315 - 87TH AVENUE
EDMONTON 7, ALBERTA, CANADA.

OUR REF:

May 20, 1975

Dr. J.W. Kramers

Report on the microfloral assemblage in sample numbers: 2-74-1; 2-74-2; 3-74-10; 3-74-21.

Sample No. 2-74-1 contains the species listed below:

Microspores and pollen

1. Triporoletes reticulatus (Pocock) Playford, 1971; Range: Barremian - Turonian.
2. Lycospora cretacea Pocock, 1962; Range: Aptian - middle Albian.
3. Biretisporites potoniaei Delcourt and Sprumont, 1955; Range: Lower Cretaceous.
4. Concavissimisporites variverrucatus (Couper) Brenner, 1963; Range: Bajocian - Albian.
5. Classopollis classoides Pflug, emend. Pocock and Jansonius, 1961; Range: Rhaetic - Eocene.
6. Exesipollenites tumulus Balme, 1957; Range: Jurassic and Cretaceous.
7. Lycopodiumsporites austroclavatidites (Cookson) Potonie, 1956; Range: Jurassic and Cretaceous.
8. Lycopodiumsporites marginatus Singh, 1964; Range: Aptian and Albian.
9. Vitreisporites pallidus (Reissinger) Nilsson,1958; Range: Triassic to Cretaceous.
10. Stereisporites antiquasporites (Wilson and Webster) Dettmann, 1963; Range: Jurassic to Tertiary.
11. Alisporites grandis (Cookson) Dettmann, 1963; Range: Upper Jurassic and Lower Cretaceous.
12. Lycopodiacidites caperatus Singh, 1971; Range: Late Albian (Paddy Member). This extends the range down to middle Albian (Clearwater Formation).
13. Cicatricosisporites hallei Delcourt and Sprumont, 1955; Range: Lower Cretaceous - Cenomanian.
14. Cicatricosisporites perforatus (Baranov, Nemkova and Kondratiev) Singh, 1964; Range: Aptian - Turonian.
15. Trilobosporites marylandensis Brenner, 1963; Range: Lower Cretaceous.
16. Concavissimisporites punctatus (Delcourt and Sprumont) Brenner,1963; Range: Berriasian to Albian.
17. Cicatricosisporites australiensis (Cookson) Potonie, 1956; Range: Cretaceous.
18. Eucommiidites minor Groot and Penny, 1960; Range: Upper Jurassic - Albian.

Dinoflagellates and acritarchs

1. Fromea amphora Cookson and Eisenack, 1958; Range: Barremian - Cenomanian.
2. Cribroperidinium orthoceras (Eisenack) Davey, 1969; Range: Valanginian - Turonian.

PROVINCE OF ALBERTA

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11315 - 87TH AVENUE
EDMONTON 7, ALBERTA, CANADA.

OUR REF:

3. *Dingodinium albertii* Sarjeant, 1966; Range: Late Hauterivian - Albian.
4. *Gardodinium eisenacki* Alberti, 1961; Range: Hauterivian - Albian.
5. *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey, 1969; Range: Barremian - Cenomanian.
6. *Chlamydophorella nyei* Cookson and Eisenack, 1958; Range: Aptian - lower Turonian.
7. *Baltisphaeridium multispinosum* Singh, 1964; Range: Middle and late Albian.
8. *Pareodinia ceratophora* Deflandre, 1947; Range: Bajocian to Albian.
9. *Canningia hirtella* (Alberti) Millioud, 1969; Range: Valanginian - Hauterivian. Range extended here to middle Albian.
10. *Odontochitina operculata* (O. Wetzel) Deflandre, 1946; Range: Late Hauterivian - Maestrichtian.
11. *Oligosphaeridium pulcherrimum* (Deflandre and Cookson) Davey and Williams, 1966; Range: Lower Cretaceous - Lower Eocene.
12. *Spiniferites cingulatus* (O.Wetzel) Sarjeant, 1970; Range: Albian - Pleistocene.
13. *Pterospermella australiensis* (Deflandre and Cookson) Eisenack and Cramer, 1973; Range: Lower Cretaceous - Paleocene.
14. *Coronifera oceanica* Cookson and Eisenack, 1958; Range: Hauterivian - Turonian.
15. *Deflandrea echinoidea* Cookson and Eisenack, 1960; Range: Albian - Senonian.
16. *Systematophora schindewolfi* (Alberti) Downie and Sarjeant, 1964; Range: Middle Barremian - upper Aptian, ? Turonian.
17. *Cyclonephelium distinctum* Deflandre and Cookson, 1955; Range: Valanginian - Danian
18. *Impletosphaeridium whitei* (Deflandre and Courteville) Morgenroth, 1966; Range: Albian - Campanian.
19. *Caligodinium aceras* (Manum and Cookson) Lentin and Williams, 1973; Range: Early Late Cretaceous. Identification doubtful, one poorly preserved specimen seen.
20. *Astrocysta cretacea* (Pocock) Davey, 1970; Range: Barremian -Cenomanian.
21. *Spiniferites ramosus* (Ehrenberg) Loeblich and Loeblich, 1966; Range: Oxfordian - early Eocene.
22. *Deflandrea* sp. cf. *D. perlucida* Alberti, 1959; Range: Barremian - Albian.
23. *Cleistosphaeridium huguonioti* (Valensi) Davey, 1969; Range: Barremian - lower Santonian.

Age: Albian.
Depositional environment: The abundance of dinoflagellates and acritarchs indicates an open marine environment.

Sample No. 2-74-2 contains the species listed below:

Microspores and pollen: *Triporoletes reticulatus*, *Lycospora cretacea*, *Biretisporites potoniaei*, *Exesipollenites tumulus*, *Vitreisporites pallidus*, *Stereisporites antiquasporites*, *Alisporites grandis*, *Cicatricosisporites australiensis* (also present in Sample No. 2-74-1). Besides these the following species are also present:
1. *Alisporites bilateralis* Rouse, 1959; Range: Upper Jurassic - Cenomanian.
2. *Cerebropollenites mesozoicus* (Couper) Nilsson, 1958; Range: Jurassic and Cretaceous
3. *Trilobosporites marylandensis* (see 15 in sample no. 2-74-1)

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Dinoflagellates and acritarchs: Cribroperidinium orthoceras, Gardodinium eisenacki, Cleistosphaeridium polypes, Baltisphaeridium multispinosum, Canningia hirtella, Odontochitina operculata, Oligosphaeridium pulcherrimum, Deflandrea echinoidea, Systematophora schindewolfi, Hystrichosphaeridium whitei, Astrocysta cretacea, Cleistosphaeridium huguonioti (also present in Sample No. 2-74-1). Besides these the following species are also present:

1. Tanyosphaeridium variecalamum Davey and Williams, 1966; Range: Hauterivian - Santonian.
2. Oligosphaeridium complex (White) Davey and Williams, 1966; Range: Valanginian - early Eocene.
3. Oligosphaeridium albertense (Pocock) Davey and Williams, 1969; Range: Middle Albian.

Age: Albian.
Depositional environment: The abundance of dinoflagellates and acritarchs indicates an open marine environment.

Sample No. 3-74-21 (Research Primrose CV) contains the species listed below:

Microspores and pollen: Classopollis classoides, Eucommiidites turmulus, Lycopodiumsporites marginatus, Vitreisporites pallidus, Stereisporites antiquasporites, Alisporites grandis, Trilobosporites marylandensis, Concavissimisporites punctatus, Cicatricosisporites australiensis (see Sample No.2-74-1 for ranges).

Alisporites bilateralis (see Sample No.2-74-2 for range).

Besides these the following species are also present:

1. Distaltriangulisporites perplexus (Singh) Singh, 1971; Range: Middle Albian - Cenomanian. Frequency: Abundant.
2. Trilobosporites apiverrucatus Couper, 1958; Range: Upper Jurassic - Albian.
3. Pilosisporites trichopapillosus (Thiergart) Delcourt and Sprumont, 1955; Range: Purbeckian to Albian.
4. Gleicheniidites senonicus Ross, 1949; Range: Jurassic and Cretaceous.
5. Deltoidospora diaphana Wilson and Webster, 1946; Range: Upper Jurassic - Tertiary.
6. Acanthotriletes varispinosus Pocock, 1962; Range: Lower Cretaceous.
7. Baculatisporites comaumensis (Cookson) Potonie, 1956; Range: Upper Triassic - Cretaceous.
8. Microreticulatisporites uniformis Singh, 1964; Range: Aptian - Cenomanian.
9. Laevigatosporites ovatus Wilson and Webster, 1946; Range: Jurassic and Cretaceous.
10. Perinopollenites elatoides Couper, 1958; Range: Jurassic - Cenomanian.
11. Trilobosporites trioreticulosus Cookson and Dettmann, 1958; Range: Aptian and Albian
12. Podocarpidites multesimus (Bolkhovitina) Pocock, 1962; Range: Jurassic and Cretaceou
13. Polycingulatisporites reduncus (Bolkhovitina) Playford and Dettmann, 1965; Range: Middle Jurassic - Paleocene.
14. Parvisaccites radiatus Couper, 1958; Range: Upper Jurassic - Cenomanian.
15. Cicatricosisporites sp. cf. Anemia exilioides (Maljavkina) Bolkhovitina, 1953; Range: Middle and late Albian.
16. Cicatricosisporites hughesi Dettmann, 1963; Range: Aptian - Danian.

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17. Couperisporites complexus (Couper) Pocock, 1962; Range: Barremian - middle Albia
18. Cingutriletes clavus (Balme)Dettmann, 1963; Range: Jurassic - Tertiary.
19. Cyathidites minor Couper, 1953; Range: Jurassic and Cretaceous.
Large bisaccate pollen (coniferous) are abundant in this sample.

Dinoflagellates and acritarchs: Astrocysta cretacea (Pocock) Davey, 1970; Range: Barremian - Cenomanian. Frequency: Abundant.
Aptea polymorpha Eisenack, 1958; Range: Upper Barremian - Albian.Frequency: Common.

Age: Albian.
Depositional environment: There is a marked increase in the number and diversity of microspores and pollen grains, derived from land. The bisaccate pollen (conifero elements) are abundant. This points to a better drained, slightly elevated land mass in the vicinity. There is a marked reduction in the diversity of the dinoflagellates and acritarchs. Only two species are present which are abundant to common. This points to a brackish, near shore environment. The sample is most likel from the lower brackish part of the Grand Rapids Formation. For example, the Grand Rapids Formation in Fort Augustus Well # 1 is 238 feet thick, out of which only the upper 72' is completely free from marine influence.
Note: The sidewall sample and the other sample have the same assemblage.

Sample No.3-74-10 (Research Primrose OV) contains the species listed below:

Microspores and pollen: Classopollis classoides, Vitreisporites pallidus, Stereisporites antiquasporites, Alisporites grandis, Eucimmidites minor (see Sample No. 2-74-1 for ranges), Alisporites bilateralis (see Sample No.2-74-2 for range), Gleicheniidites senonicus, Distaltriangulisporites perplexus (Frequency: Common), Polycingulatisporites reduncus(see Sample No. 3-74-21 for ranges). Also present is: Polycingulatisporites radiatus Singh, 1971; Range: Middle and late Albian. Described from the Loon River, Harmon, Cadotte, Shaftesbury etc.

Dinoflagellate: One specimen of Astrocysta cretacea (Barremian-Cenomanian)is present

Interpretation of data: The recovery and preservation of microflora in this sample is very poor. This indicates poor conditions of preservation e.g. sandy lithology, oxidizing environment or thermal metamorphism (deep burial resulting in high temperature and pressure). However, based on the meagre data available I think that the sample comes from the upper Mannville (i.e. Clearwater or Grand Rapids Formation beds as D. perplexus is not present in the lower part. The presence of the single specimen of the dinoflagellate Astrocysta cretacea is indicative of shallow water, brackish environment of deposition.

(Chaitanya Singh)

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Science and Technology
Science et Technologie

April 23, 1975

Your file Votre référence

Our file Notre référence

Dr. J.W. Kramers
Alberta Research Council
11315 - 87 Avenue
Edmonton, Alberta
T6G 2C2

Dear John;

Enclosed is the report on the two sidewall core samples, 2-74-1 and 2-74-2, which you submitted.

In the matter of returning the foram slides as well as the four palynomorph slides which Diane has prepared, I have talked to Art Shepherd of the ERCB Core Storage center next door, who suggests I bring them over to their office for delivery to their downtown building and thence into the Alberta Government mail courier system. I will send a copy of this letter and report by courier as well.

Diane will keep phials of the processed palynomorph material here from which additional slides can be made in the unlikely event this parcel gets lost.

I trust these arrangements will prove satisfactory. With best regards.

Yours sincerely,

John

John H. Wall

JHW/val
Enclosure

Institute of Sedimentary and Petroleum Geology
Geological Survey of Canada
3303-33rd St., N.W. Calgary, Alta.
T2L 2A7

Institut de géologie sédimentaire et petrolière
Commission géologique du Canada
3303, 33e rue N-O Calgary, Alberta
T2L 2A7

Micropaleontology report on 2 sidewall core samples submitted by Dr. J.W. Kramers, Alberta Research Council.

2-74-1 Dark grey waxy shale with thin band of light grey, fine-grained sand. About 20 grams were processed for conventional microfossils which yielded the following foraminifera:

Miliammina sproulei Nauss - one specimen
Haplophragmoides sp. cf. *H. gigas minor* Nauss
H. sluzari Mellon and Wall
"Tritaxia" athabascensis Mellon and Wall - one specimen

age: Middle Albian, from the Clearwater or Grand Rapids Formation.
environment: marine, shallow, perhaps brackish

2-74-2 Dark grey waxy shale with blebs of fine-grained sand or silt; traces fine pyrite. About 20 grams were processed for conventional microfossils which yielded the following foraminifera:

Miliammina sproulei Nauss
Haplophragmoides gigas minor Nauss
H. sp. cf. *H. multiplum* Stelck and Wall - one specimen
H. sluzari Mellon and Wall
H. spp.
Trochammina sp. - one specimen
(megaspores also present)

age: as for sample 2-74-1
environment: as for sample 2-74-1

John H. Wall

John H. Wall
Research Scientist
Geological Survey of Canada

Paleontology Subdivision
Institute of Sedimentary and Petroleum Geology
Calgary, April 23, 1975

APPENDIX E

CONTENT OF WELL FILES

1. Summary of well data
2. Well license issued by the Alberta Energy Resources Conservation Board
*3. Alberta Energy Resources Conservation Board oil sands evaluation completion report
4. Engineers report on the well
*5. Drillstem test report (if available)
*6. Geophysical well logs
7. Epilog
8. Litholog
*9. Survey plat
10. Daily drilling reports
11. Drilling mud record
*12. Tower sheets
*13. Sidewall core and oil analyses report (if available)

*These reports have been submitted to the Alberta Energy Resources Conservation Board (only the standard core analysis: bulk weight % oil and water; calculated % pore saturation; calculated porosity and lithology were submitted instead of the full sidewall core and oil analysis reports).