REPORT No. 63

Interpretation of Aeromagnetic Data in West Central Saskatchewan and East Central Alberta

by

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1960

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PROVINCE OF SASKATCHEWAN

Reprinted 1969

INTERPRETATION OF AEROMAGNETIC DATA IN WEST CENTRAL SASKATCHEWAN AND EAST CENTRAL ALBERTA

ABSTRACT

In this paper an attempt has been made to show the value of aeromagnetic control in delineating the structure and lithological units of the basement rocks in the area. The structure map of the Precambrian surface beneath the sediments, as prepared from the aeromagnetic data and available well control, reveals some significant features which in turn may have controlled the sedimentation processes in the area. In addition to suggesting the probable thickness of sediments at various points, the basement map throws additional light on some of the known sedimentary anomalies. The Precambrian structure map also indicates some local and regional high trends which may give structural-stratigraphic control for the accumulation of petroleum and natural gas in this region.

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INTERPRETATION OF AEROMAGNETIC DATA IN WEST CENTRAL SASKATCHEWAN AND EAST CENTRAL ALBERTA

R. G. AGARWAL

Introduction

Approximately two-thirds of the Precambrian rocks in Saskatchewan are covered by sediments and glacial drift (Figure 1). Most of the geophysical and geological exploration work has been done in the southern part of the Province and this has resulted in the discovery of oil and gas fields, and recently some of the richest potash beds in the world. Exploration in the northern part of the Province, where Precambrian rocks are exposed at the surface, has resulted in the development of uranium, lead, zinc and copper mining industries, though much of the area still remains unexplored. Very little is known about the configuration of the basement of central Saskatchewan which is mostly covered by sediments. Some drilling has been done in this area for oil and gas but so far has resulted in little or no success. The Geological Survey of Canada carried out aeromagnetic surveys in west central Saskatchewan and east central Alberta in 1951-52, and published the maps in 1957. Basement studies of east central Alberta have been done by Burwash (1957), Green (1958),

FIGURE I
LOCATION MAP

Garland and Burwash (1959), and Garland and Bower (1959). No comparable studies have been conducted in west central Saskatchewan to date. The main purpose of this paper is to use the aeromagnetic maps in conjunction with known data from bore holes to study basement configuration in this area and structure within the sediments, as well as the possible occurrence of economic minerals.

The area of study has been extended into the Province of Alberta in order to gain additional regional control. It covers approximately 39,200 square miles and lies between Longitudes 107°00′ W and 114°00′ W and Latitudes 54°00′ N and 56°00′ N. The drill-hole data beneath the Precambrian surface shows that the sediments of this area are underlain by rocks similar to those of the Canadian Shield. To outline the lithological and structural features of the basement, the aeromagnetic data has been analyzed both qualitatively and quantitatively.

Acknowledgments

During the course of this study the writer had the opportunity to consult Isidore Zietz of the U.S. Geological Survey on the method of aeromagnetic interpretation and gratefully acknowledges the valuable suggestions and advice thus obtained. The writer is indebted to his colleagues in the Department of Mineral Resources for the valuable suggestions and criticism received during the preparation of this report and also wishes to thank D. H. Hall, Saskatchewan Research Council, for the critical reading of the manuscript.

Topographical and Physical Features

Where Precambrian bedrock is well exposed, the lakes and rivers are controlled by the structure of the bedrock which generally trends in a northeast-southwest direction. A definite northwest-southeast trend on the sedimentary section is observed as shown by the bays of the lakes, the courses of the rivers and streams and by the linear muskegs in the vicinity. The topographical and physical features are discussed in detail by Frarey (1950), Kupsch (1954), and Burwash (1957).

General Geology

The Precambrian rocks are covered by sediments in this area except in the northeast corner. The thickness and sequence of sediments above the Precambrian is vaguely known from well control. Table 1 shows the nomenclature for the sedimentary rocks of Saskatchewan and Alberta in the general area under study.

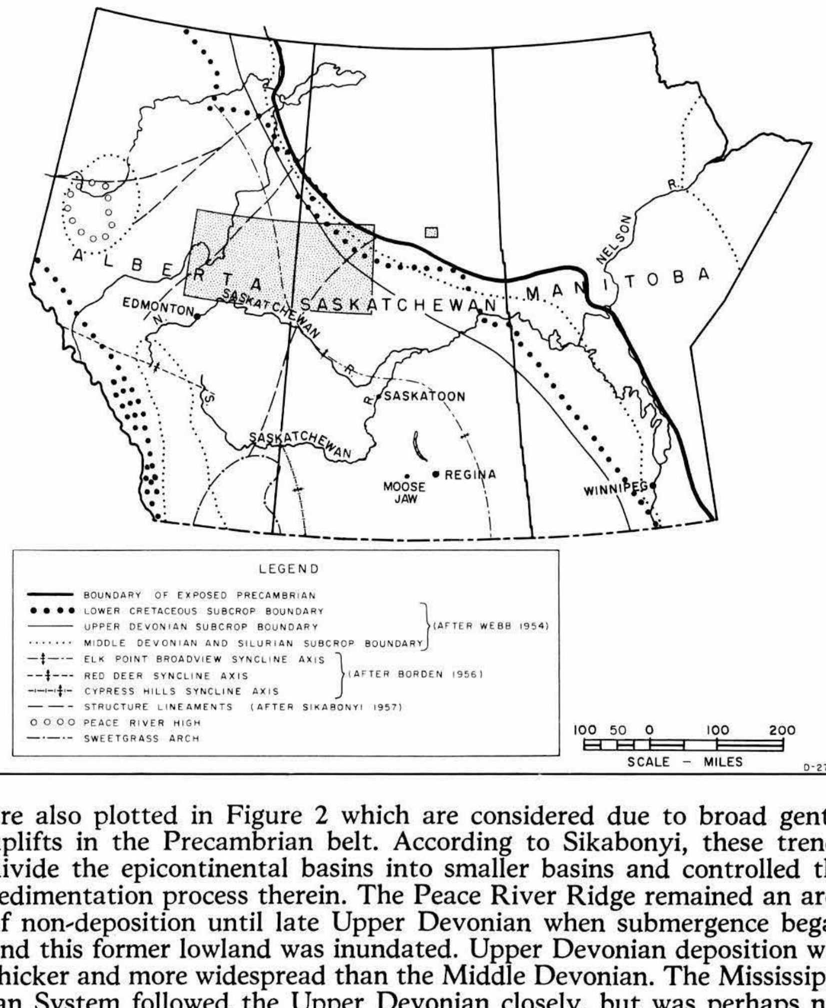
Webb (1954) and Borden (1955-56) have given an excellent review of the sedimentary geology of Western Canada, and Van Hees (1956), Buller (1958), Porter and Fuller (1959), and Belyea (1959) have dealt in detail with some formations of the sedimentary column in the area of study.

The oldest underlying sedimentary rocks are of Cambrian age, and rest unconformably on the Precambrian basement complex of igneous and metamorphic rocks. In the central Alberta plains the Upper Cambrian beds are overlain by the Elk Point Group. Eastward, in Saskatchewan, Ordovician and Silurian beds intervene and overlap the eastern margin of the Cambrian strata.

Sediments of the Elk Point group were deposited in a northwesterly trending basin. Figure 2 shows the axes of various synclines existing in these geological periods giving rise to the thick sediments along them. Some of the northeast lineaments in the Precambrian (Sikabonyi, 1957)

FIGURE 2

REGIONAL GEOLOGICAL FEATURES



are also plotted in Figure 2 which are considered due to broad gentle uplifts in the Precambrian belt. According to Sikabonyi, these trends divide the epicontinental basins into smaller basins and controlled the sedimentation process therein. The Peace River Ridge remained an area of non-deposition until late Upper Devonian when submergence began and this former lowland was inundated. Upper Devonian deposition was thicker and more widespread than the Middle Devonian. The Mississippian System followed the Upper Devonian closely, but was perhaps not as extensively deposited. The end of this period was marked by broad uplift, differential warping, and erosion. Much of the shelf continued emergent until early Lower Cretaceous time and was subjected to erosion.

Figure 2 shows the subcrop boundaries of the Devonian and Lower Cretaceous formations. The distribution of the Upper Cretaceous formation is very similar to that of the Lower Cretaceous but somewhat less extensive due to Post-Tertiary erosion. In Laramide time a broad uplift took place throughout the region accompanied by erosion. The weathered surface of the Upper Cretaceous formation forms the bed rock in most of the area and is concealed by Pleistocene and Recent deposits.

Basement Structure

The area under study is covered by a magnetic survey which was done by the Geological Survey of Canada in 1952. The resulting aeromagnetic maps were published in 1956-57, (Appendix 3). The magnetometer was flown at 1,000 feet above the ground level, mostly in an east-west direction, with an average flight line spacing of one mile. All the aeromagnetic maps published by the Geological Survey of Canada are on a scale of one inch to one mile (1:63,360), with contours drawn at a 10 gamma interval. The magnetic data are not corrected for regional variation. The correction for the regional magnetic variation would produce only a slight change in the size, shape and location of the total intensity anomalies. The approximate variation may be corrected by adding 0.5 gammas per mile from north to south and 2.8 gammas per mile from west to east.

The regional aeromagnetic map (Plate 1) has been prepared at a 50 gamma contour interval. All the magnetic data is relative to an arbitrary datum and is not an absolute measurement of the earth's magnetic field. Regional and structural trends are conspicuous on this map but for any detailed analysis of small areas the original maps published by the Geological Survey of Canada, mentioned earlier, should be consulted. The sediments in this area are non-magnetic. No intrusives in the sediments have been reported to date. As there are no known sources or reasons for magnetic anomalies in the sediments, it may be concluded that they are due to intra-basement effects. A preliminary review of the regional map (Plate 1) indicates sharp and closely contoured anomalies in the northeastern portion which are due to shallow basement rocks. In the western part of the map area the magnetic anomalies are less steep and widely contoured and are probably due to the thicker non-magnetic sedimentary section over this area.

It is possible to determine the approximate depth of the body causing an anomaly by measuring the horizontal extent of the steepest vertical gradient on the flank of the anomaly. Only those observed anomalies which have large amplitudes, cover large areas, and in general resemble theoretical fields, are usable. The method is described by Vacquier *et al* (1951) and yields reasonably good results provided the assumptions applied are valid.

Vacquier *et al* (1951) prepared theoretical charts of the total intensity of magnetic anomalies produced by a prismatic cell and these charts are compared with the large anomalies obtained from aeromagnetic surveys. The horizontal extents of the steepest gradients are measured on actual survey maps and on the model charts. These lengths, expressed in terms of depth of burial, are called "depth indices". The prismatic models used for preparing the theoretical charts are rectangular in plan and extend infinitely downward with vertical sides. It was also assumed that they have a uniform polarization which is in the direction of the present earth's magnetic field.

The depth of the sediments from the aeromagnetic maps was determined on the selected anomalies along the flight lines only since it was decided that the interpolation between the flight lines was unsatisfactory. The flight line spacing is approximately one mile, which is quite large in comparison to the average depth of the Precambrian rocks. The profiles were drawn from the magnetic contours and depths were determined directly from these profiles. The following considerations were taken into account in selecting magnetic anomalies for depth calculations (Zietz, 1959): (1) The anomalies selected were magnetically "clean", *i.e.*, the magnetic contribution from neighboring anomalies was negligible. (2) Anomalies were selected whose horizontal dimensions were large compared to their depth of burial. In this case the depth index is unity and is independent of the width of the lithologic unit. If the areal extent of the anomaly selected is too small, the depth index would be strongly dependent on the width of the magnetic rock unit. The computed depth may be considered as a maximum depth in the sense that an anomaly produced by a prism with its sides sloping outward will yield larger depths than the anomaly produced by the same prism with vertical sides. To satisfy this condition of verticality, the steepest gradient of the profiles are generally selected.

Although there are numerous anomalies on the aeromagnetic map, only a limited number were found suitable for this method of depth determination.

Aeromagnetic control in the area made it possible to prepare a theoretical regional structure map of the Precambrian surface (Plate 2). Sea level is used as datum. The solid dots indicate the actual depths to the basement from drill-hole data and others (open circle) are plotted as determined from magnetic data. The location and description of wells drilled to the Precambrian surface is given in Appendix 1. Basement contours are drawn at 500 foot intervals.

Some of the depths calculated from magnetic data are questionable and were not contoured. (*e.g.*, The values obtained in Twp. 58, Rge. 19, W4 Mer; Twp. 59, Rge. 16, W4 Mer.; Twp. 59, Rge. 14, W4 Mer. are much shallower than the values obtained from drill-hole data in the surrounding area). The shallow depths derived from the interpretation of magnetic data could be due to some intrusives in the sediments. Shallow depths may also result if the anomalies selected are of small areal extent compared to the depth, in which case the depth index would be dependent on the width of the magnetic rock unit, and in this case the method used would not be applicable. It is believed that the shallow depths referred to above are due to the non-application of the method for these particular anomalies as the assumptions used may not be valid.

There is satisfactory control over most of the area, although in some places it is reduced due to a lack of magnetic anomalies suitable for depth calculation.

Using this control and considering ten to fifteen per cent error inherent in this method of interpretation, it is impossible to compile a reliable detailed map of the Precambrian surface. However, it is a definite aid in preparing the smoothed regional basement contours illustrated in Plate 2. This map indicates several interesting structural features which require further investigation.

The actual basement topography is by no means as regular as is shown in Plate 2. There are, no doubt, many undulations, small troughs and ridges, the details of which cannot be obtained from the interpretation of magnetic data. Geocraft Limited carried out a seismic survey for Canadian Seaboard Oil Company in 1956 along a line shown in Plate 2, joining the two wells Seaboard Meadow Lake Cr. No. 2 (9-21-63-8-W3) and the Seaboard Meadow Lake Cr. No. 5 (4-5-65-12-W3). The seismic profile is shown in Figure 3, illustrating topographical changes on the Precambrian surface. It is observed that the general Precambrian high shown by the seismic profile has some correspondence with a regional magnetic high.

Very few wells have been drilled to the Precambrian in this general area but the existing control confirms a rather uniformly northeast-southwest dipping basement. The Precambrian is relatively flat in the northeast section of the map area where the rocks are exposed; then suddenly steepens and continues with uniform dip. In Twps. 64-65; Rges. 25, 26; W3 Mer. a local "high" is indicated, which has since been confirmed by seismic surveys. This occurs at the apex of a regional high

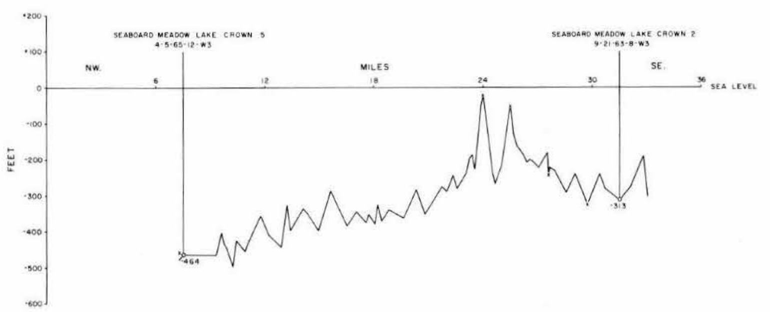
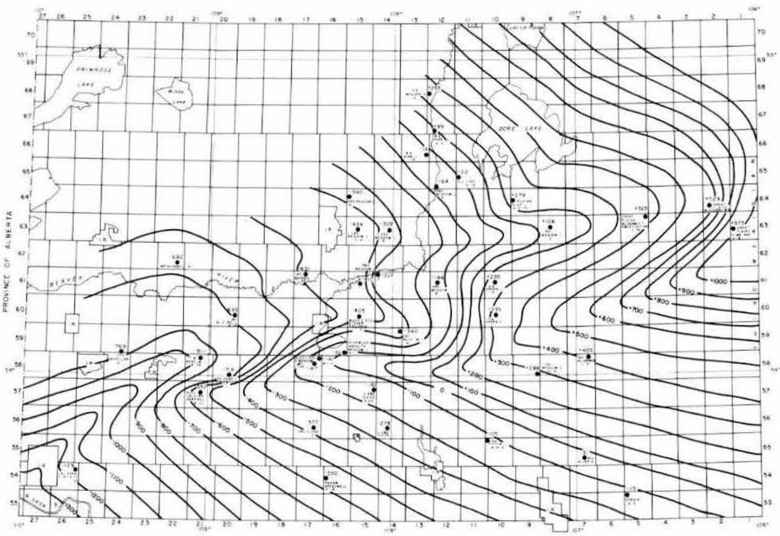


Figure 3

SEISMIC PROFILE

trend running northeast-southwest through the area. This may warrant detailed investigation. In Twp. 70 and 71, Rge. 3 and 4, W4 Mer. there is a general depression which may have given rise to a thicker sedimentary section in this region. In addition, there are two large scale northeast-southwest structural trends which appear to correspond to the linear trends pointed out by Sikabonyi (Figure 2) and may have controlled the sedimentation in this general area.

In the southeast corner of the study area a prominent northeast-southwest trending structural lineament exists in the sedimentary formations, and is shown at the top of the Ashern formation in Figure 4. It



LEGEND

Figure 4

STRUCTURE ON TOP OF THE ASHERN FORMATION

SCALE: MILES

was originally thought that this structural feature observed in the sedimentary column might have been controlled by Precambrian structure. The present configuration as interpreted from the aeromagnetic data does not reveal any uplift or the presence of any prominent and continuous ridges in this area.

Basement Lithology

In general, magnetic contours follow the outline of rock formations, especially where adjacent masses differ appreciably in their magnetic properties. Contacts may be determined through an investigation of the trends of the aeromagnetic contours. Magnetic character changes in amplitude and gradient on either side of the inferred contacts.

An excellent correlation between magnetics and known geology is illustrated by the example of the Forbes Lake area (Plate 3) which is located approximately 55 miles east of the present area of study. The airborne survey was carried out in this area by Aeromagnetic Survey's Limited in June, 1957, for the Government of Saskatchewan and the aeromagnetic maps are available from the Department of Mineral Resources. The geological survey of the same area was carried out during 1957 and 1958 by Pearson and Froese and the report was published by the Department of Mineral Resources in 1959. Magnetic contours have been superimposed on the geology of the Forbes Lake area at a 50 gamma interval. The general magnetic background is approximately 2150 to 2250 gammas and is probably due to granitic intrusive rocks (8) which cover a major portion of the map area. Two interesting oval-shaped distributions of granitic rocks occur; one is north of Moir Lake and another occurs southeast of Larocque Lake. Their compositions range from granodiorite to quartz diorite. The magnetic pattern around these rock masses is very prominent. The magnetic pattern, around another oval-shaped granitic mass between Dreaver and Nelson Lakes, is also outstanding. Most of the magnetic anomalies occur in the areas of basic volcanic rocks (1) and meta-sediments (3). The metamorphosed volcanic rocks are of andesitic composition with lesser amounts of basalt and dacite and minor amounts of acidic flow rocks. The metasedimentary rocks consist mainly of biotite gneisses and granulites with lesser amounts of calc-silicate and hornblende gneisses. Pyrrhotite is associated with the meta-sedimentary rocks along certain zones (*e.g.*, near Long. 104°40′ and Lat. 55°53′) which may cause the magnetic anomalies. It is considered that some of these regional trends continue under the sediments and may prove helpful in delineating basement lithology and structure to the southwest.

The magnetic expression of known rocks is useful in outlining lithological variations in the basement when the latter is under sedimentary cover. A unique solution, however, is not possible because of many unknown factors (*e.g.*, the size and shape of the magnetic anomaly depends on the dimensions of its source, depth of burial, and magnetic susceptibility). The exposed shield area in the east and northeast, and the Precambrian cores obtained from bore-holes prove invaluable in delineating the lithological changes. The wells which have been drilled and cored to the Precambrian surface in Alberta have been studied and described in detail by Burwash (Appendix 2). The available Precambrian cores of Saskatchewan have been studied by the writer and a description of them is given in Appendix 2.

The magnetic pattern in the area represents various lithological units of the basement. The igneous and metamorphic rocks are much more magnetic than the sedimentary rocks. As there is no evidence, to date, of igneous intrusions into the sediments, the sources of magnetic anomalies are presumed due to variations in Precambrian lithology.

The basement lithology of the study area (Plate 1) is mainly inferred from magnetic data in conjunction with the known geology in the northeast and from drill cores penetrating to Precambrian surface. The radioactive age determinations (Burwash 1957, 1958) indicate that the Precambrian rocks under these sediments belong to the same geological province as the northern shield area of Saskatchewan. In the eastern portion of Plate 1 the magnetic trends are primarily in a north-south direction with a few exceptions. Contours are closely spaced and reveal sharp anomalies due to a shallow basement. In the central part of the map the magnetic contours trend northeast but shift to a northwesterly direction in the extreme northwest which may be due to a change in strike of the basement rocks. The regional magnetic map indicates some areas with contorted magnetic anomalies, *e.g.*, in Twps. 74-81, Rges. 1-11, W4 Mer. These may be due to folded meta-sediments or basic meta-volcanics. It is observed that in the central and western part of the area magnetic contours are widely spaced. This is due to the increasing thickness of the sediments.

The basement in the east and northeast area is divided into two or three rock units. The unit (1a) is considered to consist of a metamorphic complex of basic to intermediate volcanics and meta-sedimentary rock. The area northeast of this unit was mapped by Frarey (1950), and seems to be a continuation of the same rock type. The rock units (1b) and (1c) are probably hornblende-biotite, meta-sedimentary and meta-volcanic rocks. The rock unit (1c) is assumed to have been highly metamorphosed and sheared, which might have concentrated the highly magnetic minerals in this zone. The boundary of (1c) is probably marked by a major fault zone which may have caused highly folded and sheared sediments. The rock unit (2) is designated on the basis of drill-hole cores from the Precambrian and it seems similar to (1b) except that it may contain a more acidic type of material. Unit (4) is considered to be acidic granitic rock and unit (5) schists and gneisses intruded by intermediate granitic material. There are a few probable basic intrusive bodies (3) which give rise to circular or elongated magnetic anomalies. These are mostly confined to the northeast of the map area. The approximate positions of contacts, and faults or shear zones are located on this map.

Economic Aspects

Many exploratory wells have been drilled in the Alberta portion of the study area. Some Precambrian tests have been drilled on both sides of the border (Appendix 1). Oil and gas discoveries have been mainly in the Blairmore (Mannville) formation.

St. Paul, Bonnyville, Fort Kent, Cold Lake and Harold Lake oil and gas fields in Alberta produce from Lower Cretaceous formations. Most of these fields are controlled both structurally and stratigraphically.

From the basement structure map (Plate 2) prominent high trends are noted. The Alberta fields mentioned above, lie along these positive trends. Similar reservoir conditions may extend into Saskatchewan. The area immediately east and northeast of Cold Lake as well as the Primrose Lake area should be explored in detail.

STRATIGRAPHIC CORRELATION CHART

ERA	PERIOD	EPOCH	EAST CENTRAL ALBERTA	WEST CENTRAL SASKATCHEWAN	GENERAL LITHOLOGY
CENOZOIC	QUATERNARY	PLEISTOCENE	GLACIAL DRIFT	GLACIAL DRIFT	BOULDER CLAY OR TILL AND GLACIAL LAKE CLAYS
	TERTIARY	PLIOCENE			
		MIOCENE			
		OLIGOCENE			
		EOCENE			
		PALAEOCENE	PASKAPOO ?		SHALES, SANDSTONES
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	EDMONTON		
			BEARPAW	BEARPAW	GREY SHALES WITH SILTSTONE BEDS, MARINE, BRACKISH AND CONTINENTAL DEPOSITS
			BELLY RIVER: OLDMAN, BIRCH LAKE, GRIZZLY BEAR, RIBSTONE CREEK	BELLY RIVER	CONTINENTAL SHALES, SILTSTONES AND SANDSTONES
			LEA PARK	LEA PARK	GREY SHALES, SLIGHTLY SILTY
			COLORADO GROUP — LA BICHE: FIRST WHITE SPECKLED SHALE; CARDIUM, shale; SECOND WHITE SPECKLED SHALE; shale; FISH SCALE ZONE	COLORADO GROUP — UPPER COLORADO: FIRST WHITE SPECKLED SHALE; shale; SECOND WHITE SPECKLED SHALE; shale; FISH SCALE ZONE	DARK GREY SHALES AND INTERBEDDED SILTS
		?	shale	LOWER COLORADO: shale	
		LOWER CRETACEOUS	PELICAN; VIKING	VIKING	FINE SANDSTONES AND SHALES
			JOLI FOU	JOLI FOU; SPINNEY HILL	DARK GREY SHALES WITH SANDSTONE FACIES
			GRAND RAPIDS; CLEARWATER; McMURRAY — BLAIRMORE or MANNVILLE	MANNVILLE: COLONY, SPARKY, REX, LLOYDMINSTER, CUMMINGS, DINA — BLAIRMORE	FINE GRAINED SANDSTONES, SHALES, SILTS CLEAN, COARSE GRAINED, FRIABLE SANDSTONE AT BASE
	JURASSIC	UPPER JURASSIC			
		MIDDLE JURASSIC			
		LOWER JURASSIC		WATROUS ?	BRICK RED TO ORANGE SILTY SHALES, ABUNDANT ANHYDRITE
	TRIASSIC			WATROUS	
PALAEOZOIC	PERMIAN				
	PENNSYLVANIAN				
	MISSISSIPPIAN		EXSHAW		BLACK CARBONACEOUS SHALES
	DEVONIAN	UPPER DEVONIAN	WABAMUN	QU'APPELLE GROUP; THREE FORKS	GREEN AND TAN SHALES, SOME ANHYDRITE
			WINTERBURN	NISKU	BUFF, DENSE DOLOMITES
			WOODBEND	SASK GROUP: DUPEROW	GREY TO BROWN DENSE LIMESTONES, DOLOMITES AND ANHYDRITE
			BEAVERHILL LAKE	BEAVERHILL LAKE; MANITOBA GROUP: SOURIS RIVER	PINK AND TAN DOLOMITES
		MIDDLE DEVONIAN		DAWSON BAY	TAN CRYSTALLINE DOLOMITES
			ELK POINT GROUP	ELK POINT GROUP: P. EVAP.	SALT AND ANHYDRITE (MOSTLY ABSENT)
				WINNIPEGOSIS	DENSE DOLOMITES AND LIMESTONE
				ASHERN	REDDISH BROWN DOLOMITIC SHALES
				MEADOW LAKE BEDS ?	SALT BEDS WITH DOLOMITIC SILTS; OR ANHYDRITES
		LOWER DEVONIAN	?		
	SILURIAN		ELK POINT GROUP	INTERLAKE GROUP	WHITE, PINK AND TAN CRYSTALLINE DOLOMITES
	ORDOVICIAN			STONEWALL; STONY MOUNTAIN	DENSE LIMESTONES AND ARGILLACEOUS LIMESTONES CALCEREOUS SHALES AT BASE
				RED RIVER	TAN FINELY CRYSTALLINE DOLOMITES, LIMESTONES, AND ANHYDRITE
				WINNIPEG	GREENISH GREY SHALES OVERLYING SANDSTONE
	CAMBRIAN		CAMBRIAN AND "GRANITE WASH"	DEADWOOD	GLAUCONITIC SANDSTONES AND GREENISH GREY SHALES
PRECAMBRIAN					

TABLE 1

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APPENDIX 1

LOCATION AND DEPTH OF THE WELLS PENETRATING THE PRECAMBRIAN

Well Name	Location	Depth of Precambrian Top with respect to sea level in feet
Seaboard Meadow Lake Cr. No. 2	9-21-63-8-W3	– 313
Shell Delaronde Lake A-2-1	2-1-58-9-W3	–1157
H.B.O.G. Green Lake No. 1	2-16-60-10-W3	– 953
B.A. Dore Lake 13-18	13-18-65-11-W3	– 407
H.B. Beaver River No. 1	1-21-61-11-W3	+404
Seaboard Meadow Lake Cr. No. 5	4-5-65-12-W3	– 464
B.A. Dore Lake 5-5	5-5-67-12-W3	– 290
H.B. Beaver River No. 3	16-18-68-12-W3	– 92
B.A. Dore Lake 1-12	1-12-66-13-W3	– 421
Seaboard No. 1	13-21-61-15-W3	–1213
Seaboard Meadow Lake Cr. No. 3	8-30-64-15-W3	– 835
Choqua Cougar Highwood Vanalta Meadow Lake 5-1-59-16	5-1-59-16-W3	–1559
Imperial Barnes (1-33-61-17)	1-33-61-17-W3	–1360
Rabbit Creek No. 1	15-10-58-20-W3	–2024
Imp. Blue Bell (2-13-60-20)	2-13-60-20-W3	–1745
Tidewater Meadow Lake Cr. No. 4-34	4-34-58-21-W3	–2042
Imperial Goodsoil (8-11-62-22)	8-11-62-22-W3	–1731
Cdn. Sbd. Ernestina Lk.	10-13-60-4-W4	–2727
Richfield-Bohn Lake 1	15-29-79-5-W4	– 782
Cdn. Sbd. WREP	7-14-57-6-W4	–3223
Pan. Am. Garth A-1	5-28-64-6-W4	–2541
Pacific Sunray EP 1	16-28-56-8-W4	–3531
Albert W. Lotzberg No. 1	12-19-61-8-W4	–3199
B.A. Clyde Lake 11-24	11-24-73-10-W4	–1949
Angelus Ashmont No. 1	13-3-60-11-W4	–3572
Triad Mobil Rich Lake	6-17-64-11-W4	–3145
Bear Parkford No. 1	2-3-66-15-W4	–3404
Edwand No. 1	8-26-60-16-W4	–4004
Triad Berny 6-25	6-25-66-16-W4	–3384
Imp. Wolverine 7-24	7-24-76-18-W4	–2574
Imp. Darling No. 1	16-19-62-19-W4	–4267
Imp. Egremont W6-36	6-36-58-23-W4	–5088
Imp. Grosmont No. 1	13-17-67-23-W4	–4324
Imp. Clyde No. 1	9-29-59-24-W4	–5275
Cal. Std. West Calling Lake 16-36	16-36-71-24-W4	–3760
W. R. Union *et al* Smith	6-18-72-25-W4	–4046
Imp. Bailey Selburn Riverdale	1-27-60-26-W4	–5374
Imp. Dapp No. 1	5-29-62-1-W5	–5419

APPENDIX 2

DESCRIPTION OF THE PRECAMBRIAN CORES

Saskatchewan

Seaboard No. 1 (13-21-61-15-W3)
Core (2763'-2767'): Granite, pink, medium grained, banded; some biotite, hornblende.
Core (2767'-2773'): Granite, light grey to cream, somewhat decomposed, black speckled; hornblende.

Imperial Goodsoil (8-11-62-22-W3)
Core (3458'-3461'): Biotite granite, equigranular; quartz, microcline, biotite.

Seaboard No. 3 (8-30-64-15-W3)
Core (2430'-2435'): Nodular Biotite-hornblende-granite gneiss.

Alberta (Burwash 1957)

Canadian Seaboard Ernestina Lake No. 10-13 (10-13-60-4-W4)
Quartz diorite, intruding chlorite schist.

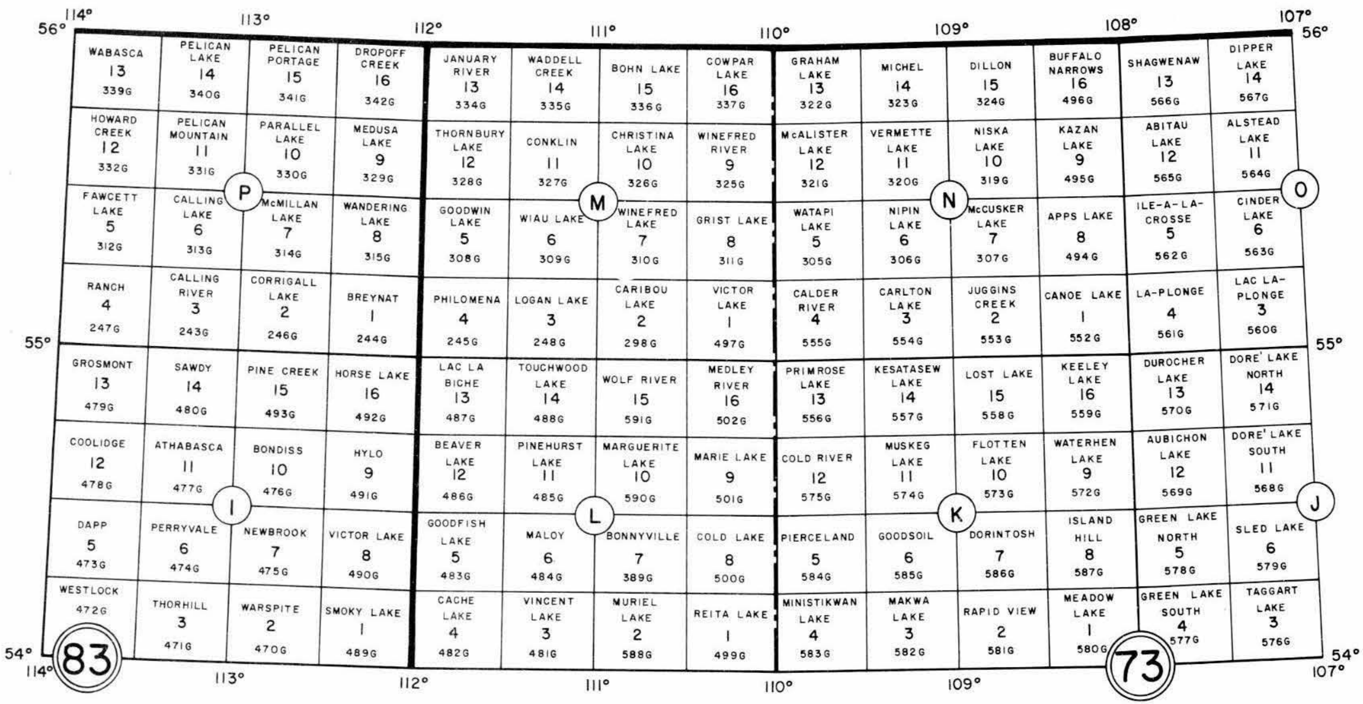
Imperial's Clyde No. 1 (9-29-59-24-W4)
Gneissic hornblende Gabbro.

Imperial's Egremont West No. 6-36 (6-36-58-23-W4)
Alkali granite.

Imperial Darling No. 1 (16-19-62-19-W4)
Alkali granite, massive, slightly cataclastic.

Imperial Dapp No. 1 (5-26-62-1-W5)
Silicic plutonic.

Imperial Grosmont No. 1 (13-17-67-23-W4)
Biotite-adamellite gneiss.



APPENDIX 3

G. S. C. AEROMAGNETIC MAPS USED FOR THE PRESENT STUDY

D-268

REGINA, SASKATCHEWAN
Printed by Lawrence Amon, Printer to the Queen's Most Excellent Majesty
1960

Reprinted 1969