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HYDROGEOLOGY OF THE TAWATINAW AREA, ALBERTA

by

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OF THE TAWATINAW AREA,

ALBERTA

Abstract

The drift is the water-bearing zone in most of the Tawatinaw area except for the southwest and the south-central part of the map area, where wells obtain water from the Wapiti Formation. The yields range from less than 1 igpm (imperial gallon per minute) to 50 igpm at a maximum. In the northeast the drift is very fine grained and clayey, and as the Lea Park shales underlie the area the yields will not be more than 5-10 igpm.

Water quality is usually good. The waters are calcium bicarbonate with low sulfates and chlorides. In the more settled southeastern corner of the map area nitrate contents become significant.

INTRODUCTION

This hydrogeological map, which presents a reconnaissance degree of detail, is a description and interpretation of existing basic data, complemented by information obtained during the summer of 1970 by means of field work, test drilling and water well inventory.

The area covered by this study is located between longitudes 112° and 114° west and latitudes 54° and 55° north. On the basis of the Alberta Land Survey system, the area lies between townships 58 and 69, and ranges 14 and 27, west of the fourth meridian and covers 5 550 square miles.

The main towns in the area are Athabasca in the north (population 1 800), Westlock in the southwest (population 3 000), and Smoky Lake in the southeast (population 900).

The following is an excerpt from "General Description of the Tawatinaw Map Sheet Area, 83I" (Canada Department of Regional Economic Expansion, 1970):

> "There is still considerable land suitable for cultivated agriculture that is uncleared. In general farms are relatively small... This is primarily a mixed farming area, with oats and barley being the most widely grown cereal crops... It is interesting to note that large acreages of bog land are being cleared and stripped and gradually brought into production..."

The types of trees commonly found in the map area (i.e. east-central part and northwestern corner of the map area) are black and white spruce, and jackpine (Alberta Department of Lands and Forests, 1968).

Acknowledgments

Kinsella Drilling of Innisfail, Alberta, carried out detailed test drilling and pump testing. Dr. D. A. St. Onge of the Geological Survey of Canada supplied useful test-hole information for parts of the area.

Compilation of water-well information on 1:50 000 scale maps prior to the start of field work, field assistance and drill-site supervision were capably handled by N. Zacharko. Others whose help is gratefully acknowledged include various district health units for chemical analyses of well water samples, the Provincial Analyst of the Alberta Department of Agriculture and the geochemical laboratory of the Research Council of Alberta for chemical analysis of water samples, and the Energy Resources Conservation Board for information such as structure test holes, electric logs, lithologs, and geological reports.

The author would like to thank all the people of the area for their excellent cooperation on this project and the water-well drillers who submitted reports on wells drilled.

This paper was critically read by O. Tokarsky, G. F. Ozoray, D. A. Hackbarth, G. M. Gabert, and R. Green, and the author wishes to express his gratitude for the many helpful suggestions.

TOPOGRAPHY AND DRAINAGE

Topography

The land surface elevation rises from about 1 800 feet in the vicinity of Lac La Biche and in the Athabasca River valley situated along the northern edge of the map area, to just above 2 300 feet in the east-central part and in the western corner of the map area. The main uplands are located in the east-central part and northwestern corner of the map area, between townships 61 and 64 and ranges 15 and 18, and between townships 65 and 69 and ranges 25 and 27, respectively. They are covered by forest and muskeg, and contain lakes. Apart from these uplands, the map area is generally flat except in the northeast where, south of Lac La Biche, sand dunes give a rolling aspect to the topography. The Athabasca River, the North Saskatchewan River, the Tawatinaw River, and White Earth Creek cut their way through the generally flat or gently rolling topography.

Drainage

The three major drainage systems are:

1) the Athabasca River drainage system – most surface water in the northern part of the map area is part of this system;

2) the North Saskatchewan River drainage system – this system drains much of the southeastern part of the map area;

3) the Pembina River drainage system – the area draining into this river was deemed large enough to consider separately from other parts of the Athabasca River drainage system in the map area.

Table 1 gives the characteristics of rivers and creeks of the three drainage systems.

Muskegs are common features in this map area. They are located mainly in the east-central part, to the east of Long Lake Provincial Park, in the northwestern corner and along the northern edge of the map area.

Lakes are numerous and range in size. The largest, Lac La Biche (probably located on a deep bedrock channel), covers 56 square miles in the map area; it is 70 feet deep at maximum, and is used as a water supply by local residents. The next largest two are: Missawawi Lake, south of Lac La Biche, and Flat Lake, northwest of the village of Boyle. The latter is shallow (30 feet at maximum).

Fish abound in several of the larger lakes which are used for summer recreational purposes.

CLIMATE

Based on Koeppen's system of climate classification, the area can be divided into two main units (Atlas of Canada, 1957): a northern region with a humid continental climate, cool summers and no dry season; and a southern region with a humid continental climate and warm summers. The mean annual rainfall ranges from 16 inches in the southeastern corner of the map area (Table 2) to 19 inches along the western edge of the area. The mean annual rainfall over the entire area is 17.28 inches (438.99 mm). The average annual potential evapotranspiration is 19.4 inches (493 mm). Values of mean annual rainfall, temperature, and total annual potential evapotranspiration for eight locations in the map area are listed in table 2.

Table 1. Characteristics of Rivers and Creeks

Drainage system	River or creek	Mean annual runoff		Drainage area (sq mi)	Length (mi)
		cfs	m^3/s		
Athabasca	Athabasca River	15118	428.0	29600 (total)	75 (in the map area)
	La Biche River	334.25	9.5	2846	20 (in the map area)
	Pine Creek	20.7	0.6	571	55
North Saskatchewan	Kennedy Creek	10.2	0.3	89	32.5
	Redwater Creek	48.3	1.37	617	-
	Waskatenau Creek	12.15	0.34	110	22
	White Earth Creek	34.11	0.97	380	45
Pembina	Dapp Creek	23.6	0.7	251	40
	Wabash Creek	14.9	0.4	120	23 (in the map area)

Table 2. Annual Precipitation, Temperature, and Potential Evapotranspiration

Station	Mean annual precipitation		Mean annual temperature		Total annual potential evapotranspiration***	
	mm	inches	°C	°F	mm	inches
Athabasca I*	475.23	18.71	1.27	34.3	478.19	18.82
Athabasca II**	420.62	16.56	0.77	33.4	482.24	18.98
Boyle*	439.38	17.30	1.22	34.22	484.29	19.06
Meanook*	461.53	18.20	2.33	36.2	504.78	19.86
Newbrook*	428.24	16.96	0.38	32.7	489.09	19.25
Lac La Biche**	452.88	17.83	1.22	34.2	501.89	19.75
Radway*	398.97	15.71	1.38	34.5	501.05	19.72
Rochester*	435.11	17.17	0.94	33.7	497.15	19.36
Average	438.99	17.28	1.18	34.1	493.44	19.42

*Obtained from Canada Department of Transport, Weather Office, International Airport, Edmonton.
**Obtained from Canada Department of Transport, Meteorological Branch, Temperature and Precipitation Tables for Prairie Provinces, Toronto.
***Calculated by Thornthwaite Method based on monthly mean data.

GEOLOGY

Previous work was done in the Athabasca-Barrhead map area by Feniak (1944), and by St. Onge (1970).

Bedrock Geology

The projected outcrop edge of the Wapiti Formation in the map area is taken from Geological Map of Alberta (Green, 1972). This boundary trends northwest with the Lea Park Formation, composed mostly of grey shales with sandstones, lying to the northeast. These grey shales can be observed in the Athabasca River valley. They form a layer which has a very low permeability and is a poor source of groundwater. Due to the presence of these shales underlying the map area, the investigation was limited to the Wapiti Formation, composed of sandstones and shales, and to the surficial deposits.

Surficial Deposits

Sands, sands and gravels, and gravels can be found over most of the map area. Sand dunes are well developed south of Lac La Biche (lake) and in the vicinity of Nestow on Highway No. 2. Sands are also found along the Tawatinaw River valley and north of the town of Athabasca. Gravels are found at several localities and gravel pits have been developed.

A preliminary map of the bedrock topography (V. A. Carlson, pers. comm., 1970) shows the presence of two major and one minor bedrock valley. One of the major valleys runs from west to east in the northern part of the map area; it deepens towards the east. At the location of a test hole drilled in the northeastern part of the map area (Sheremata, Lsd. 13, Sec. 11, Tp. 67, R. 19, W. 4th Mer.) surficial deposits consist of 174 feet of fine-grained, clayey sediments and one foot of gravel resting on the bedrock surface. High permeability values, probably representative of buried valley sands and gravels, have been encountered in wells drilled immediately to the east of the map area. However, further drilling near the eastern boundary of the map area would clarify the depth and nature of sediments in this bedrock valley, and would provide information for the area between the test hole at Sheremata and the Sand River map area to the east. A second major bedrock valley is located in the southeastern corner of the map area; available data indicate a depth of 300 to 400 feet. This valley runs in a northeasterly direction and is part of the preglacial valley of the North Saskatchewan River. A minor valley is located in the southwestern part of the map area; it is not important as a source of groundwater as it is only a slight depression in the bedrock surface.

A preliminary map (V. A. Carlson, pers. comm., 1970) shows thick surficial deposits (between 150 and 450 feet) in the southeastern corner of the map area. Thicknesses between 150 and 250 feet are found in the southwest, where flowing wells occur in the Pembina River valley. The rest of the map area is covered by surficial deposits that range from 0 to 150 feet. Locally, surficial deposits are thin in topographically flat areas, on highs, and in present-day valleys.

HYDROGEOLOGY

Eighty-five per cent of the existing wells are less than 100 feet deep; the remaining 15 per cent are much deeper and obtain water containing considerable chloride content from aquifers in the Wapiti Formation. Water-level contours drawn on the map show the water level in the main aquifer, which is, in most places, the surficial deposits. The vertical component of groundwater movement is also indicated.

Areas of flowing wells and reported flowing seismic shot holes have been outlined. Shot holes are usually less than 100 feet deep and have been drilled along the edge and in the Tawatinaw River valley, where they seem to indicate local flow systems because deeper wells in this area do not flow. Flowing wells used by farmers in the southwestern corner of the map area along the Pembina River valley are up to 250 feet deep. They are completed mainly in sands and/or gravels but flow rates are low, in the order of 1 to 5 igpm.

Test Drilling

Test drilling was carried out during the summer of 1970 at two sites:

1. Sheremata — Lsd. 13, Sec. 11, Tp. 67, R. 19, W. 4th Mer.
2. Smoky Lake — Lsd. 4, Sec. 17, Tp. 61, R. 16, W. 4th Mer.

The depth of investigation was close to 600 feet at each site. Interpretation of data from site 2 showed fairly good groundwater availability and quality.

Site 1 (Sheremata) was chosen to find the depth of the bedrock valley and to evaluate occurrence of groundwater in deposits filling the valley. The hole encountered a sequence of clayey sands with one foot of gravel resting on bedrock. The gravel was the only water-bearing zone encountered and produced a flow at the ground surface of 0.5 igpm. A two-hour pump test conducted on this aquifer gave a 20-year safe yield (Q_{20}) of 1.5 igpm. The gravel overlies the very low permeability Lea Park shales.

The purpose of the hole at site 2 (Smoky Lake) was to test the surficial materials as well as the Wapiti Formation. The hole was 575 feet deep; an observation well was added for a week-long pump test. The drift was 130 feet thick and composed mainly of clayey sands and gravels containing two water-bearing zones:

(a) 57- 60 feet — sandy gravel, medium to coarse sand with pebble gravel, giving 2 igpm;

(b) 111-121 feet — sand and gravel, very coarse sand and granule size gravel, Q_{20} = 1 igpm.

The bedrock is composed mainly of shales and sandstones. Three zones were water bearing and each was tested by means of a 2-hour pump test:

(a)	290-315 feet	very fine grained sandstone, Q_{20} = 37 igpm;
(b)	375-380 feet	very fine grained sandstone, Q_{20} =<1 igpm;
(c)	453-461 feet	light brownish, very fine grained sandstone, Q_{20} = <1 igpm.

A step-drawdown test carried out on zones (a) and (b) together indicated a pumping rate of 30 igpm for a 168-hour pump test. A 20-year safe yield of 32 igpm for the two zones was determined from results of a week-long pump test.

Safe Yields

The lack of good bail tests and pump tests in sufficient number necessitated the use of lithology, and apparent transmissivity values (Farvolden, 1961, p. 9) to outline the yield areas. Apparent transmissivity values, from bail tests in which only the initial static water level and the water level at the end of the test had been recorded, were calculated according to the modified Theis equation:

$$T = 264Q/\Delta s$$

where, T = coefficient of transmissivity in igpd/ft; Q = pumping or bailing rate in igpm; Δs = drawdown in ft/log cycle, the data being plotted on semi-logarithmic paper.

The apparent transmissivity values calculated by the above method, data from two RCA test holes, and a few transmissivity values calculated from reliable pump tests, form the basis of the yield map. Several tests were performed on individual aquifers encountered during drilling of the two RCA test holes to supply information for areas of the map where apparent transmissivity values were lacking.

The yield areas on the map are approximate and the future addition of reliable information will improve map accuracy.

Three divisions of safe yield can be made: 1-5 igpm, 5-25 igpm and 25-100 igpm. These categories usually are representative of aquifers in the surficial deposits. The category 25-100 igpm is small in extent. Where high T or apparent T values occur but could not be used to represent a yield area because of the scattering of T or apparent T values the corresponding safe yield value appears adjacent to the well symbol.

It is important to note that most of the low yield values are for aquifers in the surficial deposits. The higher values occur in the bedrock, mainly in sandstones, and in coal in the southwestern corner of the map area. However, low T values are also found in the bedrock, depending on the presence, extent, and type of sandstone layers interbedded with shales.

A number of springs are found in the area. They very seldom yield more than 10 igpm; the average discharge is between 1 and 5 igpm. The higher rates are from springs located in deeply cut valleys or gullies.

It should be noted that the area lying north of the edge of the Wapiti Formation has low yields. This is due to the presence of Lea Park bedrock sediments underlying the area. The bedrock is covered by fine, clayey surficial deposits which are usually a poor water-bearing zone, as was found in the test hole at Site 1 (Sheremata) and in farmers' wells more to the east. As noted previously, if gravels and other very permeable sediments are proven to exist in bedrock valleys in the northeastern corner of the map area, a quantity of water may be obtained. In this area the search for water should be limited to the surficial deposits.

In the rest of the map area the Wapiti Formation, in addition to the surficial deposits, might be a potential source of water.

HYDROCHEMISTRY

Total dissolved solids content for groundwater in existing wells in the map area is usually less than 1 000 ppm and thus within the limits of potability set by the Alberta Department of Health. Areas having less than 500 ppm total dissolved solids are usually recharge areas, but could also be areas where dilution occurs due to the presence of surface water, as can be seen in the east-central part of the map area which contains muskegs, forested areas and many lakes (or may be due to the fact that 1970 was a wet year). Values of over 2 000 ppm total dissolved solids occur in wells completed in the Wapiti Formation. It is very seldom that total dissolved solids values are higher than 4 000 ppm. The highest value found in the entire area is 9 438 ppm total dissolved solids.

The bicarbonate content of groundwater usually makes up over 60 per cent of the total anions when calculated as equivalents per million, and the cations may be either predominantly calcium-magnesium or sodium-potassium. There are very few well water samples having over 60 per cent of their anions as sulfates or chlorides, or both. Those that do exist are from bedrock sources. Waters having over 60 per cent of their cations as calcium and magnesium occur in discharge areas as well as recharge areas. This phenomenon probably can be explained by the effect of the nature of the sediments, in this case the surficial deposits, on groundwater chemistry. Waters from wells completed in the bedrock have 60 per cent of the cations composed of sodium or potassium, or both, probably for the same reason.

Iron

Iron is widely distributed in sediments. Observations of heavy iron oxide deposits were made in several localities, particularly at the location of springs. Iron oxide deposits were also found in bogs. The map of dissolved iron content shows that it is found very often in concentrations over 0.3 ppm. In several cases iron content was found in concentrations over 50 ppm.

Nitrates

Nitrate contents in the water from many wells constituted over 30 per cent of the total anions. The wells producing this water are commonly shallow, and the majority are located in the southeastern corner of the map area. The nitrate content is probably the result of man-made pollution as muskeg areas have been cleared in this zone. A flagrant example of how this pollution can take place was found in the Smoky Lake area, (D. V. Currie, pers. comm., 1971) where a farmer has directed surface runoff from his barnyard into a large-diameter well. The animal wastes contained in this water will most likely affect nearby wells in due course. The fact that the site is in an area of downward flow of groundwater (recharge area) and above a major bedrock valley compounds the potential problems. Proper well location and completion can prevent many problems of contaminated surface water influencing groundwater. Local agricultural and health officers can provide publications and guidance.

CONCLUSIONS

The general depth of investigation over the map area was limited to 250 to 300 feet, because few wells penetrate deeper. Further investigation might include test drilling to investigate the presence of gravel aquifers in the eastern part of the bedrock valley located in the northeastern corner of the map area.

Twenty-year safe yields range from 0-25 igpm, primarily for aquifers in surficial deposits. Further drilling in the Wapiti Formation might result in the discovery of more sources of water. Good quality groundwater with either low sulfate or chloride content, or both, occurs generally in the map area, the exception being in shallow wells in the more settled areas.

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APPENDIX A

TRACE ELEMENT DETERMINATIONS

APPENDIX A. TRACE ELEMENT DETERMINATIONS

The trace element determinations of selected waters for the Tawatinaw map area were carried out in the laboratory of the Provincial Analyst. Analytical methods used by the Provincial Analyst for trace element determinations are as follows:

SiO_2	-	colorimetric, molybdate silicate method
F	-	orion specific ion electrode
Br	-	orion specific ion electrode
Cu	-	atomic absorption spectrophotometer
Zn	-	atomic absorption spectrophotometer
Mn	-	atomic absorption spectrophotometer
Cr(hexavalent)	-	colorimetric; diphenylcarbohydrozide method
P_2O_5	-	colorimetric, amino naphtol sulfonic acid method.

APPENDIX A. TRACE ELEMENT DETERMINATIONS

Location West of 4th Mer.				Trace Element								
				SiO_2	F	Br	Cu	Zn	Mn	Cr(hex)	P	
Lsd. or ¼	Sec.	Tp.	R.	ppm	ppm	ppm	ppm	ppm	ppm	ppm	total ppm	ortho ppm
16	20	58	14	14.20	0.15	<0.10	<0.01	<0.01	<0.01	0.006	0.11	0.02
4	15	58	16	12.50	0.12	0.02	<0.01	<0.01	<0.01	0.006	0.13	0.02
2	27	58	18	9.30	0.27	nil	<0.01	<0.01	<0.01	nil	0.07	0.01
1	28	58	20	14.50	0.52	<0.01	<0.01	<0.01	<0.01	nil	0.13	0.02
12	17	58	26	20.30	0.28	nil	<0.01	<0.01	<0.01	nil	0.23	0.03
5	20	59	15	18.00	0.23	nil	<0.01	<0.01	<0.01	0.012	0.17	0.02
1	28	59	19	8.00	0.77	<0.10	<0.01	0.04	<0.01	0.028	0.29	0.27
9	16	59	23	12.00	0.62	nil	<0.01	<0.01	0.01	0.012	0.14	0.02
16	28	59	25	7.80	1.31	nil	<0.01	0.03	<0.01	0.016	0.28	0.25
16	8	60	18	15.30	0.32	<0.01	<0.01	<0.01	<0.01	0.006	0.14	0.02
13	10	60	20	8.20	0.76	0.78	0.03	0.01	<0.01	nil	0.69	0.60
12	15	60	22	15.60	0.49	<0.10	<0.01	<0.01	<0.01	nil	0.08	0.01
9	20	60	24	6.24	0.31	nil	0.01	0.01	<0.01	0.012	0.31	0.22
2	15	60	26	8.70	0.67	-	<0.01	<0.01	<0.01	0.009	0.07	0.01
8	33	61	19	20.60	0.44	<0.01	<0.01	0.04	0.03	nil	0.22	0.02
5	5	61	23	7.90	1.22	0.39	<0.01	0.06	<0.01	0.025	0.33	0.25
12	9	61	25	10.55	0.45	<0.01	<0.01	<0.01	<0.01	0.009	0.14	0.02
9	4	61	27	11.60	0.23	0.19	<0.01	0.03	<0.01	nil	0.55	0.10
4	9	62	18	10.90	0.50	nil	0.02	<0.01	<0.01	0.006	0.15	0.02
1	5	62	20	18.50	0.20	0.42	<0.01	<0.01	<0.01	0.006	0.12	0.01
4	28	62	22	15.00	0.30	nil	<0.01	<0.01	<0.01	nil	0.16	0.09
16	28	62	24	18.80	0.48	0.24	<0.01	<0.01	<0.01	nil	0.15	0.01
2	30	62	25	14.25	0.52	<0.1	<0.01	0.02	<0.01	nil	0.17	0.06
4	25	62	26	14.25	0.25	-	<0.01	<0.01	<0.01	nil	0.13	0.04
9	8	63	19	20.80	0.22	0.28	<0.01	<0.01	<0.01	nil	0.24	0.04
13	27	63	22	14.40	0.13	<0.10	0.01	<0.01	<0.01	nil	0.10	0.04
8	20	64	20	16.00	0.12	<0.10	<0.01	<0.01	<0.01	nil	0.12	0.05
13	14	65	15	15.70	0.24	0.37	<0.01	<0.01	<0.01	0.006	0.03	0.01
1	14	65	17	15.00	0.11	nil	<0.01	<0.01	<0.01	0.006	0.13	0.02
4	9	66	14	10.80	0.17	nil	<0.01	<0.01	<0.01	0.009	0.10	0.03
	21	66	16	10.10	0.19	nil	<0.01	<0.01	<0.01	0.006	0.10	0.04
13	14	66	20	19.80	0.38	0.18	<0.01	<0.01	<0.01	nil	0.17	0.01
9	14	66	22	17.40	0.32	0.33	<0.01	<0.01	<0.01	0.006	0.15	0.05
12	18	67	15	10.60	0.50	nil	<0.01	<0.01	<0.01	nil	0.10	0.03
2	21	67	17	10.20	0.46	nil	<0.01	<0.01	<0.01	nil	0.07	0.01
4	15	67	19	0.32	0.10	nil	0.01	<0.01	0.01	0.009	0.06	0.01
16	21	68	16	12.60	0.14	0.10	<0.01	<0.01	0.01	0.006	0.15	nil
3	21	68	20	3.50	0.18	nil	<0.01	<0.01	<0.01	0.009	0.11	0.02

LEGEND

Isohyet, mean annual precipitation in inches, approximate .... —18—

Mean annual precipitation:

15-20 inches ....

Meteorological station ....

Standard rain gauge only ....

Precipitation data:

Mean annual precipitation in inches (per cent rainfall) 16.86 (59.5)
Year of commencement of observations 1954
Number of years of record used to calculate mean annual precipitation (or rainfall) 15

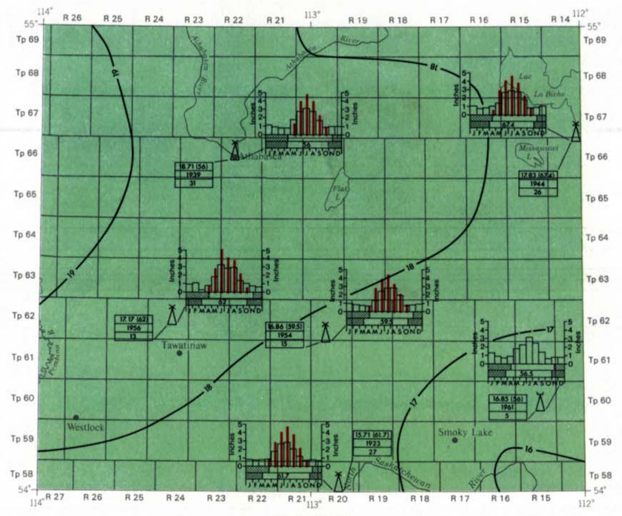
Mean monthly potential evapotranspiration* ....
Mean monthly precipitation ....
Period when surface is usually snow covered ....
Period with mean daily temperature below freezing (0°C) ....
Figure indicates percentage of mean annual precipitation falling as rain

Sources of data:

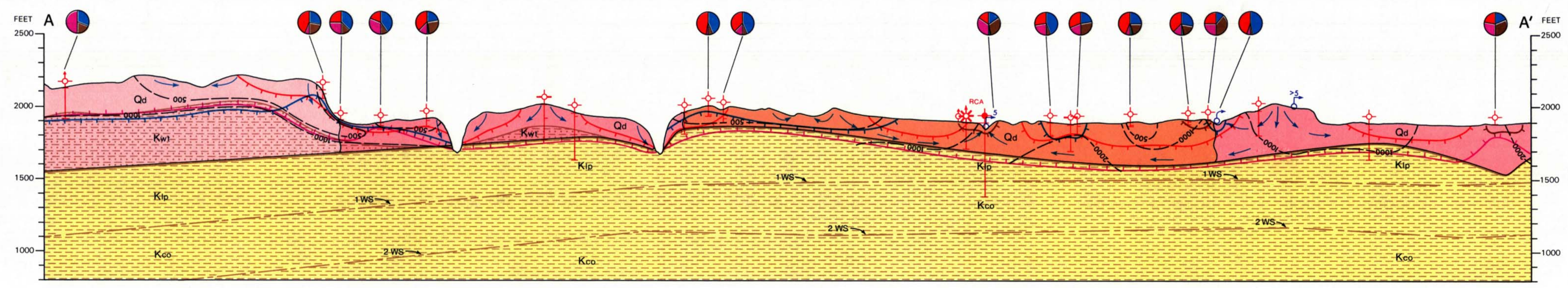
Climatic Maps of Alberta (Longley, 1968); Monthly Record of Meteorological Observations (Meteorological Branch, Canada Department of Transport); and Provisional Evaporation Maps of Canada, Department of Transport Circular 4531 (Bruce and Weisman, 1967).

*Evapotranspiration estimates are based on the Provisional Evaporation Maps of Canada.

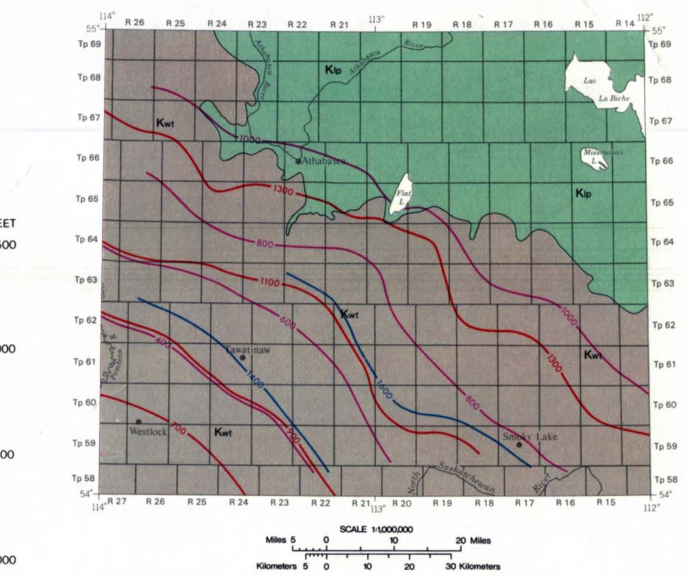
METEOROLOGY



Alberta RESEARCH



GEOLOGY



LEGEND

Kwt — Wapiti Formation: *sandstone, shale, scattered coal beds*

Klp — Lea Park Formation: *shale*

Rock unit boundary ....

Structure contour on top of Lea Park Formation .... —1400—

Structure contour on First White Specks marker .... —1100—

Structure contour on Second White Specks marker .... —800—

MAIN MAP LEGEND

Topography

Surface contours and elevation in feet (interval 100 feet) .... —3000—

Geology

Geological boundary ....

Thalweg of buried valley, approximate ....

QUATERNARY

Qd — Unconsolidated deposits

CRETACEOUS

Kwt — Wapiti Formation

Klp — Lea Park Formation

Kco — Colorado Group

White Specks markers (1 WS; 2 WS)

Lithology

Sand ....
Sand and gravel ....
Sandstone ....
Coal ....
Shale ....

Hydrography

Lake or slough, perennial ....
Lake or slough, seasonal ....
Stream, perennial ....
Stream, intermittent ....
Marsh, muskeg ....
Surface water divide ....

Hydrometry

Stream gauging station .... △

Average annual discharge in cubic feet per second 14.9
Year of commencement of observations 1966
Number of years averaged for average annual discharge figure 3
Drainage area in square miles 120

Source of data:

Surface Water Data Alberta (Inland Waters Branch, Department of Energy, Mines and Resources)

Hydrogeology

Spring, flow rate unknown ....

Spring and approximate rate of flow in imperial gallons per minute (measured or approximated in summer, 1970) 5

Nonpumping water-level contour (elevation in feet) and vertical component of groundwater movement .... Upward flow / 2000 / Downward flow

Direction of groundwater flow ....

Groundwater divide ....

Boundary of area of artesian flow ....

Groundwater Probability†

Range of average expected yield of wells (in imperial gallons per minute)

Probable: estimated from quantitative information (pump tests, bail tests, etc.)

Possible: estimated from qualitative information (flow regime, lithology, etc.)

25-100
5-25
1-5
<1

Yield boundary ....

†The indicated average expected yields to wells are predictions based on the best data available at the time of map compilation; due to data shortcomings and special conditions, local discrepancies between predicted and actual yields are inevitable. Multiaquifer completion may be necessary to obtain the yield indicated.

Wells and Other Artificial Works

Water well ....

Water well, flowing ....

Water well, shallow depth ....

Water well, 20-year safe yield calculated from apparent transmissivity, and yield value in imperial gallons per minute 26

Water well, 20-year safe yield calculated from a good bail test or a short pump test ....

Water well, 20-year safe yield calculated from a pump test of sufficient length to reflect regional hydraulic conditions ....

Seismic shot hole reported to have flowed ....

Depth scale — FEET 0, 100, 200, 300, 400 — Depth to water — Depth of well or seismic shot hole

Spring catchment ....

Research Council of Alberta test well .... RCA

Location of test well ....

Line of hydrogeological profile .... A — A′

Hydrochemistry

Calcium, Magnesium, Sodium + potassium, Carbonate + bicarbonate, Sulfate, Chloride, Nitrate (0, 50%, 100%)

Note: When the yellow Mg pie sector is absent, Ca + Mg are represented as a unit by the red pie sector.

Total dissolved solids in parts per million .... —500—

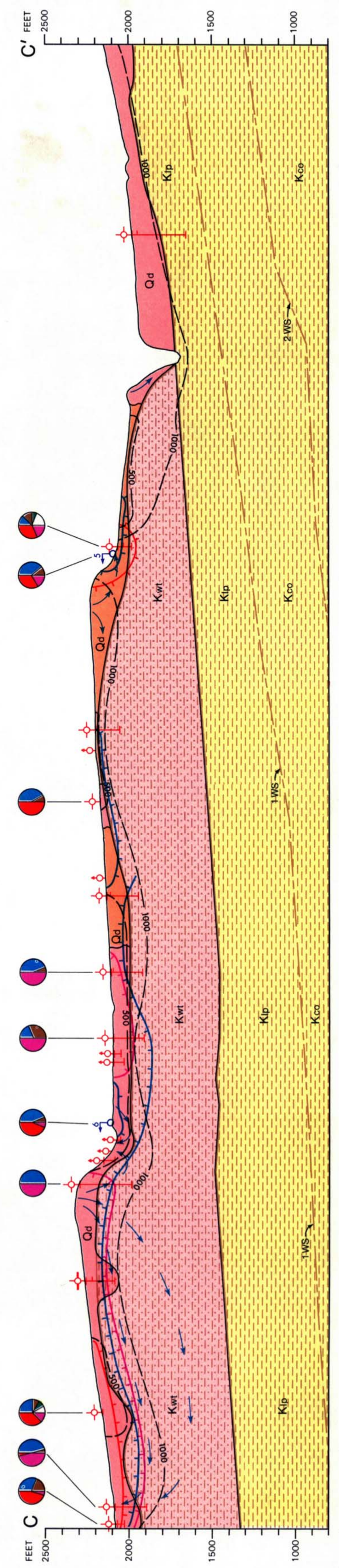
Isogram along which calcium + magnesium constitute 60 per cent of total cations*; teeth indicate direction of lesser calcium + magnesium content ....

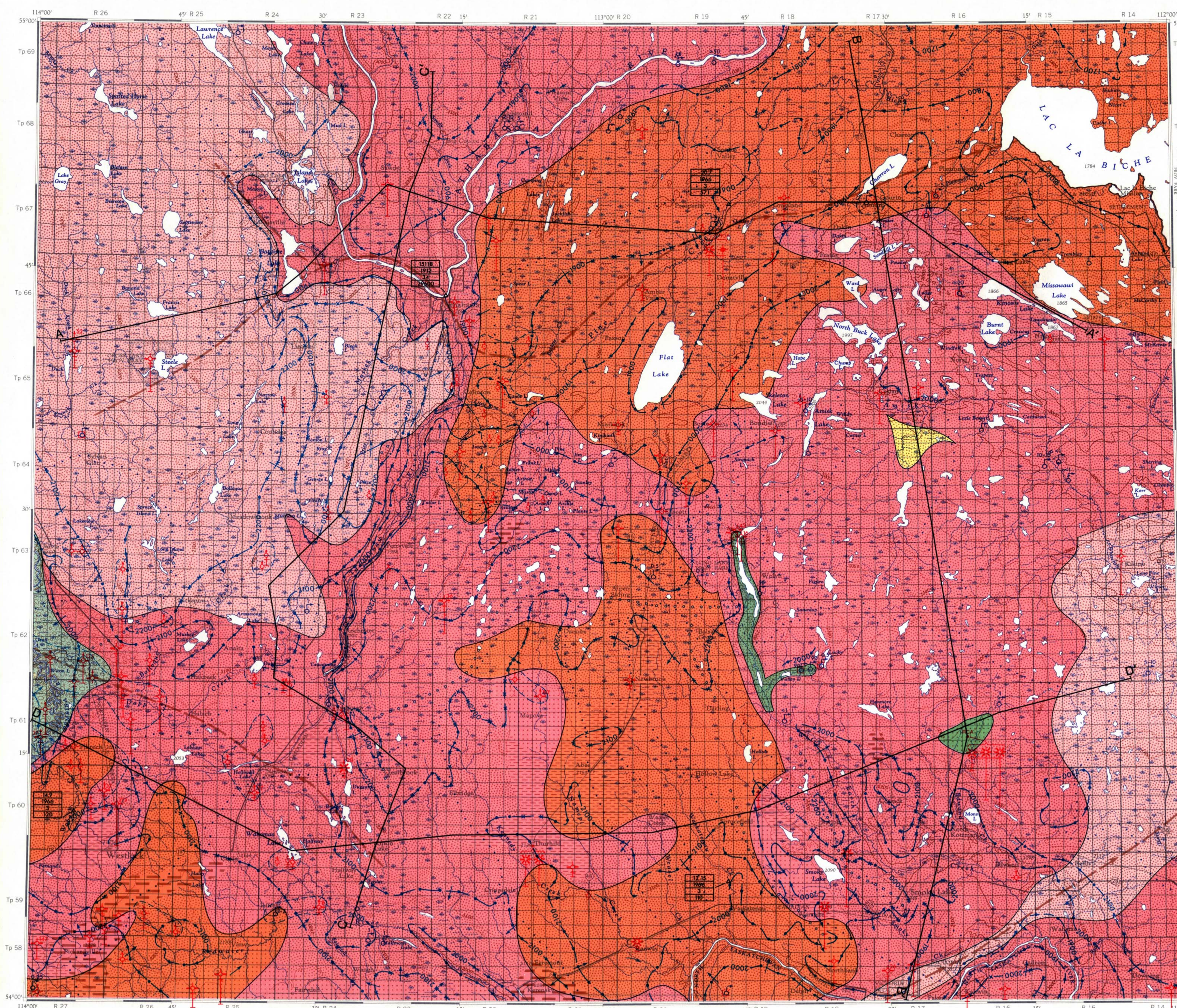
Isogram along which sodium + potassium constitute 60 per cent of total cations*; teeth indicate direction of lesser sodium + potassium content ....

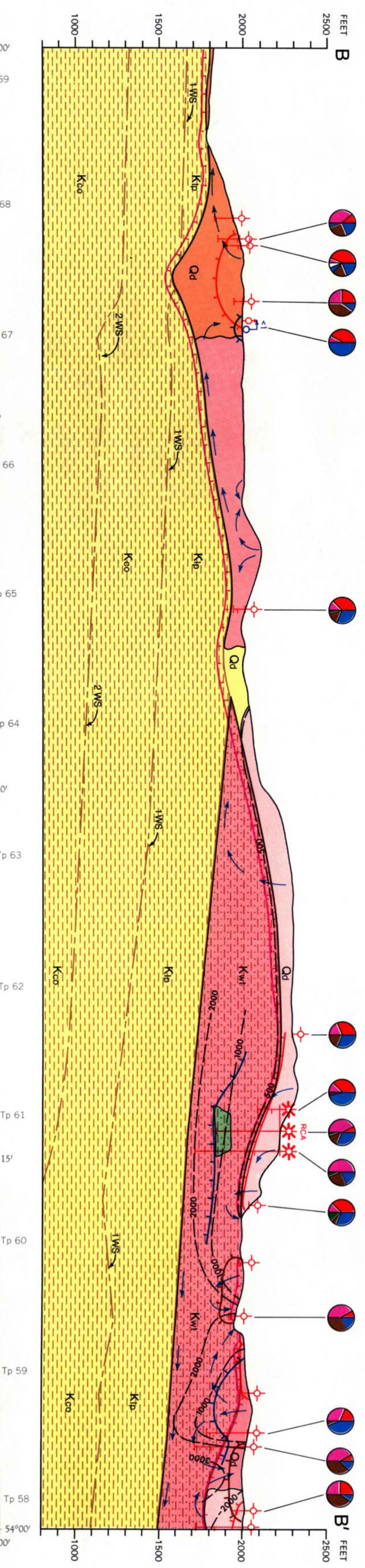
Isogram along which carbonate + bicarbonate constitute 60 per cent of total anions*; teeth indicate direction of lesser carbonate + bicarbonate content ....

Isogram along which sulfate constitutes 60 per cent of total anions*; teeth indicate direction of lesser sulfate content ....

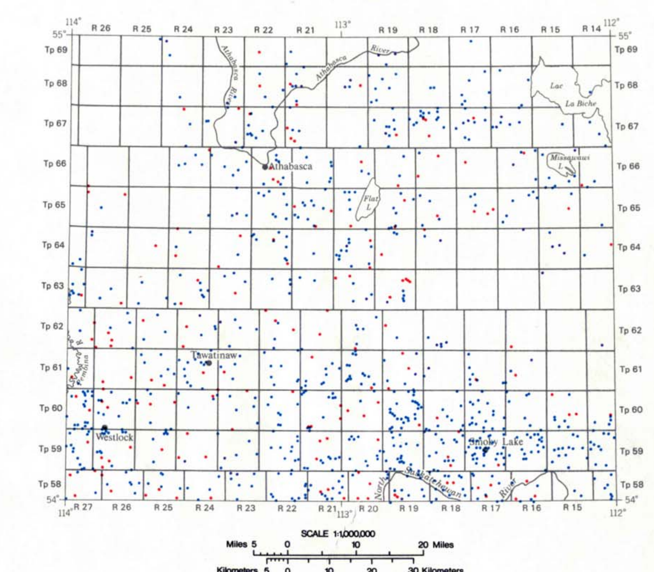
*Determined on equivalents per million basis.







DATA DENSITY



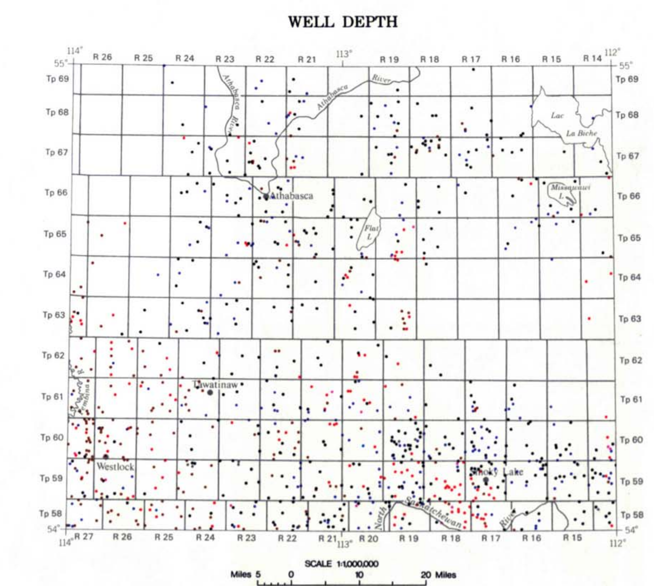
LEGEND

Data control point marking the location of a well with water level information only ....

Data control point marking the location of a well with yield information (i.e. production test) ....

Data control point marking the location of a hydrogeological surface feature ....

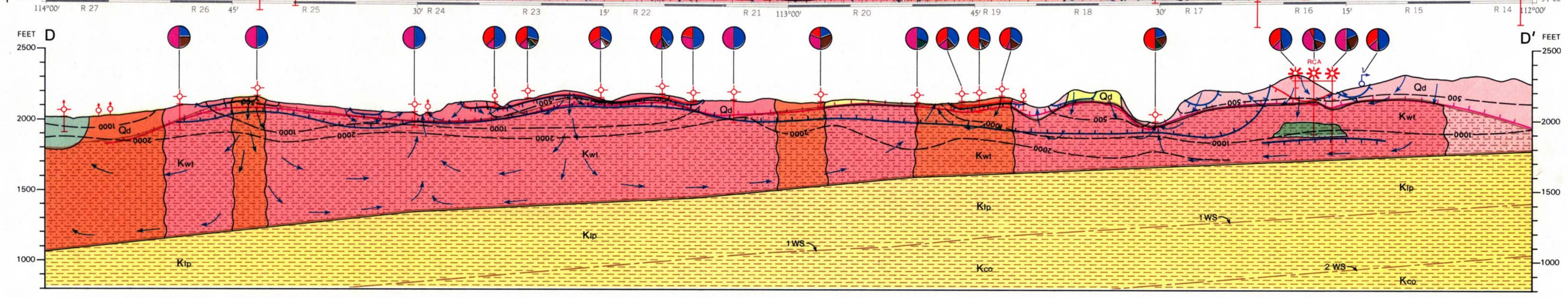
WELL DEPTH



LEGEND

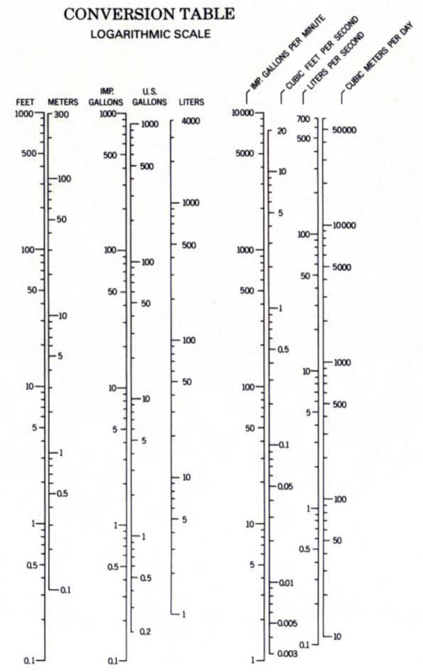
The distribution of wells within a particular depth interval (in feet) is defined according to the following code:

0 to 50 ....
50 to 100 ....
100 to 200 ....
200 to 400 ....
400 to 800 ....
>800 ....
unknown ....



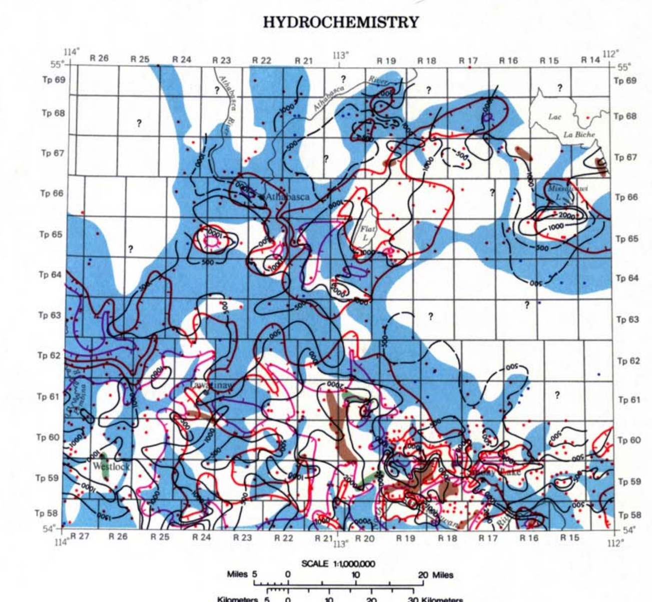
CONVERSION TABLE

LOGARITHMIC SCALE



SCALE 1:250,000 — Miles 5 0 5 10 15 20 Miles — Kilometers 5 0 5 10 15 20 25 30 Kilometers

HYDROCHEMISTRY



LEGEND

Data control point marking the location of a well with a chemical analysis ....

Data control point marking the location of a spring or surface water feature with a chemical analysis ....

Total dissolved solids in parts per million:
defined .... —1000—
approximate .... —1000—

Bicarbonate + carbonate constituting over 60 per cent of total anions* ....

Sulfate constituting over 60 per cent of total anions* ....

Chloride constituting over 60 per cent of total anions* ....

Isogram along which calcium + magnesium constitute 60 per cent of total cations*; teeth indicate direction of lesser calcium + magnesium content ....

Isogram along which sodium + potassium constitute 60 per cent of total cations*; teeth indicate direction of lesser sodium + potassium content ....

*Determined on equivalents per million basis.

All elevations in feet above mean sea level.

Vertical exaggeration of the hydrogeological profiles is approximately 40X.

An expanded legend and explanatory notes for use with this hydrogeological map series is available from the Research Council of Alberta, Edmonton, Canada.

Map to accompany Report 72-11.

Hydrogeology by D. Borneuf, 1971, based on data collected in 1970

Cartographic editing by A. Badry

Drawn by R. Clouston

HYDROGEOLOGICAL MAP TAWATINAW ALBERTA

NTS 83I