

RESEARCH COUNCIL OF ALBERTA

REPORT 72-3

**HYDROGEOLOGY
OF THE MOUNT WATT AREA,
ALBERTA**

**by
O. Tokarsky**

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Hydrogeological map, Mount Watt, NTS 84K, Alberta in pocket

HYDROGEOLOGY OF THE MOUNT WATT AREA, ALBERTA

Abstract

The Mount Watt area is largely unsettled and access is poor. The few existing water wells are usually hand dug and shallow. Hydrogeological evaluation is based on existing well data, limited test drilling, field observations of groundwater features, and on inferences made from the geologic and topographic situation.

Much of the area is of low relief underlain by shales, clays and tills of low permeability. Movement of groundwater is consequently slow, well yields very low, and water quality very poor. The highest well yields and best quality water are to be expected in surficial sands and gravels.

INTRODUCTION

This report constitutes a brief supplement to the map. It is written to direct attention to areas of interest, to anomalous situations, to significant details that cannot be clearly shown on the maps and cross sections, and to supply, where necessary, brief explanations for some of the foregoing items.

The map area, covering slightly more than 5 000 square miles, was mapped in conjunction with the Bison Lake map area (NTS 84F), to the south, during the summers of 1967 and 1968. It is largely unsettled country, although farming has been carried on in the vicinity of La Crete, Fort Vermilion, and Rocky Lane for many years. More recently, homesteads have been started in the area between High Level and Rocky Lane.

Almost all domestic wells are hand dug. Only the community of High Level has a central water distribution system and this utilizes surface water. A reservoir using surface water has been installed recently in Fort Vermilion to supplement, and eventually to replace, the individual wells presently being used. These wells are completed in shallow alluvial sands and gravels and are subject to contamination by domestic sewage.

Due to the lack of roads, much of the area was mapped by helicopter and, since existing points at which natural groundwater occurrences such as springs may be sampled are rare, hand-augered holes to 10 feet in depth were used to obtain water samples.

No previous hydrogeological surveys have been conducted, although some helpful hydrogeological observations have been made in the course of soils mapping (Lindsay *et al.*, 1959) and in botanical work (Moss, 1953).

Acknowledgments

Field operations were financed jointly by the provincial and federal governments under the terms support is gratefully acknowledged.

Other organizations contributing significantly to the project were the Water Resources Division, Alberta Department of the Environment, who supplied logs of test holes and results of the chemical analysis of groundwater samples, and the Peace River Health Unit, which supplied hydrochemical data.

Shot hole logs and structure test hole information were supplied by a number of oil companies and by the Alberta Energy Resources Conservation Board.

Test drilling was carried out by E. R. Kinsella Drilling of Innisfail and by R. Forrester Drilling of Red Deer. Field assistance was ably provided at various times by D. Withers, G. Borthwick, and W. Wolodko.

Thanks are due to D. H. Lennox and J. Tóth for suggestions on the manner of presentation of data, to Miss A. Badry for help in map synthesis and editing, to H. Weiss for drafting of the maps, and to Miss D. Cunliffe for typing of this report. G. F. Ozoray, G. M. Gabert, and D. V. Currie have critically reviewed and commented on the manuscript.

TOPOGRAPHY AND DRAINAGE

Topographic elevations range from less than 900 feet above sea level at Fort Vermilion to over 3 000 feet in the Caribou Mountains, although most of the area constitutes a broad, flat, poorly drained plain between 1 000 and 1 300 feet in elevation. The Peace River valley is incised into this plain more than 200 feet at the south end of the map area and only 50 to 60 feet at the east end, at Fort Vermilion. Mount Watt and the Caribou Mountains form the drainage divide between the Peace River and Hay River drainages.

CLIMATE

The area is characterized by short cool summers according to the Koeppen climatic zone classification. The mean annual temperature at Fort Vermilion is 28.8°F (50-year average).

The mean annual precipitation (refer to meteorological map) ranges from less than 14 inches at Fort Vermilion to more than 16 inches near Mount Watt and the Caribou Mountains (modified from Longley, 1968).

Monthly rates of evapotranspiration have been approximated from maps prepared by Bruce and Weisman (1967) and are shown for the weather station at Fort Vermilion. Evapotranspiration apparently exceeds precipitation for the months of May to October, inclusive, and is essentially negligible in other months.

The map area lies entirely within the southern fringe of the zone of discontinuous permafrost as mapped by Brown (1967). From observations during the present hydrogeological investigations it appears that nearly continuous permafrost is to be found in the Caribou Mountains. Mount Watt was free of permafrost. Other locations where ice was encountered during summer augering operations in the course of this survey and by Brown (1964) are indicated on the map. The permanence of this ice is undetermined.

GEOLOGY

The formation boundaries shown on the geological side map are essentially those of Green, Carrigy, and Mellon (1970), with one minor change necessitated due to an inferred bedrock channel. Subsurface data was obtained from Law (1955), oil-well electrical logs, the Energy Resources Conservation Board, seismic shot-hole logs, and from test holes drilled by the Water Resources Division, Alberta Department of the Environment.

A thick sequence of marine shales belonging to the Lower Cretaceous Loon River Formation and the Lower and Upper Cretaceous Shaftesbury Formation underlies most of the map area. The Upper Cretaceous Dunvegan Formation, a sequence of interbedded shales and sandstones, overlies the Shaftesbury Formation on Mount Watt and in the Caribou Mountains. Shales of the Upper Cretaceous Smoky Group overlie the Dunvegan sequence in the Caribou Mountains.

In the subsurface, Cretaceous formations lie unconformably on carbonates, and less commonly on calcareous shales, of Late Devonian age. Structure contours on the post-Paleozoic erosion surface are shown on the geological side map. The carbonate rocks lie within 200 to 300 feet of the land surface near Fort Vermilion.

Drift cover is thin over most of the area. Thicknesses are generally less than 50 feet, except within buried valleys. The most important buried valleys are in the vicinity of the Peace and Meander Rivers.

HYDROGEOLOGY

Water levels have not been contoured on the hydrogeological map because of the scarcity of well information. The few wells in the map area are shallow and hand dug, and as the water levels (i.e. the water table) conform closely to the land surface, they cannot be adequately represented at this scale of mapping.

The scarcity of wells necessitated that expected well yields be inferred from the geologic and topographic situation and from a very few test wells.

The highest yields are to be expected from gravels and sands within buried valleys and in alluvial gravels along the Peace River, and possibly from Paleozoic carbonates. The yield values shown on the map do not take into account possible water production from rocks of Paleozoic age except in the immediate vicinity of one test hole (located in NE quarter, section 29, township 108, range 13, west of the fifth meridian) in which the carbonate rocks were pump tested. This well was pumped for 48 hours at 82 imperial gallons per minute (igpm). The total drawdown was 50 feet out of an available head of 240 feet. The 20-year safe yield was tentatively calculated to be somewhat in excess of 400 igpm. An observation hole drilled 30 feet to the west obtained less than 1 igpm of water. The expected yield of the Paleozoic carbonates is therefore assumed to be extremely variable and is probably associated with channeling, vuggy porosity and detrital infilling developed during the pre-Cretaceous erosional interval.

A test well near Footner Lake, just north of High Level, on the basis of a 3 1/2 hour bail test, is rated as being capable of producing up to 25 igpm from sand and gravel laid down within a stream trench during glacial time. Buried valleys of probable preglacial origin containing a greater thickness of permeable sands and gravels, as indicated by electric logs of structure test holes, are expected to be capable of producing much greater quantities of water. The positions of buried valleys are not well established and consequently, the positioning of areas of high expected yield associated with sand and gravel within or near these valleys is questionable in many places.

Safe yields of 5-25 igpm have been assigned to the areas of aeolian sand near the Peace River, on the basis of measured flow rates of springs; and to the sandstones of the Dunvegan Formation. Yields in the La Crete area from alluvial sands and silts are likely to be variable depending on the grain size, but in any case sustained yields of over 25 igpm are unlikely.

A range of yields is also expected over a broad area covering the northeastern portion of the map area. Glacial sands and gravels which may be capable of sustained yields of up to 25 igpm are sporadically distributed over this region. Where these sands and gravels are not present, well yields of less than 1 or 2 igpm are likely.

Yields of less than 5 igpm are to be expected over the western part of the map area, where the thin drift cover consists mainly of till overlying Cretaceous shales. It is probable that difficulty in obtaining well water in this region will be experienced, except where local permeable zones within the drift and in fractured or weathered shale at the upper bedrock surface may exist and which may be capable of supplying up to 5 igpm of water.

HYDROCHEMISTRY

Hydrochemical control over much of the map area is provided by analyses of water samples from shallow auger holes less than 10 feet deep. In most places, although water may be obtained, no portion of the upper 10 feet of earth material constitutes an aquifer in the commonly accepted sense of the word, and the chemistry of the water may be quite different from that obtained from lower-lying, more permeable water-bearing zones. However, it is assumed that these analyses have regional significance and therefore are worthy of presentation.

Hydrochemical changes with depth are largely inferred from water samples obtained in the few test holes drilled, from geologic conditions and from inferred position in the hydrologic flow system.

Water quality is very poor over most of the area, the waters being mostly of the calcium-magnesium sulfate type with a high total dissolved solids content. Better quality water occurs in: 1) areas of aeolian sand near the Peace River, 2) gravel terraces along the Meander and Peace Rivers, 3) Recent alluvial sand and gravel, 4) the high areas of Mount Watt and Caribou Mountains, and 5) local areas of sand or sand and gravel in the eastern part of the map area. The generally poor water quality is a result of the slow movement of groundwater through fine-grained materials in an area of very low relief. This slow movement increases the time in contact with the fine-grained materials present in this area and results in great increases in total dissolved mineral content over short distances. A sodium-chloride type of water with 4 444 ppm of total dissolved solids was obtained from Paleozoic limestone in the one test hole drilled to test this formation. This is considered to represent water lying below the zone of most active groundwater movement.

Since groundwater is chemically nonpotable over much of the area, surface water sources are used in many places. Dugouts to collect surface water are more common than wells in the settled area north and west of the Peace River. Creek and muskeg water is also used. Surface water is, and probably will continue to be for quite some time, the most important source of potable water in the area as a whole.

CONCLUSIONS

The map area lies along the southern fringe of the zone of discontinuous permafrost. Much of the area is of very low relief and most is underlain by poorly

permeable materials. Movement of groundwater is consequently slow and water quality generally very poor. The highest well yields are to be expected in surficial sands and gravels where water quality may be good and locally in Paleozoic carbonates where water quality is very poor.

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APPENDIX A
RESEARCH COUNCIL OF ALBERTA TEST HOLES

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- 1) Location: Approximately 390 feet north, 25 feet west of SE corner, Sec. 23, Tp. 107, R. 15, W. 5th Mer. (415 feet from edge of river bank)

Elevation: 1 010 feet (estimated from 50-foot contours)

Contractor: Forrester Water Well Drilling Ltd., Oct. 1967

0- 25	clay, silty, brownish, stone-free, sandy zone at 20 feet with some water
25- 30	clay, dark grey, stone-free
30- 45	clay, silty, brownish grey, no stones, gypsum crystals at 35-40 feet
45- 63	sand, very fine grained; water-bearing; water level at 32 feet below ground surface
63- 86	sand, gravelly, poorly sorted
86- 90	till, dark grey
90-100	sand and gravel with till lenses
100-105	sand, poorly sorted, very fine to medium grained, a few pebbles
105-116	sand and gravel with till lenses; water-bearing; water level at 105 feet below ground surface
116-158	till, dark grey, a few sandy streaks
158-160	gravel, large boulders
160-165	sand, medium grained
165-168	gravel and sand
168-175	gravel and sand, some clay; water-bearing; water level at 161 feet below ground surface
175-186	sand, very fine to fine grained, some medium grained
186-189	sand and gravel, clayey
189-195	till, dark grey
195-220	clay, silty, dark grey, a few pebbles
220-223	siltstone, argillaceous, brownish grey
223-250	shale, soft, dark grey; water level in hole (cased to 196 feet) is 140 feet below ground surface

- 2) Location: NE corner of Lsd. 1, Sec. 32, Tp. 108, R. 13,
W. 5th Mer.

Elevation: 890 feet (altimeter survey)

Contractor: E. R. Kinsella Drilling Ltd., Oct. 1968

0- 6	sand, fine grained
6- 10	sand, medium grained
10- 14	sand, fine grained, dirty
14- 17	quicksand, fine grained
17- 33	clay, very silty, dark grey
33- 40	till, grey and pinkish brown
40- 45	shale, clayey, soft, dark grey
45-160	shale, dark grey, thin layers of calcareous siltstone
160-220	shale, finely fissile, grey
220-263	shale, as above, interbedded with very fine grained, dark grey, soft sandstone, oil stained; glauconite in lower 10 feet
263-272	limestone, very hard, light grey; loose gravel of limestone chips in upper 2-3 feet; water-bearing; water level 21 feet from ground surface; some gas

- Tests: 1) 2-hour step-drawdown test at total depth at 16 and 32 igpm with 36 feet of total drawdown.
- 2) 24-hour pump test at total depth at 82 igpm with 46.7 feet of total drawdown. Hole cased to 25 feet. No observation well. Scheduled observation well drilled into limestone 30 feet west of pumping well did not encounter water.

3) Location: Lsd. 10, Sec. 5, Tp. 111, R. 19, W. 5th Mer.

Elevation: 1 080 feet (estimated from 50-foot contours)

Contractor: E. R. Kinsella Drilling Ltd., Nov. 1968

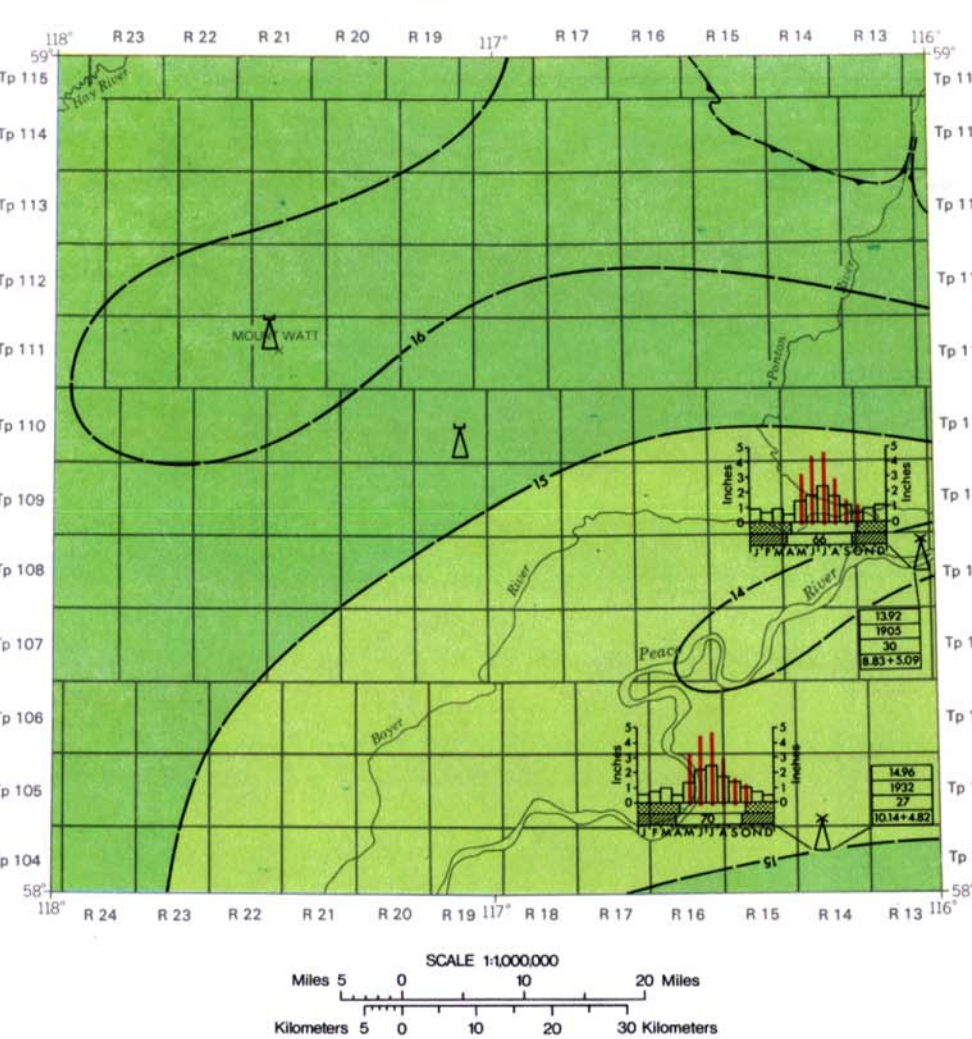
0- 16	till
16- 19	gravel
19- 40	till
40- 55	sand, fine to very fine grained, poorly sorted, and gravel
55- 60	sand, fine to medium grained, and gravel
60- 65	sand and gravel, very dirty, silty
65- 70	sand, clean, poorly sorted, very fine to fine grained, and some medium grained; water-bearing; flows to surface
70- 80	sand, very fine grained, and silt
80- 95	clay, silty
95-148	sand, very fine grained
148-150	pea-sized gravel
150-180	shale, dark grey

- Tests: 1) 1-hour open flow test from 70-foot depth (hole cased to bottom). Rate of flow decreased in 2 hours from 11.1 igpm to 7.25 igpm.
- 2) 2-hour open flow test at total depth. Five feet of #10 slot screen set at 148-153 feet. Rate of flow decreased in 2 hours from 25.0 igpm to 10.0 igpm.



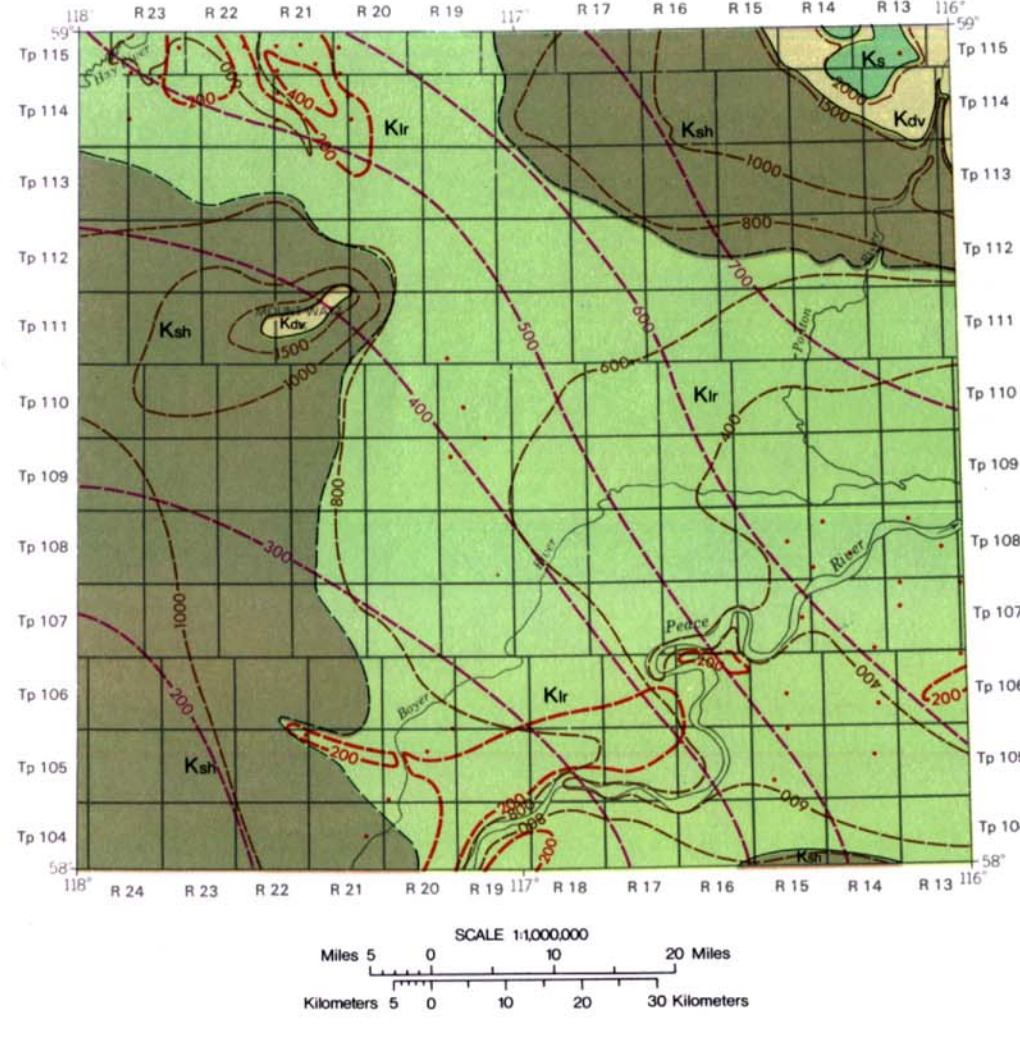
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METEOROLOGY



LEGEND
Isohyet, mean annual precipitation in inches, approximate
Boundary of discontinuous permafrost, the apex on the symbol point toward the frost free area

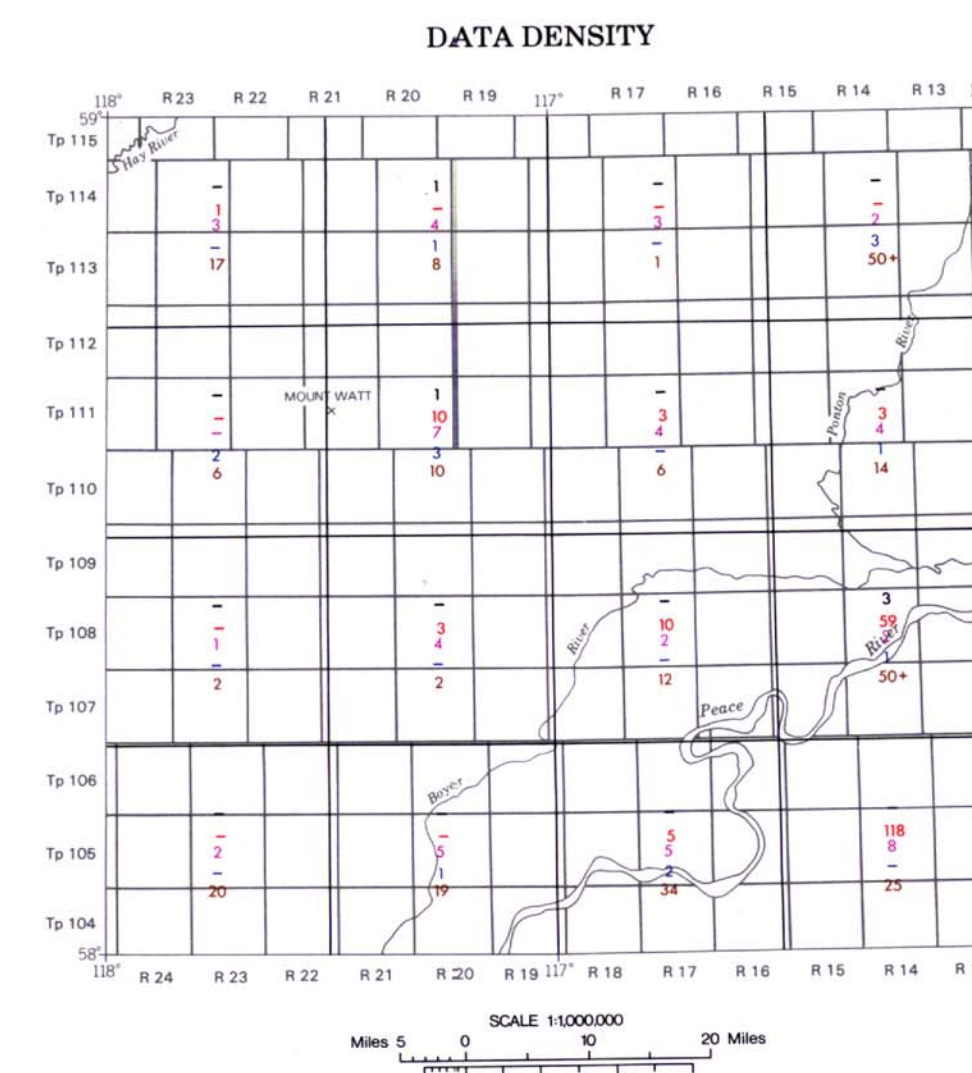
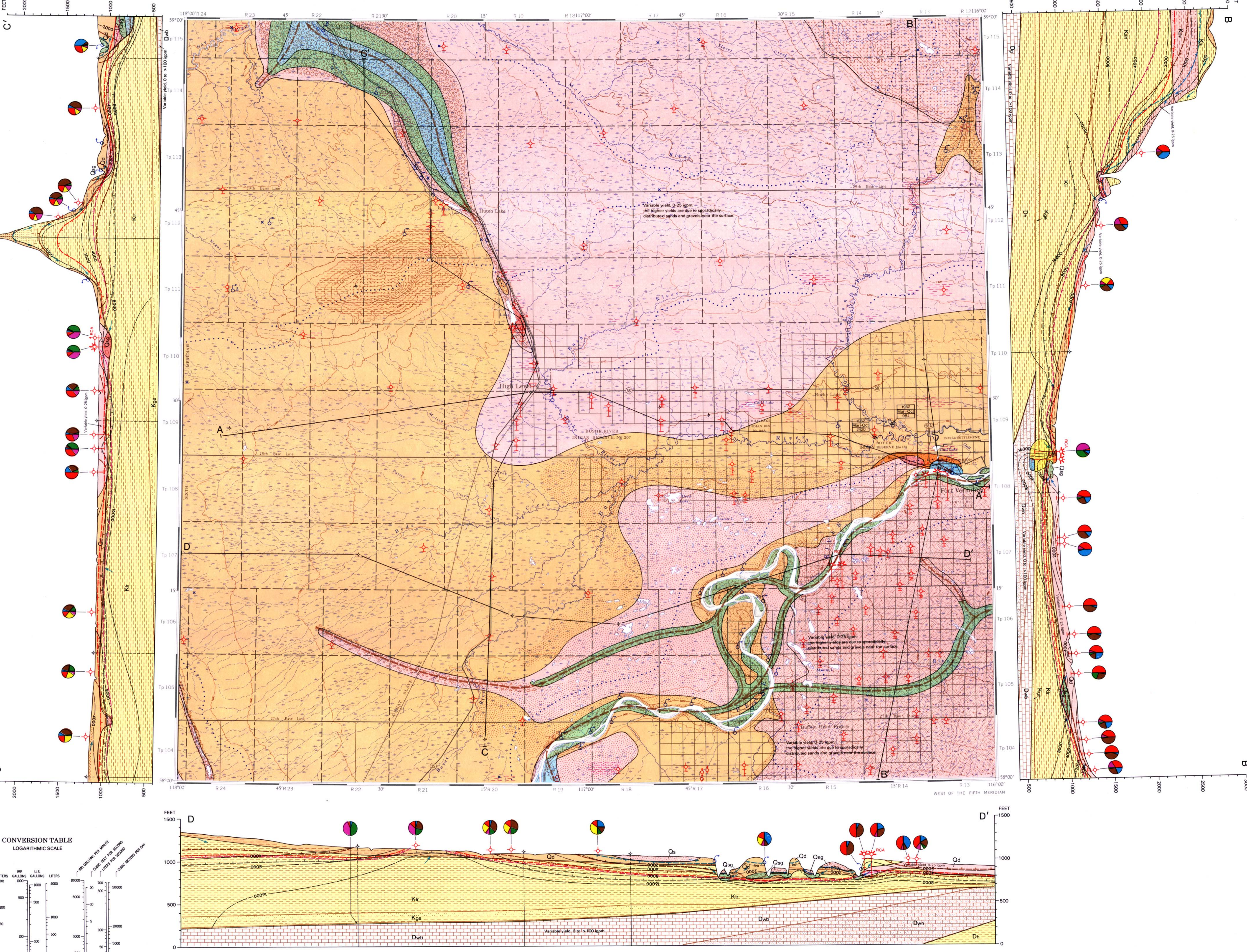
GEOLOGY



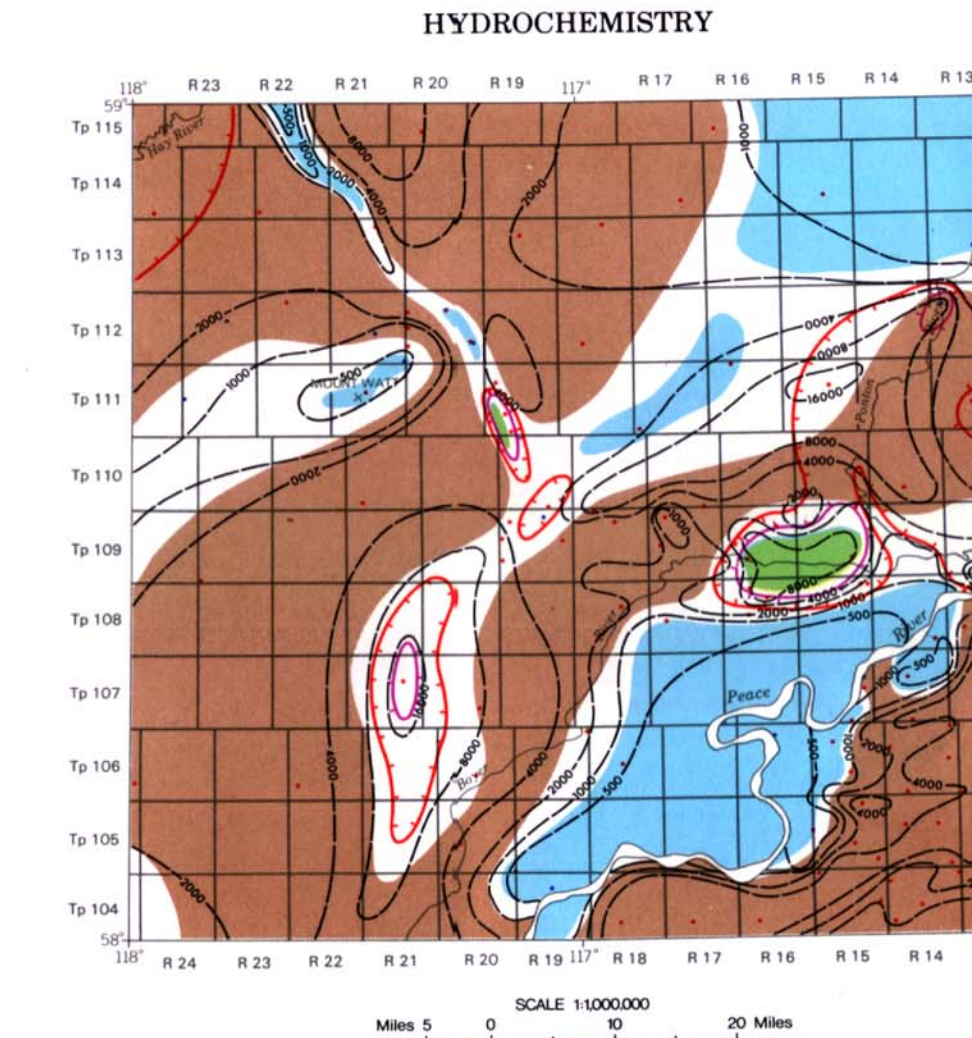
LEGEND
Smoky Group, shale and silty shale
Dauvagan Formation, interbedded fine-grained sandstone, siltstone, silty shale

MAIN MAP LEGEND

Topography
Surface contours and elevation in feet (interval 100 feet)
Geology
Geological boundary
Thalweg of buried valley, approximate



LEGEND
Figures indicate the number of data control points in each section of the map area used in construction of:



LEGEND
Data control point marking the location of a well or shallow sugar hole with a chemical analysis
Data control point marking the location of a spring or surface water feature with a chemical analysis

CONVERSION TABLE
LOGARITHMIC SCALE
FEET METERS

HYDROGEOLOGICAL MAP
MOUNT WATT
ALBERTA
NTS 84K

All elevations in feet above mean sea level.
Vertical exaggeration of the hydrogeological profile is approximately 40X.

