QUATERNARY GEOLOGY AND SAND AND GRAVEL RESOURCES OF THE RURAL MUNICIPALITY OF STE. ANNE

R6E R7E R8E

Tp8 Tp7

R6E R7E R8E

LEGEND

POST GLACIAL

8 — Alluvium: present day flood plain and/or valley fill material composed mainly of silt and clay and minor seasonally submerged organic deposits.

7 — Swamp: seasonally submerged organic deposits.

LATE GLACIAL

6 — Beach Ridges: representing major stillstands of Lake Agassiz, includes spits and offshore bars.

Littoral Sand and Gravel:

5a — Wave washed till overlain by a regressive sequence consisting of silt and clay grading upwards into sand and fine pebble gravel. Generally less than 2 metres thick and restricted to flat lying, poorly drained areas.

5b — Massive medium to fine grained sand with minor gravel generally overlying clay. Generally greater than 2 metres thick.

4 — Lacustrine clay: silt and clay deposited in the deep waters of Lake Agassiz.

GLACIAL

3 — Deltaic sand and gravel: deposited at or near the ice front during the final retreat of Keewatin ice from the area.

2 — Calcareous till: generally silt-rich and severely jointed calcareous till of north-west provenance commonly modified by wave action. Includes minor areas of sandy till of northeast provenance.

Glaciofluvial sand and gravel: glacially overridden glaciofluvial deposits consisting:

1a — Primarily of sand with minor gravel.

1b — Primarily of sand and gravel.

SYMBOLS

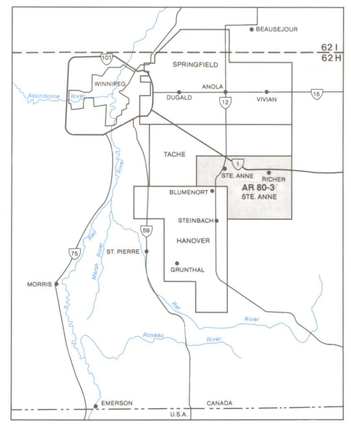
- 600 — deposit number
- GM201 — gravel pit
- GM201 — gravel pit w/station stop
- GM206 — station stop
- GB101 — backhoe test pit
- sand dune (approximate orientation of individual dunes)
- iceberg scour
- raised shoreline
- esker
- transverse bar
- spillway (partially infilled)
- moraine

MANITOBA
DEPARTMENT OF ENERGY AND MINES
MINERAL RESOURCES DIVISION

Scale 1:50 000

KILOMETRES 1 0 1 2 3 4 KILOMETRES
MILES 1 0 1 2 3 MILES

MAP INDEX



KILOMETRES 10 0 10 20 30 KILOMETRES
MILES 10 0 10 20 MILES

INTRODUCTION

Physiographic regions represented in the area are the Red River Lowlands and the Lake Terrace Plain. The Red River Lowlands is a flat area comprising thick accumulations of pro-glacial lake sediments, mainly clay. This area is interrupted by the Bird's Hill complex in the northwest corner of the area. The Red River Lowlands area is flanked on the south and east by the Lake Terrace Plain. The Lake Terrace Plain is a gently undulating area made up essentially of glacial till which is overlain by organic deposits and discontinuous proglacial lake sediments.

The thickness of Quaternary sediments overlying the bedrock is from 3-90 metres: generally 10-30 metres on the Red River Lowlands and 30-80 metres on the Lake Terrace Plain.

LATE WISCONSIN GLACIATION

Late Wisconsin continental ice has overridden the entire area four times. Initially, Labradoran ice from the northeast deposited a sandy till which occasionally crops out in the area. Three subsequent invasions of Keewatin ice from the northwest deposited finer textured tills which cover a large part of the area.

The Labradoran ice deposited the sandy Senkiw Formation (Fenton, 1974). The Senkiw till has a low stone content and an average of 60% sand, 29% silt and 11% clay (Teller and Fenton, 1980). The Senkiw till forms the uppermost till in sections 4-7-7E, 20-7-8E and 35-8-8E, in each of which it is overlain by minor lacustrine sand and gravel.

In section 4-7-7E, the Senkiw Formation and associated glaciofluvial sediments make up the core of a topographical high which was formed along the ice margin during the retreat of Labradoran ice. These sediments form a typically faulted and folded sequence of silt, sand and gravel in association with the Senkiw till. The sand and gravel layers are commonly cross-bedded with a highly variable paleo-current direction.

During the period between 21,000 and 11,000 years before present, the Keewatin ice advanced from the northwest and retreated through the area several times, depositing three discontinuous till sheets: the Roseau, the Whitemouth Lake, and the Marchand Formations (Teller and Fenton, 1980). They are generally silt-rich carbonate tills with variable stone content and are commonly well jointed with dark brown magnesium stains on the jointed surface. The colour in outcrop is generally pale to medium brown. Only two of the three tills of north-western provenance have been identified in outcrop.

Glaciofluvial deposition occurred during the retreat of the three consecutive Keewatin sheets. These deposits are divided into two groups: 1) those formed at or near the ice front, mainly kame deltas, and 2) eskers, formed in a channel, on or in the ice.

The eskers are long narrow ridges with paleocurrent directions east-southeast. They were formed by glacial meltwaters carrying sediment to the ice front.

Glaciofluvial deposits associated with the ice front form topographical highs. The gravel fraction contains 60-70% carbonate due to their association with the carbonate rich Keewatin ice. The glaciofluvial deposits comprise well to moderately well sorted sand and gravel with lesser amounts of silt and silt-rich till. They are generally overlain by a discontinuous till sheet of northwest provenance.

The first Keewatin recession took place as far north as Bird's Hill where it formed an esker-delta complex. Bird's Hill formed as a result of glacial meltwater discharging through crevasses probably created by differential ice push at the margin of the ice sheet. The meltwater flowed into a shallow proglacial lake during an early stage of Lake Agassiz (Ringrose, 1979).

During the recession of the penultimate Keewatin ice sheet, glaciofluvial deposits in the Vivian, Grunthal and Ross areas were formed (Fenton, 1974). The deposits south and west of Ross are eskers which have been modified by wave erosion. The deposits in the Vivian and Grunthal areas are kame deltas formed at or near the ice front by glacial meltwater discharging into a proglacial lake. The resulting deltas were partially ice walled and thus prone to deformation upon ice melt.

During the retreat of the last Keewatin ice, the Marchand ice sheet, the glacier halted temporarily to form the "Blumenort Moraine" which extends from Blumenort east and north to Monominto. The northern section of this feature is very complex with highly variable paleocurrent directions. Glaciofluvial deposits in the southern part, the Blumenort area, form kame terraces as they: infill a depression, unlike the other glaciofluvial deposits; paleocurrent directions are consistently east-northeast parallel to the moraine; and the presence of cut and fill structures within the granular material tends to indicate deposition within an open channel. These deposits are partially overlain by till due to minor fluctuations of the Marchand ice front.

The deltaic sand and gravel (sections 23 and 24, 11-7E) is correlated with the recession of the Marchand ice. The southeast part of the deposit was probably not overridden by glacial ice as it shows no signs of deformation. The deposit displays large scale tabular cross-bedding with a paleocurrent direction generally southward.

LAKE AGASSIZ SEDIMENTATION

During ice front recession, the area was repeatedly inundated by pro-glacial lakes which subjected the area to several periods of erosion and deposition. The most prominent of these inundations was Lake Agassiz which rose to its highest level, the Herman, during the retreat of the Marchand ice. The lake gradually drained, first to the south through the Red River valley and then to the east into north-western Ontario. During this time the lake level dropped to the Ojata strandline, approximately 290 metres, and parts of townships 5-5E, 7-8E and 8-8E emerged. About 10,000 years ago an ice advance in northwestern Ontario blocked the eastern outlet and the lake level rose to the Lower Campbell strandline and the area once again was completely under water. By approximately 8,000 years ago, Lake Agassiz had completely drained from the area (Elson, 1967).

Beach ridges marking stationary lake levels of the last regression are found throughout the Lake Terrace Plain. Lake levels represented in the area are the Ojata through to the Stonewall strandlines. The beaches are generally 1.5-3.0 metres high and made up of well sorted, horizontally bedded sand and gravel.

The regressive sand and gravel (Unit 5a) was also deposited along the shoreline of Lake Agassiz. This reversed graded sequence of clay, sand and gravel resulted as the lake level gradually lowered over a gently sloping ground surface.

The sand (Unit 5b) and the clay (Unit 4) form extensive flat plains. The sand is generally restricted to an area above 250 metres above sea level, where it overlies clay. This is also a regressive sequence, however, it is different from Unit 5a as it was deposited offshore, in a lower energy environment and therefore lacks the gravel clasts.

Iceberg scours form subtle ridges which criss-cross the clay plain. They are composed of contorted silt and clay laminae, and are believed to be the result of wind driven icebergs grounding on the clay in the bottom of Lake Agassiz. These features are unlikely to be related to the bedrock or to glaciation because there is often 30 metres of drift overlying the bedrock, the top 10 metres of which is generally clay. There are two possible sources for the icebergs:
1) the calving of frontal ice during recession, and
2) the breaking up of Lake Agassiz winter ice during spring thaw (Clayton, et. al., 1965).

ECONOMIC GEOLOGY

Diminishing gravel reserves in the Bird's Hill complex are encouraging increasing exploration and exploitation of resources in the Lake Terrace Plain area. Because of the haulage distance to Winnipeg markets, only the larger deposits are economically viable for Winnipeg consumption. A few Winnipeg based gravel suppliers are active in the area. Sand and gravel sources in the Rural Municipality of Ste. Anne comprise beach ridges (Unit 6) and glaciofluvial sand and gravel (Unit 1b).

Beach ridges are scattered throughout the Lake Terrace Plain. Economically, they have the advantage of being uniform in composition and easily defined, however they generally contain relatively small quantities of gravel in long, narrow ridges, making acquisition of a sufficiently large quantity difficult. Their value tends to be limited to local consumption.

The beach ridges are largely depleted or are unavailable for extraction because they provide attractive building sites. Deposit number 2205 is the largest beach ridge in the Rural Municipality of Ste. Anne. It is approximately 5 metres high at the crest and has not been extensively mined. One small exposure, on the east side of this beach ridge, indicates over 2 metres of granular material composed of 15 per cent gravel. This material has 100 per cent passing 25 millimetres (1 inch).

The glaciofluvial deposits are variable in composition and more difficult to define on aerial photographs. They tend to contain larger quantities and better quality gravel than the beach ridges. Resistivity surveys and a limited number of backhoe pits have enabled delineation of the larger deposits. Deposit numbers 2226 and 2228 are kame terraces. Apparent similarities to kame terraces deposited in the Blumenort area suggests that they probably contain high quality gravel reserves below the water table. These deposits are largely depleted above the water table. Deposit 2210 forms a narrow band of high quality gravel which is over 7 metres thick. The water table varies from 1 to 3 metres deep. The surface of the deposit grades into sand towards the southeast, however, gravel continues at depth as backhoe pits GB104 and GB110 intercepted gravel at depths of 3 to 5 metres. Deposit 2240 contains 3 to 5 metres of medium high quality gravel. This deposit is being mined with a "belly-dump scraper", which is a method of gravel extraction unique to the area.

Further information on the sand and gravel deposits may be obtained from the Aggregate Resources Section of the Mineral Resources Division.

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Base map information compiled from 1:50,000 N.T.S. sheets.

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