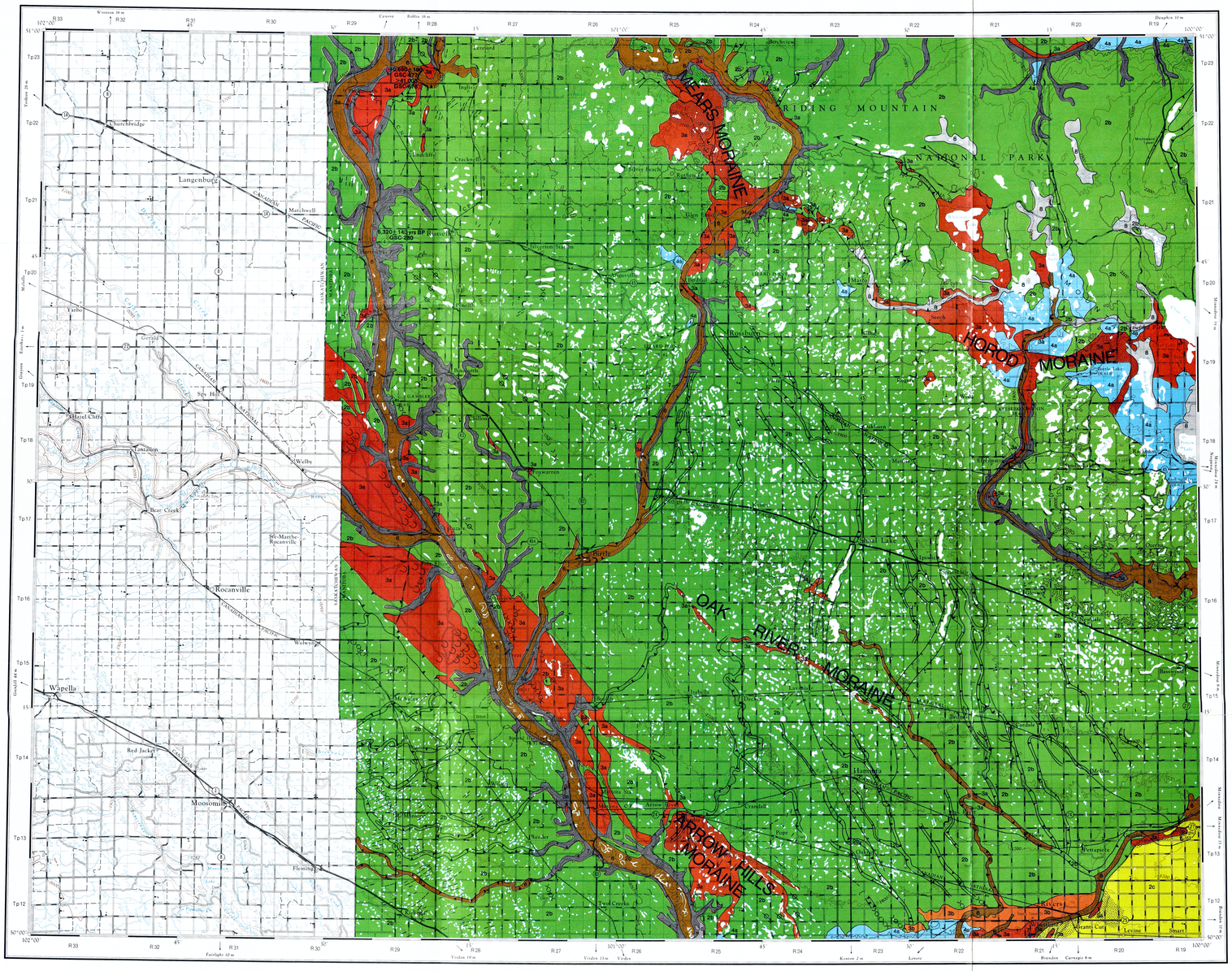
MANITOBA
DEPARTMENT OF ENERGY AND MINES
MINERAL RESOURCES DIVISION

QUATERNARY GEOLOGY MAP: SOUTHERN MANITOBA 62K RIDING MOUNTAIN



LEGEND

HOLOCENE

8	Swamp: peat and peripheral mud with some alluvium
7	Colluvial slumps, slope wash and some ice push deposits
6	Alluvial silt, sand and clay, including alluvial fans along the escarpment and present day alluvial deposits
5b	Offshore silt, locally interbedded with sand or clay
5a	Littoral and nearshore gravel, sand and silt including minor deltaic deposits
4c	Fluvio-lacustrine clay and silt, deposited as alluvial fill in major river valleys
4b	Lacustrine silt and clay deposited in deep basins of Lake Agassiz
4a	Lacustrine silt and clay deposited in basins peripheral to the main Lake Agassiz basin
3b	Deltaic coarse gravel and sand, deposited primarily as the Assiniboine delta deposits
3a	Glaciofluvial and outwash sand and gravel, with minor silt, clay and till: includes eskers, kame deltas, outwash terraces and outwash plains
2c	Till: grey calcareous silty till derived primarily from Paleozoic carbonate rocks
2b	Till: brown clay till, deposited in part as hummocky stagnation moraine: includes wave washed till and minor clay basins
2a	Till: sandy till derived primarily from Precambrian bedrock: includes minor amounts of clay till
1c	Mesozoic bedrock :primarily shales
1b	Paleozoic bedrock :primarily carbonates
1a	Precambrian bedrock :primarily crystallines

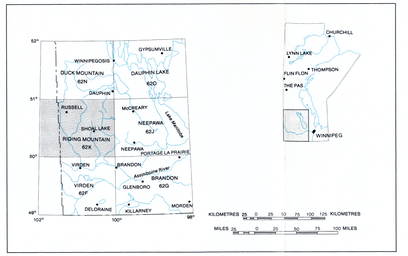
WISCONSINAN

SYMBOLS

- Sand dunes, wind direction inferred
- 14,300 ± 320 GSC-1369 — Significant stratigraphic section (Radiocarbon Date)
- Flutings, ice advance direction inferred
- Minor till ridges
- End moraine , hummocky stagnation moraine
- Beach ridges — strandlines
- Esker (direction unknown ,direction known)
- C — Elbow of capture
- Spillway
- Buried Valley

Scale 1:250 000

KILOMETRES 0 5 0 5 10 15 20 25 30 KILOMETRES
MILES 0 5 0 5 10 15 20 MILES



CLASSIFICATION OF DEPOSITS

The Riding Mountain map area lies within the Second Prairie Level or Saskatchewan Plain. The Riding Mountain Plateau, in the northeast corner of the map sheet is isolated from the western portion of the Second Prairie Level by the Assiniboine River Plain. Pre-glacial drainage patterns are inferred by major buried valleys. The largest, running northeast from Yarbo to the junction of the Assiniboine and Shell Rivers, is thought to be the Tertiary Assiniboine River valley. Two smaller channels, at Sandy Lake and Shoal Lake, drained southeast through the area (Klassen, 1965).

Present day topography is that of hummocky stagnation moraine in the northeast. Local relief is often greater than fifteen metres and kettle hole depressions are commonly waterfilled, resulting in many lakes. To the south and west the till plain is more gently rolling with average relief up to eight metres. Minor till ridges broadly parallel to the direction of ice recession, are found to the southwest of the Assiniboine River.

Four major glacial spillways, the Qu'Appelle, Assiniboine, Minnedosa and Birdtail valleys cross the area. Extensive areas of sand and gravel are present as outwash plains and kame moraine complexes in the northeast and southwest of the map sheet.

PRE-TILL DEPOSITS

The earliest known deposit in the area is the Souris sand and gravel seen in an exposure northeast of Shellmouth. It overlies bedrock at the base of pre-glacial valleys. Souris sand and gravel comprise twenty to seventy-five percent subrounded to well rounded quartzite, argillite, chert, agate and porphyritic volcanics, all of western provenance. This contrasts with the less than ten percent content of these lithologies in the typical glacial gravels of the area. The western provenance and stratigraphic position of the deposits led Elson (1956) to assign the Souris sand and gravel to an early Pleistocene age.

TILL

At least three distinct tills are found in the area. The Shell and Minnedosa tills occur at depth, whereas the Zelena Formation forms the present day topography (Klassen, 1979). The Shell Formation includes the oldest named till which only crops out in the Shell River Valley north of the map area. It is a distinct yellow brown colour and with fifty to sixty-five percent silt and clay and thirty to forty percent sand. The strong eastwest orientation of the pebbles indicates it was deposited by a westward flowing glacier (Klassen, 1969). The Minnedosa Formation is exposed along the valley of the Minnedosa River, the Shell River and the Birdtail Creek. Till of the Minnedosa Formation is pale olive in colour and sixty to seventy percent of the till matrix is silt and clay. It overlies the Shell Formation on Roaring River clay and reaches a thickness of thirty metres in the Shell River subplain deposition by ice flowing from the northeast. The Zelena till is three degrees darker in colour and is composed of forty to sixty percent silt and clay and thirty to fifty percent sand. It has a higher carbonate content in the silt and clay fraction than the Minnedosa till. Pebble orientation shows a strong northwest to southeast alignment, parallel to the striae on the boulder pavement which commonly separates the Zelena Formation from the underlying Minnedosa Formation (Klassen, 1979).

ICE-CONTACT STRATIFIED DRIFT

Eskers, kames, kame moraine complexes and outwash plains are found broadly trending southeast across the map sheet. Eskers, usually composed of sand and gravel of bedded silt, were laid down in tunnels in the ice while kames formed along the ice margin or in ice walled channels. Four kame moraine complexes,the Horod, Mears, Oak River and Arrow Hills moraines are found in the map area . Formed of eskers, kames and till ridges, they comprise silt, sand, gravel and till. Outwash covers broad areas within the Assiniboine River Valley plain or is associated with the moraine complexes. To the west of the Assiniboine River and on the east side south of Minnewasta Creek, the outwash is a smooth plain composed of 3 to 10 m sand and fine gravel; north of Minnewasta Creek the plain is pitted and the gravel coarser. Outwash associated with the Horod Moraine grades from coarse, shaley gravel in the north into sand north of Proven Lake. Outwash silt and silt deposited in glacial Lake Proven form the southwest edge of this deposit. Meltwater channels are prominent, particularly in the areas of recessional moraine. Generally they are three to six metres deep and contain one to three metres of clay, silt, sand and gravel.

DELTA AND LAKE DEPOSITS

Glaciolacustrine deposits cover a relatively small portion of the map sheet. The delta at Rivers is composed of coarse, well rounded gravel which grades into lake sand and silt south and west of the deposit. The lake deposits near the current Proven Lake are mainly bedded or laminated silt, often occurring as hummocks with over eight metres of relief. The silt hummocks are gradational with till hummocks to the northwest.

EOLIAN DEPOSITS

West of the Assiniboine River, portions of sandy outwash have been reworked into dunes that are either of indistinct shape or form ridges up to two kilometres in length. They are aligned to the southeast parallel to the prevailing wind direction and are stabilized by vegetation on the northeast slopes.

GLACIAL HISTORY

The rock types associated with the Souris sand and gravel are believed to have been brought into the area by Tertiary streams. Subsequent to the first glaciation these deposits were mixed with Quaternary gravel and deposited along the floors of pre-glacial valleys. Wood from the Shell River south exposure, probably coincident with the buried valley trending northeast from Yarbo, has been dated at >40,000 yrs. B.P.(GSC-678),(Klassen,1969, p. 5). The Shell Formation is overlain in places by the Roaring River clay which has yielded infinite dates of >37,760 yrs. B.P. (GSC-286), >34,000 yrs. B.P. (GSC-676) and >31,300 yrs. B.P. (GSC-297), (Klassen 1969, p.5). It was deposited in a lacustrine environment during the Sangamon interglacial or an early Wisconsin interstadial. The Shell till was laid by the fore be of early Wisconsin or Illinoian age. The Minnedosa till was deposited by ice flowing from the northeast. It generally underlies the Zelena Formation which includes in the Zelena Section north of Oak River, a silt bed up to one metre thick. The Zelena silt is dated to 37,000 ± 1,500 yrs. B.P. (GSC-653), (Klassen, 1969, p. 5), making the Minnedosa Formation early Wisconsin in age. The last ice advance into the area came from the northwest and deposited the Zelena till. Its position above the Zelena silt indicates it is of Classical Wisconsin age. During glacial retreat the ice sheet divided into two lobes, the northwestern lobe in the west and the Red River lobe in the east. The Valley River sublobe of the Red River entered the area from the re-entrant between Riding and Duck Mountains and may have flowed into the northeastern corner of the map area (Klassen, 1967).

Deglaciation of the area which began in the east was primarily by *in situ* stagnation and down melting of small portions of the ice sheet while most of the rest of the ice remained active. Initially glacial Lake Proven formed as meltwater ponded on the stagnant ice depositing lake silt and outwash at the same time as the Horod Moraine formed. As stagnation continued the ice separated further and the Mears Moraine complex developed between the lobes. Glacial Lake Proven expanded northward to the ice margin until drainage was established along the Minnedosa River Valley. Subsequent downcutting resulted in the drainage of (glacial) Lake Proven. The Minnedosa River continued to be the major spillway carrying water south, probably to Lake Souris. As the ice receded north of the map area, meltwater incised much of the Birdtail Creek and Assiniboine, Qu'Appelle and Shell River spillways.

The northwestern ice lobe re-entered the area during the Pipestone Creek Advance. The Pipestone Creek Moraine in Saskatchewan, and the Oak Lake Moraine in Manitoba, represent the lateral extent of the lobe. Glacial Lake Souris was dammed by the southern margin of the ice lobe. A re-advance of the Valley River sublobe resulted in the deposition of part of the outwash at Horod, Whitemouth Lake, Audy Lake and the Mears Moraine complex.

During the final recession of the northwestern lobe, the Arrow Hills Moraine was deposited. The outwash at Beulah was deposited when the ice front receded north of this position. Further recession and meltwater activity allowed re-excavation of the Assiniboine River and Birdtail Creek valleys and the deposition of outwash to the west of the Assiniboine River.

Glacial Lake Souris, possibly dammed by a re-advance of ice into the Pembina trench, flooded the Assiniboine valley plain at least to the junction with the Qu'Appelle River and deposited clay and silt in the lower valley. The delta at Rivers was built at this time as the Minnedosa River, carrying meltwater from ice stagnating on the escarpment, flowed into glacial Lake Souris (Klassen, 1966). Further ice recession led to the final drainage of glacial Lake Souris. The Assiniboine River once more began to flow down the valley, initially into glacial Lake Brandon, a remnant of glacial Lake Souris and later into glacial Lake Agassiz. Wood taken from flood-plain deposits 3m above the floor of the present Assiniboine valley north of Shellmouth has been dated at 10,690 ± 190 yrs. B.P. (GSC-677, Klassen, 1969, p. 5). South of Shellmouth deposits 5 m below the present valley floor have a much younger date, 6,320 ± 140 yrs. B.P.(GSC-280, Klassen, 1969, p. 5), indicating a period of excavation which preceded deposition of the modern alluvium.

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* Most of the map information is derived from this source.