SURFACE GEOLOGY OF THE SOURIS RIVER MAP AREA, NORTH DAKOTA

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MAP EXPLANATION

This map shows four elements of the geology of the Souris River Map Area: the lithology, topography, origin, and age of the surface sediment. Sediment characteristics are emphasized on this map; different lithologies are shown on the map by the use of color (Fig. 1). All Quaternary sediment of the same lithology is represented by map units of the same basic color. For example, two basic colors, orange and green, are used for ten different map units, but represent only two lithologies (sand and gravel; gravelly sand, silt, and clay). Because there are eight green map units of similar lithology, three different shades of green have been used to simplify use of the map.

The age and the origin of the sediment are shown with map-unit numbers. For example, a yellow map unit (sand) is interpreted to be either lake, river, or windblown sediment of a certain age. The specific interpretation is indicated by a map-unit number. Figure 2 shows the correlation diagram relating sediment age, origin, and lithology with map-unit number.

Detailed descriptions of the map units and line symbols used on this map are given in Figure 3. These descriptions include comments on the range of lithologic characteristics, possible origins, and mapping confidence of different map units.

In addition to the detailed map of the Souris River Map Area (left), three smaller, general maps are included on this sheet to aid the user in understanding the surface geology of the region. These three maps are 1) major landform areas (Fig. 4), 2) regional glacial margins (Fig. 5), and 3) regional glacial lakes and spillways (Fig. 6). The Souris River Map Area is divided into three landform areas, indicated by letters, based on the occurrence of similar or genetically related landforms (Fig. 4). During the last major glacial advance, ice covered the entire map area (Fig. 5; A). As the glacier thinned, it split into two lobes around the Turtle Mountains (Fig. 5; B); the ice remaining in the Turtle Mountains stagnated (Fig. 4; B). The Souris ice lobe flowed around the west side of the Turtle Mountains, forming some proglacial stream deposits to the north (Fig. 4; Ca) and molding topography to the south (Fig. 4; Cb). Glacial Lake Souris (Fig. 4; A) formed as meltwater ponded during the retreat of the Souris ice lobe. Sediment-laden water entered Lake Souris at the Souris River and deposited a coarse-grained delta (Fig. 4; Ac). Final drainage of Lake Souris occurred to the north (Fig. 4; Ae) into glacial Lake Hind in Manitoba (Fig. 6). During the Holocene Epoch, wind has reworked much of the sediment in Lake Souris (Fig. 4; Ad). Today, with the exception of occasional wind blowouts, sediment is reworked primarily by rivers (Fig. 4; Af, Cd).

The map of the surface geology is the result of an interpretation of the geology based on aerial photographs, field studies, and a compilation of previous work. The aerial photographs used were taken between 1951 and 1953 by the Army Map Service and printed at a scale of 1:63,400 (1 inch = 1 mile). Field studies were conducted during the summers of 1985, 1986, and 1987. Drilling data from about 600 holes, primarily from the North Dakota Geological Survey and the North Dakota State Water Commission, were used to assist this study.

This map has greatly benefited from many discussions with Ken Harris, who constructed the first map of the Atlas Series, and from a critical review by Lee Clayton. Review and comments by John Bluemle and Alan Kehew have also improved this map.

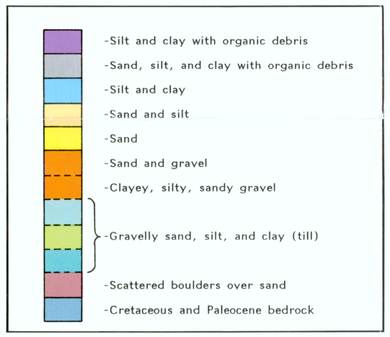


Figure 1. Sediment texture key.

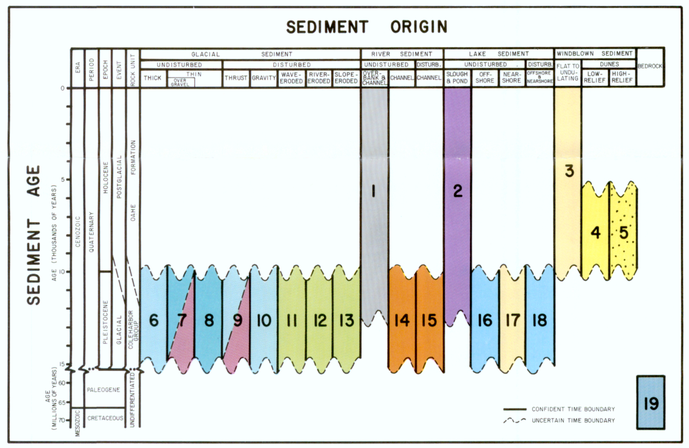


Figure 2. Correlation diagram relating sediment age, sediment origin, lithology, and map-unit number.

DESCRIPTION OF THE MAP UNITS

QUATERNARY

OAHE FORMATION

RIVER AND LAKE SEDIMENT

1 **OVERBANK SEDIMENT**: Clay, silt, sand, and disseminated organic debris; obscurely bedded; dark colored; commonly associated with sand and gravel of older, river-channel sediment. Where the sediment of this map unit occurs in alluvial fans, it commonly consists of poorly sorted to well sorted sand and gravel deposits.

2 **SLOUGH AND POND SEDIMENT**: Clay, silt, and disseminated organic debris; obscurely bedded; dark colored; generally less than 3 metres (10 feet) thick.

WINDBLOWN SEDIMENT

3 **FLAT TO UNDULATING**: Silt and sand, fine to medium grained; moderately to well sorted; obscurely bedded; surface commonly scoured and gradational to unit 4. Sediment is interpreted to be reworked sediment of unit 17.

4 **LOW-RELIEF DUNES**: Sand, fine to medium grained, well sorted; obscurely bedded; dunes are as high as 6 metres (20 feet) and generally stabilized by vegetation, but commonly have active blowouts.

HIGH-RELIEF DUNES: Same as unit 4, but dunes are commonly higher (up to 20 metres; 65 feet) and have the form of longitudinal dunes where indicated on the map by thin black lines.

COLEHARBOR GROUP

GLACIAL SEDIMENT

6 **GLACIAL SEDIMENT**: Gravelly sand, silt, and clay; unsorted, unbedded; contains some cobbles and boulders; as thick as 200 metres (600 feet) in multiple-advance deposits and as thick as 30 metres (100 feet) in single-advance deposits. The surface is flat to undulating except in the Turtle Mountains, where it is hilly.

7 **GLACIAL SEDIMENT, PALIMPSEST, OVER SAND AND GRAVEL**: Thin glacial sediment (1-57 m) consisting of unsorted, unbedded gravelly sand, silt, and clay draped over and only partially modifying the topography existing before the last glacial advance. The material underlying the thin glacial sediment is interpreted to be sand and gravel. In some areas, where this unit is shown in brown, the lithology is scattered boulders over sand. The origin of this lithology (brown) is interpreted to be similar to the gravelly sand, silt, and clay (green) except that the original deposit thickness was less and erosion during the Holocene has removed all but boulders from the thin till. Where the material underlying the boulder lag is composed of sand, blowouts are common.

8 **GLACIAL SEDIMENT, PALIMPSEST**: Same as unit 7, but lithology of underlying material is uncertain. Boundaries with this unit are commonly gradational with other glacial sediment map units.

9 **GLACIAL THRUST SEDIMENT**: Thin glacial sediment draped over slabs of older sediment that have been thrust by the glacier near its margin. The thrust sediment is highly variable in lithology (till, sand and gravel, bedrock), reflecting local geology. In some areas this unit is shown in brown, indicating as described for map-unit 7.

10 **GRAVITY-DISTURBED GLACIAL SEDIMENT**: Gravelly sand, silt, and clay; unbedded, unsorted. Topography is irregular with ridges that parallel the edge of the Turtle Mountains. Origin is uncertain, but is thought to result from mass movement, off the Turtle Mountains, facilitated by high rates of groundwater discharge in the area.

11 **WAVE-ERODED GLACIAL SEDIMENT**: Gravelly sand, silt, and clay; unsorted, unbedded. Surface was eroded by wave activity in glacial Lake Souris. Discontinuous patches of lake sediment are commonly present.

12 **RIVER-ERODED GLACIAL SEDIMENT**: Gravelly sand, silt, and clay; unsorted, unbedded. Surface has been eroded by rivers and in many places is dissected by small to large abandoned channels. In places, surface is veneered by a boulder lag or discontinuous patches of river or lake sediment.

13 **SLOPEWASHED GLACIAL SEDIMENT**: Gravelly sand, silt, and clay; unsorted, unbedded. Surface has been eroded by slopewash and other hillslope processes. Discontinuous outcrops of Cretaceous and Paleocene bedrock occur in this unit on the margins of the Turtle Mountains. Boundaries of this unit some places are gradational with sediment of alluvial fans.

RIVER SEDIMENT

14 **RIVER CHANNEL SEDIMENT**: Sand and gravel; well sorted to poorly sorted; crossbedded, planar bedded, or unbedded; up to 20 metres (65 feet) thick; deposited by glacial meltwater flowing directly from the glacier or by rivers flowing out of glacial lakes. In the vicinity of alluvial fans, boundaries are generally gradational and lithology is clayey, silty, sandy gravel.

15 **RIVER CHANNEL SEDIMENT, COLLAPSED**: Sand and gravel, well sorted to poorly sorted; faulted and contorted; hummocky topography; up to 20 metres (65 feet) thick; deposited by glacial meltwater on top of or within the glacier. The lithology is clayey, silty, sandy gravel where the river sediment is interbedded with mudflow deposits. This unit is commonly gradational with unit 14.

LAKE SEDIMENT

16 **OFFSHORE LAKE SEDIMENT**: Silt and clay; laminated; up to 10 metres (30 feet) thick. Deposited in calm-water (low-energy) areas of glacial Lake Souris.

17 **NEARSHORE LAKE SEDIMENT**: Sand and silt; planar bedded or crossbedded; well sorted; up to 30 metres (100 feet) thick. Deposited in moderate-energy areas of glacial Lake Souris, primarily by sediment-laden water carried into the lake by the Souris River. In many places, boundaries between unit 16 and 17 are uncertain, although not necessarily gradational.

18 **LAKE SEDIMENT, COLLAPSED OR ICE-WALLED**: Silt and clay, some sand; flat-bedded sediment at a higher elevation than surrounding glacial sediment or deformed sediment with a hummocky surface. The lakes in which these sediments were deposited were either surrounded by or underlain by ice.

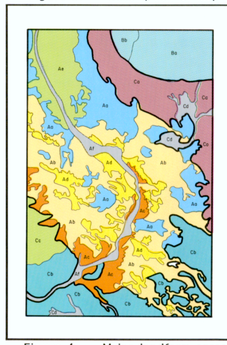
CRETACEOUS AND PALEOCENE

19 **FOX HILLS FM., HELL CREEK FM., FORT UNION GP.**: Clay, silt, sand, and lignite deposited in river, lake, or marine environments. Isolated exposures of bedrock occur on the margins of the Turtle Mountains and on river valley sides (not mappable at this scale) in the southern one-third of the map area. Bedrock units are not differentiated.

MAP SYMBOLS

- Confident map-unit boundary, judged to be within 0.4 km (0.25 mi) of the true boundary along most of its length.
- Approximate map-unit boundary, judged to be within 0.8 km (0.5 mi) from the true boundary along most of its length.
- Uncertain map-unit boundary, may be more than 0.8 km (0.5 mi) from true boundary; generally used with gradational units.
- High-relief, continuous scarp of abandoned river channel, scarps generally higher than 10 metres (30 feet).
- High-relief, discontinuous scarp of abandoned river channel; scarp disturbed by erosion or subsequent glacial advance.
- Low-relief, continuous scarp of abandoned river channel; scarps generally 3 to 10 metres (10 to 30 feet) in height.
- Low-relief, discontinuous scarp of abandoned river channel.
- Shallow, Pleistocene channel scar; identified from aerial photographs.
- Probable glacial-lake shoreline position; tick marks point lakeward. Small sediment accumulations are present at some shoreline positions.
- Lineation; in glacial sediment lines are a stylized selection of washboard ridges; in sand dunes lines mark crests of longitudinal dunes.
- Esker.
- Crest of glacial thrust ridges; sawteeth point to the direction the glacier advanced from.
- Drumlin.
- Alluvial Fan: An accumulation of stream, slopewash, and mudflow sediments in the shape of a segment of a cone, deposited where streams leaving high-relief areas enter plains.
- Mark at corner of townships to aid the user in land locations.

Figure 3. Description of map units and line symbols.



LEGEND

A. GLACIAL LAKE SOURIS

a. Offshore sediments and landforms (flat to gently undulating; silt and clay).
b. Nearshore sediments and landforms; commonly wind scoured (flat to undulating; sand and silt).
c. Delta stream sediments and landforms (gently undulating surfaces with channel scars; sand and gravel).
d. Windblown sediments; dunes (undulating to hilly; sand).
e. River-eroded plain (channel scars; scattered boulder lag over till).
f. Recent stream sediment in abandoned river channel (flat-bottomed valley; clay to sand with organics).

B. TURTLE MOUNTAINS

a. Glacier-thrust landforms and sediments (hilly; glacial sediment and bedrock).
b. High-relief, collapsed supraglacial sediment and landforms (perched lake plains, hilly; lake and glacial sediment).

C. GLACIATED PLAINS

a. Proglacial stream sediments and landforms, and till plains (collapsed and non-collapsed meltwater channels and deposits; sand and gravel; gravelly sand, silt, and clay).
b. Glacially molded sediments and landforms (drumlins, washboard ridges, thrust blocks; thin glacial sediment).
c. Stream-dissected till plain (gently undulating plains with anastomosing stream valleys; gravelly sand, silt, and clay; boulder lag).

Figure 4. Major landform areas (uppercase letters) with typical landforms and sediments (lowercase letters).

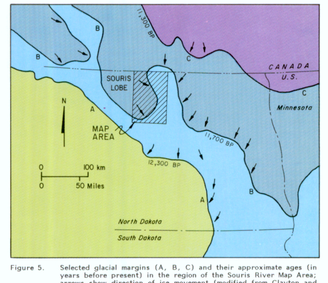


Figure 5. Selected glacial margins (A, B, C) and their approximate ages (in years before present) in the region of the Souris River Map Area; arrows show direction of ice movement (modified from Clayton and Moran, 1982).

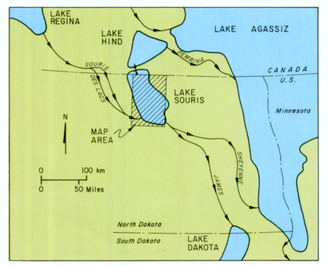


Figure 6. Major glacial lakes and glacial-lake spillways in the region of the Souris River Map Area.

GENERAL REPORTS ON THE SURFICIAL GEOLOGY OF THE MAP AREA

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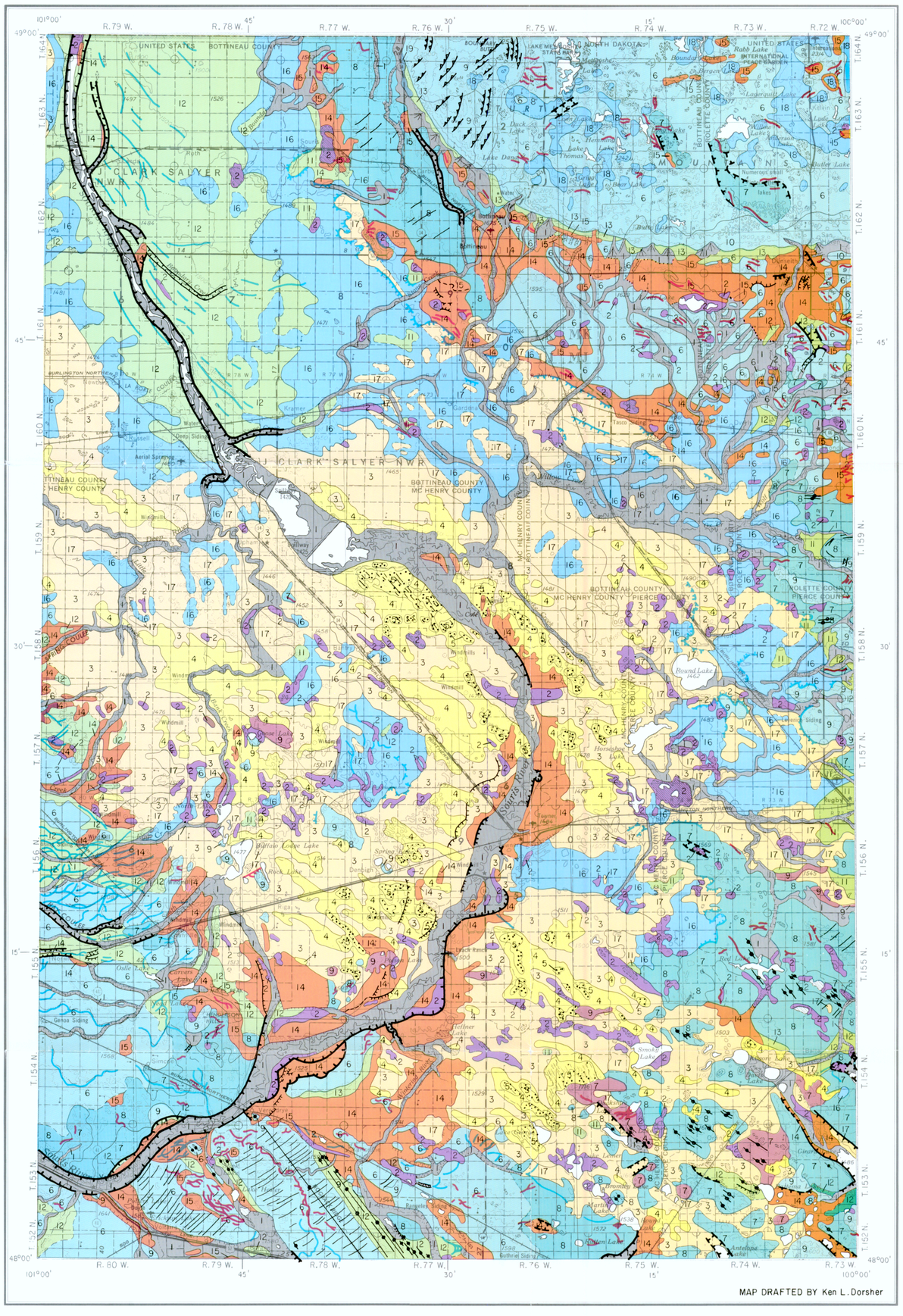
Patterson, D. D., and others, 1968, Soil survey report, county general soils maps, North Dakota: North Dakota State University, Agricultural Experiment Station Bulletin 473, 150 p., 53 county soil maps.



5 0 5 10 MILES
5 0 5 10 KILOMETERS

MAP SCALE 1:250,000

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50-FOOT INTERVALS

LEGEND

POPULATED PLACES
25,000 to 100,000 — FARGO
5,000 to 25,000 — Jamestown
1,000 to 5,000 — Rugby
Less than 1,000 — Towner

RAILROADS (Single track or Double or Multiple)
Standard gauge
BOUNDARIES
International
State
County
Park or reservation
Landplane airport
Landing area

ROADS
Primary, all-weather, hard surface
Secondary, all-weather, hard surface
Light-duty, all-weather, hard or improved
Fair or dry weather, unimproved
Trail
Interchange
Route markers: Interstate, U.S., State
Landmark: School, Church, Other
Mine
Spot elevation in feet
Marsh or swamp
Intermittent or dry stream
Power line

BASE MAP SUPPLIED BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225

13°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1987

SECTIONIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

NORTH DAKOTA

ATLAS SERIES MAP AREAS