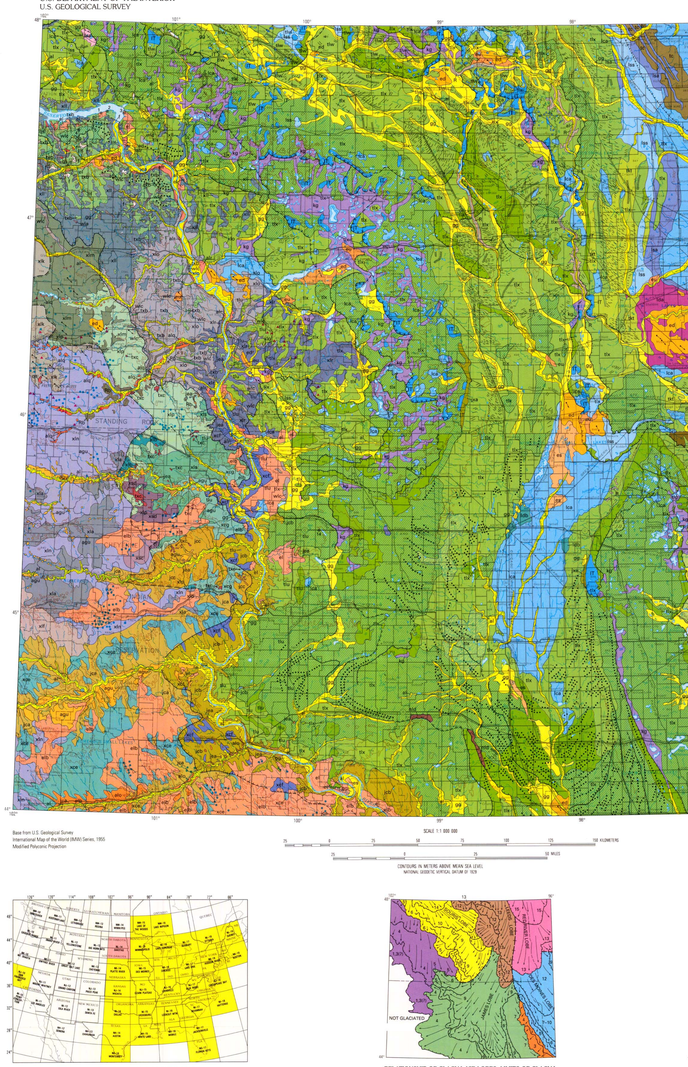
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE NORTH DAKOTA GEOLOGICAL SURVEY,
THE SOUTH DAKOTA GEOLOGICAL SURVEY, AND
THE MINNESOTA GEOLOGICAL SURVEY

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
DAKOTAS 4° × 6° QUADRANGLE
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–I–220 (NL-14)
Pamphlet accompanies map



Base from U.S. Geological Survey
International Map of the World (IMW) Series, 1955
Modified Polyconic Projection

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LIST OF MAP UNITS

HOLOCENE

jsb	SLUMP-BLOCK, EARTHFLOW, AND MUDFLOW LANDSLIDE DEPOSITS

HOLOCENE AND LATE WISCONSIN

al	ALLUVIUM
wlc	LOAMY OR CLAYEY SHEETWASH ALLUVIUM
wlc	LOAMY OR CLAYEY SHEETWASH ALLUVIUM AND LAKE DEPOSITS
lca	LAKE SILT AND CLAY
lsa	LAKE SILT AND SAND
lsa	LAKE SAND AND GRAVEL
lga	LAKE GRAVEL
ed	DUNE SAND
es	EOLIAN SHEET SAND
el	EOLIAN SILT (LOESS)
eu	EOLIAN SAND AND SILT
jsa	LANDSLIDE DEPOSITS, CLAYEY DISINTEGRATION RESIDUUM, AND SHEETWASH ALLUVIUM
jcb	LANDSLIDE DEPOSITS, CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
jsa	LANDSLIDE DEPOSITS, BOULDERY COLLUVIUM, AND SHEETWASH ALLUVIUM
wcw	CLAYEY DISINTEGRATION RESIDUUM AND SHEETWASH ALLUVIUM
wcf	CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wfc	LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND COLLUVIUM
wsc	LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wsw	SANDY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND COLLUVIUM
wsc	SANDY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS

HOLOCENE AND EARLY MIDDLE PLEISTOCENE(?)

aif	ALLUVIAL FILL DEPOSIT
efb	EOLIAN SILT (LOESS)
jcc	LANDSLIDE DEPOSITS, CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wcg	CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wlp	LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wls	LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS
wsc	SANDY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS

HOLOCENE TO PLIOCENE(?)

ss	BAKED AND FUSED BEDROCK (CLINKER)

LATE WISCONSIN

lc	CLAYEY TILL (Valderan and Hiatt Formations)
lwf	LOAMY TILL
lwf	Ground moraine
lwf	End moraine
lwf	Stagnation moraine
lcl	COLLAPSED TILL AND LAKE DEPOSITS
lsw	LOAMY TILL
lsw	End moraine
lsg	LOAMY TILL
lsg	End moraine
lsg	Stagnation moraine
tlx	LOAMY TILL
tlx	Ground moraine
tlx	Washboard moraine
tlx	End moraine
tlx	Stagnation moraine
tlx	LOAMY TILL (Tazewell Till)
tlw	LOAMY TILL
tlw	Ground moraine
tlw	End moraine
tlw	Stagnation moraine
txb	CLAYEY TO SANDY TILL
txb	Ground moraine
txb	End moraine
txb	Stagnation moraine
lcc	ICE-CONTACT SAND AND GRAVEL
qs	OUTWASH SAND
qg	OUTWASH SAND AND GRAVEL
lds	LAKE DENSITY-CURRENT UNDERFLOW FAN DEPOSIT
ldb	LAKE DELTA DEPOSIT
sl	SLACKWATER LAKE DEPOSITS AND OUTWASH SAND AND GRAVEL
lsl	LOAMY SOLIFLUCTION DEPOSIT

LATE WISCONSIN TO PLIOCENE(?)

aig	ALLUVIAL GRAVEL, SAND, AND SILT
afg	ALLUVIAL GRAVEL, SAND, AND SILT
agu	ALLUVIAL GRAVEL, SILT, AND CLAY
aig	ALLUVIAL SAND AND GRAVEL

ILLINOIAN

sil	LOAMY TILL (Tiskilwa? Till)

ILLINOIAN AND PRE-ILLINOIAN(?)

Rbc	DISCONTINUOUS CLAYEY TO SANDY TILL, GLACIOFLUVIAL DEPOSITS, AND ERRATIC BOULDER CONCENTRATIONS

PRE-PLICENE

Rb	DISSECTED BEDROCK (BADLANDS)
R	BEDROCK

DESCRIPTION OF MAP UNITS

[Map unit thicknesses ranges are typical ranges; in some areas units may be thinner than given range]

HOLOCENE

jsb SLUMP-BLOCK, EARTHFLOW, AND MUDFLOW LANDSLIDE DEPOSITS—Products of gravitational downslope movement of material.

Slump-block deposits—Masses of bedrock and unconsolidated materials that have rotated or slid downslope as a unit, with little or no flow; physical properties of the materials are variable, depending on the nature of the parent material, stratification, bedding, and sedimentary structures of displaced materials are retained. Slump-block scarps in places more than 400 m in length; crown scarp displacements generally less than 9 m; slump-block surfaces hummocky; separated by long closed depressions. Some deposits stabilized and grass covered, but others have been recently active, as evidenced by fresh scarps and sparse shrub growth. Thickness generally 10 to 30 m, locally 55 m.

Earthflow deposits—Heterogeneous mixtures of clay, silt, and sand with scattered clasts; commonly saturated and flow when wet; most flow was of dry, fine-textured clasts; transported and deposited in lobes; 9 m in length or less; not necessarily saturated, distinguished from other surficial materials. In some areas, flow lobes are superimposed on slump-block deposits; in other areas, chiefly resorbed (*l*), eroded (*e*), or buried (*b*) by younger deposits; in other areas, stabilized and grass covered. Most deposits are less than 30 m wide and less than 45 m long. Commonly in fans at mouths of gullies or on foot slopes. Thickness 1–5 m, locally more than 10 m.

Mudflow deposits—Heterogeneous mixtures of clay and silt with scattered clasts, transported and deposited as a result of rapid flow of saturated unconsolidated materials down steep slopes. Most deposits are crescentic in plan view; from exposed slide surfaces, deposits are lobate; from other sources, of gully form. Commonly in fans at mouths of gullies or on foot slopes. Thickness 1–5 m.

HOLOCENE AND LATE WISCONSIN

al ALLUVIUM—Stratified brown, yellowish-brown, brownish-yellow, brownish-gray, gray, black, or mottled clay, silt, sand, and gravel. Calcareous; partly or completely leached. Commonly in stratigraphic sequence with lacustrine sediments of other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial fan deposits and alluvium. Includes alluvial-fan deposits, alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wlc LOAMY OR CLAYEY SHEETWASH ALLUVIUM—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel. Commonly in stratigraphic sequence with lacustrine sediments of other surficial materials and bedrock. Includes alluvial-fan deposits, alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wlc LOAMY OR CLAYEY SHEETWASH ALLUVIUM AND LAKE DEPOSITS—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel; in places, mixed, interlayered, or interbedded with eolian sand and silt (*es*, *el*) or alluvium (*al*). Clayey alluvium, soil, and colluvium (*jsa*) in stratigraphic sequence with lacustrine sediments of other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lca LAKE SILT AND CLAY—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, and sand. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lsa LAKE SAND AND GRAVEL—Stratified brown, yellowish-brown, brownish-gray, gray, black, or mottled clay, silt, sand, and gravel. Calcareous; partly or completely leached. Commonly in stratigraphic sequence with lacustrine sediments of other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lga LAKE GRAVEL—Stratified brown, yellowish-brown, brownish-gray, or gray clay, silt, sand, and gravel. Calcareous; partly or completely leached. Commonly in stratigraphic sequence with lacustrine sediments of other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

ed DUNE SAND—Brown, yellowish-brown, or gray fine- to medium-grained sand; commonly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

es EOLIAN SHEET SAND—Brown, yellowish-brown, or gray fine- to medium-grained sand; commonly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

el EOLIAN SILT (LOESS)—Brown, yellowish-brown, or gray silt; commonly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

eu EOLIAN SAND AND SILT—Brown, yellowish-brown, or gray fine- to medium-grained sand and silt; commonly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

jsa LANDSLIDE DEPOSITS, CLAYEY DISINTEGRATION RESIDUUM, AND SHEETWASH ALLUVIUM—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

jcb LANDSLIDE DEPOSITS, CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

jsa LANDSLIDE DEPOSITS, BOULDERY COLLUVIUM, AND SHEETWASH ALLUVIUM—Complex map unit on steep slopes and foot slopes. Mapped over North Dakota glacial margin. Thickness generally more than 23 m.

wcw CLAYEY DISINTEGRATION RESIDUUM AND SHEETWASH ALLUVIUM—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wcf CLAYEY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS—Clayey, poorly to well-sorted silty clay, sandy clay, clayey silt, silt, sandy silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wfc LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND COLLUVIUM—Yellowish-orange, pale-yellow, yellowish-brown, grayish-yellow, olive-gray, brownish-gray, gray, or mottled calcareous loam, silt loam, sandy clay loam, and sandy loam; locally very sandy or gravelly. Commonly interbedded with or contains discontinuous lenses of clay, silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wsc LOAMY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS—Complex unit similar to unit *wfc*, distinguished from it by the presence of discontinuous lenses of pebbles, cobbles, and boulders derived from glacial deposits. Mapped over North Dakota glacial margin. Thickness generally more than 23 m.

wsw SANDY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND COLLUVIUM—Yellowish-orange, pale-yellow, yellowish-brown, grayish-yellow, olive-gray, brownish-gray, gray, or mottled calcareous sand, loamy sand, and sandy loam; locally very gravelly. Commonly interbedded with or contains discontinuous lenses of clay, silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

wsc SANDY DISINTEGRATION RESIDUUM, SHEETWASH ALLUVIUM, AND GLACIAL DEPOSITS—Complex unit similar to unit *wsw*, distinguished from it by the presence of discontinuous lenses of pebbles, cobbles, and boulders derived from glacial deposits. Mapped over North Dakota glacial margin. Thickness generally more than 23 m.

ss BAKED AND FUSED BEDROCK (CLINKER)—Brick-red, yellowish-red, purple, or black, vitreous, slaglike, or cindery baked and fused clay, silt, sand, and gravel. Formed by burning of lignite beds. Brick-red to dark-red, salmon-pink, yellowish-red, purple, or black, vitreous, slaglike, or cindery baked and fused clay, silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Included in other map units in areas too small to be shown at scale of map. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness 0.3–4 m, locally more than 8 m.

lc CLAYEY TILL (Valderan and Hiatt Formations) in Minnesota and North Dakota—Olive-brown, grayish-brown, olive-gray, gray, or mottled calcareous clay, silty clay, clay loam, silt loam, and sandy clay loam. Commonly in stratigraphic sequence (*lsw*) in the two stratigraphic sequences. Contained beds of till common locally, particularly in upper part; in places contains chalky inclusions or inclusions of oxidized clay till. Very local deposits of sand and fine gravel. Stratigraphically lowest in Minnesota, the informal Nassau drift was referred to the early Wisconsin; in Minnesota, the informal Nashua drift was referred to the early Wisconsin or pre-Wisconsin; in Minnesota, the informal Dunn drift was referred to the pre-Wisconsin in age. The drifts of the three hypothetical glaciations were not distinguished on the map because of insufficient stratigraphic criteria. The Vermillion and Dunn drifts were distinguished solely on the basis of the relative abundance of surficial boulders. Thickness 2–70 m, locally 115 m.

lwf LOAMY TILL—Brown, olive-brown, olive-gray, or mottled calcareous clay loam, silty clay loam, and sandy clay loam; locally sandy loam or clay. Textures finer than those of other tills in this quadrangle that are classed as loamy tills. The letter symbol, indicative of clayey till in the adjacent Minneapolis-Saint Paul quadrangle, is *lc*. Till of the Des Moines Lobe, Valderan and Hiatt Formations in the two quadrangles. Commonly in stratigraphic sequence (*lsw*) with other surficial deposits. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness 2–50 m, locally 115 m.

lwf Ground moraine—Broad ridges, typically with hummocky topography and deep ice-contact deposits. Thickness 2–50 m, locally more than 100 m.

lwf End moraine—Broad ridges, typically with hummocky topography and closed depressions. Thickness 2–50 m, locally more than 100 m.

lwf Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–50 m, locally more than 100 m.

lcl COLLAPSED TILL AND LAKE DEPOSITS—Complex unit of till, lake clay, and lake silt and sand. Till, typically loamy, in upper part; underlying lake deposits, typically clayey, in lower part. Thickness 2–50 m, locally more than 100 m.

lsw LOAMY TILL—Pale-yellow, grayish-yellow, yellowish-brown, reddish-brown, brown, olive-brown, yellowish-gray, brownish-gray, olive-gray, gray, or mottled calcareous loam, silt loam, sandy clay loam, and sandy loam; locally very sandy or gravelly. Commonly interbedded with or contains discontinuous lenses of clay, silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lsw End moraine—Broad hummocky ridges or narrow sharply defined ridges, commonly with undrained depressions and lag cobbles and boulders on surface. Thickness 2–30 m, locally 50 m.

lsg Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–30 m, locally more than 50 m.

lcl COLLAPSED TILL AND LAKE DEPOSITS—Complex unit of till, lake clay, and lake silt and sand. Till, typically loamy, in upper part; underlying lake deposits, typically clayey, in lower part. Thickness 2–30 m, locally more than 50 m.

lsw LOAMY TILL—Yellowish-orange, grayish-orange, pale-orange, pale-yellow, grayish-yellow, olive-gray, brownish-gray, gray, or mottled calcareous loam, silt loam, sandy clay loam, and sandy loam; locally very sandy or gravelly. Commonly interbedded with or contains discontinuous lenses of clay, silt, sand, and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lsg End moraine—Broad ridges, typically with hummocky topography and closed depressions. Thickness 2–30 m, locally more than 50 m.

lsg Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–30 m, locally more than 50 m.

tlx OUTWASH SAND—Pale-yellow, brownish-yellow, yellowish-brown, brownish-gray, olive-gray, or mottled calcareous sand and gravel; in places, partly or wholly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

tlx Washboard moraine—Broad ridges, typically with hummocky topography and deep ice-contact deposits. Thickness 2–30 m, locally more than 50 m.

tlx End moraine—Broad ridges, typically with hummocky topography and closed depressions. Thickness 2–30 m, locally more than 50 m.

tlx Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–30 m, locally more than 50 m.

tlx LOAMY TILL (Tazewell Till)—Brown, olive-brown, olive-gray, brownish-gray, or mottled calcareous loam, silt loam, sandy clay loam, and sandy loam; locally very sandy or gravelly. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

tlw LOAMY TILL—Olive-brown, olive-gray, brownish-gray, or gray clay, silty clay, clay loam, silt loam, loam, sandy loam, or loamy sand. Generally weakly calcareous or strongly calcareous. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

tlw End moraine—Broad hummocky ridges, commonly with undrained depressions and lag cobbles and boulders on surface. Thickness 2–30 m, locally more than 50 m.

tlw Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–30 m, locally more than 50 m.

txb CLAYEY TO SANDY TILL—Yellowish-orange, pale-orange, pale-yellow, grayish-yellow, olive-gray, brownish-gray, gray, or mottled calcareous clay, silty clay, clay loam, silt loam, sandy clay loam, and sandy loam; locally very sandy or gravelly. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

txb End moraine—Broad hummocky ridges or narrow sharply defined ridges, commonly with undrained depressions and lag cobbles and boulders on surface. Thickness 2–30 m, locally more than 50 m.

txb Stagnation moraine—Broad areas of hummocky collapsed topography lacking well-developed ridges. Thickness 2–30 m, locally more than 50 m.

lcc ICE-CONTACT SAND AND GRAVEL—Pale-yellow, brownish-yellow, grayish-yellow, olive-gray, brownish-gray, gray, or mottled calcareous sand and gravel; in places, partly or wholly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

qs OUTWASH SAND—Pale-yellow, brownish-yellow, yellowish-brown, brownish-gray, olive-gray, or mottled calcareous sand; in places, partly or wholly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

qg OUTWASH SAND AND GRAVEL—Pale-yellow, brownish-yellow, yellowish-brown, brownish-gray, olive-gray, or mottled calcareous sand and gravel; in places, partly or wholly leached. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

lds LAKE DENSITY-CURRENT UNDERFLOW FAN DEPOSIT—Pale-yellow, brownish-yellow, yellowish-gray, olive-gray, or mottled calcareous sand and gravel. Commonly in stratigraphic sequence with other surficial materials and bedrock. Includes alluvial-fan deposits; alluvium, or low terrace deposits; alluvial-fill deposits (*aif*); slackwater lake deposits and outwash sand and gravel (*lsl*); organic clays (*aig*); and colluvium (*jsa*). Mapped over North Dakota glacial margin, remnants of outwash and ice-contact sand and gravel (*gs*, *gg*, *kg*) are included with alluvium (*al*). Mapped over Lake Agassiz, alluvial silt and clay (*agu*), alluvium (*al*), or clay (*aig*) are included with alluvium (*al*). Thickness generally more than 23 m.

ldb LAKE DELTA DEPOSIT—Pale-yellow, grayish-yellow, yellowish-brown, brownish-gray, olive-gray, or mottled calcareous sand, silt, and clay. Well stratified; generally well sorted. Sand and some gravel along proximal margin; silt and