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SURFICIAL GEOLOGIC MAP OF THE GREATER OMAHA AREA, NEBRASKA AND IOWA

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Miscellaneous Field Studies
Map MF-2391

INTRODUCTION

The map covers a 513 square-mile area in eastern Nebraska and western Iowa from 41 degrees to 41 degrees, 22 minutes, 30 seconds north latitude and from 95 degrees, 52 minutes, 30 seconds to 96 degrees, 15 minutes west latitude. Three interstate highways and several state and federal highways serve Omaha, Council Bluffs, and other cities and towns in the map area.

The map area consists chiefly of silt (loess)-mantled uplands that flank alluvial valleys of the Missouri River, Platte River, and their major tributaries. Silt (loess) deposits, 50 to greater than 100 feet thick, commonly overlie glacial deposits in upland areas. Stream alluvium, 25-110 feet thick, underlies flood plains along the Missouri River, Platte River, and their major tributaries. Bedrock is locally exposed in quarries, road cuts, and small natural exposures in the Platte River valley.

The map shows the distribution of deposits of artificial fill, flood-plain and stream alluvium, sheetwash alluvium, wind-deposited silt (loess deposited during the last two glaciations), ice-deposited clayey material (till), as well as bedrock of the Dakota Formation and Lansing and Kansas City Groups, undivided. Areas were the younger wind-deposited silt (Peoria Loess) overlies terrace deposits are shown on the map with a pattern. Small exposures of older wind-deposited silt (Loveland Loess), till, and bedrock are shown on the map with symbols.

DESCRIPTION OF MAP UNITS

[Surficial deposits are mapped where they are estimated to be at least 1 m thick. Most of the surficial deposits are poorly exposed. The surficial deposits were locally observed in foundation excavations, road cuts, and other exposures in 1995 and 1996. Thin, discontinuous sheetwash alluvium (Qsw) and small artificial-fill deposits (af) were not mapped. Small outcrops of Loveland Loess, till, and bedrock (Dakota Formation and limestone outcrops of the Lansing and Kansas City Groups) that are too small to map are shown as geometric symbols. Mapping in and near Omaha is modified from that of Miller (1964, plates 2 and 3 at 1:24,000 scale). Mapping in the rest of the map area is based primarily on interpretation of 1:15,840- and 1:20,000-scale county soil maps (Bartlett, 1975; Borchers and others, 1984; Branham, 1989; Nixon, 1982) and interpretation of aerial photography, supplemented by examination of artificial and natural exposures. The aerial photography includes: 1:40,000-scale, black-and-white, aerial photographs taken in April and May1990 and in March and April 1993, and also 1:60,000-scale, color infrared, aerial photographs taken in May 1981 and April 1982. Age assignments for surficial deposits are based in part on soil development. Soil-horizon designations and textural terms, such as silt loam and clay loam, are those of the Soil Survey Staff (1975). Grain-size ranges given for surficial deposits are estimates that are based on the modified Wentworth scale (American Geological Institute, 1982). Dry matrix colors of the surficial deposits were determined by comparison with Munsell Soil Color Charts (Munsell Color, 1973). In general, colors of the surficial deposits are similar to those of the bedrock and other materials from which the deposits were derived. Unweathered to slightly weathered surficial deposits observed in the map area commonly range from gray (5Y 6/1) to very pale brown (10YR 8/4). In this report, the terms "alluvium" and "alluvial" refer to surficial material transported by running water confined to channels (stream alluvium) as well as material transported by running water not confined to channels (sheetwash alluvium). The term "colluvial" here refers to surficial material transported down slopes chiefly by mass-movement (gravity-driven) processes, such as creep. All of the radiocarbon and thermoluminescence ages in this report are uncalibrated. The thickness and grain-size ranges of surficial map units are based chiefly on interpretation of approximately 300 unpublished drill-hole logs and approximately 30 water-well logs on file with the Conservation and Survey Division, University of Nebraska-Lincoln, and test-hole data summarized by Burchett (1965) and Burchett and Smith (1989a, 1989b). Metric units are used in this report. A conversion table is provided for those more familiar with English units (table 1). A table containing the divisions of geologic time used in this report is also provided (table 2).]

SURFICIAL DEPOSITS

ARTIFICIAL-FILL DEPOSITS

Material composed chiefly of clay, silt, sand, gravel, and rock fragments emplaced in compacted engineered fills and uncompacted dump fills

af **Artificial-fill deposits (latest Holocene)—**Compacted and uncompacted fill material composed mainly of clay, silt, sand, gravel, and rock fragments. Mapped chiefly (1) beneath commercial structures, segments of interstate highways and other major highways, railroad tracks, airport runways, and military facilities, and (2) in landfills and earth dams and in mine dumps and storage piles. Landfills contain varying amounts of organic and inorganic trash. The distribution and configurations of landfills and other artificial-fill deposits are based on interpretation of aerial photography taken in April 1993. The configurations of some of the landfills may have changed subsequently, due to continued filling. Most of the mapped deposits were emplaced by large earth-moving equipment and probably are younger than 55 years. The thickness of artificial fill locally is 25 m in railroad embankments, and possibly more than 25 m in some landfills

ALLUVIAL DEPOSITS

Clay, silt, sand, and gravel beneath flood plains and in stream terraces, and clay, silt, and sand on hill slopes

Qal **Flood-plain and stream-channel alluvium (Holocene to Illinoian?)—** Alluvial deposits adjacent to the Missouri River and its major tributaries. Unit Qal commonly is coarser grained and more dense with increasing depth. In the Missouri River valley, unit Qal commonly consists of fine sand to silty clay in the upper 3-6 m, silty fine sand to coarse sand and minor beds of clayey silt and gravel in the underlying 5-22 m, and, locally, coarse sand and gravel in the basal 2-10 m. Sandbar deposits are common adjacent to the Missouri River (Hallberg and others, 1979), and deposits of organic silt and clay locally are present in low-lying, slack water areas (Miller, 1964). In the Platte River valley, unit Qal commonly consists of fine sand to clayey silt in the upper 1-2 m and medium to coarse sand and gravel in the lower 9-24 m. In the valleys of Papillion and Big Papillion Creeks and their major tributaries, unit Qal commonly consists of dark-brown to black clayey silt in the upper 1-5 m, light brown, gray, and greenish and bluish clayey silt in the underlying 9-19 m, and silty, fine to coarse sand or sand and gravel in the basal 0.3-3 m. Clasts are angular to well rounded; they reflect the composition of the bedrock and older coarse-grained surficial deposits in the respective drainage basins. The deposits are poorly to well sorted and poorly to well stratified. Unit Qal along minor streams tributary to the Platte River and the Missouri River north of Omaha is similar in composition to alluvium along Papillion and Big Papillion Creeks and their major tributaries. Much of the alluvium in the upper one to several or more meters in the valleys of the Missouri River (3-6 m or more), Platte River (1-2 m or more), and Papillion and Big Papillion Creeks and their major tributaries (1-5 m or more) probably is Holocene in age. Some of the underlying alluvium probably is Wisconsin in age, and some of it may be pre-Wisconsin in age. Unit Qal is equivalent in part to Miller's (1964) flood-plain alluvium (Qal) near Omaha, and in part to the DeForest Formation of Bettis (1990) in western Iowa. The Platte River valley contains significant deposits of coarse sand and gravel that have been excavated mainly for concrete aggregate near the communities of Louisville, Cedar Creek, and La Platte, Nebraska. Deposits of coarse sand and gravel have not been exploited in the Missouri River valley or in the valleys of Papillion and Big Papillion Creeks and their major tributaries because those deposits are relatively thin, deeply buried, and locally silty or contain lignite. Unit Qal generally is 8-34 m, 10-26 m, and 12-25 m thick in the valleys of the Missouri River, Platte River, and Papillion and Big Papillion Creeks and their major tributaries, respectively

Qsw **Sheetwash alluvium (Holocene)—**Chiefly massive and locally stratified clay, silt, and fine sand derived primarily from Peoria Loess (Qlp). Unit Qsw was deposited on terraces and flood plains adjacent to loess-mantled slopes. Surface soils commonly have cumulic A horizons. The sediments were deposited chiefly by unconfined overland flow; however, some of the sediments were deposited in part by gravity-driven, colluvial slope processes (chiefly creep). Unit Qsw locally includes small deposits of unmapped stream alluvium (see unit Qss), and locally it may include small areas of Peoria Loess (Qlp). Low-lying areas of the map unit may be prone to periodic sheet floods and (or) stream floods. Unit Qsw is equivalent in part to Miller's (1964) slope-wash deposits (Qsw) in and near Omaha, and in part to the DeForest Formation of Bettis (1990) in western Iowa. The estimated thickness of unit Qsw is 1-5 m

Qss **Sheetwash alluvium and stream alluvium, undivided (Holocene)—**A complex map unit that consists of units Qal and Qsw. Alluvial deposits in low terraces and beneath flood plains commonly consist of clayey silt and thin (0.5-5 cm) lenses of fine sand that locally overlie basal silty fine to coarse sand or sand and pebble gravel. The upper part commonly is dark gray to black. Unit Qss locally forms low, gently sloping fans and aprons on the flood plains of Missouri River and its major tributaries. Unit Qss is equivalent in part to Miller's (1964) terrace alluvium (Qt), slope-wash deposits (Qsw), and alluvial-fan deposits (Qaf) in and near Omaha, and in part to the DeForest Formation of Bettis (1990) in western Iowa. The thickness of unit Qss generally is 1-25 m

EOLIAN DEPOSITS

Wind-deposited fine sand, silt, and clay in sheets that mantle inter-stream areas and late Wisconsin terrace alluvium

Qlp **Peoria Loess (late Pleistocene, late Wisconsin)—**Massive, calcareous or non-calcareous, pale-yellow to light-yellowish-brown, wind-deposited clayey silt (silt loam). Peoria Loess locally stands nearly vertically in road cuts and stream cuts, and locally it has columnar joints. The grain-size distribution for 14 samples of Peoria Loess in and near Omaha average 7 percent sand (0.063-2 mm), 74 percent silt (0.004-0.063 mm) and 19 percent clay (<0.004 mm) (Miller, 1964). Peoria Loess mantles extensive areas of older loess and pre-Illinoian till (Qti) on valley sides and uplands, and it mantles late Wisconsin terrace alluvium in and near Omaha, Bellevue, and Springfield, Nebraska (Miller, 1964). In western Iowa, the lower part of the Peoria Loess is leached of carbonate minerals (Ruhe, 1969, 1983; Muhs and Bettis, 2000). Locally in eastern Nebraska and western Iowa, the lower part of the Peoria Loess has structures that may have been produced by solifluction, indicating the possible former presence of permafrost (Bettis, 1994; Mandel and Bettis, 1995).

The Peoria Loess overlies thin (generally 1-1.5 m) loess of the Gilman Canyon Formation in Nebraska (Reed and Dreeszen, 1965) and it overlies stratigraphically equivalent loess of the Pisgah unit in Iowa (Bettis, 1990). The Gilman Canyon soil (Reed and Dreeszen, 1965) or the Farmdale soil (Bettis, 1990; Forman, 1990), developed in loess, is overlain by Peoria Loess. The paleosol has granular or fine blocky structure and a lower value and slightly redder hue than the overlying Peoria Loess. The paleosol and the loess of the Gilman Canyon Formation or the Pisgah unit are exposed only in section and not at the surface in the greater Omaha area. It is unlikely that the Peoria Loess is overlain by the Bignell Loess (of Schultz and Stout, 1945), as was suggested by Miller (1964). The Bignell Loess is thin (generally less than 2 m) and discontinuous in the Great Plains, and it has not been identified in the Missouri River valley (Maat and Johnson, 1996). Reddish-brown bands in the upper part of unit Qlp, reported by Miller (1964), are unlikely to be equivalent in age to the Brady soil (of Schultz and Stout, 1945). Although these bands have not been dated, similar bands in the Peoria Loess in southwestern Iowa are too old to be Brady soil equivalents (Ruhe and others, 1971). The Brady soil formed approximately 10,500 to 9,000 radiocarbon years ago in the upper part of the Peoria Loess, prior to burial by the Bignell Loess (Johnson and May, 1992).

Some or much of the Peoria Loess probably was deposited by westerly or northwesterly paleowinds (Muhs and Bettis, 1998, 2000). The main sources of the Peoria Loess in the map area are the flood plains of the Missouri, Platte, and Elkhorn Rivers (Miller, 1964). Data from drill holes suggest that the flood plain of the Missouri River contributed more sediment that either the flood plain of the Platte River or the nearby flood plain of the Elkhorn River (west of the map area). Other sources of Peoria Loess probably include silt derived from eroded White River Group sediments west of the map area (Aleinikoff and others, 1998). Peoria Loess is prone to slumping on steep slopes, and disturbed and sparsely vegetated areas are prone to gullying and sheet erosion. The thick, dark deposits of clayey silt beneath flood plains adjacent to Papillion and Big Papillion Creeks (Qal) and beneath flood plains and in terraces along their tributaries (Qal and Qss) may have been derived in part from soil eroded from Peoria Loess surfaces. In the Platte River valley, unit Qlp locally includes small mass-movement deposits that are too small to map separately. Unit Qlp is equivalent to Miller’s (1964) Bignell and Peorian Loesses (Qbp) in and near Omaha.

Radiocarbon ages and thermoluminescence age estimates indicate that loess deposition and paleosol development were diachronous on a regional scale. Deposition of loess of the subsurface Gilman Canyon Formation in southern Nebraska and northern Kansas probably began in some areas earlier than 40,000 yr B.P. (Maat and Johnson, 1996). Deposition of loess of the laterally equivalent Pisgah unit in Iowa (Omaha area) began earlier that 35,000 yr B.P. (Forman, 1990; Oches and others, 1990). Deposition of Peoria Loess on the Gilman Canyon soil or Farmdale soil in central Nebraska began approximately 24,000 yr B.P. and ended approximately 11,000 yr B.P. (Pye and others, 1995; Maat and Johnson, 1996). Deposition in western and central Iowa began between 27,000 and 24,000 yr B.P. (Forman and others, 1992) and ended locally later than 14,000 yr B.P. (Ruhe, 1969). Deposition of Peoria Loess in southern Nebraska and northern Kansas began approximately 20,000 yr B.P. and ended approximately 10,500 yr B.P. (Maat and Johnson, 1996). Deposition in the Omaha area began approximately 25,000-24,000 yr B.P. and ended approximately 12,000 yr B.P. (Forman, 1990; Oches and others, 1990).

Unit Qlp at upland sites north of the Platte River is thickest in bluffs adjacent to the flood plain of the Missouri River (generally 17-29 m). It is slightly thinner on adjacent late Wisconsin terrace alluvium, west of Carter Lake, in Omaha (generally 12-17 m), and generally is 7-10 m thick in areas greater than 2 km west of the flood plain of the Missouri River and north of the Platte River. South of the Platte River, unit Qlp at upland sites probably is at least 10 m thick. East of the Missouri River, near the northeast corner of the map area, unit Qlp probably is more than 30 m thick (Miller, 1964), and locally it may be 40 m thick (Simonson and Hutton, 1954; Miller, 1964; Bettis, 1990)

Peoria Loess overlying late Wisconsin terrace deposits—Late Wisconsin terrace alluvium beneath Peoria Loess in Omaha commonly consists of an upper organic clayey silt and a lower (2-12 m thick) clean to silty, very fine to medium sand that locally contains thin lenses of clayey silt. A late Wisconsin age assigned to this alluvium is based on a radiocarbon age of approximately 22,000 yr B.P., for wood in terrace alluvium that is approximately 11 km north of the map area, near Fort Calhoun, Nebraska (Miller, 1964, plate 4 and figure 2). Late Wisconsin terrace alluvium in Omaha generally is 9-15 m thick

Qll **Loveland Loess (late middle Pleistocene, Illinoian)—**Massive, calcareous or non-calcareous, wind-deposited clayey silt (silt loam). The grain-size distribution for one sample of Loveland Loess in or near Omaha contains 8 percent sand, 65 percent silt, and 27 percent clay (Miller, 1964). The Sangamon soil is developed in the upper 1-2 m of unit Qll, and locally the soil has a well-expressed argillic B (Bt) horizon (Miller, 1964; Mandel and Bettis, 1995). The Sangamon soil typically is overlain by thin loess of the Gilman Canyon Formation (in Nebraska) or the Pisgah unit (in Iowa). The Gilman Canyon soil or Farmdale soil, developed in thin loess deposits, is overlain in turn by Peoria Loess (Qlp). The yellowish-brown color of the Loveland Loess and the reddish-brown color of the Sangamon soil developed in it distinguish the Loveland from the younger, late Wisconsin age, loess of the Gilman Canyon Formation or Pisgah unit and the Peoria Loess (Qlp). At a few localities in and near Omaha, Loveland Loess overlies pre-Illinoian age till (Qti) and glaciofluvial deposits and, locally, pre-Loveland clayey silt or silty clay. Continuous cores and geophysical logs from drill holes on stable sites just north of the map area indicate that the Loveland Loess overlies deposits of silty clay. These deposits are about 6-10 m thick and are interpreted to be several thin deposits of weathered loess and perhaps some local sheetwash sediment (Mason and Joeckel, 2000). Sources of the Loveland Loess within the map area probably were similar to those of the Peoria Loess. Thermoluminesence age estimates for Loveland Loess in western Iowa and southwestern Nebraska range from approximately 110,000 to 165,000 yr B.P. (Forman and others, 1992; Maat and Johnson, 1996). Ages from the loess in the Omaha area range from younger than 124,000 to approximately 164,000 yr B.P. (Forman, 1990). Unit Qll is equivalent to Miller's (1964) Loveland Loess (Ql) in and near Omaha. Unit Qll generally is 5–18 m thick

GLACIAL DEPOSITS

Chiefly ice-deposited, heterogeneous, clayey material and minor interstratified stream-deposited sand and gravel. These deposits are covered by eolian and alluvial deposits nearly everywhere

Qti **Till (middle and early? Pleistocene, pre-Illinoian)—**Poorly sorted, nonstratified, and locally jointed, ice-deposited clayey material that commonly contains granule- to pebble-size clasts. Chert, sandstone, and limestone clasts are derived from local bedrock and erratic clasts of red quartzite, granite, and other igneous and metamorphic rocks are derived from glaciated sources north of the map area. The till matrix (< 2-mm-size material) generally is very pale brown to light-gray, slightly sandy, clayey silt to silty clay (clay loam). Unit Qti locally contains lenses and beds of stratified glaciofluvial sand and pebble gravel, generally 5 cm to 6 m thick. Locally it is exposed in narrow bands, overlying bedrock, on lower slopes in valleys. Joints in the till commonly are filled with calcium carbonate, and locally they form a polygonal pattern. Unit Qti probably includes till deposited during two or more glaciations. It is equivalent, at least in part, to the Cedar Bluffs Till in eastern Nebraska (Hallberg, 1986; Swinehart and others, 1994), and also the "Kansan" till and possibly the "Nebraskan" till of Miller (1964) in and near Omaha. Unit Qti probably includes one or more tills older than the Cedar Bluffs Till. The Cedar Bluffs Till in eastern Nebraska predates the approximately 660,000-year-old Lava Creek volcanic ash bed. It is equivalent laterally to the "A2" tills of Boellstorff (1978a, 1978b) and the "Nebraskan" till of Bain (1896), Chamberlin (1896), and Kay and Apfel (1929) (see Hallberg, 1986, and Swinehart and others, 1994). A clayey, reddish-brown paleosol that locally is developed in the upper part of unit Qti is overlain by Loveland Loess (Qll) and younger Wisconsin loesses. Possibly, paleosols of more than one age are developed in tills of different ages. Unit Qti in upland areas generally is 5-40 m thick, and locally is 55 m thick. In the valleys of Papillion and Big Papillion Creeks and their major tributaries, unit Qti generally is 2-12 m thick

BEDROCK

R **Dakota Formation (Lower Cretaceous) and Lansing and Kansas City Groups (Upper Pennsylvanian), undifferentiated—**The Dakota Formation [Dakota Group of the Nebraska Conservation and Survey Division] is primarily clay, sand, gravel, shale, and sandstone (Burchett and others, 1975; Burchett and Smith, 1989a). The Dakota locally is exposed in quarries, road cuts, and small natural exposures in the Platte River valley. The Lansing and Kansas City Groups, chiefly limestone and shale, are exposed in quarries in the Platte River valley and in a quarry on the east side of the Missouri River, near the northeastern corner of the map area. Limestone from the latter quarries has been used primarily for road-surfacing material, rip rap, and fill material. The thickness of the Dakota Formation generally is 5-45 m, thickness of the Lansing Group generally is 5-20 m, and thickness of the Kansas City Group generally is 5-60 m (Burchett and others, 1975; Burchett, and Smith, 1989a)

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