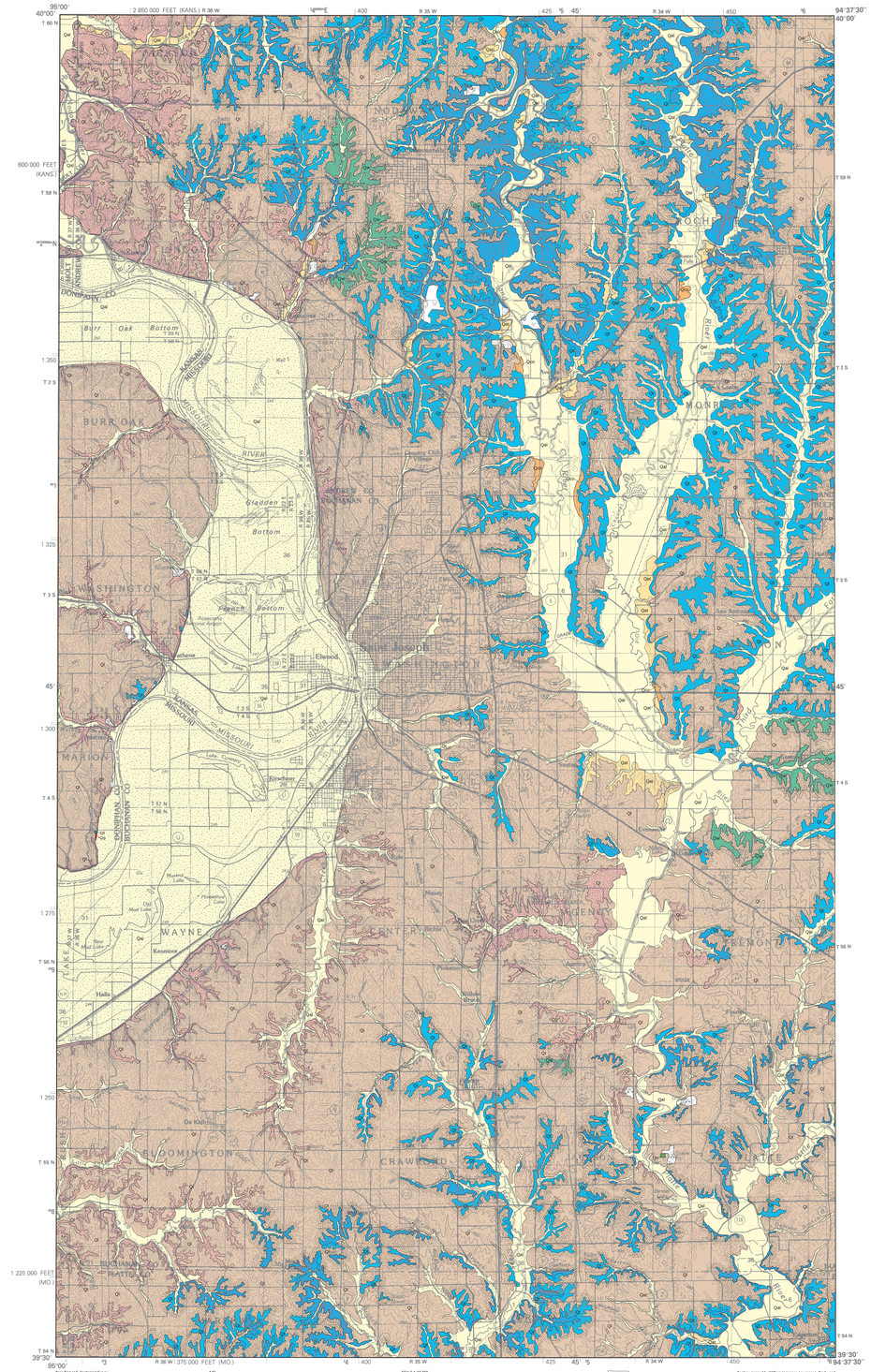
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
MISSOURI DIVISION OF GEOLOGY AND LAND SURVEY, THE KANSAS GEOLOGICAL SURVEY,
AND THE NEBRASKA CONSERVATION AND SURVEY DIVISION

MISCELLANEOUS FIELD STUDIES MAP MF–2374
Version 1.0



Base from U.S. Geological Survey
1:100,000, Saint Joseph, 1999
Projection and 10,000-meter grid, zone 15;
Universal Transverse Mercator; 25,000-foot grid ticks
based on Missouri coordinate system, west zone,
and Kansas coordinate system, north zone;
1927 North American Datum

APPROXIMATE MEAN DECLINATION, 1999

SCALE 1 : 63 360

1 MILES
1 0.5 0 1 2 3 4
1 0 1 2 3 4 5 6 7 KILOMETERS

CONTOUR INTERVAL 10 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MISSOURI
MAP LOCATION

Geology mapped by William H. Langer, Lawrence L. Brady, and David Smith in 1995-1998
Digital map layout by Norma Maes
Preparation of GIS files for map layout by Nancy Shock
Edited by F. Craig Brunstein
Manuscript approved for publication, July 26, 2001

GEOLOGIC MAP OF THE SAINT JOSEPH AREA, MISSOURI AND KANSAS

By
William H. Langer, Lawrence L. Brady, David Smith, and Roger A. Melick

2002

CORRELATION OF MAP UNITS

DESCRIPTION OF MAP UNITS

LATE PLEISTOCENE TO HOLOCENE

Qal **Alluvium**—Yellowish-brown, dark-brown, grayish-brown or dark-gray silt, clay, and very fine sand alluvium. Poorly to well sorted, poorly to well stratified. Underlies both flood plains and stream-terrace surfaces. Mapped areas include local colluvium and slope-wash deposits. Maximum thickness 15 m.

Qal′ **Alluvium in the Missouri River trench**—Overlies Quaternary glacial outwash composed of sand, silt, clay, and gravel. Outwash generally is well sorted and well stratified. Maximum thickness in the Missouri River trench is more than 33 m.

Qco **Colluvium**—Yellowish-brown, brown, grayish-brown, or gray very fine sand, silt, clay, and organic material. Derived primarily from loess. Colluvium overlies much of the sloping land in the area, but is mapped only where it is at least 1.5 m thick and where it masks the underlying geologic materials.

Qw **Weathered till**—Yellow, yellowish-brown, brownish-yellow, and olive-yellow till that was oxidized in-place by weathering of underlying **Qt**. Intense oxidation is concentrated in uppermost meter of the till, and along joints at greater depths. Oxidized joints extend downward 3-5 m into the unoxidized and unleached till. In the upper part of exposures, material along joints is intensely weathered and mottled. The transition between the oxidized and unoxidized till is gradual. Commonly the till is overlain by a thin surface deposit of lag gravel consisting of pebble-size to boulder-size clasts of limestone, chert, and erratic metamorphic and igneous rocks. Mapped only in areas of extensive surface exposures. Exists around heads of, and along upper reaches of, ephemeral drainages on the upper slopes or remainders of upper parts of exposures; lower parts are gently sloping or nearly level. Deep gullies are common.

PRE-ILLINOIAN TO LATE WISCONSIN

Qtt **Terrace alluvium**—Yellowish-brown, dark-brown, grayish-brown, or dark-gray alluvium found in terraces. Poorly to well-sorted, poorly to well-stratified silt, clay, and very fine sand. Underlies two prominent, widely spaced, distinguished terraces. The higher terrace is about 6-9 m above adjacent small stream channels. The lower terrace is about 0.5-2.5 m above flood plains adjacent to smaller streams, and as high as 9 m above flood plains adjacent to larger streams. Terraces are shown on the map as a single unit. Thickness of alluvium commonly is 5-7 m

PRE-ILLINOIAN TO EARLY WISCONSIN

Qe **Loess**—Pale-yellow, yellowish-brown, pale-brown, brown, grayish-brown, or gray, windblown very fine sand and silt. Smooth and velvety to the touch. Map unit includes loess of at least two, possibly three, different ages: Loveland Loess, Peoria Loess, and Bigbell Loess(?). Coarsest (very fine sand and silt) near Missouri River bluffs, fining to silt away from bluffs. Thickest (more than 30 m aggregate thickness of all loess deposits) along Missouri River bluffs; thins from bluffs to less than 1 m in eastern part of map area. Loveland Loess is distributed widely throughout the area. It is thin, and in many places it is incorporated in the Sangamon soil. Loveland Loess is dark-grayish-brown to brown near the surface, becoming pale yellow, yellowish brown, or pale brown at depth. It contains light-gray to white calcareous films. Most of the $CaCO_3$ has been leached, and the loess does not react with hydrochloric acid. The younger Peoria Loess is areally most widespread. It is pale brown to dark brown at the surface, becoming pale yellow, yellowish brown, pale brown, and very pale brown at depth. At some sites the Peoria Loess contains fragile white fossil shells of terrestrial snails and rounded or elongate lime concretionary nodules (loodchen). It is slightly calcareous and it reacts with hydrochloric acid. The Peoria Loess commonly overlies a Sangamon paleosol developed in pre-Illinoian till. The Bigbell Loess, if correctly interpreted as being present in the area, is grayish brown, light brownish gray, and light gray. It is poorly compacted, calcareous, and contains abundant snails. The loess commonly overlies the Brady paleosol developed in Peoria Loess.

Qe′ **Areas of loess where till is at depths of about 4 m or less below the land surface**

PRE-ILLINOIAN

Qt **Till**—Pale-brown, reddish-brown, dark-reddish-brown, greenish-gray, or dark-gray till. Firm, compact, calcareous, pebbly, cobbly, bouldery clay loam, clay, and very fine sand matrix, containing pebble- to boulder-size clasts of limestone, chert, shale, and erratic metamorphic and igneous rocks. Boulders commonly comprise about 10-15 percent of the till by volume. Fewer than 10 percent of the pebbles or larger clasts are erratics. Locally, lenses of sand and gravel are included in the till. These lenses commonly contain chalky carbonate rings 5-10 cm thick. Sediment in the lenses consists of coarse to medium gravel, subrounded sand grains, and less than 10 percent silt or clay. Sediments in the lenses are stratified, but are contorted or dip at angles not related to original deposition. These lenses are believed to have originated as frozen blocks of stratified drift that were incorporated into the till. Areas on the map where till is at or near the surface are underlain by undifferentiated glaciofluvial sand and gravel and pre glaciacuvertine fine sand, silt, and clay. Thickness commonly is as great as 20 m; maximum thickness is 50 m in buried bedrock valleys. Map unit may include till deposited during more than one glaciation.

Qfc **Fluvial gravel**—Brown, well-sorted, moderately to well-stratified chert and limestone gravel and sand. Thickness as great as 4 m. Observed only in Missouri River bluffs south of Watheza. Reported to be present in test holes drilled in buried glacial valleys

Qe **Eolian silt**—Gray, well-sorted, massive silt and very fine sand. Compact and dense. Thickness 4 m

PRE-QUATERNARY

Bedrock outcrops and near-surface bedrock—Continuous or closely spaced outcrops of bedrock, or bedrock covered by as much as 4 m of unit **Qt** (loess) or unit **Qt** (till). The predominant surficial material overlying the bedrock is shown by the map colors for units **Qt** and **Qt**. Bedrock may be weathered

Contact

Quarry

THE PLEISTOCENE SUCCESSION

Northwestern Missouri was glaciated at least twice during pre-Illinoian time. The terms "Nebraskan" and "Kansan" have been abandoned as stratigraphic names for glacial deposits in the midcontinent region of the United States (Boellstorff, 1978; Richmond, 1986); however, to provide a link with previous work in this discussion of the chronology of the St. Joseph area, those terms are used along with the current terminology.

Exposures of "Nebraskan" (pre-Illinoian A2) deposits in northwestern Missouri were described in field trip guidebooks by Howe (1968) and Bayne and others (1971). Hein and Howe (1963) proposed that the deep buried bedrock valley (the St. Joseph Valley) extending from near St. Joseph east-northeast through the map area (see index map) was formed as an ice-marginal channel that marked the terminus of the "Nebraskan" (pre-Illinoian A2) ice sheet. According to Hein and Howe (1963), all test holes in the area that penetrated two tills are north of the buried St. Joseph Valley. Documentation that tills of two different ages are present in an area commonly requires identification of a well-developed zone of weathering that separates the tills. Howe (1968) described such a weathering zone and concluded was "Nebraskan" (pre-Illinoian A2) till. His observations were north of the buried St. Joseph Valley, in a temporary exposure along Interstate 29 (see index map). Prior to the study by Hein and Howe (1963), the southern limit of the "Nebraskan" (pre-Illinoian A2) till boundary was interpreted to be south of the buried St. Joseph Valley (Holmes, 1942; Flint and others, 1959).

Bayne and others (1971) described a stratigraphic sequence of "Nebraskan" (pre-Illinoian A2?) deposits in Kansas in the Missouri River bluffs. The stratigraphic sequence described includes fluvial chert gravel. The chert gravel no longer is exposed in the locations (See index map, Walburg North #1, Walburg South #1 and #2) described by Bayne and others (1971). However, chert gravel that is interpreted to be "Nebraskan" (pre-Illinoian A2) fluvial gravel was observed in a road cut along Interstate 29 approximately 1 km south of the locality described by Bayne and others (1971) (see index map, gravel locality 4).

Howe (1968) described "Nebraskan" (pre-Illinoian A2?) periglacial silt in two exposures near St. Joseph (see index map), and suggested that the silt may be more widespread than observed. Gray, well-sorted, massive silt and very fine sand is exposed in a quarry about 9 km northwest of Edgerton (index map, silt locality 3). The material is dense and overconsolidated; it is inferred to be "Nebraskan" silt, approximately 640,000 years old (pre-Illinoian A2), perhaps of eolian origin, that was overridden by the "Kansan" (pre-Illinoian A1) ice sheet.

Till is exposed at many sites in the project area, both north and south of the buried St. Joseph Valley. All of the surface till in the map area is interpreted to be pre-Illinoian A1 till, previously referred to in the literature as "Kansan," and approximately 540,000 years old. The maximum advance of the pre-Illinoian A1 ice sheet exceeded about 80 km farther south, approximately to the west-east course of the present-day Missouri River. Most elements of the present drainage pattern in this area, including the Platte River, One Hundred and Two River, and Contrary Creek, were established following the dissipation of the pre-Illinoian A1 ice sheet. The modern topography, including the development of the present north-south part of the present Missouri River, developed since the pre-Illinoian A1 ("Kansan") glacial maximum and prior to Sangamon time (Hein and Howe, 1963). The present Missouri River course may be a result of integration of drainage across a terrain of local sags in the till plain surface that occur over earlier buried drainageways (Fryer and Leonard, 1952). Alternatively, the present Missouri River course may have originated as an ice marginal stream (Hein and Howe, 1963).

Loess was deposited on the landscape in this area, and in other areas, silt transported and deposited as outwash along the Missouri River was picked up by winds and deposited as Loveland Loess in the project area between 120,000 and 150,000 years ago.

Sangamon time was characterized by widespread soil development. Loveland Loess was leached and weathered, and iill at or near the surface was intensely weathered. Fine particles were winnowed from the till, and the remaining sand, pebbles, cobbles, and boulders formed the lag gravel that is characteristically associated with Sangamon soils formed from till.

At the end of the Sangamon or during the early Wisconsin, erosion became active, and the Sangamon soil (B-horizon) was exposed on eroded hillsides. Between 12,000 and 25,000 years ago, glaciation further north resulted in outwash deposition in the project area. Windblown silt derived from that outwash was deposited as Peoria Loess. The Sangamon/early Wisconsin weathered till was partly eroded and the remainder was incorporated into the Peoria Loess.

Brady time also was characterized by soil development. Peoria Loess was leached, and erosion removed part of the Peoria Loess from hillsides. In places, the upper part of the Brady soil was removed from the crests of hills. Previous interpretations differ regarding deposition of the Bigbell Loess in the map area. Bayne and others (1971) described geologic sections at Wyeth Park and East Hyde Park (see index map) that included Bigbell Loess. Howe (1968) described a section at the Tex Tram site (see index map) and the section at Wyeth Park. Both Bayne and others (1971) and Howe (1968) identified Bigbell Loess overlying the Brady soil. The soil was poorly developed in the sections. The most convincing argument that the Brady soil is present in the area, and that it is overlain by Bigbell Loess, is the description of the Tex Tram site by Howe (1968). Howe described the upper loess (Bigbell?) as calcareous and profusely fossiliferous, and he described the Brady soil as moderately developed. Howe's interpretation is based on observations at the Tex Tram site. However, Falkner (1990) did not indicate that Bigbell Loess is present in northwestern Missouri, and Welch and Hale (1987) restricted the Bigbell Loess to central and western Kansas. Subsequent to our observations at the Tex Tram site, the site was excavated for construction purposes and the surficial deposits were removed. Intensive studies of loess exposures elsewhere in the St. Joseph area will be required to demonstrate whether or not the Bigbell Loess is present in the map area.

During late Wisconsin time two poorly distinguished terraces formed. The higher (older) terrace generally is 6-9 m above the flood plains of small streams. The lower terrace generally is 0.5-2.5 m above flood plains adjacent to smaller streams and as high as 9 m above flood plains of larger streams. These terraces, where of sufficient aerial extent, are shown as a single unit on the map.

Davis (1953) described older, higher terrace remnants in Platte County in the southernmost part of, and south of, the map area. Those terraces were formed during Illinoian time. Commonly the surfaces are 13.5-17 m higher than the modern flood plains of the larger streams. A similar surface, about 1 m lower in height above the flood plains, is present in places along the Platte River and the One Hundred and Two River valleys. However, the latter terraces are underlain by bedrock, are discontinuous, and are poorly preserved. The bedrock-defended terraces are not shown on the map.

During the past 100 years, cultivation of the land and channelization of streams have had profound effects on the landscape. Much of the material on hillslopes was eroded and subsequently deposited in stream valleys. The present-day streams are incised in the thick alluvial fill.

MAP PREPARATION

This map was prepared as a collaborative effort with the Missouri Division of Geology and Land Survey, the Kansas Geological Survey, and the Nebraska Conservation and Survey Division.

Map units and preliminary contacts between units were identified using stereoscopic pairs of high altitude, false-color infrared, aerial photographs. Contacts were drawn on twelve USGS 7.5-minute topographic maps, and were checked in the field. U.S. Department of Agriculture Soil Survey maps at a scale of 1:62,500 for Buchanan County (Tilman and Deardorff, 1915), Andrew County (Sweet and Jordan, 1925), Platte County (Sweet and others, 1911), and Doniphan County (Kunkel and others, 1927) were used to provide a general overview of the soils of the area. A U.S. Geological Survey map at a scale of 1:24,000 showing the geohydrology of Doniphan County, Kansas (Burton, 1973); soil surveys at a scale of 1:24,000 for Buchanan County (Lockridge, 1989), Andrew County (Davis, 1990), and Platte County (Preston, 1985); and a soil survey at a scale of 1:20,000 for Doniphan County (Salter, 1980) were used to corroborate map units and field observations.

Field-checked contacts were transferred from the twelve 7.5-minute topographic maps to scale-stable 1:24,000-scale base maps that subsequently were digitized. The twelve digital files were merged into one single map coverage. For publication purposes, this single map coverage has been overlain on a 1:100,000-scale base map. Consequently, some of the natural features, cultural features, and contours on the basemap do not align as accurately with the mapped geologic contacts as they do at 1:24,000 scale. For a more accurate representation, digital files of the geologic contacts can be superimposed over USGS 1:24,000-scale digital raster graphs (DRGs) or digital line graphs (DLGs).

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INDEX MAP OF THE SAINT JOSEPH REGION SHOWING LOCALITIES DESCRIBED IN THE PLEISTOCENE SUCCESSION

CONVERSION FACTORS

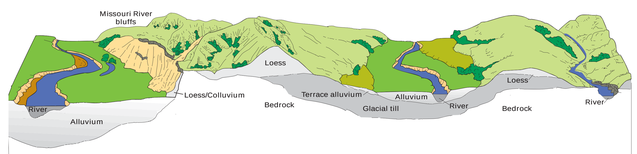
Multiply	By	To obtain
centimeters (cm)	0.3937	inches (in.)
meters (m)	3.281	feet (ft)
kilometers (km)	0.6214	miles (mi)

Typical road cuts in the vicinity of St. Joseph commonly expose 20 feet or more of loess, which is a yellowish-brown, wind-blown material that is smooth and velvety to the touch. Loess consists of very fine sand and silt near the Missouri River bluffs, and gets progressively finer away from bluffs. *(Photograph by Amy Lillenfelt, 1996.)*

Alluvium is unconsolidated material that underlies flood plains and stream-terrace surfaces. Alluvium is deposited by a stream or river, and in the St. Joseph area alluvium commonly consists of silt, clay, and very fine sand. Alluvium is exposed in the stream banks in this photograph. *(Photograph by Amy Lillenfelt, 1996.)*

Colluvium, which is a loose, incoherent mass of soil material deposited by slow continuous downslope creep, overlies much of the sloping land in the St. Joseph area. The land surface in areas underlain by colluvium commonly is hummocky, such as that shown in front of the hedgerow in this photograph. *(Photograph by Amy Lillenfelt, 1996.)*

Till is unsorted and unstratified glacial drift deposited directly by and underneath a glacier. In the St. Joseph area till consists of silt, clay, and very fine sand matrix, containing granule- to boulder-size clasts of limestone, chert, shale, and erratic boulders. The light-tan material in the upper few feet of this exposure is loess. The upper part of the till, which directly underlies the loess, is pale-brown or reddish-brown, weathered, oxidized till. At depth the unweathered till is greenish gray or dark gray. *(Photograph by William H. Langer, 1996.)*



Generalized block diagram of part of the map area, looking northward, showing spatial relationships among map units. The block diagram generally depicts conditions along a line roughly following U.S. Route 36 from a point a few miles east of Watheza eastward across most of the mapped area. The land surface on the block diagram is colored to appear natural, whereas the earth materials at depth are shown as shades of gray. Thick loess, shown as light green on the diagram, commonly overlies glacial till (also shown as light green on the diagram). In some places loess directly overlies bedrock, such as along the Missouri River bluffs. In the St. Joseph area, glacial till commonly directly overlies bedrock. Bedrock commonly outcrops at, or near, the top of the Missouri River bluffs, and is shown on the diagram as dark gray ribbons between the loess (light green) and the loess/colluvium mixture (tan). Flood plains of the Missouri River and other rivers in the area (medium green) are commonly underlain by alluvium, although in some places rivers flow directly on bedrock, as demonstrated by the easternmost river on the block diagram. Some river flood plains are flanked by stream terraces (olive green) that stand slightly higher than the modern flood plains. *(Block diagram drawn by W.H. Langer.)*

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This map was produced on request, directly from digital files, on plotting equipment.
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