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QUATERNARY GEOLOGIC MAP OF DALLAS 4° x 6° QUADRANGLE, UNITED STATES

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
MAP I-1420 (NI-14)

State compilations by
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NOTE: This map is the product of collaboration of the Oklahoma Geological Survey. the Texas Bureau of Economic Geology, and the U.S. Geological Survey, and is designed for both scientific and practical purposes. It was prepared in two stages. First, separate maps and map explanations of that part of each State included in the quadrangle were prepared by the State compilers. Second, these maps were integrated and locally supplemented by the editors; map unit symbols were revised to a uniform system of classification; and map unit descriptions were prepared from information received from the State compilers and from additional sources. Differences of mapping or interpretation in different areas were resolved by correspondence to the extent possible; most simply reflect differences in available information or differences in philosophies of mapping and serve to encourage further investigation. Richard M. Pratt plotted the volcanic ash locality symbols and prepared the index map of eolian sand and loess distribution.

Less than forty percent of the surficial deposits of the United States have been mapped and described. Traditionally, mapping of surficial deposits has focused on glacial, alluvial, eolian, lacustrine. marine, and landslide deposits. Slope and upland deposits have been mapped in detail only in restricted areas. However, an enormous amount of engineering construction and many important problems of land use and land management occur in regions of extensive slope and upland deposits (colluvium and residuum, for example). These materials have many different physical characteristics. Therefore, an effort has been made to classify, map, and describe these deposits on the basis of published and unpublished subsoil data, distribution and structure of bedrock parent materials, slope, and unpublished interpretations of individuals. An attempt has been made to show the gradual change that takes place from east to west across Oklahoma and Texas from acid soils and predominantly chemical weathering products (decomposition residua) to calcareous soils and predominantly mechanical weathering products (disintegration residua). The classification is crude, but represents a first step toward a more refined and useful product.

For scientific purposes, the map differentiates Quaternary surficial deposits on the basis of lithology, texture, genesis, stratigraphic relationships, and age, as shown on the correlation diagram and indicated in the map unit descriptions. Geomorphic features are not distinguished as map units, and terraced alluvial deposits along streams are broadly grouped in time because of the impossibility of mapping them individually at a scale of 1:1,000,000.

For practical purposes, the map is a surficial materials map. Materials are distinguished on the basis of texture, composition, and local specific characteristics such as swelling clay. It is not a map of pedologic or agronomic soils. Rather it is a generalized map of soils as recognized in engineering geology, or of subsoils or

parent materials from which pedologic and agronomic soils are formed. As a materials map it serves as a base from which engineering, land-use-planning, or land-management maps can be derived. However, it does not replace detailed site study and analysis.

The map contains the following illustrations:

An index map to the International Map of the World 1:100,000 topographic series showing the Quaternary geologic map of the Dallas 4°x 6° quadrangle and other published maps of the Miscellaneous Investigations Series (I–1420).

An illustration showing the responsibility for State compilations.

An illustration showing the correlation of map units.

An illustration showing eolian sand and loess thickness and distribution in the map area

LIST OF MAP UNITS

HOLOCENE AND LATE WISCONSIN

asa	ALLUVIAL SAND, SILT, CLAY, AND GRAVEL
ale	ALLUVIAL SILT AND CLAY
afa	ALLUVIAL-FAN DEPOSIT
es	EOLIAN SHEET SAND
ed	DUNE SAND

HOLOCENE TO ILLINOIAN

asi	ALLUVIAL, LACUSTRINE, AND EOLIAN DEPOSIT
oc	PLAYA CLAY
cga	CALCRETE-CLAST LOAM TO SANDY LOAM COLLUVIUM
cbf	BOULDERY SANDY COLLUVIUM
cbm	LIMESTONE-CLAST LOAMY COLLUVIUM
cbo	LIMESTONE-CLAST SILTY CLAY COLLUVIUM
cse	RED SILTSTONE- AND SHALE-CLAST LOCALLY GYPSIFEROUS LOAMY COLLUVIUM
csf	PEBBLY SANDY CLAY LOAM COLLUVIUM
csi	QUARTZ SANDSTONE-CLAST SANDY COLLUVIUM
csj	LIMESTONE-, SHALE-, SANDSTONE-, AND CALCRETE-CLAST LOAMY COLLUVIUM
cla	SANDSTONE- AND SHALE-CLAST COLLUVIUM
clf	ACID SHALE-CHIP CLAY-LOAM COLLUVIUM
cll	SHALE- AND SLABBY LIMESTONE-CLAST COLLUVIUM
clm	SHALE- AND SILTSTONE-CLAST LOAMY COLLUVIUM
clq	SANDSTONE- AND SHALE-CLAST LOAMY COLLUVIUM
clt	SHALE-CLAST CLAYEY COLLUVIUM
ccj	LIMESTONE- AND SANDSTONE-CLAST LOAMY COLLUVIUM
xba	SHALE- AND LIMESTONE-CLAST DISINTEGRATION RESIDUUM
xsb	QUARTZ SAND DISINTEGRATION RESIDUUM
xlc	RED SILTY CLAY DISINTEGRATION RESIDUUM
xld	RED SILTY CLAY DISINTEGRATION RESIDUUM AND GYPSUM SOLUTION RESIDUUM
xle	FINE SANDY LOAM DISINTEGRATION RESIDUUM
xlg	CALCAREOUS SANDY LOAM DISINTEGRATION RESIDUUM
xcb	CALCAREOUS CLAY DISINTEGRATION RESIDUUM
xcc	STONY SELENITIC SILTY CLAY LOAM DISINTEGRATION RESIDUUM
xcd	SANDSTONE AND MUDSTONE CLAY LOAM DISINTEGRATION RESIDUUM

LATE PLEISTOCENE

oca	LACUSTRINE CLAY, SILT, AND SAND

LATE PLEISTOCENE TO MIDDLE PLEISTOCENE

afc	ALLUVIAL- AND SHEETWASH-FAN FINE SAND AND SILT

aso CEMENTED ALLUVIAL GRAVELLY SAND
afb ALLUVIAL-FAN GRAVELLY TO SANDY LOAM

LATE PLEISTOCENE TO EARLY PLEISTOCENE

asg ALLUVIAL GRAVEL, SAND, SILT, AND CLAY
esa EOLIAN SHEET SAND
cab CEMENTED COLLUVIUM[2] AND SHEETWASH ALLUVIUM

MIDDLE PLEISTOCENE AND EARLY PLEISTOCENE

ago ALLUVIAL GRAVEL AND SAND
ocb EOLIAN AND ALLUVIAL SAND, SILT, AND CLAY

PLIOCENE

occ LACUSTRINE SAND, CLAY, AND LIMESTONE

QUATERNARY AND TERTIARY

zsa LIMONITIC SANDY DECOMPOSITION RESIDUUM
zsb QUARTZ SAND DECOMPOSITION RESIDUUM
zsd SANDY DECOMPOSITION RESIDUUM

zse CLAYEY SAND AND SANDY CLAY DECOMPOSITION RESIDUUM
zsp FINE SANDY, SILTY CLAY DECOMPOSITION RESIDUUM
zld CLAYEY SILT TO SILTY CLAY DECOMPOSITION RESIDUUM
zlq FINE SANDY LOAM DECOMPOSITION RESIDUUM
zlr CLAY LOAM AND FINE SANDY LOAM DECOMPOSITION RESIDUUM
zls SANDY CLAY LOAM DECOMPOSITION RESIDUUM
zlt RED CLAY LOAM DECOMPOSITION RESIDUUM WITH LOCAL GYPSUM RUBBLE
zcb SMECTITIC CLAY DECOMPOSITION RESIDUUM
zcc SILTY CLAY DECOMPOSITION RESIDUUM
zcg SAND, GRAVEL, SILT, AND CLAY DECOMPOSITION RESIDUUM
zcj CLAY AND SILTY CLAY DECOMPOSITION RESIDUUM
zcn SANDY CLAY LOAM DECOMPOSITION RESIDUUM
zri SILTY CLAY DECOMPOSITION RESIDUUM AND CHERTY CLAY SOLUTION RESIDUUM
zrj CLAY LOAM AND CHANNERY LOAM DECOMPOSITION RESIDUUM AND SOLUTION RESIDUUM
rcn CHERTY CALCAREOUS CLAY SOLUTION RESIDUUM
rcv STONY CALCAREOUS CLAY SOLUTION RESIDUUM
usa FELDSPATHIC SANDY FINE GRUS

LIST OF MAP SYMBOLS

CONTACT

SHORELINE

FAULT WITH QUATERNARY DISPLACEMENT—Bar and ball on downthrown side

VOLCANIC ASH BEDS

Lava Creek B ash bed (Pearlette type O)
Huckleberry Ridge ash bed (Pearlette type B)
Pearlette family of ash beds not individually identified
Pleistocene, possibly belonging to Pearlette family of ash beds
Cerro Toledo ash bed (upper?)
Guaje ash bed in Blackwater Draw Formation
Mount Blanco ash bed in Blanco Formation

DESCRIPTION OF MAP UNITS

HOLOCENE AND LATE WISCONSIN

asa ALLUVIAL SAND, SILT, CLAY, AND GRAVEL—Light-brown, gray, or grayish-brown sand, silt, and gravel intermixed or interbedded; commonly crossbedded. Locally includes lenses of clay and layers of sheetwash alluvium. In western part of mapped area, chiefly coarse quartzose sand containing lenses of subangular to well-rounded gravel. Clasts mostly calcrete derived from the Ogallala Formation (Miocene). Silt and clay become more abundant and gravel becomes finer and increasingly confined to lower part of deposit eastward across quadrangle. Quartzite, chert, limestone. and sandstone clasts also increase in abundance eastward in deposits of secondary drainages. Thickness 3–30 m; mostly 5–6 m

ale ALLUVIAL SILT AND CLAY—Dark- to light-brown or gray silt, clay, and fine sand intermixed and interbedded; includes a few lenses of subangular to subrounded gravel, especially in lower part. Clasts chiefly chert and limestone 2–4 cm in diameter. Underlies flood plains and low stream terraces in northeast part of quadrangle. Mapped areas include some sheetwash alluvium. Thickness 0.5–10 m; locally as much as 20 m

afa ALLUVIAL-FAN DEPOSIT—Yellowish- to brownish-gray gravel, coarse to medium sand, and minor silt, intermixed and interbedded; structureless to poorly bedded. Clasts chiefly angular to subrounded pebbles and cobbles of limestone, dolomite, and chert. Forms fans, chiefly in drainage of North and South Forks of Wichita River and Salt Fork of Brazos River. Thickness 2–8 m

es EOLIAN SHEET SAND—Gray to yellowish- or reddish-brown, medium to very fine sand; silty, slightly clayey; mostly quartz; minor feldspar. Distinguished as a map unit only in Texas. Commonly overlies an older alluvial deposit. Mostly stabilized by vegetation. Thickness 0.5–3 m

ed DUNE SAND—Gray to yellowish- or reddish-brown, fine to medium sand; locally silty or loamy. Mostly quartz and minor feldspar; well sorted; moderately to well rounded; generally noncalcareous. Forms dunes; relief as much as 5 m; mostly stabilized by vegetation. Commonly overlies older alluvial deposits. In Oklahoma, locally includes extensive sheet sand. Thickness 3–30 m; generally about 7 m

HOLOCENE TO ILLINOIAN

asi ALLUVIAL, LACUSTRINE, AND EOLIAN DEPOSIT (Lingos Formation (Caran and Baumgardner, 1990) in Texas)—Buff, grayish- to yellowish-brown or pale-red sequence of sediments spreading from eastern base of escarpment in western part of quadrangle. Sediments consist of basal sand and gravel overlain by lenses of calcareous, fossiliferous lacustrine clay and marl, and an upper deposit consisting of eolian sheet sand and channel deposits that are mostly eolian sand and silt interbedded with paleosols and alluvial silt, sand, and gravel. Locally overlies a paleosol developed on Permian siltstone. Basal gravel contains Rancholabrean vertebrate fauna. Youngest deposits probably early Holocene. Thickness characteristically 30–40 m; thickness varies abruptly and is as much as 75 m where deposit has filled depressions formed by collapse of the beds following dissolution of the underlying gypsum bedrock

oc PLAYA CLAY—Light-gray, light-grayish-brown to pale-brown, and brownish-gray sandy clay and silt; massive, calcareous; hard when dry, sticky and plastic when wet. Films, threads, and soft masses of calcium carbonate comprise about 5-8 percent of volume. Occurs in circular to oval closed depressions, many of which contain small intermittent playa lakes. Thousands of the depressions exist, most too small to show on map, but some in the northwest part of quadrangle are 100 m to several kilometers across. Many depressions, especially those in eolian sand, are formed by deflation and (or) dissolution of near-surface carbonate by infiltrating ground water. Others are formed by subsidence resulting from deep solution and collapse of underlying gypsum bedrock. Some depressions are rimmed by a low circular mound of brown loam about 1 m thick that overlies white indurated secondary calcium carbonate. The nearly flat surface of some deposits is characterized by pimple mounds and depressions (gilgai) of Holocene age. Thickness 0.5–5 m

cga CALCRETE-CLAST LOAM TO SANDY LOAM COLLUVIUM[1]—Reddish- to yellowish-brown, brown, or gray mixture of gravel, sand, and clay. Poorly sorted; nonbedded to thin bedded. Clasts mostly pebble to cobble size; a few are boulders. Most are fragments of calcrete. Sand is fine to medium, quartzose; forms bulk of deposit; includes admixed silt and clay. Moderately cemented with calcium carbonate in places. Mantles slopes that dissect the Ogallala Formation (Miocene). Mapped areas include bedrock outcrops and small areas of locally derived alluvium. Thickness commonly less than 1 m; locally 2–4 m at base of slopes

cbf BOULDERY SANDY COLLUVIUM[1]—Tan to brown, dark-grayish-brown, or yellowish-brown, fine sand, silt, and minor silty clay. Contains sandstone boulders; poorly sorted, nonbedded to thin bedded; some boulder fields at surface. Developed on moderate to steep slopes underlain by highly folded and faulted sandstone and shale. Mapped only in southeastern Oklahoma. Thickness 0.5–1.5 m

cbm LIMESTONE-CLAST LOAMY COLLUVIUM[1]—Dark-grayish-brown to light-brown, locally reddish brown, moderately alkaline clay loam and loam containing scattered to abundant, angular blocky to platy fragments of hard limestone, shale chips, particles of calcium carbonate cement, and, locally, sparse chert. Nonbedded to thin bedded. In places, rests in abrupt contact on hard, laminar calcium carbonate overlying limestone bedrock; elsewhere, the hard calcium carbonate is lacking and the loam, mixed with fragments, overlies fragmented limestone. On steep slopes, commonly contains more than 50 percent fragments and locally is a limestone rubble with very little matrix. Mapped areas include abundant bedrock outcrops. In valley bottoms, consists of angular to subangular stony sheetwash alluvium, but along valley of Red River is chiefly sandy to silty and thin bedded. Thickness on uplands 0.5–3 m; on moderate to steep slopes 0.1–1 m

cbo LIMESTONE-CLAST SILTY CLAY COLLUVIUM[1]—Reddish-gray to pale-reddish-brown sandy to silty clay containing abundant angular to subangular blocky clasts of limestone and chert; nonbedded to locally thin bedded. In places characterized by elongate zones of limestone rubble parallel to slope; locally includes some sheetwash alluvium. Mapped only in Texas. Thickness 0.2–1 m; may be thicker at base of slopes

cse RED SILTSTONE- AND SHALE-CLAST LOCALLY GYPSIFEROUS LOAMY COLLUVIUM[1]—Reddish- to grayish-brown, sandy silt loam to silty clay loam containing angular fragments of sandstone and siltstone, and slabs or chips of shale and thin-bedded dolomite. Abrupt contact with underlying rock. Includes zones of partly dissolved chunks and blocks of impure gypsum in a granular silty clay matrix and, in places, sheets of impure gypsum rubble. Clayey debris and rubble derived from beds of gypsum upslope that are undergoing mass wasting following former subsurface dissolution and collapse. Mapped areas include bedrock outcrops. Thickness 0.5–1 m

csf PEBBLY SANDY CLAY LOAM COLLUVIUM[1]—Reddish-brown, pebbly, silty sandy clay containing fragments of sandstone, dolomite, and limestone. Nonbedded to thin bedded. Locally includes sheetwash alluvium. Quartz pebble lag at surface. On some uplands and slopes, overlies pink clay loam or zone of calcium carbonate accumulation. Mapped areas include extensive bare bedrock outcrops, commonly in the form of flatirons and dip slopes. Mapped only in Texas. Thickness 0.2–1 m

csi QUARTZ SANDSTONE-CLAST SANDY COLLUVIUM[1]—Pale-gray, yellowish- or reddish-brown, coarse, medium, and fine quartz sand, locally pebbly. Contains sandstone rubble clasts of assorted sizes, some limonite-cemented clasts, and, locally, some limestone and chert rubble derived from rock types upslope. Commonly in abrupt contact with underlying rock. Mapped areas include local bedrock outcrops. Occurs chiefly along eastern escarpment of High Plains in southwest part of quadrangle near south border. Thickness 1–5 m

csj LIMESTONE-, SHALE-, SANDSTONE-, AND CALCRETE-CLAST LOAMY COLLUVIUM[1]—Reddish- to yellowish- or pale-brown, sandy loam containing scattered angular to subrounded clasts, mostly limestone, shale, sandstone, and calcrete; a few pebbles of black chert and pink quartz. Locally forms a scree. Occurs near top of eastern escarpment of High Plains in southern part of quadrangle. Thickness 0.5–3 m

cla SANDSTONE- AND SHALE-CLAST COLLUVIUM[1]—Very dark grayish brown to yellowish-brown silty clay, silt, and sand containing angular to subangular sandstone and shale fragments. Nonbedded to thin bedded. Developed on moderate to steep slopes. Mapped areas include sparse bedrock outcrops and patches of eolian sand. Mapped only in Oklahoma. Thickness 0.5–1.5 m

clf ACID SHALE-CHIP CLAY-LOAM COLLUVIUM[1]—Reddish- to greenish- or dark-grayish-brown, acidic, sandy to silty clay containing shale chips and subangular to well-rounded clasts of sandstone as much as 15 cm across. Mapped only in Oklahoma along east edge of quadrangle. Thickness 0.5–1.0 m

cll SHALE- AND SLABBY LIMESTONE-CLAST COLLUVIUM[1]—Very dark grayish brown to olive-gray silt loam; local iron-manganese concretions. Dominant clay mineral is smectite; swells when wet; shrinks when dry. Locally overlies remnants of clayey residuum developed from shale in area of Arbuckle Mountains and uplands to east in Oklahoma. Downslope creep of shale exposed in places. Thickness commonly less than 1.6 m; thicker at base of slopes

clm SHALE- AND SILTSTONE-CLAST LOAMY COLLUVIUM[1]—Reddish- to dark-grayish-brown silt loam to clay loam, weakly calcareous; creep of underlying shale visible locally. Present only in Oklahoma at base of uplands in north-central part of quadrangle. Thickness commonly less than 1 m

clq SANDSTONE- AND SHALE-CLAST LOAMY COLLUVIUM[1]—Reddish-brown to brown, very fine sand to silt containing clasts of red sandstone, siltstone, and shale; local dolomite and gypsum rubble in heads of some drainages. Nonbedded to thin bedded. Mapped areas include bedrock outcrops, local alluvium, and minor remnants of decomposition residuum (**zlq**). Thickness less than 0.6 m

clt SHALE-CLAST CLAYEY COLLUVIUM[1]—Yellowish-brown to gray clay to clay loam containing chips and slabs of red shale and, in places, angular fragments of limestone, dolomite, siltstone, red fine-grained sandstone, and gypsiferous rubble. Nonbedded to thin bedded. Abrupt contact with bedrock. Locally mantled with thin loess. Mapped areas include bedrock outcrops, minor alluvium, and small areas of decomposition residuum (**zlt**). Thickness generally less than 3 m; may be as much as 5 m at base of slopes

ccj LIMESTONE- AND SANDSTONE-CLAST LOAMY COLLUVIUM[1]—Dark-grayish- to reddish-brown silt loam to clay loam colluvium containing numerous scattered clasts of hard limestone and fine- to medium-grained sandstone. Occurs on slopes of Arbuckle Mountains and uplands to east in Oklahoma. Abrupt contact with patches of underlying residuum and bedrock. Mapped areas include bedrock outcrops and small patches of residuum developed on limestone and sandstone. Thickness less than 2 m

xba SHALE- AND LIMESTONE-CLAST DISINTEGRATION RESIDUUM[2]—Light reddish- to yellowish-brown silty clay loam containing abundant shale chips where developed over shale, and forming matrix of limestone rubble where developed over limestone. Locally includes some zones of dolomite and gypsum clasts. Grades down into parent rock. Underlies gently rolling uplands characterized by stair-step benches in which limestone underlies the bench surfaces and shale the frontal slopes. Mapped areas include bedrock outcrops and local limestone rubble or shale debris colluvium. Areas underlain by dolomite and gypsum commonly characterized by dissolution sinks and caves filled with collapsed rubbly residuum. Thickness less than 0.5 m to 1 m

xsb QUARTZ SAND DISINTEGRATION RESIDUUM[2]—Pale-gray to reddish-yellow, coarse to medium quartz sand, locally silty; abundant muscovite; limonite stained in places. Includes angular fragments and chunks of sandstone. Grades down into sandstone bedrock through a fragmented zone, locally impregnated and cemented with calcium carbonate. Mapped areas include broad low dunes (**ed**) of Holocene age, remnants of calcium carbonate cemented residuum (**zsb**), colluvium (**csi**). and minor alluvium. Thickness 0.5–2 m

xlc RED SILTY CLAY DISINTEGRATION RESIDUUM[2]—Orange-brown and red, mottled grayish-green, silty clay; local fine sandy clay. Grades down abruptly into red shale or dolomite on gently sloping uplands. Mapped areas commonly include bedrock outcrops and, very locally, gravelly loam colluvium on dissected slopes. Gravel is derived from deposits of Seymour Formation (**ago**) capping divides immediately upslope. Thickness 0.5–1 m

xld RED SILTY CLAY DISINTEGRATION RESIDUUM[2] AND GYPSUM SOLUTION RESIDUUM[4]—Reddish-brown, noncalcareous to highly calcareous silt loam to clay loam disintegrated from underlying shale, siltstone, and thin beds of dolomite. Includes blocky fragments or slabs of siltstone and chips of shale in lower part. Matrix in lower part also includes zones of grayish-brown, granular, silty to clayey gypsiferous rubble commonly less than 0.3 m thick derived from underlying thick beds of gypsum. Numerous sink holes resulting from subsurface dissolution and

collapse of the gypsum common. Mapped areas include bedrock outcrops and some colluvium (**cse**). Thickness generally less than 1.2 m

xle FINE SANDY LOAM DISINTEGRATION RESIDUUM[2]—Reddish-brown to reddish-gray fine sandy loam, locally calcareous; contains soft carbonate concretions. Numerous red sandstone, siltstone, or shale fragments in lower part. Grades down through fragmented zone into fine-grained sandstone, siltstone, soft shale, or calcareous shale. Mapped areas include bedrock outcrops, colluvium, sheetwash alluvium, and alluvium of local streams. Thickness commonly less than 1 m; as much as 2 m where developed on soft rocks

xlg CALCAREOUS SANDY LOAM DISINTEGRATION RESIDUUM[2]—Reddish-brown to brown, calcareous, fine sandy loam derived from underlying red, fine-grained sandstone, shale, and dolomite. Includes numerous relatively fresh rock fragments in lower part and grades down into bedrock through fragmented zone. Mapped areas include small deposits of locally derived colluvium, sheetwash alluvium, stream alluvium, and remnant patches of residuum (**zls**). Thickness 0.5–1 m

xcb CALCAREOUS CLAY DISINTEGRATION RESIDUUM[2]—Light-brown to brown or light-reddish-brown silty clay to fine sand containing chips of shale and small fragments of mudstone, siltstone, sandstone or coarse-grained limestone, on all of which the residuum is developed. Clay is calcareous and locally smectitic. Grades down into bedrock through a thin fragmented zone. Mapped only in Texas. Mapped areas include extensive unmapped, unconsolidated deposits of silt, sand, and gravel on uplands. Gravel ranges from pebbles to boulders. most of limestone, but some of quartz, quartzite, sandstone, or mudstone. Mapped areas also contain bedrock outcrops and colluvium. Thickness commonly less than 1 m; locally only 5 cm

xcc STONY SELENITIC SILTY CLAY LOAM DISINTEGRATION RESIDUUM[2]—Brown to reddish-brown silty clay loam, locally sandy. Contains abundant rubble composed of dolomite, sandstone, mudstone, and partly dissolved gypsum clasts. Material grades through fragmented zone into underlying bedrock. No pronounced karst topography. Mapped areas include bedrock outcrops and rubbly colluvium. Present in Texas south of southwesternmost Oklahoma. Thickness 0.5–1 m

xcd SANDSTONE AND MUDSTONE CLAY LOAM DISINTEGRATION RESIDUUM[2]—Yellowish- to light-reddish-brown clay loam to sandy clay loam containing abundant fragments of the underlying bedrock of mudstone, sandstone, shale, and, locally, cherty limestone. Tends to grade down through thin fragmented zone into underlying rock. In places matrix is sparse and only a thin lag rubble of relatively small fragments remains on exposed bedrock. Mapped areas include minor colluvium on lower slopes. Thickness 5–50 cm

LATE PLEISTOCENE

oca LACUSTRINE CLAY, SILT, AND SAND (Tahoka Formation in Texas)—Bluish-gray to gray, weathering light brown, selenitic lacustrine clay, silt, and locally, sand. Clay and silt are slightly calcareous, massive to weakly bedded, weakly coherent. Clay minerals include bentonite, sepiolite, and illite. Thin dolomite beds (Vigo Park dolomite, an informal, unranked unit of Reeves, 1976) in middle part of unit. Sand is gray, fine- to coarse-grained quartz, massive to weakly bedded, friable. Grades laterally into shoreline gravel at margins of deposit. Occurs on the High Plains in basins that developed in part by deflation, but chiefly as a result of collapse following dissolution by underground water of underlying salt or gypsum bedrock. Lake sediments contain late Wisconsin molluscs and vertebrate fossils; locally, underlain by unmapped olive-gray, dense, selenitic, lacustrine silt and clay of early Wisconsin age, known chiefly from borings. Thickness as much as 25 m in places; commonly 8 m, but thins laterally to less than 1 m

LATE PLEISTOCENE TO MIDDLE PLEISTOCENE

afc ALLUVIAL- AND SHEETWASH-FAN FINE SAND AND SILT—Brown to grayish-brown, silty, fine sand and clayey, fine sandy silt; sand chiefly quartz. Deposited as broad, gently sloping, thin alluvial- and sheetwash-fan deposits. Occurs on gentle slopes of valley sides that extend upward as much as 60–70 m above flood plains. Largely reworked from older alluvial deposits of Seymour Formation (**ago**). Weakly to well bedded, poorly to well sorted. Locally includes minor admixed clay. Headwater areas may include some fragments from underlying or nearby exposures of Permian sandstone, siltstone, shale, gypsum, or dolomite. Thickness 1–3 m

aso CEMENTED ALLUVIAL GRAVELLY SAND—Very pale brown, light-yellowish-brown, and very light brownish gray calcium carbonate-cemented quartz sand, silt, clay, and gravel, intermixed and interbedded. Includes alluvial-fan, sheetwash, and possible pediment deposits consisting of stratified to massive, poorly sorted clayey sand and sandy to silty clay. The sand and clay contains lenses of pebbles mixed with unsorted platy fragments of calcium carbonate and subangular to subround gravel composed of locally derived limestone, dolomite, and chert. Locally, overlies soft to hard, calcium carbonate-cemented gravelly loam or chalky clay. Lies topographically above younger terraced, weakly cemented deposits and interfingers with cemented colluvium and sheetwash deposits on adjacent slopes. Mapped areas include some cemented colluvium and small isolated areas of older alluvial deposits. Thickness commonly 2–30 m; locally, where underlain by Permian bedrock containing salt beds (anhydrite and halite), thickness varies abruptly and is as much as 80 m where deposit has filled depressions formed by collapse of the beds following dissolution of the salt

afb ALLUVIAL-FAN GRAVELLY TO SANDY LOAM—Pale-brown, yellow, light-yellowish-brown silty clay; calcareous, friable; contains interbeds of pebbly sand to sandy silt. Clasts chiefly scattered, rounded pebbles and cobbles of limestone, dolomite, and chert; local pebbles of basalt and pyroclastic rock. In places layers of concretions and sand are cemented by soft, white to very pale yellow calcium carbonate. Underlies, high, very gently sloping (1 percent slope) alluvial fans in broad valleys in central part of quadrangle. Thickness 3–12 m

LATE PLEISTOCENE TO EARLY PLEISTOCENE

asg ALLUVIAL GRAVEL, SAND, SILT, AND CLAY (alluvium of Pleistocene age, undifferentiated)—Orange-brown or brownish-gray to brown; oxidized; upper part chiefly silt and clay; becomes coarser downward. Gravel is predominantly in lower part except where fine material has been deflated. Sand is well bedded to poorly bedded; commonly crossbedded. In Texas, gravel consists mostly of pebbles and cobbles of calcrete, derived chiefly from the Ogallala Formation, and limestone. Maximum diameter about 20 cm; mostly less. Clasts of shale and platy sandstone present in some areas. In Oklahoma, gravel is also chiefly calcrete, but quartzite, other metamorphic rocks, milky quartz, chert, and fine-grained igneous rock from distant western sources are abundant locally. Sand is coarse to fine, well bedded to poorly bedded, commonly crossbedded, and chiefly quartz; feldspar abundant near Wichita Mountains. Underlies a sequence of successively higher terraces that have not been extensively studied and includes lag gravels remnant on ridge crests following erosion of Ogallala Formation. Locally, also includes Lava Creek B volcanic ash bed and older Pleistocene ash beds, and contains sites of several Pleistocene vertebrate local fauna. Thick eolian sand and silt overlie deposit in many places, especially along Red River. Thickness 0.2–30 m

esa EOLIAN SHEET SAND (Blackwater Draw Formation in Texas; described by Reeves (1976), formally defined by Holliday (1989); former "cover sands" of Frye and Leonard, 1957)—Grayish-red, reddish-brown, or very light brown, stratified to massive, silty to clayey, fine to medium sand. Commonly 1–4 laterally persistent layers, each about 1 m thick; characterized by secondary calcium carbonate nodules, films, and concretions, and a well-developed calcrete paleosol. More sandy in southwestern part of its mapped area, and more loamy in its northeastern part. Commonly contains thin lenticular beds of gray, organic-rich lake silt and clay, and local channels at its base are filled with pebbly sand. Boundary between Blackwater Draw Formation (**esa**) and underlying Blanco Formation (**occ**) at Mount Blanco revised by Holliday (1988). Lower part of Blackwater Draw Formation includes Guaje volcanic ash bed, fission-track dated as 1.4±0.2 Ma (Izett and others, 1972). Beds from Guaje ash to base of unit have reversed magnetic polarity. Unit rests disconformably on calcrete at top of Blanco Formation, on Ogallala Formation, or on Cretaceous shale. Appears to have accumulated throughout most of Quaternary time as a series of sand sheets formed during brief periods of eolian deposition between longer intervals of erosion, playa lake deposition, and soil development. Thickness commonly 4–8 m

cab CEMENTED COLLUVIUM[2] AND SHEETWASH ALLUVIUM—White, pink, light- to dark-gray, light-brown, yellowish-brown, and reddish-brown, and reddish-yellow sand, silt, clay, and gravel; extensively cemented by secondary calcium carbonate; stratified to massive; characterized by local concentration of secondary calcium carbonate in indurated laminar horizontal layers or as massive, soft zones and nodules. Forms colluvial deposits on moderate to steep slopes, and remnants of

nearly level to gently sloping, discontinuous sheetwash alluvial-fan aprons that include sparse deposits of lacustrine clay and marl. Distribution spotty in southwest part of quadrangle. Mapped areas include bedrock outcrops and small deposits on uplands. Thickness typically 3–8 m; locally as much as 12 m

MIDDLE PLEISTOCENE AND EARLY PLEISTOCENE

ago ALLUVIAL GRAVEL AND SAND (Seymour Formation and correlative upland gravel in Texas)—Light-gray, medium-gray, or yellowish-brown gravelly sand, silt, and clay. Locally contains zones of secondary calcium carbonate-cemented gravelly loam to clay. Lava Creek B volcanic ash (age 0.61 ka) present in places. In many areas, gravel consists of rounded to subrounded pebbles and boulders, mostly of gray, white, black, green, and red chert and less abundant limestone and dolomite. Deposits from sources in Cretaceous limestone contain abundant limestone pebbles. Locally include a few pebbles of dark-olive siltstone, hard quartzite, volcanic rock, porphyry, milky quartz, banded chalcedony, and various Precambrian igneous and metamorphic rocks. Caps upland flats and stream divides. Thickness commonly 1-2 m, but where underlain by Permian rocks containing salt beds, thickness varies abruptly and is as much as 25 m where deposit has filled depressions formed by collapse of the beds following dissolution of the salt

ocb EOLIAN AND ALLUVIAL SAND, SILT, AND CLAY (Tule Formation in Texas)—White to gray, brownish-red, or reddish-gray, silty, fine to medium quartz sand, greenish-gray silt and clay, and thin-bedded lacustrine limestone. Sand is massive to thin bedded and contains caliche nodules; silt and clay are indistinctly bedded and locally bentonitic. Where bentonitic, expands when wet. contracts when dry. Pebbly gravel present at base of deposit. Lava Creek B volcanic ash bed (0.61 Ma) occurs locally at top of unit. Upper(?) Cerro Toledo volcanic ash bed (age 1.23±0.02 Ma), downwind equivalent of the Cerro Toledo Rhyolite, occurs in lower part of map unit in canyon of Tule Creek. Contains molluscan and vertebrate fauna. Exposed in slopes of canyon reentrants in the High Plains. Thickness as much as 28 m

PLIOCENE

occ LACUSTRINE SAND, CLAY, AND LIMESTONE (Blanco Formation in Texas)—White to light-gray, massive to well-bedded, fine to medium quartz sand; gray to light-greenish-gray, calcareous, diatomaceous, silty to sandy, bentonitic clay; and white, hard, flaggy, thin-bedded, freshwater limestone. Sand becomes increasingly gravelly toward margin of basin. Boundary between Blanco Formation and overlying Blackwater Draw Formation at Mount Blanco revised by Holliday (1988). Contains the Mount Blanco volcanic ash bed (Izett, 1981). A possible equivalent of this ash at the 111 Ranch fossil locality in Arizona was fission-track dated at 2.32±0.15 My by J.J. Dickson (Izett, 1981). Entire map unit has reversed magnetic polarity (Lindsay and others, 1975) and is considered to represent the lower part of the Matuyama Reversed Polarity Chron (base 2.48 Ma). Mount Blanco volcanic ash bed overlies bone beds that contain the Blancan local fauna, the type fauna for the Blancan Land Mammal age. Occupies basins developed in Ogallala Formation, and is believed to have been deposited in a seasonal to semipermanent lake that existed between periods of dessication in an arid to semiarid climate. Preserved in cliffs along eastern escarpment of High Plains, chiefly in Blanco Canyon of the White River northeast of Lubbock. Thickness 19–24 m

QUATERNARY AND TERTIARY

zsa LIMONITIC SANDY DECOMPOSITION RESIDUUM[3]—Light-gray, yellowish-brown or dark-reddish-brown, clayey to silty, fine to medium quartz sand; cemented by limonite or containing irregular masses, nodules, and veins of limonite. Claystone fragments locally abundant. Grades down into sandstone, shale, and siltstone. Mapped areas commonly include local colluvium, alluvium, and bedrock outcrops. Thickness 1–10 m

zsb QUARTZ SAND DECOMPOSITION RESIDUUM[3]—Pale-gray to reddish-brown, and reddish-yellow, slightly silty to clayey, coarse to medium quartz sand, locally pebbly. Includes abundant muscovite. Contains irregular, hard, limonite-cemented masses and limonite nodules and veins. Grades down into friable to locally cemented sandstone, and, in a few places, into pebble conglomerate or claystone. Mapped areas include broad, low Holocene dunes derived or reworked from the residuum, local small areas of calcium-carbonate-cemented sandy clay residuum, thin colluvium of limonite-cemented rubble, and bedrock outcrops. Thickness commonly 1–3 m; locally 6–8 m

zsd SANDY DECOMPOSITION RESIDUUM[3]—Brown to dark-grayish- or olive-brown, medium to fine sandy loam, very locally silty clay loam; contains angular fragments of sandstone, limestone, or chips of shale. Grades down through fragmented zone into underlying bedrock. Mapped areas include locally derived colluvium and alluvium. Mapped only in Oklahoma in northeast part of quadrangle. Thickness 0.5–2 m

zse CLAYEY SAND AND SANDY CLAY DECOMPOSITON RESIDUUM[3]—Gray, light-brown, orange, or brown, clayey, fine to medium quartz sand to fine sandy silty clay; locally contains subrounded sandstone pebbles. Present only in southeast corner of quadrangle. Mapped areas commonly include some colluvium and small bedrock outcrops. Thickness 1–3 m

zsp FINE SANDY, SILTY CLAY DECOMPOSITION RESIDUUM[3]—Light- to reddish-brown very fine sand and silty clay; gray clay; some gravel. Clasts chiefly sandstone; a few of limestone. Mapped areas include colluvium and bedrock outcrops. Thickness 0.5–2 m

zld CLAYEY SILT TO SILTY CLAY DECOMPOSITION RESIDUUM[3]—Reddish- to dark-grayish-brown or dark-gray fine clayey silt to silty clay; locally calcareous. Contains small chips of shale and fragments of limestone and chert, or sandstone; local iron-manganese concretions. Grades down through fragmented zone into bedrock, mostly shale and limestone, locally minor sandstone. Mapped areas include bedrock outcrops on steep slopes and locally derived colluvium. Thickness 0.25–2 m

zlq FINE SANDY LOAM DECOMPOSITION RESIDUUM[3]—Reddish-brown to brown, fine sandy loam, locally clayey loam; slightly acid to moderately alkaline. Grades down through weathered rock into bedrock, mostly red, fine-grained sandstone interbedded with minor siltstone, and shale. Commonly thinned by slope erosion and deflation. Mapped areas include bedrock outcrops, minor alluvium, and local colluvium on steep slopes. Thickness less than 3 m

zlr CLAY LOAM AND FINE SANDY LOAM DECOMPOSITION RESIDUUM[3]—Reddish- to dark-brown or brown clay loam and silty to fine sandy loam. Sand mostly quartz and feldspar. Clay loam grades down into soft, red shale. Silty to sandy loam grades down through weathered, fractured rock into red or pink, fine-grained sandstone with interbeds of siltstone. Residuum commonly thinned by slope erosion and deflation. Mapped areas include bedrock outcrops, minor alluvium, and local colluvium on steep slopes. Mapped only in Oklahoma. Thickness as much as 3 m

zls SANDY CLAY LOAM DECOMPOSITION RESIDUUM[3]—Brown to reddish-brown, fine sandy loam to fine sandy clay loam derived from underlying red, fine-grained sandstone, shale, and dolomite. Includes scattered decomposed to near-fresh rock fragments that become more numerous in lower part. Grades into bedrock through zone of weathered rock. Mapped areas include locally derived colluvium and minor local alluvium. Thickness 1–1.5 m

zlt RED CLAY LOAM DECOMPOSITION RESIDUUM[3] WITH LOCAL GYPSUM RUBBLE—Reddish- to dark-brown or brownish-gray clay loam, locally silt loam; grades down through zone of broken rock into hard shale, limestone. dolomite, or siltstone. Contact with limestone and dolomite is abrupt and shows evidence of solution. Sinkholes and areas of partly dissolved gypsum rubble in places. Mantled with thin loess. Mapped areas include minor alluvium and local colluvium on steep slopes. Mapped only in Oklahoma. Thickness less than 3 m over shale; less than 2 m over limestone

zcb SMECTITIC CLAY DECOMPOSITION RESIDUUM[3]—Yellowish-gray, greenish-gray, light-gray, or gray clay and sand. Locally contains calcareous nodules. Clay is smectite; expands when wet; shrinks and cracks, forming structures called gilgai, when dry. Residuum grades down into marine clay, marl, calcareous sandstone, or limestone. Mapped only in Texas in southeast part of quadrangle. Mapped areas commonly include colluvium and small bedrock outcrops. Thickness 1–2 m

zcc SILTY CLAY DECOMPOSITION RESIDUUM[3]—Black to dark-gray or dark-brown silty clay; light to reddish brown where oxidized; silty clay to fine sandy clay developed from hard calcium carbonate or calcium carbonate impregnated sandy clay at contact with underlying bedrock. Clay is strongly smectitic; expands when wet, shrinks and cracks, forming structures called gilgai, when dry. Mapped areas include local colluvium and bedrock outcrops. Thickness 0.5–1 m, locally 2 m

zcg SAND, GRAVEL, SILT, AND CLAY DECOMPOSITION RESIDUUM[3]—Dark-gray, olive-gray, or grayish- to reddish-brown clay loam, silt loam, fine to medium sand, or clayey sandy gravel; contains both calcium carbonate concretions and limonite concretions. Sand chiefly quartz; gravel, 2–10 cm in diameter, contains clasts of novaculite, quartz, quartzite, and sandstone. Clay is mostly

smectite; expands when wet and shrinks when dried. Mapped areas include local alluvium, colluvium, and bedrock outcrops. Thickness 0.5–2 m

zcj CLAY AND SILTY CLAY DECOMPOSITION RESIDUUM[3]—Grayish- to yellowish-brown or brown clay to silty loam, locally mottled; fine sandy loam in places; grades down into soft shale or fractured fine-grained sandstone or siltstone. Occurs only in Oklahoma in northeastern part of quadrangle. Mapped areas include bedrock outcrops, minor alluvium, and local colluvium. Colluvium contains as much as 15 percent sandstone and shale fragments less than 25 cm long, and may be as thick as 2 m on lower slopes. Thickness commonly 0.5–2 m

zcn SANDY CLAY LOAM DECOMPOSITION RESIDUUM[3]—Light- to reddish-brown sandy clay loam, locally clay loam or silty clay loam. Includes scattered calcareous nodules and ferruginous concretions weathered from bedrock. Also includes some platy sandstone fragments and a few chert clasts. Grades down into underlying bedrock through fragmented zone. Mapped areas include bedrock outcrops and minor colluvium. Thickness 1–2 m

zri SILTY CLAY DECOMPOSITION RESIDUUM[3] AND CHERTY CLAY SOLUTION RESIDUUM[4]—Reddish-brown or dark-grayish-brown to light-brown, silty to clayey, locally loamy, slightly acid residuum derived from alternating beds of shale and locally cherty limestone. Grades down through fragmented zone into bedrock. Decomposition residuum commonly contains shale fragments; solution residuum, abundant chert and partly dissolved limestone fragments. On steep slopes, mapped areas include bedrock outcrops and locally derived colluvium. Thickness 0.5–5 m

zrj CLAY LOAM AND CHANNERY LOAM DECOMPOSITION RESIDUUM[3] AND SOLUTION RESIDUUM[4]—Pale- to dark-grayish-brown loam, clay loam, and channery loam; locally calcareous. Occurs around Arbuckle Mountains in Oklahoma in central-eastern part of quadrangle. Solution residuum overlies limestone, contains scattered fragments of solution-surfaced limestone, and extends down along fractures in underlying bedrock. In places the residuum contains rounded limestone pebbles derived from beds of limestone conglomerate and, along northern edge of Arbuckle Mountains, pebbles of granite, feldspar, and vein quartz derived from an underlying bedrock conglomerate. Channery loam is developed from shale, contains abundant shale chips, and grades down abruptly into unweathered shale. Mapped areas include locally derived colluvium and minor alluvium. Thickness as much as 2 m on limestone, commonly 0.5–1 m on shale

rcn CHERTY CALCAREOUS CLAY SOLUTION RESIDUUM[4]—Light-reddish-brown to red clay, silty clay, or sandy clay developed from limestone, marl, clay, or soft sandstone. Where developed from limestone, contains abundant solution-rounded subangular limestone fragments and scattered chert. In places, secondary platy calcium carbonate present in lower 0.5 m. Contact with underlying limestone sharp but penetrated along fractures by residuum. Contact with underlying marl, clay, or soft sandstone gradational. Mapped areas include numerous bedrock exposures, chiefly limestone, and colluvium on steep to moderate slopes of valleys that dissect the limestone. Thickness 0.2–2 m

rcv STONY CALCAREOUS CLAY SOLUTION RESIDUUM[4]—Chiefly dark-reddish-brown, pale-brown, to grayish-brown clay, in places enclosing areas of loamy residuum. Where underlain by limestone, lower part of residuum is in abrupt contact with zone of clay and remnant solution-rounded limestone fragments comprising 30–80 percent of the material. The fragment zone grades down into fractured limestone bedrock. Where underlain by shale, residuum and shale are in abrupt gradational contact; where underlain by chalk or marl, contact is more gradational. Mapped areas include bedrock outcrops and, where slopes are steep to moderate, accumulations of pale-brown, calcareous loamy colluvium, 1–2 m thick, that contains abundant fragments of limestone, shale, and secondary calcium carbonate. Thickness of residuum 1–2 m

usa FELDSPATHIC SANDY FINE GRUS[5]—Pink-tan, angular fragments 2–4 mm in diameter, in clayey, medium to very coarse sand matrix. Fragments composed of quartz, feldspar, and biotite in combination or as individual crystals weathered from granite, gneiss, and schist. Mapped areas commonly include colluvium and local bedrock outcrops. Thickness 1–2 m

[1]COLLUVIUM, for purposes of this map, is defined as material transported and deposited by mass-wasting processes.

[2]DISINTEGRATION RESIDUUM, for purposes of this map, is defined as material derived by the piece-meal breaking up of rock into particles with no appreciable lateral transport.

[3]DECOMPOSITION RESIDUUM, for purposes of this map, is defined as material derived primarily by in-place chemical weathering of clastic rock with no appreciable subsequent lateral transport.

[4]SOLUTION RESIDUUM, for purposes of this map, is defined as material derived by in-place solution of carbonate rock or carbonate-cemented rock, with no appreciable subsequent lateral transport.

[5]GRUS, for purposes of this map, is defined as material derived by in-place chemical and physical weathering of crystalline rock with no appreciable subsequent lateral transport.

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