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

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

State compilations by
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Edited and integrated by
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NOTE: This map is the product of collaboration of the Texas Bureau of Economic Geology and the U.S. Geological Survey, and is intended for both scientific and practical purposes. It was prepared in two stages. First, a map and map explanation was prepared by the State compiler. Second, information on the map was integrated with that of the adjacent map, supplemented, and related to a uniform map symbol classification by the editors. Map unit descriptions also were combined, supplemented, and coordinated with those of other maps of this series so that individual unit descriptions are applicable throughout both this map and all other maps of the series.

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, engineering construction and important problems of land use and land management are associated with regions that have extensive upland residual deposits. These materials differ widely in physical characteristics. Therefore, an effort has been made to classify, map, and describe them, based in large part on unpublished interpretations of individuals, published and unpublished subsoil data, and the distribution of bedrock parent materials. The classification is crude, but is a first step toward a more refined and useful product.

For scientific purposes, the map differentiates Quaternary surficial deposits based on a combination of criteria, such as lithology, texture, genesis, stratigraphic relationships, and age, as shown on the correlation diagram and indicated in the map unit descriptions. Some geomorphic features, such as beach ridges, are distinguished as map units. Erosional features, such as stream terraces, are not distinguished, and differentiation of sequences of alluvial deposits of different ages is rarely possible at a scale of 1:1,000,000.

For practical purposes, the map is a surficial materials map, on which 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.

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 Monterrey 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.

LIST OF MAP SYMBOLS

CONTACT

FAULT—Bar and ball on downthrown side

BEACH RIDGES, ACCRETIONARY—Mapped only in extreme northeast corner of map

DESCRIPTION OF MAP UNITS

HOLOCENE

f ARTIFICIAL FILL

asa ALLUVIAL SAND, SILT, CLAY, AND GRAVEL—Gray, brown, and yellowish-gray, coarse to fine sand and silt, chiefly quartz, and some subangular to well-rounded pebble gravel, pebbly sand, sandy gravel, interbedded and intermixed near the base. Contains dark-gray to dark-brown organic-rich silt and clay, interbedded or mixed. Calcareous; variable grain size and bedding. Alluvium of smaller streams is chiefly clay to clayey and silty sand and contains rounded pebbles composed of chert, limestone, quartzite, and petrified wood. Includes deposits of point bars, channels, and low terraces, and on large rivers, clayey silt of natural levees, crevasse splays, and clay-filled abandoned channels in flood plains. In the Nueces River valley, only the upper 4–6 m of silty sand and clay is Holocene in age. The underlying sand and gravel unit, 9–11 m thick, is late Pleistocene (**asg**). The combined alluvium partly fills a valley that was entrenched about 30 m into fluvio-deltaic deposits (**dsa**, **dla**) in late Pleistocene time, presumably when sea level was lower than present. In Rio Grande alluvial deposits, gravel consists of rounded sedimentary, mafic igneous, and volcanic rocks derived from Trans-Pecos area (50–250 km west of the quadrangle); Rio Grande flood plain and low terraces are underlain by 5–15 m of pale-brown well-sorted very fine sand to silt that grades to basal pebbly sand and sandy gravel. Fine alluvium in tributaries to Rio Grande is mottled tan, light-brown, and gray sandy clay and silt containing calcium carbonate and iron oxide nodules. Mapped areas include organic deposits of swamps. Maximum thickness of Holocene alluvium of Rio Grande is about 15 m, in Nueces River 4–6 m; in streams of smaller discharge, average thickness about 3–4 m

fl NATURAL LEVEE SILT AND CLAY—Brown to grayish-brown, light- to medium-gray silt and silty clay; includes fine quartz sand and locally, abundant plant fragments. Thin bedded to laminated; parallel, wavy, climbing ripple cross-laminations, and erosional truncations of laminae. Plant roots and burrowing fauna obliterate much internal structure. Common ferric and calcium carbonate nodules (2–4 mm to about 2 cm diameter) and plant root casts. Deposits form broad, vegetated levees 1 m high along present and former courses of Nueces River near Corpus Christi Bay. Levee deposits thin and slope gently away from channel; interbedded with silty organic clay of freshwater marshes (**hmu**) and buried deposits (not shown); silty sand of abandoned distributary channels of small prograding bayhead deltas and silty very fine sand of crevasse splays. Thickness 2–5 m

ace FLOOD-PLAIN AND BACKSWAMP SILT AND CLAY—Dark-gray to dark-brown or brownish-gray silt, clay, and silty clay. Contains minor amounts of medium to fine quartz sand. Interdistributary fine sediment of the Rio Grande delta. Mostly inactive; deposition occurs during floods that accompany large, relatively infrequent tropical storms. Burrowed by animals; locally very organic with abundant plant fragments. Includes organic-rich mud, lenses of peat, and small areas of freshwater- and brackish-marsh deposits. Extensively cultivated. Typically overlie older distributary sand deposits. Thickness 2–6 m

asp POINT-BAR AND DISTRIBUTARY SAND AND SILT—Yellowish-gray or brownish-gray quartz sand and silt; contains plant debris and some biotite. Accretionary point-bar, levee, and crevasse-splay deposits formed by distributary channels on the Rio Grande delta. Deposition occurs sporadically during brief floods following intense tropical storms. Deposits stand 1.5–3 m above adjacent deposits of interdistributary flood plains (**ace**). Numerous abandoned, sinuous channel segments are filled with silty clay or organic-rich clay and some become swamps or shallow lakes after heavy rains; total volume of the clayey channel-fills is relatively small. Point-bar deposits grade upward from crossbedded basal sandy gravel and coarse sand to silt and fine sand and locally are as thick as 12 m. Grades laterally into interdistributary silt and clay (**ace**). Levee deposits are brown, grayish-brown, and gray silt and silty clay and subordinate fine sand. Levee and crevasse-splay deposits are generally burrowed, in places containing parallel, wavy, and climbing ripple cross-laminations; locally massive. Thickness typically 5-9 m

ec DUNE CLAY AND SILT—Light-gray, brown, and brownish-gray calcareous silty clay to clayey silt and silty very fine quartz sand. Accumulations of fine to very fine quartz sand and sand-size aggregates of silt and clay deflated from saline flats. Deposits are called "clay dunes" because they appear unusually clayey, but laboratory analyses show them to be sand-silt-clay by Shepard's (1954) classification. Mean grain size of 13 samples from the upper 2 m of a dune west of Baffin Bay was 41 percent sand, 37 percent silt, and 22 percent clay (Garcia and Stelting, 1980). Illite is the main clay mineral; smectite and kaolinite are minor. Buried soils are common; dark-brown silty A horizons, 1–3 cm thick, some with plant root casts and terrestrial snail shells *(Rabdotus);* pale-brown to reddish-brown clay-enriched B horizons 10–30 cm thick. Locally, deposits contain ostracodes and laminae of clam shell fragments, chiefly *Anomalocardia.* Active dunes are elongate, crescent-shaped lunettes located on downwind margins of wind-tidal flats (**msf**) and playas which are source areas; dunes are the foredune type of Melton (1940). Inactive dune complexes are roughly circular low hills vegetated with grass, mesquite, shrubs, and cacti; agriculture is practiced on some deposits. Conditions that favor dune growth are arid to dry subhumid climate, persistent unidirectional winds, and expansive flats underlain by saline clay. Dunes cluster on eolian plains west and north of Baffin Bay, west of Laguna Madre, and on eastern deltaic plain of Rio Grande. Around Baffin Bay, dunes lie unconformably on a paleosol in the buried surface of late Pleistocene deltaic sediments (**dla**, **dsa**). Most dunes are 2–4 m high, a few are 8–12 m high and more than 1 km long. However, many in western Kleberg and Kenedy Counties are too small to show on this map. Radiocarbon dating of charcoal from three Archaic Indian hearth sites near Grullo Bayou of Baffin Bay (Smith, 1986), give an average accumulation rate of 0.3–0.6 m per 1,000 yrs for the late Holocene. Actual rates probably vary greatly over time. One site near Oso Creek (south edge of Corpus Christi) was buried by dune clay and silt, exposed subaerially, and buried again by dune silt, all within the last 2,800 years (H. A. Smith, oral commun., 1990). Thickness 1.5–12 m

es EOLIAN SHEET SAND—Pale-brown, very pale orange, and, west of about long 98°15' W., moderate-reddish-brown, moderate-brown, and light-yellowish-brown fine to very fine quartz sand and silt. Slightly clayey, loose, subangular to rounded; median grain diameter 0.14–0.17 mm (Russell, 1981b). Commonly grades downward to pale-brown, very firm, calcareous sandy clay loam. Generally well sorted. Grain size and thickness decrease westward; forms a thin discontinuous sheet of eolian silt (loess) downwind west of Baffin Bay, large dune fields (**ed**, **eda**), and deflation areas. Disconformably overlies older deltaic, fluvial, and brackish water deposits. Includes local areas of cover sand and sparse stabilized dunes (**ed**) too small to map separately. Numerous small lakes and ponds, perennial and ephemeral, occupy wind-eroded basins scattered over the eolian plain. Flat to very gently undulating plains. Thickness 0.5–5 m

bb BEACH SAND AND SHELL SAND—White, light-gray, pale-yellowish-gray, well-sorted, subangular, very fine to fine sand and minor silt. Chiefly terrigenous quartz sand, subordinate shell sand and fragments (locally shell material is dominant), with lesser amounts of chert, feldspar, and heavy minerals, sand grains of sandstone, siltstone, volcanic and plutonic rock, and foraminifera. Interbeds of quartz sand and shells common to abundant. Irregular bedding; some even, low-angle cross-stratification, cut-and-fill crossbedding. Dips irregular; some beds dip landward, but beds on the foreshore dip about 4–5° seaward. Shells concentrate on beaches of Padre Island near lat 27°12' N. where opposing longshore drift currents converge; on Little Shell Beach shells of the surf clam *Donax* (0.5–2 cm) are most abundant; on Big Shell Beach, abraded shells of clams (1–4 cm), mostly *Eontia, Mercenaria*, and *Echinochama,* are as much as 80 percent of the sediment. Underlies beaches, berms, spits, sand dunes, and barrier bars along coast. Grades seaward to marine quartzose to subarkosic very fine to fine sand; grades landward to silt, sand, and clay of wind-tidal flats (**msf**) and back-island slopes (**msc**).

Includes low, shrub-and grass-stabilized back-island dunes and active fore-island dunes, 4–12 m high on northern Padre Island. Fore-island dunes form tens of meters landward of the shoreline; composed of very well sorted, subrounded, fine quartz sand sparsely interbedded with shell sand and thin, discoid shell debris; heavy minerals (0.1–1 percent) are concentrated in black laminae; silt and clay, 4 percent or less, is admixed. Rates of dune migration averaged 10 m/yr westward on Padre Island from 1956 to 1975. Mapped areas include small vegetated back-barrier flats (**msc**). Thickness of deposit in drill holes near Corpus Christi 15–30 m; thickness near lat 27° N., 10–14 m. At south end of Padre Island, near Port Isabel, 3–4 m thick

msc BACK-ISLAND SLOPE SAND AND SILT—Light-gray to pale-yellowish-brown fine quartz sand, silty sand, and shelly sand. Interbedded storm deposits of sand, shell fragments, lenses of clay, and intermixed oyster and clam shells. Massive, mottled, worm burrowed; horizontally laminated, cross-laminated, and planar thin bedded. Deposits grade landward to lagoonal sandy clay. Sparse interbeds, 30–50 cm thick, of blue-gray burrowed clay deposited in depressions on back-barrier flats. Deposits are chiefly sheet-like wash-over fans which form when storm surges wash over the barrier island during hurricanes. Includes the landward part of wash-over channels (**msd**). Locally reworked by wind to form longitudinal, transverse, and barchan dunes, and coppice mounds; dunes are 2–4 m higher than adjacent flats. Back-island slopes lie on the landward side of Padre, Mustang, and St. Joseph (San Jose) Islands. Low relief to flat. Thickness 2–8m

msd WASH-OVER CHANNEL SAND AND SILT—Light-gray, very light gray, or brownish-gray fine quartz sand, silt, shell sand and shell fragments, interbedded and intermixed. Laminated or massive, mottled, includes oyster and clam shells. Channels form when sporadic hurricane-driven seawaves surge over barrier islands, eroding beach and dune sand, silt, and shells. All or most channels shown on the map were intensively eroded by a storm surge 3 m above mean sea level during Hurricane Allen, August, 1980, and by surges of preceding hurricanes in 1961, 1967, and 1970. After the storms, channels received sediment from normal eolian and shore deposition. Channel sand is interbedded with sheet sand which replaces it landward and in turn merges with lagoonal mud. Medial to distal parts of sand sheets are 10–50 cm thick. Deposit grades upward from a basal layer of clay pebbles and shells through shelly sand into fine sand and is characterized by channel and erosional disconformities. Irregular bedding dips 6–12°; sedimentary structures include channel-and-fill and irregular erosion surfaces. Thickness 1–4 m

msf LAGOON AND WIND-TIDAL-FLAT SAND AND CLAY—Very pale orange, light-brownish-gray, and light-greenish-gray sand; sparse medium-gray clay and silty, clayey fine to very fine quartz sand and shell sand. Abundant air-filled cavities; commonly burrowed with contorted bedding; mottled; massive, parallel and ripple cross-laminated, and thin bedded. Sparse to common interlaminated clay, algal-bound sand, filamentous blue-green algal layers near top, shells, and foraminifera-rich sand. Minor chemical precipitates, white microcrystalline aragonite and calcite laminae, oolites, and crystals of gypsum 1–2 cm across. Local calcareous nodules and veinlets, dark-gray organic clay beds. Deposits accumulate on alternately dry and flooded barren flats, 0.3 m below to 1 m above mean sea level. The subaerial flats are sporadically flooded by wind tides—lagoonal water that is moved landward by persistent onshore winds (southeasterly in summer), and short-lived northerly winter winds—or by sporadic tropical storms; low atmospheric pressure heightens floods. Small astronomical tides of 0.2–0.3 m in bays and in Laguna Madre cause little sedimentation whereas wind tides deposit clay broadly. When flats are flooded, clay and algae settle on bottom. When winds diminish, the water recedes. Fiddler crabs (*Uca*) burrow the sediment. Sand, blown from nearby dunes and beaches, then covers clay and algae deposits on emergent flats. Low flats are chiefly sandy clay with abundant clam shells and sand-sized clay aggregates and fecal pellets; higher flats are sandy. Deposits overlie lagoonal clay and interfinger seaward with marine sand (**msc**). Tidal channels cut deposits in places and are filled with quartz sand and some shells (oysters, bryozoa, and coral). Mapped areas include active eolian sand dunes on the landward side of barrier islands. West and north of Baffin Bay, sporadic storms cause torrential flooding of ephemeral tributary streams Agua Dulce and Los Olmos Creeks. The floods carry extensive sheets of fine clastic quartz sand, 1–2 m thick, onto the wind tidal flats there. Thickness of wind-tidal-flat deposits on map typically 2–5 m

hmu FRESHWATER-, BRACKISH-, AND SALINE-MARSH SILT AND CLAY—Gray, brown, black, bluish-, or greenish-gray silt and clay and organic-rich sand layers, intermixed and interbedded. Underlying most saline marshes are layers of sandy clay that alternate with peat consisting of compressed mats of shoal grass, glasswort, and cordgrass. Deposits occur along coastal lowlands, tidal creeks, levees, and in elongate swales landward of relict shoreline (**bma**). Includes small wind-tidal-flat deposits (**msf**), and prograding bayhead delta deposits of the Nueces River. Bayhead delta deposits grade upward from shelly, sandy clay at the base into ripple cross-laminated silty sand and mud, locally overlain by fine-grained levee and marsh deposits. Thickness under modern marshes 0.25–3 m but thicker locally as indicated by drill-hole data

HOLOCENE AND LATE PLEISTOCENE(?)

ed DUNE SAND, STABILIZED—Pale-brown, yellowish-brown, and moderate-reddish-brown to moderate-brown, fine to very fine quartz sand. Well sorted, subangular to rounded, mean grain diameter 0.14–0.17 mm (Russell, 1981b). Grades downward to very firm, pale-brown sandy loam that contains soft, irregularly shaped calcium carbonate masses. Near the coast, composed of about 80 percent quartz, 10 percent chalcedony and chert, 10 percent potassium feldspar, and less than 5 percent calcium-sodium feldspar. Locally, contains scarce interbeds of laminated silty very fine sand, some containing plant root casts cemented by calcium carbonate. Marked and consistent alignment of longest dimension of dunes, elongate deflation basins, and vegetation patterns parallel to prevailing southeasterly winds. Subdued relief, gently undulating uplands, linear dunes; relict eolian grain is apparent on aerial photographs. In a few restricted areas, wind deflation forms hummocky terrain and scattered depressions; some are freshwater marshes in wet years. Sand dunes are stabilized by dense live-oak, shrubs, and deeply rooted native grasses, except in Hidalgo County where they are intensively cultivated. Thickness generally 2–8 m, locally may be as thick as 20 m in buried valleys cut into Beaumont Formation (**dsa**, **dla**)

eda DUNE SAND, ACTIVE—Light-gray, very pale orange, pale-brown, and reddish-brown fine quartz sand, well sorted, subangular to rounded, massive. Locally, laminated, silty very fine sand. Near the coast, in eastern Kenedy County, banner-dune complexes are common. Banner-dune complexes are shaped like pointed flags, pointed windward to the southeast, with uneven "ragged" downwind margins to the northwest (Price, 1958). They contain deflation basins and fields of smaller barchan and longitudinal dunes that are migrating northwestward. Prevailing onshore southeasterly winds deflate sand from Pleistocene meander-belt deposits and carry it northwestward. Thickness 2–9 m

esb EOLIAN SAND AND SILT—Pale-brown to very pale orange fine quartz sand and silt, well sorted, subangular to rounded. Contains plant root casts 2–4 mm in diameter cemented by calcium carbonate. Forms actively deflating sand sheets; nearly flat; locally includes sparse, low active dunes (**eda**). Areas between sand sheets and seaward wind-tidal flats often are flooded by wind-driven tides. Thickness 2–6 m

HOLOCENE TO MIDDLE PLEISTOCENE

xga CEMENTED PEBBLY LOAM DISINTEGRATION RESIDUUM[1]—Yellowish- and brownish-red, reddish-brown, silty and clayey quartz sand, fine sandy clay; locally pale brown loam, clay loam, and sandy clay loam. Friable to very firm. Calcareous; contains varying proportions of angular pebble-size fragments of platy secondary calcium carbonate, chert, and locally, medium to very coarse grained quartzose sandstone. Where developed on conglomerate, as much as 20–50 percent of material is rounded chert, quartz, and quartzite pebbles and granules in discontinuous beds 5 cm to 1 m thick, or admixed in gravelly sandy clay. Cemented by secondary calcium carbonate that is light gray, white, pink, or very pale brown; typically occurs wholly or in part 0.2–2.5 m below surface, in various forms including platy, massive, laminar and hard, brecciated, soft chalky masses, or separate nodules. Thin surficial windblown sand deposits, sparse and widely dispersed. Underlies gently rolling uplands and plains pitted by shallow, nearly circular and elongate, closed depressions about 100–300 m across, spaced 1–3 km apart, and partly filled with yellowish-brown, gray, or red mottled calcareous sandy and silty clay with or without sparse fine chert pebbles. Grades down into interbedded claystone, marl, quartz sand, calcrete zones, and sandstone (Goliad Formation). Thickness 0.5–5 meters

xsb QUARTZ SAND DISINTEGRATION RESIDUUM[1]—Pale-gray to reddish-brown, reddish-yellow, and very pale brown quartz sand, locally clayey to silty. Calcareous and locally contains muscovite. Contains broken fragments of weakly cemented sandstone bedrock and irregular, hard, limonite- and calcium-carbonate-cemented masses, nodules, and veins ranging from a few centimeters to 2 m in thickness. Cemented zones form resistant escarpments and rolling uplands. Mapped areas locally include small, thin deposits of eolian sand and silt of Holocene age and cemented sandy clay residuum. On uplands, developed chiefly on interbedded sandstone, sandy clay, and tuffaceous siltstone and claystone and, near major river valleys, developed in colluvium on hillslopes. Locally, lag deposits of black chert pebbles and granules present on conglomerate bedrock. Thickness 1–3 m

xcb CALCAREOUS CLAY DISINTEGRATION RESIDUUM[1]—Light-brown to brown, yellowish-brown, light-reddish-brown, or mottled light-red to orange clay, sandy clay, and locally fine quartz sandy clay, commonly limonite stained. Contains chips of pale-yellowish-brown and olive shale and small fragments of mudstone, siltstone, and sandstone. Grades down to fractured siltstone, sandstone, and shale through a thin fragmented zone. May contain sparse small pebbles. Contains limonite nodules and platelets in places. Residuum may be cut by few to many seams of fine gypsum crystals and fine-grained calcium carbonate. Clay is calcareous, alkaline, locally smectitic; swells when wet, shrinks on drying. Mapped areas may contain colluvium, local alluvial terrace gravels (**asg**) of rounded clasts of quartz and chert, and outcrops of thin-bedded sandstone that form benches, especially in tributary watersheds of the Rio Grande. Some of these local deposits are cemented by laminar calcium carbonate. Thickness 0.1–3 m

xle FINE SANDY LOAM DISINTEGRATION RESIDUUM[1]—Reddish-yellow to yellowish-red, fine sandy clay loam to fine sandy loam, locally calcareous; common soft concretions and amorphous masses of secondary calcium carbonate (5–20 percent by volume), hard and laminar in many places. Contains iron oxide concretions. Moderately alkaline. Formed on gently sloping to undulating uplands. Residuum grades down into reddish-brown, brown, or yellow, fine-grained, ferruginous sandstone, varicolored clay, and silty to sandy shale. Near the Rio Grande, forms escarpments and narrow, gravel-capped drainage divides. Mapped areas generally include colluvium and local bedrock outcrops. Thickness 1–3 m

LATE PLEISTOCENE

BEAUMONT FORMATION—Includes three facies (beach ridge, distributary channel, and interdistributary) beneath a delta plain that slopes gently seaward and extends along the Gulf Coast. Delta plain is pitted with scattered shallow lakes and dry lake beds that occupy local, wind-eroded basins. Some workers conclude that the plain is coalesced low-gradient fans, and should be termed an alluvial plain. Deposits contain Pleistocene vertebrate fauna including mammoth, bison, horses, and turtle. Dips seaward beneath clastic and organic deposits of Holocene age and rests disconformably on similar middle Pleistocene deposits of the Lissie Formation (**alm**)

bma Beach and near-shore marine sand (relict beach ridge and associated sand facies)—White, light- to dark-gray, very pale brown, fine to very fine quartz sand; well sorted. Contains shells and minor discontinuous beds of clay 1–3 m thick. At Ingleside, north shore of Corpus Christi Bay, beach sand is overlain by freshwater pond marl, clay, and gray and yellow calcareous clayey sand.

The clayey sand contains one of the most diverse vertebrate fauna (of probable Wisconsin age) known from a single locality in Texas (Lundelius, 1972). Deposit generally underlies beaches, beach ridges, spits, and fore-island dunes. Part of the Pleistocene Ingleside-Live Oak barrier strandplain system that extends discontinuously, parallel to present coastline, from Baffin Bay, Texas to Lake Charles, Louisiana. Surface characterized by pimple mounds and live oak-covered, relict linear beach ridges, 3–9 m high, parallel to modern shore; grassy swales between ridges partly filled with recent sheetwash and eolian sand and mud. Exact genesis and age of the relict sand body are uncertain. Two hypotheses are (1) a coastal barrier island developed as deltas of the Beaumont Formation prograded into a high stand of sea during the Sangamon interglacial (marine oxygen isotope substage 5e, about 130-120 ka), and (2) a near-shore shallow marine sand sheet (strandplain) formed in a mid-Wisconsin high sea-level stand. Measured thickness in boreholes ranges from 10 to 25 m, 5 km northeast of Aransas Pass (north edge of map); farther south, thickness ranges from 1 to 7 m

dsa Delta sand and silt (distributary channel facies)—Yellowish- to brownish-gray, locally reddish orange, very fine to fine quartz sand, silt, and lesser amounts of chert and caliche pebbles, intermixed and interbedded. Poor to moderate sorting. Includes stream-channel, point-bar, crevasse-splay, natural-levee ridge deposits, and clayey fill in abandoned channels. Abandoned channel fill is dark-brown to brownish-dark-gray laminated clay and silt, organic rich and underlies sinuous and straight low swales or oxbow lakes. Secondary calcium carbonate cements alluvium to form very light gray to very light yellowish gray nodules, root casts, dispersed pisoliths, branching burrows, fracture fillings, hard laminar zones and soft irregular masses. Forms poorly defined meander-belt ridges and pimple mounds aligned normal to coast and 1–2 m higher than surrounding interdistributary silt and clay (**dla**). South and west of Baffin Bay, deposit is mostly buried by windblown sand and silt. Southwest of Kingsville, at two sites where mammoth bones were excavated, fossil snails and other paleoecological evidence suggests that alluvium was deposited by perennial, meandering rivers. Near the coast, includes lagoonal clays and near-shore marine sand. Interfingers with interdistributary silt and clay facies of Beaumont Formation (**dla**), and rests disconformably on Lissie Formation (**alm**). Thickness 3–10 m on outcrop; thickens' seaward in subsurface to more than 100 m

dla Delta silt and clay (interdistributary facies)—Light- to dark-gray and yellowish-brown clay, silt, and sandy clay intermixed and interbedded; contains lenses of fine sand, decayed organic material, and numerous buried organic-rich soil zones that contain calcareous and ferruginous nodules. Includes plastic and compressible clay and mud deposited in coastal river flood basins, coastal lakes, and former stream channels on a deltaic plain. Underlies and interfingers laterally with delta sand and silt of distributary channel facies (**dsa**). Mapped areas include minor coastal marsh (**hmu**) and lagoonal (**msf**) deposits near edge of mainland. Calcium carbonate-cemented sediment is common to abundant, forming very light gray to very light yellowish gray fracture fillings, laminar zones, burrows, root casts, nodules, dispersed granules, and irregular masses. Calcium carbonate-cemented layers generally conform to bedding. The layers are 0.25–2.5 m thick, have distinct to gradational boundaries, and may have formed by carbonate precipitation from vadose water in successive paleosols on an aggrading fluvial plain. A vertical sequence about 7 m thick is exposed in a borrow pit 6 km southeast of Kingsville. Such calcareous sequences may occur widely in the subsurface. South and west of Baffin Bay, deposit buried by eolian sand (**es**). Thickness 5–10 m along landward limit of outcrop; thickens' seaward in subsurface to more than 100 m

afb ALLUVIAL-FAN GRAVELLY LOAM—Yellowish- to brownish-gray, pale-brown medium sand, silty and gravelly, and clayey sand; intermixed and interbedded; massive or poorly bedded deposits of locally braided streams and alluvial-fan heads. Contains interbeds of pebbly sand to sandy silt. Clasts chiefly scattered subangular to subrounded pebbles and cobbles of chert, limestone, and dolomite. Commonly, layers of concretions and sand in the upper meter are cemented by soft to hard, white to pale-yellow calcium carbonate. Deposits are probably derived from gravel beds of the Pliocene Goliad Formation along the western edge of its outcrop; some of the thin deposits may be erosional outliers of the Goliad. Deposits form broad, very gently sloping alluvial fans in the headward tributaries of intermittent drainages and on very low, gently undulating divides between such drainages. Thickness 3–10 m

LATE PLEISTOCENE TO EARLY PLEISTOCENE(?)

asg ALLUVIAL CLAY, SILT, SAND, AND GRAVEL (alluvial terrace deposits and valley fill of Beaumont, Lissie, and Willis age, undifferentiated)—-Light-brown, reddish-brown, gray, yellowish-brown, gravelly quartz sand and silt to sandy gravel; mottled pinkish-orange or yellowish-tan clay lenses. Gravel fraction is rounded to subangular pebbles, cobbles. Crossbedded to massive; locally contains sparse boulders. Low terraces are capped by clayey sand. Nueces River clasts are brown, black chert, volcanic rock, claystone, sandstone, calcium carbonate-cemented alluvium, and silicified wood, locally cemented by iron oxide. In the entrenched valley of the Nueces River, terrace surfaces are about 5, 10, and 15 m higher than the river; some workers recognize four terraces. Terrace deposits comprise a basal crossbedded sandy gravel overlain by crossbedded sand and contain late Pleistocene bone material of mammoth, bison, turtle, and others. Teeth of Pliocene horses are believed to be eroded from older formations upriver. The terraces, called Deweyville terraces by some workers, display relict meander scrolls much larger than those of the modern Nueces River. The relict meanders may record ancestral river flood discharges that exceeded present ones, on average. Beneath the valley floor, alluvium similar to that under terraces is the basal 10–12 m of valley fill. It is buried by surficial Holocene flood-plain sand (asa). The buried fill is exposed in gravel pits 40 km west of Corpus Christi; it contains bones of mammoth, bison, glyptodont (giant "armadillo"), tapir, giant tortoise, peccary, llama, horses, and other vertebrates of late Pleistocene age (Russell, 1981a; Baskin and Cornish, 1989). Fossil wood from 11 m below the flood plain was dated at 13,230±110 radiocarbon yrs BP (J.A. Baskin, oral commun., 1990). In Webb County, deposit includes colluvium and reworked older terrace alluvium. Rio Grande deposits are chiefly sand, locally pebbly sand; gravel is subrounded limestone and chert and rounded basalt, volcanic porphyry, quartzite, milky quartz, and banded chalcedony. Thickness 3–18 m

MIDDLE PLEISTOCENE

LISSIE FORMATION—Distributary sand and interdistributary mud facies which together form deposits of the oldest fluvio-deltaic plain that parallels the Gulf Coast. Because of their small size and sparse exposure, the facies are mapped as a single unit. The deposits contain Pleistocene vertebrate fauna and dip gently seaward beneath deltaic deposits of the Beaumont Formation (**dsa**, **dls**)

alm Alluvium (undifferentiated as to texture and origin)—Light-gray, brown, tan, yellowish-brown, and reddish-brown sand, silt, and clay, intermixed. Contains iron oxide and iron manganese nodules in the upper 2–3 m. Calcareous; in places sediment is extensively cemented by calcium carbonate, forming hard concretions, nodules, pisoliths, disseminated granules, root casts, laminar calcrete and soft irregular masses. Includes interbedded, compact clayey sands, sandy clays, and organic-rich lenses. Sorting variable. Local crossbedding, and graded bedding. Includes meander-belt, levee, crevasse-splay, and distributary sand and flood-basin mud deposits. In Hidalgo County, underlies a semiarid plain, widely irrigated and cultivated. Locally veneered with thin, discontinuous stabilized eolian sand (***ed***). Thickness[2] about 60 m

EARLY PLEISTOCENE AND PLIOCENE(?)

agg ALLUVIAL SANDY GRAVEL (Uvalde Gravel as mapped by Texas Bureau of Economic Geology, 1976a, 1976b)—Pale-brown, light-yellowish-brown, reddish-brown, sandy gravel and gravelly sandy clay loam; upper few meters cemented by secondary calcium carbonate, ranging from soft laterally persistent or spotty zones to hard calcrete that will not slake in water. Thickness of calcareous zones 0.5–3 m. Abundant rounded pebbles and cobbles composed of chert, quartz, limestone, and, locally, igneous rock; some boulders. In Webb, Zapata, and Starr Counties erosional remnants of channel gravel of the ancestral Rio Grande cap rounded ridges, upland flats, and high alluvial terraces immediately north of Rio Grande. The terraces are dissected by many ravines; interfluve hillslopes range from 3 to 20 percent. Thickness 0.5–6 m

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

[2]Thickness is approximate because exposures are few in the lower coastal plain. Deposit thickens seaward, the base is usually buried, and underlying deposits commonly are similar. Drill-hole data, dated materials, and age-diagnostic fossils commonly are inadequate to aid in locating base of unit. In practice, the base is assigned in drill holes at the top of a buried paleosol, a significant change in dominant grain size or color, at a seismic-reflector horizon, or where other characteristics suggest a significant unconformity. For example, a marked decrease in rate of penetration during drilling in a cohesive clay indicates a layer of unusually large shear strength. This may be interpreted as a zone that lost pore water while exposed subaerially. In drill holes where such criteria are missing, the base of a deposit and thickness are unknown or are arbitrarily assigned.

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