Summary Report for the 2010–2011 STATEMAP Project:

Geologic Mapping to Support Improved Database Development and Understanding of Urban Corridors, Critical Aquifers, and Special Areas of Environmental Concern in Texas

Final Report

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Edward W. Collins, Jeffrey G. Paine, and Thomas A. Tremblay

Prepared for
U.S. Geological Survey
under Cooperative Agreement No. G10AC00368

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ABSTRACT

Two geologic maps have been produced for this study. The Project 1 map of the east part of the Cleburne 30 × 60 minute quadrangle, North-Central Texas, scale 1:100,000, was constructed through mapping and compilation of twenty 1:24,000-scale geologic work maps. The map and related data provide a basic geologic framework to aid in managing water and Earth resources, planning land use, identifying aquifer recharge areas, and identifying sources of aggregate and other earth resources. Geology of the area consists of Cretaceous (Albian to Coniacian) limestone, argillaceous limestone, marl, shale, and sandstone exposed across the study area, composing more than 1,500 ft of Cretaceous shelf and shore-zone deposits. This stratigraphy includes the Woodbine and Paluxy Sandstones—sources of sand within the unit's outcrop belt and important aquifers in the subsurface. Edwards and Comanche Peak limestones are also resources for lime and aggregate. Some local limestone pits are within the Georgetown Formation as well.

The Project 2 map of the Matagorda–Matagorda SW quadrangles includes the Colorado River Delta and Matagorda Peninsula of the Texas Gulf Coast. This map is intended to be used as a source of basic geologic information for managing land resources of the area and for studying shoreline changes, geologic depositional environments, land changes due to human activities, and active faulting. Geology of the area consists of Pleistocene Beaumont Formation distributary, interdistributary, and abandoned-channel sand, silt, and clay and Holocene to Modern beach, dune, tidal-flat, washover, distributary, levee, marsh, swamp, and floodplain-sand, silt, and clay deposits. Marsh, tidal-flat, and back-barrier deposits are faulted.

INTRODUCTION

This STATEMAP work dealt with mapping in two project study areas. Project 1 involved mapping within a part of the major transportation and population corridor that extends from North to South-Central Texas (figs. 1 and 2). Geologic maps constructed for this project help fulfill some of the high-priority needs for geologic mapping in Texas and complement ongoing studies of land and water resources and the mapping of nonenergy mineral resources in Texas. Mapping for Project 1 was done for the east part of the Cleburne 30 × 60 minute quadrangle, which lies adjacent to the Dallas-Fort Worth metropolitan area along part of Interstate 35W, a major population and transportation corridor. Basic geologic knowledge gained from new geologic maps of this fast-growing urban-suburban corridor will address the need for an accurate geologic map data set for proper management of water and earth resources and responsible land use. The Cretaceous Woodbine sandstone aquifer, which is being stressed from pumpage, is an aquifer important to the area.

Another Texas STATEMAP study area, Project 2, lies within the Texas Gulf Coast corridor and includes the Matagorda–Matagorda SW quadrangles of the Colorado River Delta area (figs. 1 and 2). This coastal area contains environmentally sensitive geologic environments, such as salt and brackish marshes, that are being stressed by natural processes and human activities. The area also contains economically important features and infrastructure of the recreation, marine-shipping, and petroleum industries. New geologic maps for these areas will address geologic framework needs for planning and management of land use, evaluating historical changes of coastal depositional environments, addressing erosion issues, permitting activities related to resource development, and educating the public. The detailed maps will be used to evaluate shoreline changes, changes in geologic depositional environments, and effects of human activities on coastal geologic environments, as well as to establish baseline data useful for managing this environmentally sensitive coastal area.

Figure 1. Location of geologic mapping, Projects 1 and 2.

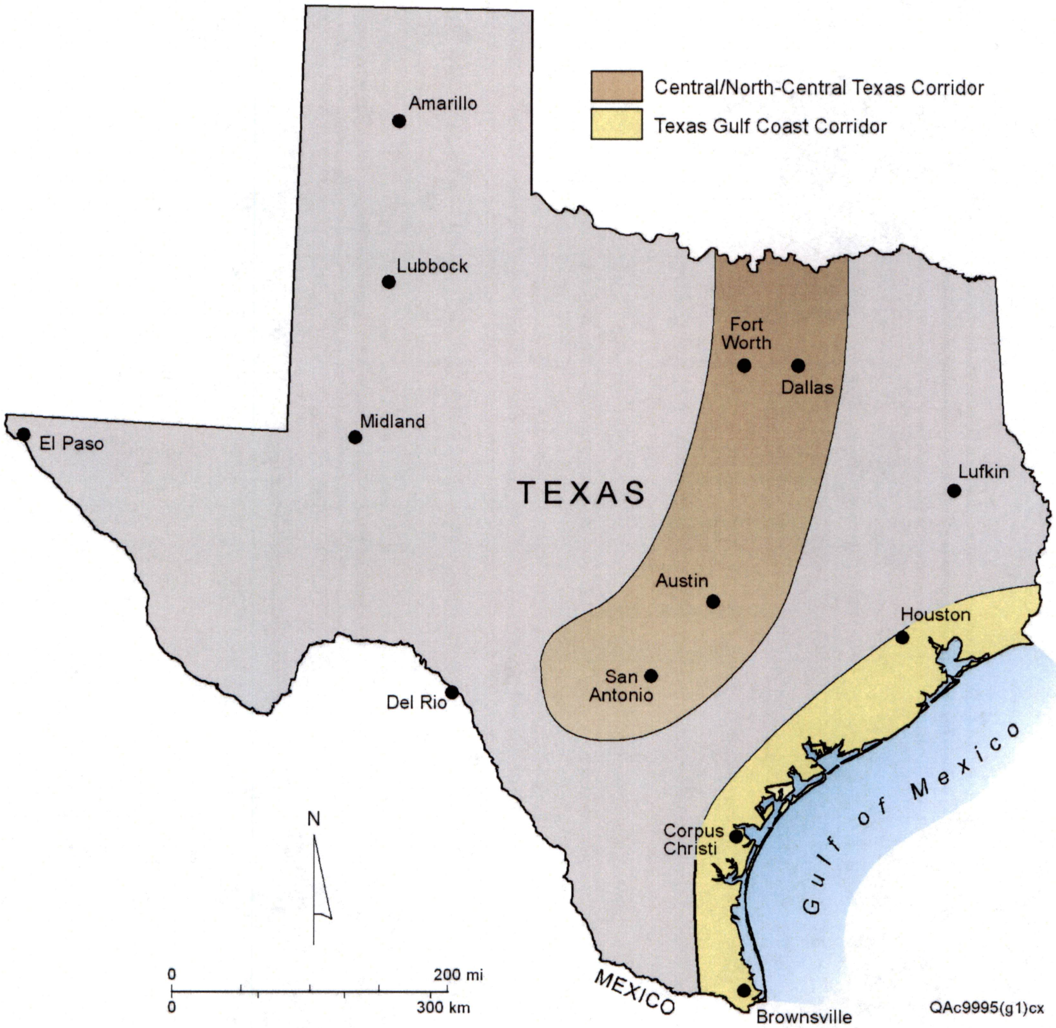

Figure 2. Priority regions for mapping in Texas.

PROJECT 1: GEOLOGIC MAPPING OF THE EAST PART OF THE CLEBURNE 30 × 60 MINUTE QUADRANGLE, SOUTH FORT WORTH–TEXAS INTERSTATE 35W CORRIDOR

The deliverable for Project 1 is the *Geologic Map of the East Part of the Cleburne, Texas, 30 × 60 Minute Quadrangle: South Fort Worth–Interstate 35W Corridor*, scale 1:100,000 (in pocket). This map presents basic geologic information that can be used by laypersons, as well as professionals, who are involved in managing earth and water resources, planning land use, and designing construction projects. Included with the map are diagrams of the map location and the 7.5-minute quadrangles that were mapped, a detailed map explanation, a cross section, a stratigraphic column illustrating general lithology of the mapped units, a geophysical log displaying log responses for the subsurface stratigraphy at the eastern map area (down regional dip), three inset maps illustrating elevations of three key subsurface horizons (base of the Cretaceous, top of the Paluxy Formation, and base of the Woodbine Formation), summary text, and selected references. Geology illustrated on the map is based on field and aerial-photograph interpretations after review of previous works about the area's geology, including works cited on the map (in pocket). Two previous regional maps that cover the map area are the 1:250,000-scale Dallas sheet (McGowan and others, 1972) and the 1:174,000-scale geologic map of Johnson County (Winton and Scott, 1922). Twenty 1:24,000-scale geologic quadrangle work maps were constructed and digitized to produce this 1:100,000-scale map of the east part of the Cleburne 30 × 60 minute quadrangle. New mapping was done for eleven 1:24,000-scale quadrangles. Nine Bureau of Economic Geology 1:24,000-scale work maps were also reviewed, revised with new mapping, and adapted to the 1:100,000-scale map compilation (in pocket). The topographic base was created from digital files of the Texas Natural Resources Information Services (TNRIS) for U.S. Geologic Survey 7.5-minute topographic quadrangle maps. Digital files of roads, railroads, county boundaries, drainage, and lakes were also obtained through TNRIS. Shallow geophysical logs aided in refining the mapping for areas with thick vegetation, soil cover, and limited outcrops and aided construction of the cross section and inset maps.

The map area borders the Dallas-Fort Worth metropolitan area, the second-largest urban area in Texas, and is crossed by Interstate 35W, a major north-south road corridor through Texas (figs. 1, 3, and 4). U.S. Highway 67 is a major northeast-southwest-trending transportation route across the area that links the study area to Dallas. This area consists of hilly and flat terrain and three distinct, north-south-trending, physiographic belts described in some of the classic works of R. T. Hill (1900, 1901). The physiographic provinces include, from east to west, the Blackland Prairies, Eastern Cross Timbers, and Grand Prairie. The west margin of the map area is also crossed by the Brazos River Valley. In general, soils of the physiographic areas are linked to the surface geologic units that are exposed within north-south-trending outcrop belts. Within the Grand Prairie, rocky soils are developed on limestone units, and some clay-rich soils are developed on units that contain clay, marl, and shale. The hilly Eastern Cross Timbers region, coinciding on its west margin with a west-facing cuesta, contains post oak woods and sandy soils developed on the Woodbine Sandstone. In the west part of the Blackland Prairies, Eagle Ford shale has weathered to form relatively deep, black, clay-rich soil. The Blackland Prairie also contains a west-facing escarpment as much as 200 ft high. This Whiterock Escarpment is capped by the Austin Chalk, which overlies the Eagle Ford Shale at the escarpment.

Geologic units exposed across the map area comprise about 1,500 ft of Cretaceous marine shelf and shore-zone deposits (figs. 3, 4, and map in pocket). These strata dip gently east-southeastward toward the East Texas Basin and lie west of major fault zones bounding the East Texas Basin (Reaser and Collins, 1988; Ewing, 1991). Lying beneath Cretaceous rocks in the subsurface are Paleozoic rocks and the buried Ouachita Fold and Thrust Belt (Flawn and others, 1961) .

Depositional facies of the mapped Cretaceous deposits and the effects of cyclic, relative-sea-level fluctuation on them have been well documented by previous workers (Hayward, 1988a,b; McFarlan and Menes, 1991; Sohl and others, 1991; Scott, 1993; Yurewicz and others, 1993). The exposed Lower Cretaceous rocks record deposition of three stratal groups: the Trinity, Fredericksburg, and Washita. Only the uppermost limestone and marl of the Glen Rose, upper Trinity Group, are within the map area. Hayward (1988a) reported that upper Glen Rose strata studied near the map area indicate deposition at a marine shelf to basin transition zone. He noted that sandy limestone layers of the uppermost Glen Rose indicate regression near the end of Glen Rose deposition. Overlying Fredericksburg Group strata, composed of Paluxy sandstone, Walnut clay and limestone, Comanche Peak limestone, and the rudist-bearing Edwards limestone, record another transgression marked by initial sand deposition followed by marl and limestone deposition in estuarine and normal marine conditions. Washita Group strata above the Fredericksburg Group also record relative-sea-level fluctuations. Lower Washita rocks are composed of Kiamichi clay and Georgetown limestone, argillaceous limestone, and lesser clay and marl. Georgetown strata are equivalent to the stratigraphic section north of the map area that is composed of Duck Creek limestone, Fort Worth limestone, Denton clay, Weno limestone and shale, and Main Street limestone (Hayward and Brown, 1967; Hayward, 1988a; Salvador and Quezada Muneton, 1989; McFarlan and Menes, 1991). Georgetown rocks within the map area have been subdivided into three informal subdivisions for mapping: (Kgt1) a lower limestone and lesser argillaceous limestone interval; (Kgt2) a middle-clay, marl, and lesser limestone interval; and (Kgt3) an upper limestone and lesser argillaceous limestone and marl interval (map in pocket).

Upper Washita strata are composed of Grayson shale and marl, marking the lower part of the Upper Cretaceous. Most upper Washita Buda deposits were eroded from this area prior to Woodbine deposition, although one minor erosional remnant of Buda limestone was noted by Adkins and Lozo (1951). Above this basin margin unconformity, the Upper Cretaceous strata are composed of the Woodbine, Eagle Ford, and Austin Groups. Woodbine sandstone shale and clay were deposited in a barrier and prodelta-shelf setting (Oliver, 1971; Hayward, 1988b). Overlying the basin-margin unconformity at the top of the Woodbine is Eagle Ford Group shale that was deposited within a shelf setting (Adkins and Lozo, 1951; Hayward, 1988b). The upper contact of the Eagle Ford is another basin-margin unconformity with the Austin Group. Austin Group chalk, marl, and limestone were deposited in an open marine setting (Dawson and others, 1983; Hovorka, 1998).

Locally overlying the Cretaceous bedrock units in the study area are stream alluvium and terrace deposits. The latter consist of broad, well-developed terraces at varied elevations adjacent to the Brazos River and terraces associated with some of the larger tributary streams and creeks. Although the deposits are relatively minor, these local units have supplied some needed sand and gravel resources to the region. Other important earth resources include Cretaceous limestone for lime and aggregate, particularly Edwards and Comanche Peak limestone, and some local limestone pits are within the Georgetown Formation as well. Woodbine and Paluxy Sandstones are sources of sand within the unit's outcrop belts, in addition to being important aquifers in the subsurface (Hall, 1976; Baker and others, 1990). Sandstones at the base of the Cretaceous section compose another important aquifer for the area, the Trinity aquifer (map, in pocket). The base of Cretaceous rocks marks the base of fresh and usable-quality (3,000 tds) water in the map area. Diagrams on the map illustrate elevations of the base of the Cretaceous rocks, the top of the Paluxy sandstone aquifer, and the base of the Woodbine sandstone aquifer. Lower Cretaceous limestone intervals may also be water bearing, and Austin chalk also contains groundwater locally (Mace, 1998).

Geological considerations are key to managing and planning use of land and to designing construction projects within the map area. In their statewide mapping (1:500,000 scale) of land resources of Texas, Kier and others (1977) mapped geohydrologic, mineral-land, physical-property, geomorphic, process, and biologic units and noted characteristics of the units. These land-resource units relate in general to surface geology, and this geologic map can be used in conjunction with the statewide, larger-scale, land-resource map for review of land-use properties of geologic units. For example, within the map area, Eagle Ford and Grayson outcrop belts are expansive clay-mud areas. Some general properties include high shrink-swell potential and infiltration capacity, as well as low slope stability and foundation strength. The Woodbine Sandstone is a secondary aquifer recharge area with high to moderate infiltration capacity and foundation strength and low to moderate shrink-swell capacity. The Glen Rose through Georgetown outcrop belts of the western map area are composed mostly of hard limestone and limy mud, in which general slope stability and foundation strength may be high in limestone areas and low to moderate in limy mud areas. Infiltration may be moderate in limestone areas and low to moderate in limy mud. The Austin Chalk and Edwards Limestone, east and west parts of the study area, respectively, are massive limestones with the potential of being mined for lime used in cement. A few general properties are high foundation strength and slope stability and moderate to difficult excavation potential.

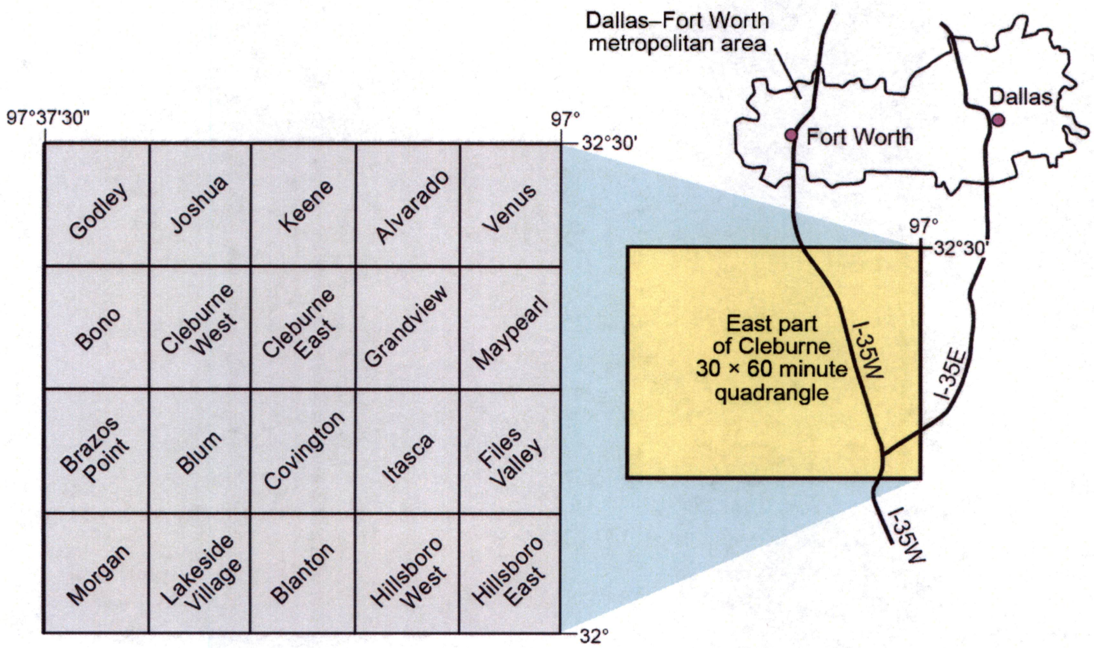

Figure 3. Setting and quadrangles of map area, Project 1.

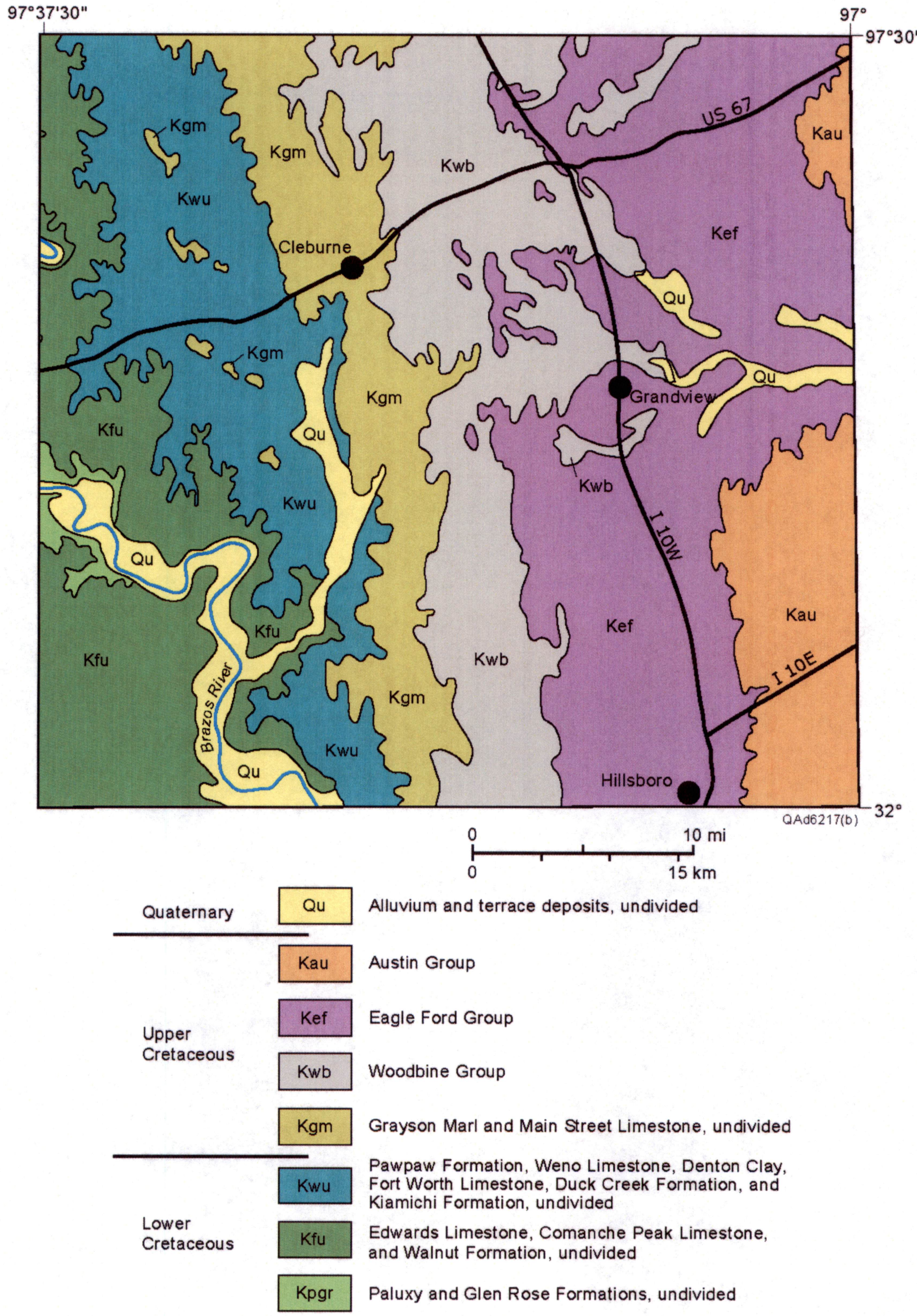

Figure 4. Simplified geologic map of the study area, Project 1.

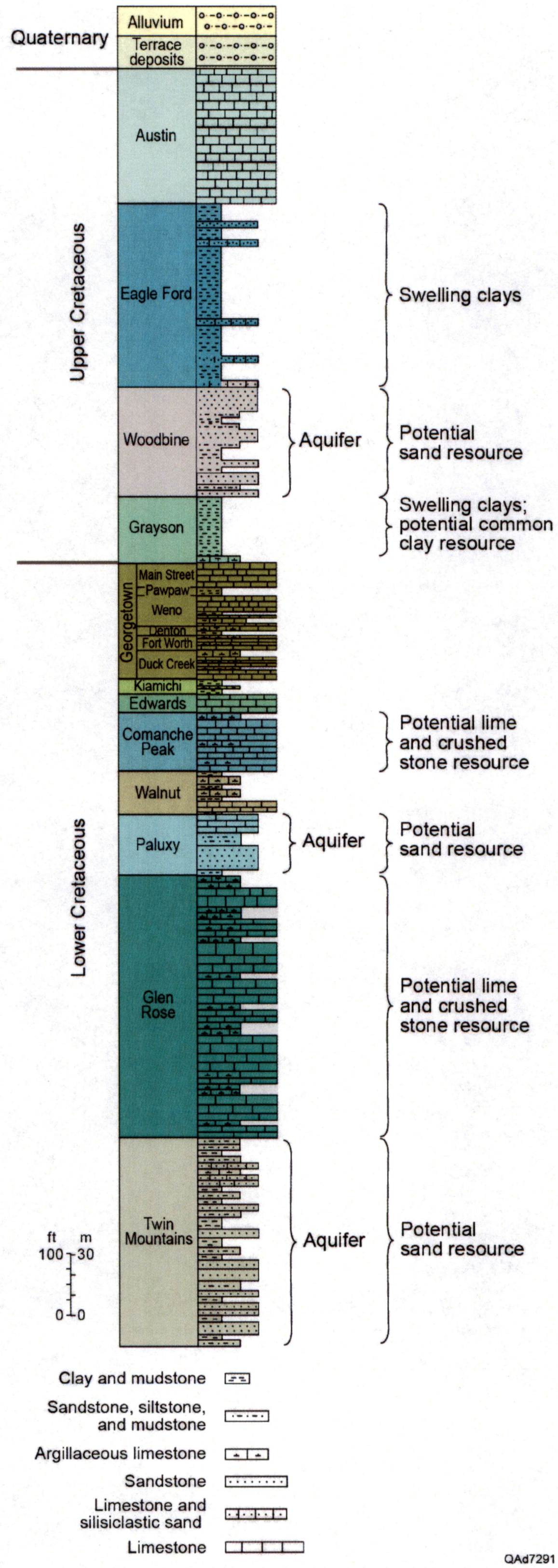

Figure 5. Stratigraphic column for Project 1 area.

PROJECT 2: GEOLOGIC MAPPING OF THE MATAGORDA–MATAGORDA SW QUADRANGLES, TEXAS GULF COAST

The geologic map constructed for Project 2 covers the Colorado River Delta and Matagorda Peninsula area within the Matagorda and Matagorda SW quadrangles (figs. 1, 6, and map in pocket). This area lies within fluvial-deltaic, bay/estuary, and strandplain settings having sensitive geologic environments that are being stressed by natural processes and human activities. The Matagorda and Matagorda SW quadrangles contain a delta of the Colorado River system that has prograded across Matagorda Bay, connecting the coastal plain with the Matagorda Peninsula. This delta serves as a divide between Matagorda and East Matagorda Bays. Natural and human-influenced activities affect the active processes of sedimentation and erosion within this coastal setting. Geologic environments here are diverse (McGowan and others, 1976). The geology within this study area includes Pleistocene and Holocene to Modern deposits and active normal faults (McGowan and others, 1976; White and Morton, 1997; Paine, 2010). Pleistocene sediments include Beaumont Formation distributary, interdistributary, and abandoned-channel deposits containing sand, silt, and clay (map in pocket). Modern and Holocene units consist of beach, dune, tidal-flat, washover, distributary, levee, marsh, swamp, and floodplain deposits. The large fault illustrated on the map strikes about N45°E, dips southeastward, and has a subtle scarp as high as 2 ft at some locations. At the surface it cuts marsh, tidal-flat, and back-barrier deposits. This map also illustrates past rates of shoreline erosion along the Matagorda Peninsula.

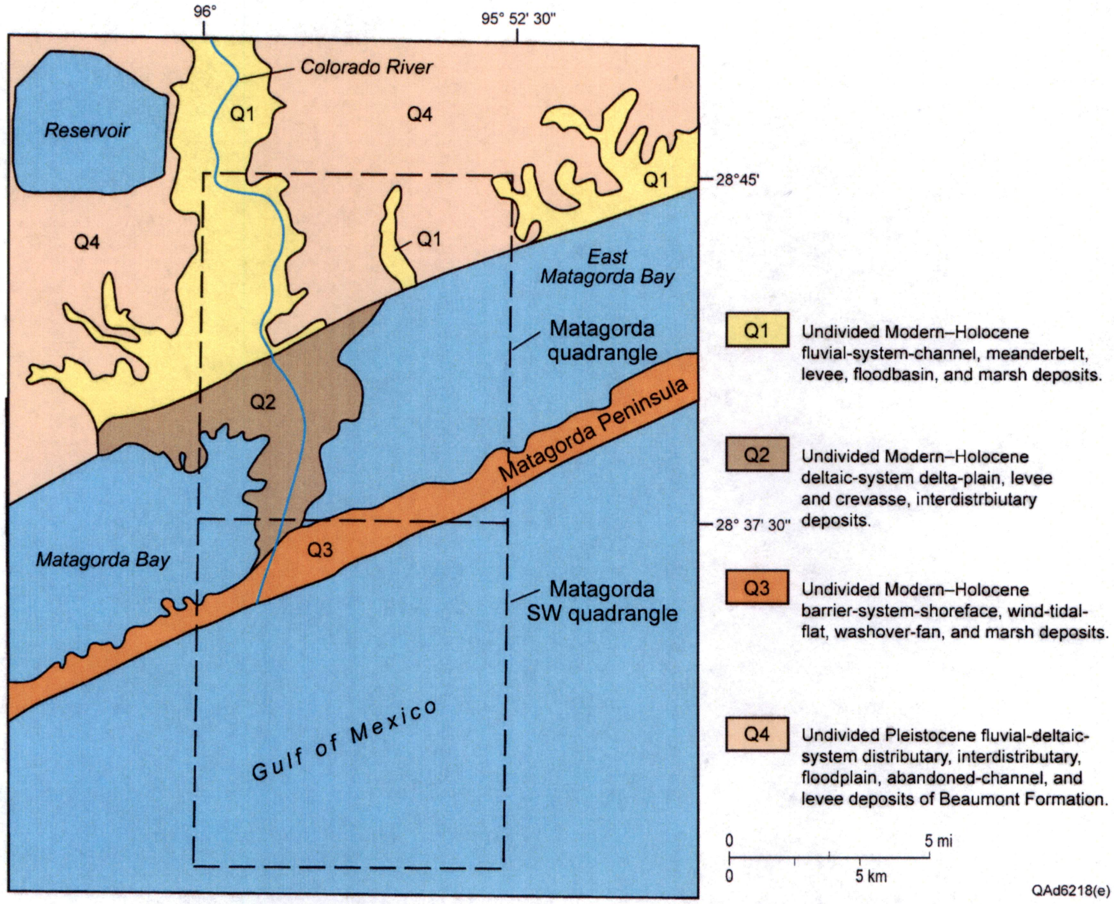

Figure 6. Simplified geologic map and setting of quadrangles for Project 2, Geologic Mapping of Matagorda–Matagorda SW Quadrangles, Texas Gulf Coast.

Mapping procedures were (1) compilation of available data determined to be reliable, including recent wetlands map data interpreted at BEG, and (2) mapping of geologic units and features using field observations and aerial photographs. Digital imagery photographed in 2001, 2008, and 2010 was used for mapping. Previous regional maps that cover this map area include the 1:125,000-scale *Environmental Geology, Bay City-Freeport Sheet (*McGowen and others, 1976), the 1:125,000-scale map of *Distribution of Wetlands and Benthic Macroinvertebrates, Bay City-Freeport Area* (White and others, 1988), and the 1:250,000-scale *Geologic Atlas of Texas Beeville-Bay City Sheet* (Aronow and others, 1975). Fault data used were from Paine (2010). Modern wetland geologic environments were adapted from unpublished Bureau of Economic Geology data sets by W. A. White in 2002 and T. A. Tremblay in 2008. Shoreline and dune mapping of the peninsula used 2010 photography as a base. Shoreline erosion rates were adapted from Paine and others (2011).

The geologic map of Matagorda–Matagorda SW quadrangles will aid in management, development, and use of this part of the Texas Gulf Coast. This study area, within fluvial-deltaic, bay/estuary, and strandplain settings, contains diverse geologic environments in which erosion and sedimentation processes are active (McGowan and Brewton, 1975). Population growth and industrial development have increased in past years and are expected to continue increasing. Substantial wetlands have been lost in this area owing to erosion along the Gulf shore, subsidence caused by active surface faults, dredging for navigation channels, saltwater intrusion through dredged channels, shore erosion, road construction, regional subsidence, and sea-level rise. This area, similar to other Gulf of Mexico coastal areas, is subject to seasonal hurricanes and tropical storms.

This map is intended to be used in conjunction with elevation data, data from historical charts, aerial photography since the 1930's, and previous geologic maps to evaluate (1) shoreline changes, (2) changes in geologic depositional environments, (3) changes resulting from human activities, and (4) active faults. Maps are needed for models that will help identify areas most susceptible to change and to identify environmentally critical upland areas, which, if preserved, will allow wetlands to transgress as relative sea level rises. The map will also be used for education, and it is planned to be used by the Lower Colorado River Authority Matagorda Bay Nature Park as a source of information and for display of the area's geology. The map and digital data set are also planned to be used by the General Land Office Coastal Management Program's High School Outreach Program. Geologic maps and other Texas coastal data are routinely used by the General Land Office of Texas and the Texas Parks and Wildlife Department, as well as local government officials and developers, for management and resource planning of the Texas coast.

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