Summary Report for the 2005–2006 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, Thomas A. Tremblay, James C. Gibeaut, Rachel L. Waldinger, William A. White, Jay A. Raney, Rebecca C. Smyth, Tiffany L. Hepner, John R. Andrews, and Roberto Gutierrez

Prepared for
U.S. Geological Survey
Under Cooperative Agreement No. 05HQAG0046

Bureau of Economic Geology
Scott W. Tinker, Director
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ABSTRACT

Eleven geologic maps, 1:24,000 scale, have been constructed for Galveston and Mustang Barrier Islands and for part of the Brazos River Valley and its aquifers. The maps are intended to be used by professionals and laypersons as a source of general geologic information that relates to land and resource use and management. The geologic maps of the barrier islands include (a) Northern Mustang Island (Port Aransas quadrangle), (b) Southern Mustang Island (Crane Islands NW quadrangle), (c) Northeastern Galveston Island (Galveston quadrangle), (d) Central Galveston Island (Lake Como quadrangle), and (e) Southeastern Galveston Island (Sea Isle and San Luis Pass quadrangles). These maps display island wetland and upland geologic environments. Geologic maps of the Brazos River Valley study area include six quadrangles: Baileyville, Hammond, Maysfield, Calvert, Gause, and Hearne South. These maps and cross sections show the geologic framework of the Brazos alluvial aquifer in an area where it intersects three other Texas aquifers, the Carrizo-Wilcox, Queen City, and Sparta.

INTRODUCTION

This Texas STATEMAP project involved the geologic mapping of areas where improved geologic information can impact development, land and resource use, environmental protection, and public education. Work during the past complements ongoing studies of land and water resources of Texas. Project 1, New Geologic Mapping of Barrier-Island Areas of the Texas Gulf Coast, addresses geologic framework needs required for the planning of land use and for assessment and management of two environmentally sensitive barrier-island coastal areas that are increasing in population. Maps of these areas will support crucial activities such as evaluating historical changes of coastal depositional environments, addressing erosion issues, understanding and managing processes that affect the integrity of the islands, and educating the public. Project 2, Geologic Mapping of Brazos River Valley and Associated Aquifers, Robertson and Milam Counties, Texas, deals with new mapping in an area where a prolific alluvial aquifer, the Brazos River alluvial aquifer, intersects three other significant Texas aquifers, the Carrizo-Wilcox, Queen City, and Sparta. This geologic map will be used to evaluate the area's geologic framework, to aid in our understanding of the physical and hydrologic relationships between the aquifers and to provide geologic information useful for managing water quality and availability.

PROJECT 1: New Geologic Mapping of Barrier-Island Areas of the Texas Gulf Coast

This Texas STATEMAP project involved mapping Holocene geologic units associated with the coastal depositional environments of Galveston and Port Aransas areas along the Texas Gulf Coast (figs. 1–3). These areas include Galveston and Mustang Islands—barrier islands that contain urban and natural areas. Maps of the northeast and central parts of Galveston Island are within the Galveston and Lake Como 1:24,000-scale quadrangles, respectively. The map of southeastern Galveston Island combines Sea Isle and San Luis Pass 1:24,000-scale quadrangles. Maps of northern and southern Mustang Island are within Port Aransas and Crane Islands NW 1:24,000-scale quadrangles. Mapping procedures included (1) compiling available data that are determined to be reliable, (2) mapping geologic units and features on aerial photographs, and (3) field mapping and refining of photo-based map interpretations. Photography used included 2002 and 2004, 0.5-pixel, color infrared digital imagery. Airborne topographic lidar data were also studied. Previous regional 1:250,000-scale maps of the Project 1 area include the Environmental Geologic Atlas of the Texas Coastal Zone—Galveston-Houston and Corpus Christi areas (Fisher and others, 1972; Brown and others, 1976).

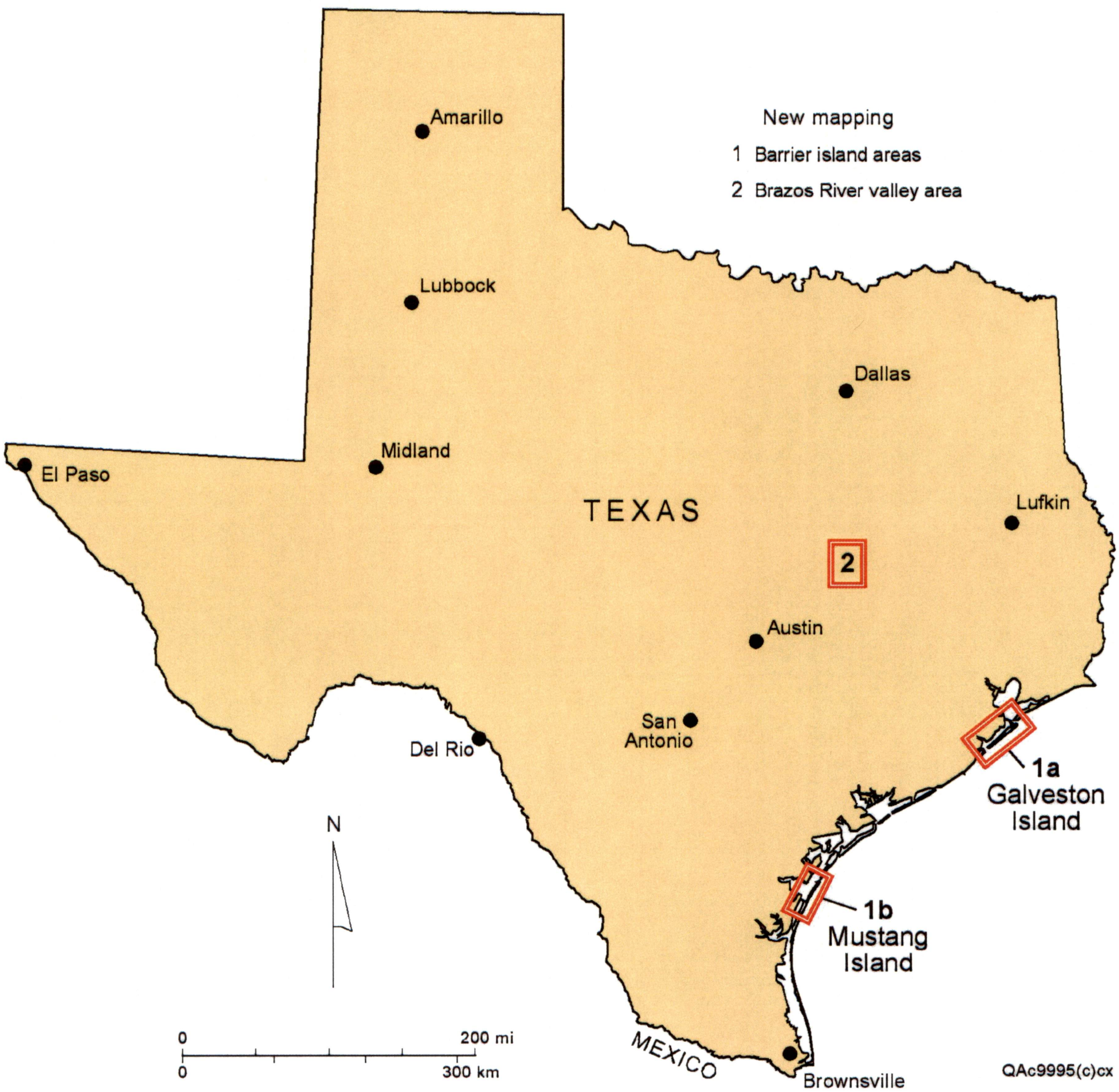


Figure 1. Location of Texas project study areas. Project 1 is New Geologic Mapping of Barrier Island Areas of the Texas Gulf Coast. Project 2 is Geologic Mapping of Brazos River Valley and Associated Aquifers, Robertson and Milam Counties, Texas.

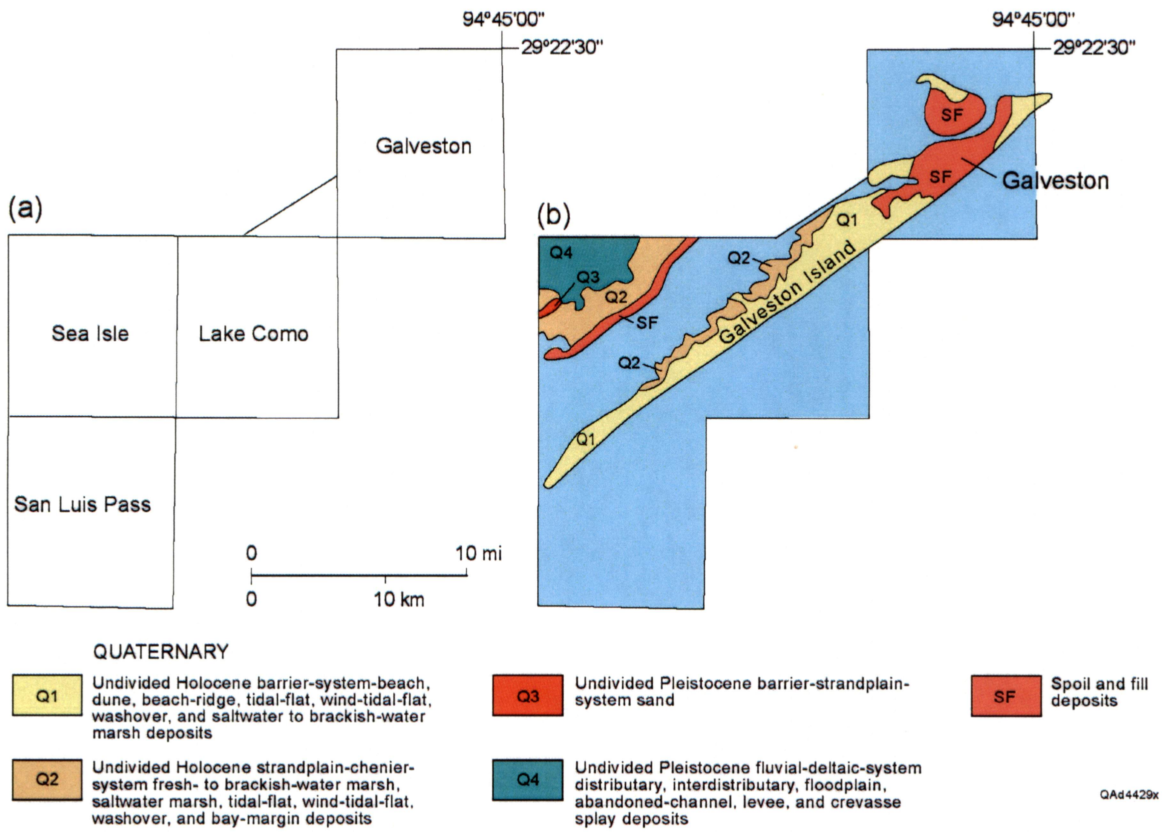


Figure 2. Quadrangles and simplified geologic map of Galveston Island area for Project 1.

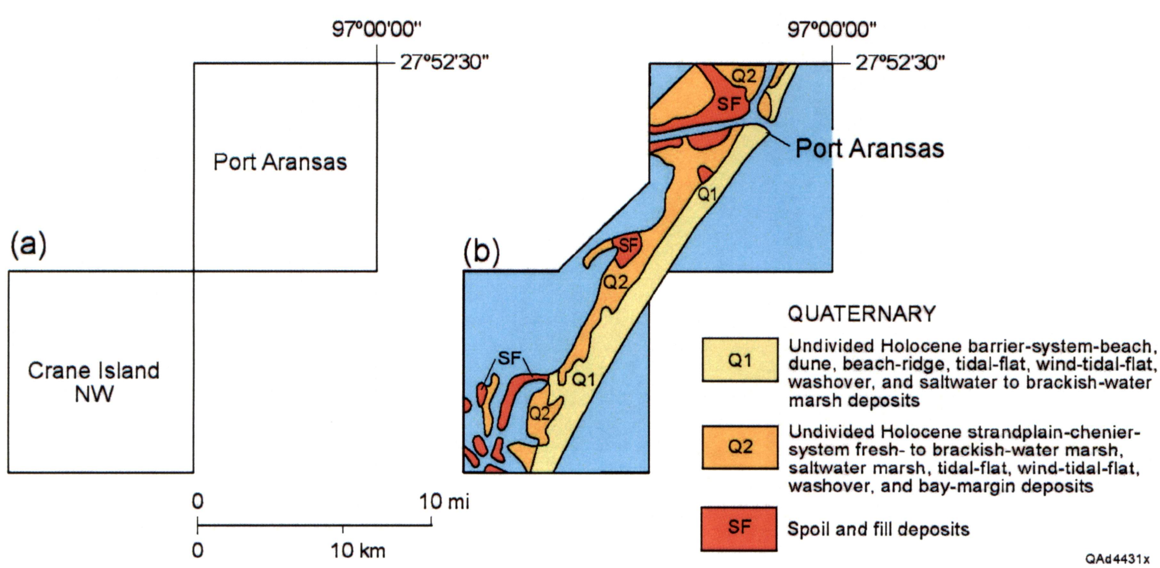


Figure 3. Quadrangles and simplified geologic map of Mustang Island area for Project 1.

Galveston and Mustang barrier-island settings contain an array of environments that range from topographically lower, permanently inundated estuarine and marine subtidal areas to topographically higher intertidal wetlands, and to topographically higher fore-island dune areas and island uplands. Typical environments across the islands include the Gulf beach, fore-island dunes, uplands/vegetated barrier flats, fresh to brackish marshes, salt marshes, tidal flats, and seagrass and algal beds in subtidal bay and lagoon settings adjacent to the islands (fig. 4). Geologic maps of these islands will be used to study ongoing natural processes, to make land and resource management decisions, and to support ongoing coastal studies. Within these barrier-island settings, natural and human-induced processes, including erosion along the Gulf shore, subsidence, dredging for navigation channels, saltwater intrusion through dredged channels, road construction, regional subsidence, and sea-level rise, can rapidly change island environments, such as beach, dune, wetland, and upland areas. For example, Mustang Island has undergone an extensive loss of tidal-flat areas and an increase in estuarine marshes and seagrass beds since 1950, probably as a result of relative rise in sea level (sea-level rise + subsidence) (White and others, 2006). For another example, Gulf shoreline changes along Galveston Island between 1930 and 2005 provide data that have been used to determine average annual erosion and deposition rates and to model projected shoreline changes for the future (Gibeaut and others, 2005). Most of the island's shore south of the Galveston seawall has experienced erosion, with average annual shoreline retreat rates as much as 10 ft in one area. Conversely, the north part of the island's Gulf shoreline has advanced at an average annual rate of as much as 9 ft.

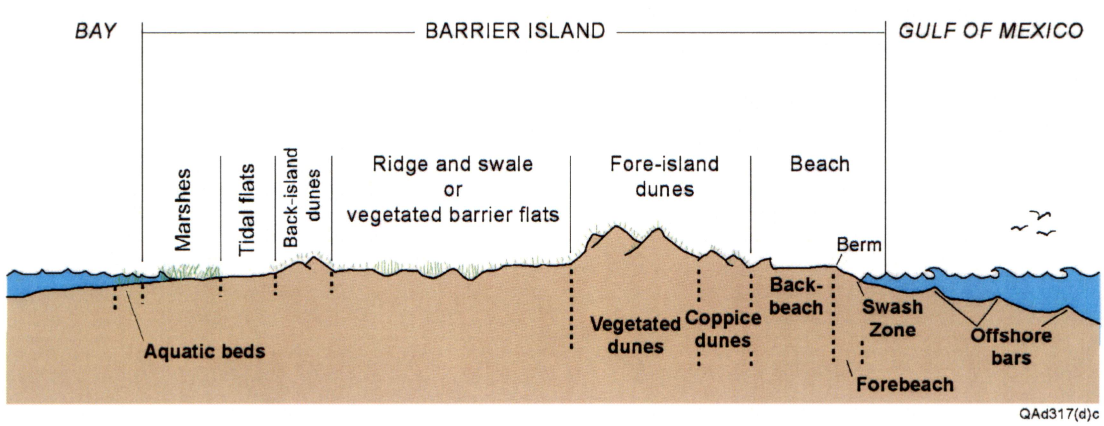


Figure 4. Schematic profile of barrier island illustrating major environments from Gulf to bay. Not drawn to scale. Modified from Raney and White, 2002.

PROJECT 2. Geologic Mapping of Brazos River Valley and Associated Aquifers, Robertson and Milam Counties, Texas

Geologic mapping of Brazos River Valley and the associated aquifers, Robertson and Milam Counties, Texas, deals with the first year of a 2-year project in an area where a prolific alluvial aquifer, the Brazos River alluvial aquifer, intersects three other significant Texas aquifers, the Carrizo-Wilcox, Queen City, and Sparta. This year's mapping deals with six 1:24,000-scale quadrangles within Robertson and Milam Counties: Baileyville, Hammond, Maysfield, Calvert, Gause, and Hearne South (figs. 1, 5). Study methods included review of previous work, field mapping, interpretation of 1:20,000- and 1:63,000-scale aerial photographs, and collection and evaluation of geophysical and driller's logs for subsurface stratigraphic controls at depth and at the ground surface, where vegetation often obscures geologic units and associated soils. Previous 1:250,000 regional maps that encompass the study area include Austin and Waco Geologic Atlas sheets (Proctor and others, 1970; Proctor and others, 1974).

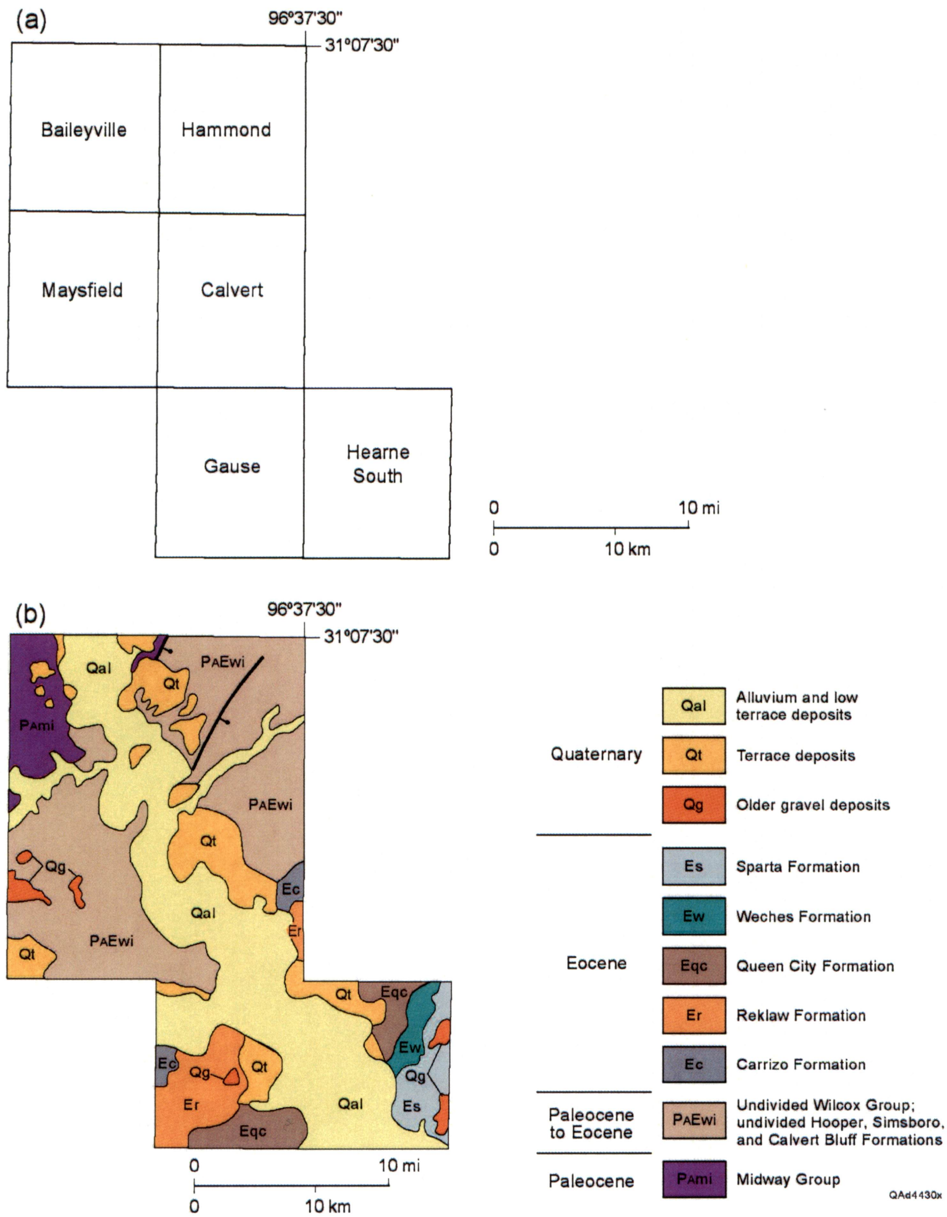


Figure 5. (a) Quadrangles and (b) simplified geologic map of Project 2 area, Brazos River Valley and associated aquifers, Robertson and Milam Counties, Texas.

In the Project 2 area, the Brazos River lies within a broad alluvial valley that has eroded into upper Paleocene through Eocene deposits of the Midway and Wilcox Groups and Carrizo, Reklaw, Queen City, Weches, and Sparta Formations (figs. 6, 7, 8, 9, appendix). Thin remnants of older Pleistocene alluvial deposits exist within the margins of the river valley. This study area encompasses a 30-mi section of the locally prolific Brazos River alluvial aquifer, where it intersects and is hydrologically connected to three other significant Texas aquifers, the Carrizo-Wilcox, Queen City, and Sparta. Hydrocarbon exploration and production activities have taken place throughout the area for more than 50 years. Sand and gravel quarries in Brazos River terraces are common.

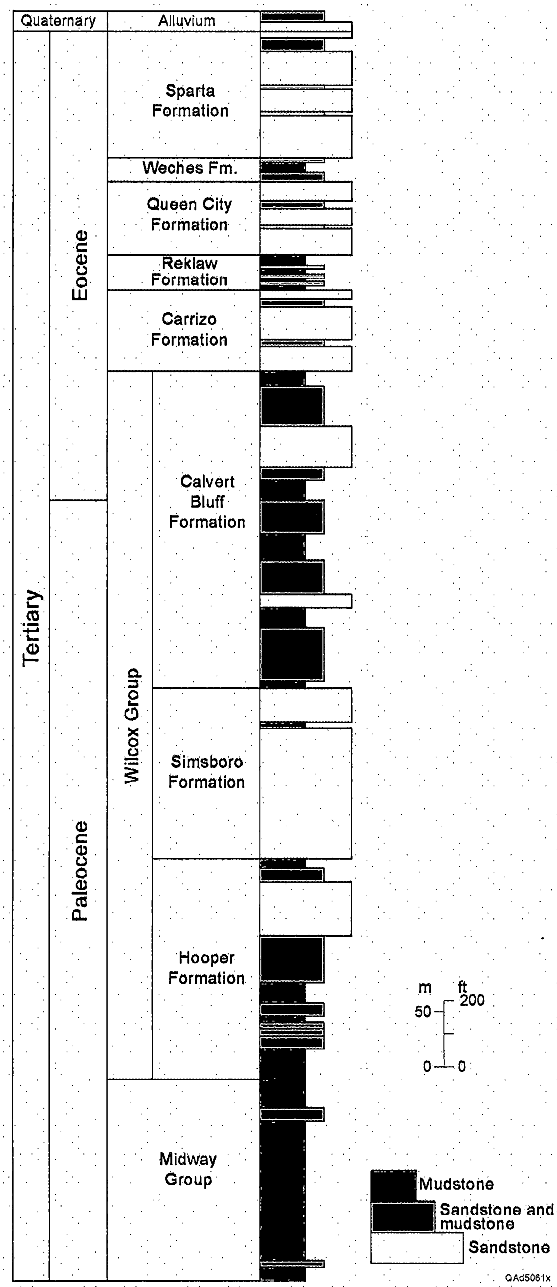
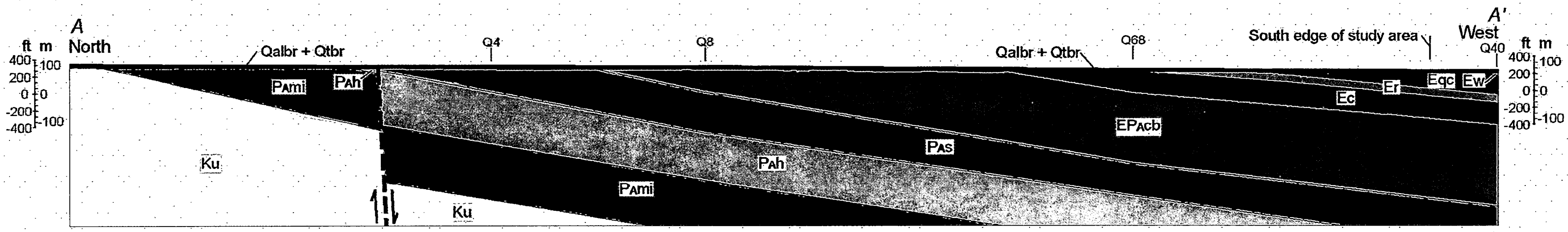


Figure 6. Stratigraphic column of Project 2 area.



Quaternary	Qalbr	Brazos River alluvium
	Qtbr	Brazos River terrace deposits
Eocene	Es	Sparta Formation
	Ew	Weches Formation
	Eqc	Queen City Formation
	Er	Recklaw Formation
	Ec	Carrizo Formation
Eocene - Paleocenee	EPAcb	Calvert Bluff Formation of Wilcox Group
Paleocene	PAsb	Simsboro Formation
	PAh	Hooper Formation
	PAmi	Midway Group
Cretaceous	Ku	Undivided Cretaceous deposits

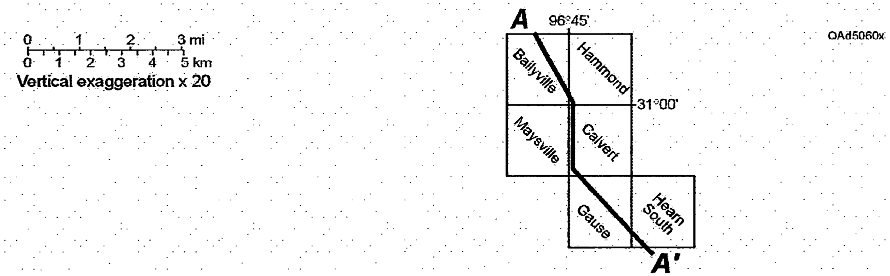


Figure 7. Cross section A-A' illustrating geology of Project 2 area in stratal dip direction, north to south.

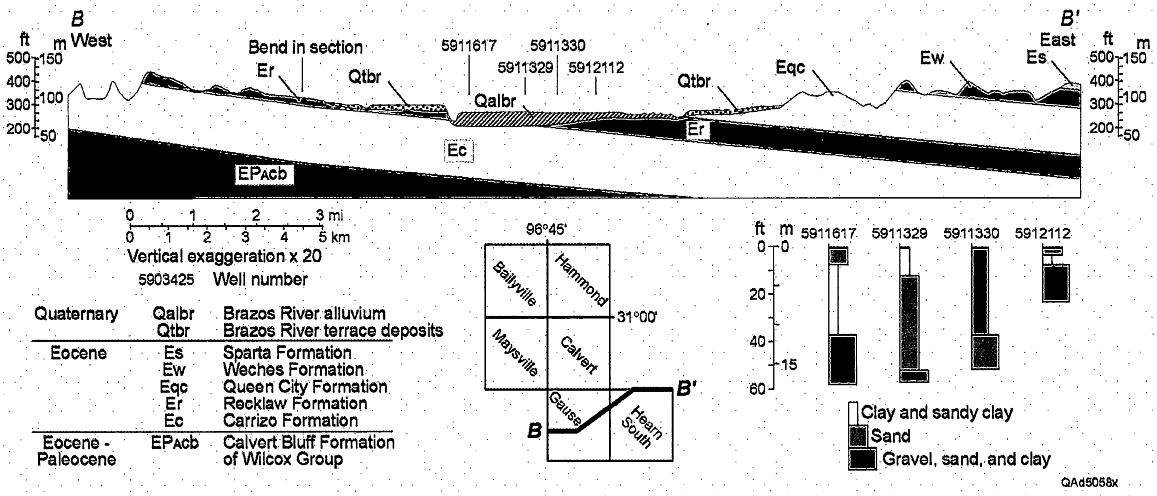


Figure 8. (above) Cross section B-B′ illustrating geology of Project 2 area from west to east, across Brazos River Valley; (below right) lithologic logs for Brazos River alluvial aquifer deposits.

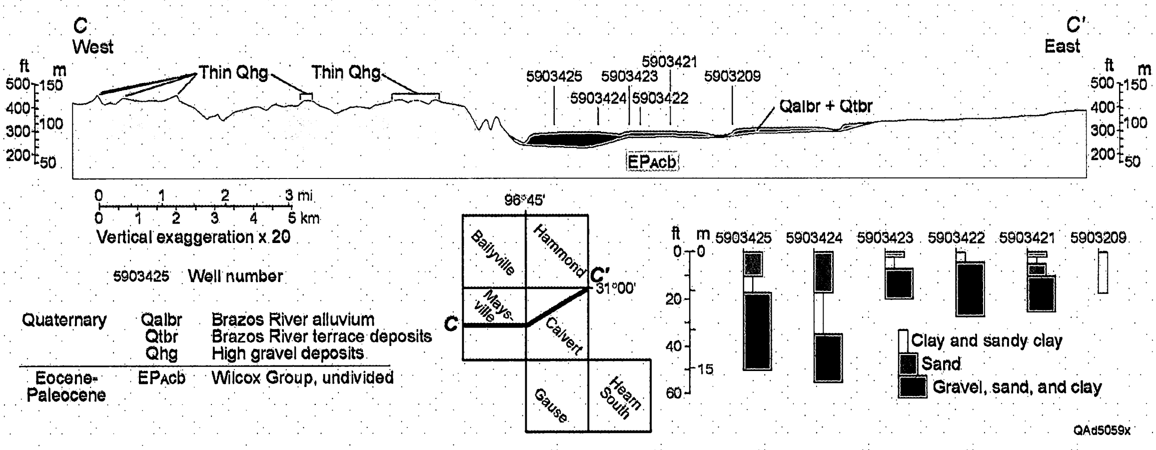


Figure 9. (above) Cross section C-C′ illustrating geology of Project 2 area from west to east, across Brazos River Valley; (below right) lithologic logs for Brazos River alluvial aquifer deposits.

In the north part of the study area, Midway mudstone is overlain by Wilcox Group mudstones and sandstones of the Hooper, Simsboro, and Calvert Bluff Formations. Wilcox deposits are undivided in the northwest part of the study area because outcrops are rare owing to thick vegetation and sufficient shallow subsurface data to support mapping were not available to study. The Hooper consists of as much as 600 ft of mudstone, along with some sandstone and minor lignite. Ayers and Lewis (1985) reported that, in general, Hooper sediments depict an upward-coarsening genetic sequence that records a succession from prodelta through distributary-channel fill, delta-plain mudstone, and lignite. In their regional investigation, Ayers and Lewis (1985) interpreted a fluvial depositional setting for the Hooper proximal facies and a deltaic setting for the distal facies. The study area coincides with the area where Ayers and Lewis (1985) interpreted primary fluvial input for these deposits. The Wilcox Simsboro Formation, overlying the Hooper Formation, is principally sandstone, along with lesser mudstone and mudstone conglomerate. It may contain minor lignite in some places. Ayers and Lewis (1985) reported that Simsboro sediments were deposited by a bed- to mixed-load fluvial system (McGowen and Garner, 1970) that fed Wilcox deltas farther basinward (Fisher and McGowen, 1967). Simsboro deposits are as much as 500 ft thick in the study area, although thinning occurs beyond the map area. Wilcox Calvert Bluff deposits are mudstone, along with some siltstone and sandstone and various amounts of lignite. Commercial lignite exists within the lower part of the unit (Kaiser, 1974, 1976, 1978; Kaiser and others, 1978; 1980; Ayers and Lewis, 1985). Kaiser (1978) and Ayers and Lewis (1995) interpreted that Calvert Bluff sediments had been deposited in lower alluvial and upper to lower deltaic-plain settings. They interpreted that Simsboro and Calvert Bluff deposition indicates a change from the dominantly alluvial-plain Simsboro to the more deltaic Calvert Bluff. Overlying Wilcox Group deposits are Carrizo Formation sandstone and lesser siltstone and mudstone that compose an approximately 240-ft-thick unit within the study area. Ayers and Lewis (1985) reported that the Carrizo at outcrop is fluvial, although downdip and east of the map study area it is deltaic. Wilcox and Carrizo strata compose the major Carrizo-Wilcox aquifer (Thorkildsen and Price, 1991).

Strata above the Carrizo Formation represent repetitive packages of transgressive to regressive deposits (Fisher, 1964). Fisher (1964) reported that the transgressive deposits generally included open-marine, glauconitic sands and marls overlain by restricted marine clays. He noted that in some areas open-marine clays that are interbedded with or overlie basal glauconitic strata represent inundative deposits. Regressive deposits generally consist of fluvial to marginal-marine, sand-rich deposits overlain by lagoonal and floodplain, mud-rich carbonaceous deposits. The units composing these transgressive-regressive strata packages include the Reklaw-Queen City, Weches-Sparta, and Cook Mountain-Yegua Formations (Renick and Stenzel, 1931; Stenzel, 1938; Fisher, 1964; Guevara and Garcia, 1972; Ricoy and Brown, 1977; Hobday, 1980). The Reklaw Formation is an approximately 100-ft-thick unit that is sand-rich and glauconitic in its lower part, and mostly mudstone and siltstone with lesser thin sandstone in its upper part. Hematite- and limonite-cemented deposits, sometimes called *ironstone*, are common. Queen City deposits are principally quartz sandstone, along with lesser siltstone and mudstone. It is approximately 225 ft thick and is a minor aquifer. Weches Formation deposits are composed of quartz-rich, glauconitic greensand, mudstone, and claystone. This fossiliferous unit is as much as 80 ft thick and is overlain by 150 to 200 ft of Sparta Formation quartz sandstone. Sparta sandstone serves as a minor aquifer. Downdip of the study area, the Cook Mountain Formation is mostly mudstone and claystone, along with some glauconitic sandstone. It is fossiliferous and as much as 300 ft thick. Cook Mountain deposits are overlain by Yegua Formation sandstone, mudstone, claystone, and lignite. The unit is between 750 and 1,000 ft thick, and sandstones serve as minor aquifers.

Brazos River alluvial deposits are as thick as 60 ft and typically consist of a lower, relatively coarser grained interval composed of gravel, sand, and mud that is between 30 and 5 ft thick (figs. 8, 9). In general, terrace deposits are thinner than deposits within the river's floodplain, although terrace deposits may contribute groundwater to the thicker alluvial aquifer areas. Older, isolated terrace deposits consist of remnant gravel-rich deposits that are at higher elevations than the broad, well-developed terraces at varied elevations adjacent to the Brazos River. At some places the high gravel deposits are well cemented with hematite and limonite. At other places the high gravel appears to be remnant lag deposits. Mining of gravel from the terrace deposits has met some of the demand from past development of the area, and the potential for future gravel production still exists. Abandoned sand and gravel pits within the Brazos River alluvial deposits and Tertiary units are of environmental concern because they have the potential to be used for illegal dumping, which could cause the impairment of surface- and groundwater quality.

ACKNOWLEDGMENTS

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APPENDIX: EXPLANATION OF GEOLOGIC UNITS

Brazos River Valley, Robertson and Milam Counties, Texas

Baileyville, Hammond, Maysfield, Calvert, Gause,

and Hearne South Quadrangles, Texas

(1:24,000 scale)

QUATERNARY

Qal—Alluvium. Gravel, sand, silt, and mud along streams and rivers; inundated regularly. Includes undivided low terrace deposits along minor drainages. Includes some local bedrock outcrops that are undivided.

Qalbr—Alluvium of Brazos River. Gravel, sand, silt, and mud; as thick as 60 ft. Driller's logs indicate a lower, relatively coarser grained interval composed of gravel, sand, and mud that is between 30 and 5 ft thick, overlain predominantly by sand and mud intervals.

Qt—Terrace deposits. Gravel, sand, silt, and mud along streams and rivers.

Qtbr—Terrace deposits of Brazos River. Gravel, sand, silt, and mud. Driller's logs indicate thicknesses of less than 30 ft.

Qhg—High gravel deposits. Pebble- to cobble-sized gravel, along with sand, silt, and mud. Gravel is chert, quartz, limestone, and igneous and metamorphic rock; lithologies may vary at different locations. At relatively higher elevations than well-defined Brazos River terraces. Commonly dissected. Some deposits are gravel lag. Some high gravel deposits are well cemented with limonite and hematite. Includes some areas where remnant gravel, sand, silt, and mud have been reworked into the soil but where pebbles and cobbles are common.

TERTIARY

Eocene

Es—Sparta Formation. Sandstone. Sand is quartz; very fine to fine grained; well sorted; micaceous. Minor thin layers and lenses of silt, mud, and clay. Thickness 150 to 200 ft.

Ew—Weches Formation. Glauconite greensand, sand, mudstone, and claystone; partly calcareous. Quartz sand common. Hematite- and limonite-cemented claystone to sandstone, sometimes called *ironstone*, is common. Marine fossils. Commonly forms dark-olive and dark-red, mud-rich soil. Thickness as great as 80 ft.

Eqc—Queen City Formation. Sandstone. Some mudstone interbeds. Sand is quartz; fine grained. Some glauconite. Total thickness about 225 ft.

Er—Reklaw Formation. Sandstone and mudstone; generally friable. Upper part, sometimes called *Marquez member*, is mud to mudstone and silt to siltstone; carbonaceous; glauconitic. Lower part, sometimes called *Newby member*, is fine- to medium-grained quartz sand to sandstone and mud to mudstone; glauconitic. Hematite- and limonite-cemented mudstone to sandstone, sometimes called *ironstone*, is common. Some ledges of ironstone and eroded pebble-size ironstone. Weathers to brown and yellowish-orange and forms red soil. Total Reklaw thickness as great as 100 ft.

Ec—Carrizo Formation. Sandstone, fine to coarse grained, with some siltstone and mudstone; generally friable. Crossbedding common. Some hematite- and limonite-cemented mudstone and sandstone, sometimes called *ironstone*. Unit commonly forms ridges. Thickness as great as 240 ft.

Eocene to Paleocene

EPAwi—Wilcox Group, undivided. Undivided Calvert Bluff, Simsboro, and Hooper Formations. Mudstone, siltstone, and sandstone; friable. Approximate thickness between 1,500 and 1,800 ft.

EPAcb—Calvert Bluff Formation. Mudstone, along with some siltstone and sandstone, all friable, and various amounts of lignite. Hematite- to limonite-cemented concretions. Locally glauconitic in upper part of unit. Mudstone is massively to thinly bedded with silt and sand. Sandstone is medium to fine grained, crossbedded, and burrowed. Lignite, with seams generally 1 to 5 ft, most common in lower part of unit. Unit thickness as much as 1,000 ft.

EPAcb+PAsb—Undivided Calvert Bluff and Simsboro Formations. Mudstone, siltstone, and sandstone; friable.

Paleocene

PAsb—Simsboro Formation. Sandstone and some mudstone and mudstone conglomerate; all generally friable. Sandstone is typically medium to coarse grained, along with some fine-grained sandstone to sandy mudstone. Crossbeds common. Minor lignite. Typically forms gently rolling hills. Thickness as much as 500 ft.

PAh—Hooper Formation. Mudstone and some sandstone; all generally friable. Minor lignite. Concretions of hematite- and limonite-cemented mudstone and sandstone, sometimes referred to as *ironstone concretions*. Some glauconite in lowermost part. Sandstone in upper part of the unit is typically fine to medium grained and crossbedded, whereas sandstone in lower part of the unit is generally very fine grained and crossbedded. Thickness as much as 600 ft.

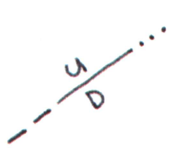
PAmi—Midway Group. Mud to mudstone and lesser sand. Outcrops are rare. Two undivided formations are Wills Point (upper) and Kincaid (lower). Wills Point mud to mudstone is siltier and sand-rich in the upper part where it grades into the Wilcox. Concretions. Wills Point contains glauconitic sand and limestone lenses near its base (Plummer, 1932; Gardner, 1933). Midway Group characteristically contains thick mud- to clay-rich soils that are often cultivated. Midway Group thickness is as great as 600 ft.

CRETACEOUS

Upper Cretaceous

Kn—Navarro Group, undivided. Marl and calcareous clay.

Map Symbols



Fault; **U**, upthrown side; **D**, downthrown side; dashed where relatively less distinct than solid; dotted where covered.

50ft

Line indicating approximate 50-ft thickness of Brazos River alluvium. Alluvium thins toward floodplain margins. Interpreted from sparse driller's logs and records of selected water-well depths.

5912822
(-30)
[+232]

Water well in Brazos River alluvial aquifer. Seven-digit number = State well number. Most recent measurement of depth, in feet, to water from surface shown in parentheses (-30). Corresponding elevation of water, in feet relative to mean sea level, shown in brackets [+232]. Complete water-well database maintained and available through Texas Water Development Board. Wells without water-level data used for interpretation of alluvium thickness.

Unit contacts drawn as solid lines are relatively more distinct in the field and on aerial photographs than those drawn by dashed lines.