TEXAS STATEMAP PROGRAM SUMMARY, FY19 (2019–2020)

by

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PROJECT 1: GEOLOGIC MAPPING OF THE UPPER TEXAS GULF OF MEXICO COASTAL PLAIN (LAKE STEPHENSON QUADRANGLE, 1:24,000)

Tiffany L. Caudle and Jeffrey G. Paine

PROJECT 2: GEOLOGIC MAPPING OF THE MIDDLE TEXAS GULF OF MEXICO COASTAL PLAIN (BLOOMINGTON AND OLIVIA QUADRANGLES, 1:24,000)

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PROJECT 3: MINERAL RESOURCE MAPPING (INDUSTRIAL SAND) IN CENTRAL TEXAS (KATEMCY QUADRANGLE, 1:24,000)

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PROJECT 4: GEOLOGIC MAPPING IN THE NORTHEAST AUSTIN URBAN GROWTH CORRIDOR, CENTRAL TEXAS (TAYLOR QUADRANGLE, 1:24,000)

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ABSTRACT

Five geologic maps have been completed at 1:24,000 scale in four project areas with support from STATEMAP and the Bureau of Economic Geology's State of Texas Advanced Resource Recovery program (STARR). Three of these maps were on the Texas Coastal Plain, including one (the Lake Stephenson quadrangle) on the upper Texas Coastal Plain in the Galveston Bay area and two (the Bloomington and Olivia quadrangles) on the middle Texas Coastal Plain in the Matagorda Bay area. These maps continue efforts to (1) better understand the evolution of the coastal plain in response to sea-level change associated with numerous Quaternary glacial and interglacial cycles and (2) develop more effective methods to map low-relief coastal deposits using high-resolution topographic maps produced from airborne lidar data and near-surface geophysical methods. High-resolution topography and geophysical methods both aid identification of stratal units and distribution in areas where exposures are poor or nonexistent.

Mineral-resource mapping produced one map (the Katemcy quadrangle) to extend recent mapping of an industrial sand resource area in central Texas. This map facilitates the develoment of mineral resources of the state, emphasizing those that will help meet the demand for industrial sand for hydraulic fracturing and construction. The detailed map can be used to evaluate and explore the mineral-resource potential of the area.

Mapping in the central Texas urban growth corridor northeast of Austin produced one map (the Taylor quadrangle) that extends previous mapping in this critical urban growth and transportation corridor. This map addresses ongoing need for planning and managing groundwater, surface water, land use, and construction projects where rapid population growth and suburban development have caused an increased demand for water and earth resources.

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INTRODUCTION

Bureau of Economic Geology (Bureau) researchers conducted geologic mapping supported by STATEMAP and by the State of Texas Advanced Resource Recovery program in four project areas (fig. 1) during the 2019-2020 project year. Mapping in these areas complements ongoing studies of land, mineral, and water resources and environmental concerns of Texas.

Project 1 continued a multiyear effort begun in 2018 to map areas of general interest in the upper Texas Coastal Plain with mapping of the Lake Stephenson quadrangle, situated on the shores of West Bay and Trinity Bay in the Galveston Bay complex. This environmentally sensitive area is being considered for a major federal engineering project intended to protect infrastructure around Galveston Bay from inundation during future storms.

Project 2 continued a multiyear effort to map low-relief Pleistocene and Holocene strata on the middle Texas Coastal Plain in the Matagorda Bay area (fig. 1) using high-resolution digital elevation models (DEMs) produced from airborne lidar surveys and near-surface geophysical methods to identify depositional units. Mapping was completed in the Bloomington and Olivia quadrangles to address the Holocene and Pleistocene history of the region, including the response of the Texas Coastal Plain to major climatic and sea-level changes accompanying the numerous Quaternary glacial/interglacial cycles.

Mapping for project 3 focused on sand resources in central Texas (fig. 1) to support the economic development of mineral resources. A geologic map of the Katemcy quadrangle was completed for Project 3 to extend earlier STATEMAP mapping in this area and to support analysis of potential sand resources for industrial-grade sand used in hydraulic fracturing as well as sand and gravel for construction.

Project 4 continued a multiyear effort to extend detailed geologic mapping in the central Texas urban growth corridor to peripheral areas facing increased developmental pressure as urban areas expand. The Taylor quadrangle, located in the northeastern part of the growth area, was

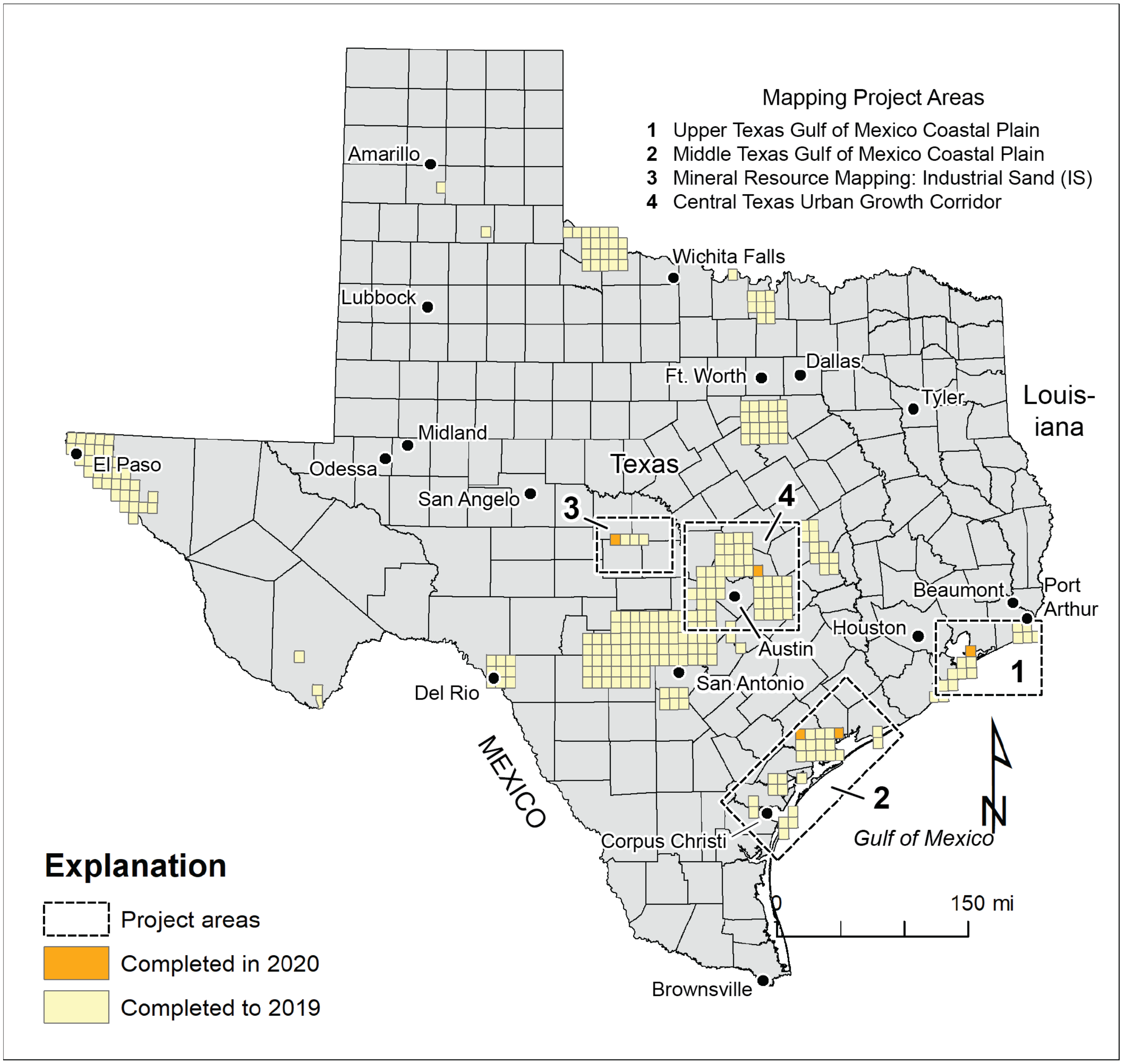

Figure 1. Location of geologic mapping areas on the upper Texas Coastal Plain (project 1), on the middle Texas Coastal Plain (project 2), in the central Texas mineral-resource area (project 3), and the central Texas urban-growth corridor (project 4).

completed this year. Population growth and suburban development have increased stress on limited water and land resources. Project 4 mapping complements a long-term effort to develop a 56-quadrangle, digital geologic-map data set of the Austin–San Marcos area. This collection will address needs for planning and managing groundwater and surface water, as well as land use and construction projects.

PROJECT 1: GEOLOGIC MAPPING OF THE UPPER TEXAS GULF OF MEXICO COASTAL PLAIN (LAKE STEPHENSON QUADRANGLE, 1:24,000)

Tiffany Caudle and Jeffrey G. Paine

Project 1 mapping focused on Holocene and Pleistocene geology along the upper Texas Gulf of Mexico coast (figs. 1 and 2). The completed map included the Lake Stephenson and part of the Smith Point quadrangles, located adjacent to the Flake quadrangle mapped in 2019 (Caudle and Paine, 2019). The Lake Stephenson and Smith Point quadrangles are along the southeast part of the Galveston Bay estuary system. The quadrangles are northeast of Galveston and southeast of Houston. The map addresses geologic framework needs for planning and management of land use for sensitive coastal environments, evaluating depositional history and environments, identifying potential erosion issues, supporting permitting activities and studies related to resource development, and educating the public.

Mapping procedures included (1) compiling available data, (2) mapping geologic units and features using lidar-derived elevations and aerial photographs, (3) making field observations of geologic units, and (4) producing final maps. Photography used in the study was 1-m resolution, natural color, National Agricultural Inventory Program (NAIP) digital imagery photographed in 2016 and 60-cm resolution, natural color, NAIP digital imagery photographed in 2018. Photography was supplemented by a 50-cm cell size DEM constructed from topographic data acquired during an airborne lidar survey flown by Fugro USA Land, Inc. in 2018 for the Texas Natural Resources Information System (TNRIS), Texas Water Development Board (TWDB), and Houston-Galveston Area Council (H-GAC) as part of the Texas Strategic Mapping (StratMap) program. Previous regional maps that cover this area include the 1:250,000-scale Geologic

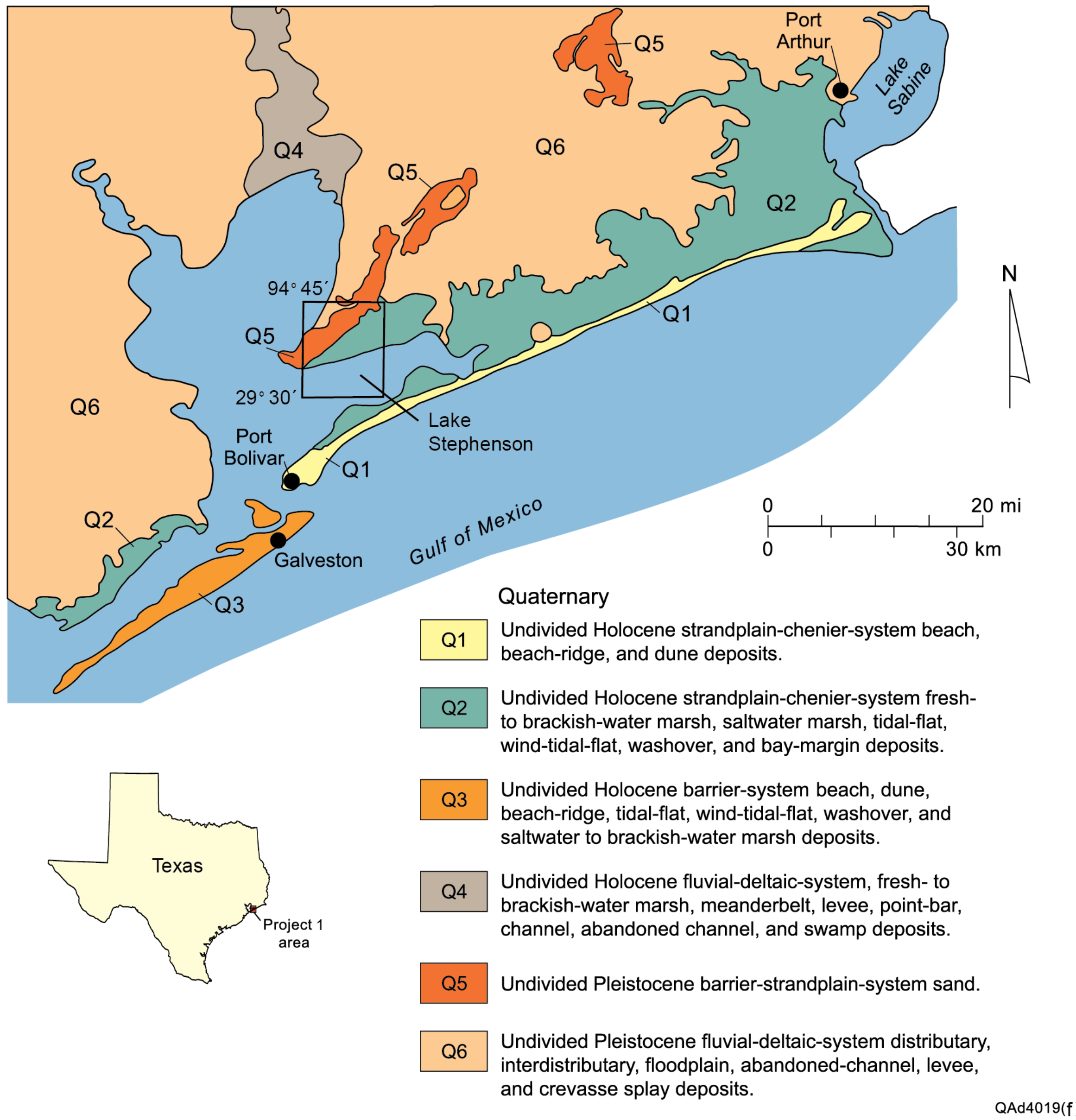

Figure 2. Generalized geologic map of the upper Texas Coastal Plain (project area 1), including the Lake Stephenson quadrangle mapped in 2020.

Atlas of Texas, Houston Sheet (Aronow and others, 1968; revised 1982), the 1:125,000-scale Environmental Geologic Atlas, Glaveston-Houston Sheet (Fisher and others, 1972), and the 1:125,000-scale map of Distribution of Wetlands and Benthic Macroinvertiebrates (White and others, 1985).

Strata in the Lake Stephenson and Smith Point quadrangles include sediments deposited within a Holocene bay-estuary system and a Pleistocene barrier-strandplain system (figs. 2 and 3). Much of the area is less than 15 feet above mean sea level. The map identifies Holocene units consisting of tidal flat, beach, stream channel, and coastal marsh deposits. An additional Holocene unit includes a low berm parallel to the East Bay shoreline that is interpreted as abandoned beach and storm deposits, perhaps formed during more open-Gulf conditions that existed before the formation of Bolivar Peninsula, or perhaps during a slight Holocene sea-level highstand. Pleistocene units include Beaumont Formation barrier island, estuarine, and fluvial-deltaic deposits. Man-made features identified included land artificially elevated by fill. Bay margin deposits down thrown from adjacent Pleistocene deposits indicate a northeast to southwest trending fault in the northeastern portion of the Lake Stephenson quadrangle.

Figure 3. Surface expression of the Pleistocene Ingleside barrier system at Smith Point.

PROJECT 2: GEOLOGIC MAPPING OF THE MIDDLE TEXAS GULF OF MEXICO COASTAL PLAIN (BLOOMINGTON AND OLIVIA QUADRANGLES, 1:24,000)

Jeffrey G. Paine and Lucie Costard

Project 2 geologic mapping focused on Pleistocene and Holocene geology along the middle Texas Gulf of Mexico coast (figs. 1, 4, and 5). The completed maps include geologic maps of the Bloomington quadrangle on the northeastern margin of the Guadalupe River valley in Victoria County, and the Olivia quadrangle (and part of the Keller Bay quadrangle) along the northern shore of Matagorda Bay in Calhoun and Jackson counties (figs. 4 and 5). These maps continue a multiyear effort to complete 1:24,000-scale geologic mapping between San Antonio Bay and Matagorda Bay, where the principal focus is to better understand the distribution of Pleistocene and Holocene barrier-island, bay, lagoon, deltaic, and fluvial depositional units comprising the

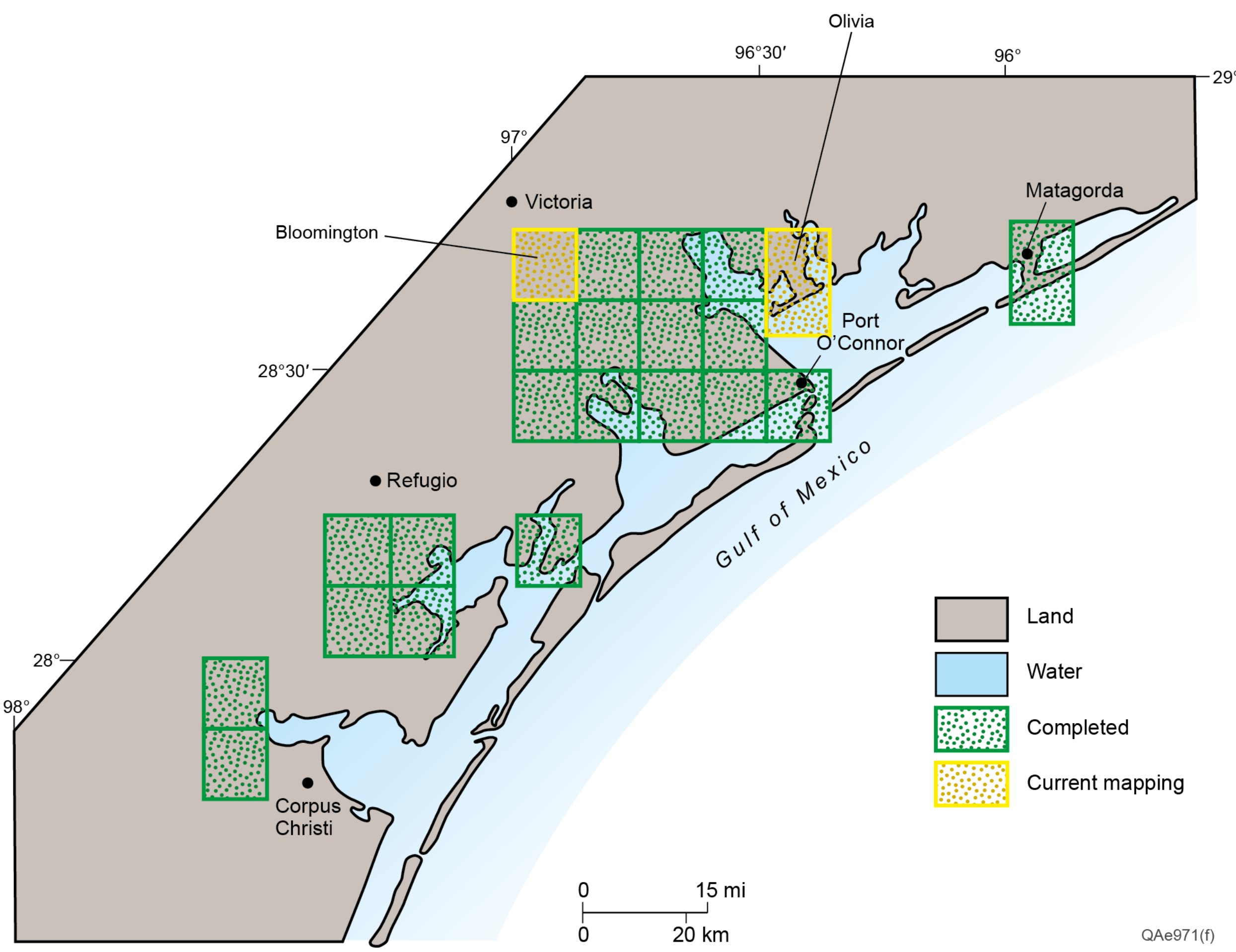

Figure 4. Status of geologic mapping along the middle Texas Coastal Plain (project area 2), including the Bloomington and Olivia (and part of the Keller Bay) quadrangles mapped in 2020.

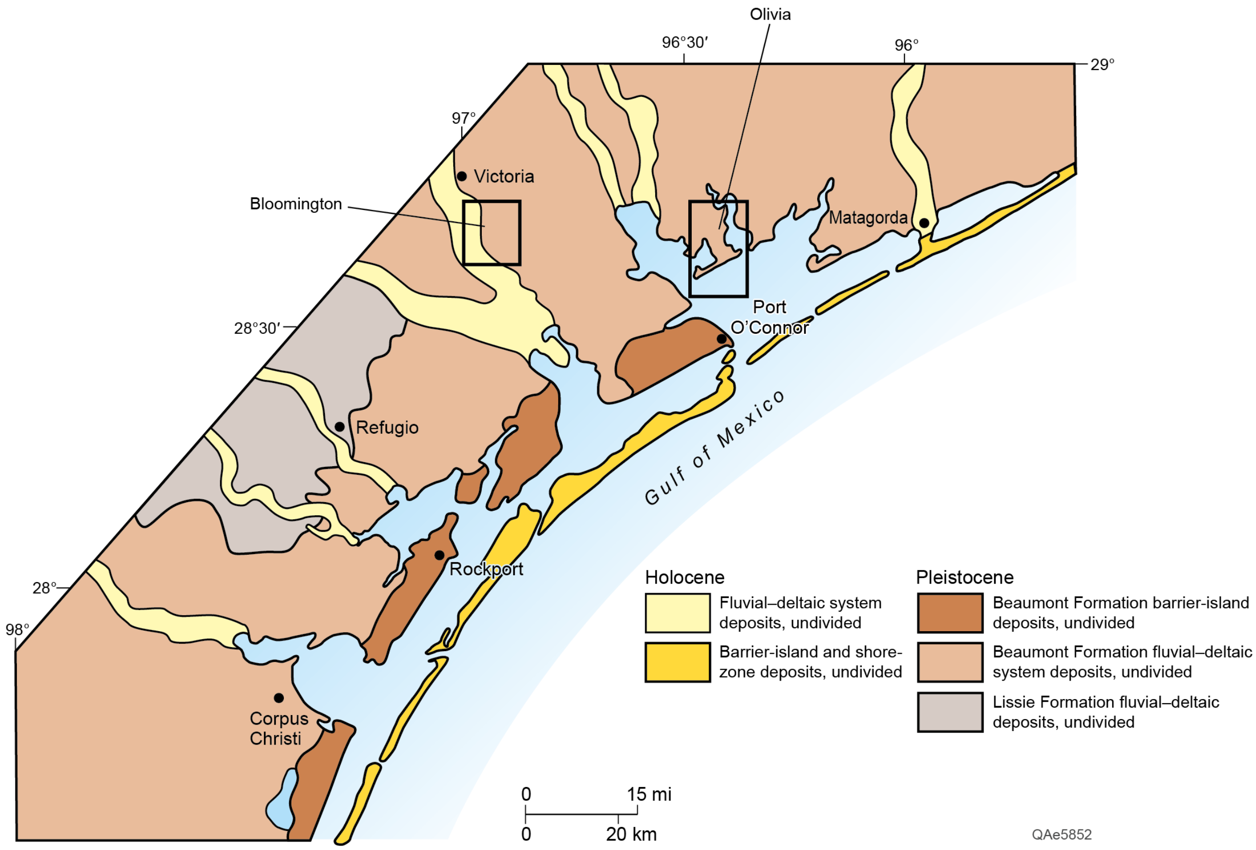

Figure 5. Generalized geologic map of the middle Texas Coastal Plain (project area 2), including the Bloomington and Olivia (and part of the Keller Bay) quadrangles mapped in 2020.

Pleistocene Beaumont Formation and younger fluvial, deltaic, estuarine, and marine deposits of sand, silt, and clay. Generally, these strata have aggraded during Quaternary interglacial periods of relatively high sea level and have undergone soil formation, erosion, and incision during glacial periods of relatively low sea level. Previous mapping efforts that guided depositional environment interpretations include the Beeville-Bay City sheet of the Geologic Atlas of Texas at 1:250,000-scale (Aronow and others, 1975 [revised 1987]) and maps in the Port Lavaca volume of the Environmental Geologic Atlas of the Texas Coastal Zone at 1:125,000 scale (McGowen and others, 1976) and the Submerged Lands of Texas, also at 1;125,000 scale (White and others, 1989).

Goals of the project are to augment aerial imagery with high-resolution DEMs acquired during airborne lidar surveys to allow detailed mapping of previously unrecognized depositional features such as channel complexes, terminal-phase paleochannels, levees, crevasse splays, floodplains, and alluvial terraces within Quaternary strata. Geophysical measurements conducted as a part of the mapping effort supplemented lidar data and aerial imagery by measuring lateral and vertical distribution of electrical conductivity using surface and borehole geophysical instruments. These measurements can serve as a proxy for clay content, a critical discriminator in determining depositional environment in low-energy coastal-plain systems. This mapping approach for use on low-relief coastal plains was developed during STATEMAP efforts along the middle Texas coastal plain over several years (Paine and Collins, 2016a; Paine and others, 2017; Paine and others, 2018a; Paine and others, 2019). Geologic maps completed previously in the Matagorda Bay area include the Port O'Connor quadrangle (Paine and Collins, 2016b), the Seadrift NE and Port Lavaca East quadrangles (Paine and Collins, 2017a, b), the Kamey and Point Comfort quadrangles (Paine and others, 2018b, c), and the Placedo and Port Lavaca West quadranges (Paine and Costard, 2019a, b).

New geologic mapping in the Bloomington quadrangle was based on 2018 aerial imagery, a lidar-derived DEM at about 3-m cell size obtained from the U.S. Geological Survey, and field investigations by Bureau researchers that included six time-domain electromagnetic induction (TDEM) soundings from the surface to maximum depths of 74 to more than 200 m and ground-conductivity measurements at 51 sites using Geonics EM31 and EM38 frequency-domain electromagnetic induction (FDEM) ground conductivity meters (McNeill, 1980a, b; see map and supplemental sheet for locations, conductivity profiles, and conductivity values). Mapped units include Holocene fluvial deposits in the Guadalupe River valley and minor tributary valleys, including floodplain, point bar, and abandoned channel deposits, late Pleistocene to Holocene fluvial sediments deposited in four distinct terraces inset into the Pleistocene Beaumont Formation along the valley margin (figs. 6 and 7), and Beaumont Formation sandy mud in southeasterly trending channel complexes and silty clay in interchannel areas.

Figure 6. View across a late Pleistocene alluvial terrace inset into the Beaumont Formation in the Bloomington quadrangle. The topographic rise evident in the distance along the road is the boundary between the younger terrace and the older Beaumont Formation.

Figure 7. Fluvial cross bedding in sand and gravel deposits being mined from sand pits on late Pleistocene alluvial terraces in the Bloomington quadrangle.

New geologic mapping in the Olivia and northern half of the Keller Bay quadrangles was based on 2018 aerial imagery, a 1-m-cell-size DEM derived from an airborne lidar survey conducted by Bureau staff in 2015, and field investigations that included seven TDEM soundings (fig. 8) to maximum depths of 77 to more than 200 m and FDEM ground-conductivity measurements at 27 sites (see map and supplemental sheet for locations, conductivity profiles, and conductivity values). These quadrangles, located along the northern shore of Matagorda Bay and surrounding Carancahua and Keller bays, are dominated by Pleistocene Beaumont Formation fluvial, deltaic, and estuarine units (fig. 9) that include sandy muds deposited in southerly to southwestwardly trending channel complexes and floodplain or delta-plain mud deposited in interchannel areas. Axes of major channel complexes were also mapped. Common Holocene units mapped in the area include fluvial floodplain deposits and bay-margin muddy, vegetated flats and beaches and spits composed of shelly sand.

Figure 8. Bureau staff acquiring time-domain EM data near Olivia in the Olivia quadrangle, March 2020.

Figure 9. Exposure of burrowed deltaic to estuarine deposits in the Pleistocene Beaumont Formation along the Keller Bay shoreline, Olivia quadrangle.

PROJECT 3: MINERAL RESOURCE MAPPING (INDUSTRIAL SAND) IN CENTRAL TEXAS (KATEMCY QUADRANGLE, 1:24,000)

Brent A. Elliott

Project 3 focused on mapping related to sand resources in the Katemcy quadrangle in central Texas (figs. 1 and 10). Mapping focused on the Cambrian-Ordovician Hickory Sandstone of the Riley Formation. Hickory Sandstone in central Texas has historically been a major hydraulic-fracturing-sand resource for Texas (Elliott and others, 2016; Kyle, 2011), as well as host of a major aquifer for central Texas that serves as a source of water for municipalities, individual ranches and homes, agricultural operations, and industrial needs. Previous regional maps, scale 1:250,000, that include the map areas can be found in the Geologic Atlas of Texas, Llano Sheet (Barnes and Rose, 1981). Kyle (2011) and Elliott and others (2016) discussed industrial sands of the Cambrian-Ordovician Hickory Sandstone of the Riley Formation. Previous STATEMAP mapping in the central Texas sand district include Spice Rock, Fredonia and Pontotoc quadrangles (Elliott, 2015, 2017a, 2017b).

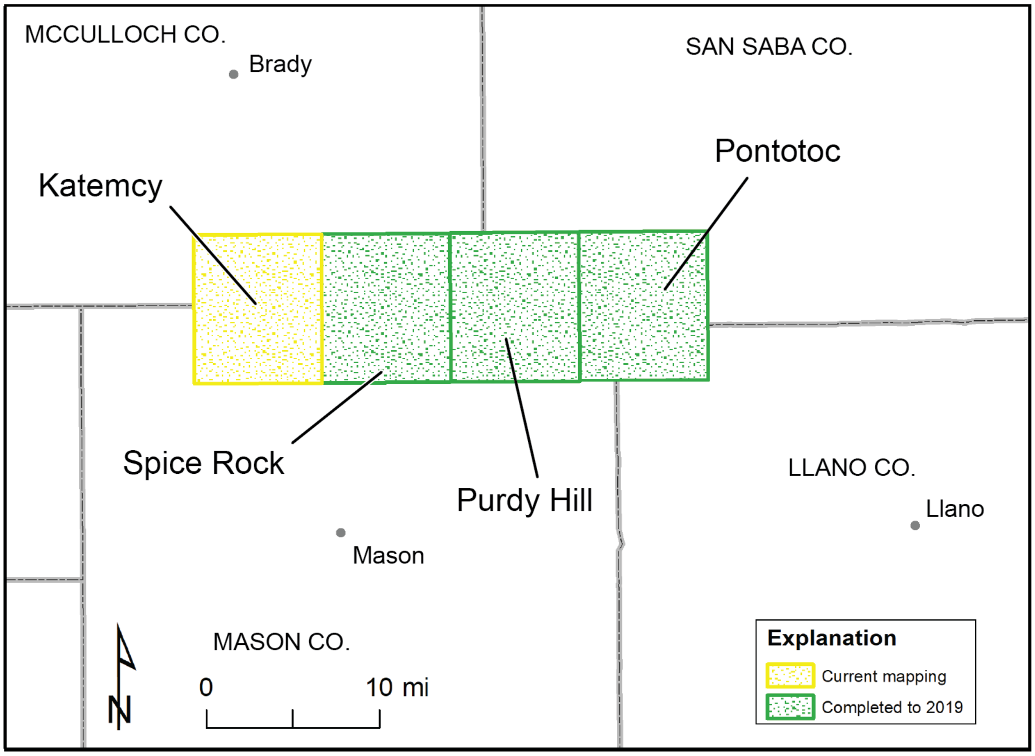

Figure 10. Map of the mineral resource mapping area of central Texas (project area 3, fig. 1). The current quadrangle (Katemcy) completes a series of four quadrangles mapped in this area to date.

Bedrock units mapped in the Katemcy quadrangle include Precambrian Town Mountain Granite with remnants of Packsaddle Schist, Cambrian Hickory Sandstone, Cap Mountain Limestone, Wilberns Formation Sandstone and Limestone, Ordovician Tanyard Formation Limestone and Dolomitic Limestone, Cretaceous Hensell Sandstone, and Edwards Limestone. Late Paleozoic normal faults cut strata across the study area.

PROJECT 4: GEOLOGIC MAPPING IN THE NORTHEAST AUSTIN URBAN GROWTH CORRIDOR, CENTRAL TEXAS (TAYLOR QUADRANGLE, 1:24,000)

Charles M. Woodruff, Jr. and Lucie Costard

The Taylor quadrangle occupies the central part of the Blackland Prairie region that makes up the inner-most reaches of the Gulf Coastal Plain in Texas (figs. 1 and 11). The Blackland belt almost bisects the state from southwest of San Antonio, extending to the northeast, coastward of the Balcones Escarpment beyond Temple, Waco, and Dallas almost to the Red River (Ferguson, 1986). This region is vitally important to the economy of Texas because of its prime farmland and the value of its agricultural products. The Taylor quadrangle is noted for its thick, fertile clay

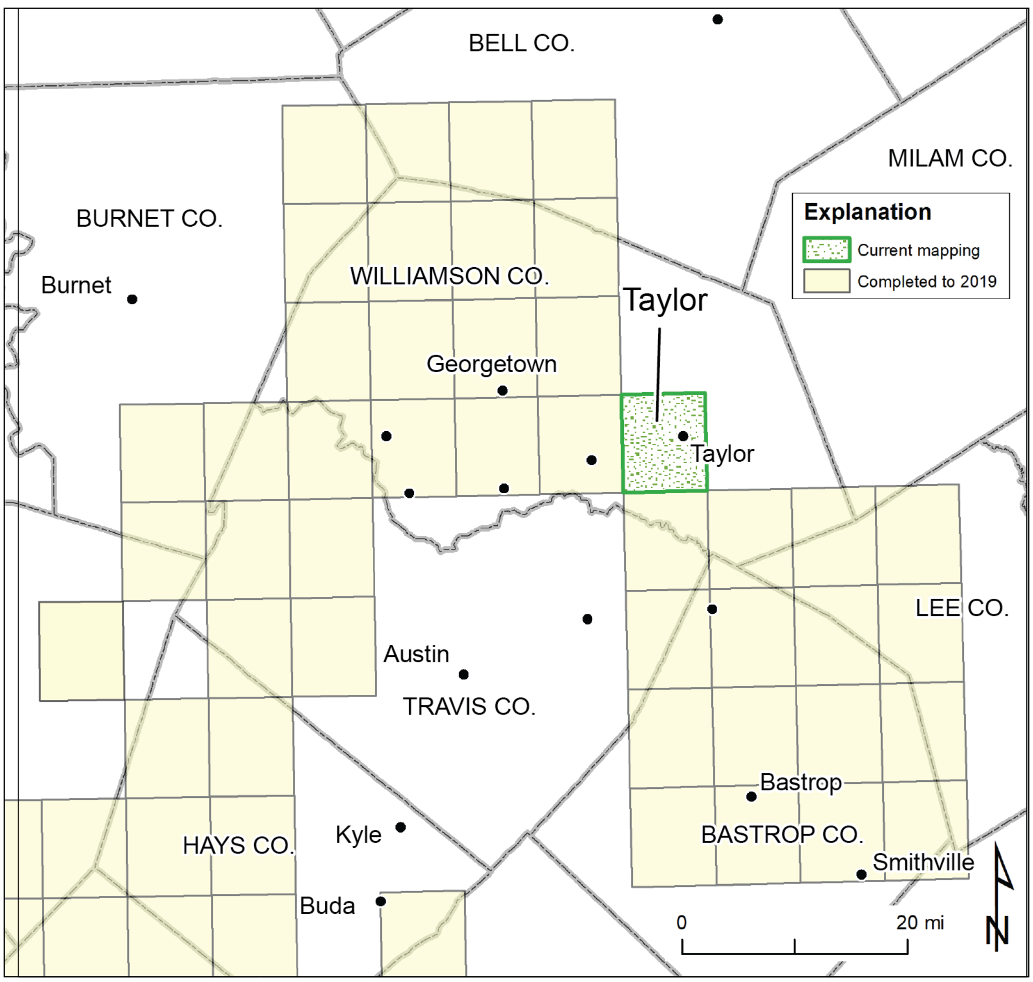

Figure 11. Map of the central Texas urban growth corridor (project area 4, fig. 1). Also shown are quadrangles completed as of June 2019 and the quadrangle mapped this year (Taylor).

and clay-loam soils, and these dark brown, to nearly black soils give the Blacklands their name. One of the characteristic soil series mapped on this quadrangle by soil scientists of the U.S. Department of Agriculture is the Houston Black Clay (Werchan and Coker, 1983), which has been designated "the State Soil of Texas" by the Texas Legislature in recognition of its bountiful crop production — especially cotton and grain sorghum.

The prairie landscape that makes up the entire Taylor quadrangle consists of low-relief terrain (approximately 170 ft of total relief within the boundaries of this map). Likewise, ground slopes are mostly low to moderate (2 to 8 percent). Geologic substrates within the boundaries of this map consist of claystone and marl strata of Late Cretaceous age that is mapped as a single, combined unit consisting of the Taylor and Navarro Groups (Barnes, 1974). In addition, Quaternary units include high gravel deposits of Pleistocene age that blanket most of the upland areas of the map as well as local alluvial valley deposits of Holocene age along the larger creeks. The high-standing Quaternary unit represents ancient stream deposits from watercourses that are no longer present within the limits of the map. These ancient fluvial systems contain clasts derived chiefly from the land west of the Balcones Escarpment including watersheds extending into the crystalline rock terrain of the Llano Uplift. The most recent units contained on this map are alluvial valley deposits from several water courses, the largest of which is Mustang Creek that cuts across the map from northwest to southeast and extends along the southern margins of the town of Taylor. Several smaller stream valleys also contain similar alluvial deposits: Turkey Creek to the north; Battleground Creek to the south; and a small part of Boggy Creek that flows off the mid-reaches of the map's south boundary.

The agricultural resources contained within the limits of this map are derived from the long-term weathering of the clay bedrock units and carbonate-rock clasts deposited by ancient river systems. The gravels are predominantly limestone (with some river-worn chert and quartz fragments); weathering products from these limestone clasts are mainly clay with some silt and sand fractions. Hence, soils all across this quadrangle consist of clays and clay loams characteristic of the Blackland Prairies. These soils—besides being highly valued as cropland—also pose engineering problems, owing to their low bearing strength, high plasticity, and high corrosion potential. The soil plasticity causes the soils to shrink when dry and swell when wet, and this produces great stresses on man-made structures. It also promotes slope failures—either along excavated exposures or areas cut by streams.

No rock or mineral resources are currently being extracted on the Taylor quadrangle, but there are several abandoned gravel pits situated along the margins of the Quaternary high gravel deposits. Some of these abandoned pits now impound water for livestock use. The low permeability of the claystone bedrock areas offers potential sites for burial of wastes (i.e. sites for sanitary landfills).

The high gravel unit also serves as a shallow source of groundwater, and numerous wells are shown on this map (derived from on-line data bases of the Texas Water Development Board). However, the gravel sections are, at maximum, about 20 ft thick, so the water resources are highly limited and suitable mainly for use by a single homestead. Moreover, such shallow groundwater resources are subject to contamination from surface activities such as the use of septic tanks.

The town of Taylor taps a much more reliable groundwater resource: the basal Cretaceous sandstone and conglomerate strata that make up the Hosston Sand. Taylor's water supply comes from five wells that extend to depths on the order of 3,300 ft. Water produced from these wells have elevated temperatures (approximately 480 C or 1180 F as reported by Woodruff and others, 1982). This water must be cooled by aeration before being distributed to municipal water users.

ACKNOWLEDGMENTS

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