Summary Report for the 2003–2004 STATEMAP Project:
Geological 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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Jay A. Raney and James C. Gibeaut, project coordinators,

and
Edward W. Collins, Thomas A. Tremblay, Rachel Waldinger, and William A. White

Prepared for
U.S. Geological Survey
Under Cooperative Agreement No. 03HQAG0053

Bureau of Economic Geology
Scott W. Tinker, Director
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INTRODUCTION

This Texas STATEMAP project involves geologic mapping of areas where improved geologic information can assist the management and use of land and water resources. Work during the past year focused on new geologic mapping within two project study areas (fig. 1): (1) Hill Country Trinity aquifer near Kerrville and Bandera, Central Texas, and (2) Christmas Point quadrangle—San Luis Pass area, Texas Gulf of Mexico coast. The geologic maps produced by this project will aid professionals and the public in making informed decisions regarding land use, aquifer management, and environmental protection for urban-growth corridors in Texas. Maps of the project 1 Hill Country Trinity aquifer area will be used to make decisions regarding aquifer management and modeling, land use, and environmental protection for Central Texas, a region where population growth is causing greater demands for use of water and Earth resources. The map produced for project 2 involves a Texas Gulf of Mexico coast area near San Luis Pass, the Christmas Point quadrangle. Mapping Holocene and Pleistocene environmental geologic units associated with coastal depositional environments within this important tidal-inlet area of the Texas Gulf Coast will support crucial activities such as evaluating historic changes of coastal depositional environments, addressing erosion issues, educating the public, and establishing a framework for conducting studies and presenting data for management of other Texas inlets.

Deliverables produced for this 2003–2004 contract year are (1) project 1: 10 open-file geologic quadrangle maps (1:24,000) of the Hill Country Trinity aquifer near Kerrville and Bandera, Central Texas, and (2) project 2: open-file geologic quadrangle map (1:24,000) of the Christmas Point quadrangle—San Luis Pass area, Texas Gulf Coast. Methods used for the projects included standard field techniques, study of aerial photographs, and review of previous work. Mapping of the Christmas Point quadrangle also involved digital photography and mapping techniques.

Existing regional geologic maps that encompass project 1, Hill Country Trinity aquifer area near Kerrville and Bandera, are the 1:250,000-scale Llano sheet (Barnes, 1981) and San Antonio sheet (Brown and others, 1974). A regional map, scale 1:250,000, of Edwards Group strata was constructed by Rose (1972) during his investigation of Edwards strata. Regional maps that cover project 2, Christmas Point quadrangle—San Luis Pass area, include the 1:125,000-scale *Environmental Geologic Atlas of the Texas Coastal Zone—Galveston–Houston Sheet* (Fisher and others, 1972) and the 1:125,000-scale map of *Submerged Lands of Texas, Galveston–Houston Area* (White and others, 1985).

PROJECT 1: NEW GEOLOGIC MAPPING OF THE HILL COUNTRY TRINITY AQUIFER NEAR KERRVILLE AND BANDERA, TEXAS

Work for project 1 occurred within the Hill Country Trinity aquifer near Kerrville and Bandera, Texas (figs. 1 through 3). This area, located west of Austin and north-northwest of San Antonio, is experiencing demands on its land and water resources that are caused partly by population increases to the region. The area straddles the east edge of the Edwards Plateau, the designated boundary between the Edwards–Trinity aquifer of the plateau and the Hill Country Trinity aquifer. Landscape of the study area is dissected by the Guadalupe and Medina Rivers and their tributaries. Open-file

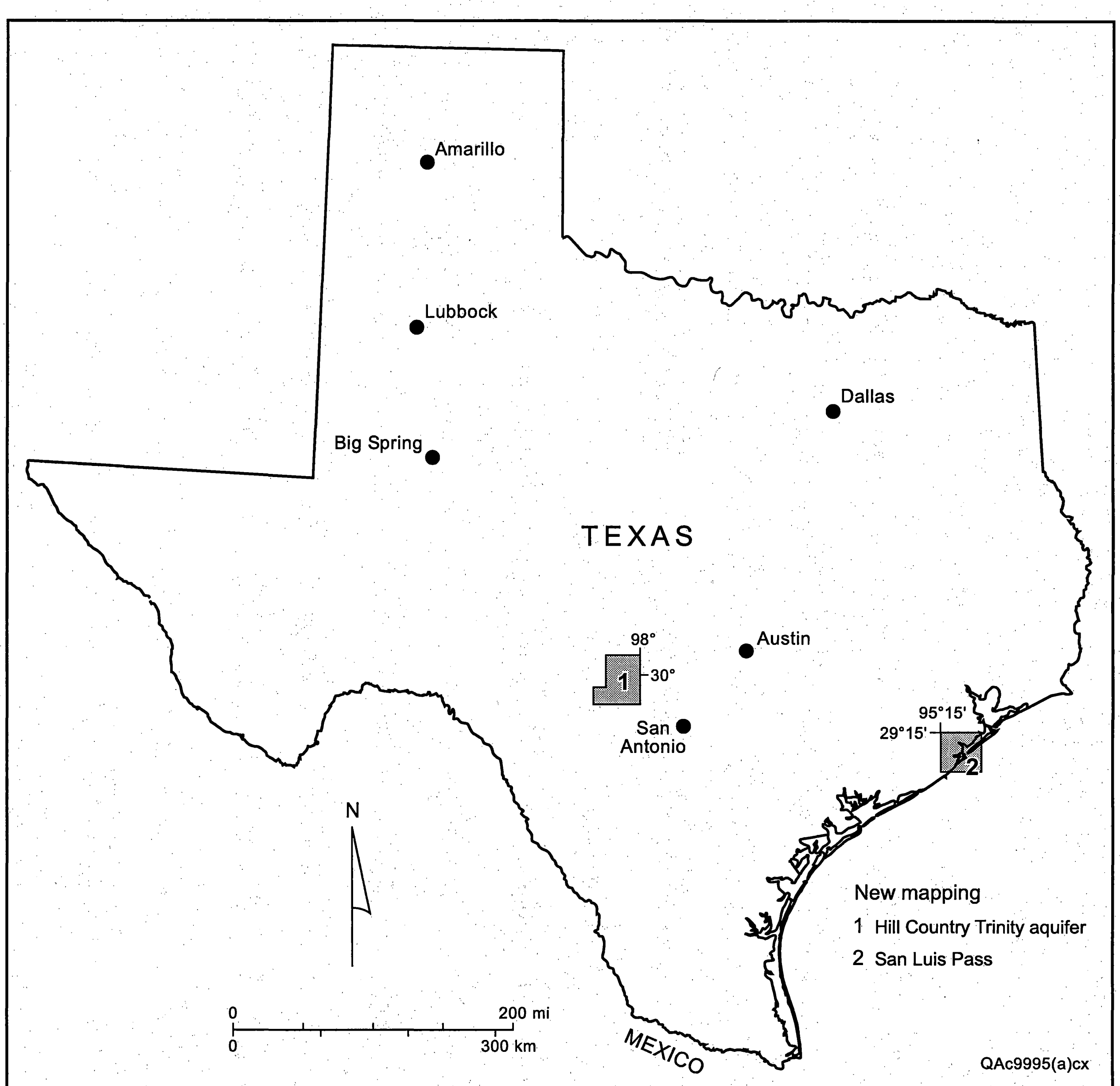

FIGURE 1. Location of Texas project study areas. Geologic mapping projects include project 1, Hill Country Trinity aquifer, Kerrville and Bandera area, Central Texas; and project 2, geologic mapping of the Christmas Point quadrangle, Texas—San Luis Pass area, Texas Gulf of Mexico coast.

geologic maps were completed for the Hunt, Kerrville, Legion, Echo Hill Ranch, Fall Creek, Center Point, Love Creek, A Bar A Ranch, Rock Cliff Reservoir, and Bandera Pass quadrangles (fig. 3). Mapping of these quadrangles completes detailed map coverage of the Hill Country Trinity aquifer. These project 1 quadrangles lie adjacent to areas that have been previously mapped (fig. 3). Areas to the east and south have been mapped at a 1:24,000 scale during previous STATEMAP projects. Digital compilations of open-file, 1:24,000-scale maps have been constructed and published at 1:100,000 scale for part of the area to the south of project 1 study area (Collins, 2000). The area to

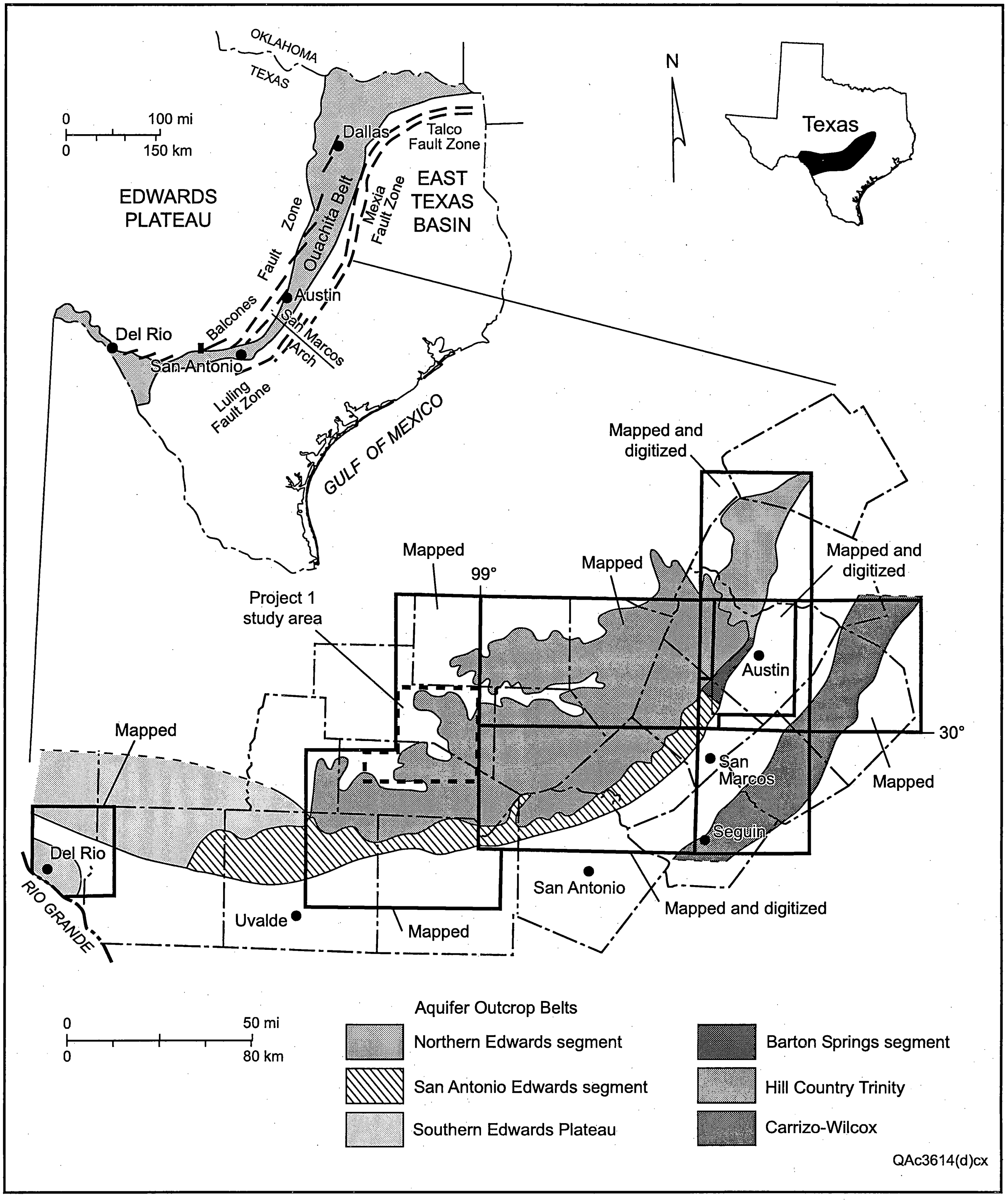

Figure 2. Setting of outcrop belts for Trinity, Edwards, and Carrizo aquifers and location of project 1 and areas of previous mapping and map digitization.

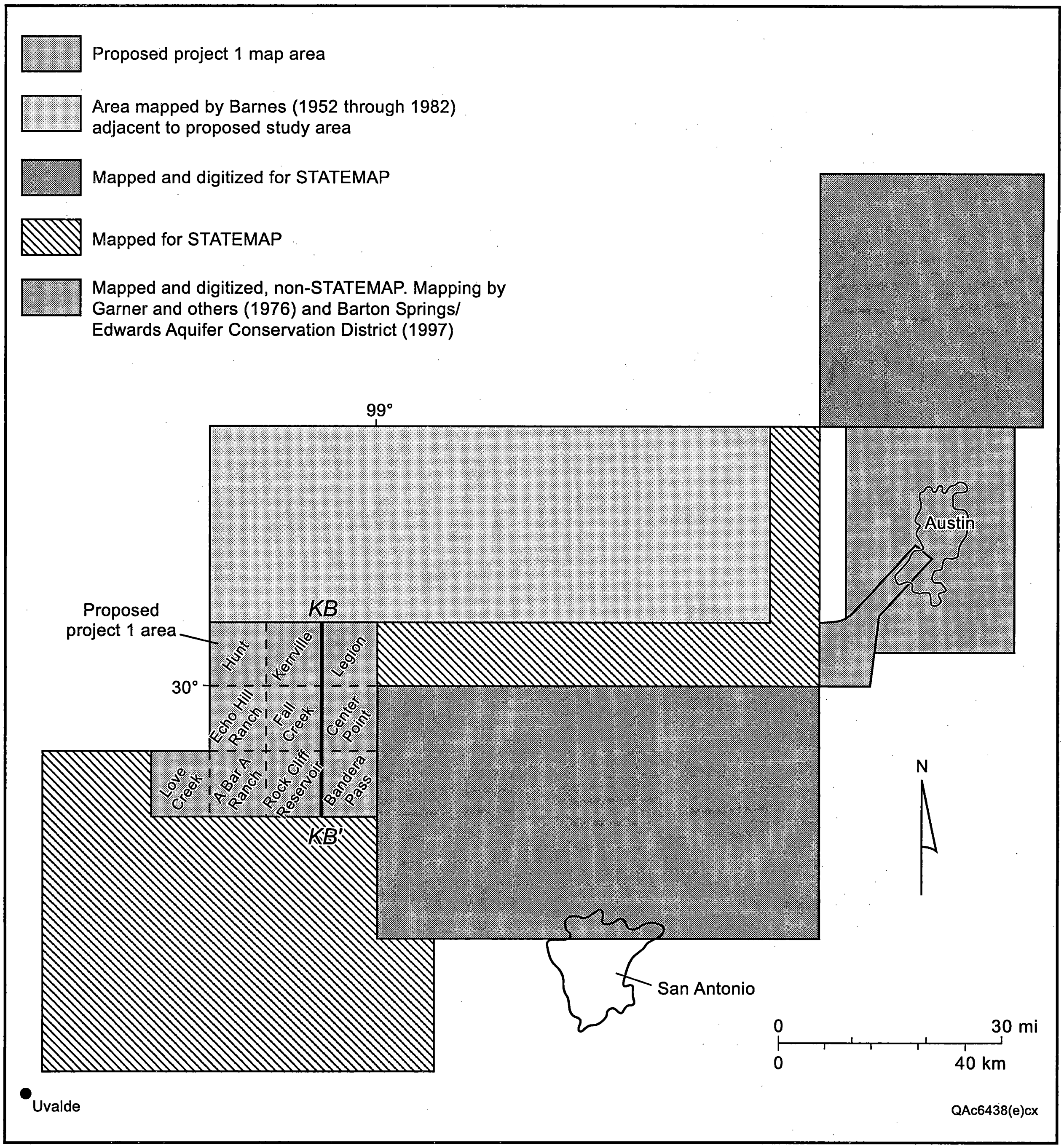

Figure 3. Location and quadrangles (1:24,000 scale) for project 1 area, Hill Country Trinity aquifer, Kerrville and Bandera area, Central Texas.

the north of project 1 study area has been mapped at 1:31,680 scale (Barnes, 1952a–c; 1954a–d; 1956a, b).

Geology of the Kerrville–Bandera area consists mostly of Cretaceous lower and upper Glen Rose, Fort Terrett, and Segovia limestone, argillaceous limestone, dolomitic limestone, and minor

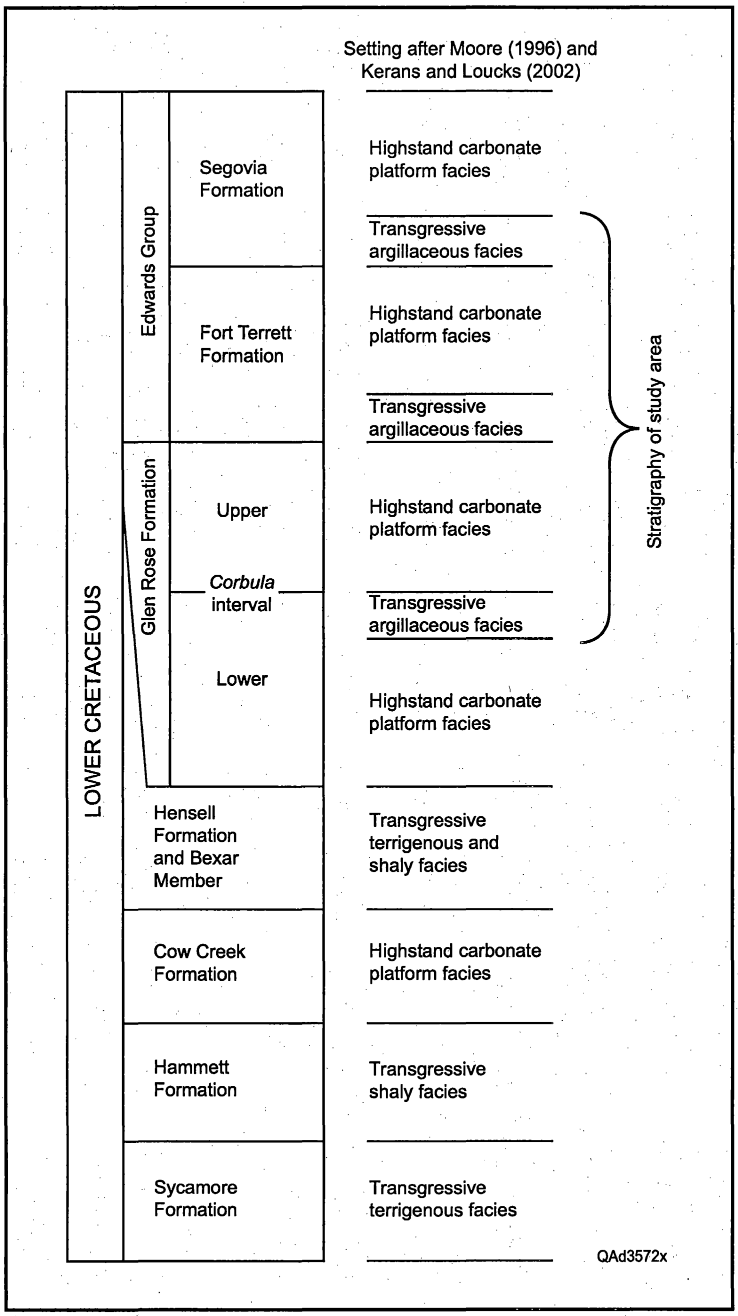

Figure 4. Stratigraphy of project 1 area, Hill Country Trinity aquifer, Kerrville and Bandera area, Central Texas. Rocks of Glen Rose Formation and Edwards Group lie at the surface in the study area. Subsurface strata comprise Hensell, Cow Creek, Hammett, and Sycamore deposits. The Hill Country Trinity aquifer is composed of the Sycamore through Glen Rose stratigraphic section.

marl (figs. 4, 5). Glen Rose rocks comprise the Trinity aquifer deposits at the surface in the mapped area. Subsurface Trinity aquifer host rocks include Hensell sandstone, mudstone, and conglomerate, which regionally exhibit an interfingering relationship with Glen Rose strata, and older Cretaceous Cow Creek limestone, Hammett shale (generally non-water-producing), and Sycamore sandstone, siltstone, mudstone, and conglomerate. Fort Terrett and Segovia rocks compose the Edwards Group that caps Glen Rose rocks.

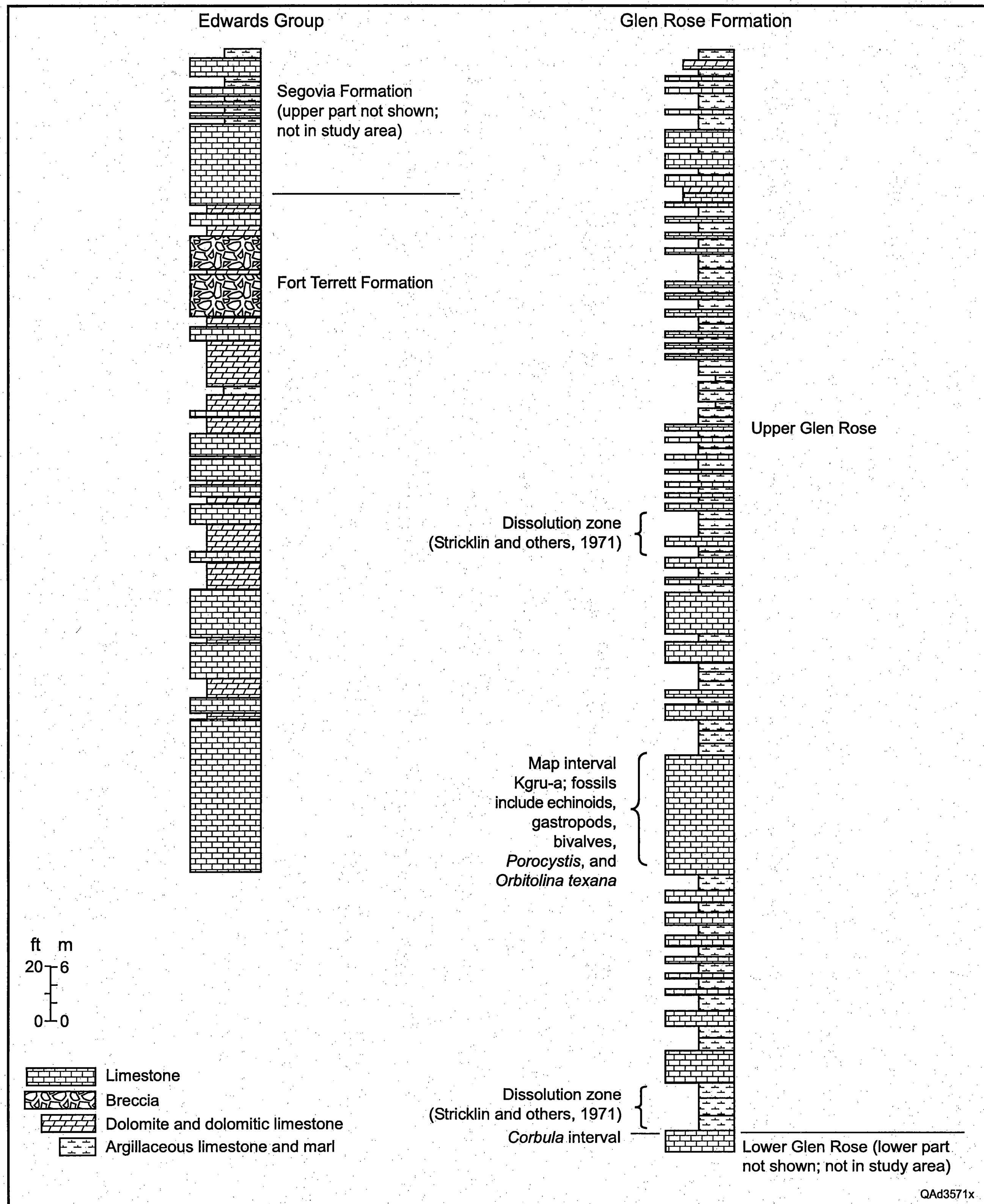

Figure 5. Generalized lithostratigraphic columns for Edwards Group and Glen Rose Formation of project 1 area, Hill Country Trinity aquifer, Kerrville and Bandera area, Central Texas. Data for columns from field data collected from this study and review of Stricklin and others (1971) and Rose (1972).

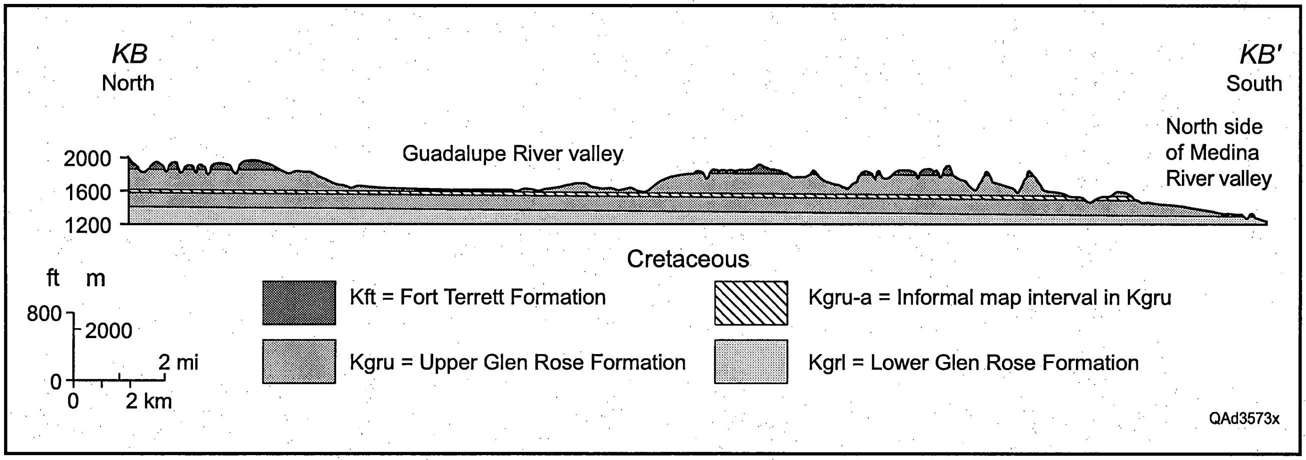

FIGURE 6. North-south cross section KB-KB′ illustrating general geologic setting and landscape of project 1 area, Hill Country Trinity aquifer, Kerrville and Bandera area, Central Texas.

Cross section KB-KB′ illustrates the general geologic setting of the area (fig. 6). Strata exhibit only a slight regional dip. The Edwards Plateau, capped by Edwards Group rocks, has been dissected by the Guadalupe and Medina Rivers and their tributaries. Upper Glen Rose rocks cover most of the study area, and Edwards rocks cap the higher hills. Glen Rose strata are mostly interbedded limestone and argillaceous limestone that were deposited within broad marine-shelf and shelf-margin settings (figs. 4, 5). The stair-stepped topography that is characteristic of the unit's landscape is caused by alternating erosionally resistant and nonresistant limestone and argillaceous limestone. Some dolomite and dolomitic limestone occur within the Glen Rose Formation's upper part. Dissolution zones, characterized by contorted clay-rich sediments and local fractured and box-work fabric, were reported by Stricklin and others (1971) to represent stratal intervals that were originally deposited as evaporite beds that later underwent dissolution. Mapping in the study area verified the local existence of these units, although weathering of the sediments and the soil and vegetation cover prevented tracing these intervals throughout the entire study area. However, an informal map interval consisting of a fossil-rich nodular limestone and some argillaceous limestone was mapped throughout the area to provide a local stratigraphic marker interval within the ~200-ft-thick upper Glen Rose. Fossils within this informal map interval include echinoids, gastropods, bivalves, *Porocystis globularis*, and *Orbitolina texana*. Glen Rose rocks are capped by Edwards Group limestone, dolomite, and dolomitic limestone along the margins of the Edwards Plateau and the higher hills of the drainage divide bounding the Guadalupe and Medina Rivers (fig. 6). Steep slopes within the more argillaceous parts of the Glen Rose, often caused by construction projects, are susceptible to landslides and rock falls. Quaternary terrace deposits and alluvium of the Guadalupe and Medina Rivers and their terraces are other prominent geologic units of the area. Pits dug for Quaternary sand and gravel, as well as for Cretaceous limestone aggregate, provide an Earth resource important to construction and development of the region and the area's economy. Abandoned pits are also of environmental concern because they have the potential to be used for illegal dumping and, as a result, possible impairment of surface-water and groundwater quality.

Springs are numerous within the study area. A preliminary evaluation of the stratigraphic position of springs identified on quadrangle base maps throughout the mapped study area indicates that there are about as many springs within the upper Glen Rose Formation (40) as there are within Edwards Group strata (44). About 13 springs discharge within 20 ft of the contact between the two units. In the study area this contact typically marks a boundary between Edwards nodular limestone and more clay-rich Glen Rose strata comprising argillaceous limestone with interbeds of limestone and dolomitic limestone. Of the 40 mapped springs that discharge from the ~400-ft-thick upper Glen Rose unit, 20 springs discharge from strata of the upper 100 ft. A more regional evaluation of springs and the Trinity aquifer outcrop belt is needed to determine whether the upper ~100 ft of the Glen Rose Formation, or other parts of the unit, characteristically contain many springs.

PROJECT 2: NEW GEOLOGIC MAPPING OF THE CHRISTMAS POINT QUADRANGLE—SAN LUIS PASS AREA, TEXAS GULF COAST

The project 2 study area was Christmas Point quadrangle of the San Luis Pass area, a tidal inlet area near Galveston, Texas (figs. 1, 7). Geologic maps of this area aid in the management and development of this important island–tidal-inlet–bay-delta margin area of the Texas Gulf of Mexico coast. Management and resource planning of this environmentally sensitive and locally densely populated coastal area are important to commercial and recreational interests and the economy of the State. The San Luis Pass tidal inlet is one of the most utilized passageways for commercial and recreational vessels in Texas. The islands include locally populated areas and some of the most used recreational areas along the coast. Natural depositional and erosional processes and human-induced activities affect water quality, littoral sediment budget, wetland boundaries, and shoreline changes. Geologic maps of this area are needed to make land and resource management decisions and to support ongoing coastal studies. For example, the geologic map of Christmas Point quadrangle may be compared with previous maps to evaluate shoreline changes, changes in geologic depositional environments, and changes from human-induced activities. This map and future maps of adjacent areas will also be used for public education.

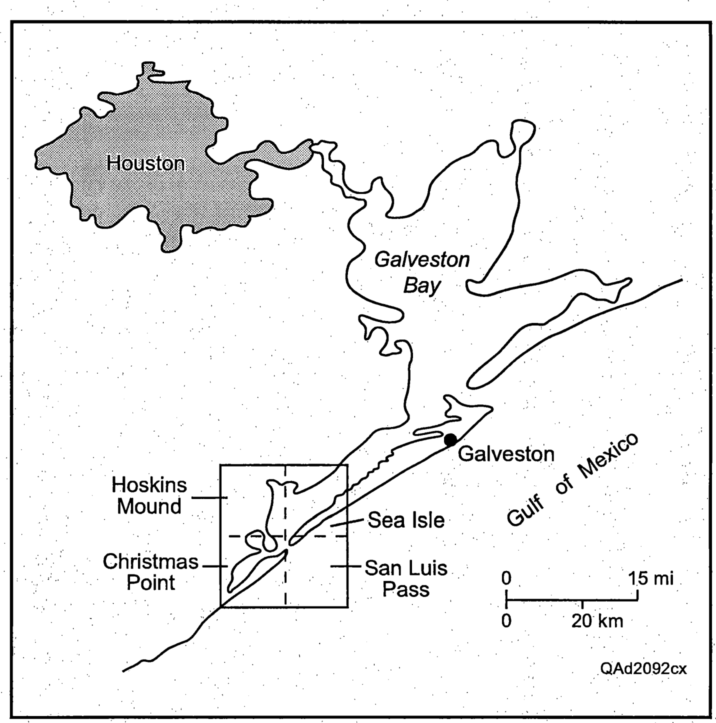

FIGURE 7. Location of San Luis Pass area, Texas Gulf of Mexico coast. Project 2 focused on geologic mapping of Christmas Point quadrangle (1:24,000 scale) for this work year.

Geology of Christmas Point quadrangle consists of Pleistocene Beaumont Formation units and Modern-Holocene units that exist within two settings: (1) fluvial-deltaic, marsh, bay systems and (2) a barrier-island system. Two Pleistocene Beaumont Formation units were mapped within the fluvial-deltaic, marsh, bay systems: deltaic, clayey sand and silt and interdistributary mud and clay. These units occur in upland areas. Modern-Holocene units identified within this system include estuarine-marsh and tidal-creek, levee, point-bar, abandoned-channel, beach and berm, and oyster-reef environments and associated deposits. Other important features mapped are areas of dredge material and water. Several faults that cut deposits within the map area are distinguished by ponded water on downthrown fault blocks and vegetation contrasts across the faults.

Comparisons between distributions of geologic environments and associated deposits within the fluvial-deltaic, marsh, and bay systems mapped for this study and for (1) 1950's photography and (2) environmental geologic mapping done during 1972 that used 1950's photography as a base (Fisher and others, 1972) are ongoing. Preliminary observations indicate an increase in (1) number of ponds and lakes, as well as enlargement of some ponds and lakes, mostly within marsh areas, and (2) human activities since the 1950's, including dredging and enlarging of canals, construction of roads and buildings, and local areas of shoreline loss along parts of the bays.

Mapping of San Luis, Follets, and Mud Islands included delineating geologic depositional environments related to critical wetland habitats and island-beach and shore-zone deposits. Mapped geoenvironmental units follow wetland habitat classification, as described in the U.S. Fish and Wildlife Service National Wetlands Inventory (NWI) classification (Cowardin and others, 1979). Units are classified as estuarine, palustrine, or marine systems. The estuarine system has subtidal aquatic beds (E1AB) and unconsolidated bottom (E1UB). In the Christmas Point quadrangle, aquatic beds define areas containing seagrasses. Unconsolidated bottom refers to areas of open water. The estuarine system also contains intertidal marshes (E2EM), flats (E2US), and reefs (E2RF). The palustrine system, which pertains to brackish and freshwater habitats, consists of marsh (PEM) and unconsolidated bottom (PUB). The marine system contains a subtidal unconsolidated bottom unit (M1UB) and intertidal flat units (M2US).

ACKNOWLEDGMENTS

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The views and conclusions contained in this map are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government. The authors disclaim any responsibility or liability for interpretations from this report or related maps or digital data or decisions based thereon.

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APPENDIX A: EXPLANATION OF GEOLOGICAL UNITS FOR THE HILL COUNTRY TRINITY AQUIFER NEAR KERRVILLE AND BANDERA, TEXAS

A Bar A Ranch, Bandera Pass, Center Point, Echo Hill Ranch, Fall Creek, Hunt, Kerrville, Legion, Love Creek, and Rock Cliff Reservoir Quadrangles
(scale 1:24,000)

QUATERNARY

Qal—Alluvium. Gravel, sand, silt, and mud; mostly modern drainage-way deposits; includes some undivided thin, local terrace deposits and local bedrock outcrops.

Qt—Terrace alluvium. Gravel, sand, silt, and mud.

Qt + Kgru—Undivided terrace deposits and Cretaceous Glen Rose Formation.

Qu—Undivided fan, slope-wash, and terrace deposits. Gravel to mud.

Ql—Landslide deposits.

LOWER CRETACEOUS

Edwards Group:

Ks—Segovia Formation. Limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Person Formation of Balcones Fault Zone area; only minor outcrop areas in west part of study area; west of map area as much as 360 ft thick.

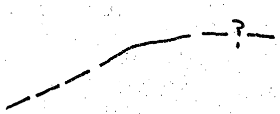
Kft—Fort Terrett Formation. Limestone, dolomitic limestone, dolomite, and lesser argillaceous limestone; approximately equivalent to Kainer and Walnut Formations of the Balcones Fault Zone area; shallow subtidal to tidal-flat cycles common; crystalline limestone/dolomitic limestone common; fossils include bivalves, gastropods, rudistids, and milliolids; upper part contains some leached evaporitic intervals and breccias; lower 20 to 60 ft is equivalent to the Walnut Formation (Kw) of the Balcones Fault Zone area.

Kgru—Upper Glen Rose Formation. Limestone, dolomitic limestone, argillaceous limestone, and some marl; shallow subtidal to tidal-flat cycles common; alternating resistant and recessive beds form stair-step topography; dolomitic in upper and lower parts; abundant fossils include bivalves, rudistids, oysters, echinoids, and foraminifera *Orbitolina texana*; leached evaporitic intervals often referred to as dissolution zones;

thickness as much as 400 ft. Includes informal map interval Kgru-a, a 40- to 60-ft-thick nodular and argillaceous limestone interval with some beds containing abundant echinoids, gastropods, bivalves, *Porocystis globularis*, and *Orbitolina texana*.

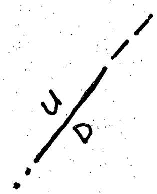
Kgrl—Lower Glen Rose Formation. Limestone, dolomitic limestone, argillaceous limestone, and some marl; top of unit marked by interval with one to three thin, resistant, 1- to 3-ft-thick beds containing *Corbula*; *Corbula* interval above very fossiliferous unit that often includes echinoid *Salina texana*; *Corbula* interval below a leached evaporitic interval of upper Glen Rose; abundant fossils include bivalves, rudistids, oysters, echinoids, and foraminifera *Orbitolina texana*; massive and thick beds common; unit thickness between 200 and 270 ft.

MAP SYMBOLS



Contacts

Contacts drawn as solid lines are relatively more distinct in the field and on aerial photographs than when they are drawn as dashed lines; question marks (?) indicate where contacts are uncertain.



Normal fault; U=upthrown block, D=downthrown block.

Faults drawn as solid lines are relatively more distinct in the field and on aerial photographs than where they are drawn as dashed lines; dotted lines show where faults are covered by unfaulted deposits.