Summary Report for the New Braunfels, Texas, STATEMAP Project, 1995

by

Edward W. Collins and Jay A. Raney

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Bureau of Economic Geology
Noel Tyler, Director
The University of Texas at Austin
Austin, Texas 78713-8924

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Geologic mapping of the 7.5-minute quadrangles that make up the 1:100,000-scale New Braunfels, Texas, sheet (figs. 1 and 2) has continued as scheduled during 1994–1995. Ten quadrangles (Van Raub, Helotes, Waring, Ranger Creek, Jack Mountain, San Geronimo, Comfort, Turkey Knob, Pipe Creek, and Medina Lake) were mapped during this time (fig. 2). During the 1994–1995 contract year, we completed mapping for the 1:100,000-scale New Braunfels, Texas, sheet, an area that contains 32 7.5-minute quadrangles. We anticipate the color 1:100,000-scale geologic map and its text will be published during 1996 as scheduled. This project has succeeded in making useful geologic information for a geologically critical part of Texas available to the public. Thirty-two open-file geologic maps, at 1:24,000 scale, are available, and studies related to the mapping contributed to three published papers (Collins, 1993; Collins, 1994; Collins, in press).

This year's (1994–1995) mapping of the quadrangles that make up the western part of the 1:100,000-scale New Braunfels sheet benefited from many previous geologic studies of the Central Texas region. Some of these studies include those by Holt (1956), Arnow (1959), Reeves and Lee (1962), Rose (1972), Abbott (1973), Waddell (1976), Grimshaw and Woodruff (1986), Maclay and Small (1986), Small (1986), Stein (1993), and Hovorka and others (1994). Maps completed this year encompass an area that includes the Balcones Fault Zone and escarpment and the eastern margin of the Edwards Plateau. The following summary discusses the geology of the entire New Braunfels, Texas, sheet.

The 1:100,000-scale New Braunfels, Texas, sheet encompasses a region that is undergoing rapid urban growth. It lies within part of the recharge zone of the Edwards aquifer and includes a complex part of the Balcones Fault Zone. The geology of this region is important to geologists and other professionals involved in planning land use, designing construction projects, and studying the Edwards aquifer. Recharge of the aquifer may be locally enhanced at karst features, faults, and joints. Faulted aquifer strata influence regional ground-water flow, and faults locally juxtapose strata having different physical properties, creating potential construction/foundation problems. The geologic maps prepared for this area provide some of the most useful and fundamental information for this geologically critical area of Central Texas.

A major part of the Balcones Fault Zone and the associated Balcones escarpment crosses the 1:100,000-scale New Braunfels, Texas, sheet (figs. 1 and 3). The fault zone, one of the main structural features of Central Texas, extends east-northeastward from near Del Rio to San Antonio, where the zone bends northward through New Braunfels, Austin, Georgetown, and Waco and continues toward Dallas. Normal faults composing the zone are either more common or more pronounced between Uvalde and Georgetown, an area that coincides with the Balcones escarpment, a prominent fault-line scarp that is an area of major offset across the fault zone. The fault zone generally follows the strike of the Cretaceous outcrop belt and the structural grain of the buried Paleozoic Ouachita fold and thrust belt. Balcones faults mark the edge of the Texas Coastal Plain and are a manifestation of gulfward tectonic extension, flexure, and tilting along the perimeter of the Gulf of Mexico. Most movement on the Balcones Fault Zone is thought to have occurred during the late Oligocene or early Miocene (Weeks, 1945).

In the area mapped for this study, the fault zone covers approximately two-thirds of the southeastern part of the map. This part of the fault zone is composed of en echelon normal fault strands that mostly strike N40°–70°E and dip southeastward. Fewer faults dip northwestward. Subsidiary faults strike northwestward, northward, and eastward. Rare outcrops containing larger faults indicate that fault surfaces are irregular, have dips between 60° and 85°, and display striations running parallel to subparallel to the fault dip. Smaller subsidiary faults commonly dip between 45° and 85°. Within the map area, the composite stratigraphic displacement (structural relief) across the fault zone is as much as ~1,600 to ~1,800 ft. In the study area, the fault zone consists of multiple major 2- to 7-mi-wide fault blocks bound by long series of southeast-dipping, tight, en echelon large normal faults that have throws ranging between ~100 and ~850 ft (fig. 3). Smaller fault blocks exist within the larger fault blocks, and many smaller faults with throws ranging from less than 1 to 100 ft cut strata across the fault zone. These series of tight, en echelon large faults that bound the large fault blocks consist of individual fault strands that are commonly between 6 and 16 mi long. Maximum displacement is generally in the central part of individual fault strands, and displacement decreases horizontally toward the fault tips. Some of the larger southeast-dipping faults are associated with northwest-dipping antithetic faults than bound narrow grabens, which are ~3,000 to ~4,000 ft wide.

Normal faults of the fault zone are commonly surrounded by zones of highly fractured strata (Collins, in press). Abundant fractures (mostly small faults and some joints) adjacent to faults are well connected both laterally and vertically by numerous intersecting and crosscutting fractures. Locally anastomosing fault arrays grade into breccia. In general, faults that have large throws have wide, highly fractured zones or breccia zones. Fracture spacing and connectivity decrease away from master faults. Fracture zones associated with smaller faults have larger fracture spacings and poorer fracture connectivity than do the highly fractured zones that occur directly adjacent to the master faults.

Within the map area near northwest San Antonio, the fault zone and units of the outcrop belt have an ~8-mi-wide right step of the largest displacement faults, and a southwest-dipping relay ramp (San Antonio ramp) has formed between the large faults (fig. 4). Relay ramps, also called transfer zones, are structures that sometimes form between the tips of two en echelon normal faults dipping in the same direction (Larsen, 1988; Peacock and Sanderson, 1991, 1994). A ramp connects the hangingwall and footwall blocks of two en echelon faults. Relay ramps may consist of a mosaic of intermingled faults that have multiple strikes. The large, west-northwest-striking en echelon master faults associated with the San Antonio relay ramp have maximum throws of >800 ft. Smaller faults within the relay ramp strike in many different directions, have throws mostly <100 ft, and form small fault blocks. Structural relief of Edwards Group strata across the ramp varies because of local structural complexities. Along the approximate axis of the ramp, aquifer strata drop ~300 ft across 6 mi because of gentle folding and small faulting. However, local areas within the ramp exhibit smaller structural relief. Greater structural relief also exists locally. The northeastern part of the 1:100,000-scale New Braunfels, Texas, map area is at the edge of another large (6-mi-wide) fault-zone step and relay ramp, the northeast-dipping San Marcos ramp (Grimshaw and Woodruff, 1986), which is east of the study area. Smaller ramp structures also exist between more closely spaced, smaller (throws <300 ft) en echelon faults. Relay ramps may be important to ground-water investigations of the area because the ramps represent places within the fault zone where aquifer continuity is relatively good, both because strata are relatively continuous in ramp steps between faults and because the small faults having multiple strikes within ramps may have numerous intersections.

The stratigraphy of the mapped area is described in Appendix A: Explanation of Geologic Units. Cretaceous limestone, dolomitic limestone, marl, and shale crop out along the fault zone and represent >2,000 ft of shelf deposition on the southeast-trending San Marcos Arch. Northwest of the Balcones escarpment, the outcrop belt consists mostly of cyclic, shallow subtidal to tidal-flat limestones and dolomitic limestones of the 650-ft-thick Glen Rose Limestone and the ~550-ft-thick Edwards Group. Nearshore siliciclastic-rich limestones of the 40- to 50-ft-thick Hensel and ~75-ft-thick Cow Creek Formations locally crop out beneath the Glen Rose Limestone along the Guadalupe River at the western margin of the fault zone. At the northwestern part of the map area, the eastern margins of the Edwards Plateau are capped by Edwards Group strata.

Within the fault zone in the southeastern two-thirds of the map, open-shelf limestones and shelf/prodelta shale that overlie the Edwards Group comprise <30 ft of Georgetown limestone (possibly absent locally), 30 to 50 ft of Del Rio clay/shale, 40 to 65 ft of Buda limestone, 15 to 25 ft of Eagle Ford shale, and ~90 to 150 ft of Austin chalk. The relatively thin post-Edwards deposits are preserved within graben west of the escarpment as well as locally along the escarpment. A local packstone to grainstone facies containing abundant altered volcanic material and distinct scour surfaces may indicate shallow-water deposition along the flank of a volcano during upper Austin Group/lower Taylor Group deposition. Southeast of the escarpment, poorly exposed shelf marls, argillaceous limestones, and shale/clay of the >600-ft-thick Taylor Group make up much of the Cretaceous outcrop belt that is commonly covered by Quaternary sand and gravel of the Leona Formation, local older (Pliocene–Pleistocene) gravel, and younger sand and gravel of terraces of the main drainage ways. Active and abandoned sand/gravel and limestone quarries are common in the study area. The active quarries along the Balcones Escarpment mine limestone for crushed stone and cement.

The Edwards Group outcrop belt within the fault zone approximately defines the main recharge area and unconfined part of the Edwards aquifer, the sole source aquifer of San Antonio, Texas. The subsurface Edwards Group south and southeast of the fault zone represents most of the confined aquifer. Georgetown limestones overlying Edwards limestones on the San Marcos

Platform comprise thin (<60 ft) strata that are commonly grouped with the aquifer. Del Rio clay overlies the aquifer strata. Beneath the Edwards aquifer lie limestone and marl of the Glen Rose Formation, which in its upper part is generally less permeable than the Edwards strata.

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Appendix A: Explanation of Geologic Units

New Braunfels–San Antonio Region

Anhalt, Bat Cave, Bergheim, Boerne, Bulverde, Camp Bullis, Castle Hills, Comfort, Devil's Backbone, Fischer, Helotes, Hunter, Jack Mountain, Kendalia, Longhorn, Marian, McQueeney, Medina Lake, New Braunfels East, New Braunfels West, Pipe Creek, Ranger Creek, San Geronimo, Sattler, Schertz, Sisterdale, Smithson Valley, Spring Branch, Turkey Knob, Van Raub, Waring, and Wimberley quadrangles, Texas

(1:24,000 scale)

QUATERNARY UNITS

Alluvium (**Qal**). Unconsolidated gravel, sand, silt, and clay along streams and rivers; relatively free of woody vegetation, inundated regularly. Clasts are mainly carbonate and chert. Along minor drainages, includes undivided terrace deposits. Includes some local bedrock outcrops that are undivided.

Terrace deposits (**Qt**). Unconsolidated gravel, sand, silt, and clay along streams and rivers. These deposits are mostly above flood level along entrenched streams. Upper surface commonly slopes gently downvalley and toward the stream. Along Blanco River **Qt** may be as thick as 15 ft locally. Along Guadalupe River **Qt** may be as thick as 20 ft locally.

Quaternary deposits undivided (**Qu**). Unconsolidated gravel, sand, and clay not clearly associated with a stream or river. Includes slope wash, alluvium, colluvium, and locally older Quaternary deposits. As thick as 15 ft.

Leona Formation (**Qle**). Fine calcareous silt grading down into coarse gravel. As thick as 60 ft (in wells).

TERTIARY UNITS

Gravel deposits (**QTg**). Gravel and sand; well-rounded pebble- to cobble-sized gravel common, few boulders; mostly chert and limestone, commonly cemented by caliche. Deposits typically cap topographically high areas. Precise age unknown; deposits are possibly equivalent to late Tertiary or Quaternary Uvalde Gravel. Thickness ranges from several feet of gravel lag to more than 10 ft.

Eocene

Wilcox Group (**Ewi**). Mudstone with varying amounts of sandstone and lignite; outcrops are rare. Contact with underlying Midway Group based on sandier soils associated with Wilcox Group. Thickness ranges 440 to 1,200 ft.

Midway Group. Undivided with Cretaceous Navarro and upper Taylor Groups of similar lithology (**KtnEmi**); see description below.

CRETACEOUS UNITS

Upper Cretaceous

Basalt (**Kb**). Occurs as poorly exposed dikes and/or small plugs. Precise age uncertain.

Cretaceous upper Taylor and Navarro Groups and Eocene Midway Group, undivided (**KtnEmi**). Clay, marl, and some silt/siltstone and sand/sandstone; gray to yellowish brown, poorly indurated, calcareous; outcrops are rare. Weathers to thick, black, clayey soil. Eocene Midway Group composed of clay, silt, and sand. Lower part glauconitic; phosphatic nodules and pebbles common in lowermost part; silt and sand become more abundant upward and grade into sand and mudstone of Wilcox Group. Thickness ranges 100 to 400 ft. Cretaceous Navarro and upper Taylor Groups, undivided, composed of clay, marl, sandstone, and siltstone; lower part is clay, dominantly montmorillonitic. Upper part is marl, clay, sandstone, and siltstone; marl and clay are glauconitic; thin sandstone beds have poor lateral continuity. About 950 ft thick.

Lower Taylor Group, undivided (**Ktl**), includes Pecan Gap and Anacacho Formations. Marl, chalky limestone, and some clay; locally fossiliferous; weathers to thick black soil. Total thickness averages 400 ft; Pecan Gap Formation is as much as 400 ft thick in Guadalupe County. Pecan Gap thins westward and is overlain by Anacacho Formation in western Bexar and Medina Counties. Anacacho Formation is as much as 500 ft thick west of Bexar County and thins eastward into Bexar County.

Austin and lower Taylor Groups, undivided (**KauKtl**).

Austin and lower Taylor Groups, undivided, packstone and grainstone facies (**KauKtl grnstn**). Limestone and chalky limestone; packstone and grainstone fabric common; altered volcanic material abundant; fossiliferous; fossil fragments, oysters, bivalves; local crossbeds and scour surfaces; thickness and lateral contacts uncertain because of limited outcrop.

Austin Group (**Kau**). Chalk, marl, and limestone. Light gray to white, thin- to thick-bedded, massive to slightly nodular. Chalk mostly microgranular calcite with minor foraminifera tests; abundant *Inoceramus* prisms. Chalk forms ledges and alternates with marl and locally bentonitic seams. Sparsely glauconitic, pyrite nodules partly weathered to limonite are common. Thick caliche on most outcrops. Thick black soil with juniper and live oak in low-relief areas. Locally highly fossiliferous with oysters, pelecypods, echinoids, ostracodes, and forams. Thickness ranges 135 to 200 ft.

Eagle Ford Formation (**Kef**). Shale, siltstone, and limestone. Upper part limestone and shale. Shale dark gray. Limestone light yellowish brown, flaggy, in beds as much as 4 ft thick. Lower part siltstone and very fine grained sandstone, light yellow to gray, laminated, flaggy, some limestone, silty, medium brown, laminated. Flat to gently rolling topography. Covered with dark brown soil on slopes; outcrops are rare. Strata at slope break of Eagle Ford/Buda contact commonly fossiliferous with oysters, ostracodes, forams, fish bones and teeth, and *Inoceramus*. Thickness ranges 15 to 30 ft.

Lower Cretaceous

Buda Limestone (**Kbu**). Limestone. Hard and dense to chalky; poorly bedded to nodular, glauconitic, fossiliferous; abundant broken shell fragments locally. Light gray to pale orange; weathers dark gray to brown. Thinner bedded and argillaceous near upper contact. Lower part is soft chalky limestone. Upper contact is disconformable, sharp, and conspicuous. Forms resistant cap on hills. Weathers to form thin red-brown soil with rounded cobbles of limestone. Less glauconitic and less iron oxide stained than Georgetown Formation. More fossil gastropods than Austin Group. Burrows filled with chalky marl. Abundant pelecypods, forams, ostracodes, serpulids, echinoid spines, and bryozoans. Locally, solitary corals and green algae. Thickness ranges 40 to 65 ft.

Del Rio Formation (**Kdr**). Clay. Gypsiferous, calcareous, pyrite common; poorly indurated, plastic, dark gray to olive brown; abundant *Ilymatogyra arientina* (formerly *Exogyra arietina*). Becomes less calcareous and more gypsiferous upward; blocky, medium gray, weathers light gray to yellowish gray. Some thin lenticular beds of highly calcareous siltstone. Slope forming or underhanging where slumped below overlying Buda. Forms highly expansive soil. Water tanks for livestock commonly excavated on outcrop. Upper and lower contacts gradational. Marine megafossils include abundant *Ilymatogyra arientina* (formerly *Exogyra arietina*) and other pelecypods. Thickness ranges 15 to 50 ft.

Georgetown Formation (**Kgt**). Limestone and some marl. Nodular to bedded, gray to tan; abundant fossils include *Waconella wacoensis* (formerly *Kingena wacoenisis*) and *Gryphaea washitaensis*. Few interbeds of marl 2 to 3 inches thick. Upper contact is conformable and gradational where exposed, commonly obscured by slumping of the overlying Del Rio Formation. Lower contact is disconformable. Diverse assemblage of fossils includes ammonoids, forams, echinoids, and pelecypods. Unit poorly exposed and mostly inferred on map; locally may be absent. As thick as 30 ft.

Person Formation (**Kp**). The Person Formation is the upper unit of the Edwards Group in the Balcones Fault Zone outcrop belt. Limestone and dolomitic limestone. Shallow subtidal to tidal-flat cycles. Honeycombed limestone interbedded with chalky to marly limestone and recrystallized limestone; bedded to massive; leached and collapsed intervals. Locally, pockets of red clay (terra rosa) in karst collapse features. Thin dark-red soil and residual chert regolith covered with sparse vegetation. Lower 20 to 30 ft comprises regional dense member, a dense argillaceous limestone; commonly thin flaggy beds. Mappable bench (regional dense member) at contact with underlying Kainer Formation. Mud cracks preserved near lower contact. Upper contact is burrowed, disconformable. Fossils include pelecypods, gastropods, rudistids. Thickness ranges 130 to 150 ft.

Kainer Formation (**Kk**). The Kainer Formation is the lower unit of the Edwards Group in the Balcones Fault Zone outcrop belt. Limestone and dolomitic limestone. Shallow subtidal to tidal-flat cycles. Upper part contains common hard grainstone interbedded with marly mudstone and wackestone; honeycomb porosity common; middle to lower part contains limestone; dolomitic limestone and some leached evaporitic rocks and breccias in middle part. Some researchers include strata composing Walnut Formation, **Kw**, with lower part of

Kainer Formation (**Kk**). Residual chert mantles uplands underlain by Kainer. Horizontal current laminations or low-angle cross-stratification present. Lower part is locally clayey, coarsely crystalline limestone. Fossiliferous; rudistids, caprinids, miliolids, oysters, and gastropods. About 250 ft thick.

Segovia Formation (**Ks**). The Segovia Formation is the upper unit of the Edwards Group in the eastern Edwards Plateau and is approximately equivalent to the Person Formation of the Balcones Fault Zone area. Limestone, dolomitic limestone, and marl. Only minor outcrop areas in northwest part of map area. West of map area as much as 360 ft thick.

Fort Terrett Formation (**Kft**). The Fort Terrett Formation is the lower unit of the Edwards Group in the eastern Edwards Plateau and is approximately equivalent to the Kainer and Walnut Formations of the Balcones Fault Zone area. Lateral lithologic changes between Kainer and Fort Terrett deposits are gradational and related to minor facies changes. Limestone, dolomitic limestone, and marl. Shallow subtidal to tidal-flat cycles. Upper part contains some leached evaporitic rocks and breccias. Lower 20 to 40 ft is subtidal limestone that is approximately equivalent to the Walnut Formation (**Kw**) of the Balcones Fault Zone area.

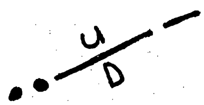
Walnut Formation (**Kw**). Limestone, marl, and dolomitic limestone; undifferentiated Bull Creek and Bee Cave Members; upper Bee Cave Member consists of fossiliferous marl; *Exogyra texana* common; Bee Cave Member thins and may pinch out toward the southwest; along steep slopes the marly Bee Cave Member commonly supports denser vegetation than does the overlying Kainer Formation; lower Bull Creek Member comprises limestone and dolomite interbedded with some marl; gastropods common; *Exogyra texana*; gradational contact with underlying Glen Rose Formation. Cream to light yellowish brown. Karst locally; some honeycomb porosity. Some researchers include **Kw** as lower part of Kainer Formation (**Kk**) southwest of Hays County. Formation as much as 30 to 50 ft thick.

Glen Rose Formation (**Kgru** and **Kgrl**). *Corbula* interval divides the formation into upper and lower parts. **C** on map indicates locality of *Corbula* observed in outcrop. Limestone, dolomitic limestone, and marl. Shallow subtidal to tidal-flat cycles. Alternating resistant and recessive beds forming stair-step topography; limestone, wackestone, packstone, grainstone, hard to soft and marly, 3- to 10-ft-thick, shoaling-upward cycles common, light gray to yellowish gray; dolomite, fine-grained, porous, yellowish brown. Locally burrowed; local honeycomb porosity; marine megafossils include molluscan steinkerns, rudistids, oysters, and echinoids; local dinosaur tracks. Upper part, **Kgru**, relatively thinner bedded, more dolomitic, and less fossiliferous; some intervals of disturbed bedding and collapse breccia possibly caused by evaporite solution; about 400 ft thick. Lower part, **Kgrl**, commonly more massive, contains some rudistid reefs and mounds. *Corbula* interval at top with abundant steinkerns of *Corbula harveyi* (Hill) in one to three thin, resistant, 1- to 3-ft-thick beds composing an interval as much as 15 ft thick; thickness ranges 200 to 270 ft. Entire formation about 650 ft thick.

Hensel Formation (**Kh**). Upper half sandy limestone. Medium- to coarse-grained sand, glauconitic, massive to bedded; weathers dark reddish brown to grayish brown. Lower half sandy limestone, sandy dolomite, and sandstone. Medium- to coarse-grained sand; poorly indurated, calcareous geodes, yellowish brown and olive gray; fossils are *Exogyra* and oysters; thickness averages 45 ft.

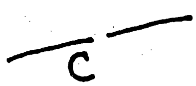
Cow Creek Limestone (**Kcc**). Upper part limestone. Calcarenite, well indurated, massive to bedded, fossiliferous, local crossbedding; some siliceous nodules; commonly forms distinct ledge; top surface contains limonite nodules and poorly defined borings. Lower part clayey limestone. Poorly indurated, sandy and dolomitic intervals, locally very burrowed, white to yellowish and brownish; forms steep undercut bluffs and gentle slopes; total thickness averages 75 ft; basal part of unit does not crop out; exposed interval about 50 ft thick.

Map Symbols



Fault; **U**, upthrown side; **D**, downthrown side; dashed where inferred, dotted where covered.

Karst-related collapse or subsidence of bedrock.



Corbula interval that separates Glen Rose Formation into upper and lower parts. **C** indicates locality of *Corbula* observed in outcrop.

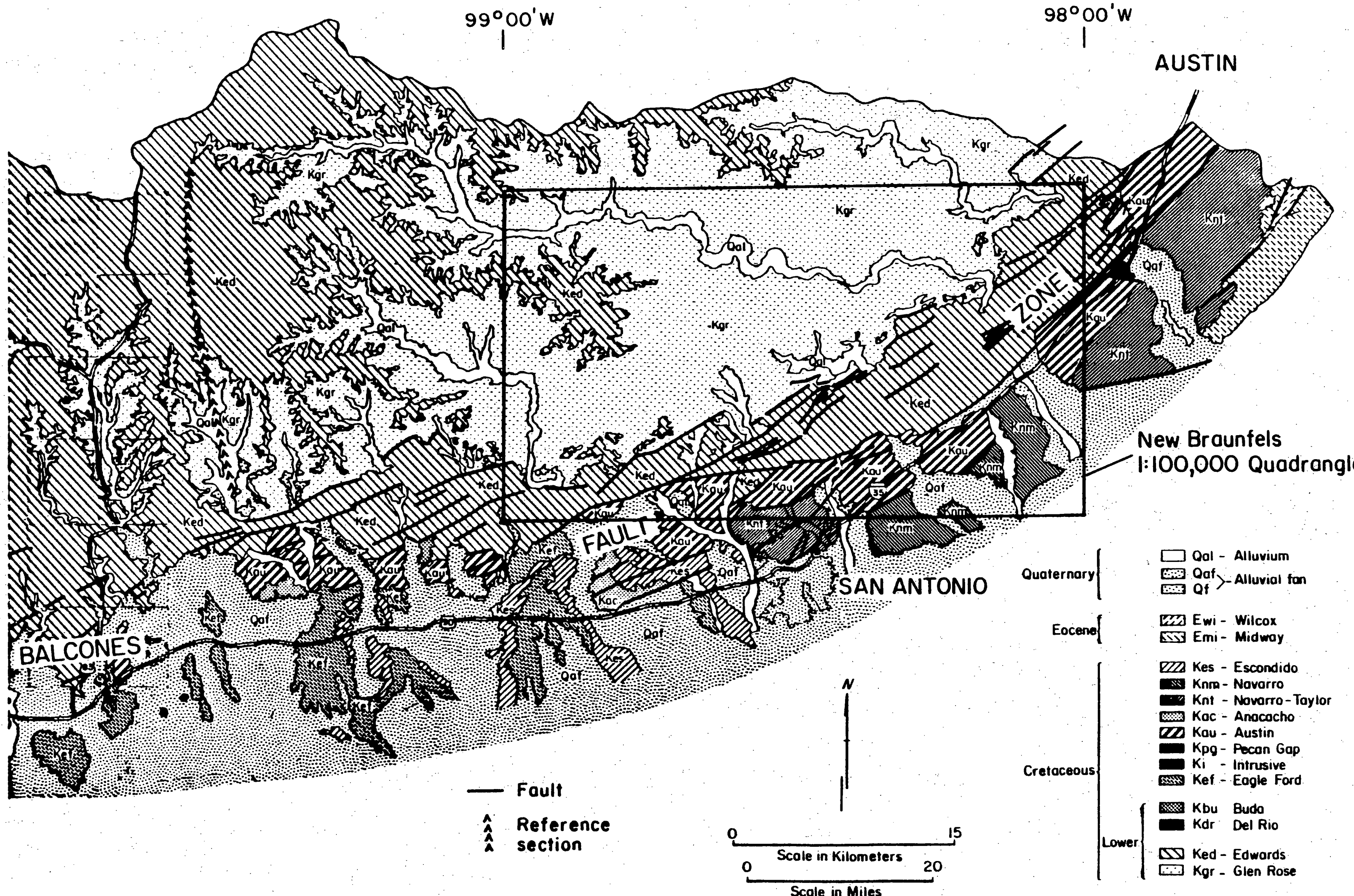


Figure 1. Location of the New Braunfels sheet overlaying regional geology of the southern Edwards Plateau and Balcones Fault Zone.

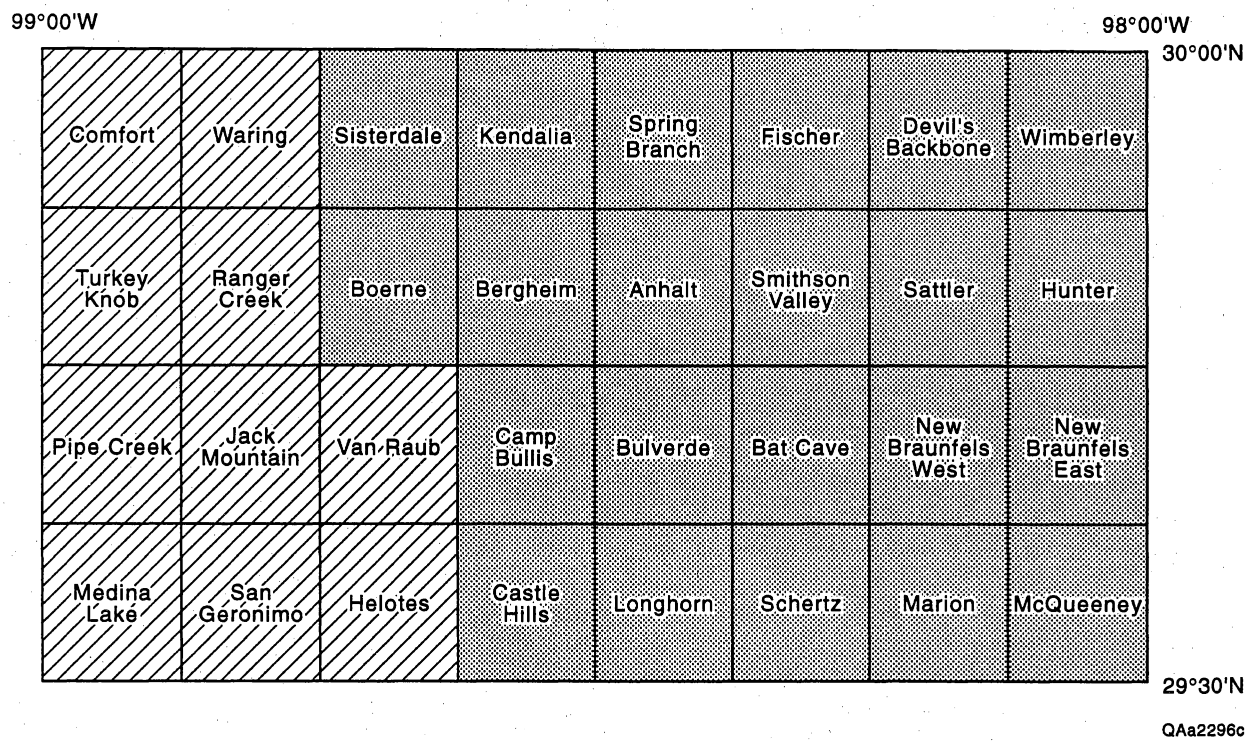


Figure 2. Diagram of 7.5-minute topographic quadrangles that compose the 1:100,000-scale New Braunfels sheet. Diagonal lines indicate the quadrangles mapped this year. Stippled area was mapped during previous years.

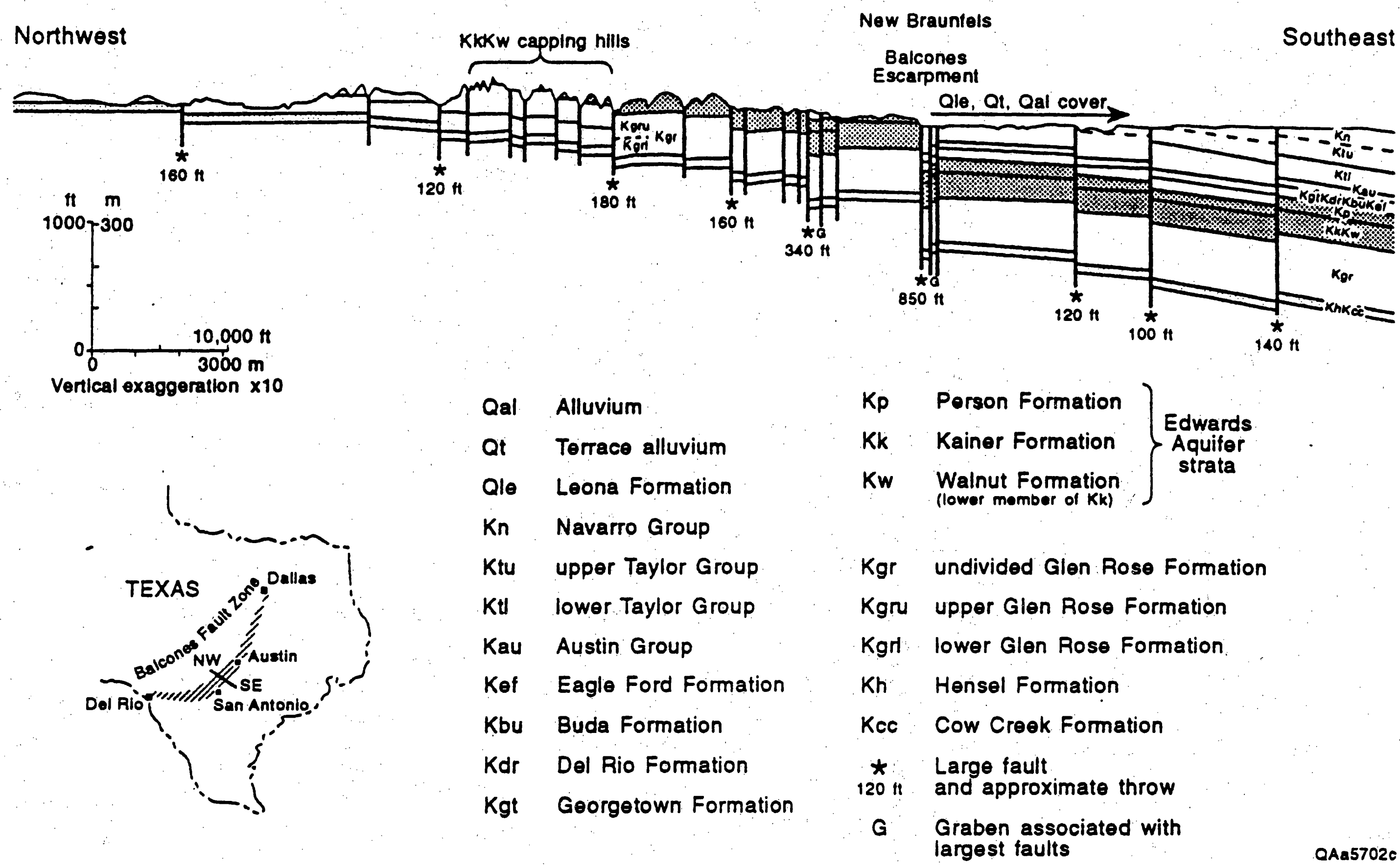


Figure 3. Structural cross section of the Balcones Fault Zone at New Braunfels, Texas.

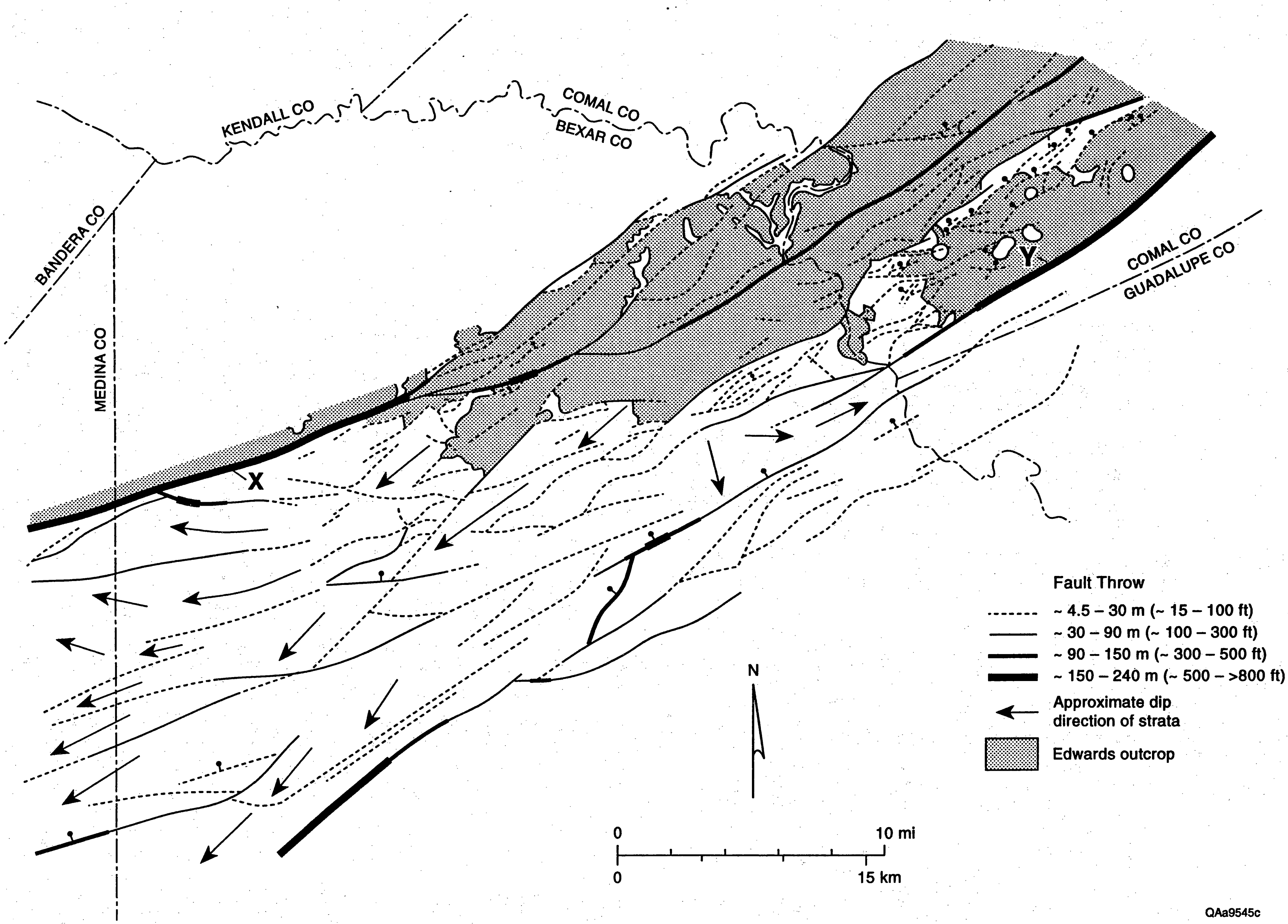


Figure 4. Fault map of San Antonio relay ramp illustrating Edwards outcrop, faults (having >15 ft of throw) and fault-throw variations, and approximate dip directions of Edwards strata within ramp area. Bars mark downthrown side of faults. Faults without bars are downthrown toward the southeast or south and are most common. X and Y indicate master faults of relay ramp.