

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 (Ewl). 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 *Kingenella wacoensis*) 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.

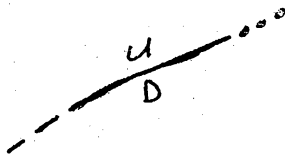
Glen Rose Formation (Kgru and Kgri). *Corbula* interval divides the formation into upper and lower parts. C on map indicates locality of *Corbula* observed in outcrop. Limestone, dolomitic limestone, and marl. Shallow subtidal to tidal-flat cycles. Alternating resistant and recessive beds forming stair-step 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, Kgri, 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. Calcareenite, 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.