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Scientific Investigations Map 3418
Pamphlet accompanies map

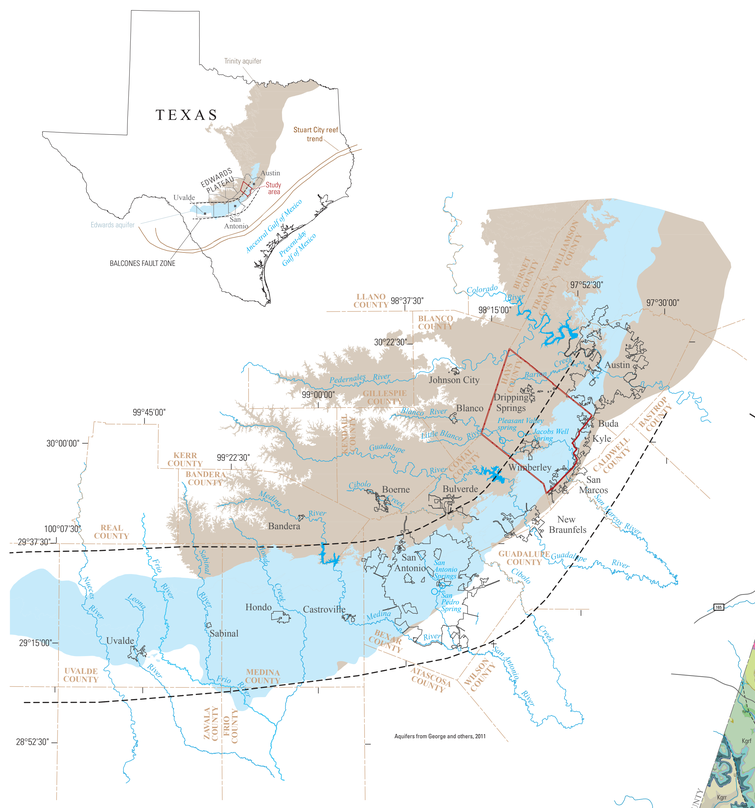
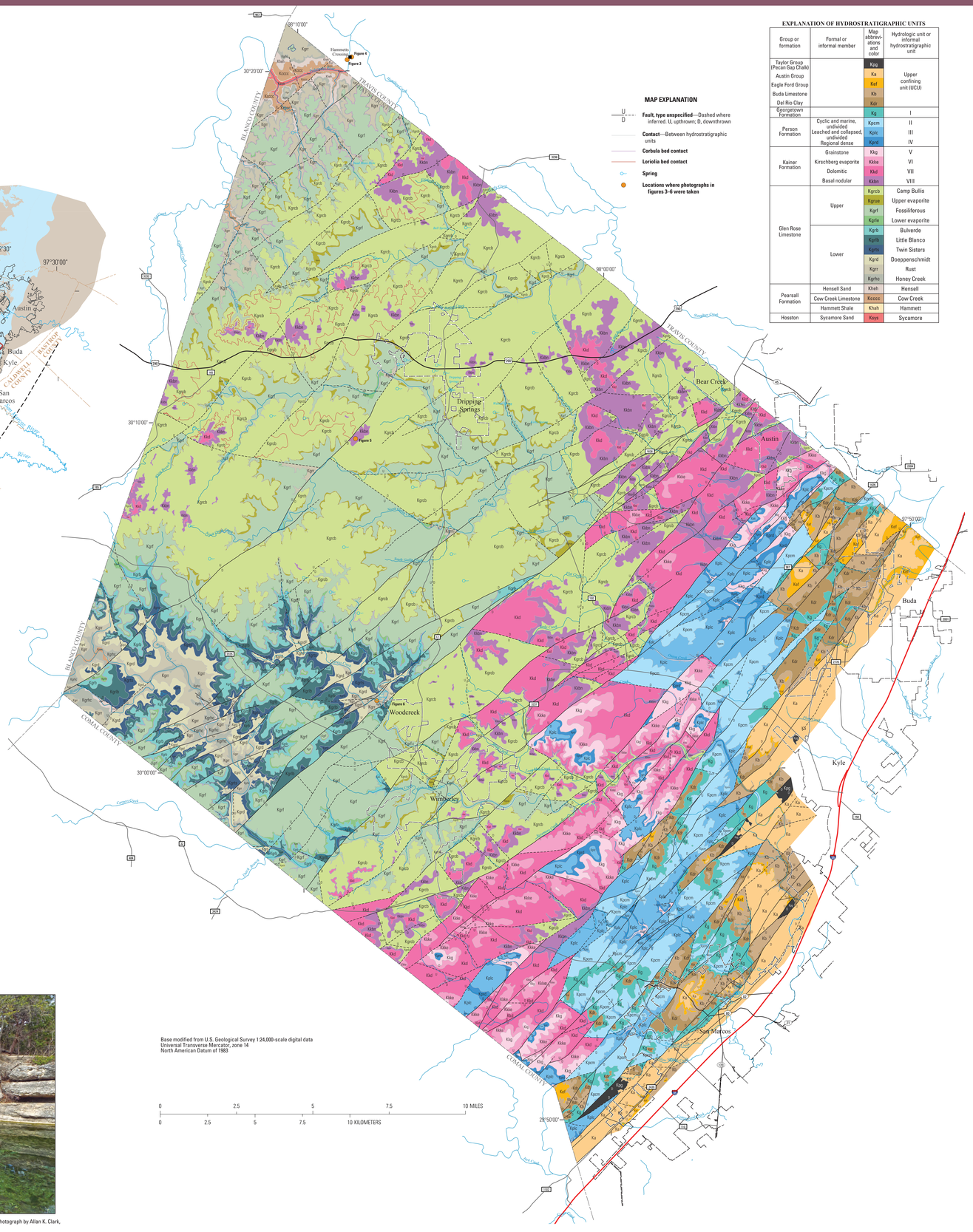


Figure 1. Location of the study area relative to the State of Texas, Hays County, the outcrops of the Edwards and Trinity aquifers, and the Balcones fault zone.



MAP EXPLANATION

U/D **Fault, type unspecified**—Dashed where inferred. U, upthrown; D, downthrown

Contact—Between hydrostratigraphic units

Corbula bed contact

Loriolia bed contact

Spring

Locations where photographs in figures 3–6 were taken

EXPLANATION OF HYDROSTRATIGRAPHIC UNITS

Group or formation	Formal or informal member	Map abbreviations and color	Hydrologic unit or informal hydrostratigraphic unit
Taylor Group (Pecan Gap Chalk)		Kpg	Upper confining unit (UCU)
Austin Group		Ka	
Eagle Ford Group		Kef	
Buda Limestone		Kb	
Del Rio Clay		Kdr	
Georgetown Formation		Kg	I
Person Formation	Cyclic and marine, undivided Leached and collapsed, undivided Regional dense	Kpcm Kplc Kprd	II III IV
Kainer Formation	Grainstone	Kkg	V
	Kirschberg evaporite	Kkke	VI
	Dolomitic	Kkd	VII
	Basal nodular	Kkbn	VIII
Glen Rose Limestone	Upper	Kgrcb	Camp Bullis
		Kgrue	Upper evaporite
		Kgrf	Fossiliferous
		Kgrle	Lower evaporite
	Lower	Kgrb	Bulverde
		Kgrlb	Little Blanco
		Kgrts	Twin Sisters
		Kgrd	Doeppenschmidt
		Kgrr	Rust
		Kgrhc	Honey Creek
Pearsall Formation	Hensell Sand	Kheh	Hensell
	Cow Creek Limestone	Kccc	Cow Creek
	Hammett Shale	Khah	Hammett
Hosston	Sycamore Sand	Ksys	Sycamore

Figure 3. Conglomerates within the Sycamore Sand at Hammetts Crossing, Travis County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 27, 2018).

Figure 4. Bedding plane porosity that developed at the junction between the bedding plane and a fracture within the Cow Creek Limestone (Cow Creek hydrostratigraphic unit) at Hammetts Crossing, Travis County, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 27, 2018).

Figure 5. Marker bed known as the Loriolia Bed, found 80 feet below the contact of the Glen Rose Limestone and the Kainer Formation. The photograph was taken north of Farm to Market Road (FM) 195, approximately 1,500 feet west of the intersection of FM 220 and FM 195. The *Loriolia texana* fossils are identified by white arrows (photograph by Allan K. Clark, U.S. Geological Survey, June 15, 2017).

Figure 6. Jacobs Well Spring, which forms the headwaters of Cypress Creek north of Wimberley, Texas (photograph by Allan K. Clark, U.S. Geological Survey, February 27, 2018).

Figure 2. Summary of the geologic framework and hydrostratigraphy of the Edwards and Trinity aquifers within Hays County, Texas (modified from Clark and others, 2016a, b; Clark and Morris, 2017).

[Period, Epoch, Age, group, formation, members, and lithology modified from Hill (1891), Imlay (1945), Whitney (1952), Loco and Stricklin (1966), Stricklin and others (1971), Rose (1972), Stricklin and Smith (1973), Amsbury (1974), Imlay (1974), Perkins (1974), Barnes (1976), Barker and Ardis (1996), Clark and others (2009, 2013, 2014), Wierman and others (2010), Blome and Clark (2014), Hunt and others (2015), Rose (2017), and U.S. Geological Survey (2018); abbreviations modified from Barnes and Rose (1981) and Clark and others (2016a, b); *Orbitolina minuta* (Douglas, 1960), *Orbitolina texana* (Roemer, 1852), aquifers from Maclay and Small (1976) and Ashworth (1983); thickness from outcrop, Clark and others (2009, 2014), Wierman and others (2010); hydrologic function modified from outcrop (Clark and others, 2009, 2013, 2014; Wierman and others, 2010; Clark and Morris, 2015); porosity types modified from Choquette and Pray (1970). Fabric selective: IP, interparticle porosity; IC, intercrystalline porosity; SH, shelter porosity; MO, moldic porosity; BU, burrowed porosity; FE, fenestral; BP, bedding plane porosity. Not fabric selective: FR, fracture porosity; CH, channel porosity; BR, breccia; VUG, vug porosity; CV, cave porosity; BRBs, black rotund bodies; *no further subdivision]

Geology						Hydrostratigraphy					
Period	Epoch	Group	Formation	Member (formal or informal)	Lithology	Map abbreviations and color	Hydrologic unit	Hydrostratigraphic unit (HSU)[1]	Thickness (outcrop in the study area, in feet)[2]	Hydrologic function	Porosity type	Field identification
Late Cretaceous	Taylor	Taylor	Pecan Gap Chalk	*	Marl, calcareous clay, blue in the subsurface weathers greenish yellow; fossils, large *Exogyra ponderosa*	Kpg	Upper confining unit in the Edwards aquifer	Pecan Gap	230–540	Confining	None	Yellow clay, blue clay in freshly dug exposure; large *Exogyra ponderosa*
	Austin	Austin	*	*	Massive, chalky, locally marly, mudstone, nodular wackestone, nodular bioturbated wackestone; *Gryphaea aucella*, *Inoceramus* sp.; volcanic and terrigenous clastics, calcite	Ka		Austin	130–250	Aquifer (locally where connected to the Edwards aquifer), confining	IP, MO, FR, BP, CH, CV	White, chalky limestone; *Gryphaea aucella*, *Inoceramus* sp.
	Eagle Ford	Eagle Ford	*	*	Brown, flaggy, sandy shale and argillaceous limestone; iron nodules; *Inoceramus* sp., shark teeth, fossil fragments; petroliferous odor	Kef		Eagle Ford	20–40	Confining	IP, FR, BP	Brownish-red sand, thin flagstones; petroliferous
	Washita	Buda Limestone	*	*	Buff to light gray, dense nodular mudstone and wackestone, calcite-filled veins, bluish dendrites, iron nodules, iron staining; shell fragments	Kb		Buda	40–50	Confining	FR, BP, CV	Porcelaneous limestone, with calcite-filled veins, bluish dendrites
		Del Rio Clay	*	*	Fossiliferous blue-green to yellow-brown clay, packstone, iron nodules; *Ilymatogyra arietina*	Kdr		Del Rio	40–50	Confining	None	Clay, holds water, fossiliferous; *Ilymatogyra arietina*
		Georgetown	*	*	Reddish-brown, gray to light tan shaley mudstone and wackestone, black dendrites, iron nodules, iron staining; *Pleisiotumilites brazoensis*, *Waconella waconensis*	Kg	Edwards aquifer	I	20–40	Confining	MO	Black dendrites, iron nodules and staining, *Pleisiotumilites brazoensis*, *Waconella waconensis*
	Edwards	Person	Cyclic and marine, undivided		Pelletal limestone, mudstone, miliolid grainstone, packstone, chert (beds and large nodules); caprinid, crossbedded	Kpcm		II	80–90	Aquifer	MO, BU, VUG, BP, FR, CV	Thin graded cycles; massive beds to relatively thin beds; crossbeds, caprinids
			Leached and collapsed, undivided		Recrystallized limestone, mudstone, wackestone, packstone, grainstone; chert (beds and large nodules); iron-stained, stromatolitic, *Toucasia* sp., *Montastrea roemeriana*, oysters	Kplc		III	70–90	Aquifer	BU, VUG, FR, BP, BR, CV	Bioturbated iron-stained beds separated by massive limestone beds; stromatolitic limestone, *Montastrea roemeriana*
			Regional dense[1]		Dense, shaley, mudstone, wackestone, oyster-shell mudstone and wackestone, iron staining, chert	Kprd		IV	20	Confining	FR, CV	Wispy iron-oxide stains, thin bedded, often white in aerial photographs
		Kainer	Grainstone[1]		Miliolid, skeletal fragmented grainstone, mudstone, wackestone; chert (beds and nodules); crossbedded and ripple marked	Kkg		V	40–50	Aquifer	IP, BU, FR, BP, CV	Crossbedded, ripple marks, miliolid grainstone
			Kirschberg evaporite[1]		Highly altered crystalline limestone, chalky mudstone, occasional grainstone associated with tidal channels; chert (beds and nodules); coarse-grained spar, breccia and travertine, dissolution has removed all evaporites in the study area	Kkke		VI	40–50	Aquifer	IP, MO, VUG, FR, BR, CV	Boxwork porosity with neospar and travertine frame
			Dolomitic[1]		Chert (absent in lower 20 feet), dolomitic mudstone to grainstone	Kkd		VII	90–120	Aquifer	IP, IC, MO, BU, VUG, FR, BP, CV	Massively bedded light gray, *Toucasia* sp., abundant
			Basal nodular[1]		Shaley, nodular limestone, burrowed mudstone, wackestone, packstone, miliolid grainstone, dolomite, contains dark, spherical textural features (locally known as black rotund bodies [BRBs]; caprinid, *Ceratostreon* [*Exogyra*] *texana*, miliolid, gastropods; area transition to basal nodular containing oyster beds and shale	Kkbn		VIII	40–80	Aquifer (confining unit in areas without caves)	IP, MO, BU, BP, FR, CV	Massive, nodular and mottled limestone, BRBs, and orange wisps, *Ceratostreon texana*, seeps and springs, ferns growing near contact of underlying unit
		Trinity	Glen Rose Limestone	Upper	Alternating beds of burrowed wackestone, packstone, miliolid grainstone, argillaceous limestone	Kgrcb	Trinity aquifer	Camp Bullis	230	Confining	BU, BP, FR, CV (occasional)	Alternating beds of limestone and argillaceous limestone, fossils rare, stairstep topography
					Dissolved evaporites, highly altered crystalline limestone and chalky mudstone, breccia, boxwork voids	Kgrue		Upper evaporite	0–10	Aquifer	IP, MO, BU, BR	Weathers to an orangish red with a pebbly texture, often has less cedar growth and thicker grasses, boxwork porosity, springs and seeps
					Alternating wackestone, packstone, miliolid grainstone, argillaceous limestone, mudstone, silty mudstone at base; *Hemiaster* sp., *Neithea* sp., *Orbitolina minuta* (Douglas, 1960), *Porocystis globularia*, *Protocardia texana*, *Tapes decepta*, *Turritella* sp., gastropods, mollusks (section not subdivided into an upper and lower unit as in Bexar and Comal Counties)	Kgrf		Fossiliferous	90–130	Semiconfining	MO, BU, FR, CV	Limestone and argillaceous limestone, *Orbitolina minuta* (Douglas, 1960)
					Dissolved evaporites, highly altered crystalline limestone and chalky mudstone, breccia, boxwork voids; Corbula beds	Kgrle		Lower evaporite	10	Aquifer	IP, MO, BU, BR	Weathers to an orangish red with a pebbly texture, often has less cedar growth and thicker grasses, boxwork porosity, *Corbula* sp., springs and seeps
				Lower	Wackestone, grainstone, argillaceous wackestone, shale, evaporites; monopleurid, *Toucasia* sp., *Macraster* sp., *Nerinia* sp., *Orbitolina texana* (Roemer, 1852), *Porocystis globularia*, *Salenia texana*, gastropods, pecten, and pelecypods	Kgrb		Bulverde	0–40	Semiconfining	MO, BR, BP, FR	*Salenia texana* bed immediately below Corbula bed, abundant fossils including *Porocystis globularia*, *Orbitolina texana* (Roemer, 1852), *Macraster* sp., *Nerinia* sp., pecten, gastropods, pelecypods
					Mudstone, wackestone, argillaceous wackestone, boundstone; caprinid, monopleurid, *Toucasia* sp., *Orbitolina texana* (Roemer, 1852), gastropods, pectens, pelecypods	Kgrlb		Little Blanco	0–40	Aquifer	MO, BU, BP, FR	Limestone beds thicker and more resistive to erosion than overlying and underlying units, *Orbitolina texana* (Roemer, 1852), patch reefs
					Argillaceous wackestone, shale; *Orbitolina texana* (Roemer, 1852), gastropods, pelecypods	Kgrts		Twin Sisters	0–40	Semiconfining; confining shale beds	IP	Thick argillaceous beds, thin shale beds, *Orbitolina texana* (Roemer, 1852); contains ponds and seeps, often little vegetation, steeper slopes often with "badlands" type weathering, thinner in areas where patch reefs are present in the underlying Doeppenschmidt HSU
					Mudstone, wackestone, packstone, grainstone, boundstone, argillaceous wackestone and packstone, miliolid grainstone; caprinid, *Toucasia* sp.	Kgrd		Doeppen-schmidt	0–80	Aquifer	IP, MO, BU, BP, FR, CV	*Orbitolina texana* (Roemer, 1852), limestone beds thicker and more resistive than overlying and underlying patch reefs formed on rudist, reefal talus
					Alternating beds of argillaceous wackestone, packstone; mudstone, wackestone, packstone, grainstone, miliolid grainstone; monopleurid, *Nerinia* sp., *Orbitolina texana* (Roemer, 1852), *Tylostoma* sp., and oysters, pectens, and pelecypods	Kgrr		Rust	40–90	Semiconfining	IP, FR, CV	Forms stairstep topography with soils, *Orbitolina texana* (Roemer, 1852)
					Wackestone, packstone, grainstone, boundstone, burrows; caprinids, miliolid, *Orbitolina texana* (Roemer, 1852), *Toucasia* sp., *Trigonia* sp., *Turritella* sp., various corals, pectens, shell fragments	Kgrhc		Honey Creek	20–60	Aquifer	IP, MO, BU, BP, FR, CH, CV	Thick beds of wackestone, packstone, grainstone; corals, caprinid, *Trigonia* sp., cliff forming; outcrop often contains large limestone float with large channel and moldic porosity, caves and springs
		Pearsall	Hensell Sand		Dolomitic limestone, claystone, siltstone, ferrigeneous sand; conglomerate/breccia composed of red sandstone, at base of unit; oysters, quartz geodes	Kheh		Hensell	0–40	Aquifer	IP, MO, SH, CV	Quartz geodes, large oyster shells, reddish sandy soil with good grass growth, red sandstone conglomerate /breccia at base
			Cow Creek Limestone		Very fine-grained to fine-grained carbonate sand (grainstone), localized crossbedding; Areas of coral and rudist biostromes (boundstone) overlain by rippled, crossbedded grainstone	Kccc	Confining units	Cow Creek	40–80	Aquifer	IP, MO, BU, VUG, BP, FR, CH, CV	Carbonate sands, crossbedding near top, biostrome composed of corals and rudist, talus slopes
					Dolomitic mudstone, wackestone, packstone; oysters							
			Hammett Shale		Upper: claystone, with siltstone lenses, overlain by fossiliferous dolomitic limestone Lower: siltstone and dolomite	Khah		Hammett	20–50	Confining	None	Holds surface water; springs at contact with Cow Creek
		Hosston	Sycamore Sand		Sand, silt, clay, and conglomerate	Ksys	Lower Trinity aquifer, Trinity aquifer	Sycamore	50	Aquifer	IP, BP, FR, CV	Sand, silt, and conglomerate

[1]Informal.
[2]Thickness range based on field mapping in the study area.

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By
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2018

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