BUREAU OF ECONOMIC GEOLOGY
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GEOLOGIC QUADRANGLE MAP NO. 38

Austin West, Travis County, Texas

BY

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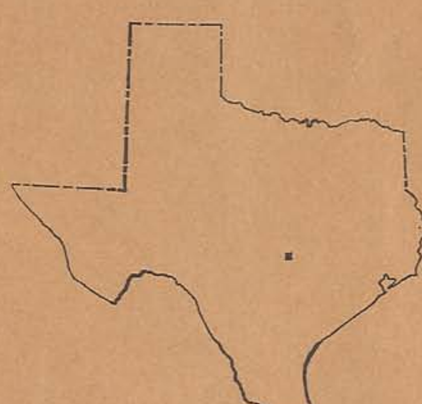

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TO ACCOMPANY MAP—GEOLOGIC
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GEOLOGY OF THE AUSTIN WEST QUADRANGLE, TRAVIS COUNTY, TEXAS

PETER U. RODDA

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ABSTRACT

The rocks exposed in the Austin West quadrangle are Cretaceous marine limestones and clays and Quaternary alluvial deposits. The Cretaceous rocks dip gently eastward and are broken by one large (Mount Bonnell) fault and numerous small, northeast-trending faults comprising the Balcones fault zone. Most faults are downthrown to the east; total displacement across the fault zone is about 1,000 feet. Most of the quadrangle is west of the fault zone in the highly dissected hill country; the rocks consist mostly of interbedded hard and soft limestone, dolomite, and marl (Glen Rose, Walnut, and Edwards Formations). In the Balcones fault zone limestone units (Edwards, Georgetown, and Buda Formations) and clay units (Del Rio Clay and Eagle Ford Formation) are complexly faulted and moderately to strongly dissected. In the southeast corner of the quadrangle limestone (Austin Group) and clay (Eagle Ford Formation) crop out at the west margin of the blackland prairie. The Colorado River flows across the area from northwest to southeast, and six terrace deposits (Sand Beach, Riverview, First Street, Sixth Street, Capitol, and Asylum) consisting mostly of sand and gravel parallel the river and occupy successively higher topographic positions; the deposits are more extensixe east of the Mount Bonnell fault. Other alluvial deposits are developed along tributary streams.

The limestone units generally are stable and resistant, are difficult to excavate, have mostly moderate to high permeability, and pose few engineering problems; they are sources of crushed stone and other building materials; one unit (Edwards Formation) is an important aquifer. The clay units are weak, unstable, impermeable, and corrosive and generally require special engineering designs. Alluvial deposits are easily excavated, have moderate to low stability and strength, have high permeability, and may need special designs for large structures; the deposits are important aquifers and sources of sand and gravel.

INTRODUCTION

The Austin West quadrangle is the first in a series of 1:24,000-scale geologic maps of the Austin area designed to provide basic geologic data for planners, engineers, and others.

The geology was mapped on vertical aerial photographs at a scale of 1:20,000 and transferred to the U. S. Geological Survey, 7.5-minute, topographic base map. Geologic and engineering data compiled for each map unit are summarized in the accompanying table.

Setting.—The Austin area includes portions of several physiographic regions; it extends from the dissected remnants of the Edwards Plateau (the hill country) eastward across the blackland prairie to the edge of the post-oak sand belt of the coastal plain. The boundary between the coastal plain and the hill country is the complex Balcones fault zone and Balcones escarpment, an abrupt topographic rise at the west margin of the fault zone.

Most of the Austin West quadrangle is in the strongly dissected, western hill country, but the map area extends eastward across the Balcones escarpment and the weakly to moderately dissected Balcones fault zone into the west margin of the gently rolling blackland prairie. Elevations range from 420 feet to 780 feet east of the escarpment and from 490 feet to 1,050 feet in the hill country.

The Austin West quadrangle is entirely within the drainage of the Colorado River, which flows across the area from northwest to southeast. West of the Balcones escarpment the river meanders are entrenched in a deep, narrow, limestone valley. For about 5 miles east of the escarpment the river forms a broad shallow loop across the Balcones fault zone; steep limestone bluffs along the south (cut) bank contrast with the series of alluvial terraces rising in broad steps to the north. East of the map area the river meanders in a broad alluvial valley excavated in the clay and sand of the coastal plain. Major tributaries of the Colorado River in this quadrangle include east-flowing Barton Creek and south-flowing Bull Creek and Shoal Creek.

Previous work.—Only papers of direct interest to the Austin West quadrangle are cited. Hill (1890) and Hill and Vaughan (1898, 1902) discussed stratigraphy, structure, and mineral resources of the Austin area. The report by Hill and Vaughan (1902) is the most comprehensive, including a geologic map of the Austin area at a scale of 1:125,000. Papers of more restricted scope are cited at appropriate places in the text.

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STRATIGRAPHY

Introduction.—Rocks exposed in the Austin West quadrangle are marine limestone and clay of Cretaceous age and alluvial gravel, sand, silt, and clay of Quaternary age. Cretaceous units generally strike northeast and dip gently eastward, but in the Balcones fault zone dips are commonly varied. The exposed Cretaceous units have an aggregate thickness of about 1,150 feet, most of which is limestone. Fossils are common in most of the Cretaceous units and are useful guides to the stratigraphy. The common megafossils of the Austin area are illustrated in Adkins (1928), Hill and Vaughan (1902), and Stanton (1947). Regional aspects of Cretaceous stratigraphy are discussed in Adkins (1933), Hill (1901), and Young (1967).

CRETACEOUS ROCKS

GLEN ROSE FORMATION

The Glen Rose Formation crops out in the northwestern two-thirds of the quadrangle and is the oldest and most extensive rock unit. In the Austin area the Glen Rose consists of about 700 feet of mostly thinly interbedded hard and soft limestone, dolomite, and marl. The beds vary in their resistance to erosion, forming a distinctive stair-step topography. The upper 450 feet of the formation crop out in this quadrangle; lower units are exposed to the west. Five informal members have been mapped, primarily on the relative abundance of thin dolomite beds. The upper and middle members are highly dolomitic and the others much less so. The oldest member crops out along the Colorado River at the western edge of the map area, and younger members occupy successively higher topographic levels. The members persist but thin to the west.

Soils developed on the Glen Rose are mostly thin, brownish-gray, calcareous, gravelly clay loams (Brackett soils), with lesser amounts of mostly thin, brownish, calcareous and noncalcareous clays (Crawford, Denton, San Saba, and Tarrant soils).

The Glen Rose supports growths of oak, juniper, hackberry, and other trees. Oaks are more abundant on the more permeable beds, junipers more abundant on clayey, less permeable limestones.

Member 1.—This member includes all the Glen Rose between the basal Cretaceous sands and the *Corbula* bed, a widespread thin bed, or series of beds, of hard orange-brown limestone containing abundant specimens of the small elongate clam *Corbula harveyi* (Hill, 1893). Total thickness of Member 1 is 250 to 300 feet, but only the upper 30 feet crop out in the Austin West quadrangle. Member 1 is exposed along Lake Austin in the western part of the map area. The upper 30 feet consists of gray to tan, nodular to thin-bedded, burrowed limestone, marly limestone, and marl. (Filled tubular burrows made by crustaceans and other invertebrates are common features of many limestones in the Austin area. The burrow filling generally has a coarser texture and a darker color than the surrounding limestone.) Immediately below the *Corbula* bed is a distinctive highly fossiliferous limestone containing abundant *Porocystis globularis,* a sub-spherical plant fossil about 25 mm in diameter, *Orbitolina texana,* a discoidal foraminifer about 5 mm in diameter, and other megafossils. *Porocystis* is abundant in the Glen Rose and rare in the Bee Cave Member of the Walnut; *Orbitolina* occurs only in the Glen Rose.

Member 2.—Member 2 is about 120 feet thick and consists of gray to tan, thin to thick interbeds of fine- to medium-grained limestone, sandy limestone, burrowed nodular limestone, and marl. Hard, thick-bedded granular limestones generally form prominent ledges. Megafossils are common in marly limestones and marls.

Member 3.—Member 3 is about 70 feet thick and consists mostly of thin- to medium-bedded, nodular weathering, fine-grained gray-brown dolomite and dolomitic limestone and burrowed, gray to tan limestone and marly limestone. Dolomite beds comprise about one-third of the member and are more common in the lower part.

Member 4.—Member 4 is about 120 feet thick and generally resembles Member 2. The unit consists of gray to tan, commonly burrowed, thin- to thick-bedded, fine- to medium-grained limestone and marly limestone. In the Austin West quadrangle Member 4 forms steep slopes, well exposed in Westlake Hills and in the Mount Bonnell–Bull Creek area. Megafossils are abundant in many beds; hard, granular, ledge-forming limestones commonly contain abundant miliolid Foraminifera.

Member 5.—The youngest member of the Glen Rose consists of about 100 feet of thin-bedded, gray-brown, fine-grained, porous dolomite and burrowed, dolomitic limestone. The upper 10 to 20 feet are deeply weathered, soft, and pulverulent. In the Mount Bonnell area many beds in Member 5 contain pockets of pale blue to white celestite. Member 5 forms relatively gentle slopes between the steeper slopes of Member 4 and the resistant limestone ledges of the overlying Bull Creek Member of the Walnut Formation. The lower part of Member 5 is sparsely vegetated and forms a light-colored band on aerial photographs. The contact between Member 5 and the Bull Creek is poorly exposed.

The Mount Barker section of Feray et al. (1949, pp. 23–29, pl. 6) includes descriptions of Members 4 and 5. Member 4 is also well exposed in the cut on Bull Creek road below Cat Mountain. Members 2 to 5 are exposed in road cuts and slopes below St. Stephens School.

WALNUT FORMATION

In Central Texas the name Walnut Formation has been applied traditionally to oyster-shell marls and marly limestones that overlie the Glen Rose or Paluxy Formations and underlie the nodular Comanche Peak Limestone or the massive rudist-bearing Edwards Formation. Based on regional relationships the Walnut Formation of the Austin area has been subdivided into five members, three of which have been recognized in the Austin West quadrangle (Moore, 1961, 1964). These are, in ascending order, the Bull Creek, Bee Cave, and Cedar Park Members. The Bull Creek and Bee Cave Members have contrasting lithologies and have been mapped separately. The type localities of both of these units are in the Austin West quadrangle (Moore, 1961, 1964). The Cedar Park is here included in the Edwards Formation because of similar physical character and topographic expression.

Walnut soils are dark brown to brownish-gray, shallow to deep, calcareous clay and clay loam (Brackett and Tarrant soils).

Bull Creek Member.—This unit forms a prominent topographic bench high in the landscape west of the Mount Bonnell fault. The Bull Creek Member consists of 35 feet of mostly hard, resistant, thin- to thick-bedded, gray to tan, fine- to medium-grained, commonly burrowed limestone. Much of the limestone is composed of shell fragments; miliolid Foraminifera are abundant in some beds. The type locality of the Bull Creek is a cut on City Park Road, 0.4 mile west of Ranch Road 2222 (Bull Creek Road) (Moore, 1961). The contact with the overlying Bee Cave Member is sharp; the upper surface of the Bull Creek is bored, pitted, iron-stained, and case-hardened. The borings were made by Cretaceous marine clams. Vegetation on the Bull Creek is mainly an oak-juniper association similar to that on the Glen Rose.

Bee Cave Member.—The Bee Cave Member is 30 feet thick and consists of soft, gray to tan, extensively burrowed, mostly nodular, fine-grained limestone, marly limestone, and marl. The unit is marly at the base and grades upward to nodular limestone. The contact between the Bee Cave and Edwards is gradational and is placed at the transition from nodular limestone below to the hard, resistant, burrowed, fine-grained, commonly dolomitic limestone of the Edwards Formation. Megafossils are common in the Bee Cave Member. The oysters *Exogyra texana* and *Gryphaea mucronata* are especially abundant in the lower part; a distinctive, 1 to 2 mm-long, conical foraminifer, *Dictyoconus walnutensis,* is abundant in a narrow zone near the top of the unit. The type locality of the Bee Cave Member is a cut on Bee Cave Road, 0.3 mile west of the intersection with St. Stephens School Road (Moore, 1961). The Bee Cave is well exposed along Balcones Drive between Northland Drive and North Hills Drive and on the west slope of Mount Barker (Feray et al., 1949, pp. 23–24, 29–30, pls. 6, 7). Juniper is especially abundant on this member.

EDWARDS FORMATION

The Edwards Formation is characterized by rudist limestones, dolomite, nodular chert, and solution-collapse features (Fisher and Rodda, 1969; Rodda et al., 1966). Rudists are elongate, conical bivalves (clams) common in Cretaceous rocks but now extinct (Rodda et al., 1966, pp. 5–8). The Edwards caps the high topography west of the Mount Bonnell fault and crops out extensively in the Balcones fault zone to the east. A complete Edwards section is not exposed in the Austin area, but regional relationships suggest that the Edwards is about 300 feet thick in the Austin West quadrangle (Fisher and Rodda, 1969; Tucker, 1962). In the Austin West quadrangle, the Edwards has been subdivided into four informal members on the basis of lithology.

Edwards soils are red-brown, dark brown, and dark gray, mostly thin, calcareous and noncalcareous clays (Crawford, San Saba, Speck, and Tarrant soils). Vegetation on the Edwards includes live oak, post oak, juniper, elm, hackberry, and persimmon.

Member 1.—This unit has an estimated thickness of 200 feet and consists of thin- to thick-bedded, gray-brown porous dolomite and dolomitic limestone, and hard, gray to tan, fine- to medium-grained limestone commonly containing rudists. Gray to black nodular chert is common and is especially abundant in the dolomite beds. The lower 60 feet of Member 1 is exposed mostly west of the Mount Bonnell fault north of the Colorado River and in Westlake Hills. The upper 110 feet of Member 1 crop out only east of the main fault; principal exposures are in the high bluffs of the Colorado River between Bee Creek and Zilker Park, in bluffs of Barton Creek, and in other areas southwest of Tom Miller Dam. An estimated 30 feet of the lower part of Member 1 do not crop out in the map area. The lower part of Member 1 is well exposed in the old quarry in the northeast corner of the quadrangle and in a cut on the West Loop north of Bee Cave Road. Hard, fine-grained, burrowed, dolomitic limestone at the base is overlain by cherty, thin- to thick-bedded rudist limestone, dolomite, and dolomitic limestone (Rodda et al., 1966, p. 253; Young, 1963b, p. 127). A 5- to 10-foot-thick solution-collapse zone is exposed in this interval in the cut north of Bee Cave Road. The upper part of Member 1 is well exposed in the Colorado River bluffs below Tom Miller Dam, in cuts along Red Bud Trail, and in bluffs along Barton Creek. Thin- to thick-bedded, fine- to medium-grained limestones with rudists grade upward to dolomitic limestones and dolomites with abundant chert. The top of Member 1 is marked by a 20-foot-thick, iron-stained, cavernous, solution-collapse zone containing brecciated limestone, dolomite, chert, coarsely crystalline calcite, and residual red clay. This zone is widespread in Central Texas and indicates the former extent of a thick gypsum-anhydrite unit (Kirschberg Evaporite) (Fisher and Rodda, 1969). Collapse is due to removal of evaporite by solution. Much of the evaporite was removed during or shortly after deposition of the overlying Member 2; little or no evaporite remains in the map area. Many of the numerous caves of the Austin area are in this solution-collapse zone.

Member 2.— Member 2 is 40 feet thick and consists of a few feet of gray to tan, thin-bedded, fine-grained, cherty dolomitic limestone at the base, overlain by interbedded gray to tan, thin- to thick-bedded, fine- to coarse-grained cherty limestone with rudists, miliolid Foraminifera and other shells, and fine-grained, thin-bedded flaggy limestone. The lower beds have been folded and fractured by collapse into the evaporite-solution zone of Member 1. The base of Member 2 is marked by a prominent layer of elongate, gray chert nodules. Nodular chert is common in the lower part of the unit; the upper part generally is chert-free. Member 2 grades upward into the nodular and flaggy limestones of Member 3. Member 2 crops out extensively in the Balcones fault zone; it is well exposed in cuts on Red Bud Trail and in the bluffs of Barton Creek and forms broad, high, chert-strewn surfaces eastward from the Mount Bonnell fault south of the Colorado River.

Member 3.—This unit consists of 10 to 15 feet of mostly soft, nodular, fossiliferous, burrowed, marly limestone and marl. *Pleuromya knowltoni* (Hill, 1893), a small elongate clam about 40 mm long, is the most abundant megafossil and is characteristic of the unit. The oyster *Exogyra texana* and other mollusks and echinoids are less common. Locally the nodular limestone and marl are interbedded with, or grade laterally to, fine-grained, flaggy limestone; Member 3 grades upward to flaggy limestones of Member 4. The narrow outcrop of Member 3 extends over a wide area in the fault zone. In the Rollingwood area good exposures are in cuts along Bee Cave Road and along a small valley northeast of Pickwick Lane. It is also well exposed in parts of the Barton Creek drainage and in a small abandoned quarry ¾ mile south of Eanes School. Member 3 characteristically supports a thick growth of juniper. This unit is correlative with the Kiamichi Formation to the north and east (Feray et al., 1949; Tucker, 1962; Wilbert, 1967).

Member 4.—Member 4 is 40 feet thick and consists mostly of gray to tan, fine-grained, thin- to thick-bedded limestone, dolomitic limestone, and dolomite. Flaggy limestone and thin interbeds of limestone and marl at the base of the unit are overlain by a 3-foot bed of hard, fine-grained, rudist limestone (the Austin marble). Above this is a 6- to 10-foot sequence of dolomite, dolomitic limestone, and a thin solution-collapse zone. The upper 10 to 15 feet of Member 4 are slightly nodular, hard, mostly fine-grained, thin- to medium-bedded limestone with minor interbeds of dark gray marl. These upper beds contain fossil oysters (*Gryphaea washitaensis*), the brachiopod *Kingena wacoensis,* and, in the northern outcrops, the large ammonite *Eopachydiscus brazoense.* The upper part of Member 4 includes beds previously considered part of the Georgetown Formation but here mapped with the Edwards because of similar physical characteristics. South of the Colorado River Member 4 crops out in the Balcones fault zone from the Mount Bonnell fault to Zilker Park and is most extensive in the Rollingwood community. North of the river Member 4 crops out discontinuously from Johnson Branch north to the old quarry on the Highland Park School grounds. A section in Johnson Branch is described in Feray et al. (1949, pp. 47–49, pl. 11).

The contact of Member 4 with the overlying Georgetown Formation is placed at a slight topographic bench above which the limestones are more nodular and marly, the fossils, especially oysters, are more varied and abundant, and juniper is increasingly abundant. The change generally is not strongly marked, but between the West Loop and Barton Creek the contact is sharp and the upper surface of Member 4 is bored, pitted, and iron-stained. Regional implications of the Edwards-Georgetown transition are discussed by Martin (1961), Rose (in press), Tucker (1962), and Wilbert (1967).

GEORGETOWN FORMATION

The Georgetown consists mostly of thin interbeds of gray to tan, richly fossiliferous, nodular, fine-grained limestone, marly limestone, and marl. Fossil oysters are varied and abundant; many beds are composed mainly of oyster shells. *Gryphaea washitaensis,* the large *Exogyra walkeri,* and *Arctostrea carinata* are common to abundant; the latter two are diagnostic of the Georgetown. Other oysters, clams, snails, ammonites, echinoids, and the brachiopod *Kingena wacoensis* are common. The Georgetown generally has the same distribution as Edwards Member 4 but is topographically higher. A nearly complete Georgetown section is exposed in the railroad cut of the I. & G. N. RR. north of West 6th Street (Feray et al., 1949, pp. 45–48, pl. 11). Thickness of the Georgetown in the Austin West quadrangle is generally about 55 feet but varies from 40 to 60 feet. This variation in thickness implies either an erosional unconformity below the Georgetown or facies change between the Georgetown and upper Edwards, or possibly a combination of the two. The problem is a regional one beyond the scope of this project. The regional stratigraphy of the Georgetown and the nature of the Edwards-Georgetown transition are discussed by Martin (1961), Rose (in press), Tucker (1962), and Wilbert (1967). The contact with the overlying Del Rio Clay is gradational but abrupt and is poorly exposed.

Soils on the Georgetown are mostly dark brown to dark gray, thin to thick, calcareous clay and clay loam (Brackett, Denton, and Tarrant soils). The Georgetown supports an oak-juniper vegetation with junipers especially abundant.

DEL RIO CLAY

The Del Rio is composed of dark olive or bluish-gray to yellow-brown, pyritic, gypsiferous clay and marl and is about 75 feet thick in the Austin West quadrangle. A few thin siltstone and sandstone beds are present near the top of the unit. The ram's-horn oyster *Exogyra arietina* is characteristic of the Del Rio and occurs profusely in the lower part. The oyster *Gryphaea roemeri* is common near the top of the unit; other megafossils are less common. Gypsum (selenite) is common as scattered crystals and thin fracture fillings. The Del Rio crops out extensively north and east of Barton Creek and north of the Colorado River from Shoal Creek west to the Mount Bonnell fault.

Outcrops are poorly exposed; the clay fails by slump and creep even on shallow slopes. Below caps of Buda Limestone the Del Rio Clay forms steep to moderate slopes mantled by Buda limestone rubble which supports a growth of live oak and juniper. Elsewhere the Del Rio has a cover of grass and scattered mesquite trees. Partial sections of the Del Rio along Shoal Creek and Barton Springs Road are described in Feray et al. (1949, pp. 49–51, pls. 12, 13).

Del Rio soils are mostly dark gray to yellow-brown, deep to shallow, calcareous clays (Ferris, Heiden, and Houston Black soils). Soils on the Del Rio slopes covered with limestone rubble are brownish-gray, shallow, calcareous, gravelly clay loams (Brackett soils).

BUDA FORMATION

In the Austin West quadrangle the Buda Formation consists of 35 feet of hard, resistant, fine-grained, burrowed, glauconitic, shell-fragment limestone. The lower half is marly, nodular, and less resistant and forms a receding slope beneath the harder upper part. The contact of the Buda with the overlying Pepper Shale is sharp but poorly exposed. The Buda thins northward. On the outcrop freshly broken surfaces of Buda are characteristically colored shades of yellow to pink. The Buda is richly fossiliferous, but specimens are difficult to extract from the hard limestone. The lower and upper parts have distinct fossil assemblages. The ammonite *Budaiceras* is characteristic of the lower Buda, and the large, rough scallop *Pecten roemeri* is typical of the upper Buda. The oyster *Gryphaea roemeri* is abundant in the basal Buda and in the top of the underlying Del Rio Clay. Hixon (1959) and Martin (1961, 1967) discussed the regional stratigraphy of the Buda; Shattuck (1903) and Whitney (1911) illustrated a variety of Buda fossils.

The Buda crops out over a wide area in the Austin West quadrangle and generally forms vertical scarps or steep slopes above the Del Rio Clay. During normal erosion of the Buda large and small blocks of the highly fractured limestone are slowly detached from the scarp faces and slump or creep down the Del Rio slopes. The Buda forms high bluffs along Shoal Creek and crops out north of 35th Street and west to the Mount Bonnell fault. South of the Colorado River the Buda caps the bluff above Barton Springs Road and forms southwest-trending bluffs high above the east side of Barton Creek. Scattered outcrops extend to the western part of Rollingwood and south to the West Loop. The type locality of the Buda is along Shoal Creek north of 29th Street just east of the Austin West quadrangle. Sections on Shoal Creek, Bouldin Creek, and South Lamar Boulevard are described by Martin (1961, 1967).

Soils on the Buda Formation are mostly dark brown to red-brown, shallow to deep, calcareous and noncalcareous clays (Crawford and Tarrant soils). Live oaks, juniper, elm, hackberry, and persimmon are common on the Buda outcrop.

EAGLE FORD FORMATION

The Eagle Ford Formation is about 40 feet thick and consists mostly of dark gray, massive, calcareous clay, with about 9 feet of thin interbeds of silty and sandy, flaggy limestone, clay, and bentonite near the middle of the unit. This limestone unit has been named the Bouldin Member by Adkins and Lozo (1951). The Eagle Ford map unit includes the underlying Pepper Shale, a dark gray to black, laminated, fissile, noncalcareous plastic clay about 3 feet thick. The top of the Eagle Ford is marked by about 3 feet of interbedded, burrowed marl, marly limestone, and chalk, which forms a receding slope beneath the harder massive limestone of the Austin Group. The Austin–Eagle Ford contact is lithologically gradational in the Austin West quadrangle (Feray et al., 1949). Fossil oysters, clams (especially *Inoceramus*), and ammonites are common in some beds. Principal outcrops of the Eagle Ford Formation are at the east edge of the quadrangle. The Eagle Ford forms broad flat topography north of 35th Street from east of Bull Creek Road to Camp Mabry and west of South Lamar Boulevard. Two thin outliers of Eagle Ford cap low hills in the western part of the fault zone. A complete section of the Eagle Ford is exposed on West Bouldin Creek east of South Lamar Boulevard (Feray et al., 1949, pp. 51–55, pl. 14). (The Eagle Ford along part of Bouldin Creek was inadvertently omitted from the printed map.) The Eagle Ford thickens to the north and continues to thin south of Austin; the Pepper Shale does not extend south of Travis County.

Soils of the Eagle Ford are dark brown to brownish-gray, thin to thick, calcareous silty clay and clay loam (Austin, Brackett, Eddy, and Stephen soils). Eagle Ford outcrops generally support a cover of grass with scattered mesquite and hackberry.

AUSTIN GROUP

The Austin Group consists of about 350 feet of chalk, limestone, marly limestone, and marl. In the Austin area the Austin Group has been subdivided into six separately mapped formations. Parts of the two lowest formations (Atco and Vinson) crop out in small areas in the Austin West quadrangle; these units are much more extensive to the east and south. The Austin units generally form moderately dissected, light-colored slopes with growths of live oak and juniper. Soils on the Austin Group are mostly dark brown to brownish-gray, thick to thin, calcareous silty clay and clay loam (Austin, Brackett, Eddy, and Stephen soils).

Atco Formation.—The Atco Formation, the lowest subdivision of the Austin Group, is about 125 feet thick and is composed of gray to white, thin- to thick-bedded, massive to slightly nodular, fine-grained limestone, chalk, and marly limestone; megafossils are uncommon. The lower 60 feet and upper 20 feet of the Atco crop out in fault blocks in the southeast corner of the map area. Along West Bouldin Creek the basal Atco forms bluffs above the less resistant Eagle Ford. In the southeast fault block about 20 feet of upper Atco underlies the Vinson Formation; the Atco-Vinson contact is gradational. An outlier of basal Atco crops out above the Eagle Ford in the highest part of Camp Mabry.

Vinson Formation.—The Vinson Formation is about 75 feet thick and consists mainly of gray to white, thin- to thick-bedded, massive chalk. The Vinson is softer and less resistant than the Atco Formation. The lower 50 feet of the Vinson crop out in a fault block in the extreme southeast corner of the Austin West quadrangle. Small fossil oysters are the only common megafossils in the Vinson in this area.

QUATERNARY ROCKS

Colorado River terrace deposits.—Six separate Colorado River terrace deposits are mapped in the Austin West quadrangle. From highest to lowest (oldest to youngest) these are: Asylum, Capitol, Sixth Street, First Street, Riverview, and Sand Beach terrace deposits. These units are most extensive east of the Mount Bonnell fault and are progressively broader and more extensive from lowest to highest. East of the main fault, in the Austin West quadrangle, the Asylum and Capitol deposits are only on the north side of the river. Much of the western part of Austin is built on these terrace deposits. West of the main fault the three highest units are preserved as isolated erosional remnants on both sides of the river.

The terrace deposits are composed of mostly unconsolidated gravel, sand, silt, and clay derived from Cretaceous and pre-Cretaceous rocks to the west. The gravel is mainly limestone and chert with minor amounts of igneous and metamorphic rocks. Much of the original limestone has been removed by solution, resulting in a high proportion of chert. Gravel is more abundant at the base of each terrace unit and grades to finer material upward.

The Asylum and Capitol deposits have a higher proportion of gravel than the lower units. The higher gravels are cemented locally with calcium carbonate. The Asylum, Capitol, and Sixth Street deposits are characteristically colored orange brown; the lower deposits are typically yellow brown.

The upper surfaces of the terrace deposits are generally flat or gently undulating; lower surfaces are irregular, reflecting the buried bedrock topography. In the Austin West quadrangle the Asylum, Capitol, and Sixth Street deposits have maximum thicknesses of 25 to 30 feet; maximum thickness of each lower unit is about 40 feet. The Asylum and Capitol deposits are highly dissected, with extensive exposures of bedrock. The Sixth Street deposit is slightly dissected, and a narrow bedrock outcrop is exposed locally between the Sixth Street and First Street units. The First Street, Riverview, and Sand Beach deposits are relatively undissected and no bedrock is exposed between the units.

The Sand Beach and Riverview terrace deposits were frequently flooded before regulation of Colorado River flow by a series of dams. The upper surface of the First Street terrace deposit is the level of the highest recorded floods (1869, 1935) (Dalrymple et al., 1939).

More extensive discussions of the Colorado River terrace deposits are in Hill and Vaughan (1898), Urbanec (1963), Weber (1968), and Weeks (1945).

Soils on the Asylum, Capitol, and Sixth Street deposits are mostly brown-red, noncalcareous sandy loam, gravelly sandy loam, and loamy fine sand (Chaney, Dougherty, and Travis soils). Soils on the First Street deposit are mostly brown, calcareous, sandy loams (Hardeman soils). Soils on the Riverview and Sand Beach deposits are mostly light brown to gray-brown, calcareous silty clay loam, fine sandy loam, and fine sand (Lincoln, Norwood, and Yahola soils).

Tributary terrace deposits.—Alluvial terrace deposits are well developed on Barton Creek, Bull Creek, Shoal Creek, and other smaller creeks in the Austin West quadrangle. The terrace deposits consist of gray to tan, mostly unconsolidated, limestone and chert gravel and sand, and calcareous silt and clay, derived from the surrounding Cretaceous rocks. Locally, the sand and gravel are cemented by caliche. Thickness of the terrace deposits is highly variable; maximum thickness is about 20 feet. There are two distinct levels of terrace deposits on Barton Creek—in the Zilker Park area and west of the Mount Bonnell fault. The higher terrace deposits are generally broader and more dissected. On the west part of Barton Creek the upper terrace unit is composed mostly of wedge-shaped point bars that thicken downstream and were deposited on downstream-dipping, rock-cut benches. The two levels have been mapped as a single terrace unit.

Also included with the tributary terrace deposits are local, high, gravel deposits between the Colorado River and the West Loop. These small deposits are only partly related to modern streams, and they probably include material shed locally from east-facing limestone scarps.

Soils on the tributary terrace deposits are mostly dark brown to dark gray, calcareous, clay loam, silty clay, and clay (Frio, Volente, and San Saba soils).

Alluvium.—This unit includes frequently flooded, unconsolidated gravel, sand, and silt in the modern channels of the tributary streams. Maximum thickness of the alluvium is about 20 feet. Also included in this unit is alluvial material immediately below Tom Miller Dam that was deposited by the flood following the dam failure of 1900 (Taylor, 1900). Modern sediments in Lake Austin are as much as 60 feet thick and were derived mostly from silting of the lake behind the early Austin dams prior to the construction of Mansfield Dam (Lake Travis) and Tom Miller Dam (Taylor, 1900, 1924).

STRUCTURE

The general structure of the Austin area is a gently dipping homocline broken by one large fault (Mount Bonnell fault) and numerous small faults comprising the Balcones fault zone. The broad regional dip is to the southeast, but in the Austin area the general dip is northeast into the Round Rock syncline (Tucker, 1962). Dips generally are low in the Austin West quadrangle. The Glen Rose, Walnut, and basal Edwards Formations west of the Mount Bonnell fault generally dip northeast at about 20 feet per mile. Drag on the Mount Bonnell fault changes this to an east dip of 50 feet per mile into the fault. In the Balcones fault zone the general dip is east-northeast at about 50 feet per mile. Locally, in fault blocks and in solution-collapse zones, dips vary greatly. East of the Austin West quadrangle the regional dip increases to between 100 and 150 feet per mile. The structure of the Austin area is discussed in Muehlberger and Kurie (1956) and Dunaway (1962).

Faults.—The Balcones fault zone is a belt of northeast-trending dip-slip normal faults. Most of the faults strike about N. 40° E.; displacement on the faults mapped in the Austin West quadrangle ranges from about 600 feet on the Mount Bonnell fault to a few feet on the smallest faults. The largest fault other than the Mount Bonnell fault has a maximum net slip of about 150 feet; most mapped faults have net slips of less than 50 feet. Fault traces generally are covered, and faults with less than 10 feet of net slip, though numerous, are difficult to map away from road cuts and creek bluffs. North of the Colorado River most fault traces are concealed by residential development and terrace deposits; small faults are well exposed at Barton Springs, Campbells Hole, and elsewhere along Barton Creek. Fault planes generally dip between 55° and 75°. About 60 percent of the faults are downthrown to the east, about 40 percent to the west. Total stratigraphic displacement across the Balcones fault zone in the Austin West quadrangle is about 1,000 feet. From south to north in the fault zone faults striking about N. 10° E. transfer the displacement westward across the fault zone.

The Mount Bonnell fault is the major structural feature of the area. The fault trends N. 40° E. and dips east. The fault is downthrown to the east, and maximum net slip is about 600 feet at Hucks Slough below Mount Bonnell. Displacement decreases northward and southward to about 450 feet at the south and east boundaries of the quadrangle. The Mount Bonnell fault extends south into Hays County and north into the Austin East quadrangle where the displacement is taken up by other en echelon faults.

Joints.—The two pairs of dominant joint sets of this area are reflected in the trends of the incised meanders of the Colorado River and Barton Creek. The more prominent pair strike N. 40° E., parallel to the Balcones faults, and N. 45° W.; both sets extend over the map area. In the northern and western part of the quadrangle a secondary pair strike N. 10° W. and N. 80° E.; to the east the strikes of these two joint sets change progressively to the sets striking N. 40° E. and N. 45° W. (Muehlberger and Kurie, 1956). The joints are mainly vertical tension fractures, with shear fractures near faults and solution-collapse zones.

Folds.—Folds associated with solution-collapse zones in the Edwards Formation have amplitudes up to 20 feet and are well exposed in the high river bluffs below Tom Miller Dam and in cuts on Red Bud Trail. Many Balcones faults have produced small drag folds.

ENGINEERING GEOLOGY AND LAND USE

Engineering data for the Austin area have been compiled from information generously provided by private firms and government agencies. Test data and general engineering evaluations for each geologic unit are presented in table 1. This table presents general engineering characteristics of the map units as background for land-use planning; it does not eliminate the need for detailed site studies. Test data include unit weight, moisture content, seismic velocity, compressive strength, plasticity index, and absorption pressure—absorption swell. General engineering evaluations concern slope stability, foundation characteristics, excavation characteristics, and infiltration capacity.

Limestone units (Glen Rose, Walnut, Edwards, Georgetown, Buda, Atco, and Vinson Formations) pose few construction problems; they generally are stable even on relatively steep slopes. Excavation generally is difficult, but parts of softer units (Glen Rose and Walnut Formations and Austin Group) are rippable. Bearing capacity is high; special foundation support generally is not needed. Infiltration capacity varies. Coarse-grained limestones, dolomites, and cavernous zones (Edwards Formation and parts of the Glen Rose and Walnut Formations) are highly permeable, and intermittent springs in these units cause drainage problems. Absorption of sewage tank effluent can be high, but possible contamination of underground and surface water supply is a hazard. Caverns and sinkholes in the Edwards Formation may require grouting or other fill material. Fine-grained and marly limestones (parts of the Glen Rose, Walnut, and Edwards Formations, the Georgetown and Buda Formations, and the Austin Group) generally are much less permeable, but even these limestones commonly are highly fractured and permeable to depths of a few feet below natural slope surfaces.

The clay units (Del Rio Clay and Eagle Ford Formation) may pose severe building problems and generally require special engineering designs. These clay units generally are unstable even on shallow slopes. Excavation is relatively easy. Bearing capacities are low and they have high shrink-swell values. Infiltration capacity is low, generally inadequate for septic tank effluent.

Slope stability of alluvial deposits (Colorado River terrace deposits, tributary terrace deposits, and alluvium) ranges from high to low depending on water saturation, topographic position, degree of cementation of the sand and gravel, and nature of the underlying bedrock. Saturated, uncemented deposits on steep slopes above bedrock clays are least stable; unsaturated, cemented deposits on low slopes above limestone bedrock are most stable. Most alluvial deposits in the Austin West quadrangle are between the extremes. Excavation is relatively easy even for light equipment, but saturated deposits pose problems of stability and water removal. Bearing capacity is low to moderate; shrink-swell values are low to high depending on clay content. Large structures may require special engineering designs. Infiltration capacity generally is high with adequate absorption of septic tank effluent, but saturated units may have low fluid acceptance. Topographically lower units are frequently or permanently saturated. Higher units may have local, perched water tables; building sites excavated in these units may have recurring drainage problems.

Corrosion characteristics of map units can be classified generally. The clays (Del Rio and Eagle Ford) have low permeability and tend to be highly corrosive; the more permeable limestones (Glen Rose, Walnut, Edwards, Georgetown, Buda, Austin) and alluvial deposits are slightly to moderately corrosive. Corrosiveness is strongly affected by other factors. The use of different metals connected together, or a single kind of metal buried in two or more kinds of rock or soil, produces a corrosive battery effect. The nature of the backfill is important; poorly drained or poorly aerated earth materials are more corrosive. Cathodic protection is the only safe treatment for metals; use of plastic pipe will reduce corrosion problems.

ROCK AND MINERAL RESOURCES

CONSTRUCTION MATERIALS

The Austin area has large resources of construction materials. At various times crushed limestone, dimension limestone, lime and cement raw materials, sand and gravel, and brick clay have been produced in the Austin West quadrangle (Burchard, 1910; Nickell, 1961).

Although substantial reserves of these materials exist in the Austin West quadrangle, few of them are likely to be produced in the near future. The reserves are largely in the east and southeast parts of the quadrangle, an area either within the Austin city limits or being rapidly urbanized. Limestone and sand and gravel deposits in the western part of the area probably will be utilized for road construction and other local use.

Edwards Formation.—The Edwards Formation contains large reserves of durable, high purity limestone suitable for a variety of construction, chemical, and industrial uses (Rodda et al., 1966). Edwards limestones are unmatched in the Austin area for purity and durability, and few other limestones have been quarried. The calcium carbonate content of Edwards Member 2 generally exceeds 97 percent; laterally equivalent beds are used for lime-making and other purposes at McNeil and Georgetown. Edwards Member 1 also contains high purity limestone and much dolomite. Chert nodules generally are abundant in Edwards dolomites; high silica content makes the dolomite unsuitable for commercial production.

For many years a large quarry in the northeast corner of the map area produced high-purity crushed stone from the lower part of Edwards Member 1. The quarry site has been reclaimed for commercial, residential, and school developments. Many years ago, in the western part of Austin near Tom Miller Dam, limestone of Edwards Member 2 was burned to make lime. The quarry has long since been reclaimed for residential building sites, but one old vertical brick kiln still stands.

The Edwards Formation was also the source of dimension stone used extensively in Austin before 1900, and sparingly since then (Barnes et al., 1947; Nickell, 1941). In the western part of the city small quarries were opened in the lower part of Member 4 along Johnson Branch and west toward Red Bud Trail and in scattered places south of the Colorado River. Two kinds of stone were produced, commonly from the same quarry: thin-bedded, fine-grained, dense limestone flags and a dense, massive, fine-grained limestone (the Austin marble) containing abundant fossil shells of the rudist *Toucasia*. The Austin marble is about 3 feet thick and overlies several feet of the flaggy limestone beds.

Near the turn of the century Portland cement was produced from Georgetown Limestone and Del Rio Clay in the east-central part of the map area.

Alluvial deposits.—Sand and gravel have been produced at various times in the Austin West quadrangle. The lower two Colorado River terrace units have been worked extensively; higher Colorado terrace units have been worked locally. The lower units contain proportionately less gravel than the upper units, and grain size generally decreases down river. Recent production of Colorado River alluvial deposits in the Austin West quadrangle has been from the dredging of the modern channel below Tom Miller Dam.

A large amount of sand and gravel were produced from a Barton Creek terrace deposit south of Barton Springs. The pit has been filled and converted to a residential subdivision. Small amounts of sand and gravel have been obtained elsewhere in the tributary terrace deposits. West of the Mount Bonnell fault the Barton Creek terrace deposits contain significant reserves of limestone sand and gravel.

Brick clay was obtained from a low Colorado terrace deposit on the south side of the river near the east edge of the map area. The clay was fired at comparatively low temperatures, producing a cream-colored, relatively soft brick. These operations were suspended many years ago, and used "Austin common" brick is now in great demand.

GROUND WATER

In the Austin area ground water is a source of water for some small communities, for rural domestic and stock use, and for recreation (Mount et al., 1967; Hill and Vaughan, 1898). The principal aquifers are the Edwards Formation and the basal Cretaceous sands.

The basal sands crop out to the west along the shores of Lake Travis; they lap out westward against the Llano Uplift and dip eastward beneath the Austin area (Barnes, 1948; Fisher and Rodda, 1966). Wells in the Austin West quadrangle have reached the sands at elevations of 200 to −1,200 feet (Arnow, 1957). Water quality is variable but generally potable.

The Edwards Formation, especially the lower dolomitic member, supplies water to several wells in this area and is the source of Barton Springs. Underflow in the lower Edwards moves down dip to the springs from at least as far south as Onion Creek in Hays County. The flow of Barton Creek infiltrates the porous lower Edwards east of the Mount Bonnell fault and is a major contributor to the Edwards–Barton Springs reservoir. Barton Springs flow from fractures in upper Edwards limestone associated with the northeast-dipping Barton Springs fault. Net slip on the fault is about 30 feet. Other springs near Barton Springs, and springs at the base of Deep Eddy bluff (Hill and Vaughan, 1898), are supplied by the same underground reservoir. Wells in the lower Edwards have supplied water for Rollingwood community and other areas south of the Colorado River. Water quality in the Edwards varies widely, and in some areas the water is unusable for most purposes (Mount et al., 1967).

Dolomitic units of the Glen Rose Formation are minor aquifers and locally supply small amounts of water of relatively poor quality. Following high rainfall, water flows from outcrops of Glen Rose dolomite, and these intermittent springs pose homesite drainage problems.

The lowest Colorado River terrace deposits commonly are saturated and can supply large amounts of water to wells. Main recharge is from the river. Other alluvial deposits contain small and seasonally variable water supplies; higher Colorado River and tributary terrace deposits supply small amounts of water from perched water tables.

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TABLE 1. GENERAL CHARACTERISTICS AND ENGINEERING PROPERTIES OF GEOLOGICAL UNITS, AUSTIN WEST QUADRANGLE.

GEOLOGIC UNIT	MAP SYMBOL	THICKNESS (feet)	GENERAL CHARACTERISTICS	ENVIRONMENTAL GEOLOGIC CHARACTERISTICS: SLOPE STABILITY	EXCAVATION CHARACTERISTICS	FOUNDATION CHARACTERISTICS	INFILTRATION CAPACITY	ROCK AND MINERAL RESOURCES	ENGINEERING TEST DATA: UNIT WEIGHT (lbs./cu. ft.)	MOISTURE (% by weight)	SEISMIC VELOCITY (feet/second)	TRIAXIAL COMPRESSION (tons/sq. ft.)[1]	UNCONFINED COMPRESSION (tons/sq. ft.)	PLASTICITY INDEX (Atterberg Limits)	ABSORPTION SWELL (%)	ABSORPTION PRESSURE (lbs./sq. ft.)
Alluvium	Qal	0-20	Unconsolidated gravel, sand, silt, and clay of tributary streams; includes flood-deposited material immediately below Tom Miller Dam.	Moderate to low--commonly water saturated	Readily excavated by light machinery	Bearing capacity moderate to low; shrink-swell low to high	Generally high with adequate absorption of septic tank effluent; may be saturated seasonally and have low fluid acceptance	Minor source of sand and gravel. Yields small variable supplies of water; supply subject to drought	81 to 107	3 to 70	1,000 to 2,500	0.5 to 2.5	0.1 to 5.16 (mostly under 3.0)	4 to 60 (mostly 20 to 60)	0.5 to 6.75	600 to 8,400
Colorado River Terrace Deposits Sand Beach Riverview First Street Sixth Street Capitol Asylum	 Qsb Qrv Qfs Qss Qca Qas	 0-40 0-40 0-40 0-25 0-30 0-25	Mostly unconsolidated, yellow- to orange-brown gravel, sand, silt, and clay; consists mostly of Cretaceous limestone and chert fragments with minor amounts of older igneous, sedimentary, and metamorphic rocks. Gravel more common in higher (older) units, and more abundant near base of each unit. Upper surface of First Street terrace is level of maximum recorded flood (1869, 1935). Lower three units partly or completely flooded above Tom Miller Dam. Lower two units were frequently flooded prior to regulation of flow by Colorado River dams. Terrace deposits above flood level support growths of live oak and post oak.	Moderate to low	Readily excavated by light machinery	Bearing capacity moderate to low; large structures may require special design; shrink-swell low to moderate	Generally high with adequate absorption of septic tank effluent; lower units may be saturated and have low fluid acceptance	In the past supplied much sand and gravel; now mostly urbanized. May yield substantial supplies of water, more in lower terrace deposits	82 to 123	2 to 35	1,000 to 2,500	0.1 to 3.5	0.5 to 7.3 (mostly under 4.0)	8 to 66 (mostly 10 to 40)	0.03 to 3.5	400 to 8,400
Tributary Terrace Deposits	Qt	0-20	Mostly unconsolidated, light gray to tan, gravel, sand, silt, and clay; consists of locally derived limestone and chert gravel and calcareous silt and clay. Forms terraces along Barton Creek, Bull Creek, Shoal Creek, and other smaller creeks; includes minor, topographically high, alluvial deposits not directly related to modern streams.	Moderate to low	Readily excavated by light machinery	Bearing capacity moderate to low; shrink-swell low to moderate	High; adequate absorption of septic tank effluent	Potential source of sand and gravel; some previous operations now urbanized. May yield minor supplies of water	82 to 120	3 to 40	1,000 to 2,500	0.7 to 5.0	1.0 to 4.0	7 to 55 (mostly 20 to 40)	0.0 to 7.5	200 to 6,400
Austin Group Vinson Formation Atco Formation	 Kvs Kat	 50 80	Vinson: Gray to white, thin- to thick-bedded, massive chalk. Atco: Gray to white, thin- to thick-bedded, massive to slightly nodular, fine-grained limestone, marly limestone, and chalk. Both: Forms light-colored, moderately dissected slopes with live oak and juniper. Thickness incomplete; only lower part of each unit exposed.	High	Difficult to excavate with light equipment; generally can be ripped with heavy equipment	Bearing capacity high; shrink-swell generally low	Low to moderate; marginal to adequate absorption of septic tank effluent	None in this area; potential cement raw material elsewhere in Austin area	87 to 123	10 to 30	4,000 to 6,000	*	10 to 250 (mostly over 40)	10 to 40 (marly units)	0.1 to 0.8	400 to 1,400
Eagle Ford Formation	Kef	40	Upper part is dark gray clay; middle part consists of thin interbeds of sandy and flaggy limestone, chalk, clay, and bentonite; lower part is mostly dark gray calcareous clay. Includes Pepper Shale at base--soft, laminated, noncalcareous, three feet thick. Generally forms grassy, low relief areas with few native trees.	Low to moderate; decreases with increasing moisture content	Moderately easy to excavate; limestone and sandstone beds may require ripping	Bearing capacity generally low; may need special foundation design or excavation down to Buda Limestone; high shrink-swell	Low; generally inadequate absorption of septic tank effluent	None in this area	80 to 115	10 to 45	2,000 to 8,000	0.7 to 8.0	1 to 300 (clays mostly under 10; thin limestone and sandstone beds mostly over 60)	8 to 70 (mostly 20 to 50)	0.1 to 3.8	800 to 2,600
Buda Formation	Kbu	35	Gray to tan, hard, fine-grained, glauconitic, shell fragment limestone. Lower part less resistant and slightly nodular weathering. In outcrop fresh surfaces yellowish to pink. Commonly forms steep slopes above the Del Rio Clay. Live oak, juniper, elm, and hackberry are common on this unit.	Generally high but may fail at edges of steep slopes above weak Del Rio Clay	Excavation difficult; generally requires blasting	Bearing capacity generally high, but may be low at outcrop edge above slopes of Del Rio Clay	Low	None	*[2]	*	8,000 to 11,000	*	60 to 420	*	*	*
Del Rio Clay	Kdr	75	Dark gray to olive brown, pyritic, gypsiferous, calcareous clay containing abundant <u>Exogyra arietina</u> (ram's horn oyster). Poorly exposed in steep to shallow slopes below Buda limestone. Del Rio slopes readily fail by slide and creep; slopes commonly covered with a thin layer of Buda limestone rubble which supports typically limestone vegetation of live oak and juniper. Elsewhere the Del Rio supports only a cover of grass and scattered mesquite trees.	Low; decreases with increasing moisture content; fails when wet on shallow slopes	Moderately easy to excavate with light machinery	Bearing capacity low; structures need special support; high shrink-swell	Low; inadequate absorption of septic tank effluent	None	100 to 123	10 to 30	2,000 to 4,500	1.5 to 2.5	3 to 20 (mostly under 10)	20 to 56 (mostly 30 to 50)	4.7 to 8.4	4,400 to 6,600
Georgetown Formation	Kgt	55	Thin interbeds of gray to tan, nodular weathering, hard, fine-grained limestone, marly limestone, and marl, containing abundant fossil shells. Forms moderate to shallow slopes above more resistant Edwards limestone. Supports a limestone vegetation with juniper especially abundant.	High	Excavation difficult; blasting generally required	Bearing capacity high; no special support needed	Low	None	*	*	7,000 to 9,000	*	40 to 300 (mostly over 100)	*	*	*
Edwards Formation Member 4 Member 3 Member 2 Member 1	 Ked_4 Ked_3 Ked_2 Ked_1	 40 10 40 200	Member 4: Mostly hard, dense, gray to tan, thick- to thin-bedded, fine-grained limestone; soft, dolomitic near middle; lower part flaggy bedded. Member 3: Mostly soft, nodular weathering, gray to tan, marly limestone, with abundant growth of juniper. Member 2: Mostly hard, light gray to tan, fine- to medium-grained, thin- to thick-bedded limestone; thin beds mostly fine grained, flaggy; thicker beds coarser grained with abundant rudist fragments and miliolid foraminifers. Chert nodules in lower third. Member 1: Mostly thin- to medium-bedded, gray-brown, porous dolomite and dolomitic limestone, and gray to tan, fine- to medium-grained rudist limestone. Nodular chert common. Top of unit is a 20-foot cavernous, solution-collapse zone. Total thickness estimated; complete section not exposed. All members: Forms weakly to deeply dissected topography mostly east of Mount Bonnell fault. Members 1, 2, and 4 generally support growths of oak, juniper, hackberry, persimmon, and other plants.	High	Excavation difficult to moderate; blasting generally required	Bearing capacity high; no special support needed	Low in fine-grained dense limestones, moderate to high in coarse-grained limestones, dolomites, and cavernous zones	Source of high-grade crushed stone; large quarry in northeast map area recently urbanized. Lower Ked_4 was source of dimension stone (Austin Marble and paving flags). Ked_1 is important aquifer; source of Barton Springs and other springs	*	*	7,000 to 11,000	*	95 to 300 (mostly over 200)	*	*	*
Walnut Formation Bee Cave Member	Kbc	30	Soft, gray to tan, nodular weathering, fine-grained limestone, marly limestone, and marl with abundant fossil shells. Forms steep, light-colored, juniper-covered slopes on high topography west of Mount Bonnell fault.	Moderate to high	Excavation moderate to difficult, probably rippable in part	Bearing capacity moderate to high; special support generally not needed	Low to moderate; absorption of septic tank effluent probably marginal	Minor source of road material	*	*	3,000 to 7,000 (estimated)	*	50 to 200 (estimated)	*	*	*
Bull Creek Member	Kbk	35	Hard, dense, gray to tan, fine- to medium-grained, thin- to thick-bedded limestone; shell fragments and miliolid foraminifers common. Forms prominent bench on high topography west of main fault. Limestone vegetation of live oak, juniper, hackberry, and other plants.	High	Excavation difficult; blasting required	Bearing capacity high; no special support needed	Low to moderate	Minor source of road material	*	*	7,000 to 11,000 (estimated)	*	100 to 300 (estimated)	*	*	*
Glen Rose Formation Member 5 Member 4 Member 3 Member 2 Member 1	 Kgr_5 Kgr_4 Kgr_3 Kgr_2 Kgr_1	 100 120 70 120 30	Member 5: Mostly thin-bedded, gray-brown, fine-grained, porous dolomite; upper 10 to 20 feet pulverulent. Member 4: Gray to tan, mostly thin- to thick-bedded, fine- to medium-grained limestone and marly limestone. Many beds with fossil shells. Member 3: Gray brown to tan, thin interbeds of dolomite, dolomitic limestone, limestone, and marly limestone. Member 2: Gray to tan, thin to thick interbeds of fine- to medium-grained limestone, marly limestone, and marl. Many beds with fossil shells. Member 1: Gray to tan, thin- to thick-bedded limestone, marly limestone, and marl. At top is thin, orange-brown limestone ledge with abundant small fossil clams (<u>Corbula harveyi</u>); underlying marly limestone abundantly fossiliferous. Thickness is minimum; lower contact not exposed. All members: Forms moderately to deeply dissected hill country west of main fault. Typified by stair-step topography with oak-juniper vegetation.	High to moderate	Excavation difficult to moderate; blasting commonly needed	Bearing capacity generally high to moderate; thin, weak marl beds can be excavated down to harder, more stable limestone beds	High in dolomitic units; moderate to low in other units	Minor source of road material; dolomitic members are minor aquifers	*	*	3,000 to 10,000 (estimated)	*	90 to 250 (estimated)	*	*	*

1/ Derived partly from penetrometer correlation bearing curves of the Texas Highway Department

2/ *Test not applicable or test data not available

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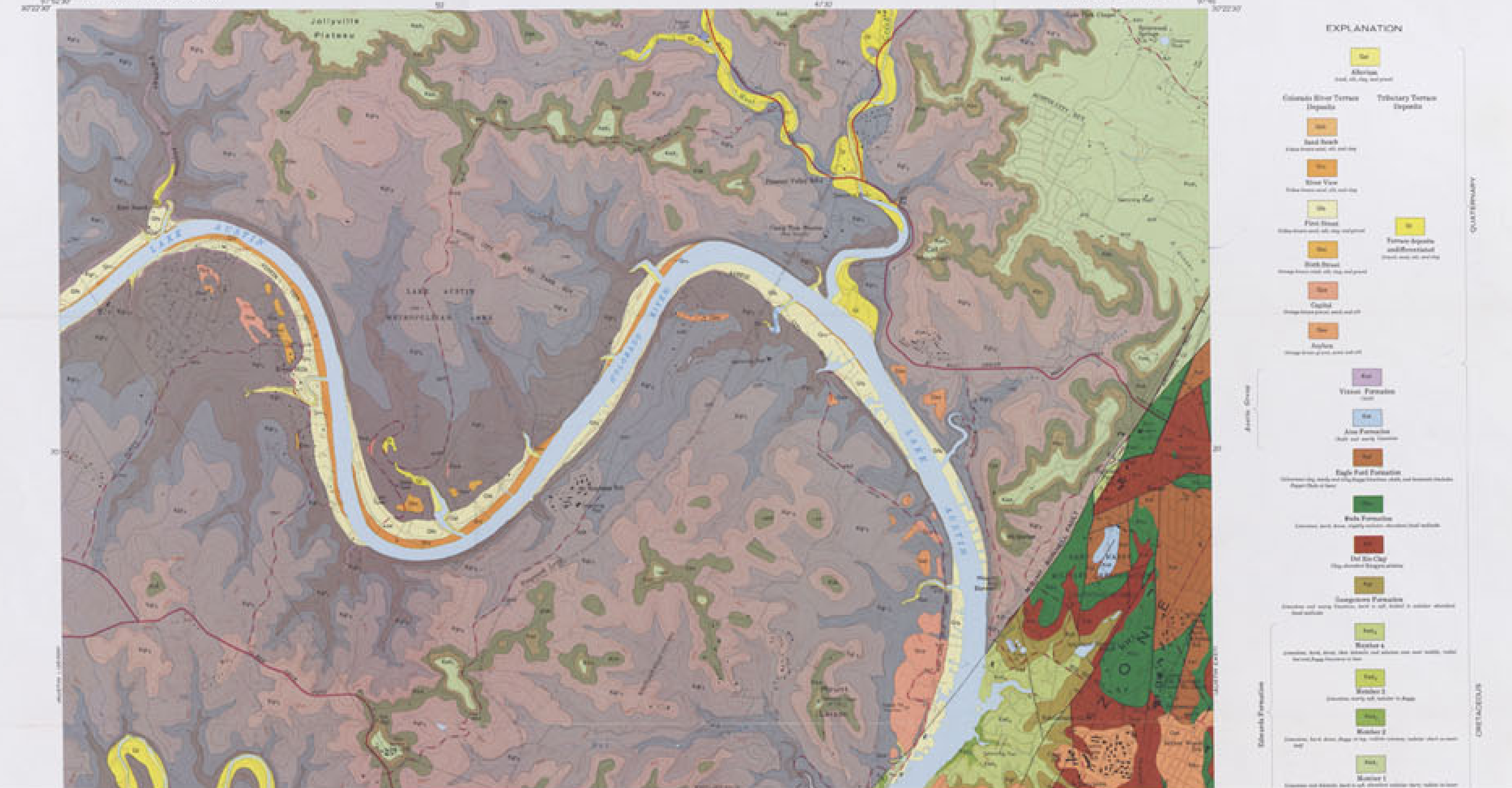
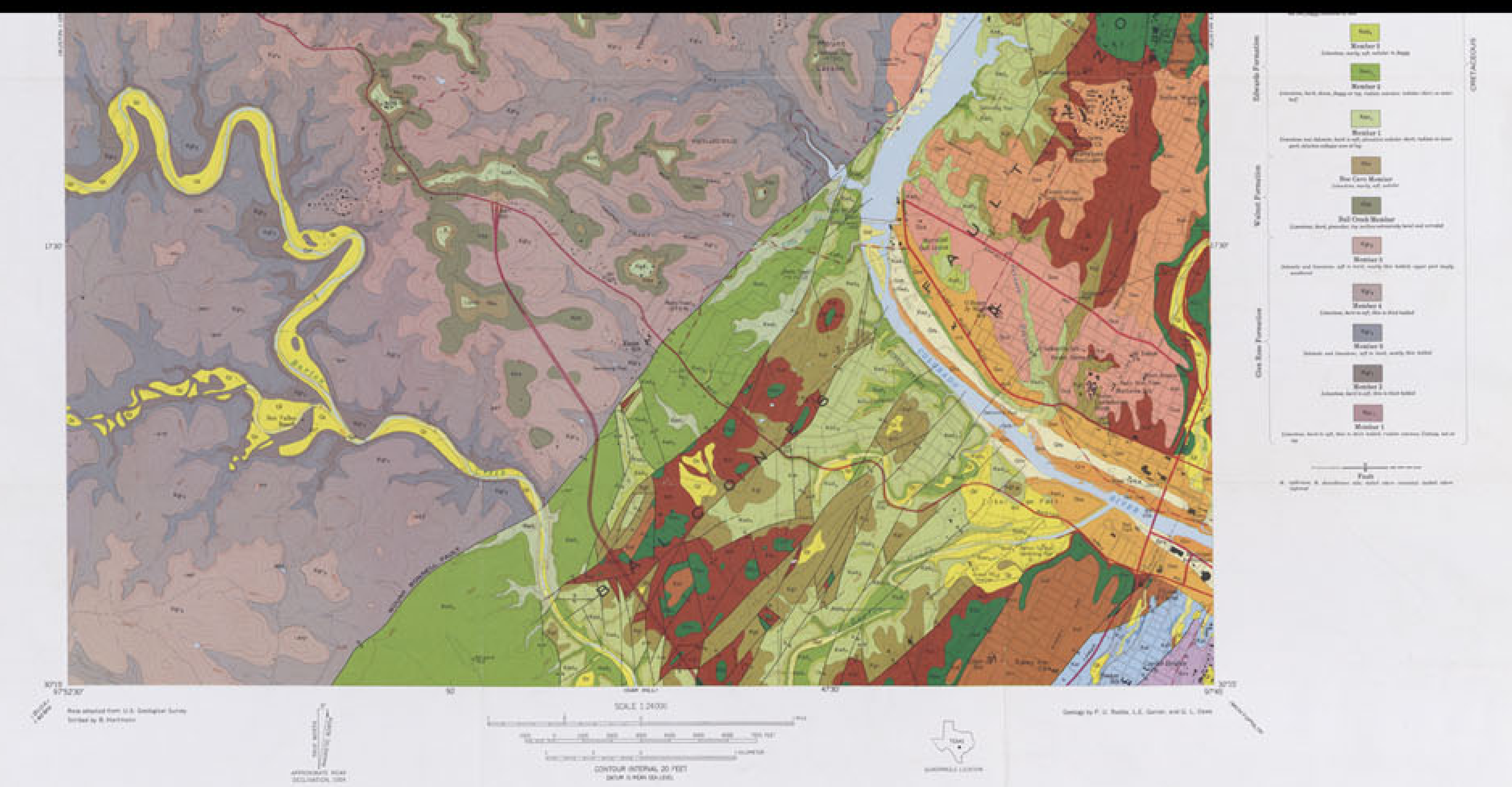
PETER T. FLAWN, DIRECTOR

GEOLOGIC QUADRANGLE MAP NO. 38
AUSTIN WEST
TRAVIS COUNTY, TEXAS





GEOLOGIC MAP OF THE AUSTIN WEST QUADRANGLE, TRAVIS COUNTY, TEXAS

1969

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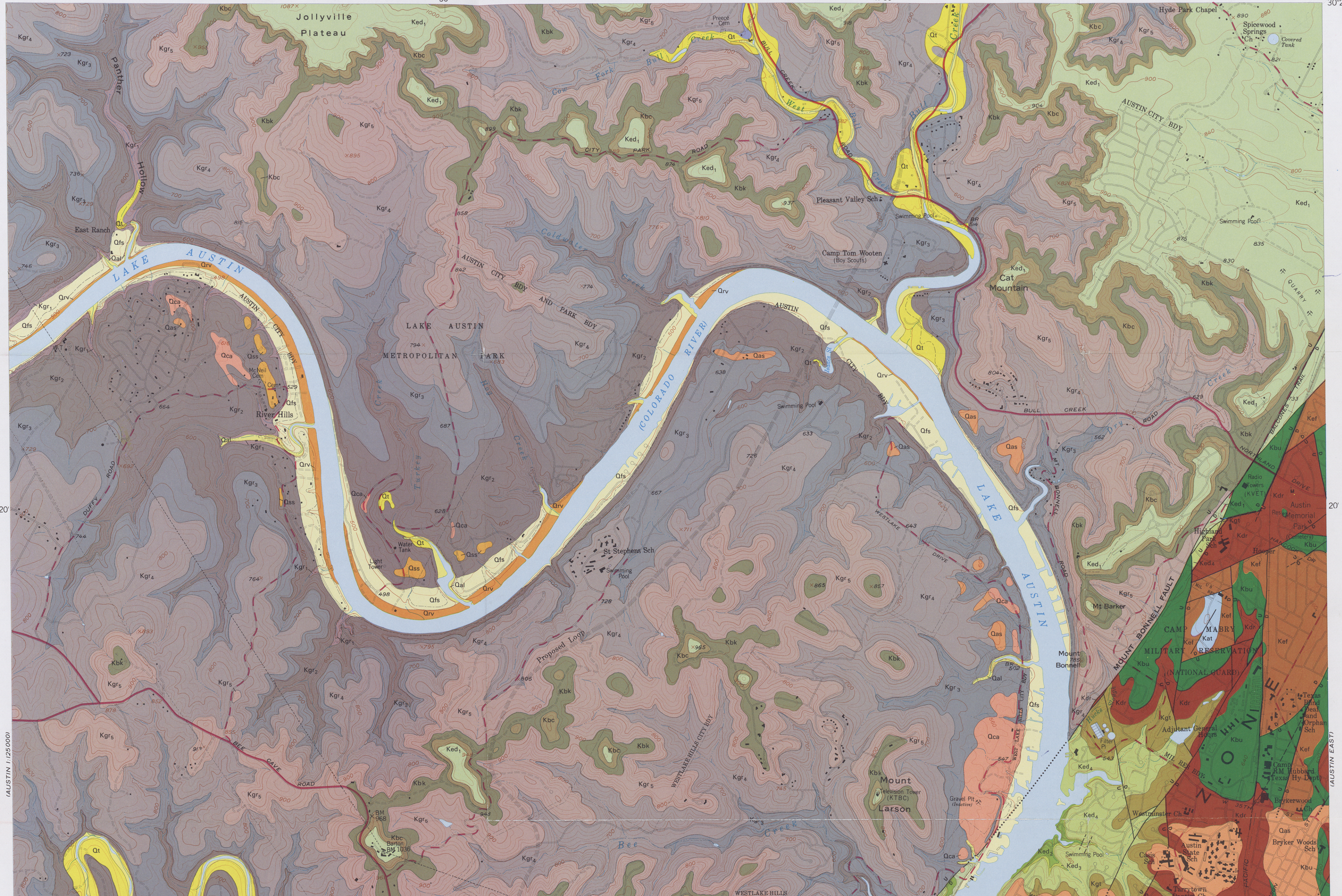

EXPLANATION

Qal — Alluvium
Sand, silt, clay, and gravel

Colorado River Terrace Deposits

Qsb — Sand Beach
Yellow brown sand, silt, and clay

Qrv — River View
Yellow brown sand, silt, and clay

Qfs — First Street
Yellow brown sand, silt, clay, and gravel

Qss — Sixth Street
Orange brown sand, silt, clay, and gravel

Qca — Capitol
Orange brown gravel, sand, and silt

Qas — Asylum
Orange brown gravel, sand, and silt

Tributary Terrace Deposits

Qt — Terrace deposits undifferentiated
Gravel, sand, silt, and clay

QUATERNARY

Austin Group

Kvs — Vinson Formation
Chalk

Kat — Atco Formation
Chalk and marly limestone

Kef — Eagle Ford Formation
Calcareous clay, sandy and silty flaggy limestone, chalk, and bentonite (includes Pepper Shale at base)

Kbu — Buda Formation
Limestone, hard, dense, slightly nodular, abundant fossil mollusks

Kdr — Del Rio Clay
Clay, abundant Exogyra arietina

Kgt — Georgetown Formation
Limestone and marly limestone, hard to soft, bedded to nodular, abundant fossil mollusks

Edwards Formation

Ked_4 — Member 4
Limestone, hard, dense; thin dolomite and solution zone near middle, rudist bed and flaggy limestone at base

Ked_3 — Member 3
Limestone, marly, soft, nodular to flaggy

Ked_2 — Member 2
Limestone, hard, dense, flaggy at top, rudists common; nodular chert in lower half

Ked_1 — Member 1
Limestone and dolomite, hard to soft, abundant nodular chert; rudists in lower

CRETACEOUS

Edwards Formation

Ked₃ — **Member 3**
Limestone, marly, soft, nodular to flaggy

Ked₂ — **Member 2**
Limestone, hard, dense, flaggy at top, rudists common; nodular chert in lower half

Ked₁ — **Member 1**
Limestone and dolomite, hard to soft, abundant nodular chert; rudists in lower part; solution-collapse zone at top

Walnut Formation

Kbc — **Bee Cave Member**
Limestone, marly, soft, nodular

Kbk — **Bull Creek Member**
Limestone, hard, granular; top surface extensively bored and corroded

Glen Rose Formation

Kgr₅ — **Member 5**
Dolomite and limestone, soft to hard, mostly thin bedded; upper part deeply weathered

Kgr₄ — **Member 4**
Limestone, hard to soft, thin to thick bedded

Kgr₃ — **Member 3**
Dolomite and limestone, soft to hard, mostly thin bedded

Kgr₂ — **Member 2**
Limestone, hard to soft, thin to thick bedded

Kgr₁ — **Member 1**
Limestone, hard to soft, thin to thick bedded, rudists common; Corbula *bed at top*

CRETACEOUS

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

(BUDA) 1:62 500

Base adapted from U.S. Geological Survey
Scribed by B. Hartmann

TRUE NORTH — MAGNETIC NORTH — 9°
APPROXIMATE MEAN DECLINATION, 1954

SCALE 1:24 000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

TEXAS
QUADRANGLE LOCATION

Geology by P. U. Rodda, L.E. Garner, and G. L. Dawe

(MONTOPOLIS)

GEOLOGIC MAP OF THE AUSTIN WEST QUADRANGLE, TRAVIS COUNTY, TEXAS
1969