



THE WALTZ ACROSS TEXAS

- Geology Tour
- Archeology/Biology Tour
- Scenic Tour

Geology Tour Road Log

by George Veni

The field trip begins by examining some recent and hydrologically active karst features of the southwestern Edwards Plateau, then moves to older, relict features formed by previous flow regimes. In the modern unconfined aquifer large springs discharge from conduits, but most sites of groundwater recharge occur through morphologically subdued, yet hydraulically efficient solutioned fractures. The paleo-aquifer was a confined system with large conduits formed by diffuse recharge through permeable, non-cavernous strata where the Del Rio Clay was thin or absent. The incision of streams along the margins of the Edwards Plateau drained the paleo-aquifer and initiated development of the modern aquifer.

Definitive conclusions cannot be drawn from the available data due to the lack of extensive cave surveys, cave exploration, and karst field studies within this area. Further research will lead to refinements and changes in the proposed model. Observations and suggestions on the area's karst development are welcome. For insights into the region's history, prehistory, culture, and biology, see the accompanying Archeology/Biology and Scenic Tour road logs, which partially cover the same route as the Geology Tour.

| Total miles | Miles since last stop | Description |
|-------------|-----------------------|---|
| 0.0 | 0.0 | FORT CLARK SPRINGS OVERLOOK OF THE BALCONES ESCARPMENT |

STOP 1 The features discussed here at Fort Clark will not be examined during the trip because they can be visited anytime during convention week. The field trip convenes in the parking lot west of the Las Moras Inn Restaurant to provide an overview of the southwestern Edwards Plateau. Look north over Las Moras Creek. The escarpment runs east to west and gently rises north of Brackettville. The trip route will first extend west (left) along the base of the escarpment, which becomes less pronounced with decreased faulting as distance from the Balcones Fault Zone increases.

Two hills stand steeply above the terrain north of Brackettville. Pinto Mountain on the left (northwest) and Las Moras Mountain marked by the radio tower on the right (northeast) are erosion-resistant Tertiary intrusions of basalt that rose along Miocene-age Balcones faults. The field trip will return to Brackettville down Highway 674 which runs between these two igneous

hills. Brackettville marks the western extent of such intrusions and of the Balcones Fault Zone. Some basalt is mined farther east near Uvalde. The effect of these intrusions on cave development has not been studied but is probably minimal. The basalts probably act as local barriers to groundwater flow in the Edwards (Balcones Fault Zone) Aquifer.

The southwestern Edwards Plateau area is highly dissected by streams; along the field trip route, it rarely has the appearance of a “plateau.” Streams generally run south, perpendicular to the trend of the Balcones Escarpment. Valleys floored on the Edwards or equivalent limestones are usually dry or losing streams that flood seasonally. Major, gravity-drained springs occur in streams that cut to the base of the Edwards Limestone where groundwater is perched on the Glen Rose Formation.

Directly below the Las Moras Inn overlook is Las Moras Creek, which rises about 150 m to the northwest at Las Moras Spring. The westernmost artesian spring within the Balcones Fault System, its water rises along a fault from the Edwards Limestone through the Austin Chalk (see Figure 5 in this volume’s geology chapter). The average discharge is about 654 L/sec and the temperature is a near-constant 22.5°C. Saturation indices calculated from unpublished chemical analyses show the water is generally at or slightly above saturation with respect to calcite. The spring’s drainage basin is not defined; the only potentiometric map of the area places it in an improbable position atop a groundwater divide (Bennett and Sayre, 1962). The authors of the map realized this potentiometric position was incorrect, yet they had insufficient well data to produce a more accurate representation (Ted A. Small, U.S. Geological Survey, personal communication, 1993).

About 120 m southwest of Las Moras Inn is the Quarry Amphitheater, an old stone quarry within the Austin Chalk. The stone was removed between 1871-1875 to construct many of the older buildings at Fort Clark. Unfortunately, the Austin from the quarry was of poor quality, and superior building stone from more distant quarries was later hauled in by wagons. The crumbly and weathered walls of buildings east of the Fort Clark Information Center are built of the locally derived Austin. Small solutional openings can be seen in the Amphitheater, and some small, poorly studied caves occur in the Austin near Fort Clark (see the description of Brackettville Sink, Kinney County, in the “Texas Wild Caves” chapter).

| Total miles | Miles since last stop | Description |
|-------------|-----------------------|---|
| 0.0 | 0.0 | Begin mileage at Fort Clark Springs gate and head west on U.S. 90. |
| 0.6 | 0.6 | Historical marker commemorates the Seminole Indian Scout Cemetery 2.9 mi. to the south. See Scenic Tour, “Black Seminole Indian Scouts.” |
| 4.6 | 4.6 | Cross from the Austin Chalk outcrop onto the Tertiary Uvalde Gravel, a coarse, caliche-cemented outwash from the Edwards Plateau. Given the roughly level terrain, the contact is best noted by changes from the thin, stony, light-yellow soil on the Austin to the thicker, light brown, and more vegetated soil on the Uvalde. |
| 7.3 | 7.3 | Historical marker on right (north) side of the highway describes the abandoned town of Delores located about 13 km to the south. See Scenic Tour, “Delores.” |
| 12.4 | 12.4 | Cross onto the Eagle Ford Group west of Road 3008, and return onto the Uvalde Gravel after 2.2 miles. |
| 18.0 | 18.0 | Bridge over Sycamore Creek and cross from Kinney County into Val Verde County. The roadcut on the left (south) side of the highway and west of the creek exposes stream terrace gravels on Buda Limestone. The historical marker across the highway commemorates the Chihuahua Road, the life-line between Chihuahua, Mexico, and the Texas port of Indianola. See Scenic Tour, “Chihuahua Road.” |
| 24.0 | 24.0 | Main gate to Laughlin Air Force Base on left (south) and commemorative historical marker. Laughlin is primarily used for pilot training, including some exotic missions like the U-2 spy plane and the space program. See Scenic Tour, “Laughlin Air Force Base.” |
| 24.5 | 24.5 | Del Rio city limits approximately mark where you cross onto the Salmon Peak Limestone. The limestone is poorly exposed due to alluvial cover. The city was founded as a Spanish mission, San Felipe del Río, in 1635. See Scenic Tour, “City of Del Rio.” |
| 28.6 | 28.6 | Turn right (north) into golf course. |

29.2 29.2 **SAN FELIPE SPRINGS**

STOP 2 The San Felipe Springs are the fourth largest spring group in Texas and comprise of about 10 springs along a 3-km-long reach of San Felipe Creek. Spring #1-3 are the largest and are within the San Felipe Golf Course, and #2 and #3 are pumped for municipal usage. The springs were first used as a water supply by nomadic Indians. Their later discovery by Europeans in 1590 became the key to the success of settlements in the 1800s, which grew into the City of Del Rio. See the other road logs, “San Felipe Springs” and “Canal System of Del Rio” for more information on their history and biology. Diving efforts to explore the springs have thus far been thwarted by constrictions that raise the outflow to impassable velocities.

Since the construction of the Amistad Dam in 1969, the International Boundary Commission has monitored the discharge and chemistry of the springs. Little information has been published, and there have been no detailed hydrologic or geochemical modeling of the springflow. The most noted hydrologic facet of the springs is that discharge increased by 31% to a mean 3.84 m³/sec after the completion of the Amistad Dam. However, the flow is decreasing due to groundwater pumping. The springs’ drainage basin is poorly defined but likely includes much of the area to the north between the Devils River and the groundwater drainage divide that extends north from Brackettville. The minimum recorded mean annual discharge from the springs is 0.83 m³/sec, and the mean annual maximum is 4.3 m³/sec. Saturation indices calculated from water analyses show the discharge is usually at or slightly above saturation with respect to calcite. The lack of travertine near the springs may indicate that the groundwater is actually undersaturated, and that water sampling at the spring pool allows carbon dioxide to degas and raise calcite saturation indices to higher levels. The quality of the springflow is excellent and is given only precautionary treatment with chlorine. Nitrate levels have been recently increasing, and development on the springs’ drainage basin has prompted concern about their future water quality (Cross, 1989).

- 29.8 0.6 Return to U.S. 90 and turn right (west) into Del Rio.
- 30.0 0.8 Cross San Felipe Creek.
- 30.9 1.7 Follow U.S. 90 as it makes a right turn and heads north. Turning left (south) leads 4 mi. into Ciudad Acuña, Coahuila, México.
- 34.6 5.4 Amistad National Recreational Area headquarters on right (east). The large

Veni, G., W. R. Elliott, R. Ralph, R. Burnett, and S. Souby. 1994. The waltz across Texas: geology tour, archeology/biology tour, and scenic tour. Pp. 99–132, in *The Caves and Karst of Texas* (W. R. Elliott and G. Veni, eds.). National Speleological Society, Huntsville, Alabama. 252 pp.

- 35.2 6.0 Junction with U.S. 277/377. Stay on U.S. 90.
- 36.9 7.7 A fault parallels the highway and upthrows the Del Rio Clay, so it is exposed on the hillside to the right (north).
- 39.0 9.8 First view of Lake Amistad on the right (north).
- 41.1 11.9 Clear view of both the Rio Grande valley to the left (south) and Lake Amistad to the right (north).
- 42.8 13.6 Spur 349 to the Amistad Dam. Stay on U.S. 90.
- 44.2 15.0 Bridge over Devils River arm of Lake Amistad.
- 48.9 19.7 Begin to climb stratigraphically upsection by crossing onto a sequence of Del Rio Clay, Buda Limestone, Boquillas Flags, and Uvalde Gravel. Tilted beds in the roadcut are in a subsidence sinkhole, similar to one seen at upcoming Stop 3.
- 51.1 21.9 Tepee structures occur in roadcuts through the Boquillas Flags over the next 1.1 mi.

RELICT SUBSIDENCE SINKHOLE

STOP 3 Please watch out for traffic; this stop is along a highway roadcut. Steeply tilted beds in this roadcut along U.S. 90 mark the presence of a subsidence sinkhole (see fig. 5 in the “Hydrogeology” chapter of this volume). Large caves formed during the Miocene or Pliocene began to collapse as they enlarged to unstable widths. The subsidence sinkhole noted in the road log immediately prior to this stop has about 90 m of displacement, an amount that suggests water actively flowed through the conduits at the time of collapse, solutionally removing breakdown and allowing further subsidence. Additionally, the presence of heavily solutioned rock within most of the subsidences indicates that the original conduits were located well below the water table, and groundwater rose to solutionally enhance further collapse. The leveled land surface over this and other subsidences demonstrates they are relicts and unrelated to modern processes, and that the subsided blocks were not solutioned by recent point recharge.

Also present within this roadcut are tepee

structures, steeply upturned beds of Boquillas Flags that look like upside-down “Vs” in the roadcuts. Johnston (1983) discusses possible origins for the structures, the most likely being hydration of anhydrites interbedded in the Boquillas. Their regular uplift from specific beds support this hypothesis, as well as all tepees having axial fractures through which vadose water seeped into the unit. The fractures clearly pre-date the tepees since they extend below them into undeformed rock. The precipitation of calcite within the fractures probably resulted from the common ion effect following mixing and hydration of the sulfates. Less dramatic undulations within the Boquillas also may have formed by evaporite hydration.

60.2 8.7 Return along U.S. 90 and turn right (west) on Spur 349.

62.8 11.3 **AMISTAD DAM**

STOP 4 Park at the Visitor Center and walk along the road atop the dam (watch out for traffic) to the international border.

The Amistad Dam was built between 1963 and 1969 to provide flood control, hydroelectric power, and a recreational site for the cities of Del Rio, Texas, and Ciudad Acuña, Coahuila, México. The dam was built cooperatively by the two nations (“Amistad” is Spanish for friendship) and measures 9.7 km long and up to 77.4 m high. The greatest challenge in constructing the dam was its location in a karst area. Many geologists feared it would never hold water, losing it into the solutioned rock.

To ensure that the Amistad Reservoir was hydrologically sealed, an ambitious grout curtain was installed. On the U.S. side of the border, 3,850 grout holes were drilled with a total linear drilled distance of 254.8 km. Of these, 136 boreholes each required over 28 m³ of grout, with a maximum intake of 174 m³. A total of 17,414 m³ of cement and sand grout was used to fill the voids. The boreholes were initially drilled on 3 m centers, with additional holes spaced as close as 0.8 m if the primary holes required more than 1.4 m³ of grout. Diablo Cave, a major cave extending under the dam site, required considerable attention and grout.

Although leakage from Lake Amistad now contributes significantly to the discharge of the San Felipe Springs, the grout program was largely successful, and the lake maintains its level with minimal leakage along the U.S. side of the dam. Some leakage can be observed about 50 m downstream from the dam on the Mexican side of

the Rio Grande, where a spring issues from a cave developed along a fault. Grouting on the Mexican side of the dam was not as intensive or thorough, and several such springs have appeared. The International Boundary Commission monitors springs on both sides of the Rio Grande within a 100-km radius downstream of the dam.

64.0 1.6 Return along Spur 349 and turn left (north) on the road to Laughlin Air Force Base, Amistad Recreational Area.

65.9 3.1 **LUNCH AT LAKE AMISTAD**

STOP 5 Lake Amistad is the major recreational resource in the southwestern Edwards Plateau. Recreational caving has certainly been stymied by the lake which has inundated many caves or raised the water table to submerge many passages. One important site is Goodenough Spring, which was the third largest spring in Texas with a mean discharge of 3.9 m³/s. The spring is currently 44 m underwater but still discharges water into the lake, a flow that can often be seen as a calm upwelling on the lake’s surface. Divers report the spring issues from a cave, but it remains poorly explored due to the water depth. The spring is atypical for the area; its drainage basin probably spans the area between the Pecos and Devils rivers, and its temperature of about 28°C is well above the mean groundwater temperature of the region. During the winter months, the portion of Lake Amistad over Goodenough Spring is a popular fishing area since fish congregate in the warm rising waters.

68.2 2.3 Return to U.S. 90 and turn right (south).
75.8 9.9 Turn left (north) from U.S. 90 onto

U.S. 227/377 and drive up the Del Rio Clay, Buda Limestone, and Eagle Ford Group (Boquillas Flags on west side of Lake Amistad) as you climb a hill that roughly marks the southern edge of the Edwards Plateau.

80.6 14.7 Bridge over San Pedro Creek arm of Lake Amistad. The north side of the bridge exits onto the Del Rio Clay.

82.1 16.2 Uvalde Gravel caps Del Rio Clay and upper Salmon Peak Limestone.

88.0 22.1 Cross onto the Salmon Peak Limestone.

88.7 22.8 Intersection with Recreation Road 2, which heads west 6.8 mi. to the Rough Canyon Marina on Lake Amistad.

| | | | |
|---------------|------|--|--|
| 91.7 | 25.8 | Drive up and down through outcrops of Del Rio Clay, Buda Limestone, and the Eagle Ford Group for the next 5 miles. | 91 m. Curiously, this value is also the maximum displacement recorded from the subsidence sinkholes, and is also the distance from the top of the Edwards Group to the horizon where the large relict conduits were formed. Further research may determine if a synergistic interaction exists between tectonic and solutional grabens in the Carta Valley Fault Zone. |
| 92.4 | 26.5 | A large roadcut through the Eagle Ford Group shows the abrupt change in lithology with the underlying Buda Limestone, also dramatically seen in changes in soils and vegetation on the hillsides north of the roadcut. Soils on the Buda are thin to non-existent, stony, creamy in color, and support little vegetation; soils on the Eagle Ford are thicker, darker, and generally covered with grass and other plants. | Paleokarst features are also present in the roadcut, formed after deposition of the Devils River Limestone and filled by Del Rio Clay. None of the local paleokarst features are believed to be extensive. |
| 96.4 | 30.5 | Border patrol inspection station. Vehicles are often required to stop here and be checked for illegal aliens. | 105.8 4.6 Continue east on U.S. 377 and cross from Val Verde County into Edwards County. |
| 97.5 | 31.6 | Intersection of U.S. 277 and 377. U.S. 277 continues north to Sonora; turn east on 377 to Carta Valley and Rocksprings, and enter the Carta Valley Fault Zone. The Del Rio Clay is exposed on the hill northeast of the intersection, and 377 begins by climbing eastward over the Del Rio and a nodular horizon of the Buda Limestone. Watch for locally increased dips in strata, several faults, and changes in lithology over the next 20 mi. Numerous "caliche pits" occur along 377 where the Del Rio was excavated for use as road base material. | 107.8 6.6 Village of Carta Valley—namesake for the notorious and now-defunct Carta Valley S.U.C.K.S. (Society of Underground Cavers, Karstologists, and Speleologists). Also the namesake of the Carta Valley Fault Zone; one of its greatest displacements occurs about 2.5 mi. south of town where a small exposure of Austin Chalk occurs in a graben surrounded by Devils River Limestone. Some caves in this area will be open during the convention. |
| 101.2 | 35.3 | CARTA VALLEY FAULT ZONE | 111.7 10.5 Intersection with F.M. 2523 which heads south to Del Rio. Continue on U.S. 377 which turns northeast toward Rocksprings. |
| STOP 6 | | This location is roughly along the facies boundary where the Salmon Peak Limestone changes into the Devils River Limestone. It is also along a roadcut, so please watch out for traffic. | 115.5 14.3 Climb onto the drainage divide between the Devils River watershed on the left (west) and the Nueces River on the right (east). The highway follows the divide for about 3 miles. |
| | | The roadcut at this stop has small grabens and faults of the Carta Valley Fault Zone. This wrench fault system, where the predominant direction of bedrock shift is parallel to its E-W trend, is of probable Laramide age. The faults in this roadcut are minor and juxtapose Del Rio Clay and Devils River Limestone. Although the Carta Valley Fault Zone is a major structural feature that contains several caves, its impact on cave development has yet to be examined. Freeman's (1968) and Webster and Bolden's (1983) observation of younger rocks in some fault breccias indicates that during tensional faulting some fractures must have been open to depths of up to | 117.8 16.6 The approximate facies boundary where the upper portion of the Devils River Limestone changes into the Segovia Member of the Edwards Limestone. Note how the Segovia is more thinly bedded, and has thicker and more frequent marl interbeds than the Devils River or Salmon Peak limestones. |
| | | | 133.4 32.2 Gentle folds exposed in the roadcuts are solutional in origin. The Kirschberg Evaporite underlies the Segovia Member, and solutional removal of its gypsum commonly results in the collapse or buckling of overlying units. |

| | | | |
|------------|---|---------------|--|
| 142.0 40.8 | Cross onto the Buda Limestone; the Del Rio Clay is very thin in this area. | | has been obtained over private roads to the Devils Sinkhole. The Texas Parks and Wildlife Department is planning to build a road in the near future, which would be accessible to general visitors and tour buses. |
| 142.7 41.5 | Intersection with Highway 674 which heads south to Brackettville; stay on U.S. 377. | | |
| 145.7 44.5 | Enter the town of Rocksprings (pop. 1,300). U.S. 377 “T’s” into U.S. 55; turn right (east) into town. | | |
| 145.9 44.7 | Historical marker on left (north) where the first school in Rocksprings was built in 1891. | 158.0 56.8 | DEVIL’S SINKHOLE STATE NATURAL AREA |
| 146.1 44.9 | Town plaza, courthouse, and historical markers on left (north). Rocksprings is the county seat of Edwards County, created in 1858 and named after early Texas leader and colonizer Hayden Edwards. The county’s claim to fame is as the “angora goat capital of the world.” The courthouse was built in 1897 of “rusticated limestone.” | STOP 7 | The Devil’s Sinkhole, a 42-m pit, is the largest single cave chamber and the third deepest cave known in Texas. Detailed descriptions of the cave, its biology, and its long and colorful history are in the “Texas Wild Caves” section of this guidebook. Geomorphologically, the cave is simply a large collapsed chamber with most of the room in the Segovia Member of the Edwards Limestone and the lower portions and sumps extending into the Fort Terrett Member. The room initially formed under phreatic conditions by slow-moving groundwater. Collapse resulted as nearby valleys incised and dropped groundwater levels to drain the room. Vadose water solutionally enlarged some fractures and enhanced the collapse process; vadose seepage still trickles down the walls of the main shaft. |
| 146.2 45.0 | “T” intersection. U.S. 55 turns right (south) to Uvalde; turn left (north) on U.S. 41 and head northeast towards Junction. | | Many physical and geophysical attempts have been made to locate large passages or rooms adjacent to the Sinkhole. None have succeeded. Although the cave size is unusual, seemingly isolated chambers of this sort are not unusual in the Edwards Plateau region. Entrances to significant conduits are presumably buried beneath the collapse, but the passages are probably not proportional in size to the main chamber. Mixing corrosion may have contributed to the cave’s size, but more work is needed to determine why many such one-room caves occur on the Edwards Plateau. |
| 146.7 45.5 | Rocksprings city limit. Historical marker on the left (north) describes the origin of the town’s name. The “Rock Spring,” a shallow and now intermittent flow out of the Buda Limestone first attracted travelers to this location. The town dates its origin to 1889 when the first water well was dug. | | |
| 146.8 45.6 | Historical marker on the right (south) marks the Rocksprings Cemetery, which not only provides eternal rest for local residents but also has the remains of travelers from more rugged days gone by. More than 1,000 graves were dug after the April 1927 tornado that devastated the town. | 173.3 15.3 | Return to Rocksprings on U.S. 377 and continue west to the intersection with Highway 674. Turn left (south) onto 674. |
| 146.9 45.7 | U.S. 377/41 follows the drainage divide between Hackberry Creek, which drains south into the Nueces River, and northward drainage to the South Fork of the Llano River which flows to the east. The road crosses on and off the Buda and Segovia; the Del Rio is thin in this location. | 175.3 17.3 | Descend off the Buda Limestone onto the Segovia Member of the Edwards Limestone. |
| 154.0 52.8 | Intersection where U.S. 377 and U.S. 41 divide. The road log to the next stop is not given because one-time access | 186.7 28.7 | Intersection with the base of the West Nueces River valley. The road turns south and stays near the valley floor for the next 12 mi. This location also marks the approximate facies boundary between the Segovia Member of the Edwards Limestone and the |

- 189.9 31.9 Devils River Limestone. Cross the West Nueces River. In this section the river only flows seasonally. Flash floods are common due to the minimal soils and vegetation on the hillsides. Thick but cobbly alluvium occurs in the floodplain.
- 193.5 35.5 Cross Two Mile Draw. If you look behind you and to the left (east) you'll see a cliff undercut by the stream causing a slump in limestone beds.
- 196.8 38.8 Overlook of the West Nueces River. The river often flows in this location because of perching on the upper member of the Glen Rose Formation. The Glen Rose is not well exposed here, but in valleys farther east it is characterized by stair-step topography from its limestone interbedded with clay and marl.
- 197.3 39.3 Historical marker on left (east) commemorates the Thurman Ranch, which in 1882 became the first settlement in the valley. A small community developed by 1895, and founder Joe Thurman served as doctor, dentist, and coffin maker. The ranch bred race horses.
- 200.1 42.1 The best overlook of the West Nueces Valley. The river is usually dry here because the Glen Rose, and consequently the water table, are below the bed of the stream.
- 200.9 42.9 Cross Four Mile Draw.
- 201.9 43.9 The highway turns away from the river but stays within the West Nueces watershed for the next 12 miles.
- 203.5 45.5 Cross Government Draw.
- 206.7 48.7 Entrance to Kickapoo Caverns State Natural Area on the right (west). The main entrance may change in the near future to gate about 2 mi. further south on Highway 674. Access to Kickapoo Cavern is via a one-time use route and is not described in this road log.

207.5 49.5 **KICKAPOO CAVERN**

STOP 8 Everyone must wear a helmet and carry at least one helmet-mounted lamp or a large flashlight (pen lights or mini-mag lights are not adequate). The

cave is approximately situated along the facies boundary between the Devils River Limestone to the north and the Salmon Peak Limestone to the south.

Kickapoo Cavern (see "Caves of Kickapoo Caverns State Natural Area" for a full report) formed by slow-moving phreatic groundwater that entered the Devils River Limestone through the Buda Limestone and the Eagle Ford Group. The water may have originated as far as 60 km to the north where the Del Rio Clay is absent or thin enough to permit recharge to underlying units. Collapse of the original solutional conduit occurred when streams incised the Edwards Plateau and drained water from the cave. A 3 m deep sink in the floor just inside the first side passage exposes a small section of solutionally-formed wall. Holes in the flowstone-covered floor along the southern and southwestern portion of the main passage were formed by condensation-corrosion, and possibly reflect air circulation from uncollapsed passage segments, the entrances of which are buried under the breakdown. The lack of modern airflow and the antiquity of the surrounding large, inactive speleothems (dated as older than 350,000 years) suggest that the holes formed during some paleo-air-circulation regime. Helictites near the end of the main passage and dripstone speleothems in the first side passage have not been dated but are clearly of recent origin. About 60 m from the entrance, a 16 m wide horst (an upthrown fault block) with 20 cm of displacement perpendicularly crosses the passage with no apparent effect on cave development. The entrance was formed when valley erosion intersected the cave.

209.5 2.0 **GREEN CAVE BAT FLIGHT**

STOP 9 Green Cave formed the same as Kickapoo Cavern. The only intact portion of phreatic passage is at the base of the entrance ramp. Downcutting surface valleys have twice intersected the cave, once to form its entrance and once at its opposite end, blocking exploration. Although some of the cave's smaller speleothems are relatively recent, dating of the most recent deposits on the large speleothems indicates they are about 256,000 years old, and most are older than 350,000 years. Some of the nicer stylolites (pressure-resolution features in the bedrock) seen in Texas caves occur near the back of Green; they are apparently unrelated to the cave's development. For a complete report on the cave, see "Caves of Kickapoo Caverns State Natural Area." The colony of Mexican free-tailed bat, *Tadarida brasiliensis mexicana*, that occurs here is up to 500,000, and one can get right below the flight

and see the bats up close. Please do not touch the bats unless you are a designated helper who has had rabies vaccine. See the Archeology/Biology road log, “Green Cave Bat Flight,” for more details.

- 210.7 1.2 Return to the entrance of Kickapoo State Natural Area and head south on Highway 674. 228.1 18.6
- 211.7 1.7 Entrance to the Piñon Ranch on the left (east). Mexican piñon pine trees, *Pinus cembroides*, are relicts of the cooler Pleistocene climate that existed up to about 10,000 years ago. Several piñons occur in the valleys of Kickapoo State Natural Area. They have long needles, edible nuts, and often look like large Christmas trees. 231.3 21.8
232.4 22.9
- 216.3 6.8 The farm that is on both sides of the road is rare because the Edwards Plateau soils are usually too thin for agriculture. Most Plateau farms are set in stream floodplains. This farm is set along a minor stream, but soil development is further prompted by a local outcrop of Del Rio Clay.
- 216.6 7.1 Cross a fault marking the west end of the Balcones Fault Zone. The fault is not evident from the highway except by the change from alluvium to limestone outcrops.
- 219.2 9.7 Begin the descent down the Balcones Escarpment. The view is the reverse of and looking back toward Stop 1. The large hills up ahead are Las Moras Mountain to the left (southeast) with the radio tower, and Pinto Mountain to the right (southwest). These hills are Tertiary basalts that intruded through Cretaceous units via Balcones faults. The basalts are more resistant to erosion and stand as hills high above the surrounding plain of softer sedimentary rocks.
- 221.8 12.3 Cross off the Salmon Peak Limestone onto flat alluvial plains.
- 223.3 13.8 Pinto Mountain is on the right (west).
- 225.7 16.2 On the left (east) side of the road is the entrance to Alamo Village, which has movie-set replicas of the Alamo and old San Antonio. *The Alamo*, *Lonesome Dove*, and many other western movies,

TV shows, and commercials have been filmed here. The hillside just south of the entrance is a fault scarp exposing the Del Rio Clay and capped by the Buda Limestone. The highway continues south and onto these units. Cross two faults and from the Buda Limestone onto the Eagle Ford Group. The location of the faults can be approximated by the change to the thicker, darker, and more vegetated soils on the Eagle Ford. To the left (east) is Las Moras Mountain; the low, broad hill immediately to its north is also a basalt intrusion.

Enter the town of Brackettville.

Intersection of Highway 674 with U.S. 90 at Fort Clark Springs. End of road log.

Archeology/Biology Tour Road Log

by William R. Elliott and Ron Ralph

| Total miles | Miles since last stop | Description |
|-------------|-----------------------|---|
| 0.0 | 0.0 | Exit Fort Clark Springs, turning left (west) onto U.S. Highway 90. We will go west to Langtry for our first stop, then travel east again for several stops on the way back to Brackettville. After a break at Fort Clark Springs, the bus will head up to Kickapoo Caverns State Natural Area for the evening bat flight at Green Cave. |

At Brackettville we are in a transition zone between the “South Texas Brush Country” (part of the Tamaulipan Biotic Province), and the Edwards Plateau. As we drive west we will cross the Devils River, then the Pecos River onto the Stockton Plateau, an extension of the Edwards Plateau. The mean annual rainfall declines from about 51 cm (20 in.) at Brackettville to 38 cm (15 in.) at Langtry, where we enter another transition zone, which some might call the easternmost fringes of the Chihuahuan Desert. Please refer to the beginning of the Geology Tour Road Log for comments on the local geology and hydrology, and to the Scenic Tour Road Log for comments on local history.

| | | |
|-----|-----|--|
| 0.6 | 0.6 | Intersection of RM 3348. Three miles southwest of here is the Seminole Indian Scouts Cemetery. A Texas Historical Marker discusses the importance of the Scouts and the story of their bravery and courage. See Scenic Tour, “Black Seminole Indian Scouts.” |
|-----|-----|--|

FLORA The vegetation of the brush country is dominated by mesquite while the Edwards Plateau is dominated by an association of live oak, Ashe juniper, Texas oak, mescal bean, and Texas persimmon. On some plateau hillsides one may find an occasional Mexican piñon pine, *Pinus cembroides*, which has long needles

and edible nuts, and often looks like a large Christmas tree. The piñon probably is a relict of the Pleistocene, when the climate here was cooler and wetter. In dry creek bottoms one may find soapberry and netleaf hackberry. Hackberry, which requires more moisture than most other trees here, rarely may be found on uplands growing out of sinkholes and cave entrances. Its yellowish-green leaves can be a good tell-tale for ridge-walking cavers. Shin oak, which is shrubby, occurs at Kickapoo Caverns State Natural Area and is good habitat for the endangered black capped vireo.

In the Lower Pecos River area typical flora includes several species of prickly pear, tasajillo, ocatillo, other cacti, ceniza (“Texas sage”), blackbrush and other acacias, mesquite, Spanish dagger, Texas sotol, and lechuguilla. The most common prickly pear is *Opuntia lindheimeri*, which may have yellow, orange, or red flowers. *Echinocereus*, the strawberry cactus, is humpy-looking with crimson or magenta blooms. We may not see these flowers since the desert plants only bloom after a rain. Watch out for lechuguilla, a low, spiny *Agave*—the barbed spines easily penetrate shoes and break off in your flesh.

FAUNA Typical birds in these areas include roadrunner, turkey vulture, black vulture, occasional golden or bald eagle, raven, scaled quail, mourning and white-winged dove, hawks, heron, and sandpiper. Common mammals are coyote, bobcat, white-tailed deer, armadillo, javelina (collared peccary), porcupine, raccoon, and ringtail. The latter four species frequent caves. Caves are especially important habitat for coons, who love to eat Texas persimmons and many other foods, then deposit their feces in caves. Coon feces grows sprouts, fungi, and bacteria, and provides a rich nutrient source for springtails, which undergo rapid population blooms. The springtails are then preyed upon by many different arthropods. Rock squirrels are common on the Plateau—one has been seen hiding nuts in Kickapoo Cavern. Cave bats in the area include Mexican free-tailed bat, cave myotis, and the old man bat. Western diamondback rattlesnakes sometimes den in cave

entrances but not in deep cave interiors. Other venomous snakes in the area are the banded rock and black-tailed rattlesnakes; and the broadbanded and trans-Pecos copperheads. The more unusual invertebrates include tarantulas, vinegaroons (“whip-scorpions”, a tropical arachnid that sprays a mixture of acetic and caprylic acid from glands at the base of the whip-tail), amblypygids (“scorpion spiders” or “whipless whip-scorpions”, another tropical arachnid, which is nontoxic and sometimes is found in caves), and brown to black cave scorpions (*Vaejovis reddelli*). See Reddell’s chapter on “The Cave Fauna of Texas” in this volume for further information and photos.

4.6 4.6 Crossing from the Austin Chalk outcrop onto the Tertiary Uvalde Gravel, a coarse, caliche-cemented outwash from the Edwards Plateau. Given the roughly level terrain the change is best noted by changes from the thin, stony, light-yellow soil on the Austin to the thicker, light brown, and more vegetated soil on the Uvalde.

7.4 7.4 “Delores” historical marker on right (north) side of highway describes the abandoned town of Delores located about 13 km to the south on the banks of Las Moras Creek. See Scenic Tour, “Delores.”

18.6 18.6 “Site of Chihuahua Road” historical marker on right (north) side of highway. See Scenic Tour, “Chihuahua Road”

24.2 24.2 Main gate to Laughlin Air Force Base on left (south) and commemorative historical marker—see Scenic Tour, “Laughlin Air Force Base.”

24.7 24.7 Del Rio City limits approximately mark where you cross on to the Salmon Peak Limestone. The limestone is poorly exposed due to alluvial cover. See Scenic Tour, “City of Del Rio.”

28.0 28.0 Intersection of U.S. Highway 90 and 277 at the stop light. Go right on Bedell Street to bypass the city (stay on 90 and continue straight to the next light if you want to see the strip. You can pick up the road log again in 4 mi. when you pass the headquarters for the Amistad National Recreational Area).

30.1 30.1 Intersect Highway 90 again after passing the Del Rio Recycling Center

31.9 31.9

35.5 35.5

48.0 48.0

83.6 83.6

84.1 84.1

85.9 85.9

STOP 1

This first stop on the tour gives you a view of Mexico to the south and some of the large rockshelters that flank both sides of the Rio Grande, which is called the “Río Bravo” in Mexico. Many of these shelters are covered by the waters of Lake Amistad, the headwaters of which are below you. Tamarisk or salt cedar forms an impenetrable barrier on the vega or flood plain between the colluvial limestone slopes and the lake. Return to Bud and Pansy’s restaurant for refreshments or visit the Judge Roy Bean Center for shade and a cool drink of water.

86.9 1.0

BONFIRE SHELTER

STOP 2

Eagle Nest Canyon. Look upstream to “The World’s Deepest Pothole,” a cave spring that seldom flows. Cave divers found it filled with rubble at a depth of 5 m. Downstream and hidden behind a large breakdown slab, Bonfire Shelter represents the largest and southernmost “bison jump” or “bison kill” known in the New World. Various short-term occupations by prehistoric people over the last 11,000 years were punctuated by two major bison killing events; one at 8,000 years and the other at 2,000 years ago. Both used the same method. First, bison were caught on the high mesa above the shelter to the east and slowly herded

and taking a 90 degree left at the dirt wall. Go right (north) and find yourself on the edge of town.

Pass the Amistad National Recreational Area headquarters on the right.

This is your first view of Amistad Reservoir on your right. Note the sage, blackbrush and increasingly drier countryside.

Geologic note—subsidence sinkhole and teepee structures in Boquillas Flats in roadcuts. See Geologic Tour, Stop 3, “Relict Subsidence Sinkhole,” for a description.

Turn left on Loop 25 to Langtry. Judge Roy Bean’s “Jersey Lilly” (see Scenic Tour, Stop 1). Turn left on the dirt road and drive south past the post office on your left and the hamburger joint (“Bud and Pansy’s”) on your right. Continue on following the best road down to the Rio Grande.

RIO GRANDE ROCKSHELTERS

south and then west along the flat-topped mountain edge. Next, as the bison swung north, they were constricted by rock mounds or fires on the east and stampeded until too late—a narrow cleft appeared in their path. A few jumped, a few swerved to the right, but many fell to their deaths piling up in a talus cone of fresh meat. The Indians processed the animals as their ancestors had in the past, leaving large portions behind buried under other animals. Secondary processing occurred as choice muscle bundles were separated from long bones and ribs. The evidence of this kill remained hidden until a curious archaeologist poked around the corner of the rockshelter to behold the time-encapsulated event. Several excavations have been done at this site.

93.1 6.2 Road cut shows Boquillas Flagstone overlying Devils River Limestone.

97.5 10.6 **THE SILVER SPIKE**

STOP 3 See Scenic Tour, Stop 2, “The Silver Spike.”

101.5 4.0 Middle of the Pecos River high bridge over the Pecos River.

101.6 4.1 Look closely—the road cuts through an ancient sediment-filled cave. In the south roadcut the cave is 1.3 m high, and in the north roadcut it is nearly 3 m high.

101.8 4.3 **PECOS RIVER OVERLOOK**

STOP 4 Pecos River overlook on right. Great view of the Pecos River High Bridge, the mouth of the Pecos at its confluence with the Rio Grande and Mexico to the south—see Scenic Tour, Stop 3, “Pecos River Overlook.” The Stockton Plateau lies west of the Pecos, and is geologically equivalent to the Edwards Plateau. Edwards-equivalent limestones also are found in adjacent Mexico, but contain a slightly different fauna, such as a new *Prietella* blind catfish from Sótano de Amezcua, about 60 km south of here. Caves on the Texas side contain a fauna that is in between the typical Central Texas and northern Mexico cave faunas. Tropical components in Texas caves in this area include amblypygids (“scorpion spiders”), *Speocirolana hardeni* isopod, old man bat, and others (see Reddell’s chapter on “The Cave Fauna of Texas” in this volume).

103.2 1.4

SEMINOLE CANYON STATE PARK

STOP 5 Seminole Canyon State Park entrance on the right. **Lunch will be here.** Take the guided tour to Fate Bell Rockshelter, which was inhabited for a span of 9,000 years and contains 3,000 year-old Indian pictographs.

Early man first visited this area 12,000 years ago, a time when now-extinct species of elephant, camel, bison and horse roamed the landscape. The climate at that time was more moderate than nowadays and supported a lush vegetation that included pine, juniper and oak woodlands in the canyons with luxuriant grasslands on the uplands. These early people developed a hunting culture based upon large mammals such as the mammoth and bison. No known evidence exists that these first inhabitants produced any rock paintings.

By 7,000 years ago, the region had undergone a climatic change that produced a landscape much like today’s. A new culture appeared in this changed environment. These people were gatherers rather than hunters, and lived in small groups since the land would not support larger units. Sotol, yucca, and other arid-adapted plants, together with small animals such as lizards, snakes, mice, fresh-water mussels and fish, provided them with food.

Despite the struggle for survival, some of these prehistoric people found the creative energy to paint the pictographs found in Fate Bell and other rock shelters of the Lower Pecos River Country. The distribution of this distinct style is limited to the Rio Grande, Pecos and Devils River area. More than 200 pictograph sites are known to contain examples of this style of rock art ranging from single paintings to caves containing panels of art, some more than 100 m long. Although numerous figures or motifs are repeated in different locations, the exact meaning of the paintings is unknown.

Fate-Bell was excavated by A. T. Jackson in 1932 (his 1933 map is shown on the left). See a photo of his excavation in “Lower Pecos Prehistory” and comments on his conservation role in “Conservation of Texas Caves and Karst” in this volume). Additional work was done in the early 1960s by Mark Parsons as part of the pre-inundation studies for Lake Amistad. This is one of the best preserved and interpreted archeological sites in the area.

The hiking trail to the Panther Cave overlook is great, but we probably will not have time today. On the uplands east of Seminole Canyon is Seminole Sink, a cave that was used for shaft burials by Archaic-age people about

7,000 years ago The cave was the object of a multidisciplinary study by archeologists, biologists, geologists, and paleontologists in 1984. At that time Elliott found a rare protoschizomid, a tropical arachnid similar to a whip-scorpion, the first such species found in a Texas cave. A dart point and remains of 21 different people were found in the cave.

130.3 27.1 AMISTAD DAM

STOP 6 Spur 349 on the right takes you 2 mi. to the dam. A total of 17,414 m³ of cement and sand grout was used to fill the underlying and adjacent voids to prevent leakage through the karst. See Geology Tour, Stop 4, “Amistad Dam.”

137.6 7.3 FOUR-MILE CAVE

STOP 7 Intersection of U.S. 90 with 277/377, which goes north to Devils River State Natural Area, Carta Valley, and interesting cave country. See Geology Tour stops 6-9, which take this route back to Bracketville. Four-Mile Cave is a maze that is not completely explored or mapped. It contains cave myotis bats *Myotis velifer incautus*, a rich invertebrate fauna, and *Eurycea* cave salamanders in hard-to-find lower level pools. We may only have time for a quick look-see. See the Val Verde County section in the “Texas Wild Caves” chapter for a complete description and map of the cave.

142.4 4.8 SAN FELIPE SPRINGS

STOP 8 Turn into golf course to the left. The springs are located at the end of the narrow road 0.4 mi. from Highway 90. The average flow is 3.84 m³/sec (60,865 gal./min). Spring flow has declined recently due to pumping of groundwater—see Geology Tour, stop 2. Air Force divers explored the two spring conduits in the 1960s and may have seen fish or salamanders. Divers have reported that the force of the water blows them out of the spring entrance. An attempt will be made soon by the Texas Memorial Museum to see if blind species live here. The known aquatic fauna at the springs is a mixture of temperate and Neotropical species. Two new species of caddis flies were recently found, which have burrowing larvae in the bottom sediments. A large river prawn, *Macrobrachium carcinus*, of lobster size, was common here but has declined. Common species of insects abound here too. The Texas Historical Marker just past the cut-off on the right side of Highway 90 describes the acequia or waterway constructed by the

people of Del Rio in the early 1800s to irrigate farmland (see Scenic Tour, “Canal System of Del Rio).”

170.0 27.6 Return to Fort Clark for rest and regrouping. The bus will leave again in time for the bat flight at Green Cave.

170.0 0.0 Leave Fort Clark for Kickapoo Caverns State Natural Area and Green Cave.

175.0 5.0 On the right (east) side of the road is the entrance to Alamo Village, which has movie-set replicas of the Alamo and old San Antonio. *The Alamo*, *Lonesome Dove*, and many other western movies, TV shows, and commercials have been filmed here.

193.5 24.1 GREEN CAVE BAT FLIGHT

STOP 9 The bus will drop us near the entrance of Green Cave. Its colony of Mexican free-tailed bats, *Tadarida brasiliensis mexicana*, is about 500,000, and but one can get right below the flight and see the bats up close. Please do not touch the bats unless you are a designated helper who has had rabies vaccine. Domestic honey bees sometimes build a hive in a crevice inside the entrance. A colony of cave swallows, *Hirundo fulva pallida*, live in the entrance room and may be seen after the bat flight is over. Sometimes a western coachwhip snake, *Masticophis flagellum testaceus*, lurks in the crevices above the entrance and will take bats that have landed there. These snakes are 1.2 to 1.7 m long. Although they are nonpoisonous they bite like hell, so leave them alone. When crowds are not present owls frequent the entrance during the flight and prey on bats. You may see hawks overhead catching bats on the wing. It's dinnertime! For a complete report on the cave, see “Caves of Kickapoo Caverns State Park” in this volume.

217.6 24.1 Return to Bracketville and Fort Clark Springs. End of road log.

Scenic Tour Road Log

by Robert Burnett and Susan Souby

| Total miles | Miles since last stop | Description |
|-------------|-----------------------|---|
| 0.0 | 0.0 | Fort Clark Springs entrance, Brackettville. Head west on U.S. Highway 90. The trip will begin by first driving to Langtry, our farthest stop, then making the remaining stops as we return to Fort Clark. |
| 0.6 | 0.6 | Intersection of RM 3348. Three miles southwest of here is the Seminole Indian Scouts Cemetery. A Texas Historical Marker discusses the importance of the Scouts and the story of their bravery and courage. |

BLACK SEMINOLE INDIAN SCOUTS

The story of the Black Seminoles begins in the early 1800s in Florida where many African descendants living outside the Seminole Indian settlements adopted the Indian way of life. The Black Seminoles were former slaves from big plantations in the South who had escaped or been bought or captured by the Seminole Indians. They fought along with the Seminole Indians when the U.S. Army tried to break up their villages and open the area to more whites. Their courage and bravery in battle, though greatly outnumbered, made the second Seminole Indian War (1835-1842) the most costly Indian war in U.S. history. After their inevitable defeat and betrayal by the Army about reservation living, the Seminoles decided to escape to Mexico. In exchange for protection against “wild Indians” the Mexican authorities provided the Seminoles land and tools. Until the end of the Civil War, the Black Seminoles remained in Mexico fighting both the Indians and slave traders. In 1870, a band of Black Seminoles returned to the U.S., hired by the Army as scouts to fight the Indians along the border. They fought eight years of campaigns against the Apaches and Comanches, some of the best fighters in North America. The Black Seminoles fought in 25 actions without a man killed or seriously wounded, and four received the Congressional Medal of Honor.

When the Army disbanded the Indian scouts in 1914, the Black Seminoles were displaced once again. When told they could no longer live in the Indian camp on Las Moras Creek, they moved across the creek to Brackettville.

Descendants of the Black Seminoles still gather twice

a year to honor their heritage, on Seminole day in the fall and on June 19th (“Juneteenth”). However, the Juneteenth celebration is only in sympathy for the emancipation of other Texas slaves—the Black Seminoles won their freedom long before.

4.6 4.0 Crossing from the Austin Chalk outcrop onto the Tertiary Uvalde Gravel, a coarse, caliche-cemented outwash from the Edwards Plateau. Given the roughly level terrain the change is best noted by changes from the thin, stony, light-yellow soil on the Austin to the thicker, light brown, and more vegetated soil on the Uvalde.

7.4 2.8 “Delores” historical marker on right (north) side of highway describes the abandoned town of Delores located about 13 km to the south on the banks of Las Moras Creek.

DELORES

Delores was founded in 1834 by John Beales, the greatest “land king” in Texas, who owned about 30 million hectares (75 million acres) in Texas and New Mexico. The community known as Beales Rio Grande Colony was named Delores after his wife and occupied by 59 settlers. Drought and Indian raids hurt the town, which was destroyed within two years when its people fled the Mexican Army during the Texas Revolution only to be killed by Comanches.

12.1 4.7 Intersection of RM 3008 which heads north to Rocksprings

18.2 6.1 Bridge over Sycamore Creek and crossing from Kinney County into Val Verde County.

18.6 0.4 “Site of Chihuahua Road” historical marker on right (north) side of highway.

CHIHUAHUA ROAD

In the 19th century, the Chihuahua Road was a life line that connected Chihuahua, Mexico, with the Texas port of Indianola via San Antonio. Opened to exploit rich trade in Mexican silver and gold, the road eventually carried all types of goods (including in 1860, 27 camels,

adventurers, settlers, soldiers, and “forty-niners” bound for the California Gold Rush). All sorts of vehicles used the road: stagecoaches, wagons, ox-carts, and traveling ambulances, which were light carriages with 1.3-m wheels. Not until the railroad came to San Antonio in 1877 did this road lose its commercial importance.

24.2 5.6 Main gate to Laughlin Air Force Base on left (south) and commemorative historical marker.

LAUGHLIN AIR FORCE BASE MILITARY AVIATION IN VAL VERDE COUNTY

In 1911, eight years after the Wright Brother’s historic flight at Kitty Hawk, North Carolina, Galbraith Perry Rodgers landed his plane at Del Rio while on the First Transcontinental flight across the United States. The arrival of a plane in Del Rio was a major event then, but it became a common sight in later years. During World War I, the town was a center of aerial patrols along the United States/Mexico border. In 1919 planes were dispatched to the area in reaction to Pancho Villa’s border raids. One pilot stationed here to fly border patrols was Lt. James H. Doolittle, who later gained international fame in World War II.

In the 1940s Del Rio was chosen as the site of an air base because of the flat terrain and the mild climate. Opened as the first B-16 bombardier school, Laughlin Air Force Base was named in honor of Lt. Jack T. Laughlin, the first pilot from Del Rio killed in action in World War II. Later a pilot training school, it closed after the war. In 1952, through the efforts of local residents, it was reopened. Laughlin has been utilized for astronaut training, strategic air command U-2 reconnaissance missions, the development of air training command’s undergraduate pilot training mission, and other important innovations.

24.7 0.5 Del Rio City limits approximately mark where you cross on to the Salmon Peak Limestone. The limestone is poorly exposed due to alluvial cover.

CITY OF DEL RIO

The city was originally named San Felipe del Río after a Spanish mission founded here in 1635. Indians soon destroyed the mission but the name stuck until settlement resumed in 1868 around the San Felipe Springs. The name was shortened to Del Rio in 1883. The town’s location and prosperity was determined by good agricultural land south of the modern highway, abundant water from the springs and the Rio Grande, the major thoroughfares of the Rio and the Southern

Pacific Railroad, and its proximity for trade with Mexico. The Val Verde County seat was set in Del Rio in 1887, and the city’s current population is about 35,000.

29.0 4.3 San Felipe Springs about 300 m (¼ mi.) to the right (north).

SAN FELIPE SPRINGS

A group of 10 or more springs with seven large pools, San Felipe Springs is the fourth largest spring in Texas. From 1542 onward, the springs were an oasis for explorers, soldiers, and freighters. In 1675 priests named the seven pools for the King of Spain. In the 18th century Comanches camped here on their war trail into Mexico. In 1808 a mission was established 3 mi. downstream, on San Felipe Creek, and in 1834 the first settlement of San Felipe del Rio began. By 1856-57, these springs were the crossroads of the 1,470 mile San Antonio-to-San Diego mail route and the Chihuahua Road used by wagons hauling silver and gold from Mexico to Indianola, the chief port on the Texas coast. After settlers came in 1864, the “Mother Ditch” and other irrigation canals were dug for irrigating vineyards, orchards, and gardens, and soon Del Rio was founded. Water was hauled to town and sold by barrel or jug until 1900 when a water system was installed. In 1882, two gristmills used the water for power and in 1901 the spring water powered an electric light and ice plant. San Felipe Springs are still the sole water supply for the city of Del Rio and Laughlin Air Force Base. They furnish water for swimming pools, a small lake, and for the winery. Amistad Reservoir increased the flow of the springs since 1968 by providing additional recharge to San Felipe Springs. However, flows have decreased recently due to pumping of groundwater.

29.3 0.3 “Canal System of Del Rio” historical marker. Cross San Felipe Creek.
“U.S. Camel Corps drank here 1857 Camp Del Rio” handwritten sign.

CAMELS IN TEXAS

The Texas frontier was the scene of an unusual experiment in desert transportation in the late 1850s. Twenty years earlier a major in the Army, then stationed in Florida, proposed the idea of using camels for transportation in the Indian campaigns in the West. In 1855 Congress passed a bill authorizing \$30,000 for the importation of camels. A year later the first shipload of 32 camels arrived at the Texas port of Indianola from North Africa. Another shipment of 44 arrived the next year.

The Camel Corps was stationed at Camp Verde, near Kerrville, northwest of San Antonio. The experiment

was generally successful. The camels could travel farther on less food and water than a horse or mule and could carry more. The Camel Corps surveyed a wagon road from New Mexico to California in 1857 and traveled twice to Big Bend, once in the summer of 1859 to survey supply routes in the Trans-Pecos and again in the summer of 1860 to locate a new post on the Rio Grande and to survey a road between there and Fort Davis. However, they were never used on a large scale. The Civil War interrupted the surveys, and afterward the railroad became the dominant mode of transportation.

- 29.5 0.2 Intersection of U.S. 90 & 277 (Bedell St.). Turn right on Bedell St.
- 31.7 2.2 Intersection U.S. 290 Turn Right (north) on U.S. 90.
- 33.5 1.8 Amistad National Recreational Headquarters on the right (east). The large fenced parking lot to its north is filled with vehicles impounded for carrying illegal aliens or drugs into the U.S.
- 34.0 0.5 Bear left on U.S. 90. Highway 277/377 goes north to Devils River State Natural Area, Carta Valley, and interesting cave country. See Stops 6 and 7 of the Geology Trip for more information.
- 36.9 2.9 First view of Lake Amistad on right (north). Note the sage, black brush and increasingly dryer countryside as you leave the Tamaulipan Biotic Province and enter the Chihuahuan Desert.
- 39.7 2.8 Blackbrush Point Road to the right (north).
- 41.3 1.6 Diablo East Road to the right (north).
- 41.7 0.4 Junction Spur 349 to Amistad Dam of Lake Amistad.
- 43.2 1.5 Bridge over the Devils River arm of Lake Amistad.
- 47.0 4.8 Evans Creek bridge.
- 51.1 4.1 Tepee structures occur in roadcuts through the Boquillas Flags over the next 1.1 mi. (see Geology Trip, Stop 3, for an explanation).
- 52.2 1.1 Spur 406 on the left (south) to Castle Canyon.
- 61.1 4.5 Blinking yellow light in Comstock; intersection with RM 163 north to Juno & Ozona.
- 62.3 1.2 Pandale Crossing; intersection RM 1024.
- 64.7 2.4 Railroad crossing-main Southern Pacific

- 65.2 0.5 line.
Road cuts of Boquillas Flags over Buda Limestone for the next 16 mi.
- 66.3 1.1 View of the Serranía del Burro in Mexico, which contains caves.
- 69.2 2.9 Seminole Canyon Bridge crossing.
- 69.8 0.6 Old railroad cut on right.
- 70.2 0.4 **Seminole Canyon State Park.**

We will not stop here but you are encouraged to visit here at another time. Early man first visited this area 12,000 years ago, a time when now-extinct species of elephant, camel, bison and horse roamed the landscape. The climate at that time was more moderate than nowadays and supported a lush vegetation that included pine, juniper and oak woodlands in the canyons with luxuriant grasslands on the uplands. These early people developed a hunting culture based upon large mammals such as the mammoth and bison. No known evidence exists that these first inhabitants produced any rock paintings.

By 7,000 years ago, the region had undergone a climatic change that produced a landscape much like today's. A new culture appeared in this changed environment. These people were gatherers rather than hunters, and lived in small groups since the land would not support larger units. Sotol, yucca, and other arid-adapted plants, together with small animals such as lizards, snakes, mice, fresh-water mussels and fish, provided them with food.

Despite the struggle for survival, some of these prehistoric people found the creative energy to paint the pictographs found in Fate Bell and other rock shelters of the Lower Pecos River Country. The distribution of this distinct style is limited to a district that includes a portion of the Rio Grande, Pecos and Devils River. More than 200 pictograph sites are known to contain examples of this style of rock art ranging from single paintings to caves containing panels of art, some more than 100 m long. Although numerous figures or motifs are repeated in different locations, the exact meaning of the paintings is buried with the people who painted them.

The canyon probably is named for the Black Seminole Army scouts stationed at Fort Clark during the 1870s. In the canyon is Fate Bell Shelter, which contains some of North America's oldest pictographs believed to have been painted as long as 4,000 years ago. The shelter can be visited on a park tour. Not open to the public is Seminole Sink, a shaft-burial cave used numerous times over 7,000 years.

- 71.8 1.6 Pecos National Recreation Area and Pecos River overlook to the left.

- 72.0 0.2 Look closely. The road cuts through an ancient sediment-filled cave. In the south roadcut the cave is about 1.3 m high, and in the north roadcut it is nearly 3 m high.
- 72.3 0.5 Bridge over Pecos River.
- 75.0 2.7 View of Pecos Railroad Bridge to right (northeast); also a water tower.
- 76.2 1.2 View of old railroad cuts to the left.
- 76.8 0.6 Silver Spike roadside rest stop. View of the Rio Grande cliff down canyon
- 77.6 0.8 Junction of old and new railroad.
- 87.4 9.8 View of Langtry and Rio Grande to the left.
- 87.9 0.5 Bridge over Eagle Nest Canyon.
- 9.0 1.1 **JUDGE ROY BEAN'S "JERSEY LILLY"**

STOP 1 Roy Bean was born in Kentucky, was a trader in Mexico in 1848, and was mining in New Mexico when the Civil War broke out. As a spy and scout, he joined the Texans in the command of General John R. Baylor during the 1861-1862 Arizona-New Mexico campaign. He organized an irregular company called the "Free Rovers". In a narrow canyon, he took part in the capture of 800 Federals by 250 Confederates. After 1862 he was a Confederate freighter, hauling cotton to Matamoros from San Antonio and bringing into Texas wartime goods: guns, ammunition, medicines, cloth, shoes, and food.

In 1882 he began following, with a tent saloon, the crews building the railroad along the Rio Grande. Cooperating with the Texas Rangers, he was appointed Justice of the Peace. He tamed the rough frontier town of Langtry, where he spent the rest of his life. He won fame in unique court decisions, as in the trial and fining of a dead man for carrying a concealed weapon. Judge Roy Bean lived a life in which fiction became so intermingled with fact that he became a legend within his own lifetime. The basis for his reknown were the decisions that he reached in the Jersey Lilly saloon as the "Law West of the Pecos." Court was held frequently on the porch. Spectators grouped about on horseback and in the building. Bean was not above breaking off proceedings long enough to serve customers in his courtroom-bar-home.

The Judge's law library consisted of a single volume—an 1879 copy of the Revised Statutes of Texas. He seldom consulted it, however, calling instead on his own ideas about the brand of justice that should apply. This he effectively dispensed together with liberal quantities of bluff and bluster. Since Langtry had no jail, all offenses were deemed finable with Bean pocketing the fines.

Veni, G., W. R. Elliott, R. Ralph, R. Burnett, and S. Souby. 1994. The waltz across Texas: geology tour, archeology/biology tour, and scenic tour. Pp. 99–132, in *The Caves and Karst of Texas* (W. R. Elliott and G. Veni, eds.). National Speleological Society, Huntsville, Alabama. 252 pp.

Drunken prisoners often were chained to mesquite trees in front of the building until they sobered up enough to stand trial.

Bean reached a peak of notoriety when on February 21, 1896, he staged the banned Fitzsimmons-Maher heavyweight boxing title fight on a sand bar in the Rio Grande, a stone's throw from his front porch. By holding it on Mexican territory he outwitted Texas Rangers sent to stop the match—and turned a handsome profit for his shrewdness.

His building was named the "Jersey Lilly" [*sic*] for the famous English actress Lillie Langtry, whom Bean admired and for whom he claimed to have named the town. His lamp frequently burned into the night as he composed letters to her, but he never saw her since her only visit to Langtry occurred in 1904, less than a year after Bean died.

- 89.5 0.5 Return to U.S. 90 turn right (east) to head back toward Del Rio.
- 90.5 1.0 Bridge over Eagle Nest Canyon. Look upstream (left, north) to "The World's Deepest Pothole," a cave spring that seldom flows. Cave divers found it filled with rubble at a depth of 5 m. Downstream (right, south), hidden behind a large breakdown slab, Bonfire Shelter represents the largest and southernmost bison jump or "bison kill" known in the New World (see Archeology/Biology Tour, Stop 2, "Bonfire Shelter"). Various short term occupations by prehistoric people over the last 11,000 years are highlighted by two major bison killing events, one at 8,000 years ago and the other at 2,000 years ago.
- 100.7 10.2 Exit to Silver Spike Roadside Park.

STOP 2 THE SILVER SPIKE

The Southern Pacific Railroad completed a bridge across the mouth of the Pecos River in 1882. The bridge, which was about 12 m (40 ft.) above the river, provided a much needed rail link between California and New Orleans. In 1969, before the reservoir filled, the pilings for this old railroad bridge were still visible. At one time during 1882, there were over 8,000 Irish and Chinese laborers working between Langtry and the Devils River. This 24.5 mile stretch of track had two 460-m (1,500-ft.) tunnels blasted through solid rock using up to 500 barrels of gunpowder a day. They were the first railroad tunnels built in Texas. Both tunnels are still plainly visible

along the U.S. side of the Rio Grande. In 1890, construction began on a new railroad bridge located about 4 mi. upriver from the original one. Completed in 1891, the new bridge shortened the old route by 13 mi. At 98 m (321 ft.) in height and 664 m (2,180 ft.) in length, it was one of the highest and longest bridges in the world at the time. In 1944, this bridge was replaced by the current bridge that crosses the Pecos. The old bridge was dismantled and sold to a South American country where it is rumored to still be in use. The current bridge was built at the same height but is 241 m (790 ft.) shorter. The concrete and rock footings for the 1891 bridge can still be seen today about 120 m (400 ft.) upstream from the modern bridge. During periods of low water, portions of an old concrete pump house, that once pumped water to a tank on the eastern riverbank, become exposed and pose a hazard to boaters.

106.2 5.5 Turn right to the Pecos River Overlook.
106.8 0.6 Pecos River Overlook.

STOP 3 PECOS RIVER OVERLOOK

Following the Civil War, there was an ever increasing need for the military to provide regional protection for settlers and immigrants traveling west. The two main east/west roads across Texas at this time were the Spanish Chihuahuan Trail and the Butterfield Trail, both of which crossed the Pecos much farther upstream. The Army wanted to build a crossing of the Pecos nearer the river's junction with the Rio Grande. In 1875, Lieutenant Bullis from Fort Clark was assigned the task. Following an old Indian crossing and making use of a natural ford in the Pecos, Bullis selected a crossing point about ½ mi. from the mouth. Rather than build a bridge, Bullis, with the help of the Black Seminole Scouts, blasted out a crude but usable wagon trail. The lower crossing is located on the east bank just below the present-day road to the Pecos boat ramp. The upper crossing is plainly visible on the west bank of the Pecos about one mile above the U.S. Highway 90 bridge. Bullis' Trail remained the primary crossing of the lower portion of the Pecos River for over 40 years. In the 1920s a bridge was constructed about 12 m (40 ft.) above the natural ford used by Bullis' Trail. The upper and lower crossings were relocated and widened for automobiles.

107.4 0.6 Return to U.S. 90 turn right (east) toward Del Rio.
107.5 0.1 Road to the right goes to Pecos River National Recreation Area.
110.0 2.0 Cross Seminole Canyon.
137.4 27.4 Turn right at Spur 349 to Amistad Dam

of Lake Amistad.
Visitor Center at Amistad Dam.

STOP 4 AMISTAD DAM (See Geology Tour, Stop 4, "Amistad Dam.")

142.4 1.6 Rejoin U.S. 90 heading east toward Del Rio.
149.9 7.5 Del Rio city limits.
154.1 4.2 Turn left on Gibbs St.
154.7 0.6 Turn right (south) on U.S. 277 toward Eagle Pass.
155.1 0.4 After crossing bridge over San Felipe Creek, turn right on West De la Rosa.
155.5 0.4 Right on Gillis at stop sign, then cross the bridge over San Felipe Creek.
155.6 0.1 Memo's.

STOP 5 LUNCH at Memo's.

155.6 0.0 Head south on Gillis. Cross the bridge over San Felipe Creek.
155.7 0.1 Turn right (west) on Bridge St. and drive through San Felipe Park. Pass Tardy Dam.

CANAL SYSTEM OF DEL RIO

Crude irrigation systems, drawing water from San Felipe Springs and Creek were first devised by Indian and Spanish inhabitants of this area. Anglo-American settlers also saw the need for irrigation in this arid region, and about 1869 a group of landowners formed the San Felipe Agricultural, Manufacturing & Irrigation company. Among early stockholders were W. C. Adams, Donald Jackson, Joseph Ney, Randolph Pafford, James H. Taylor, and A.O. Strickland. They dammed San Felipe Creek just below the springs, and by 1871 had built canals diverting water to 600 hectares (1,500 acres) of land. Under an 1875 irrigation law, the company received a 99-year state charter which authorized the digging of two canals; five-mile-long "Madre Ditch" and mile-long "San Felipe Ditch", plus lateral canals. In 1876 the state inspector reported that the San Felipe Company had irrigated about 1,200 hectares (3,000 acres). Land grant provisions of an 1876 law awarded the company 2,000 hectares (5,000 acres) of state land for the total mileage of its canals.

In addition to promoting agricultural development, the work of the San Felipe Company stimulated the growth of Del Rio, since the irrigation canals provided water to the city as well. Today this vital water supply system is still in operation.

- 155.9 0.2 Right on Taini Ave. Cross aqueduct, the Old Santa Fe Canal, then cross an older and bigger aqueduct, Madre Canal. Look to the right at the top of the slope for the Old Ice House location. Today only a small portion remains of the dam, which diverted water from San Felipe Creek to provide water power to operate the compressors and condensers at the plant. The faction seeking organization of the county known as the “Ice House Clique” took its name after this ice factory.
- 156.0 0.1 Left (west) on Greenwood.
- 156.3 0.3 Sacred Heart Church is on the southeast corner Greenwood & Mill; courthouse on the northeast corner. Head through the stop sign to the stop light at Pecan St. The bus station is ½ block down Greenwood.
- 156.4 0.1 Turn left on Pecan. Abandoned church on right on Pecan.
- 156.5 0.1 Turn left onto Canal St. at light. Proceed to Y. Bear right at Y where Canal becomes Cantu St. Note aqueduct under road at Y.
- 156.6 0.1 Cross over another aqueduct just before crossing the bridge over San Felipe Creek.
- 156.7 0.1 Continue south on Cantu St. to Brown Plaza. Circle Brown Plaza and exit west on Cisneros.

BROWN PLAZA

First plaza established in Del Rio—a city built on the site of a pre-Colombian Indian village. Abundant water, which attracted the Indians, also drew to this spot the earliest Europeans to visit Texas, including Cabeza De Vaca (1535) and Castano de Sosa (1590).

The permanent community of San Felipe del Rio was founded after frontier protection was assured in the 1860s. The San Felipe Agricultural, Manufacturing & Irrigation Company (organized October 8, 1869) promoted settlement by giving land to its employees. Railroad lines reached Del Rio in 1880 and 1884, furthering growth.

Brown Plaza, dedicated on Cinco de Mayo (May 5), 1908, was a gathering place for the community. A bandstand (or kiosk) was built by the people. Musical concerts delighted audiences and performers. The plaza was the scene of political and social gatherings. Formal promenades became a custom. Travelers rested here and cooked their food over charcoal fires.

Veni, G., W. R. Elliott, R. Ralph, R. Burnett, and S. Souby. 1994. The waltz across Texas: geology tour, archeology/biology tour, and scenic tour. Pp. 99–132, in *The Caves and Karst of Texas* (W. R. Elliott and G. Veni, eds.). National Speleological Society, Huntsville, Alabama. 252 pp.

George Washington Brown (1836-1918), donor of the plaza, was born in North Carolina, migrating west in his youth. He served his adopted state for 43 years in offices of County Clerk and District Clerk. The plaza was restored in 1969.

- 157.0 0.3 Cross the bridge over San Felipe Creek. Note aqueduct on the right and cross it, approaching Cassinelli Gin House at the corner of Pecan and Academy.

CASSINELLI GIN HOUSE

Italian stonemason G. B. Cassinelli and his partner John Taini were recruited in their native country by an American contractor who wanted them to construct buildings in New York. Shortly after their arrival in the United States, the project failed and they went to work for the railroads. Later they were hired by the federal government to construct several stone buildings at Fort Clark in Brackettville. When that project was completed, they came to Del Rio to work on the Val Verde County courthouse.

Cassinelli became a successful area businessman. He owned a general store, a contracting firm, and sold wood, hay, lime and brick. In 1903 he purchased land at this site for the construction of a cotton gin house. This two-story brick and stone commercial structure was built soon after. The ground floor housed Cassinelli’s short-lived cotton gin operation and the upper floor was used for community dances and receptions. Located near a ford of San Felipe Creek, and downstream from an ice house and dam built by Cassinelli, the gin house was a popular site for many early Del Rio social functions. The building was converted to a residence in the early 1950s, but the alterations were later destroyed by fire.

- 157.1 0.1 Turn right on Pecan. Turn left on Ney.
- 157.2 0.1 Turn left on South Main. Note second Taini Home at 1100 South Main (southwest corner of Ney and South Main)
- 157.4 0.2 Continue south on South Main past the Whitehead Museum. See brochure in packet .
- 157.5 0.1 Turn left on Nicholson to Hudson. The house directly in front is Taylor Rivers.

TAYLOR-RIVERS HOUSE

James H. Taylor (died 1876), one of the five founders of Del Rio, and his wife Paula (Losoya, died 1902), a native of Mexico, moved here from Uvalde about 1870 and built this one-story adobe residence. A prominent landowner and merchant, Taylor also owned a local

gristmill. After his death, Paula married Charles Rivers (died 1879) and later operated the home as a boarding house. She also became a benefactress for the city's Mexican community, contributing land for a school and cemetery. The Taylor-Rivers house remained in her family until 1939.

- 157.6 0.1 Turn right on Hudson; note the aqueduct on left side of street. Cross a small aqueduct.
- 157.7 0.1 On the right is the Mason Foster house. Cross a small aqueduct on the south edge of the property.

MASON-FOSTER HOUSE

A native of New York, local businessman James H. Mason (1835-1916) constructed his home here shortly after he purchased the site in 1887. He later developed a spring on the property for mineral baths and a medicinal drink. John J. Foster (1867-1935), a Del Rio attorney and civic leader, bought the residence in 1905. During his ownership major additions were made to the original four-room frame structure. Interior detailing included artwork by Foster's wife Mary (1868-1958). The residence remained in the Foster family until 1962.

- 157.8 0.1 Turn right at the stop sign and blinking red light at Qualia Drive. The Val Verde Winery is on the right. Note the aqueduct that runs parallel to Qualia Drive on the left. Continue south on Qualia. Note smaller aqueducts running off Qualia to the west.

VAL VERDE WINERY

Known as Texas' oldest bonded winery, it is the only survivor of about 25 once operated in the state. It was founded in 1883 by Frank Qualia, who came in 1882 to Del Rio (then a town of 200) from Milan, Italy. In 1883 he married Mary Franke. The Qualias and neighbors planted vineyards and made wine for family and friends in the old country tradition.

The original winery, still in use, is kept cool by 46-cm (18-in.) adobe walls. Louis Qualia and wife Kathleen use Spanish Lenois and Herbemont grapes in making 7,570 L (2,000 gal.) of wine yearly.

- 158.4 0.6 Home of the late Dr. John R. Brinkley on the left. Brinkley became a most colorful and controversial figure during the 1930s by advertising his patent medicines and goat gland operations from his Mexican based 1,000,000-watt

radio station XERA, the first "border blaster."

- 159.7 1.3 Intersection w/ Spur 277 (Las Vacas) and the border crossing to Ciudad Acuña.

STOP 6 BORDER CROSSING TO CIUDAD ACUÑA

One can cross here as a day tourist without any special papers. Trips to the interior of Mexico require a tourist visa and vehicle papers (see "Caving in Northern Mexico" near the end of this volume for more details.)

- 165.7 30.0 Return to Brackettville and Fort Clark Springs. End of road log.

We will take a break, then the bus will head to Kickapoo Caverns State Natural Area for the bat flight at Green Cave (see page 119). There will be other trips to see the bat flight during the week.

LITERATURE CITED

- Texas State Historical Association. 1952. *The Handbook of Texas*, Volume I & II. Texas State Historical Association.
- Thybon, Scott. n.d. Against all odds, Black Seminoles won their freedom. *Smithsonian Magazine*.
- Tyler, Ronnie C. 1975. *The Big Bend, A History of the Last Texas Frontier*. Washington, D.C.: National Park Service.
- Veni, G. 1979. Diving at the World's Deepest Pothole! *Texas Caver*, 24(3): 36-38 pp.