



Supplemental road log 2: From junction of NM-137 and Sitting Bull Falls road to Salt Flat graben, via Queen, west Guadalupe Rim, El Paso Gap, Dog Canyon and Crow Flats

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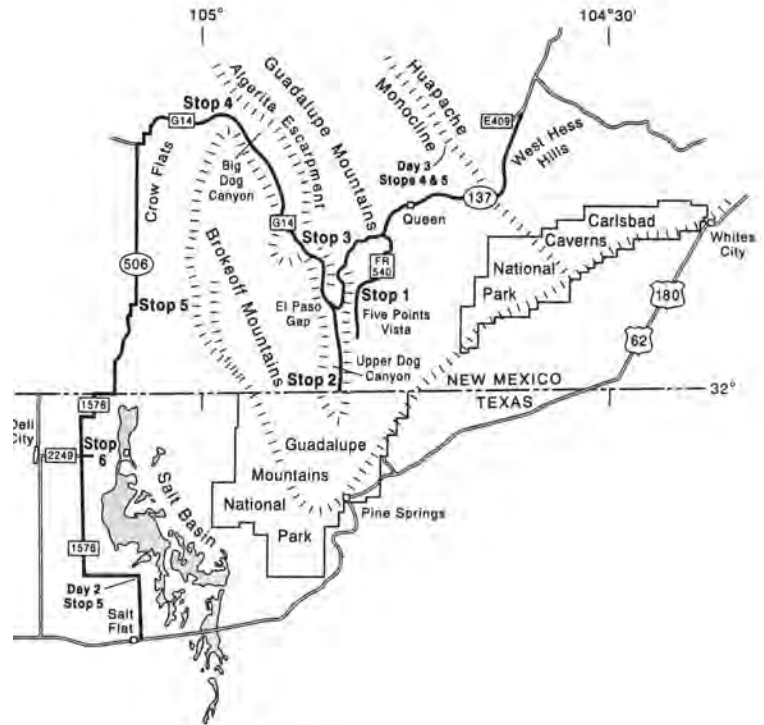
SUPPLEMENTAL ROAD LOG 2, FROM JUNCTION OF NM-137 AND SITTING BULL FALLS ROAD TO SALT FLAT GRABEN, VIA QUEEN, WEST GUADALUPE RIM, EL PASO GAP, DOG CANYON AND CROW FLATS

DAVID W. LOVE and JOHN W. HAWLEY

LOG 2A, ON NM-137 FROM EDDY-409 JUNCTION TO QUEEN, EL PASO GAP AND DOG CANYON CAMPGROUND, WITH EXCURSION TO GUADALUPE RIM OVERLOOKING SHATTUCK VALLEY

Mileage

- 0.0 Start on NM-137 at junction with Eddy-409 (mi 46, Third-Day Road Log). This point is located near the southern edge of the Seven Rivers Embayment, a topographic basin caused by the erosion of less resistant red beds and evaporites in the shelfward facies of the Tansill, Yates and Seven Rivers Formations. The Hess Hills to the south and east are at the northern edge of the northeastern Guadalupe Mountains. Resistant backreef rocks of the Tansill, Yates and Seven Rivers Formations form the upland surface. To the west is the main part of the Guadalupe Mountains. Its broad summit area, the Queen Plateau, is capped by resistant backreef carbonates of the Queen, Grayburg and San Andres Formations. These beds dip up to 12° along the Huapache monocline, which forms the northeastern edge of the plateau for more than 25 mi. Last Chance Canyon drains eastward from the northern Guadalupe Mountains across the Seven Rivers Embayment and Cueva Escarpment. Although the geomorphic history of this area has not been scrutinized, terraces along this drainage show multiple episodes of incision and aggradation. The lower intermediate terrace of Last Chance Canyon drainage here consists of up to 30 ft of bouldery gravel with Stage V pedogenic calcrete at top. This log may be enhanced through use of walking tours in Meader-Roberts et al. (1991). **0.1**
- 0.1 Descend to low Holocene terrace, floodplain and channel complex of Last Chance Canyon Draw. This large drainage includes Sitting Bull and Huapache Canyons and several other major watershed drainages to the west and northwest. **0.3**
- 0.4 Crossing Last Chance Canyon Draw. **0.2**
- 0.6 Pleistocene terrace deposits overlie east-dipping Queen Formation in stream cut to right (3:00). **0.4**
- 1.0 Milepost 31. Queen Formation to right. **0.6**
- 1.6 Route leaves valley of Last Chance Draw. Continue southward across stepped sequence of calcrete-capped strath terraces on deformed beds of the Queen Formation. **1.2**
- 2.8 Cattle guard. Small quarry in Queen Formation to right. Ridge to right capped by flaggy Queen dolomite. **0.2**
- 3.0 Milepost 29. Gypsiferous Queen beds exposed on both sides of road. Road to left (east) leads to springs in



Queen Formation. Junction of Trimble and Huapache Canyons 1 mi to southwest (1:00) at base of escarpment. Route ahead is in Guadalupe Mountains area mapped by Hayes (1964). **0.5**

- 3.5 Deformed Queen flaggy dolomite exposed in ditch to right. **0.2**
- 3.7 Junction (elevation 4495 ft). Continue south on Queens Highway. Huapache monocline ahead can be traced northwest to Texas Hill, around the west side of the Texas Hill dome and further northwest. West Hess Hills are to the south and east. **0.3**
- 4.0 Milepost 28. Cuts to left in undulatory Queen red beds and dolomites. **1.0**
- 5.0 Milepost 27. Huapache monocline across drainage to west and north (Fig. S-2.1). Hill to left capped with Queen dolomite over red and white flaggy sandstones interbedded with dolomite. **0.3**
- 5.3 Junction. Road to left (east) crosses West Hess Hills, which are capped with limestone and dolomite of Seven Rivers Formation. Hillslopes are in gypsum and mudstone facies of the Seven Rivers Formation. Cross synclinal flexure at base of Huapache monocline; leave Seven Rivers Embayment and the Pecos Valley Section of the Great Plains physiographic province. Route for next 40 mi crosses northern prong of the Guadalupe Mountains, which forms the eastern edge of the Sacramento section of the Basin and Range province. **0.3**



FIGURE S-2.1. Huapache monocline viewed north of NM-137 near Milepost 27.

- 5.6 Climbing steeper grade through roadcuts in Queen gray dolomite and sandstone. **0.4**
- 6.0 Milepost 26. **OPTIONAL STOP** in turn out to right. Gray to yellowish-gray dolomites and sandstones of Queen Formation in roadcuts and slopes. Thayer Hill and other high ridges to south capped by Seven Rivers Formation and canyons to north are cut into top of Grayburg Formation. Sharp curves ahead. **0.5**
- 6.5 Eddy-410 (X-Bar Road) to left (east) leads to Serpentine Bends of upper Dark Canyon. Outcrops in canyon to south are Grayburg and roadcuts are Queen Formation. According to Kelley (1971), the Queen undergoes a facies transition in this vicinity with limestone and dolomite to the south and gypsum, mudstone and dolomite to the north. Route crosses cattle guard to enter Guadalupe District, Lincoln National Forest and climbs to Guadalupe Mountain summit. Exposures ahead are mostly gray to yellowish sandstone and gray flaggy dolomite of Queen Formation (see Hayes, 1964). **0.5**
- 7.0 Thayer Hill to south at 9:00 is capped with Seven Rivers Formation and outcrops along road are in the Queen Formation. Route ascends to dissected surface of the Queen Plateau that is capped by resistant backreef carbonates of the Queen Formation and Shattuck Sandstone Member. **0.3**
- 7.3 Upper Trimble Canyon to right is joined by Huapache Canyon 2.5 mi to north. This area has excellent exposures of the Grayburg Formation, which is downwarped in the Huapache Monocline. **0.6**
- 7.9 Cattle guard. Crossing summit of Guadalupe Mountains (Queen Plateau); route for next 19 mi is primarily on the Queen Formation. Moran's (1954) type locality for the Queen is in sec. 36, T24S, R22E, about 1.25 mi south-southwest of here. **0.3**
- 8.2 Upper Dark Canyon at 9:00. **2.0**
- 10.2 Red Lake to left (south). **0.2**
- 10.4 Cattle guard. Forest Road 527 to south leads to Turkey Canyon. **0.3**
- 10.7 Road and trail to right lead to head of Huapache Canyon and Guadalupe Administrative site (drinking water available). **1.1**
- 11.8 Sitting Bull Falls Trail (No. 68) to right (elevation 5725 ft). **1.1**
- 12.9 Ridge Road (Eddy-431) to left. Lots for sale. **0.2**
- 13.1 Turkey Canyon Road (Eddy-530) to left. **0.1**
- 13.2 Eddy-411, Guadalupe Christian Camp Road to right. Road leads to Queen Cemetery and mine. **0.1**
- 13.3 Memorial Monument to Frank A Kindel. Plaque reads: "In memoriam, Frank A. Kindel, The flying paper boy of the Guadalupe, October 30, 1892, May 31, 1964. Whatever propelled Frank A. Kindel through life left an undiminishing wake. Whether riding his unicycle in a parade, greeting and entertaining visitors to his community or dropping newspapers from his piper cruiser to ranchers and hunters in these Guadalupe Mountains, he lived a life of service dedicated to his family, his community and his fellow man. On his last day in life, he flew the Rev. Mr. Willis E. Plapp to this site to conduct sunrise services for members of the Pecos Valley Trail Ride. The services were the last for Frank. He flew across the Great Divide into Eternity when his plane crashed near this spot in the Lincoln National Forest." This section of the highway was first paved as a memorial air strip. **0.3**
- 13.6 Entering Queen (elevation 5840 ft). According to Pearce (1965), J. W. Tulk "built a store and post office here in 1905. The nearest water was on the ranch of two brothers, J. C. and M. J. Queen and Mr. Tulk agreed to name the place Queen for the use of the water." The post office lasted until 1920. **0.2**
- 13.8 Queen store and RV park. **1.2**
- 15.0 Milepost 17. Route descends to valley-side slopes of Turkey Draw, which leads east to Turkey Canyon. **0.5**
- 15.5 Road curves to left (south). Forest Road 524 to right leads to Pine Canyon, a headwaters tributary of Last Chance Canyon. **0.5**
- 16.0 Milepost 16. Road near Queen/Grayburg contact. Hayes (1964) mapped the exposed sandstone/dolomite section as Grayburg here, whereas Kelley (1971) correlated these rocks with the basal Queen Formation. **1.0**
- 17.0 Milepost 15. Prepare for left turn ahead. **0.2**
- 17.2 Take Guadalupe Ridge Road (Forest Road 540) to left (elevation 6076 ft). Roadcuts ahead in orange sandstone and gray dolomite of upper Grayburg or basal Queen Formations. Route returns to this junction at mi 40.7. **0.6**
- 17.8 Take Forest Road 540 as it curves right (south); Eddy-412 to left. Road descends toward Robinson Draw. **0.3**
- 18.1 Cattle guard. Bedded dolomite with minor red sandstone in cuts to left are in upper Grayburg Formation of Hayes (1964). **0.5**
- 18.6 Flood gage at crossing of Robinson Draw. Queen outcrops on right. **0.6**
- 19.2 Road follows flaggy gray dolomite of Queen Formation. **0.5**
- 19.7 Flaggy dolomite and red sandstone of Queen Formation in cuts. **0.5**
- 20.2 Orange sandstone of Queen Formation in cut. **0.2**
- 20.4 Cattle guard. Hill ahead capped with Seven Rivers Formation. **0.9**
- 21.3 Cuts to left in Queen Formation. **0.3**
- 21.6 Entering Klondike Gap (elevation 6575 ft). Queen dolomite and sandstone capped with thick, dark soil. **0.1**
- 21.7 Cattle guard. Upper Dark Canyon via Eddy-412A to left. Continue south on Forest Road 540. **0.3**
- 22.0 Upper Dark Canyon at 11:00. Cuts on right in tan sand-



FIGURE S-2.2. Disharmonic wavy bedding in tan sandstone and gray dolomite of Queen Formation.

stone and gray dolomite of Queen Formation exhibit prominent disharmonic wavy bedding (Fig. S-2.2). **1.0**

23.0 More Queen Formation orange and red sandstone and gray dolomite. **1.5**

24.5 Rim of western Guadalupe escarpment to right. **0.2**

24.7 Cattle guard. Orange Queen sandstone to left. **0.3**

25.0 **STOP 1.** Turnout number 1 (elevation about 6800 ft) at rim of escarpment opposite El Paso Gap (elevation 5500 ft). Cuts in Queen Formation to left. This is the first of five vista turnouts overlooking Shattuck Valley and Upper Dog Canyon. On a clear day much of the southern New Mexico—western Texas region can be seen from this point (Figs. S-2.3, S-2.4, S-2.5, S-2.6, S-



FIGURE S-2.4. View north along Shattuck Escarpment, Shattuck Valley, Algerita Escarpment, and Dog Canyon. NM-137 passes through El Paso Gap (Fig. S-2.7) at left center.

2.7). This vantage point is Stop III-1 of Meader-Roberts et al. (1991). A walking tour leads down the escarpment over the Queen to the basal Grayburg. Exposed Grayburg is 435 ft thick, divided almost in half between lowstand through transgressive systems tracts and overlying highstand systems tracts. The facies of Grayburg here reflects a position 2 mi seaward from exposures in Last Chance and Stone Canyons (mi 47.4 below). The faulted Queen/Grayburg section exposed in the 1000-ft-thick escarpment face will be observed again in the last part of Log 2A through Shattuck Valley and Upper Dog Canyon (mi 47.5-55.6). **0.3**

25.3 Large turnout ahead (Fox Vista). **0.5**

25.8 Deer Hill turnout (Buck Vista) to right; roadcut in Queen to left. Deer Hill (elevation 7058 ft) is capped with carbonate facies of the Seven Rivers Formation (see section 19 of Hayes, 1964). **0.7**

26.5 High cut to left in interbedded dolomite, gray shale and sandstone of basal Seven Rivers Formation. **0.5**

27.0 Road curves away from scarp at head of Dark Canyon. Seven Rivers dolomite interbedded with shale in roadcuts ahead. **0.2**

27.2 Vista point to right at head of Devil's Den Trail 202 to Upper Dog Canyon. **0.2**



FIGURE S-2.5. View west across Upper Dog Canyon and Brokeoff Mountains, with Cornudas Mountains, mid-Tertiary intrusions, in distance. Grayburg is well exposed on Manzanita Ridge in foreground.

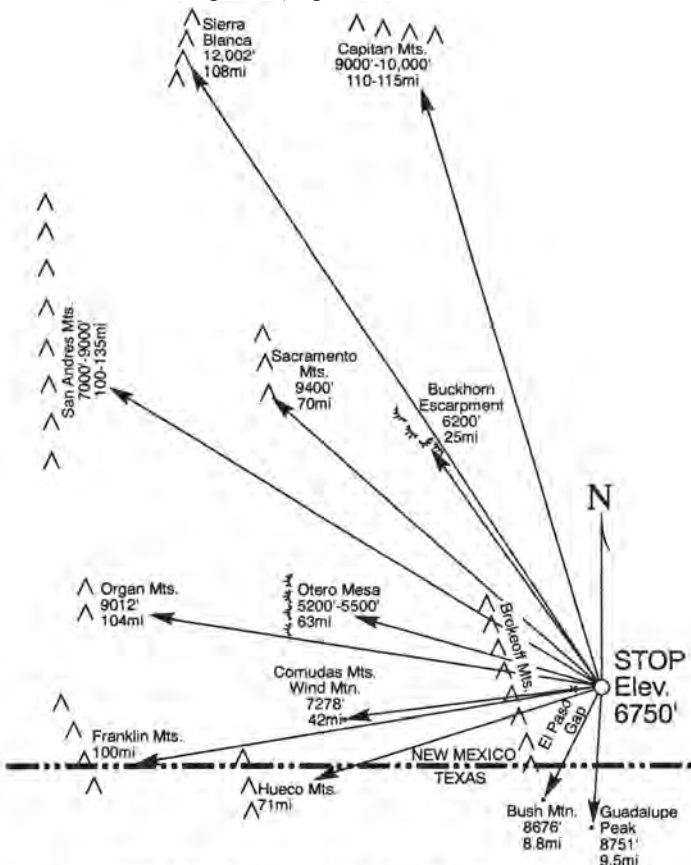


FIGURE S-2.3. Panoramic index from Stop 1, Guadalupe Rim.



FIGURE S-2.6. View south along Shattuck Escarpment toward higher Guadalupe Mountains. Prominent cliff exposure of Grayburg in foreground.



FIGURE S-2.7. El Paso Gap through horst of Queen over Grayburg Formations. Upper Dog Canyon beyond.

- 27.4 Upper end of Dark Canyon to left as road rounds hill capped with Seven Rivers Formation. 0.3
- 27.7 Vista point to right. Seven Rivers dolomite in cuts ahead. 0.4
- 28.1 Five Points Vista to right. More Seven Rivers exposures ahead. 0.3
- 28.4 Road curves left (east) away from escarpment. Head of Devil's Den Canyon to right. 0.4
- 28.8 Curve to right (southeast). Yates/Seven Rivers contact to right; Yates sandstone and siltstone in cuts ahead. 0.2
- 29.0 End of road at Guadalupe Ridge Trail Head (Trail No. 201). This "high point" of the tour (elevation about 7200 ft) is located at the southwest end of Guadalupe Ridge (Barrera del Guadalupe). Turn around and return to NM-137. 11.7
- 40.7 **Turn left** on NM-137. Road junction is on Grayburg of Hayes (1964) or Queen of Kelley (1971). 0.9
- 41.6 Milepost 14. Road crosses patch of Queen Formation (Hayes, 1964). 0.3
- 41.9 Route descends into Hamm Draw on Grayburg Formation (Hayes, 1964; Kelley, 1971). 0.4
- 42.3 Hamm Well to left. Crossing Hamm Draw; route ahead for next 10 mi is primarily on Grayburg dolomite. 1.1
- 43.4 Junction north; Forest Road 523 to crest of Pickett Hill (elevation 6501 ft), which consists of Grayburg Formation. 0.1
- 43.5 Crossing drainage divide on western crest of the Guad-

alupes; Pecos Slope to east and Salt Basin Graben to west. 0.1

- 43.6 Milepost 12. Start steep descent at west edge of the main (northwestern) prong of the Guadalupe Mountains. This point is near the north end of a major normal fault zone that defines the western escarpment of the Guadalupe from here south to Texas. The Guadalupe fault system steps *en echelon* to the northwest with a faulted and folded ramp caught in between (Fig. S-2.8). As the road descends to the west, it crosses a small north-trending anticline, syncline and anticline in Grayburg strata along the ramp. Queen Formation in small hills on ramp to south. 0.4
- 44.0 Junction to right is Eddy-413, "National Livestock Road," and Forest Road 67. This is the northern Rim Road that leads to the Algeria-Buckhorn Escarpment. 0.4
- 44.4 Grayish, craggy ledges of Bonney Canyon Member of San Andres Formation (Kelley, 1971) form a small wedge exposed in faulted escarpment to east and are in slight contrast to browner dolomite beds of the overlying Grayburg Formation. Top of scarp to south has 150-200 ft of Queen Formation. Farther south, Queen Formation is capped with Seven Rivers carbonates. Road winds between hills of Queen Formation before continuing descent on the Grayburg. Kerans et al. and Ferris et al. (this volume) describe detailed stratigraphic relationships in the sequence of Leonardian and Guadalupian rocks (San Andres-Grayburg-Queen) exposed in the Al-

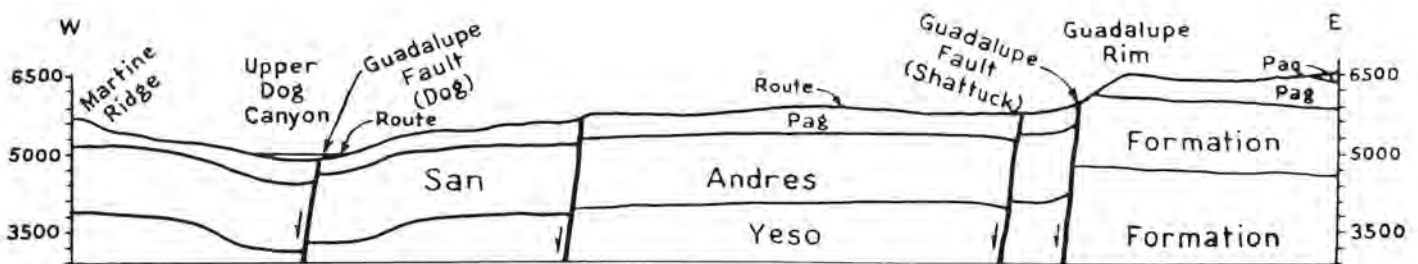


FIGURE S-2.8. West-east structure section from Martine Ridge across Upper Dog Canyon, northern Shattuck Valley, and Guadalupe rim as interpreted by Kelley (1971). Exposed formations of the Artesia Group are the Grayburg, Pag, and Queen, Paq. Recent work (Kerans and Nance, 1991; Lindsey, 1991; Kerans et al., this volume) has led to revision of the boundaries between the San Andres, Grayburg and Queen. Queen should cap the Grayburg in the central part of the cross section.

- gerita Escarpment from here north to the Little Dog Canyon area of the northern Guadalupe Mountains. 0.2
- 44.6 Milepost 11. Irabarne Canyon to right and Shattuck Valley at 12:00. View to south shows the north-south structural grain of the western margin of the Guadalupe Mountains here. At 12:00 is El Paso Ridge, a south-plunging horst, flanked to the east by the Shattuck Valley (graben), to the immediate west by Upper Dog Canyon (graben) and subsequently by Martine Ridge (horst), Big Dog Canyon and Brokeoff Mountains on the horizon (Meader-Roberts et al., 1991, p. 76; Fig. S-2.8). West-dipping Grayburg Formation with contorted bedding in cut to left. 1.3
- 45.9 Leave Lincoln National Forest. Base of Irabarne Canyon to northwest exposes Bonney Canyon Member of San Andres Formation (Kelley, 1971); upper part of canyon wall is Grayburg and top is Queen Formation (Lindsay, 1991). Route crosses Grayburg dipslope. 0.6
- 46.5 Slow. Switchback ahead. **0.1**
- 46.6 Milepost 9. Switchback. Upper Stone Canyon to right in Grayburg and basal Queen. 0.8
- 47.4 Curve crosses drainages at base of hill that feed Stone Canyon. Stone Canyon is Stop 2 of Day 2 of Meader-Roberts et al. (1991) field trip to examine upward shoaling facies tracts of the Grayburg Formation. Shattuck Valley to south. **0.1**
- 47.5 Ranch to left at head of Shattuck Valley. El Paso Ridge to west is capped with Queen Formation, with Grayburg forming the slopes (Kelley, 1971). **1.1**
- 48.6 Milepost 7. Drainage divide (elevation about 5580 ft) between Stone Canyon and El Paso Gap. **0.8**
- 49.4 El Paso Gap School House to left. Entering El Paso Gap. The hill east of the old school house is Seven Rivers Formation. The southern end of the hill has gypsum as well as dolomite and marks the southernmost penetration of evaporites into the shelf margin for the Artesia Group as well as the Seven Rivers Formation. The main scarp to the east is dominated by Grayburg Formation, with the uppermost 150 to 200 ft composed of Queen Formation (see mi 25.0). 0.2
- 49.6 Junction in El Paso Gap. Stay on NM-137 to Dog Canyon Campground of Guadalupe Mountains National Park. Exit log through Crow Flats to US-62/180 continues from this junction. **0.1**
- 49.7 Roadcut to left in dolomite of Grayburg Formation. **0.4**
- 50.1 Continue south on east flank of Dog Canyon valley. Note lack of faults that disrupt surfaces of valley fill or valley margins. **5.5**
- 55.6 **STOP 2.** Milepost 0 and cattle guard at New Mexico-Texas state line. Entering Guadalupe Mountains National Park. Note mixed juniper/oak forest. Seven Rivers dolomite exposed in hillslope to right. Stratigraphy of cliffs to east are Seven Rivers Formation on skyline, Queen Formation, Grayburg Formation, a fault and Seven Rivers Formation repeated at base of steep slope (Fig. S-2.9). 0.3
- 55.9 Dog Canyon Ranger Station (elevation 6300 ft). **End of Supplemental Road Log 2A.** Return to El Paso Gap. **6.3**

LOG 2B, FROM EL PASO GAP TO SALT FLAT JUNCTION (US-62/180), VIA BIG DOG CANYON, CROW FLATS, AND DELL CITY (TEXAS) AREA

Mileage

- 0.0 Junction of graded Eddy-415 and NM-137 in El Paso Gap (elevation 5492 ft). Sign reads Dell City, 55 miles, El Paso, 155. Continue north on Eddy-415; road dips



FIGURE S-2.9. West Guadalupe Escarpment northeast of New Mexico-Texas line at Dog Canyon Campground area of Guadalupe Mountains National Park. Escarpment is capped by the Grayburg-Queen sequence.

- through commonly dry wash. Note brown sandstone below gray dolomite in Grayburg Formation at base of cliff to right. Queen Formation is exposed in upper part of the cliff (Hayes, 1964; Kelley, 1971). **0.5**
- 0.5 Cattle guard. Continue north on valley floor of Upper Dog Canyon. Alluvial fill is primarily of late Quaternary age. **0.6**
- 1.1 Road crosses ridge of Grayburg Formation with cap of Queen Formation. **0.4**
- 1.5 Leave Eddy County, enter Otero County. Route ahead on Otero-G 14 drops back to floor of Upper Dog Canyon. Martine Ridge to west consists of Grayburg Formation. Queen caps El Paso Ridge to east. **0.7**
- 2.2 Back on floor of upper Dog Canyon Valley. Gully to right in late Quaternary exposes gravelly to loamy alluvium capped with dark organic soils. **0.6**
- 2.8 Small alluvial fan spreads out from mouth of Stone Canyon to right and Grayburg sandstone is exposed in low cut on left. Across valley to the west, prominent monocline brings Grayburg down and terminates San Andres exposures in scarp (Kelley, 1971). **0.2**
- 3.0 Crossing Stone Canyon Arroyo. **0.5**
- 3.5 Cliff exposure of Grayburg along Dog Canyon Arroyo to left. **0.2**
- 3.7 Roadcuts to right in upper Quaternary fan alluvium derived from Six Shooter Canyon. **0.2**
- 3.9 Cattle guard. **0.2**
- 4.1 Arroyo crossing more upper Quaternary fan alluvium in cuts to right. **0.2**
- 4.3 Road on late Quaternary fan; weak to moderate (Stage **II** and **III**) development of horizons of carbonate accumulation in surface soils. **0.2**
- 4.5 Road on floor of upper Dog Canyon (upper Holocene alluvium and active arroyo channel deposits). **0.4**
- 4.9 Cobbly to loamy upper Quaternary fan alluvium in cut to left. Moderately developed, but nonindurated horizons of soil-carbonate accumulation (stage III) indicate a late Pleistocene age for much of the fan surface. **0.9**
- 5.8 Coarse gravelly inner valley fill to right cut by arroyo channels in Upper Dog Canyon. "The Rim" of the Queen Plateau at 3:00 (elevation about 6200 ft) is at southern end of the Algerita Escarpment, which here rises about 1200 ft above the canyon floor (Hayes, 1964). **0.7**
- 6.5 **STOP 3.** Otero-G17 to west (elevation 4924 ft). "Dell City 48." Big Ridge across valley to west is part of Brokeoff Mountains and consists of Grayburg Formation on San Andres Formation (Boyd, 1958). San Andres and Yeso Formations in Brokeoff Mountains undergo facies changes from northwest shelf phase to north (San Andres and Yeso Formations), through basin-margin phase (San Andres transition facies and Victorio Peak Member) in this area, to Delaware basin phase (Cherry Canyon, Cutoff Member and Victorio Peak Member, Bone Spring Formation in subsurface) near Texas line to south (Boyd, 1958; Black, 1975). Kelley (1971, fig. 4) showed facies changes in lower San Andres (Bonney Canyon and Rio Bonito) members from north to south along Sacramento and Guadalupe Mountains. See papers by Ferris et al., Fitchen, and Kerans et al. (this volume) for overviews of Guadalupe Mountain geology and new interpretations of Leonardian and Guadalupian stratigraphy in the Brokeoff Mountain and western Guadalupe escarpment area. **0.3**
- 6.8 Cross Upper Dog Canyon Arroyo. Entering valley of Big Dog Canyon. High-level remnant of older valley fill to right (2:00) is capped with gravelly soil profile more than 3 ft thick, with stage III to weak stage IV horizon of soil-carbonate accumulation. Beneath soil is a 25 to 30 ft exposure of coarse gravelly to loamy brown alluvium. Fossil snails were noted in the lower loamy layer. **0.3**
- 7.1 Upper San Andres limestone in knob to right (Hayes, 1964). **0.3**
- 7.4 Cattle guard. Route traverses alluvial fill of Big Dog Canyon. The Algerita Escarpment forms the west edge of the Guadalupe Mountains from 11:00-4:00. For the next 10 mi the Little Dog and Pup Canyons Roadless Area encompasses the escarpment and was mapped by Hayes and Bigsby (1983). Scarp at south end consists of fault-repeated carbonates of San Andres Formation (Fig. S-2.10). The rim of the escarpment is locally capped by 150-250 ft of Grayburg Formation: *Grayburg frosting on San Andres cake*. Ferris et al. and Kerans et al. (this volume) provide a very detailed picture of the Guadalupian/Leonardian, Upper San Andres Formation exposed along the escarpment between here and the Little Dog Canyon area (mi 16.9). **1.5**
- 8.9 Road to right (elevation about 4750 ft). Crossing undissected, late Quaternary alluvial plain. **1.0**
- 9.9 Low knob of upper San Andres limestone to left. Big Dog Canyon Arroyo exits valley to northwest through Box Canyon. **0.8**
- 10.7 Skirting upper San Andres limestone ridge to left. **1.0**
- 11.7 Cattle guard. Small playa lake at 1:00 on valley floor. **0.7**
- 12.4 Playa road to right (northeast). Yeso Formation crops out at base of San Andres cliffs from 12:00-3:00 and consists of gray dolomite, gypsum and yellowish-gray siltstone in beds less than a foot thick. **0.9**
- 13.3 Low ridges of upper San Andres Formation to left and right. Numerous small down-to-the-west faults offset San Andres and Yeso Formations in escarpment with major boundary fault buried by Quaternary alluvium. **2.3**



FIGURE S-2.10. Algerita Escarpment, San Andres with Grayburg veneer, and undissected alluvial plain.

- 15.6 Faulted northeastern rim of Big Dog Canyon (12:00-1:30) mapped by Hayes and Bigsby (1983). Near Hayes' (1964) cross sections A-A' and B-B'. 0.3
- 15.9 Cross arroyo in lower Big Dog Canyon. 1.0
- 16.9 **STOP 4.** Drop into gully; north wall is late Pleistocene terrace with basal reddish brown, loamy valley fill overlain by about 10 ft of gravelly alluvium with weak-Stage IV pedogenic calcrete. Road to right leads to Little Dog Canyon and northern abutment of Brokeoff Mountains against Guadalupe Mountains. Algerita Escarpment (1:00-5:00) is capped by (upper) Fourmile Draw Member of San Andres Formation (Kelley, 1971). This is the northern end of the Upper San Andres section that is described in detail by Ferris et al. (this volume). Base of escarpment is Yeso and faulted San Andres Formation (Hayes and Bigsby, 1983). 0.1
- 17.0 Continue down valley on late Pleistocene terrace gravel. 0.8
- 17.8 Cross arroyo channels; route curves to west toward Salt Flat Graben, passing through water gap in low San Andres limestone cuesta (tilted west). 0.2
- 18.0 Route on upper Pleistocene terrace gravel. 0.6
- 18.6 Cattle guard. Dry hole oil test drilled 2.5 mi north spudded in faulted San Andres Formation. Route (Otero-G14) descends into northern Salt Basin on Quaternary alluvial fan. Salt Flats to south. 1.3
- 19.9 Good view at 2:00 of western face of Guadalupe Mountains north of Algerita Escarpment. This point is near the eastern boundary of the Salt Flat Graben, but no late Quaternary piedmont fault scarps have been noted here. Kelley (1971, p. 39), however, does document late Quaternary displacement along a basin-range boundary fault crossing the piedmont slope about 20 mi to north. 1.1
- 21.0 West-tilted block of San Andres forms hill to north. Curve southwest toward Crow Flats. 0.8
- 21.8 Junction. Keep left. Cornudas Mountains on skyline at 12:30. Continue southwest toward Crow Flats on Pleistocene piedmont slope. 1.0
- 22.8 Road follows north-south township boundary (R 18E and R19E). Crossing distal part of Box Canyon alluvial fan (Big Dog Canyon drainage). 0.1
- 22.9 Junction with road from northwest along Pifion Wash and cattle guard. 1.0
- 23.9 Route turns west along township boundary (T23S and T24S). 0.3
- 24.2 Cattle guard. Good view to north (2:00-3:00) of faulted front of northern Guadalupe Mountains. 0.7
- 24.9 Curve to south on section line road. Valley fill is still gravelly fan alluvium (Late Quaternary). 0.8
- 25.7 Cattle guard. Rise to slightly higher surface at distal edge of Box Canyon fan. 0.2
- 25.9 Curve to west. Crossing northern end of Crow Flats on section line road. 1.0
- 26.9 Junction. **Turn left** and continue south across Crow Flats on NM-506 (Dell City 28 mi). Route to right (NM-506) leads northwest to Pifion in the southeastern Sacramento Mountains. 2.6
- 29.5 Cattle guard. Pavement starts. Continue south (Dell City 25 mi) across floor of northern Salt Basin. West front of Brokeoff Mountains to left (Fitchen, this volume). Road to right (west), toward mouth of Boardwell Canyon, leads to Orogrande (US-54) and the Fort Bliss-McGregor Range. This route crosses the Van Winkle and lower Sacramento River basins and the site of Pleistocene pluvial lake Sacramento (Hawley, 1993). 6.0
- 35.5 Note mound of gypsiferous valley fill. Basin-floor elevation here is about 3660 ft. According to King (1948) this is the highest possible level inundated by a large lake (area about 350 mi²) during the late Pleistocene (Wisconsin) glacial stage (see discussion at mi 52.5). 0.5
- 36.0 Curve to right. Well at section corner ahead. Lower Humphrey Canyon to east. **STOP 5.** Overview of the geology of the northern Diablo Plateau and west face of the Brokeoff Mountains (Boyd, 1958; Fitchen, this volume). The Diablo Plateau, to the west of the Salt Basin Graben, is a broad, east-tilted homoclinal structure that is bounded on the west by the Hueco Bolson graben. Uplands at the western edge of the Plateau include the Hueco Mountains (TX) and Otero Mesa (NM). The hydrogeology of the Texas part of the Plateau is described by Sharp (1989) and Kreitler et al. (1990). Natural discharge of much of area's ground-water is by evaporation in gypsum playas of the central Salt Basin Graben. Black (1975) presented an excellent overview of the Paleozoic stratigraphy and structure (Fig. S-2.11) of the "Otero platform" area of the Diablo Plateau in New Mexico. Laccolithic and domal intrusions of middle Tertiary age penetrate the Precambrian, lower Paleozoic, Pennsylvanian, Permian and (locally) Cretaceous section that underlies the Plateau surface (Barker et al., 1977). The main intrusive center that straddles the State Line at the Cornudas Mountains is described by McLemore and Gulinger (this volume); and Cretaceous

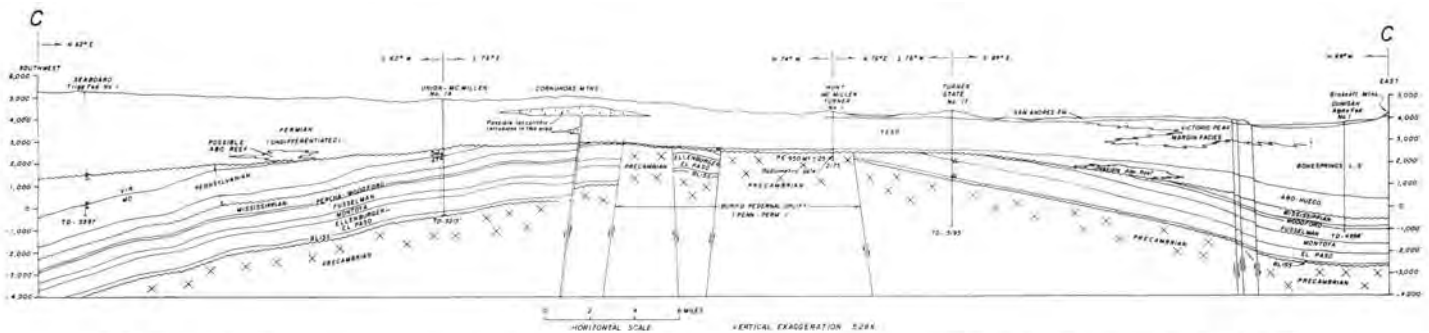


FIGURE S-2.11. East-west cross section from lower Humphrey Canyon to Tularosa Basin west of Cornudas Mountains (from Black, 1975).

- rocks in that area are discussed by Kues and Lucas (this volume). **0.5**
- 36.5 **Turn left** at relay tower. Continue south along west edge of Crow Flats. **0.9**
- 37.4 Cattle guard. Turn right. **0.3**
- 37.7 Curve south along base of low escarpment (San Andres limestone) marking the eastern edge of the northern Diablo Plateau and western border of the Salt Basin Graben. **0.8**
- 38.5 Canyon cuts escarpment to right. Route crosses late Quaternary surface of small alluvial fan. Gravel pit ahead to left. **1.2**
- 39.7 Route crosses another Quaternary fan surface. **0.3**
- 40.0 Route rounds spur of San Andres limestone on gravelly alluvial apron at base of cliffs. At 9:00 to 11:00 note dune ridges on playa-lake plain. **0.8**
- 40.8 Cienega School to left. **0.2**
- 41.0 Cattle guard. West face of Brokeoff Mountains at 9:00 across complex of alkali playas and dune ridges on the northern end of Salt Flat. **1.0**
- 42.0 Cattle guard. Rounding south end of spur of San Andres limestone. **0.2**
- 42.2 Junction. **Take left fork** and continue south on Otero-G5 across distal part of alluvial fan heading in Culp Canyon 2 mi to west. **2.3**
- 44.5 **Turn right** at New Mexico-Texas state line. Enter Hudspeth County and continue west on Texas Farm Road (FR) 1576; Dell City 10 mi. Center pivot irrigation systems to left and right. This part of Hudspeth County, Texas and Otero County, New Mexico is the only large area of ground-water development for irrigation agriculture in the region between the Hueco Bolson near El Paso and the Pecos Valley (Scalapino, 1950; Bjorklund, 1957; Gates et al., 1980). Ground water is produced from fractured and cavernous zones in the middle to lower Permian (San Andres/Yeso-Victorio Peak/Bone Spring) sequence of carbonate rocks (Sharp et al., this volume). A veneer of upper Cenozoic alluvium is also present in valley and solution-subsidence depression areas. Large flood-control structures southwest of Dell City, which were built after large arroyo floods in 1966, also function as ground-water recharge sites. Captured floodwater is injected into the shallow carbonate aquifer system through 12 large-diameter wells at rates of up to 2000 gpm (Logan, 1984). **1.4**
- 45.9 **Turn left (south)** on Texas FR-1576 through agricultural area. General geology of area is shown on Van Horn-El Paso atlas sheet of the Texas Bureau of Economic Geology (1983). The lower San Andres Formation on the New Mexico side of the state line is now correlated with the upper Victorio Peak Formation (see Kerans et al., this volume). **1.1**
- 47.0 Curve right (west). "Dell City 7, Salt Flat 21." **0.7**
- 47.7 Crossing western edge of Salt Flat Graben (elevation about 3660 ft); route rises on San Andres Formation. **0.3**
- 48.0 Turn left and continue south on FR-1576; dropping back to basin floor. **2.9**
- 50.9 Knob of mid-Tertiary syenitic intrusive forms hill to right (elevation 3826 ft) that projects through the basin fill. **0.3**
- 51.2 Junction. **Turn left** (east) on graded road. Dell City is 3 mi west on FR-2249. Excellent view at 11:00-2:00 of the west face of the Guadalupe Mountains (Fig. S-2.12). **1.3**
- 52.5 **STOP 6** (elevation 3640 ft), next to feedlot at large pit in gypsiferous basin-floor deposits. This site (Fig. S-2.13) was visited during a field trip emphasizing regional hydrogeology held in conjunction with the 1990 Meeting of the Geological Society of America (Kreider and Sharp, 1990, p. 6, stop 7). A well-developed pedogenic gypcrete horizon is formed at the top of the exposed section. The gypsiferous basin fill was probably deposited by a combination of eolian and geochemical processes. Gypsum in the Salt Flat playas to the east is now being deposited by ground water. The elevation here, however,



FIGURE S-2.12. West face of Guadalupe Mountains from Stop 6. See Figs. 2.25 and 2.26.



FIGURE S-2.13. Aerial view of northern Salt Basin and Crow Flats about 5 mi east of Dell City, Texas and 1 mi northeast of Stop 6. New Mexico-Texas state line crosses upper part of photo at northern end of Linda Lake gypsum playa. Site of Mary Spring is located in embayment at playa's west edge (lower center). Eastern edge of Otero platform (Diablo Plateau) at upper left is capped by San Andres limestone. Center pivot sprinkler systems are 0.5 mi in diameter (J. W. Hawley, March 1987).

is 20-30 ft above the general level of the modern gypsum playas (3610-20 ft). The strong gypsic surface soil and the higher topographic position suggest that the basin floor at this site is a relict playa-lake plain and dune complex dating from an earlier (late? Pleistocene) interval of aggradation. The Salt Flat playa system is discussed in more detail at mi 81.3 of the Second-Day Road Log.

King (1948) proposed that a large lake (as much as 350 mi² in area and 50 ft deep) flooded the basin floor to a elevation of about 3660 ft during the late Wisconsin, full-glacial interval. Miller (1981) and Smith and Miller (1986) named this inferred body of water "Lake King." There is no clear evidence for shoreline deposits at the suggested high-stand elevations, however and much more detailed field work needs to be done before definitive statements can be made about "Lake King" history (Hawley, 1993). Changing ground-water inflow and discharge regimes to and from the Salt Flat area also complicate interpretations of lake and playa paleohydrology and need to be considered in any models of Salt Basin depositional history and environments (Sharp, 1989; Kreitler, et al., 1990). Return to FR-1576. **1.3**

53.8 Stop sign. **Turn left (south)** on FR-1576 to continue Salt Basin tour. Hunt Oil Co. No. 1 Dyer 2 mi southeast

of Dell City encountered a silicic sill in Yeso Formation beneath shallow alluvium (King and Harder, 1985). Dell

City and connecting roads to the Cornudas Mountains are 3 mi to west. **1.5**

55.3 East-dipping San Andres—Victorio Peak limestones in Wilcox Hills to right. Continue south on western part of Salt Basin floor dotted with dune mounds (elevation about 3635 ft). **5.7**

61.0 San Andres—Victorio Peak crops out in low ridges west of road that are cut by northwest-trending normal faults. **1.1**

62.1 Route crosses alluvial fan at faulted west margin of Salt Basin Graben (Henry and Price, 1985). Limestones of the San Andres or Victorio Peak Formations crop out in hills to west. **0.3**

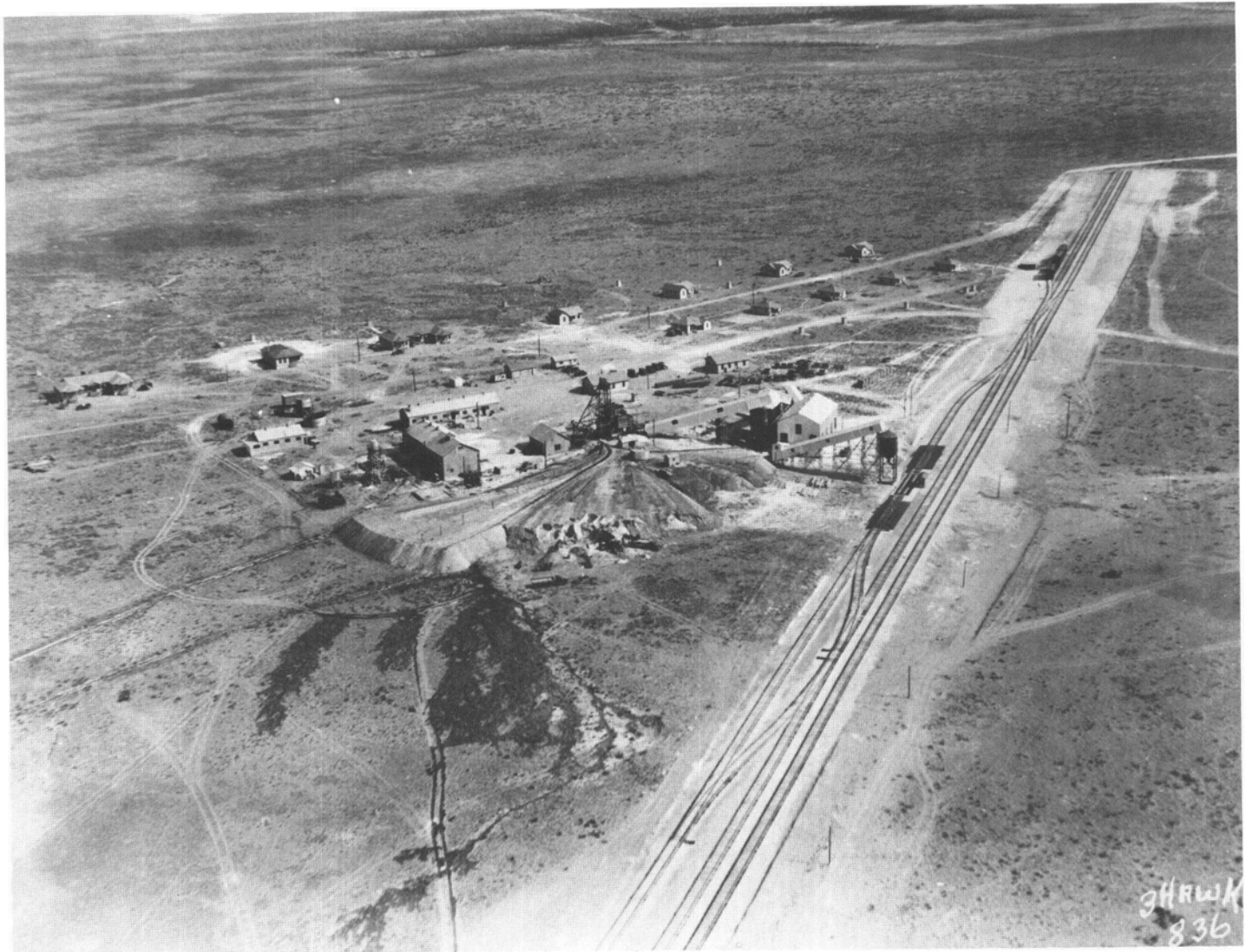
62.4 Curve to left (east). Continue east across dune and fan area. **1.0**

63.4 Crossing lower Antelope Draw distributaries. **3.1**

66.5 Curve to right at Second Day Stop 5. Continue south on dune-capped alluvial-fan complex of lower Antelope Draw. See mi 86.6 to 91.2 on Second-Day Road Log. **4.6**

71.1 Salt Flat Junction of FR-1576 with US-62/180. Carlsbad 78 mi; El Paso 87 mi.

End of Supplemental Road Log 2.



Early development in January 1934 of the Delaware Basin's first potash mine owned by the Potash Company of America. Aerial photograph by 3 Hawks. Courtesy of Southeastern New Mexico Historical Society of Carlsbad.