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AN INTEGRATED GEOLOGICAL AND GEOPHYSICAL STUDY OF THE SALT BASIN GRABEN, WEST TEXAS

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INTRODUCTION

The Salt Basin graben of Trans-Pecos Texas (fig. 1) is a 200 km (130 mi) long and 8 to 32 km (5 to 20 mi) wide topographic depression that trends approximately N10°W along the Culberson-Hudspeth County line into southern New Mexico. This basin separates the Diablo Plateau, Sierra Diablo, Carrizo and Van Horn Mountains (to the west) from the Guadalupe, Delaware, Apache and Davis Mountains (to the east). To the south the basin bifurcates around the Wylie Mountains forming Lobo Flat to the southwest and Michigan Draw to the southeast (fig. 1). The Salt Basin receives its name from the alkali lakes and dry alkali flats present mainly along the western edge of the basin from about 31°20'N latitude towards its northern end in Otero County, New Mexico. The basin fill is composed of a variable thickness of unconsolidated Cenozoic alluvial and lacustrine gravels, sands, silts and clays. According to King (1948), the Salt Basin graben represents a down-dropped portion of the earth's crust with rocks of the immediately adjacent mountains having been either warped or faulted down into their present positions. (*See also* Goetz, this guidebook.)

Previous studies of the regional tectonic and geologic setting of Trans-Pecos Texas have included the Salt Basin graben only as a side light. In this study, geological and geophysical data have been integrated in an attempt to further elucidate the subsurface geometry and tectonic setting of the basin. In addition to surficial geologic data, geophysical and geologic information was compiled in the form of gravity, magnetic and subsurface well data. The gravity and magnetic data were used to produce a regional Bouguer gravity map and regional total field magnetic intensity map. The subsurface well information (fig. 2; Table 1) was utilized along with geophysical constraints in producing computer-modeled cross sections across the Salt Basin graben and adjacent areas. These two-dimensional computer models were calculated using the technique of Talwani and others (1959).

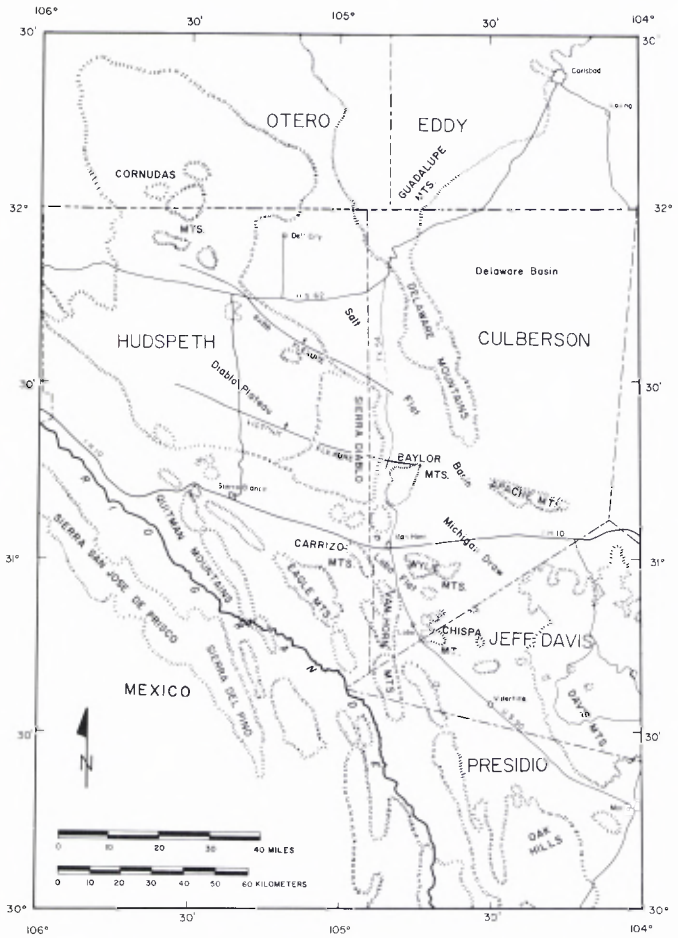


Figure 1. Index map of the study area.

GEOLOGIC HISTORY

The complicated Precambrian history of the area is discussed elsewhere in this guidebook (*see* papers by Davidson and by Denison) and culminated with the deposition of the Van Horn

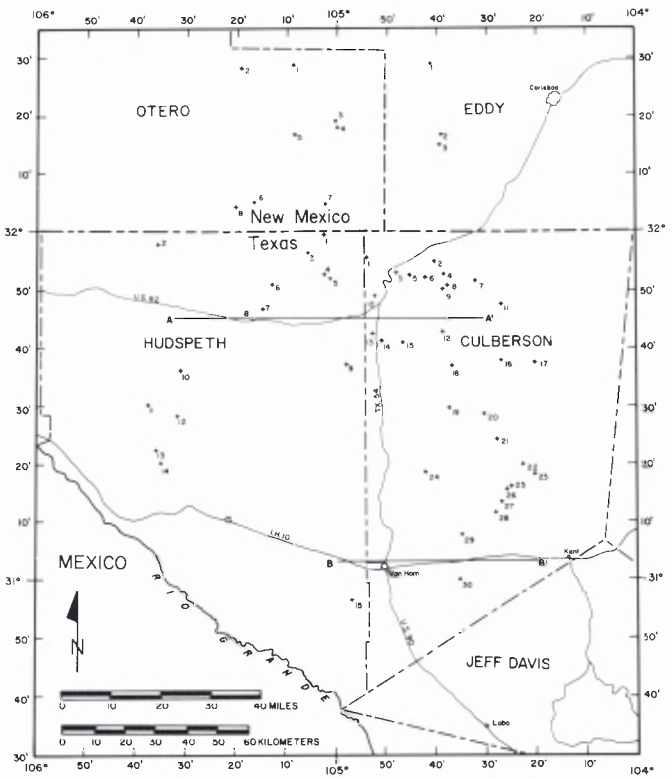


Figure 2. Well data and locations of gravity profiles. Numbered well locations correspond with entries in Table 1.

Table 1. Well information.

No.	Company	Well	Location	Date Elev (ft) TD (ft)	Source	Tops (ft) (referred to sea level)
			Culberson County, Texas			
1	Pure Oil Co.	No. 1 Hunter	Sec. 34, Blk. 66, T-1; T & P Sur.	5-13-48 5308 6649	WTGS. Pre-Miss. x-section (1955)	Woodford (+128) Montoya (-902) Ellenburger (-1282)
2	Bonanza Co.	Pierson	Sec. 26, Blk. 64, T-1; T & P Sur.	4-4-67 4417 7026	UTEP Log Files	Bone Spring (+1447) Penn. (-1958)
3	Texaco, Inc.	Culberson "L" Fee No. 1	Sec. 45, Blk. 65, T-1; T & P Sur.	2-22-61 5353 8700	Midland Log Library	Devonian (-2253)
4	H.L. Brown Jr.	F.J. Barrett #1	Sec. 48, Blk. 64 T-1; T & P Sur.	9-26-73 4441 8220	Midland Log Library	Density Log
5	TXL Corp.	Culberson "C" Fee #1	Sec. 1, Blk. 65, T-2; T & P Sur.	1-4-61 4970 7749	UTEP Log files	Wolfcamp (+160) Mississippian (-2392) Devonian (-2637)
6	Amoco Prod. Co.	F.J. Barnett "A" #1	Sec. 4, Blk. 64, T-2; T & P Sur.	1-13-77 4440 7373	Midland Log Library	Density Log
7	Magnolia Petro.	No. A-1 Homer, Cowden	Sec. 12, Blk. 63, T-2; T & P Sur	8-13-52 3917 11,651	WTGS Pre-Miss. x-section (1955)	Woodford (-5713) Montoya (-6873) Ellenburger (-7343)
8	Socony Mobil Oil Co.	#1 State Cowden	Sec. 24, Blk. 64, T-2; T & P Sur.	4-11-61 4316 7700	UTEP Log Files	
9	Socony Mobil Oil Co.	State Barret #1	Sec. 18, Blk. 63, T-2; T & P Sur	3-6-60 4257 9591	Midland log Library	
10	D & J Equipment Co.	J.C. Hunter, Jr. #2	Sec. 2, Blk. 120, PSL Sur	6-21-68 4050± 6695	Midland Log Library	Bone Spring (-1040) approx.
11	TXL Oil Corp.	Culberson B-T Fee #1	Sec. 33, Blk. 62, T-2; T & P Sur.	10-29-60 4056 12,638	UTEP Log Files	Bone Spring (+381) Woodford (-6627) Devonian (-6749) Ellenburger (-8354)
12	Humble Oil & Ref. Co.	M.C. Sibley #1	Sec. 24, Blk. 68, PSL Sur.	3-25-61 4782 8620	Midland Log Library	Bone Spring (+2947) Pennsylvanian (-2768)
13	N. Amer. Royalties, Inc.	Potter #1	Sec. 31, Blk. 119 PSL Sur.	12-23-71 3891 5400	Midland Log Library	Hueco (+233)
14	J.M. Huber Corp.	Tom Potter #1	Sec. 2, Blk. 118 PSL Sur.	5-18-68 3943 6362	Midland & UTEP Log Library	Bone Spring (+2086)
15	Anderson & Prichard	No. 1 Bordens	Sec. 34, Blk. 69, PSL Sur.	3-18-36 4565 5000±	Jones (1949)	TD in Pennsylvania
16	Amoco Prod. Co.	V.C. Rounsaville "A" #1	Sec. 1, Blk. 107, PSL Sur.	12-7-76 4074 11,200	Midland Log Library	Density Log
17	American Quasar Pet. Co.	V.C. Rounsaville #1	Sec. 13, Blk. 108 PSL Sur.	5-12-73 3865 15,000	UTEP Log Files	Bone Spring (-662) Wolfcamp (-5052) Woodford (-9862) Silurian-Devonian (-10,042)
18	Standard Oil Co. of Tx.	M.V.C. Rounsaville #1	Sec. 8, Blk. 106, PSL Sur.	8-12-68 4933 8400	Midland Log Library	

Table 1. (continued)

No.	Company	Well	Location	Date Elev (ft) TD (ft)	Source	Tops (ft) (referred to sea level)
19	Gulf Oil Corp.	M.A. Grisham #1	Sec. 18, Blk. 99 PSL Sur.	7-23-48 5674 6000	WTGS Feild Trip Guidebook (1960)	Bone Spring (+4554) Woodford (+1704) Montoya (+359) Ellenburger (-136)
20	El Paso Co.	No. 1 Montgomery	Sec. 17, Blk. 100 PSL Sur.	7-31-53 4495 6613	WTGS Pre-Miss. x-section (1955)	Woodford (-190) Montoya (-1325) Ellenburger(-1985)
21	Sinclair	Looney	Sec. 22, Blk. 97, PSL Sur.	12-2-60 4298 8770	UTEP Log Files	Bone Spring (+1328) Wolfcamp (-752) Devonian (-4217)
22	I.W. Lovelady	Veale #1	Sec. 20, Blk. 91, PSL Sur.	7-15-58 4587 2271	UTEP Log Files	Delaware (+2481)
23	I.W. Lovelady	J.B. Foster #1	Sec. 10, Blk. 89, PSL Sur.	9-13-58 4130 2809	UTEP Log Files	Delaware (+1519)
24	Fred A. Davis West and Armour	Davis #1	Sec. 5, Blk. 86, PSL Sur.	9-24-=59 3760+ 8201	Midland Log Library	Montoya (+2160) (approx.) Ellenburger (+60) (approx.)
25	Continental Oil Co.	J.B. Foster #1	Sec. 24, Blk. 88 PSL Sur.	6-5-52 4127 5270	WTGS Field Trip Guidebook (1960)	Bone Spring (+1314) Woodford (+734) Montoya (+9) Ellenburger (-706)
26	Gulf Oil Co.	J.B. Foster C #1	Sec. 2, Blk. 62, PSL Sur.	8-21-69 4134 5100	UTEP Log Files	
27	Sun Ray Mid-Cont. Oil Co.	J.B. Foster #1	Sec. 22, Blk. 62, PSL Sur.	12-10-61 4589 4049	Midland Log Library	Density Log
28	Humble Oil & Ref. Co.	Reynolds Cattle Co. "B" No. 1	Sec. 33, Blk. 62, PSL Sur.	6-24-43 5060 5417	WTGS Field Trip Guidebook (1960)	Wolfcamp (+1980) Ellenburger (+650) Bliss (-280)
29	La Gloria Oil & Gas Co.	Stansbury No. 1	Sec. 5, Blk. 82, PSL Sur.	4-19-56 3833 3245	UTEP Log Files	Wolfcamp (+1484) Ellenburger (+804)
30	Cosden Pet. Corp.	Cockrell #1	Sec. 7, Blk. 80 PSL Sur.	9-19-53 4014 3700	McCunn, et al. (1962) and UTEP Log Files	Heuco (+1779) Pow Wow (+1474) Precambrian (+1072)
			Hudspeth County, Texas			
1	Hunt Petro Corp.	C.L. Ranch #5	Sec. 5, Blk. 67, T-1; T & P Sur.	11-15-76 3640 5506	Hunt Energy Corp.	San Andres (+1484) Yeso (+1114) Abo (-91) Wolfcamp (-904)
2	Magnolia Petro. Corp.	Univ. 39881 #1	Sec. 19, Blk. C, Univ. Lands Sur.	7-30-53 5031 5420	Midland Log Library	El Paso (+840) Bliss (-330)
3	Pan Amer. Petro. Corp.	List Anderson #1	Sec. 23, Blk. 68, T-1; T & P Sur.	6-2-61 3634 6630	Hunt Energy Corp.	San Andres (+3055) Pow Wow (1165) Ellenburger (+1095) PreE (Hazel) (+665)
4	Hunt Petro. Corp.	C.L. Ranch #1	Sec. 44, Blk. 67, T-1; T & P Sur.	10-8-76 3624 5232	Hunt Energy Corp.	San Andres (+2515) Abo (+790) Wolfcamp (-1905) Silurian (-1428)

Table 1. (continued)

No.	Company	Well	Location	Date Elev (ft) TD (ft)	Source	Tops (ft) (referred to sea level)
5	Pan Amer. Petro. Corp.	Ed Hammock #1	Sec. 4, Blk. 67, T-2; T & P Sur.	8-7-62 3642 7060	Hunt Energy Corp.	Abo (+436) Wolfcamp (-192) Woodford (-1905) Ellenburger (-3295)
6	General Crude	Merril-Voyles #1	Sec. 8, Blk. 69, T-2; T & P Sur.	11-18-52 3866 4794	Flawn (1956) and UTEP Log Files	Yeso (+2689) Devonian (+1409) Ellenburger (+224) Precambrian (-908)
7	Albert R. Jones	Mowry No. 1	Sec. 36, Blk. 70, T-2; T & P Sur.	5-29-46 4040 4518	Jones (1949)	El Paso (-100)
8	Robertson Co., Inc.	Mowry	Sec. 47, Blk. 70, T-2; T & P Sur.	12-11-55 4010 4150	Midland and UTEP Log Library	Woodford (+1289) Montoya (+229) Ellenburger (+92)
9	Faith Minerals, Inc.	1 Westly West	Sec. 36, Blk. 118 PSL Sur.	1-11-77 3621 10,740	Midland Log Library	TD in Ellenburger
10	Hassle Hunt Trust	Univ. M-49 #1	Sec. 9, Blk. M Univ. Lands Sur.	10-21-69 4910 8250	UTEP Log Library	Bliss (-2970) Precambrian (-3310)
11	Kewanee Oil Co.	Moseley A #1	Sec. 15, Blk. 17 PSL Sur.	7-1-75 4998 5053	Midland Log Library	
12	Hassle Hunt Trust	Mosely #1	Sec. 27, lk. 24 PSL Sur.	1-30-70 4748 5702	Midland Log Library	Fusselman (+1618) El Paso (+720)
13	Gulf Oil Corp.	No. 1 Burner State	Sec. 14, Blk. 19 PSL Sur.	2-24-63 4642 9224	Dennison & Hether- ington (1969) and UTEP Log Files	Wolfcamp (-1242) El Paso (-2697) Bliss (-3907) Density Log
14	Stanolind Oil & Gas Co. American Land	No. 1 Roseborough	Sec. 7, Blk. 21 PSL Sur.	1929 4799 1789	Dennison & Hether- ington (1969)	Precambrian ? (+3199)
15	U.S. Geol. Survey	J.C. Davis #1 Water Test	Sec. 26, Blk. 67, T-9; T & P Sur.	10-2-74 4188 2019	Midland Log Library	TD in Bolson fill Density Log
			Otero County, New Mexico			
1	Standard of Texas	No. 1 Scarp	Sec. 18, TWP. 21S Rge. 18E	1948 5340 2664	Dennison & Hether- ington (1969) and Flawn (1956)	Precambrian (+2760)
2	Le Fores	No. 1 Federal	Sec. 22, Twp. 21S Rge. 16E	5300+ 2255	Dennison & Hether- ington (1969)	Approx. Precambrian (+3070)
3	W R. Weaver	Thompson #1	Sec. 9, Twp. 23S Rge. 19E	6-19-62 4545 3848	Midland Log Library	Woodford (+1752) Ellenburger (+867)
4	Campbell	#1 McMillan	Sec. 15, Twp. 23S Rge. 19E	3-28-61 4327 3189	Midland Log Library	Woodford (+1164) Fusselman (+1150)
5	Coral	No. 1 Warren	Sec. 19, Twp. 23S Rge. 18E	2353	Dennison & Hether- ington (1969)	
6	Turner	No. 1 State	Sec. 36, Twp. 25S Rge. 16E	1-13-60 4312 5195	Dennison & Hether- ington (1969)	Precambrian (+1208)

Table 1. (continued)

No.	Company	Well	Location	Date Elev (ft) TD (ft)	Source	Tops (ft) (referred to sea level)
7	E.J. Dunigan, Jr.	Alpha Federal #1	Sec. 31, Twp. 25S Rge. 19E	4-10-70 3792 4998	Hunt Energy Corp.	Wolfcamp (-208) Woodford (-942) Silurian (-1018)
8	Hunt Petro. Co.	McMillan-Turner #1	Sec. 5, Twp. 26S Rge. 16E	1943 4165 2176	Dennison & Hetherington (1969) and Flawn (1956)	Precambrian (+2090)
			Eddy County, New Mexico			
1	Magnolia	No. 1 State "W"	Sec. 16, Twp. 21S Rge. 22E		Dennison & Hetherington (1969)	Precambrian interval 11,230-11,312
2	Humble Oil Co.	No. 1 Huapache	Sec. 35, Twp. 23S Rge. 22E	12,631	Dennison & Hetherington (1969)	TD in Precambrian
3	Humble Oil Co.	No. 2 Huapache	Sec. 23, Twp. 23S Rge. 22E	12,582	Dennison & Hetherington (1969)	TD in Precambrian

Sandstone. The Van Horn Sandstone and underlying units were tilted and faulted before deposition of the Cambrian–Ordovician Bliss Sandstone.

According to LeMone (1969), during the Cambrian–Ordovician period in this area a complex series of transgressions and regressions occured, the El Paso limestone group to the west and the laterally equivalent Ellenburger Group to the east were deposited. The Upper Ordovician Montoya group rests on an angular unconformity throughout the study area and is overlain unconformably by Silurian rocks. South of the study area, the Ouachita–Marathon and Devonian time the study area was included in the subsiding Tobosa Basin (Galley, 1958) which provided the depositional environment for the dolomite, limestone and shale units being formed. A major uplift occurred toward the east during Mississippian time and formed the Central Basin Platform which split the Tobosa Basin into the Midland and Delaware Basins. Pennsylvanian time saw the development of wide carbonate reefs along the basin rims (Hills, 1972). During Permian time, great thicknesses of limestones with some sands and shales were deposited filling in the Delaware Basin. Eventually these sediments restricted circulation and high limestone reefs were formed (the Capitan reef). Also, sequences of evaporites began to form. The evaporation process continued until the close of the Permian going nearly to completion in the northeastern Delaware Basin as evidenced by sylvite deposits located southeast of Carlsbad, New Mexico.

Little or no Triassic and Jurassic sediments are present in the study area, but Cretaceous limestones, sandstones, and shales have been deposited on the eroded Paleozoic strata of the Diablo Plateau and southwestern Delaware Basin.

The Tertiary was a time of volcanism, intrusive activity and block faulting. These events are discussed elsewhere in this guidebook.

TECTONIC SETTING

The oldest tectonic features in the area are in the Precambrian rocks of the Carrizo and Van Horn Mountains. King (1940) suggests that two episodes of folding and thrusting occurred in the Precambrian, probably originating from a geosyncline that was deformed before the beginning of the Paleozoic. The Streeruwitz fault and metamorphic textures are used as evidence of this Precambrian tectonism.

The much-debated Texas Lineament passes through the southern end of the study area. Muehlberger (1965) reported that this feature represented a large-scale, Late Paleozoic, right-lateral, strike-slip fault zone as evidenced by displacement of basement provinces across this zone. Wiley (1970) further investigated this feature in the Van Horn area and concluded, on the basis of geophysical, as well as geologic, data that it represents a zone of Late Paleozoic faulting that has remained a weak influence on later structural trends in the surrounding basins and platforms. Wiley (1970) further states that geophysical evidence points against large strike-slip displacement.

King (1948) studied the Late Paleozoic tectonism in the Salt Basin area. His study showed that the Sierra Diablo region was uplifted and faulted during the Pennsylvanian while the Guadalupe–Delaware Mountain area remained stable. During the Permian, the Babb, Victorio and other flexures (fig. 1) developed parallel to Pennsylvanian structures. These flexures seem to represent zones of weakness along which sinking of the Delaware Basin took place, as evidenced by reef zones in portions of the flexures and deep-water deposition on the lower sides of these flexures (King, 1948). Muehlberger and others (1978) have identified these same flexure zones as being recently faulted along some portions of their extent.

During the Mesozoic, minor movement probably occurred in the southern Sierra Diablo as evidenced by faulting north of a Precambrian inlier in this area (King, 1948). Farther to the southwest, in Mexico, the Chihuahua Tectonic Belt was being deformed at this time and may have been influenced by the presence of the Diablo Platform.

During the Cenozoic, the area was uplifted and large fault blocks were broken off to form the present-day mountain ranges in the area (e.g., the Baylor Mountains). These fault blocks were downdropped and tilted forming complex grabens or "half-grabens" which at present underlie the basins in the area (Wiley, 1970). Thus, the area has become associated with the Basin and Range Province of the western United States and is the southeastern limit of that province.

Tertiary volcanics ranging in age from 16 to 46 m.y. old have been implaced in scattered positions throughout Trans-Pecos Texas but in a rather broad northwest-southeast trend. These scattered volcanics seem to outline the margin of the Diablo Plateau while being more heavily concentrated south of the study area in the Davis Mountains and Big Bend region. These volcanic centers are believed to have originated as a result of the subduction of the eastern edge of the Pacific plate as it passed beneath the overriding North American plate (Barker, 1979).

The Rio Grande rift may extend into the study area, and Seager and Morgan (1979) have presented a summary of the current knowledge accumulated on the Rio Grande rift and its possible southern extent. They conclude that the rift exists as an upper mantle or asthenospheric upwarp which is responsible for the high heat flow values, recent volcanism, exceptionally deep basins and late Quaternary faulting observed along its surface extent.

The southern extent of the rift system is a topic of debate and Seager and Morgan (1979) place the most likely southern end at the Los Muertos Bolson in northern Chihuahua and at the east margin of the Hueco Bolson near El Paso. The Salt Basin lies farther to the east of these defined limits but may have been affected by the rift. An intriguing aspect of the Salt Basin graben is the evidence for recent tectonism. Muehlberger and others (1978) have discussed the late Quaternary faulting present and concluded that these active faults (generally north-south trending with as much as 5 m of displacement) nearly all occur along pre-existing structures. Further evidence provided by Reilinger and others (1980) on a releveling survey of benchmarks from Carlsbad, New Mexico to El Paso, Texas shows some interesting results. A first-order resurvey revealed departures in measurements from those of previous first-order surveys. The Diablo Plateau region was discovered to have risen some 19 cm between 1934-1977, while the Salt Basin has subsided some 4 cm since 1957. Reilinger and others (1980) conclude that this movement is most likely of tectonic origin.

Heat-flow data in the study area are quite sparse (Taylor and Roy, this guidebook). However, as heat generated in the lower crust is estimated to take 10 m.y. to propagate to the surface, the Salt Basin area may not yet have received any measureable amounts of heat from the Rio Grande rift system, if present.

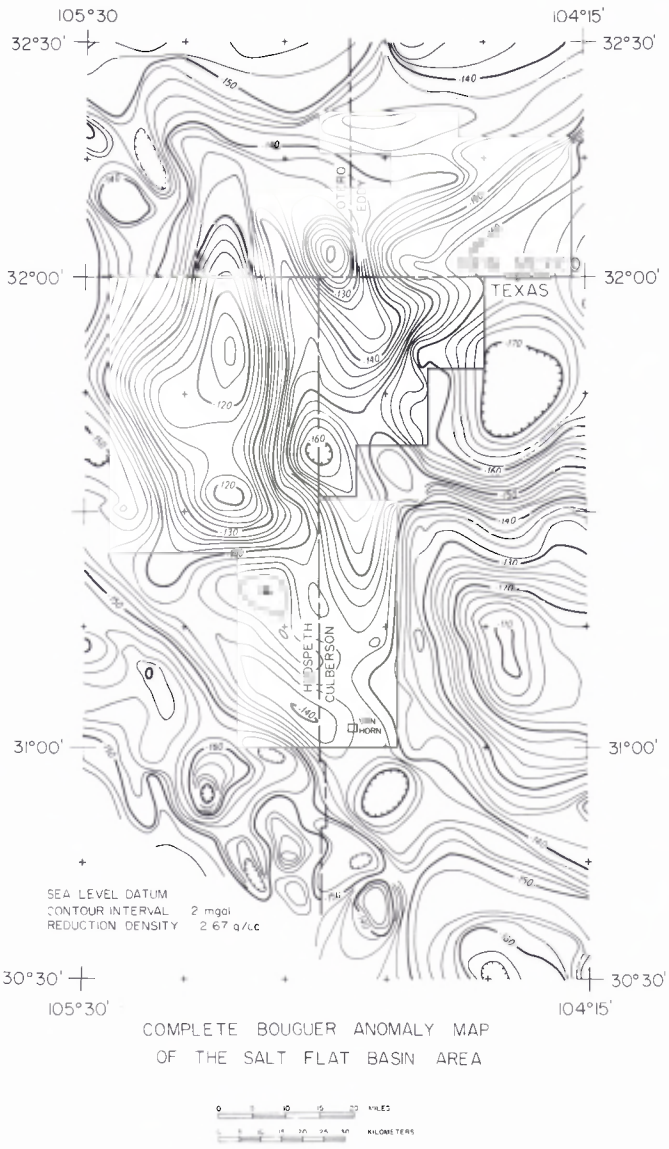


Figure 3. Gravity map of the study area.

GEOPHYSICAL DATA

A total of over 4400 gravity readings were compiled in the study area. In addition to data taken in this study, sources for these data include Mr. Hart Brown, Texas Tech University; Covert (1976); Wiley (1970); and the Defense Mapping Agency. These data were reduced to Bouguer anomaly values by employing standard corrections (Dobrin, 1976) calculated by computer. Principal facts for these data, as well as a detailed description of the reduction process are on open file at the University of Texas at El Paso. The terrain-corrected Bouguer anomaly values were contoured to produce the map shown in Figure 3.

Aeromagnetic data in the area were available through the National Uranium Resource Evaluation (NURE) program and the U.S. Geological Survey (1977). A preliminary map of the NURE data was provided by Oak Ridge National Laboratories. The NURE data were flown along east-west flight lines at a spacing of approximately 5 km. The flight elevation was 150 m above the ground surface. North-south-trending flight lines spaced 3 km apart were used in the survey flown by the U.S. Geological Survey. This survey was flown at an elevation of 300 m above the ground surface. These two data sets were manually merged to produce the map shown as Figure 4. U.S. Geological Survey data were used only for the area south of 31°N latitude.

Subsurface data from all available drill holes were compiled (fig. 2). The tops of various formations were picked and recorded in Table 1. A map of the thickness of fill in the Salt Basin graben was available through the U.S. Geological Survey (Gates and others, 1978).

A few formation density logs were available in the area, and along with density information provided by Keller and others (this guidebook) and Decker and Smithson (1975), average values for the subsurface units modeled were determined.

REGIONAL GRAVITY AND MAGNETIC ANOMALIES

The regional gravity and magnetic maps constructed as part of this study correlate well with the regional geologic features present. The northern Diablo Plateau in Hudspeth County, Texas shows up as both a gravity and magnetic high. As Precambrian rocks outcrop at the Pump Station Hills and Tertiary intrusives are present, this would be expected. However, these anomalies are broad suggesting a possible deep source. The computer modeling

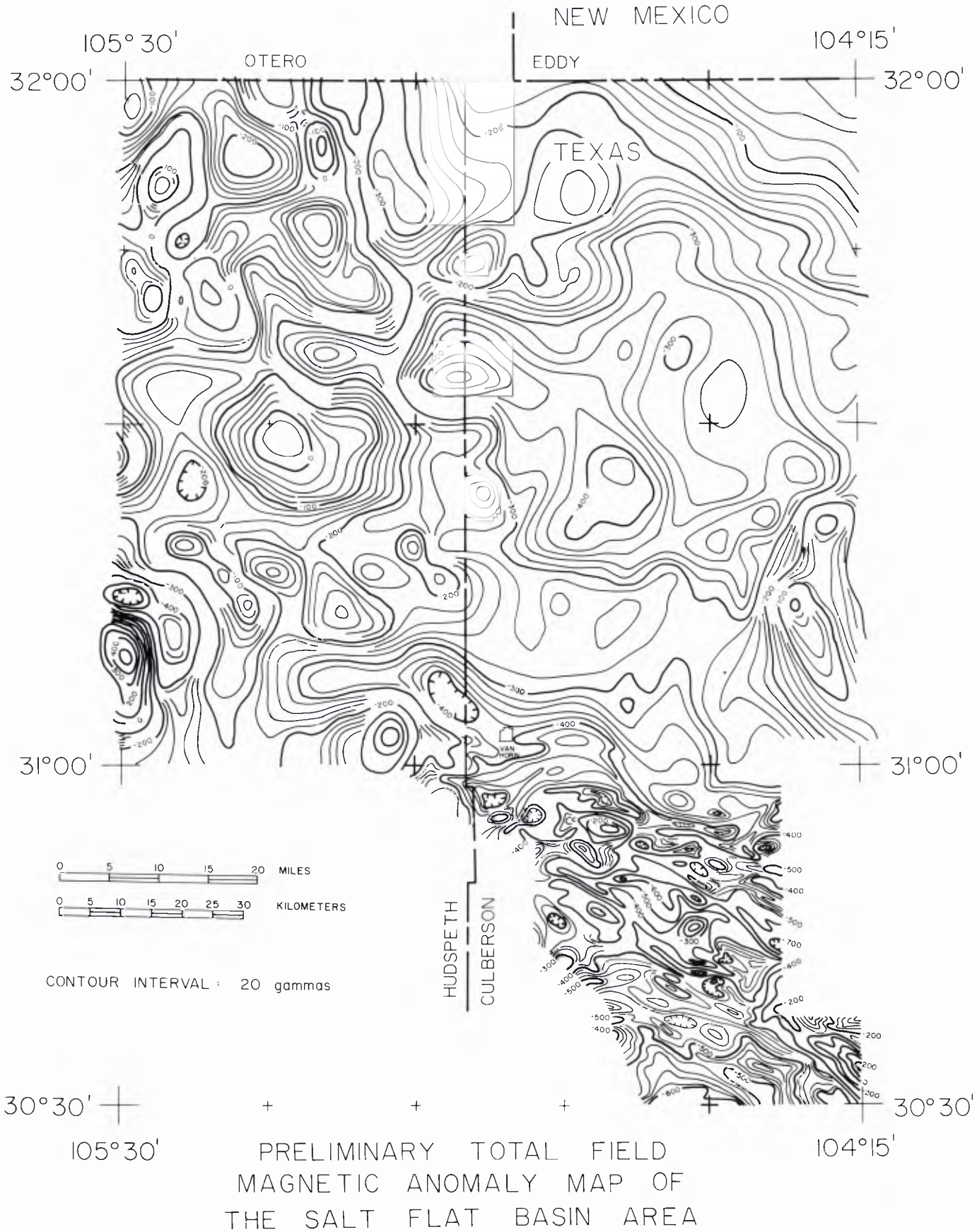


Figure 4. Preliminary aeromagnetic map of the study area. Data north of 31°N latitude were provided by Oak Ridge National Laboratories as part of the National Uranium Resource Assessment program (Bendix Field Engineering Corporation, Grand Junction, Colorado).

indicates the presence of upper crustal high-density material in this area, possibly related to the source of volcanic activity in this area as suggested by Barker (1977).

The Salt Basin graben area is represented by both gravity and magnetic lows trending north-northwest along the surface extent of the basin. The Bouguer gravity map clearly indicates the west boundary fault of the basin along the Sierra Diablo scarp as a steep gravity gradient. The gravity and magnetic maps also indicate a bifurcation of anomalies around the area of the Wylie Mountains. The lowest gravity and magnetic values are observed in the area of the Delaware Basin. These observed anomalies are due to the great thickness of sediments present in the area. An interesting intense northeast-trending gravity high is present in the area of the Apache Mountains. This gravity high must be attributed to an upper crustal density anomaly, because its location in the southern portion of the Delaware Basin precludes a shallow origin.

GRAVITY MODELS

One of the major analyses carried out in this study was computer modeling of gravity profiles (fig. 2) across the Salt Basin graben and adjacent areas. This modeling was carried out employing the technique of Talwani and others (1959). This method computes the theoretical gravitational attraction of any two-dimensional, user-designed polygon through a line integral calculation. The density information and formation tops available from drill holes, as well as the bolson fill data (fig. 5) served as important constraints in the modeling. Thus, the modeling could be considered to be the construction of a geologic cross-section with the aid of geophysical data.

The computer model (model 1) profile A-A′ is shown in Figure 6. This profile runs along U.S. Highway 62 and 31°45′N latitude for some 100 km. This model requires thickening of the crust towards the east under the Permian Basin and implies the transition zone from Basin and Range Province to Great Plains Province could occur in the Salt Basin area. Low-density mantle material (3.2 gm/cc) is implaced at the western end of the profile and indicates the presence of mantle material associated with the Rio Grande rift system. The high-density (2.9) upper crustal block under the central Diablo Plateau confirms, as Barker (1977) earlier suggested, a high-density subsurface source for the Tertiary volcanics in the area.

Model 2 for profile A-A′ (fig. 6) is an attempt to model the Salt Basin graben proper. For this model residual gravity values were calculated by removing a linear regional gravity trend. These residual values better reflect the gravitational effect of near-surface features. Model 2 clearly indicates the steeply dipping western boundary fault of the Salt Basin graben and more complex faulting associated with its eastern margin. The depth to Precambrian basement in the lowest portion of the graben is approximately 2.9 km.

Profile B-B′ runs along Interstate Highway 10 and 31°30′N latitude for some 60 km from west of Van Horn to east of Kent, Texas (fig. 7). The subsurface configuration in this area has been modeled to 10 km and demonstrates the bifurcation of the Salt Flat Basin around the upthrown block of the Wylie Mountains. An intrusion is indicated in the Carrizo Mountain area where a gravity low coincides with outcrops of metamorphic rocks. An intrusion which is most likely associated with the Davis Mountain volcanics just to the south is also indicated in the eastern portion of the model. The depth to Precambrian basement is indicated as being approximately 2 km in the deepest areas underlying Lobo Flat and Michigan Draw. An intense gravity high is indicated as being present in the eastern portion of the profile. This large upper crustal mass masks any effects of possible crustal thickening in this area.

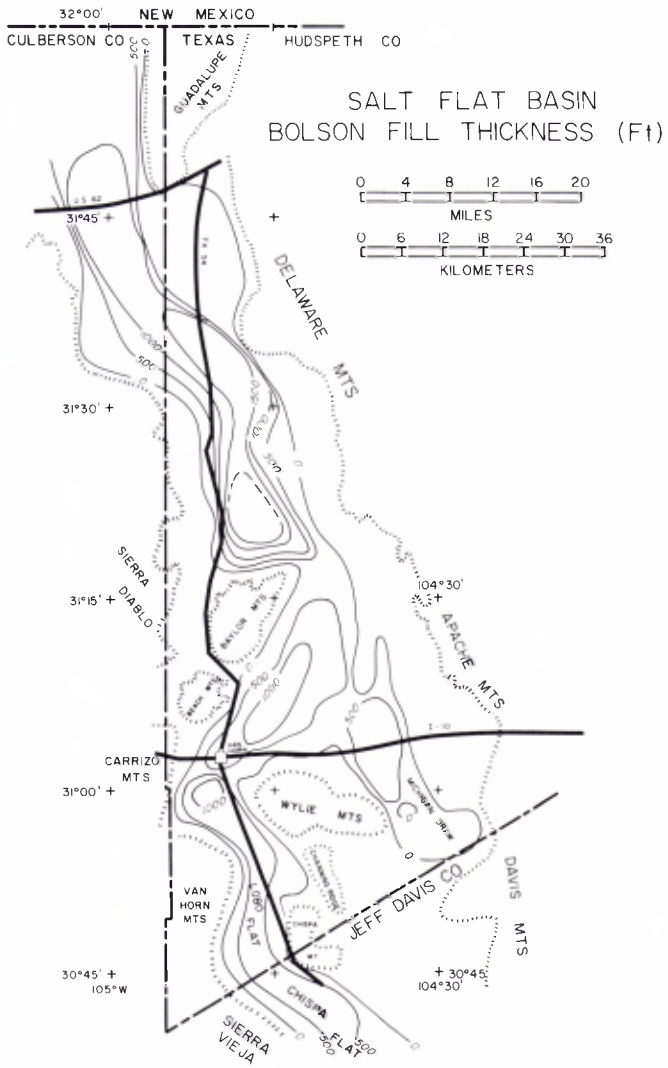


Figure 5. Map of the distribution of bolson fill. Modified from Gates and others (1978).

CONCLUSIONS

The geological and geophysical data reviewed and presented here attest to the structural complexity of the Salt Basin area. There is evidence for Precambrian tectonism with continued activity right up to contemporary vertical movements. The area is presently in a transition zone from relatively thin crust associated with the Basin and Range Province and Rio Grande rift to the thick crust of the Great Plains. The gravity data suggest that this transition occurs very near the Salt Basin, but deep seismic soundings are badly needed.

The exact relations are not clear, but the large volume of pre-Cenozoic strata preserved within the Salt Basin and the fact that the basin fill is generally less than 500 m thick suggests a pre-Cenozoic origin for this basin with a complex history of vertical movements. The contemporary vertical movements and Quaternary fault scarps in the area suggest that the relation of this feature to the Rio Grande rift is worth further investigation. Several major upper crustal anomalies are indicated which also may have considerable significance.

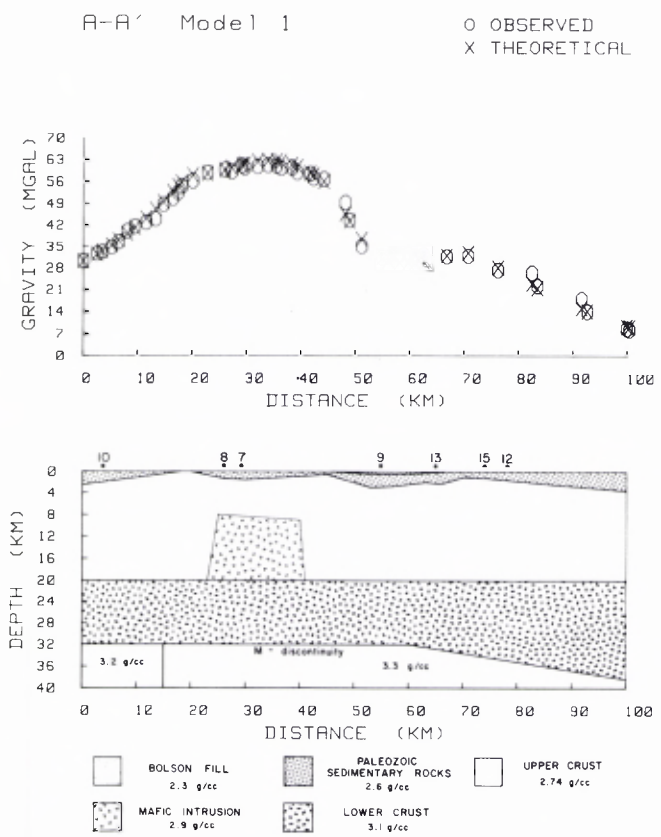


Figure 6a. Computer model for profile A-A′, Model 1. Numbered dots correspond to well control shown in Figure 2.

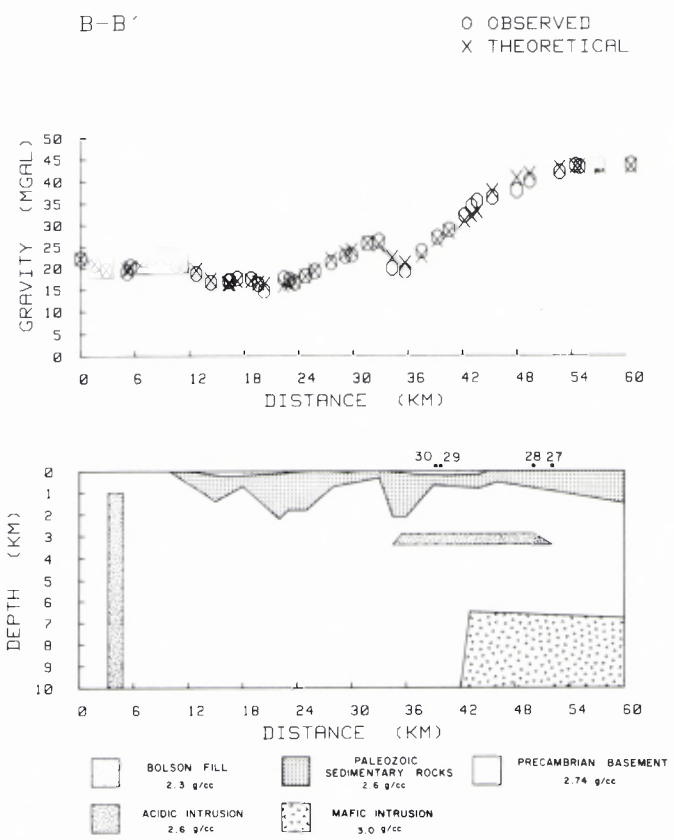


Figure 7. Computer model for profile B-B′, Figure 2.

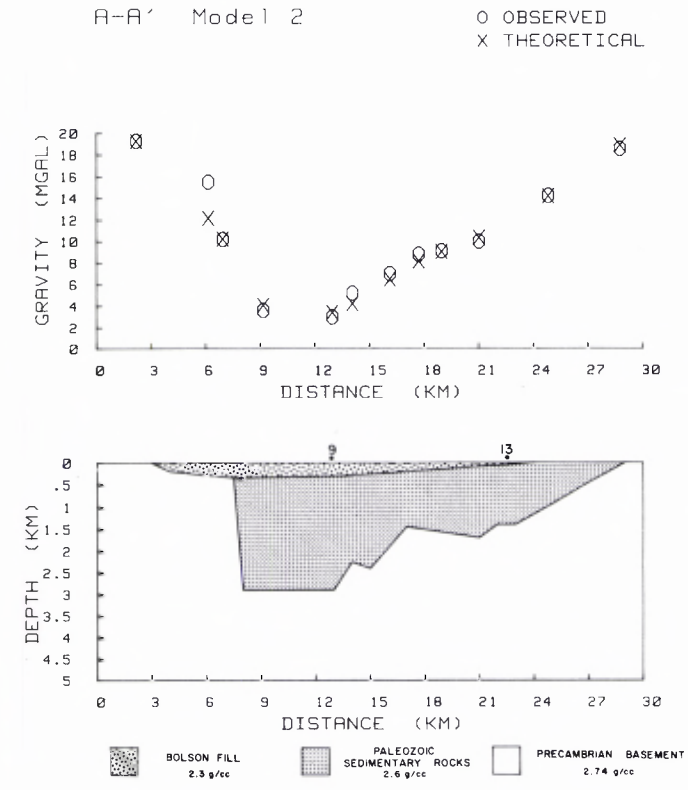


Figure 6b. Profile A-A′, Model 2.

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REFERENCES

Barker, D.S., 1977, Northern Trans-Pecos magmatic province: Introduction and comparison with the Kenya rift: Geological Society of America Bulletin, v. 88, p. 1421-1427.

———, 1979, Cenozoic magmatism in the Trans-Pecos Province: Relation to the Rio Grande rift, *in* Rio Grande rift: Tectonics and magmatism: American Geophysical Union, Washington, D.C., p. 382-392.

Covert, L. L., 1976, A gravity and tectonic study of Trans-Pecos Texas (M.S. thesis): University of Kentucky, Lexington, 64 p.

Decker, E. R. and Smithson, S. B., 1975, Heat flow and gravity interpretation across the Rio Grande rift in southern New Mexico and West Texas: Journal of Geophysical Research, v. 80, p. 2542-2552.

Denison, R. E. and Hetherington, Jr., E.A., 1969, Basement rocks in far West Texas and south-central New Mexico: *in* Border Stratigraphy Symposium, New Mexico Bureau of Mines and Mineral Resources, Circular 104, p. 1-16.

Dobrin, M. B., 1976, Gravity field measurements and reduction, *in* Introduction to Geophysical Prospecting: McGraw-Hill, Inc., New York, p. 404-434.

Galley, J. E., 1958, Oil and geology in the Permian Basin of Texas and New Mexico: *in* Habitat of Oil, American Association of Petroleum Geologists, Special Publication, p. 395-446.

Gates, J. S., White, D. E., Stanley, W.D. and Ackermann, H.D., 1978, Availability of fresh and slightly saline ground water in the basins of westermost Texas: U.S. Geological Survey Open-File Report 78-663, 115 p.

Hills, J. M., 1972, Late Paleozoic sedimentation in West Texas Permian Basin: American Association of Petroleum Geologists Bulletin, v. 56, p. 2303-2322.

Jones, T. S., 1949, East-west cross-section through southern Permian Basin of West Texas: West Texas Geological Society, 1949.

King, P. B., 1940, Older rocks of Van Horn Region, Texas: American Association of Petroleum Geologists, Bulletin, v. 24, p. 143-156.

———, 1948, Geology of the southern Guadalupe Mountains, Texas: U.S. Geological Survey, Professional Paper 215, 183 p.

LeMone, D. V., 1969, Cambrian-Ordovician in El Paso border region, *in* Border Stratigraphy Symposium: New Mexico Bureau of Mines and Mineral Resources, Circular 104, p. 17-25.

McCunn, J. H. and Walker, R.D., 1962, General geologic relationships between outcrops of the Diablo Plateau Region and the subsurface of the Permian Basin of West Texas, *in* Leonardian facies of the Sierra Diablo region West Texas: Permian Basin Section Guidebook, 1962 Field Trip, Society of Economic Paleontologists and Mineralogists, p. 91-103.

Muehlbergber, W. R., and Belcher, R. C. and Goetz, L.K., 1978, Quaternary faulting in Trans-Pecos Texas: Geology, v. 6, p. 337-340.

———, 1965, Late Paleozoic movement along the Texas Lineament: Transactions, New York Academy of Science, ser. 11, v. 27, p. 385-293.

Reilinger, R., Brown, L. and Powers, D., 1980, New evidence for tectonic uplift in the Diablo Plateau Region, West Texas: Geophysical Research Letters, v. 7, p. 181-184.

Seager, W. R. and Morgan, P., 1979, Rio Grande rift in southern New Mexico, West Texas, and northern Chihuahua, *in* Rio Grande rift: tectonics and magmatism, American Geophysical Union, Washington, D.C., p. 87-106.

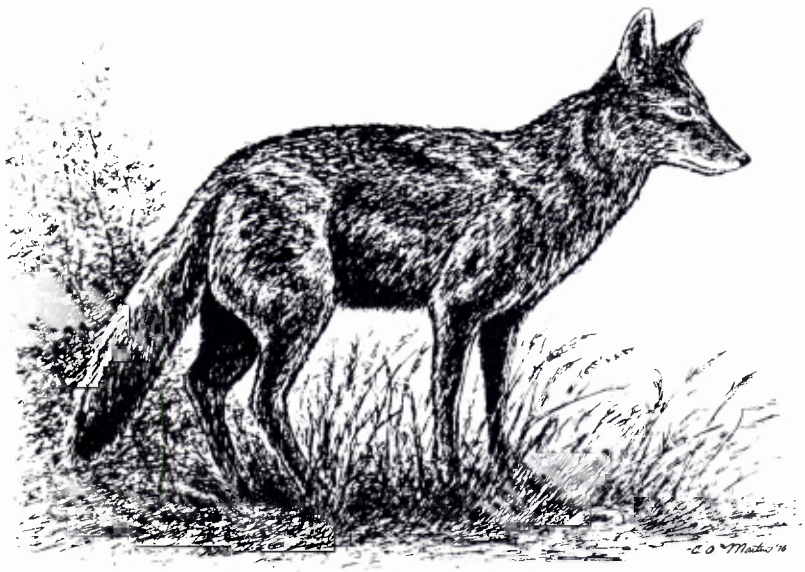
Talwani, M., Worzel, J. L. and Landisman, M., 1959, Rapid gravity computations for two-dimensional bodies with application to the Mendocino Submarine Fracture Zone: Journal of Geophysical Research, v. 64, p. 49-59.

U. S. Geological Survey, 1977, Aeromagnetic map of the Salt Basin area, Texas: U.S. Geological Survey, Open-File Report, p. 77-231.

West Texas Geological Society, 1955, Pre-Mississippian cross-section: Stratigraphic Problems Committee.

———, 1960, Geology of the Delaware Basin and field trip guidebook: p. 91-92.

Wiley, M. A., 1970, Correlation of geology with gravity and magnetic anomalies, Van Horn-Sierra Blanca region, Trans-Pecos, Texas (Ph.D. thesis): University of Texas, Austin, 329 p.



Coyote, *Canis latrans*.