Giant desiccation polygons in Wildhorse Flat, west Texas

Lisa K. Goetz

1980, pp. 285-287. https://doi.org/10.56577/FFC-31.285

in:

Trans Pecos Region (West Texas), Dickerson, P. W.; Hoffer, J. M.; Callender, J. F.; [eds.], New Mexico Geological Society 31st Annual Fall Field Conference Guidebook, 308 p. https://doi.org/10.56577/FFC-31

This page is intentionally left blank to maintain order of facing pages.

GIANT DESICCATION POLYGONS IN WILDHORSE FLAT, WEST TEXAS

LISA K. GOETZ
Conoco Inc.
Minerals Department
9301 Indian School Rd. NE, No. 210
Albuquerque, New Mexico 87112

INTRODUCTION

Giant polygonal contraction cracks have developed in a restricted portion of the Salt Basin playa. These fractures are located in "Wildhorse Flat" on the terminus of an alluvial fan originating in the eastern Baylor Mountains at 31°15′ N latitude, 104°43′ W longitude (figs. 1 and 2).

They were first noticed on a 1946 Edgar Tobin aerial photograph and again on a 1953 aerial photograph. Pratt (1958) photographed and discussed the growth of these features. Underwood and DeFord (1975) described the Baylor Mountain fractures and compared them to those on Eagle Flat, West Texas. In February, 1977, I flew over and photographed these polygons. Figure 3 shows the development of the fractures sketched from aerial photographs taken in 1946, 1953, 1957, 1961, and 1977.

The long history of drought in the region is well documented. Groundwater level is a critical factor in the development of giant desiccation cracks and the combination of drought and pumping for irrigation strongly affects its position. Figure 4 shows a plot of the water-level fluctuations in the wells of Hudspeth and Culberson Counties. Only selected wells were measured by the Texas Water Development Board; they were not measured every year, nor were they checked at regular intervals. It is important to note that the number of wells has increased greatly and that they draw water from several different aquifers.

It can be observed that for all but six years (1949, 1955, 1956, 1961, 1966, 1972) since records began to be kept in 1948, the number of wells in which the water level fell three meters exceeded or equaled the number of wells in which the water table rose three meters.

Water well 47-43-701 pumps from the Salt Basin aquifer; it is less than a kilometer north of the giant contraction cracks. Water-level fluctuations indicate the conditions under which the fractures grew: The water level fell twelve meters between 1953 and 1964. It rose nine meters between 1964 and 1965. Between 1965 and 1970 the water table remained within a half meter of the 1965 level. The level fell four and one-half meters in the year 1970 to 1971 and rose the same amount in the ten months between February and December, 1971, (Texas Water Development Board, 1977).

ORIGIN OF BAYLOR MOUNTAIN POLYGONS

The most important process contributing to the formation and growth of the giant contraction cracks at the base of the Baylor Mountains is desiccation. Prolonged drought in Salt Basin and the increasing rate of water withdrawal in the Wildhorse subbasin combine to create a severe drying effect both on the playa surface and in the subsurface.

Resistivity work by White and others (1977) indicates a large percentage of clay in the soils fractured by desiccation. The soils of the playas and fans in the Wildhorse subbasin are rich in carbonates, particularly calcite, as they are weathered from the limestones of the Beach, Baylor, and Apache Mountains, as well as the Diablo Platform. Sheet silicates may have been derived from the sandstone units and talc deposits farther upstream from the playas. Thus, the soils supporting these fractures exhibit many of the characteristics indicated by Langer and Kerr (1966) as conducive to desiccation fracturing.

Three geologic processes are suggested as possible causes of the stresses necessary to produce the observed orthogonal pattern of the desiccation cracks. The simplest explanation is that the fractures are relict, inherited from the drying of Pleistocene lakes. The original fractures would have paralleled the receding lakeshore, while secondary fractures would have developed orthogonal to the lakeshore. However, the present fracture patterns are not confined within the boundaries of the older lakes; instead, the fractures appear only on the west side of the subbasin in three or

Figure 1. Looking east across the northern half of the giant desiccation cracks in the Baylor Mountain fan. Light-colored line crossing north-south is a ranch road.

Figure 2. Looking east across the southern half of the desiccation cracks in the Baylor Mountain fan. The Apache Mountains are on the horizon.

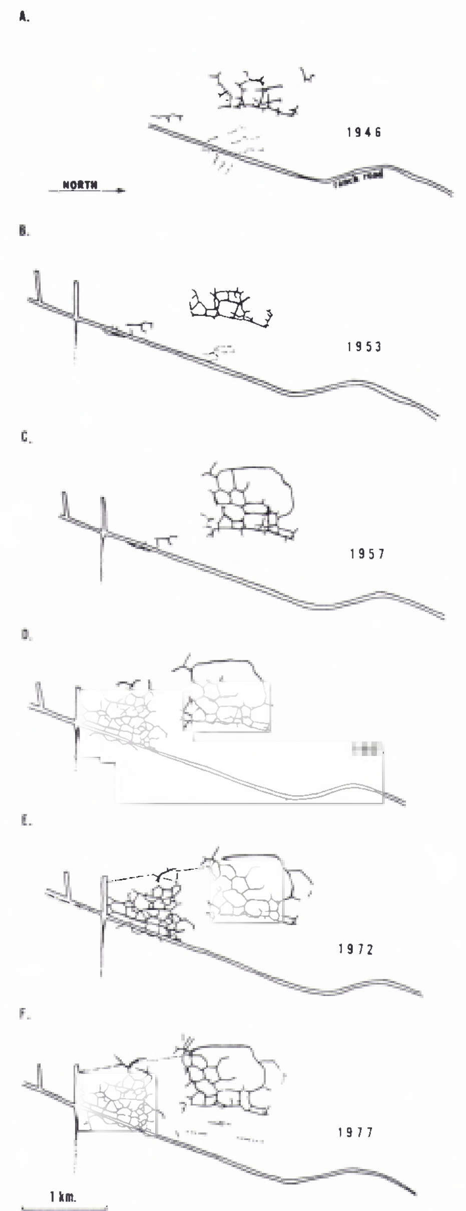


Figure 3. Orthogonal views of the desiccation cracks, sketched from aerial photographs taken in years indicated.

possibly four locations. Primary fractures are aligned subparallel to north-trending fault scarps left by Quaternary tectonism (fig. 5).

A second possibility is that continuing subsidence of the western side of the basin floor, coupled with the lowering of the piezometric surface by drought and pumping, could cause the groundwater surface to withdraw down a slope. This would also create an orthogonal pattern similar to that described for the drying Pleistocene lakes, but the cracks would be more likely to form along the west side than around the entire basin perimeter.

The singular parallelism of the primary fractures leads one to suspect a third possible mechanism, interaction with a fault cutting older Holocene alluvium. If such a fault exists, the related gouge would act as a semipermeable boundary along the western edge of the subsiding basement block; the fault would disturb the radial tension field produced by simple basin subsidence coupled with the drying of a playa lake bed. Uneven subsidence in the alluvium across the faulted basement blocks would increase the tension already present in the capillary zones due to desiccation. If the fault zone acted as a semipermeable barrier, as Kreitler (1976) has described, then horizontal tensions in the alluvial capillary zones would be increased dramatically as aquifers on the upslope side of the fault were recharged by ephemeral streams crossing into the graben, while aquifers on the other side of the fault were depleted by water withdrawal for irrigation.

The network of desiccation cracks at the base of the Baylor Mountains has more than doubled in area since Pratt (1958) reported primary fracture lengths of 600 and 1050 meters. The importance of soil type and the proximity to moisture at depth in controlling the development of these fractures is suggested by the slower propagation rate of the fractures that are exposed to runoff or playa flooding. Fractures on higher ground or farther away from stream courses have grown more quickly.

Soil differences may account for the break in the primary fractures in the polygonal pattern at the base of the Baylor Mountains. A tongue of coarse fanglomerate may cover this area, obscuring the effects of desiccation while transmitting the induced stresses to the clay-rich soils about it.

CONCLUSION

The Baylor Mountain contraction cracks are desiccation features produced in hard calcite-rich clay soils. The polygonal pattern of fractures with some orthogonal trends was caused by an additional east-west tensional stress. This stress probably resulted from recent tectonic subsidence of the basin, coupled with effects of water withdrawal for irrigation. Continued pumping in the basin will probably further increase the area covered by these giant polygonal fractures.

ACKNOWLEDGMENTS

The bulk of the data for this paper comes from master's thesis research; the guidance and encouragement of master's committee chairman, W. R. Muehlberger is asknowledged gratefully. I wish to express special gratitude to the Minerals Department, Conoco, Inc., Albuquerque office and particularly D. W. Wentworth, District Geologist. Field support was from National Aeronautics and Space Administration Grant NSG 7250.

REFERENCES

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

Kreitler, C. W., 1976, Faulting and land subsidence from ground-water and hydrocarbon production, Houston–Galveston, Texas: Proceedings of Second International Symposium on Land Subsidence, Anaheim, CA, December 14-17, 1976, 14 p.

Langer, A. M. and Kerr, P. F., 1966, Mojave playa crusts—physical properties and mineral content: Journal of Sedimentary Petrology, v. 36, no. 2, p. 377-396.

Pratt, W. E., 1958, Large-scale polygonal jointing: American Association of Petroleum Geologists Bulletin, v. 42, no. 9, p. 2249-2251.

Texas Water Development Board, 1977, Open-file report on water well measurements in Hudspeth and Culberson Counties, Texas: Austin, Texas Water Development Board (computer print-out).

Underwood, J. R. and DeFord, R. K., 1975, Large-scale desiccation fissures in alluvium, Eagle Mountain Area, *in* Geology of the Eagle Mountains and Vicinity, Trans–Pecos Texas: Society of Economic Paleontologists and Mineralogists, Permian Basin Section, Guidebook, Publication 75-15, p. 135-139.

White, D. E., Gates, J. S.; Smith, T. J. and Fry, B. J., 1977, Ground-water data for Salt Basin, Eagle Flat, Red Light Draw, Green River Valley and Presidio Bolson, westernmost Texas: U.S. Geological Survey, open-file report 77-575, 14 p.

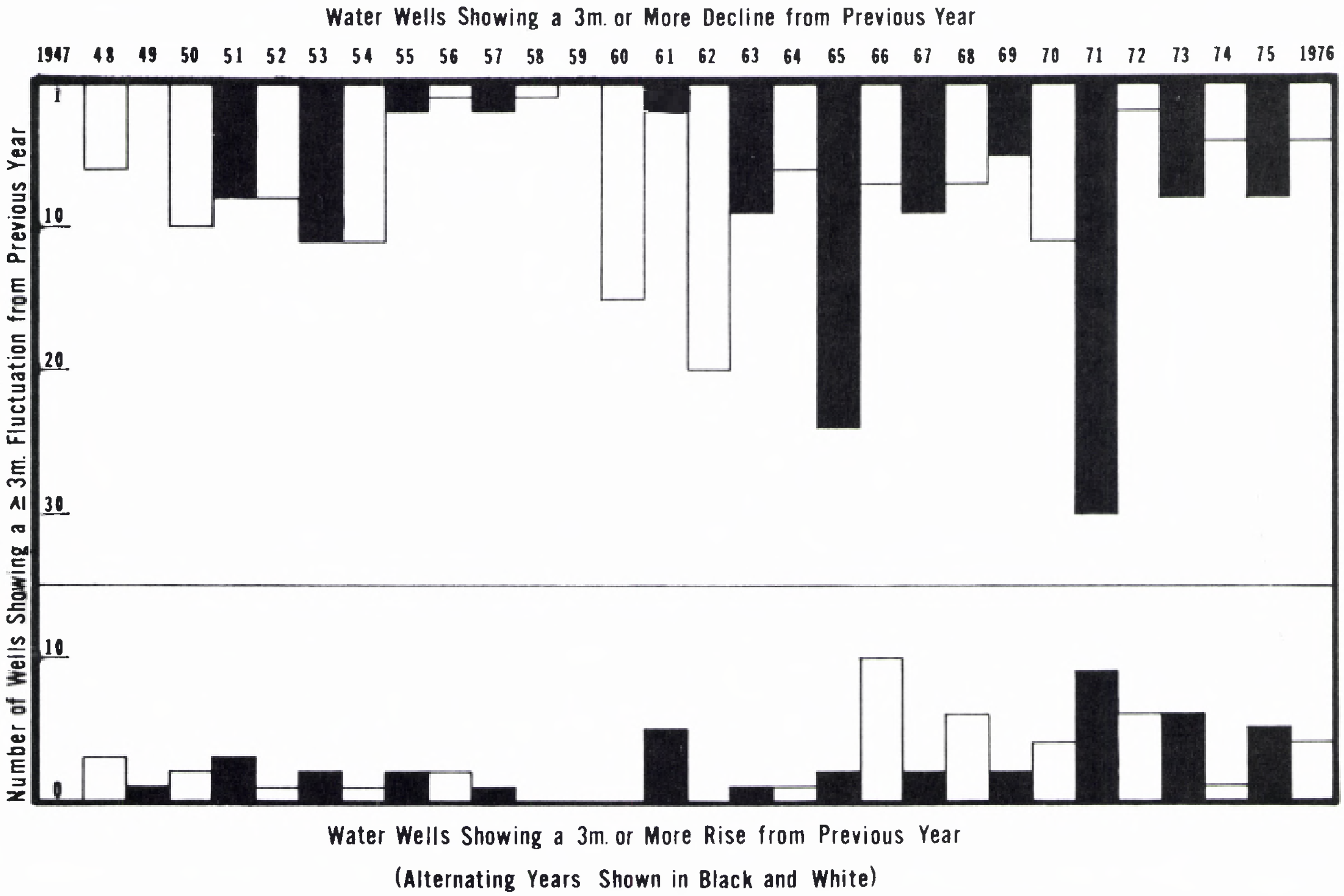


Figure 4. Yearly fluctuations of levels in water wells of Hudspeth and Culberson Counties, Texas (data from Texas Water Development Board).

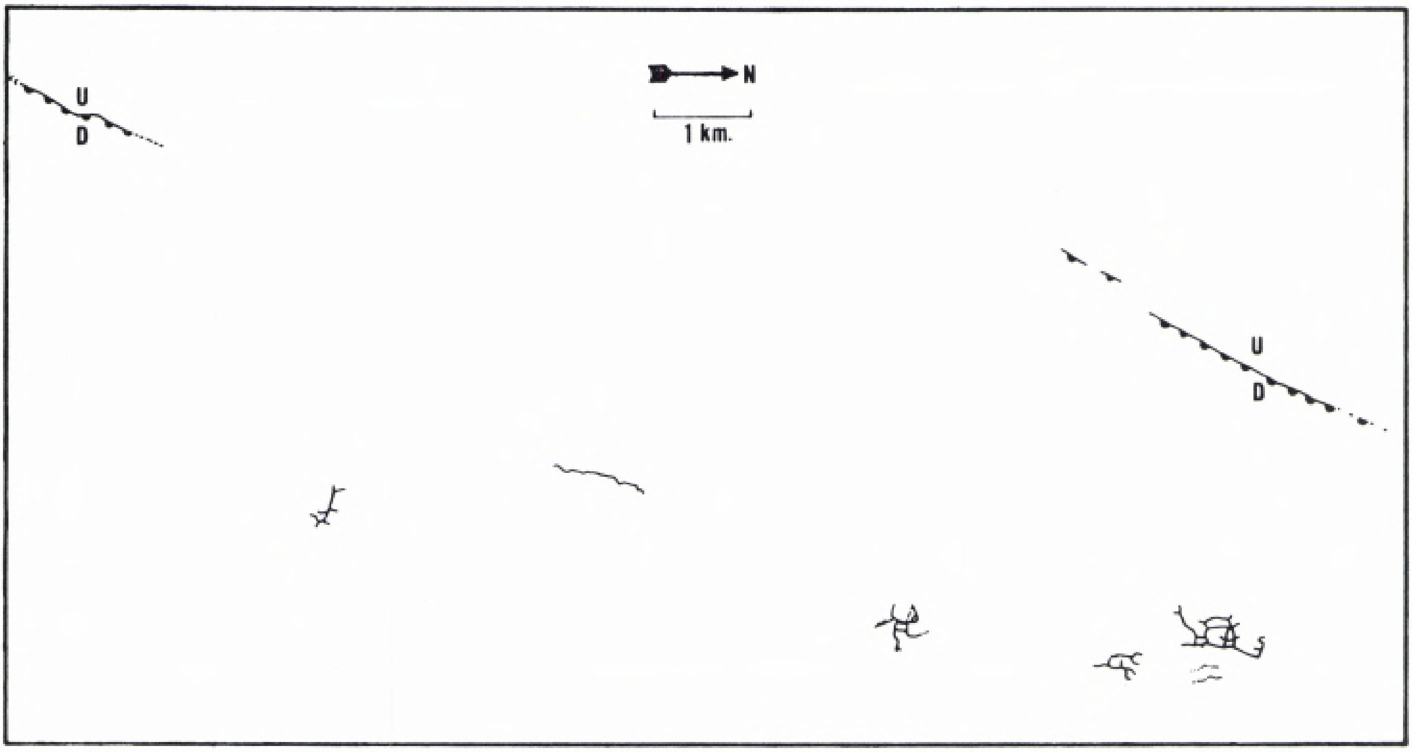
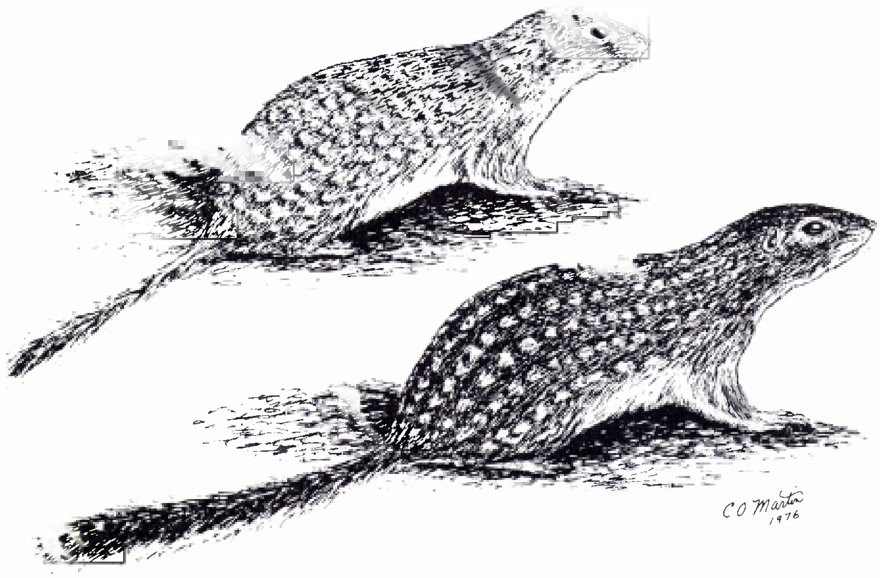


Figure 5. Subparallel orientation of alluvial fault scarps and giant desiccation cracks, as seen on 1953 aerial photographs.



Two ground squirrels of the genus *Spermophilus:* above, *S. spilosoma;* below, *S. mexicanus.*