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QUATERNARY FAULTING IN SOUTHEASTERN BRISCOE COUNTY, TEXAS

by

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CAUTION

This report describes research carried out by staff members of the Bureau of Economic Geology that addresses the feasibility of the Palo Duro Basin for isolation of high-level nuclear wastes. The report describes the progress and current status of research and tentative conclusions reached. Interpretations and conclusions are based on available data and state-of-the-art concepts, and hence, may be modified by more information and further application of the involved sciences.

Prepared for the
U. S. Department of Energy
Office of Nuclear Waste Isolation
under contract no. DE-AC-97-83WM46615

Bureau of Economic Geology
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Downwarped and penecontemporaneously faulted beds of late Quaternary terrigenous sediment are well exposed in southeastern Briscoe County, Texas. Deformation probably was caused by subsidence of the Permian subcrop owing to dissolution of bedded salt at depth. Fluvial sands and gravels and lacustrine clays fill a subsidence basin, producing a locally thickened Quaternary section. A well-developed paleosol above lacustrine deposits was tilted and laterally truncated prior to modern eolian deposition at the site.

Active, recently active, and inactive subsidence features are common in the western Rolling Plains of Texas. Most of these features are small, karstic sinkholes up to 330 ft (100 m) in diameter and subsidence basins a few miles long. Gustavson and others (1982) investigated more than 400 of these features (dolines) in Hall and Briscoe Counties, Texas. These structures formed and are forming as a result of dissolution of Upper Permian (Ochoan and Guadalupian) evaporites, particularly halite, at depths of 650 to 1,000 ft (200 to 300 m) (Gustavson and others, 1982; McGookey and others, in press).

A similar pattern of karstic subsidence produced features of comparable size throughout late Pleistocene and Holocene time. During this interval, subsidence may have been more widespread than it is today because of the wetter climate and presumably greater rates of infiltration and transmissibility of ground water in the late Pleistocene (Caran and McGookey, in press). The moist climate of the late Pleistocene turned sinkholes and subsidence basins into pluvial ponds and lakes, the largest of which probably also received phreatic discharge. Limnic and lacustrine deposits occupy a stratigraphically consistent position in the Quaternary section of the western Rolling Plains. At one site these deposits are more than 30 ft (9.1 m) thick and show evidence of structurally enhanced deposition.

This site, a steep-walled gully 47 ft (14.4 m) deep, in southeastern Briscoe County (fig. 1), provides excellent exposure of structurally deformed lacustrine deposits. The laterally continuous beds of laminated, calcareous clay are moderately sapropelic and contain abundant unworn shells of aquatic and riparian mollusks. These sediments were deposited in the low-energy environment of a shallow lake. The beds and individual laminae originally were horizontal, but those on the southern flank now dip 11° to 16° to the northwest, with a strike of N55°E (fig. 2). Beds of lacustrine sediment elsewhere at the site also dip toward the center of the basin but at a lesser angle. An overlying bed, probably a paleosol, dips into the basin, as well, but much less steeply. In addition, lacustrine beds low in the exposed section contain numerous small penecontemporaneous faults and clay-filled fractures.

South of and stratigraphically below the tilted lacustrine sediments are cross-bedded fluvial sands and gravels exposed in the walls of the gully. Joints and normal faults are common in these sediments in a zone about 66 ft (20 m) wide. Total vertical offset across this zone of deformation is several meters. The normal faults have two principal trends, N90°E, 66°N, and N65°E, 62°SE. These and other antithetic sets form small grabens. Some beds in downthrown blocks thicken markedly across faults, whereas others simply are offset. Vertical displacement measured along one fault plane is 3.9 inches (10 cm) (fig. 3). The amount of displacement decreases to zero about 6.6 ft (2 m) higher in the section at this location, indicating that movement along part of the fault was penecontemporaneous with deposition of the sediments. A scour feature at the base of the gravel along this fault plane (fig. 3) is evidence that some movement also predated deposition of the gravel.

The fault shown in figure 3 created fracture porosity, thereby allowing preferential movement of solute-rich ground water. Adjacent to the fault plane, beds below the conspicuous layer of gravel are more highly cemented, whereas beds above the gravel are more thoroughly stained with iron oxides than are strata farther from the fault.

The combination of (1) laminated lacustrine sediments dipping at a relatively steep angle, capped with (2) a nearly conformable but less steeply dipping paleosol, and (3) underlying beds of penecontemporaneously faulted sand and gravel indicates that structural disturbance and subsidence occurred before, during, and after formation and infilling of the lake. The location of this site is several miles closer to the Caprock Escarpment (fig. 1) than are the dolines studied by Gustavson and others (1982), but still is within the zone of salt dissolution along the margin of the Southern High Plains (Gustavson and others, 1981).

This example illustrates that recent structural deformation near the Caprock Escarpment has faulted Quaternary sediments and altered the near-surface ground-water regime in those sediments. Under slightly different circumstances, this type of structural disturbance could lower local base levels and enhance or initiate incision. Subsidence and faulting also provide permeable pathways for infiltrating ground water. Over an extended period these processes could be expected to affect the rate of retreat of the Caprock Escarpment. Investigation of the thick package of Quaternary sediments along the flank of the escarpment may provide a realistic assessment of the rates at which these processes have occurred under varying conditions of climate.

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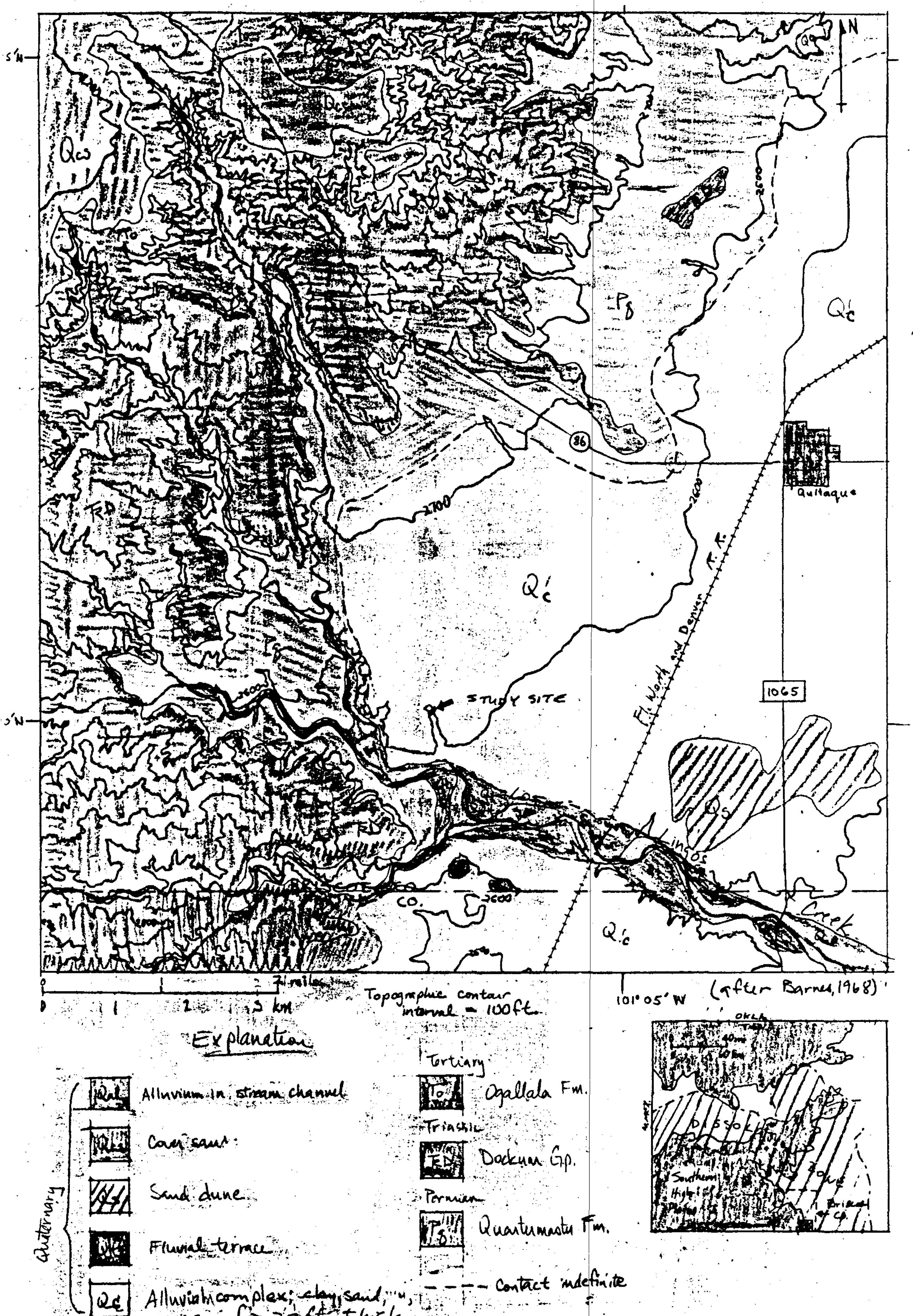
Figure Captions

Figure 1. Location of tilted lacustrine deposits and faulted sand and gravel deposits in southeastern Briscoe County, Texas. Distance from structurally disturbed sediments to the foot of the Caprock Escarpment varies from 1.3 to 2.9 mi (2.1 to 4.6 km).

Figure 2. Tilted Quaternary sediments. Lower contact of calcareous gray clay (arrow) dips 11° to 16° NW, with a strike of N55°E. North is to the left. For location of this site, see figure 1.

Figure 3. Fault in Quaternary sediments. Downthrown to the left, vertical displacement is 3.9 inches (10 cm). Scour along fault plane at base of gravel layer suggests movement preceded deposition of gravel. Antithetic faults in sand above gravel layer in downthrown block indicate that the fault has been active since deposition of sand. Fault orientation is N90°E, 66°N. Scale bar is numbered in 3.9-inch (10-cm) increments.



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