U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Map and data for Quaternary faults in West Texas and adjacent parts of Mexico

by

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Open-File Report 96-002

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1996

QAe786

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PLATES

Plate 1. Map of Quaternary faults in West Texas and adjacent parts of Mexico ..... in pocket

Map and data for Quaternary faults in West Texas and adjacent parts of Mexico

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Prepared as part of the
UNITED STATES MAP OF MAJOR ACTIVE FAULTS AND FOLDS
under the International Lithosphere Program
World Map of Major Active Faults, Project II-2
Michael N. Machette, Co-chairman

A collaborative effort of the U.S. Geological Survey,
State Geological Surveys, Academia, and Industry

Introduction

The "World Map of Major Active Faults" Project is compiling a series of digital maps for the United States and other countries that show the locations, ages, and activity rates of major earthquake-related features such as faults and fault-related folds; the companion database includes published information on these seismogenic features. This effort is sponsored by International Lithosphere Program (ILP) Project II-2 and funded by the Earthquake Hazards Reduction Program (EHRP) through the U.S. Geological Survey. The maps and accompanying databases represent a key contribution to the new Global Seismic Hazards Assessment Program (ILP Project II-0) for the International Decade for Natural Disaster Reduction. This compilation, which describes surface faulting in West Texas and adjacent parts of Mexico, is the first of many similar State and regional compilations that are planned for the project.

This compilation is presented as a traditional map product and printed catalog of data; however both should be available in digital form in the future. The database provides referenced data on a variety of geographic, geologic, and paleoseismologic parameters. The fault data were compiled by the senior authors (Edward W. Collins and Jay A. Raney, Texas Bureau of Economic Geology) as part of ongoing studies of active faulting in the West Texas area and adjacent parts of Mexico. The U.S. Geological Survey authors are responsible for organizing and integrating State and regional products under the national project, including the coordination and oversight of contributions from individuals and groups (Michael N. Machette, Project Chief), database design and management (Kathleen M. Haller), and digitization and manipulation of map data (Richard L. Dart).

Strategy for Map and Database

The primary intention of this compilation is for use in seismic hazard evaluation. For studies of regions having low seismicity such as West Texas, it is particularly important to incorporate geologic information on discrete faults that have evidence of Quaternary movement. Paleoseismic studies, which evaluate the history of surface faulting or deformation along a given structure, provide a long-term

perspective that helps augment the relatively short historic records of seismicity in many regions. In particular, the frequency and location of large-magnitude earthquakes in many parts of the U.S. is poorly defined by the historic record. Thus, an understanding of the seismogenic characteristics of prehistoric (Quaternary) faults may provide a vital key to improving seismic hazards assessments in critical regions.

The map and database have been designed for well-studied faults that occur within the U.S. However, the bulk of seismogenic structures are relatively poorly studied, thus giving the appearance that the database is incomplete. Nevertheless, the design of the map and database permits (1) identification on the basis of which faults are considered to be hazardous and (2) expansion with the completion of new studies. The map depicts characteristics of faults that exhibit evidence of Quaternary surface faulting, including timing of most recent movement, sense of movement, slip rate, and continuity of surface expression. Fault traces were taken from original sources and compiled on 1° x 2° (1:250,000-scale) quadrangle base maps and digitized for use in *Arc/Info. In addition to location and style of faulting, the map shows the time of most recent movement and slip rate for each structure (as a proxy for fault activity). These data, as well as name and affiliation of the compiler, and geographic and other paleoseismologic parameters are included in the database.

Timing of most recent movement is depicted by one of five age categories: historic, Holocene and latest Pleistocene (<15 ka), late Quaternary (<130 ka), late and middle Quaternary (<750 ka), or Quaternary (<1.6 Ma). These age categories permit defining a maximum time of movement without constraining the minimum time. This strategy allows estimates to be made where there are conflicts in timing in the published literature. For example, if Holocene (<10 ka) movement is suspected but only late Pleistocene (10-130 ka) movement can be documented, then the inclusive late Quaternary (<130 ka) category is used for the time of the most recent movement. In terms of this map, no faults in West Texas and adjacent Mexico are known to have had surface-rupturing earthquakes in historic time, so only the older four age categories are shown on the map. Suspected or inferred Quaternary faults are shown as dotted lines; structures with known late Tertiary (or older) movement are not shown unless there is compelling evidence of Quaternary movement (geomorphology, offset surficial deposits, etc.).

Slip rate is also depicted by broad groupings that encompasses all rates of fault activity on a National scale. Four slip-rate categories have been defined for this project: less than 0.2 mm/yr, 0.2 to less than 1 mm/yr, 1-5 mm/yr, and greater than 5 mm/yr. These broad categories segregate most intraplate structures (<5 mm/yr) from major plate-bounding structures (generally >5 mm/yr). The 1-5 mm/yr slip-rate category is typical of major intraplate faults such as the Garlock fault in California and Wasatch fault zone in Utah. All of the faults in West Texas and adjacent Mexico are characterized by published or inferred slip rates of less the 1 mm/yr, and all but the East Franklin Mountains fault [900] have published or inferred rates of less than 0.2 mm/yr. If no published slip rate exists (indicated by "unknown"), the compiler has assigned a slip-rate category as determined from his or her impressions of the structure and the region. The absence or presence of recent movement over some time interval may be a basis for estimating a slip rate; one can use a variety of geomorphic and geologic relations to place a fault in its most likely age and slip-rate categories. For example, a normal fault that does not cut Holocene (<10 ka) or latest Pleistocene (<15 ka) deposits probably has a slip rate of less than 1 mm/yr because during the Holocene (past 10 k.y.) at least 10 m of slip would accumulate at rates of 1 mm/yr or greater; this most likely would have been released in several large surface rupturing earthquakes.

The database includes a number of fields that provide supporting information on the previously mentioned parameters, as well as additional descriptive, geologic, and paleoseismologic parameters not

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* Use of trade or brand names, such as Arc/Info, are for descriptive purposes and do not constitute endorsement by the U.S. Geological Survey or the Department of Interior.

depicted on the map. The descriptive information includes fault number and name, a brief synopsis, compilation information, and physical location of the structure. Because the project will integrate data from the entire United States, the database requires that each seismogenic structure have a unique number (where cited in the text, a fault's number is enclosed by square brackets). In general, most of the structures in a given state or region are sequentially numbered. Names are determined from the literature and from common usage, and although some structures in different regions have the same name, no attempt was made to avoid such duplications. Geologic data include setting, geomorphic expression, and age of faulted deposits, all in descriptive form. Additional paleoseismologic data include descriptions of trenching studies and published recurrence intervals. Database field titles are shown in bold and are defined in Appendix A, which is derived from the general guidelines for the project (Haller and others, 1993 #655). When the computer database is implemented, the user will be able to search for data in a specific field or a combination of fields. Nonsearchable fields, such as "Comments", document the source of data.

Compilations such as this one provide a useful tool for making comparisons of spatial and temporal patterns of faulting at local, regional, and national scales. However, a database is a powerful tool only if it represents a systematic collection of data. With this in mind, we have attempted to present only data currently in print and reference all data as completely as possible. An effort has been made to include all pertinent data, especially where conflicts may be apparent. In order to achieve some level of consistency where multiple interpretations exist in the published literature, we established a hierarchy that defines what data will be presented in the primary field. We give highest priority to fault-related studies, particularly those addressing the Quaternary history of a fault, over general geologic studies. In most cases, more recent studies are given priority over less recent ones. A more detailed scale of mapping (*e.g.*, 1:24,000 scale) is given priority over a less detailed scale (*e.g.*, 1:250,000 scale). Even though we give the most weight to recent topical studies of Quaternary faulting, alternative interpretations are provided in the appropriate "Comments" field.

The majority of faults in West Texas and adjacent Mexico are characterized by rather limited investigations; however, the database is designed for well-studied faults in regions of high seismicity and historical faulting such as California. In order to accommodate large differences in the level of study from fault to fault, we established three fault types to simplify data compilation and readily convey the level of current knowledge. All structures are described as either simple, sectioned, or segmented. In general, simple faults are poorly known, have few or no paleoseismologic studies, and can are characterized by a single age and slip-rate category for their entire length. At the other end of the spectrum is a segmented fault—one that is well studied and is comprised of seismogenic and structural entities (segments) that act independently of one another. By our requirements, the timing of the most recent ruptures on a segmented fault is well established through trenching or historical surface rupture with supporting geomorphologic and geologic data (scarp morphology, stratigraphic control on times of faulting, geologic structures that may control physical segmentation, etc.). In some cases, pronounced contrast in the geomorphic expression of faulting along strike combined with trenching studies that define the chronology of the youngest parts of the fault is sufficient to permit discussion of the structure as segmented. If the data for segments are not compelling (such as those defined solely on morphologic data or geometric rupture patterns), then we describe the fault as having sections (a nongenetic descriptive term). Sections may be defined on the basis of relative-age criteria, by fault geometry, by the presence and preservation of scarps, by a single trench, or from other geologic data (gravity, structure, etc.). In our scheme, the difference between a sectioned fault and one that is segmented is often based on the number and distribution of paleoseismic investigations that have been completed. Even though referenced pieces of work may discuss "segmentation" or "segments," the compiler determines if the level

of knowledge is sufficient to retain usage of the term in the database. For our purpose, all of the faults in West Texas and adjacent Mexico are defined as simple faults with the exception of the West Lobo Valley fault zone [918, four sections] and the Caballo fault [906, two sections]. All of the simple faults are shown on the map and listed in the database by a three-digit numeric identifier (*e.g.*, 916). The sectioned fault is identified by an additional lowercase alpha character (*e.g.*, 918a). The alpha characters (a-d) are unique to each of the sections; "a" is assigned to the northernmost (or westernmost) section and "d" to the southernmost (or easternmost) section.

Synopsis of Quaternary faulting in West Texas and Adjacent Mexico

Two previous compilations of Quaternary faults in West Texas and adjacent Mexico were made by Howard and others (1978 #312) and Nakata and others (1982 #147). Both were traditional map products showing location and age of youngest known displacement. No supporting data were included on the map sheets nor were the faults described in additional text. Since the earlier compilations, additional faults have be recognized in this region and some detailed studies have been performed to better constrain various paleoseismologic characteristics.

This database includes 24 Quaternary faults: 22 are classified as simple and 2 are classified as having sections. Two faults, the East Franklin Mountain [900] and the Amargosa [905], have formed major scarps during the Holocene or latest Pleistocene (<15 ka), whereas there was late Quaternary (<130 ka) movement on six faults, middle or late Quaternary (<750 ka) movement on seven additional faults, and Quaternary (<1.6 Ma) movement on the remaining nine faults. Quaternary faults in the mapped area are characterized by recurrence intervals ranging from 9-22 k.y. for the most active structure (the East Franklin Mountain fault [900]) to at least 125-250 k.y. for the less active structures. The resultant slip rates are very low and all but the East Franklin Mountain fault (0.2- 1 mm/yr) fall into the less than 0.2 mm/yr category. Of the 28 faults and fault sections in the mapped area, 15 are characterized by published or documented slip rates, whereas slip rates on the remaining 13 are unknown but probably very low (<0.2 mm/yr).

Much of the data in this compilation has come from reconnaissance field studies, and only three faults have been trenched with their paleoseismic history in mind. These include the East Franklin Mountains fault [900], the Campo Grande fault [902], and the West Eagle Mountains-Red Hills fault [913]. These studies, and others in the Rio Grande rift of New Mexico, have shown that recurrent movement is prevalent on the Quaternary faults, but that their recurrence intervals may differ by as much as an order of magnitude (*i.e.*, <25 k.y. versus 250 k.y.). Of the Quaternary faults in West Texas and adjacent Mexico, the most active are probably the East Franklin Mountains [900], the Amargosa [905], and the northern section of the Caballo [906a].

However, if one considers that a locality may be affected by all the active faults within a certain range (e.g., 100 km radius), then the concept of a *composite recurrence interval* must be considered. If 10 faults, each having an individual recurrence interval of 40 k.y., are located within 100 km of a critical facility then the site might be affected by strong ground shaking once every 4,000 years (on average) as a result of exposure to a larger number of faults. For example, Machette (1987 #847) has shown that the East Franklin Mountains fault is just the southern one-quarter of a 182-km-long fault zone that extends from south of the International Border with Mexico (in the city of Juarez) north through El Paso and Fort Bliss and into New Mexico along the west side of White Sands Missile Range. This fault zone is one of the longer active normal faults in the Rio Grande rift, exceeded only by the Sangre de Cristo fault zone in northern New Mexico and southern Colorado. The most recent movement on the East Franklin Mountains fault probably was in the latest Pleistocene or early(?) Holocene, but the fault has a long

history of recurrent movement as documented by Quaternary scarps as much as 60 m high (Machette, 1987 #847). Machette (1987 #847) estimated that this entire fault zone is comprised of five discrete faults or fault sections that each have probable recurrence intervals of 10-20 k.y. for major surface-rupturing earthquakes (M >6.5). If this is true, then a major surface-rupturing earthquake may occur about once every 2,000-4,000 years somewhere on the fault zone. The majority of these earthquake would affect the White Sands area of southern New Mexico most, although strong ground shaking may also affect the El Paso/Juarez metropolitan area, which has an estimated population approaching 2 million. El Paso has nearly 600,000 people living in a relatively small area (El Paso County), whereas Ciudad Juárez just across the Rio Grande has a burgeoning population roughly estimated to be at least 1.2 million in 1991 by the Rio Grande Council of Governments (J.R. Keaton, written commun., 1995).

The largest historical earthquake to affect the El Paso region was a MM VI (cited in Collins and Raney, 1991 #846). However, both El Paso and Ciudad Juárez are threatened by the East Franklin Mountains fault, which extends through the heart of both downtown areas. Two moderately large earthquakes have struck West Texas in the 20th Century. The first was a M_w 6.3 (Doser, 1987 #904) earthquake that occurred in 1931 near Valentine, Texas (plate 1), in the Lobo Valley (Dumas, 1980 #906). Although this earthquake has been "placed" on the Mayfield section [918c] (Doser, 1987 #904) of the West Lobo Valley fault zone, it had an extremely large epicentral location error of about ±40 km (Dumas, 1980 #906) and there is no evidence that the fault ruptured at the surface. Doser's studies (1987 #904) show that there could have been 23-28 cm of normal offset at 10 km depth on a N. 10-20° W., 54° E. fault beneath Lobo Valley, and the earthquake may have nucleated at the boundary between the Neal [918b] and Mayfield [918c] sections of the West Lobo Valley fault zone.

On April 14, 1995, a M_w 5.7 earthquake struck West Texas (National Earthquake Information Center, 1995 #910) and caused minor damage to the Alpine-Marathon area (plate 1). From our compilation, there appears to be no mapped Quaternary faults that might have been responsible for this earthquake. Our preferred focal mechanism is a N. 35° W. slip plane (fault) having a 53° SW. dip (National Earthquake Information Center, 1995 #910) . The earthquake may have occurred on a structure that is unmapped, on one that has yet to daylight, or on a pre-Quaternary fault of which there are many in the epicentral region (see Muehlberger, 1980 #905, fig. 5). Although this earthquake caught the populace by surprise, the fault studies described in this database show that tens of faults in the mapped area have the potential for causing surface rupturing and strong ground motion.

Quaternary faults in the mapped area have two dominant trends: northerly and northwesterly. The north-trending faults are distributed throughout the mapped area, whereas the northwest-trending faults are mainly restricted in the area south of U.S Interstate Highway 10. This change in fault-orientation pattern occurs near the northern limit of the northwest-trending Texas Lineament, which Muehlberger (1980 #905) considers to be a major structural boundary of pre-Cambrian heritage that has controlled much of the later tectonic activity. Presumably, faults within the Texas Lineament (zone), which is nearly 100-km wide (Muehlberger, 1980 #905, fig. 1), in West Texas, are responding to both late Cenozoic and older zones of pre-existing weaknesses.

We would like to thank Jeff Keaton of AGRA Earth and Environmental, Inc., Salt Lake City, Utah, and Chris Henry of the Nevada Bureau of Mines and Geology, Reno, Nevada, for their thoughtful reviews and comments.

STRUCTURE ATTRIBUTES

Structure Number 900
Comments: Referred to as fault 6 in Machette (1987 #847).

Structure Name East Franklin Mountains fault
Comments: Named by Machette (1987 #847). Fault extends from the northeast margin of the Franklin Mountains in southern New Mexico south through Texas and across the Rio Grande along the southeast margin of the Sierra de Juárez in Chihuahua, Mexico.

Synopsis: This long fault forms a series of range-front scarps along the eastern base of the Franklin Mountains. Studies of scarp morphology and reconnaissance mapping of faulted and unfaulted Quaternary deposits are the source of data for this fault. Results from trench investigations (Barnes and others, 1995 #909; Keaton and others, 1995 #877; Scherschel and others, 1995 #876) were still preliminary at the time of this compilation. No significant work has been done on the fault in Mexico, thus its age and southern limit are poorly known.

Date of compilation 05/16/95

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin; M.N. Machette, U.S. Geological Survey, Denver, Colorado

State Texas; New Mexico; Chihuahua, Mexico

County El Paso (TX); Dona Ana (NM)

1° x 2° sheet El Paso, Las Cruces

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photos and 1:24,000- to 1:250,000-scale maps of Sayre and Livingston (1945 #850), Morrison (1969 #848), Harbour (1972 #849), Machette (1987 #847), Collins and Raney (1991 #846; 1993 #852), Keaton (1993 #851), and Raney and Collins (1994 #872; 1994 #873).

Geologic setting Down-to-east, range-front fault bounding east side of the Franklin Mountains and Sierra de Juarez. This fault is part of a longer system that includes the Artillery Range [2051], Organ Mountains [2052], and San Andres Mountains [2053] faults in New Mexico.

Sense of movement N
Comments: Sense of movement inferred from topography and from trench exposures of J.R. Keaton and J.R. Barnes (written comm., 1995).

Dip 76°
Comments: Dip measured in shallow excavation across northern end of fault (J.R. Keaton and J.R. Barnes, written comm., 1995).

Dip direction E

Geomorphic expression Distinct scarps are between 2 and 60 m high (Machette, 1987 #847; Collins and Raney, 1991 #846). Some scarps have compound slopes indicating young morphology superposed on older scarps. Steepest slope-angles are between 13° and 23° depending on height. Scarps are well dissected by streams draining the Franklin Mountains. Fault consists of multiple strands along mountain front. Urbanization of El Paso and Juarez (Mexico) and young alluvium of the Rio Grande cover most of the southern part of the fault.

Age of faulted deposits Mostly Quaternary alluvium along the eastern piedmont of the Franklin Mountains and Sierra de Juarez (Raney and Collins, 1994 #872; 1994 #873). Reconnaissance investigations of faulted alluvium indicates deposits at least as young as late Pleistocene are faulted (Machette, 1987 #847; Collins and Raney, 1991 #846; 1993 #852; 1994 #853; Barnes and others, 1995 #909; Keaton and others, 1995 #877; Scherschel, 1995 #916; Scherschel and others, 1995 #876) . Holocene(?) or upper Pleistocene deposits have been faulted during the two most recent events.

Detailed studies A single trench was excavated across the northern part of the fault in January 1995 by AGRA Earth and Environmental, on contract to the U.S. Geological Survey. Preliminary results of this trenching have been published by Keaton and others (1995 #877), Barnes and others (1995 #909), and Scherschel (1995 #916). All interpretations suggest 3 or 4 surface rupturing events since the late middle Pleistocene (past 130 k.y.) on the basis of relations between colluvial materials, soils, and faults in the exposure. Two dates from colluvial wedges: 10.9 ka and 15.6 ka are reported by J.R. Keaton and J.R. Barnes (written comm., 1995). At the trench site, the Jornada II alluvium (late middle Pleistocene) is estimated to be offset vertically 8.5 m (Scherschel, 1995 #916) to as much as 9.8-10.6 m (Keaton and others, 1995 #877).

Timing of most recent paleoevent (1) Holocene and post glacial (<15 ka)

Comments: Timing based on trenching (J.R. Keaton and J.R. Barnes, written comm., 1995) and morphometric analysis of small (single-event) scarps (Machette, 1987 #847). Barnes and others (1995 #909), Keaton and others (1995 #877), Scherschel and others (1995 #876), and Scherschel (1995 #916) suggested that the most recent event is older than the Isaack's Ranch alluvium, which is considered to be latest Pleistocene. J.R. Keaton and J.R. Barnes (written comm., 1995) reported that the likely range for the most recent event is 8-12 ka based on scarp morphology and radiocarbon date from scarps-derived colluvium of 10.9 ka. Additionally, soil studies by Monger (unpublished data, 1995) suggest that the oldest unfaulted deposits adjacent to the trench site are equivalent to the Organ (Holocene) alluvium, which may be as old as 8 ka.

Recurrence interval 9-22 k.y. (unknown interval)

Comments: The most recent work on the East Franklin Mountains fault suggests that short episodes of faulting, with displacement events recurring every 9-22 k.y., alternating with long stable intervals of 75-100 k.y. (Barnes and others, 1995 #909; Keaton and others, 1995 #877), whereas Scherschel (1995 #916) suggests recurrence intervals of about 30 k.y. for an unspecified period of time. Collins and Raney (1993 #852) estimated the average recurrence interval for large surface ruptures since middle Pleistocene may be 15-30 k.y. These values are based on (a) estimated number of inferred large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) assumption that faulted middle Pleistocene (Jornada I) deposits are approximately 250-500 ka, and (c) >25-32 m of throw measured on middle Pleistocene surfaces.

Slip Rate (C) 0.2-1.0 mm/yr

Comments: The short-term slip rate is thought to be higher than the long-term rate due to clustering of events during late Quaternary time; the higher slip rate is used here to define the appropriate slip-rate

category. J.R. Keaton and J.R. Barnes (written comm., 1995) suggest a slip rate of 0.3 mm/yr for the past 3 events (less than about 30 ka) is possible, but a long-term (<500 ka) slip rate of 0.1 mm/yr is also consistent with the data. Scherschel (1995 #916) suggests an even lower average slip rate, 0.065 mm/yr. A long-term slip rate of ≤0.25 mm/yr since middle Pleistocene time can be inferred on the basis of >25-32 m of throw (Collins and Raney, 1993 #852).

Length (km) 44.7

Average strike (azimuth) 003°

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STRUCTURE ATTRIBUTES

Structure Number 901
Comments: Referred to as fault 6 on figure 1 and table 2 of Machette (1987).

Structure Name Hueco fault zone
Comments: Named by Seager (1980 #843). Refers to numerous Quaternary faults within the northwestern part of the Hueco bolson (basin) in Texas and southern New Mexico. Faults extend from southern part of Tularosa basin, about 15 km northeast of White Sands, New Mexico, south-southeastward through the Hueco basin to the area east of Tornillo, Texas, north of the floodplain of the Rio Grande.

Synopsis: This broad anastomosing fault zone is composed of numerous eolian sand covered scarps within the northwestern part of the Hueco basin. Reconnaissance mapping and studies of scarp morphology are the sources of data. Detailed site studies have not been conducted because of the thick cover of eolian sand and general lack of natural exposure.

Date of compilation 10/31/93

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas; New Mexico

County El Paso (TX); Otero (NM); Dona Ana (NM)

1° x 2° sheet El Paso; Las Cruces

Province Basin and Range

Reliability of location Good
Comments: Location in Texas based on 1:250,000-scale map compiled from 1:24,000- to 1:48,000-scale mapping of Seager (1980 #843), Henry and Gluck (1981 #845), and Collins and Raney (1991 #846). Locations in New Mexico based on 1:125,000-scale map of Seager and others (1987 #627).

Geologic setting These down-to-west and down-to-east faults form a broad N-S elongate zone within the northwestern part of the Hueco basin (Seager, 1980 #843; 1983 #844) that, where undeformed, forms a rather flat, regular surface.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from disruption of the basin's generally flat topography.

Dip
Comments:

Dip direction E; W

Geomorphic expression The Hueco basin (Seager, 1980 #843; 1983 #844) generally has a rather flat, regular surface, but is deformed by a wide zone of north-trending faults. These faults have subtle scarps between 2 m and 7 m high that are covered by thick deposits of eolian sand (Collins and Raney, 1991 #846; 1993 #852). Maximum scarp-slope angles are usually less than 3°. Gentle low-relief alluvial drainageways commonly are present on downthrown fault block and trend subparallel to the fault scarps. The faults are shown as dashed lines on the map owing to the presence of faulted calcic soils, which are occasionally seen beneath the cover of eolian sand. Burrell and Tilford (1995 #908) suggested that some of the scarp-like features within the Hueco and Tularosa basins may be the result of other processes, such as fluvial erosion, piping, or fissuring.

Age of faulted deposits Middle Pleistocene alluvium (Collins and Raney, 1991 #846); no detailed studies have been conducted to determine if younger (late Quaternary) deposits are faulted.

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: Timing of movement is not well constrained, but scarps are present on middle Pleistocene deposits (Collins and Raney, 1991 #846). Cross-cutting relationships with younger deposits are unknown.

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: A very low slip rate of <0.005-0.05 mm/yr is inferred from small amounts of displacement (2-7 m) of middle Pleistocene deposits (minimum age 130 ka, probable age at least 400 ka).

Length (km) 116

Comments: The fault zone extends about 64.5 km in Texas and another 51.5 km in New Mexico. However, the composite length of all the faults in the zone is many times this length.

Average strike (azimuth) 354° ± 20°

Comments: This average strike is for fault zone only within Texas.

References

#908 Burrell, J.K., and Tilford, N.R., 1995, Genesis of closed linear depressions in West Texas—Tectonics, dissolution, or other cause? [abs.], *in* Diversity in engineering geology and groundwater resources: Association of Engineering Geologists, 38th Annual Meeting, Sacramento, California, October 2-8, 1995, p. 39.

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#845 Henry, C.D., and Gluck, J.K., 1981, A preliminary assessment of the geologic setting, hydrology, and geochemistry of the Hueco Tanks geothermal area, Texas and New Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 81-1, 48 p.

#843 Seager, W.R., 1980, Quaternary fault system in the Tularosa and Hueco basins, southern New Mexico and west Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and west Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 131-135.

#844 Seager, W.R., 1983, Possible relations between Quaternary fault system, mode of extension, and listric range boundary faults in the Tularosa and Hueco basins, New Mexico and Texas, *in* Meader-Roberts, S.J., ed., Geology of the Sierra Diablo and southern Hueco Mountains west Texas: Permian Basin Section, Society of Economic Paleontologists and Mineralogists, Field Conference, May 1983, Guidebook, p. 141-150.

#627 Seager, W.R., Hawley, J.W., Kottlowski, F.E., and Kelley, S.A., 1987, Geology of east half of Las Cruces and northeast El Paso 1° x 2° sheets, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 57, 3 sheets, scale 1:250,000.

STRUCTURE ATTRIBUTES

Structure Number 902
Comments:

Structure Name Campo Grande fault
Comments: Named by Strain (1966 #864). Fault extends from northeast of Tornillo, Texas, southeast to area 4 km north of Finley, Texas.

Synopsis: Fault composed of en echelon scarps in southeastern part of the Hueco basin. Reconnaissance studies of scarp morphology and detailed mapping of faulted and unfaulted Quaternary and Pliocene deposits are the sources of data. Three trenches and two hillside excavations across this fault have been described by Collins and Raney (1990 #842).

Date of compilation 08/27/94

Compiler and affiliation E. W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth; El Paso

1° x 2° sheet Van Horn, El Paso

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map mostly compiled from 1:24,000-scale maps of Collins and Raney (1994 #869; 1994 #868; 1994 #871; 1994 #870). Fault also mapped by Albritton and Smith (1965 #840), Strain (1966 #864), Sergent Hauskins & Beckwith Consulting Geotechnical Engineers (1989 #874), and Collins and Raney (1990 #842; 1991 #846; 1993 #852).

Geologic setting This down-to-southwest fault bounds the deepest part of the southeastern Hueco basin. Collins and Raney (1991 #841; 1993 #852; 1994 #853) have described three possible sections to the fault based on surface map pattern (geometry) and determinations of basin-fill and bedrock displacements from seismic-reflection data. However, only the southeast part of the fault has been studied in detail on the ground and thus the fault is considered as a simple structure.

Sense of movement N
Comments: Not studied in detail, although along the southeast part of fault high-angle grooves on fault planes within Pliocene and early Pleistocene basin-fill deposits suggest dip-slip movement (Collins and Raney, 1990 #842).

Dip 60°-89°
Comments: Fault dip measured in outcrops and excavations of Pliocene-Pleistocene sediment and interpreted from seismic data.

Dip direction SW

Geomorphic expression Locally, the fault forms distinct but eroded scarps that are 1.5-11 m high. Much of the fault's surface trace is dissected, eroded, or covered by eolian sand (Collins and Raney, 1990 #842; 1991 #846; 1993 #852) . The southeast part of the fault is most distinct and best exposed due to large arroyos that cross the fault. Most or possibly all of the northwest and central parts of fault are covered by windblown sand.

Age of faulted deposits Pleistocene and Pliocene deposits are faulted. Along the southeast part of the fault, the youngest deposits displaced are middle to upper Pleistocene (Collins and Raney, 1990 #842; 1991 #846; 1993 #852), whereas some upper Pleistocene and Holocene deposits are unfaulted.

Detailed studies Two hillside excavations and three trenches across southeast part of the fault have been described by Collins and Raney (1990 #842). These exposures were studied in conjunction with shallow augering, field mapping, and morphologic analysis of scarps. In summary, their work shows a pattern of recurrent movement whereby successively younger units have lesser amounts of displacement. On the downdropped block of one fault strand, calcic soil horizons (0.5-1.0 m thick; stage III morphology) are offset vertically 1-2 m each indicating at least five episodes of movement, deposition, and surface stabilization since 0.4-0.6 Ma. The maximum vertical offset during the most recent faulting event was about 1 m.

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: The age of the youngest faulted deposits, and hence youngest paleoevent, was estimated from the development of calcic soils along the southeast part of the fault (Collins and Raney, 1990 #842; 1991 #846). Middle-upper Pleistocene deposits are vertically displaced as much as 3 m, whereas upper Pleistocene-Holocene deposits are not faulted.

Recurrence interval 50-100 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval of large surface rupturing earthquakes since middle Pleistocene may be as great as 50-100 k.y. for the southeastern part of the fault. These values are based on (a) their estimate of five large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are 250-500 ka (although they may be 400-500 ka on the basis of their 1- to 1.5-m thick, stage IV morphology calcic soils), and (c) 10 m of throw measured on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Maximum average slip rate since middle Pleistocene time is ≤0.08 mm/yr as determined from 10 m of throw on middle Pleistocene deposits for southeast part of fault (Collins and Raney, 1993 #852). However, a minimum time of 130 ka (youngest middle Pleistocene) was used to estimate the slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.02-0.04 mm/yr.

Length (km) 44.4

Average strike (azimuth) 305° ± 12°

References

#840 Albritton, C.C., Jr., and Smith, J.F., Jr., 1965, Geology of the Sierra Blanca area Hudspeth County Texas: U.S. Geological Survey Professional Paper 479, 131 p.

#842 Collins, E.W., and Raney, J.A., 1990, Neotectonic history and structural style of the Campo Grande fault, Hueco basin, trans-Pecos Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Report of Investigations 196, 39 p.

#841 Collins, E.W., and Raney, J.A., 1991, Neotectonic history and geometric segmentation of the Campo Grande fault—A major structure bounding the Hueco basin, trans-Pecos Texas: Geology, v. 19, p. 493-496.

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#868 Collins, E.W., and Raney, J.A., 1994, Geologic map of the Campo Grande Mountain quadrangle, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Open-File Map, 1 sheet, scale 1:24,000.

#871 Collins, E.W., and Raney, J.A., 1994, Geologic map of the Cavett Lake quadrangle, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Open-File Map, 1 sheet, scale 1:24,000.

#869 Collins, E.W., and Raney, J.A., 1994, Geologic map of the Diablo Canyon West quadrangle, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Open-File Map, 1 sheet, scale 1:24,000.

#870 Collins, E.W., and Raney, J.A., 1994, Geologic map of the Fort Hancock quadrangle, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Open-File Map, 1 sheet, scale 1:24,000.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#874 Sergent Hauskins & Beckwith Consulting Geotechnical Engineers, 1989, Preliminary geologic and hydrologic evaluation of the Fort Hancock Site (NTP-S34), Hudspeth County, Texas, for the disposal of low-level radioactive waste: Technical report to Hudspeth County, Texas, Hudspeth County Conservation and Reclamation District No. 1, Hudspeth County Underground Water Conservation District No. 1, El Paso, Texas, 5-30—5-31 p.

#864 Strain, W.S., 1966, Blancan mammalian fauna and Pleistocene formations, Hudspeth County, Texas: Texas Memorial Museum Bulletin 10, 55 p.

STRUCTURE ATTRIBUTES

Structure Number 903
Comments:

Structure Name Acala fault
Comments: Named by Collins and Raney (1993 #852); also referred to as faults 7 and 8 by Collins and Raney (1991 #846). This fault is about 5 km north of Acala, Texas, for which it is named.

Synopsis: This short fault is comprised of two en echelon scarps in the southeast part of the Hueco basin. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 10/31/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:12,000- to 1:250,000-scale maps of Collins and Raney (1991 #846).

Geologic setting This short down-to-southwest fault is located in the central (axial) part of the Hueco basin (Collins and Raney, 1991 #846; 1993 #852).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SW

Geomorphic expression The fault is characterized by two strands that have highly degraded scarps. Morphometric analysis of the scarps indicate that they are 1-2.2 m high and have maximum slope angles of about 4°.

Age of faulted deposits Quaternary and Tertiary(?). The youngest known faulted deposits are middle Pleistocene (Collins and Raney, 1991 #846; 1993 #852). It has not been determined if late Quaternary deposits are faulted.

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)
Comments: The youngest faulted deposits are estimated to be middle Pleistocene on the basis of 1- to 1.5-m thick, stage IV calcic soils (Collins and Raney, 1991 #846; 1993 #852). It has not been determined if deposits younger than middle Pleistocene age are faulted.

Recurrence interval 30-60 k.y. (<500 ka)

Comments: Not studied in detail, but Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 30-60 k.y. This value is based on (a) their estimated number of inferred large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250 to 500 k.y. old (although deposits are probably 400-500 k.y. old on the basis of their 1- to 1.5-m thick stage IV morphology calcic soil), and (c) 18 m of throw measured on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is ≤0.14 mm/yr based on 18 m throw of middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (about 130 ka) was used to estimate average slip rate. If one uses 400-500 ka as the age, then the average slip rate could be as little as 0.04-0.06 mm/yr.

Length (km) 7.5

Average strike (azimuth) 308° ± 12°

References

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

STRUCTURE ATTRIBUTES

Structure Number 904
Comments:

Structure Name Arroyo Diablo fault
Comments: Named by Collins and Raney (1993 #852); also referred to as fault 10 by Collins and Raney (1991 #846). Fault extends from Arroyo Diablo (~2 km southeast of Campo Grande Mountain) southeastward to near Arroyo Balluco (~5 km north of Interstate Highway 10).

Synopsis: Fault forms discontinuous scarps in the southeastern part of Hueco basin; scarps are en echelon to the Camp Grande fault [902]. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Best preserved scarps are ~1.7 km south of Campo Grande Mountain. Outcrops in Arroyo Diablo and Arroyo Balluco show faulted basin-fill deposits overlain by unfaulted upper Pleistocene deposits. Trench investigations have not been conducted.

Date of compilation 10/31/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:12,000- to 1:250,000-scale maps of Collins and Raney (1991 #846).

Geologic setting This down-to-southwest fault bounds a deep part of the southeastern Hueco basin (Collins and Raney, 1991 #846). As such, it may be a section of the Campo Grande fault [902] (Collins and Raney, 1993 #852) which also bounds a deep part of the Hueco basin. However, the Arroyo Diablo fault exhibits only 1.6-3 m of vertical displacement of middle Pleistocene deposits, whereas the Campo Grande fault has 10 m of throw on middle Pleistocene deposits.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip 60°-85°
Comments: Dip based on outcrops of faulted Pliocene-Pleistocene sediment.

Dip direction SW

Geomorphic expression The fault is marked by subtle discontinuous scarps that are 1.7 and 2.5 m high (where measured). The maximum slope angle of one compound scarp is as much as 15°, suggesting young (late Quaternary) movement. Much of the fault's trace is covered by unfaulted deposits (Collins and Raney, 1991 #846).

Age of faulted deposits Quaternary and late Tertiary. The youngest faulted deposits, which are vertically displaced 1.6-3 m, are middle Pleistocene in age (Collins and Raney, 1991 #846; 1993 #852).

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: The youngest faulted deposits are estimated to be middle Pleistocene because they are capped by 1- to 1.5-m thick calcic soils (Collins and Raney, 1991 #846; 1993 #852). Upper Pleistocene deposits are not known to be faulted, yet the scarp morphology suggests movement may be this young.

Recurrence interval 125-250 k.y. (<500 ka)

Comments: Not studied in detail, but Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 125-250 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka (although the deposits are probably 400-500 ka on the basis of calcic soils 1-to 1.5-m thick having stage IV morphology), and (c) 1.6-3 m of measured throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is ≤0.02 mm/yr based on <3 m throw of middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (about 130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.01 mm/yr.

Length (km) 13.9

Average strike (azimuth) 322° ± 9°

References

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

STRUCTURE ATTRIBUTES

Structure Number 905
Comments:

Structure Name Amargosa fault
Comments: Name from Barnes and others (1989 #855) and Keaton and others (1989 #856). Fault extends along northeastern margin of the Amargosa Range (Sierra de la Amargosa) and adjacent ranges in Mexico from a point 20 km south of Tornillo, Texas, southeastward to about 30 km south of old Fort Quitman, Texas. The fault lies entirely within Mexico.

Synopsis: Fault forms a series of distinct and continuous, fresh-appearing range-front scarps. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 08/02/94

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Chihuahua, Mexico

County

1° x 2° sheet Van Horn; Marfa; El Paso

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,00-scale map compiled from aerial photographs and 1:10,000- to 1:50,000-scale maps of Collins and Raney (1991 #846; 1993 #852). Other maps of fault include those by Muehlberger and others (1978 #854), Woodward and others (1978 #865), Henry and others (1985 #866), Sergent Hauskins & Beckwith Consulting Geotechnical Engineers (1989 #874), and Collins and Raney (1991 #846; 1993 #852).

Geologic setting Down-to-northeast, range-front fault bounds the northeast side of Sierra de San Ignacio, Sierra de la Amargosa, and Sierra San José del Prisco (Collins and Raney, 1991 #846; 1994 #853). This fault is probably one of the predominant structures that control the southwestern margin of the Hueco basin at this latitude.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topographic expression.

Dip 75° to 80°
Comments: Dip based on outcrops of faulted Pliocene-Pleistocene sediment (Collins and Raney, 1991 #846).

Dip direction NE

Geomorphic expression Distinct scarps are commonly between 2.8 and 32 m high. Scarps on older Quaternary deposits are considerably larger than on younger deposits, indicating a long history of recurrent movement on the fault. Maximum scarp-slope angles are commonly between 19° and 27°, suggesting late Pleistocene or Holocene(?) movement.

Age of faulted deposits Mostly Quaternary and Pliocene alluvium and basin-fill sediment; locally Cretaceous bedrock is faulted against younger basin-fill and alluvium. Deposits at least as young as upper Pleistocene are faulted and aerial photographic studies indicate that, locally, scarps are present on deposits of possible Holocene age (Collins and Raney, 1991 #846; 1993 #852).

Detailed studies

Timing of most recent paleoevent (1) Holocene and post glacial (<15 ka)

Comments: Upper Pleistocene age for youngest faulted deposits was estimated from the development of calcic soils. Mapping from aerial photographs indicates deposits of possible Holocene age are faulted (Collins and Raney, 1991 #846; 1993 #852).

Recurrence interval 20-40 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated the approximate range of average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 20-40 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka (although deposits are probably 400-500 ka on the basis of calcic soils 1- to 1.5-m thick having stage IV morphology), and (c) >24 m of measured throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate on northwest part of the Amargosa fault since middle Pleistocene is probably ≤0.2 mm/yr based on >24 m of throw on middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (about 130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.05-0.1 mm/yr.

Length (km) 67.8

Average strike (azimuth) 315° ± 21°

References

#855 Barnes, J.R., Shlemon, R.J., and Slemmons, D.B., 1989, The Amargosa fault—A previously unstudied major active fault in northern Chihuahua, Mexico, *in* Engineering geology of mountain and plain: Association of Engineering Geologists, 32nd Annual Meeting, Vail, Colorado, October 1-6, 1989, Abstracts and Program, p. 50.

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#866 Henry, C.D., Gluck, J.K., and Bockoven, N.T., 1985, Tectonic map of the Basin and Range province of Texas and adjacent Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Miscellaneous Map 36, 1 sheet, scale 1:500,000.

#856 Keaton, J.R., Shlemon, R.J., Slemmons, D.B., Barnes, J., and Clark, D.G., 1989, The Amargosa fault—A major late Quaternary intraplate structure in northern Chihuahua, Mexico: Geological Society of America Abstracts with Programs, v. 21, no. 6, p. 148.

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

#874 Sergent Hauskins & Beckwith Consulting Geotechnical Engineers, 1989, Preliminary geologic and hydrologic evaluation of the Fort Hancock Site (NTP-S34), Hudspeth County, Texas, for the disposal of low-level radioactive waste: Technical report to Hudspeth County, Texas, Hudspeth County Conservation and Reclamation District No. 1, Hudspeth County Underground Water Conservation District No. 1, El Paso, Texas, 5-30-5-31 p.

#865 Woodward, L.A., Callender, J.F., Seager, W.R., Chapin, C.E., Gries, J.C., Shaffer, W.L., and Zilinski, R.E., 1978, Tectonic map of Rio Grande rift region in New Mexico, Chihuahua, and Texas, *in* Hawley, J.W., ed., Guidebook to Rio Grande rift in New Mexico and Colorado: New Mexico Bureau of Mines and Mineral Resources Circular 163, 1 sheet, scale 1:1,000,000.

STRUCTURE ATTRIBUTES

Structure Number 906
Comments:

Structure Name Caballo fault
Comments: Named by Jones and Reaser (1970 #858). Fault extends from about 8 km east of old Fort Quitman, southeastward to Indian Hot Springs. The fault most likely continues southeastward into Mexico beneath young alluvium of the Rio Grande.

Synopsis: The Caballo fault bounds the west side of the Quitman Mountains. The fault is mostly covered although several short scarps are preserved along the northern of its two sections. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 11/29/93

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas; Chihuahua, Mexico

County Hudspeth (TX)

1° x 2° sheet Van Horn, Marfa

Geologic setting Down-to-southwest fault that bounds the west margin of the Quitman Mountains.

Number of sections 2
Comments: Two possible sections have been suggested by Collins and Raney (1991 #846; 1993 #852), although detailed work along the entire length of the fault has not been done. Reconnaissance fieldwork suggests north and south parts of the fault may have had different rupture histories.

Length (km) 42.1

Average strike (azimuth) 326° ± 8°

SECTION ATTRIBUTES

Section number 906a

Section name Unnamed (northern) section

Comments: Sections arbitrarily divided near mid point of concealed part of fault on west side of Quitman Mountains.

Reliability of location Good

Comments: Locations based on a 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:48,000-scale maps of Jones and Reaser (1970 #858) and Collins and Raney (1991 #846).

Sense of movement N

Comments: Not studied in detail; sense of movement inferred from topography.

Dip

Comments:

Dip direction SW

Geomorphic expression Local well-dissected scarp along this section of fault; much of fault's length is inferred or covered (Collins and Raney, 1993 #852).

Age of faulted deposits Pliocene-Pleistocene sediment. Middle-upper Pleistocene deposits are vertically displaced as much as 7 m; younger upper Pleistocene deposits appear to be unfaulted.

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: Age of youngest faulted deposits, middle-upper Pleistocene, estimated from development of calcic soils (Collins and Raney, 1993 #852). Scarps were not observed on upper Pleistocene to Holocene deposits. Reconnaissance fieldwork suggests north and south parts of the fault may have had different rupture histories (*i.e.*, segments), although detailed field work along the entire length of the fault has not been done.

Recurrence interval 20-40 k.y. (<500 ka)

Comments: Not studied in detail but Collins and Raney (1993 #852) estimated the average recurrence interval for large surface ruptures of north part of fault since middle Pleistocene may be as great as 20 to 40 k.y. Value based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka (although deposits are probably 400-500 ka on the basis of their 1- to 1.5-m thick calcic soils, which have stage IV morphology), and (c) 24 m of measured throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate is ≤0.2 mm/yr based on 24 m of throw of middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (about 130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.05-0.1 mm/yr.

Length (km) 18.7

Average strike (azimuth) 321° ± 3°

Section number 906b

Section name Unnamed (southern) section

Comments: Sections arbitrarily divided near mid point of concealed part of fault on west side of Quitman Mountains.

Reliability of location Good

Comments: Locations based on a 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:48,000-scale maps of Jones and Reaser (1970 #858) and Collins and Raney (1991 #846).

Sense of movement N

Comments: Not studied in detail; sense of movement inferred from topography.

Dip 70°–80°

Comments: Dip based on outcrops of faulted Cretaceous limestone and Pliocene-Pleistocene sediment (Collins and Raney, 1993 #852).

Dip direction SW

Geomorphic expression No distinct scarps were found along this section of the fault; much of it's length is inferred or covered (Collins and Raney, 1993 #852).

Age of faulted deposits Fault cuts Pliocene-Pleistocene deposits along part of its trace. It also has placed Pliocene-Pleistocene deposits against limestone bedrock in some areas (Jones and Reaser, 1970 #858; Henry, 1979 #959; Collins and Raney, 1991 #846) .

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)

Comments: Age of youngest faulted deposits is Pleistocene as estimated from development of calcic soils (Collins and Raney, 1993 #852). Scarps were not observed on middle Pleistocene or younger deposits. Reconnaissance fieldwork suggests north and south parts of the fault may have had different rupture histories, although detailed field work along the entire length of the fault has not been done.

Recurrence interval ND

Comments: Not studied in detail, but long recurrence interval inferred from comparison with northern section [906a], which appears more active.

Slip Rate unknown; probably <0.2 mm/yr

Comments: Low slip rate inferred from comparison with northern section [906a], which appears to be <0.2 mm/yr.

Length (km) 23.4

Average strike (azimuth) 326° ± 8°

References

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#959 Henry, C.D., 1979, Geologic setting and geochemistry of thermal water and geothermal assessment, Trans-Pecos Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Report of Investigations 96, 48 p.

#858 Jones, B.R., and Reaser, D.F., 1970, Geology of southern Quitman Mountains, Hudspeth County, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geologic Quadrangle Map 39, 24 p. pamphlet, 1 sheet, scale 1:48,000.

STRUCTURE ATTRIBUTES

Structure Number 907
Comments:

Structure Name Unnamed fault
Comments: Fault extends from about 1 km north of the Williams Ranch house in Guadalupe Mountains National Park, southeastward for about 5 km. This unnamed fault was originally mapped by King (1948 #857).

Synopsis: Range-front fault at southwestern base of Guadalupe Mountains. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 12/30/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Culberson

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on a 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,000-scale photos of King (1948 #857) and Collins and Raney (1993 #852).

Geologic setting Down-to-the-west range-bounding fault at the southwestern base of the Guadalupe Mountains; also includes two subsidiary faults that are antithetic to the main strand.

Sense of movement N
Comments: Not studied in detail although at one locality, grooves on fault plane are parallel to dip of fault plane (E.W. Collins, unpublished field notes, 1993).

Dip 74°
Comments: Dip measured from exposure of main, range-bounding fault (E.W. Collins, unpublished field notes, 1993).

Dip direction SW
Comments: (E.W. Collins, unpublished field notes, 1993).

Geomorphic expression This fault is marked by a sharp bedrock-alluvium contact that lacks a distinct scarp. Subsidiary antithetic faults have eroded scarps.

Age of faulted deposits Quaternary alluvium and Permian limestone (King, 1948 #857).

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: A conservative estimate is made here even though faulting may have occurred as recently as the late Quaternary. Detail studies to support young faulting has not been conducted.

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: A low slip rate is inferred from general knowledge of slip rate estimated for other faults in the region.

Length (km) 9.5

Average strike (azimuth) 327° ± 11°

References

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#857 King, P.B., 1948, Geology of the southern Guadalupe Mountains Texas: U.S. Geological Survey Professional Paper 215, 183 p., 1 pl., scale 1:48,000.

STRUCTURE ATTRIBUTES

Structure Number 908
Comments:

Structure Name East Flat Top Mountain fault
Comments: Named by Collins and Raney (1993 #852). Fault extends from about 1.5 km west of Salt Flat, southward to about 12 km west of Sierra Prieta.

Synopsis: This series of scarps lie at the western edge of the Salt basin. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted. Does not include northwest-trending features shown by Goetz (1977 #863), which have not been confirmed as faults.

Date of compilation 12/30/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,000-scale of Collins and Raney (1993 #852). Other maps showing fault include those of King (1965 #860), Belcher and others (1977 #875), and Goetz (1977 #863; 1980 #859).

Geologic setting Down-to-east fault that bounds the western margin of Salt Basin (King, 1965 #860; Goetz, 1977 #863; 1980 #859; Collins and Raney, 1993 #852; 1994 #853).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction E

Geomorphic expression Local distinct scarps as much as 2.5 m high on late Pleistocene or younger deposits, although much of the fault's surface trace is covered or eroded (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary (King, 1965 #860; Collins and Raney, 1993 #852). Scarp is present on deposits at least as young as late Pleistocene (Collins and Raney, 1993 #852). Does not include features north and west of Salt Flat, as shown by Goetz (1977 #863); these features are mainly cracks and fractures in young playa deposits and have not been confirmed as faults.

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: Faulted surficial sediment is unconsolidated, lacks a well-developed calcic soil horizon, and probably is late Pleistocene and/or Holocene in age (Collins and Raney, 1993 #852).

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 21.1

Average strike (azimuth) 351° ± 13°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#863 Goetz, L.K., 1977, Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, unpublished M.S. thesis, 136 p.

#859 Goetz, L.K., 1980, Quaternary faulting in Salt Basin graben, West Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and West Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 83-92.

#860 King, P.B., 1965, Geology of the Sierra Diablo region Texas: U.S. Geological Survey Professional Paper 480, 185 p., 1 pl., scale 1:62,500.

STRUCTURE ATTRIBUTES

Structure Number 909
Comments:

Structure Name North Sierra Diablo fault
Comments: Named by Collins and Raney (1993 #852). This short fault is about 30 km south-southeast of Salt Flat and extends west from Apache Canyon about 4 km.

Synopsis: Short, west-northwest-trending scarps bounding the north margin of Sierra Diablo and Salt Basin. Mapping and reconnaissance field studies of fault scarps have been conducted, but no trench investigations.

Date of compilation 12/30/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Culberson; Hudspeth

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,00-scale maps of Collins and Raney (1993 #852). Other maps of fault include those by Belcher and others (1977 #875), and Goetz (1977 #863; 1980 #859) .

Geologic setting This down-to-the-north fault bounds the north margin of the Sierra Diablo and Salt Basin. The fault possibly may be a section of the East Sierra Diablo fault [910] (Collins and Raney, 1993 #852). The North Sierra Diablo fault coincides with a part of the Babb flexure (Goetz, 1980 #859).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction N

Geomorphic expression The westward part of the fault is marked by locally distinct scarps on Quaternary alluvium; elsewhere, the fault is covered or eroded.

Age of faulted deposits Quaternary
Comments: Age of deposits from mapping of Goetz (1977 #863; 1980 #859) .

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: Based solely on presence of scarp on Quaternary alluvium (Collins and Raney, 1993 #852).

Recurrence interval ND
Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip-rate estimates for other faults in the region.

Length (km) 4.3

Average strike (azimuth) 276° ± 8°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#863 Goetz, L.K., 1977, Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, unpublished M.S. thesis, 136 p.

#859 Goetz, L.K., 1980, Quaternary faulting in Salt Basin graben, West Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and West Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 83-92.

STRUCTURE ATTRIBUTES

Structure Number 910
Comments:

Structure Name East Sierra Diablo fault
Comments: Named by King (1965 #860), but also used by Collins and Raney (1993 #852). Goetz (1977 #863) referred to northern part of the fault as Kings fault. The fault extends from northeast edge of alluvial fan of Apache Canyon, southward to area several kilometers west of ranch houses at Nutt Ranch.

Synopsis: Series of range-front en echelon scarps at the eastern base of Sierra Diablo. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 08/30/94

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from 1:24,000- to 1:65,000-scale photos and maps of Collins and Raney (1993 #852). Other maps of fault include those of King (1965 #860), Belcher and others (1977 #875), and Goetz (1977 #863; 1980 #859) .

Geologic setting Down-to-the-east fault bounding east margin of Sierra Diablo and western side of Salt basin (Collins and Raney, 1993 #852; 1994 #853) .

Sense of movement N
Comments: Not studied in detail; sense of movement inferred form topography.

Dip
Comments:

Dip direction E

Geomorphic expression Local distinct scarps; much of fault's surface expression is covered or eroded. Scarp along northern part of fault is about 1.8 m high (Collins and Raney, 1993 #852).

Age of faulted deposits Upper and middle Quaternary alluvium. No age determinations have been made to document if Holocene deposits are faulted (Collins and Raney, 1993 #852).

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)
Comments: Faulted surficial sediment includes a young, 2-m-thick alluvial fan of probable Holocene-upper Pleistocene age which is underlain by sand and gravel having a calcic soil with stage I to II morphology (Collins and Raney, 1993 #852).

Recurrence interval 80-160 k.y. (<500 ka)

Comments: Not studied in detail, but Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures along the north part of fault may be as great as 80-160 k.y. since middle Pleistocene time. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) a measured 4 m of throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is ≤0.03 mm/yr on the basis of 4 m of throw on middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.01-0.02 mm/yr.

Length (km) 32.5

Average strike (azimuth) 359° ± 22°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#863 Goetz, L.K., 1977, Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, unpublished M.S. thesis, 136 p.

#859 Goetz, L.K., 1980, Quaternary faulting in Salt Basin graben, West Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and West Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 83-92.

#860 King, P.B., 1965, Geology of the Sierra Diablo region Texas: U.S. Geological Survey Professional Paper 480, 185 p., 1 pl., scale 1:62,500.

STRUCTURE ATTRIBUTES

Structure Number 911
Comments:

Structure Name West Delaware Mountains fault zone
Comments: Named by Collins and Raney (1993 #852). Fault extends from about 14 km south of the intersection of U.S. Highway 180 and Texas Highway 54 south-southeastward to about 6 km north of Ocotillo Well.

Synopsis: This fault zone forms a series of en echelon scarps along the west margin of the Delaware Mountains. Reconnaissance studies of scarp morphology and mapping of Quaternary deposits along the western fault of this zone are the sources of data. Trench investigations have not been conducted.

Date of compilation 12/30/93

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Culberson

1° x 2° sheet Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,000-scale photos of Collins and Raney (1993 #852). Other maps of fault include those by Belcher and others (1977 #875) and Goetz (1977 #863; 1980 #859) .

Geologic setting Down-to-the-west en echelon faults that separate the west flank of the Delaware Mountains from the eastern (deepest) part of the Salt basin (Goetz, 1977 #863; 1980 #859; Collins and Raney, 1993 #852; 1994 #853).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SW

Geomorphic expression Faults of this zone form distinct scarps and a sharp bedrock-alluvium contact. The westernmost scarp is as much as 2.3 m high and has a maximum scarp-slope angle of 9°-11° (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary alluvium; one fault strand places Quaternary alluvium against Permian bedrock. The youngest faulted deposits are at least as young as late Pleistocene, but there have been no detailed studies to determine if Holocene deposits are faulted (Collins and Raney, 1993 #852).

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: Faulted deposits include sand and gravel that have calcic soils with stage I to II morphology of probable Holocene-late Pleistocene age (Collins and Raney, 1993 #852).

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 24.6

Average strike (azimuth) 326° ± 16°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#863 Goetz, L.K., 1977, Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, unpublished M.S. thesis, 136 p.

#859 Goetz, L.K., 1980, Quaternary faulting in Salt Basin graben, West Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and West Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 83-92.

STRUCTURE ATTRIBUTES

Structure Number 912
Comments:

Structure Name East Baylor Mountain-Carrizo Mountain fault
Comments: King (1965 #860) named this structure for the part of the fault that lies east of Baylor Mountain. Collins and Raney (1993 #852) proposed that it include related faults that continue southwestward along the east side of the Carrizo Mountains and thus modified the fault's name to include both mountain blocks. The fault extends along the entire southeastern flank of the Baylor Mountain, southwestward to about 1.5 km north of the Southern Pacific Railroad tracks.

Synopsis: This fault lies at the eastern base of the Baylor, Beach, and Carrizo Mountains. It is mostly covered, although three eroded scarps provide evidence of young movement along part of the fault. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 01/25/94

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Culberson

1° x 2° sheet Van Horn, Marfa

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,000-scale maps of Collins and Raney (1993 #852). Other maps of fault include those of King (1965 #860), Belcher and others (1977 #875), and Goetz (1977 #863; 1980 #859) .

Geologic setting Down-to-the-east en echelon faults that separate the southwestern flank of the Baylor Mountain and eastern flanks of the Beach and Carrizo Mountains from the Wild Horse basin (southern arm of the Salt basin) (Goetz, 1977 #863; 1980 #859; Collins and Raney, 1993 #852) .

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SE

Geomorphic expression The fault's trace is marked by subtle and eroded scarps, one of which is 1.8 m high and has a maximum scarp-slope angle of 5°. Much of fault's length is covered by Quaternary sediment (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary deposits; locally, fault is entirely within Precambrian sandstone west of the Carrizo Mountains (King, 1965 #860; Collins and Raney, 1993 #852).

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: Timing not well constrained, but fault scarps are present on middle to upper Quaternary deposits that have a 0.3- to 0.7-m thick stage IV calcrete.

Recurrence interval 125 -250 k.y. (<500 ka)

Comments: Not studied in detail, but Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 125-250 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka and (c) a measured 1.6 m of throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is <0.01 mm/yr on the basis of 1.6 m of throw for middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.003-0.006 mm/yr.

Length (km) 41.2

Average strike (azimuth) 030° ± 7°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#863 Goetz, L.K., 1977, Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, unpublished M.S. thesis, 136 p.

#859 Goetz, L.K., 1980, Quaternary faulting in Salt Basin graben, West Texas, *in* Dickerson, P.W., and Hoffer, J.M., eds., Trans-Pecos region southeastern New Mexico and West Texas: New Mexico Geological Society, 31st Field Conference, November 6-8, 1980, Guidebook, p. 83-92.

#860 King, P.B., 1965, Geology of the Sierra Diablo region Texas: U.S. Geological Survey Professional Paper 480, 185 p., 1 pl., scale 1:62,500.

STRUCTURE ATTRIBUTES

Structure Number 913
Comments:

Structure Name West Eagle Mountains-Red Hills fault
Comments: Named by Collins and Raney (1993 #852) for geographic features along the fault. Fault extends from about 20 km southeast of Sierra Blanca, southeastward to about 7 km due south of Eagle Peak.

Synopsis: Fault consists of three scarps although most of fault is covered. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. One approximately 3.7-m-deep trench has been excavated across the northern part of the fault.

Date of compilation 11/30/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Marfa, Van Horn

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000-scale maps of Collins and Raney (1993 #852). Some fault strands were mapped by Underwood (1963 #862).

Geologic setting Down-to-southwest fault that bounds the west side of the Red Hills and Eagle Mountains (Collins and Raney, 1993 #852; 1994 #853).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography and offset of deposits in trench. However, trench did not expose any indicators of slip direction along fault planes.

Dip 85°-88°
Comments: Dips based on trench exposure of Pliocene-Pleistocene sediment.

Dip direction SW

Geomorphic expression Most of the fault's surface trace has been eroded or is covered. However, there are three dissected scarps (1, 1.5, and 7 km long) along the fault. These scarps are between 1.4 and 4 m high and have maximum scarp-slope angles of as much as 4° (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary and late Tertiary. Youngest faulted deposits are middle-upper Pleistocene (Collins and Raney, 1993 #852).

Detailed studies One approximately 3.7-m-deep trench across the fault has been described by Collins and Raney (1993 #852). In the trench, the fault is expressed as a zone of disrupted sand- and gravel-sized sediment having vertically rotated pebbles and cobbles. On the upthrown fault block, poorly sorted cobble-, pebble-, and boulder-sized clasts of limestone and sandstone are capped by a 1- to 1.2-m-thick K horizon characterized by stage IV+ morphology. As much as 15 cm of pebbly sand and silt overlies the calcrete. On the downthrown fault block, there are three faulted calcic soil horizons formed in material that has a distinct grain-size contrast with the upthrown fault block.

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: The approximate age of the youngest faulted deposits was estimated from calcic soil development (Collins and Raney, 1993 #852). Middle to upper Pleistocene deposits are displaced vertically about 0.5 m, but the throw on middle Pleistocene deposits is locally as much as 2.7 m.

Recurrence interval 80-160 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 80-160 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) 2.7 m of measured throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is <0.02 mm/yr on the basis of 2.7 m of throw on middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.005-0.01 mm/yr.

Length (km) 24.1

Average strike (azimuth) 312° ± 15°

References

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#862 Underwood, J.R., Jr., 1963, Geology of Eagle Mountains and vicinity, Hudspeth County, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geologic Quadrangle Map 26, 32 p. pamphlet, 1 sheet, scale 1:48,000.

STRUCTURE ATTRIBUTES

Structure Number 914
Comments:

Structure Name Ice Cream Cone fault
Comments: Named after a nearby geomorphic feature (Collins and Raney, 1993 #852); also referred to as fault 12 by Collins and Raney (1991 #846). Fault extends from about 20 km northwest of Indian Hot Springs, southeastward to about 6 km northwest of Indian Hot Springs.

Synopsis: This down-to-southwest fault is southwest of the Quitman Mountains and parallel to the Rio Grande. The fault's trace is eroded and poorly expressed at the surface. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 11/30/94

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas

State Texas

County Hudspeth

1° x 2° sheet Marfa

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- to 1:65,000-scale maps of Collins and Raney (1991 #846; 1993 #852).

Geologic setting This down-to-southwest fault is southwest of the Quitman Mountains and east of but parallel to the Rio Grande (Collins and Raney, 1991 #846; 1993 #852).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from offset of beds.

Dip <85°
Comments: Dip measured at surface (Collins and Raney, 1993 #852).

Dip direction SW

Geomorphic expression Fault trace is eroded and poorly expressed on piedmont and terrace deposits graded to the Rio Grande; much of fault's length is covered (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary alluvium and Tertiary basin-fill deposits. Youngest faulted deposits are believed to be middle-upper Pleistocene alluvium (Collins and Raney, 1991 #846; 1993 #852).

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)
Comments: Age of youngest faulted deposits as estimated from calcic soil development (Collins and Raney, 1991 #846; 1993 #852).

Recurrence interval ND
Comments:

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle-late Pleistocene is ≤0.1 mm/yr based on 13 m of throw on middle-late Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.03-0.05 mm/yr.

Length (km) 9.6

Average strike (azimuth) 301° ± 5°

References

#846 Collins, E.W., and Raney, J.A., 1991, Tertiary and Quaternary structure and paleotectonics of the Hueco basin, trans-Pecos Texas and Chihuahua, Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geological Circular 91-2, 44 p.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

STRUCTURE ATTRIBUTES

Structure Number 915
Comments:

Structure Name West Indio Mountains fault
Comments: Named by Collins and Raney (1993 #852). The fault extends from about 10 km south-southwest of Eagle Peak, south to the Bramlett Ranch (1 km north of the International Boundary); the fault probably continues southward several kilometers or more into Mexico beneath alluvium of the Rio Grande.

Synopsis: Fault consists of a series of scarps along the western base of the Indio Mountains. Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources of data. Trench investigations have not been conducted.

Date of compilation 11/30/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas; Chihuahua (Mexico)

County Hudspeth (TX)

1° x 2° sheet Marfa

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000-scale maps of Collins and Raney (1993 #852). Some fault strands were mapped by Underwood (1963 #862).

Geologic setting Down-to-west and southwest range-front fault bounding the west side of the Indio Mountains and east side of Red Light Draw (Collins and Raney, 1993 #852; 1994 #853).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography and displacement of deposits.

Dip 70°
Comments: Dip measured in an arroyo exposure (located 6 km north of Bramlett Ranch) that exposes faulted Pliocene-Pleistocene sediment (Collins and Raney, 1993 #852).

Dip direction SW

Geomorphic expression Much of fault's surface expression has been eroded or buried. Scarp heights are commonly 1-3 m. A scarp along one fault strand has a maximum slope angle of 11°-14° (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary alluvium and upper Tertiary basin-fill deposits (Collins and Raney, 1993 #852). The youngest deposits known to be faulted deposits are upper Pleistocene.

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: Approximate age of youngest faulted deposits was estimated from development of calcic soils. Fault may have ruptured during the Holocene although detail studies to verify displacement of Holocene deposits have not been conducted (Collins and Raney, 1993 #852).

Recurrence interval 40-80 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as much as 40-80 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) approximately 9 m of throw measured on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is ≤0.1 on the basis of 9 m of throw for middle Pleistocene deposits (1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.02-0.04 mm/yr.

Length (km) 21.6

Average strike (azimuth) 332° ± 21°

References

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

#853 Collins, E.W., and Raney, J.A., 1994, Impact of late Cenozoic extension on Laramide overthrust belt and Diablo Platform margins, northwestern trans-Pecos Texas, *in* Ahlen, J., Peterson, J., and Bowsher, A.L., eds., Geologic activities in the 90s: New Mexico Bureau of Mines and Mineral Resources Bulletin 150, p. 71-81.

#862 Underwood, J.R., Jr., 1963, Geology of Eagle Mountains and vicinity, Hudspeth County, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geologic Quadrangle Map 26, 32 p. pamphlet, 1 sheet, scale 1:48,000.

STRUCTURE ATTRIBUTES

Structure Number 916
Comments:

Structure Name East Eagle Mountains fault
Comments: Named by Collins and Raney (1993 #852) for the mountain range west of fault. This short fault is about 20 km south of Allamoore and about 8 km west of the boundary between Hudspeth and Culberson counties.

Synopsis: Short fault scarp on Quaternary alluvium mapped from aerial photos. Not studied or confirmed on ground.

Date of compilation 12/01/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Hudspeth

1° x 2° sheet Marfa

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from aerial photographs and 1:24,000- and 1:48,000-scale maps of Collins and Raney (1993 #852).

Geologic setting This down-to-east fault bounds the southeast margin of the Eagle Mountains (Collins and Raney, 1993 #852).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction E

Geomorphic expression Distinct but short scarp on alluvial-fan deposits (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary alluvium. Collins and Raney (1993 #852) mention that the faulted alluvial-fan deposits are probably middle Pleistocene, although this was not confirmed because access to the fault was not available during their study. They based their interpretation on ground investigations conducted several kilometers to the north and the east-northeast where a fan with similar aerial-photograph characteristics and the distal part of a coalescent-fan piedmont both have calcretes with stage IV morphology, which suggests a probably middle Pleistocene age.

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: The scarp is on alluvial-fan deposits, but has not been studied on the ground. However, aerial photographic studies and field investigations several kilometers away suggest that the faulted deposits may be middle Pleistocene in age (Collins and Raney, 1993 #852).

Recurrence interval ND
Comments:

Slip Rate unknown; probably <0.2 mm/yr
Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 1.0

Average strike (azimuth) 349° ± 3°

References

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

STRUCTURE ATTRIBUTES

Structure Number 917
Comments:

Structure Name Unnamed fault
Comments: Fault extends from about 6 km east of Santiago Peak southeastward to about 3.5 km northeast of YE Mesa.

Synopsis: This short fault bounds the northeast side of the Santiago Mountains. Fault was first identified by W.R. Muehlberger on aerial photographs, but it has not been studied on the ground and is only briefly mentioned in the literature.

Date of compilation 10/17/95

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Brewster

1° x 2° sheet Emory Peak

Province Basin and Range

Reliability of location Good
Comments: Location based on 1:250,000-scale map compiled from 1:65,000-scale aerial photos by Collins in 1995.

Geologic setting This down-to-northeast fault bounds the northeast side of the Santiago Mountains and the southwestern part of the Marathon basin.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction NE

Geomorphic expression The fault forms a scarp on Quaternary(?) alluvial-fan deposits. The scarp was identified on aerial photographs (Muehlberger and others, 1994 #913) but it has not been studied in the field.

Age of faulted deposits Quaternary(?). Aerial photograph interpretations indicate that the faulted deposits are probably Quaternary in age, but they have not been studied in the field.

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments:

Recurrence interval ND
Comments:

Slip Rate unknown, probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 4.9

Average strike (azimuth) 295° ± 16°

References

#913 Muehlberger, W.R., Dickerson, P.W., and Stevens, J.B., 1994, Stop II—Persimmon Gap Trail, *in* Laroche, T.M., and Viveiros, J.J., eds., Structure and tectonics of the Big Bend area and southern Permian Basin, Texas: West Texas Geological Society Publication 94-95, p. 102.

STRUCTURE ATTRIBUTES

Structure Number 918
Comments:

Structure Name West Lobo Valley fault zone
Comments: Named by Collins and Raney (1993 #852) for fault's position along the west margin of Lobo Valley. Fault includes 4 sections: Fay [918a], Neal [918b], Mayfield [918c], and Sierra Vieja [918d]. The entire fault zone has also been called the Mayfield fault by Muehlberger and others (1978 #854; 1985 #911) after its proximity to Mayfield Ranch however the West Lobo Valley name is more descriptive. Northern end of fault zone is about 10 km south of Van Horn; the zone extends south-southeastward along the eastern base of the Van Horn Mountains and Sierra Vieja to a point about 18 km southwest of Valentine.

Synopsis: This long fault zone consists of a distinct series of continuous and discontinuous range-front scarps. The zone has been mapped by many, including Twiss (1959 #861), Belcher and others (1977 #875), Muehlberger and others (1978 #854), Henry and others (1985 #866), Machette and Personius (unpublished field notes made available to Collins), and Collins and Raney (1993 #852). Reconnaissance studies of scarp morphology and mapping of faulted Quaternary deposits are the sources for fault data. No trench investigations have been conducted.

Date of compilation 01/25/93

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Culberson, Jeff Davis, Presidio

1° x 2° sheet Marfa

Province Basin and Range

Geologic setting Down-to-the-east range bounding fault zone that separates the Van Horn Mountains and Sierra Vieja (on the west) from Lobo Valley (basin). Collins and Raney (1993 #852; 1994 #853) determined that the throw is greater than 11 m on middle Pleistocene deposits along the southernmost section (Sierra Vieja [918d]) of the fault zone.

Number of sections 4
Comments: Collins and Raney (1993 #852; 1994 #853) interpreted four fault sections on the basis of the fault's geometry, map pattern, and reconnaissance studies of offset data for the fault strands that compose the zone.

Length (km) 59.0

Average strike (azimuth) 338 ° ± 28°

SECTION ATTRIBUTES

Section number 918a

Section name Fay section

Comments: Named the Fay fault by Collins and Raney (1993 #852) for two scarps near Fay, an abandoned railroad siding. This short part of the fault zone is about 10 km south of Van Horn and is west of and en echelon to the Neal section [918b].

Reliability of location Good

Comments: Location based on 1:250,000-scale map compiled from field mapping using aerial photographs and 1:24,000-scale topographic maps (Collins and Raney, 1993 #852).

Sense of movement N

Comments: Not studied in detail; sense of movement inferred from scarp topography.

Dip

Comments:

Dip direction E

Geomorphic expression Two short en echelon scarps. The northernmost scarp is 1.4 m high and has a maximum scarp-slope angle of 13° (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary alluvium. Middle Pleistocene alluvial-fan deposits are offset vertically 1.2 m (Collins and Raney, 1993 #852). It has not been determined if upper Pleistocene and/or Holocene deposits are faulted.

Detailed studies

Timing of most recent paleoevent (3) middle and late Quaternary (<750 ka)

Comments: Approximate age of known youngest faulted deposits estimated from development of calcic soils (Collins and Raney, 1993 #852). It has not been determined if upper Pleistocene and Holocene deposits are faulted or unfaulted.

Recurrence interval 125-250 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 125-250 k.y. These values are based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) approximately 1.2 m of throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is ≤0.01 mm/yr on the basis of 1.2 m of throw on middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.003-0.005 mm/yr.

Length (km) 3.6

Average strike (azimuth) 338 ° ± 28°

Section number 918b

Section name Neal section

Comments: Named the Neal fault by Twiss (1959 #861). Section extends from the Southern Pacific Railroad crossing at U.S. Highway 90 southwestward to the concave-to-the-east bend in the Van Horn Mountains. The Neal section is en echelon to the Fay [918a] and Mayfield [918c] sections.

Reliability of location Good

Comments: Location based on 1:250,000-scale map compiled from results of aerial photograph and field mapping using 1:24,000-scale aerial photographs and topographic maps (Collins and Raney, 1993 #852). This fault has also been mapped by Twiss (1959 #861), Belcher and others (1977 #875), Muehlberger and others (1978 #854), Henry and others (1985 #866), and Machette and Personius (unpublished data made available to Collins).

Sense of movement N

Comments: Not studied in detail; sense of movement inferred from topography.

Dip

Comments: Probably high angle as determined from analogy with other Quaternary faults in area.

Dip direction E; SE

Geomorphic expression North part of fault section consists of several short en echelon scarps having heights of about 2.2 m and maximum scarp-slope angles as steep as 8°. The main continuous fault at the base of the Van Horn Mountains has a very distinct scarp with maximum slope angles ranging between 14° and 22° and heights ranging between 1.6 and 4.8 m. On the upthrown block, bedrock is shallow and locally exposed at the surface (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary. Middle Pleistocene alluvium is offset at least 5 m vertically. Alluvium of possible upper Pleistocene to Holocene age is offset vertically at least 1 m (Collins and Raney, 1993 #852).

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: Approximate age of youngest known faulted deposits was estimated from calcic soil development (Collins and Raney, 1993 #852). Upper Pleistocene to Holocene(?) deposits, which have a stage II calcic soil, are vertically offset 1 m. Some young (Holocene) arroyo terraces are unfaulted, although more work is needed to determine fault cross-cutting relationships of older Holocene deposits.

Recurrence interval 60-125 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 60-125 k.y. This recurrence interval is based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) approximately 5 m of measured throw on middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene time is ≤0.04 mm/yr on the basis of 5 m of throw on middle Pleistocene deposits (Collins and Raney, 1993 #852). Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.01-0.02 mm/yr.

Length (km) 18.3

Average strike (azimuth) 013° ± 10°

Section number 918c

Section name Mayfield section

Comments: Named the Mayfield fault by Twiss (1959 #861). Fault section extends from concave (to the east) part of Van Horn Mountains (about 8 km southwest of Lobo) southeastward to a point about 20 km northwest of Valentine. At its northern end, the Mayfield section is en echelon to the Neal section [918b]. At the southern end of the Mayfield section, the boundary with the Sierra Vieja section [918d] is a bedrock salient.

Reliability of location Good

Comments: Location based on 1:250,000-scale map compiled from reconnaissance and field mapping using 1:24,000-scale aerial photographs and topographic maps (Collins and Raney, 1993 #852). This fault has also been mapped by Twiss (1959 #861), Belcher and others (1977 #875), Muehlberger and others (1978 #854), Henry and others (1985 #866), and Machette and Personius (unpublished notes made available to Collins).

Sense of movement N

Comments: At one locality, striations preserved in bedrock along the fault surface are parallel to the fault's dip. This observation, coupled with dip and basin topography, suggests that the sense of movement has been normal (Collins and Raney, 1993 #852).

Dip 70°-80°

Comments: Striations preserved on bedrock along the fault plane are parallel to the fault's dip, implying pure dip-slip movement (Collins and Raney, 1993 #852).

Dip direction NE

Geomorphic expression Most of the fault's trace is expressed as a relatively continuous single-slope-angle scarp with maximum angles between 18° and 23° and heights between 4 m and 7 m. Bedrock is shallow and locally at the surface on the upthrown fault block.

Age of faulted deposits Quaternary. Middle Pleistocene deposits are offset vertically as much as 6 m (Collins and Raney, 1993 #852). Relationships between post middle Pleistocene deposits and the fault have not been determined.

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: The approximate age of the youngest known faulted deposits was estimated from calcic soil development (Collins and Raney, 1993 #852). Middle Pleistocene deposits having a stage IV calcic soil are offset, whereas some young (Holocene) terraces are unfaulted. The amount of offset of middle Pleistocene deposits (6 m) suggests several middle Pleistocene or younger paleoevents. More work is needed to determine if upper Pleistocene and Holocene deposits are faulted. Machette and Personius (unpublished notes made available to Collins) reported that the most recent surface ruptures occurred in the late Pleistocene to possibly early Holocene on the basis of their morphometric analyses.

Recurrence interval 50-100 k.y. (<500 ka)

Comments: Not studied in detail. Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 50-100 k.y. Their recurrence interval is based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka, and (c) approximately 7.5 m of measured (cumulative) throw on middle Pleistocene deposits, which are cut by two closely spaced, subparallel strands of the fault.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is approximately ≤0.05 mm/yr (Collins and Raney, 1993 #852) based 7.5 m of throw on middle Pleistocene deposits. Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.02-0.03 mm/yr.

Length (km) 20.0

Average strike (azimuth) 310° ± 14°

Section number 918d

Section name Sierra Vieja section

Comments: Named the Sierra Vieja fault by Collins and Raney (1993 #852) for en echelon series of fault strands along the eastern base of the Sierra Vieja. The section's north boundary with the Mayfield section [918c] is marked by a series of low bedrock hills that lie basinward of the Sierra Vieja, about 20 km northwest of Valentine. The Sierra Vieja section extends southward to an area about 15 km southwest of Valentine and includes one basinward strand.

Reliability of location Good

Comments: Location based on 1:250,000-scale map compiled from field mapping using 1:24,000-scale aerial photographs and topographic maps (Collins and Raney, 1993 #852). This fault has also been mapped by Twiss (1959 #861), Belcher and others (1977 #875), Muehlberger and others (1978 #854), Henry and others (1985 #866), and Machette and Personius (unpublished notes made available to Collins).

Sense of movement N

Comments: Not studied in detail; sense of movement inferred from topography.

Dip

Comments:

Dip direction E

Geomorphic expression Multiple en echelon fault strands are expressed by single and compound (multiple-event) scarps. E.W. Collins and J.A. Raney measured scarp heights of 2-14.5 m. Some compound scarps are as much as 14.5 m high and have young appearing elements that are between 2 and 3.5 m high and as steep as 20°. The less steep parts of the compound scarps have scarp-slope angles that are between 6° and 11°. Muehlberger and others (1978 #854) also measured compound scarps over 7 m high and M.N. Machette and S.F. Personius (unpublished notes made available to Collins) reported scarps as high as 6 m and scarp-slope angles of as much as 23°. These morphometric analyses suggest multiple faulting events during the late Quaternary.

Age of faulted deposits Quaternary. Approximate age of youngest known faulted deposits was estimated from calcic soil development (Collins and Raney, 1993 #852). Upper Pleistocene to Holocene(?) deposits are offset 3.5 m vertically. Some young (Holocene) terraces are unfaulted although more work is needed to determine if older Holocene deposits are offset.

Detailed studies

Timing of most recent paleoevent (2) late Quaternary (<130 ka)

Comments: Vertical offset of possible middle Pleistocene deposits is as great as 8-11 m and deposits of possible upper Pleistocene-Holocene(?) age are offset as much as 3.5 m. The latest surface rupture may have produced about 1-2 m of vertical displacement if the steeper element of compound scarps was caused by a single rupture (Collins and Raney, 1993 #852). It is likely that at least two surface ruptures have displaced upper Pleistocene deposits; the youngest event may offset early(?) Holocene deposits.

Recurrence interval 35-70 k.y. (<500 ka)

Comments: Collins and Raney (1993 #852) estimated that the average recurrence interval for large surface ruptures since middle Pleistocene may be as great as 35-70 k.y. Their recurrence interval is based on (a) their estimate of the number of large-displacement (1- to 2-m) surface ruptures since middle Pleistocene time, (b) the assumption that faulted middle Pleistocene deposits are approximately 250-500 ka and (c) approximately 8-11 m of measured throw for middle Pleistocene deposits.

Slip Rate (D) <0.2 mm/yr

Comments: Average slip rate since middle Pleistocene is approximately ≤0.1 mm/yr (Collins and Raney, 1993 #852) based on 8-11 m of throw on middle Pleistocene deposits. Youngest middle Pleistocene time (130 ka) was used to estimate average slip rate. If one uses 250-500 ka for the age of the deposits, the average slip rate could be as low as 0.02-0.04 mm/yr.

Length (km) 22.0

Average strike (azimuth) 346° ± 22°

References

#875 Belcher, R.C., Goetz, L.K., and Muehlberger, W.R., 1977, Map B—Fault scarps within Quaternary units in West Texas, *in* Goetz, L.K., ed., Quaternary faulting in Salt Basin graben, West Texas: The University of Texas at Austin, M.S. thesis, 1 pl., scale 1:500,000.

#852 Collins, E.W., and Raney, J.A., 1993, Late Cenozoic faults of the region surrounding the Eagle Flat study area, northwestern trans-Pecos Texas: Technical report to Texas Low-Level Radioactive Waste Disposal Authority, under Contract IAC(92-93)-0910, 74 p.

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STRUCTURE ATTRIBUTES

Structure Number 919
Comments:

Structure Name West Wylie Mountains fault
Comments: Named by Hay-Roe (1957 #867) for the fault that flanks the western side of the Wylie Mountains. Fault is about 6 km west-southwest of Van Horn and extends southeastward along the Wylie Mountains and western edge of Canning Ridge to a point about 9 km east-southeast of Lobo.

Synopsis: West of Canning Ridge, a scarp on Quaternary deposits at the southern part of the fault has been confirmed on aerial photographs and by fly-over identification. Field studies of the scarp have not been conducted to characterize its age.

Date of compilation 01/25/93

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Culberson

1° x 2° sheet Marfa; Van Horn

Province Basin and Range

Reliability of location Good
Comments: Identified on 1:24,000- to 1:65,000-scale photos by Collins and Raney (1993 #852) and compiled on 1:250,000-scale base map. Fault also was mapped by Hay-Roe (1957 #867).

Geologic setting This down-to-the-west range-front fault separates the northeast Lobo Valley from the Wylie Mountains and Canning Ridge. Little is known about the amount of Quaternary offset or time of most recent movement on the fault.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SW; W

Geomorphic expression A distinct scarp on Quaternary alluvial-fan deposits is preserved west of Canning Ridge (Collins and Raney, 1993 #852).

Age of faulted deposits Quaternary. Fault also cuts older basin-fill (Tertiary) and bedrock deposits (Hay-Roe, 1957 #867; Collins and Raney, 1993 #852).

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: Not studied in detail. Aerial photographic interpretations and reconnaissance field studies of accessible areas west of the scarp indicate that faulted deposits are probably middle Pleistocene or older (Collins and Raney, 1993 #852).

Recurrence interval ND
Comments:

Slip Rate unknown; probably <0.2 mm/yr
Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 19.0

Average strike (azimuth) 328° ± 13°

References

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#867 Hay-Roe, H., 1957, Geology of Wylie Mountains and vicinity, Culberson and Jeff Davis Counties, Texas: The University of Texas at Austin, [Texas] Bureau of Economic Geology Geologic Quadrangle Map 21, , scale 1:63,360.

STRUCTURE ATTRIBUTES

Structure Number 920
Comments:

Structure Name Unnamed fault
Comments: This fault is located about 8 km southeast of Candelaria.

Synopsis: This fault was shown on a regional map by Henry and others (1985 #866). It has been investigated with aerial photographs and Henry (unpublished data) noted approximately 20-m-high scarps during a reconnaissance field visit to the fault area.

Date of compilation 01/31/94

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Presidio

1° x 2° sheet Marfa

Province Basin and Range

Reliability of location Good
Comments: Identified on 1:24,000-scale photos by Collins in 1994 and compiled on 1:250,000-scale base map. Also mapped on 1:24,000-scale photos and shown on regional 1:500,000-scale map by Henry and others (1985 #866).

Geologic setting Down-to-the-west fault at the northeastern margin of the Presidio basin, a Neogene basin that may be part of the southern Rio Grande rift (Henry and others, 1985 #866).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction W

Geomorphic expression Scarp on Quaternary alluvium and Tertiary sedimentary deposits (Henry and others, 1985 #866).

Age of faulted deposits Quaternary

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: Not studied in detail. Aerial photograph interpretations and reconnaissance field studies in accessible areas west of the scarp indicate that faulted deposits are probably middle Pleistocene or older (Collins and Raney, unpublished data). However, until further investigations are conducted, the fault is considered to be Quaternary.

Recurrence interval ND
Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 3.3

Average strike (azimuth) 350° ± 6°

References

#866 Henry, C.D., Gluck, J.K., and Bockoven, N.T., 1985, Tectonic map of the Basin and Range province of Texas and adjacent Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Miscellaneous Map 36, 1 sheet, scale 1:500,000.

STRUCTURE ATTRIBUTES

Structure Number 921
Comments:

Structure Name Unnamed fault
Comments: Fault extends from about 3 km east of Ruidosa, southeastward to about 15 km southeast of Ruidosa.

Synopsis: This fault was shown on a regional map by Henry and others (1985 #866). To date, it has only been investigated on aerial photographs.

Date of compilation 01/31/94

Compiler and affiliation E.W. Collins, Bureau Economic Geology, The University of Texas at Austin

State Texas

County Presidio

1° x 2° sheet Presidio

Province Basin and Range

Reliability of location Good

Comments: Identified on 1:24,000-scale photos by E.W. Collins in 1994 and compiled on 1:250,000-scale base map. Also mapped on 1:24,000-scale photos and shown on regional 1:500,000-scale map by Henry and others (1985 #866).

Geologic setting Down-to-the-west fault within the Presidio Basin, a Neogene basin that may be part of the southern Rio Grande rift (Henry and others, 1985 #866).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SW

Geomorphic expression Scarp on Quaternary piedmont-slope deposits. The scarp was identified on aerial photographs and has not been studied in the field.

Age of faulted deposits Quaternary. Results of reconnaissance field studies by E.W. Collins and J.A. Raney a few kilometers to the west and north of the fault indicate that the fault probably cuts upper to middle Pleistocene deposits.

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: Not studied in detail. Aerial photographic interpretations and reconnaissance field studies in accessible areas west of the scarp indicate that the faulted deposits are probably no older than middle Pleistocene (Collins and Raney, unpublished data). However, until further investigations are conducted, the fault is considered to be Quaternary.

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 13.6

Average strike (azimuth) 339° ± 10°

References

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STRUCTURE ATTRIBUTES

Structure Number 922
Comments:

Structure Name Unnamed fault
Comments: North part of fault is about 12 km southeast of Ruidosa. Fault extends southeastward to a point about 18 km southeast of Ruidosa.

Synopsis: This fault was shown on a regional map by Henry and others (1985 #866). To date, it has only been investigated by aerial photographic studies.

Date of compilation 01/31/94

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Presidio

1° x 2° sheet Presidio

Province Basin and Range

Reliability of location Good
Comments: Identified on 1:24,000-scale photos by E.W. Collins in 1994 and compiled on 1:250,000-scale base map. Mapped on 1:24,000-scale photos and shown on regional 1:500,000-scale map by Henry and others (1985 #866).

Geologic setting Down-to-the west fault within the Presidio Basin, a Neogene basin that may be part of the southern Rio Grande rift (Henry and others, 1985 #866).

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography.

Dip
Comments:

Dip direction SW

Geomorphic expression Fault is marked by two closely spaced scarps on Quaternary piedmont-slope deposits. The scarps were identified on aerial photographs and have not been studied in the field. Results of aerial photograph study by E.W. Collins suggests that the easternmost scarp is higher than the western scarp.

Age of faulted deposits Quaternary. Results of reconnaissance field studies by E.W. Collins and J.A. Raney a few kilometers west of the fault indicate that the fault probably cuts deposits at least as young as upper to middle Pleistocene.

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)

Comments: Not studied in detail. Interpretations of aerial photographs and reconnaissance field studies in accessible areas west of the scarp indicate that the faulted deposits are probably no older than middle Pleistocene (Collins and Raney, unpublished data). However, until further investigations are conducted, the fault is considered to be Quaternary.

Recurrence interval ND

Comments:

Slip Rate unknown; probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 7.9

Average strike (azimuth) 328° ± 15°

References

#866 Henry, C.D., Gluck, J.K., and Bockoven, N.T., 1985, Tectonic map of the Basin and Range province of Texas and adjacent Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Miscellaneous Map 36, 1 sheet, scale 1:500,000.

STRUCTURE ATTRIBUTES

Structure Number 923
Comments:

Structure Name Dugout Wells fault
Comments: Named by Stevens (1994 #914). Fault extends from about 2.5 km northeast of Panther Junction to about 0.75 km east of Dugout Wells, Big Bend National Park.

Synopsis: Fault is on western side of the Tornillo Graben. Stevens (1994 #914) briefly described the faulted deposits as being Quaternary in age and recognized a low scarp. Detailed observations and measurements of scarp morphology have not been made, nor has the fault been confirmed by field studies.

Date of compilation 10/17/95

Compiler and affiliation E.W. Collins, Bureau of Economic Geology, The University of Texas at Austin

State Texas

County Brewster

1° x 2° sheet Emory Peak

Province Basin and Range

Reliability of location Poor
Comments: Location based on 1:250,000-scale map compiled from 1:65,000-scale aerial photographs by E.W. Collins in 1995 and brief description of Stevens (1994 #914) and P.W. Dickerson (oral commun., 1995).

Geologic setting This down-to-northeast fault is on the western side of the Tornillo Graben. It may be the same fault that Henry and others (1985 #866) mapped, although they did not find evidence of Quaternary surface rupture.

Sense of movement N
Comments: Not studied in detail; sense of movement inferred from topography. Some Cenozoic faults in the Big Bend region exhibit oblique and horizontal slip, thus detailed investigations of the Dugout Wells fault are required to determine the actual sense of movement.

Dip
Comments:

Dip direction NE

Geomorphic expression Stevens (1994 #914) recognized a low scarp but did not report its heights or slope angles.

Age of faulted deposits Quaternary. Stevens (1994 #914) reported Quaternary deposits as faulted but did not describe the fault or faulted deposits in detail.

Detailed studies

Timing of most recent paleoevent (4) Quaternary (<1.6 Ma)
Comments: Based on Stevens (1994 #914).

Recurrence interval ND

Comments:

Slip Rate unknown, probably <0.2 mm/yr

Comments: Inferred low slip rate based on general knowledge of slip rate estimates for other faults in the region.

Length (km) 3.3

Average strike (azimuth) 343° ± 5°

References

#866 Henry, C.D., Gluck, J.K., and Bockoven, N.T., 1985, Tectonic map of the Basin and Range province of Texas and adjacent Mexico: The University of Texas at Austin, [Texas] Bureau of Economic Geology Miscellaneous Map 36, 1 sheet, scale 1:500,000.

#914 Stevens, J.B., 1994, Stop 8—Dugout Wells, *in* Laroche, T.M., and Viveiros, J.J., eds., Structure and tectonics of the Big Bend area and southern Permian Basin, Texas: West Texas Geological Society Publication 94-95, p. 87.

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Appendix A

Definition of Fault-Database Terms

Specialized fields (shown in bold letters) provide abstracted data, most of which will be in searchable fields when the digital database is released. In addition to the searchable fields, more detailed information is provided in the following "Comments" section. The following description provides definitions of fields (in alphabetic order) and indicates where various information, if known, can be found. In-text citations of references are in a traditional format with the exception of a reference-specific number at the end, in lieu of the traditional alpha character following the publication year. All fault numbers cited in the text are bounded by brackets, [ ], to differentiate them from reference numbers.

Age of faulted surficial deposits This field includes the ages of faulted deposits *at the surface*. In general, this data is from geologic mapping, but in a few cases it may be from descriptions in referenced work. An estimate of the length of the fault (in percent) that is within a particular age of deposit is included when possible. In some cases, the age of faulted deposits may not be in agreement with the timing of the most recent paleoevent. This inconsistency may arise because of the manner in which particular studies are given preferable citation based on recency and scope of the study.

Average strike The length-weighted average strike of the trace of the structure in azimuthal degrees followed by one standard deviation of the strike. The standard deviation is given to provide a general impression of the sinuosity of the mapped structure. The azimuthal values are confined to the northwest and northeast quadrants of the compass (i.e., 0°-90° and 271°-359°).

Compiler and affiliation The name and affiliation of the person(s) primarily responsible for compilation or update of data presented for the structure. Full names and address of these compilers follow in Appendix B.

County If the structure is in more than one county, we list the county in which the majority of the structure is located, followed by county name(s) for the remainder of the structure.

Date of compilation This field lists the date that the data were compiled for this project in a format reflecting month/day/year.

Detailed studies This field includes a synopsis of detailed site-specific studies, typically trenching. Study sites are numbered sequentially from north to south or west to east in the format of fault number, 601; segment, C or section letter, c; and site number , 3 (*e.g.* 601C-3). Paleoseismic data from these studies appear in appropriate fields that document recurrence interval, slip rate, and timing of most recent paleoevent. Sites where only morphologic studies were conducted are not included.

Dip Measured dip or range of dip values and dip direction. In many cases, these data are near-surface dip measurements at specific locations that are digitized for latitude and longitude. Additional data include approximate location and the type of material in which the fault is exposed are included in "Comments".

Dip direction General dip direction of the structure defined by compass quadrants: north (N), west (W), south (S), east (E), northwest (NW), northeast (NE), southwest (SW), southeast (SE).

Geologic setting This statement provides a generalized perspective of the fault in terms of its regional geologic setting, amounts of total offset, and general age of offset strata.

Geomorphic expression General description of the structure's geomorphic expression including the presence or absence of fault scarps, offset streams, monoclines, shutter ridges, associated landslides, etc.

Length This field specifies the end-to-end length of the Quaternary-age fault as measured from 1:250,000-scale maps.

Name (Structure name, Segment name, or Section name) The earliest referenced name for a structure, fault segment or fault section (where appropriate) generally is given preference, except in cases where there is a more commonly accepted name used in the recent literature. "Comments" also contains other names and references in which they are used, the geographic limits of the structure, north to south or west to east, as shown in this compilation; various geographic limits that are different in other studies are also included. Minor changes in original name may have been made for reasons of clarity or consistency (such as segment to section) where appropriate.

Number

Structure number The structure (fault or fold) is assigned a number within the predetermined limits for the region. References to the same structure shown in other compilations are included in "Comments".

Segment number An upper-case alpha character is assigned to the northernmost or westernmost segment of a fault (*e.g.*, fault 305 has three segments: 305A, 305B, 305C).

Section number A lower-case alpha character is assigned to the northernmost or westernmost section of a fault (*e.g.*, fault 207 has three sections: 207a, 207b, 207c).

Number of sections (only used for faults with sections) Numeric value for number of sections (*e.g.*, 4) defined in studies that do not meet the minimum requirements for segments established for this compilation. "Comments" include reference in which sections are discussed; if the term "segment" is used in the literature, an explanation of why "section" is used in the database is provided.

Number of segments (only used for faults with segments) Number of distinct seismogenic segments defined by minimum criteria for considering a fault as segmented. These include: (1) trenching on all segments, (2) trenching on a sufficient number of segments accompanied with clear morphologic age differences where trenching has not been done, or (3) historical surface faulting that ruptured only a part of fault that has one of the previously mentioned criteria. Even though many authors have used the word "segment" in their discussions, we have restricted its use to those faults that are well studied in a paleoseismologic sense. In cases where more than one model for segmentation has been presented in the literature, the "preferred" model is based on recency and completeness of study; a brief discussion of other models is included in "Comments".

1° x 2° sheet If the structure is in more than one quadrangle (1° x 2° sheet), the quadrangle in which the majority of the structure is located is listed first, followed by quadrangle name(s) for the remainder of the structure.

Province Field contains physiographic province names defined by Fenneman and Johnson (1946 #461). All of the faults in West Texas are in the Basin and Range province; no province name is shown for the Amargosa fault [905] because Fenneman and Johnson (1946 #461) did not extend his boundaries into Mexico.

Recurrence interval Time interval in yr (based on historic data, calendric, or calibrated radiocarbon dates), in ^{14}C yr (based on uncalibrated radiocarbon dates), in k.y. (based on less precise dating, stratigraphy, or geomorphology), or not determined (ND). Also included is the time interval (in parenthesis) for which this recurrence interval is valid. Alternative published recurrence intervals, starting with that which applies to the most recent time interval, are included in "Comments."

References Complete bibliography of all cited references is provided for each structure.

Reliability of location Reliability of location (Good or Poor) is related to the scale of the source map from which the trace of the structure and to the method by which the trace of the structure was mapped. To qualify for a "Good" location, the trace of the structure must have been published on a topographic base map at a scale of 1:250,000 or more detailed and accurately located on original map using photogrammetry or similar methods, or the trace of the structure was published on a topographic base map at a scale of 1:100,000 or more detailed, but transferred without photogrammetric methods. Less than above standards (less detailed scale, planimetric base, transfer by inspection, etc.) constitute a "Poor" location. Judgments of reliability may not directly relate to map symbols (solid, dashed, dotted) that are used; however, all concealed or inferred faults are considered poorly located.

Section name (see Name)

Section number (see Number)

Segment name (see Name)

Segment number (see Number)

Sense of movement Includes thrust (T), less than 45°; reverse (R), greater than 45°; dextral, right lateral (D); sinistral, left lateral (S); or normal (N). For oblique slip, principle sense of movement is followed by secondary sense (*i.e.*, DT). Ratios of the slip components are included, where known, in order to better characterize sense of movement (*i.e.*, DT 3:1).

Slip rate The primary field shows one of four slip-rate categories defined for this compilation: <0.2 mm/yr, 0.2 to less than 1 mm/yr, 1-5 mm/yr, >5 mm/yr. "Unknown" precedes the slip-rate category if no known published slip rate exists. "Comments" include a synopsis of published slip rates and pertinent documentation.

State If the structure is in more than one State, the State in which the majority of the structure is located is listed first, followed by State name(s) for the remainder of the structure.

Structure name (see Name)

Structure number (see Number)

Synopsis This field provides a short summary that describes the level of study, and provides a snapshot of the scope of data that follows in the database.

Timing of most recent paleoevent (faulting or folding event) The primary field shows one of the four prehistoric age categories: Holocene and post glacial (<15 ka), late Quaternary (<130 ka), middle and late Quaternary (<750 ka), or Quaternary (<1.6 Ma). This field only documents prehistoric surface faulting. If there is historical surface faulting or folding, it will be documented under "Historical Surface Faulting". No faults in West Texas and adjacent Mexico have had historic surface faulting.